Post Graduate Degree Programme (CBCS) in Geography

Semester – II

Paper Code: GEO/CC/T-207

Paper: Population and Settlement Geography

University of Kalyani

Kalyani

Nadia – 741235

West Bengal

Course Materials Compiled by:	
Dr. Ayan Rudra Directorate of Open and Distance Learning University of Kalyani, West Bengal	**Group – GEO/CC/T-207: Population and Settlement Geography**

July 2022

Published by the Directorate of Open and Distance Learning,

University of Kalyani, Kalyani -741235, West Bengal.

Disclaimer: This self-learning material is based on different books, journals and web-sources.

Director's Message

Satisfying the varied needs of distance learners, overcoming the obstacle of distance and reaching the unreached students are the threefold functions catered by Open and Distance Learning (ODL) systems. The onus lies on writers, editors, production professionals and other personnel involved in the process to overcome the challenges inherent to curriculum design and production of relevant Self Learning Materials (SLMs). At the University of Kalyani a dedicated team under the able guidance of the Hon'ble Vice-Chancellor has invested its best efforts, professionally and in keeping with the demands of Post Graduate CBCS Programmes in Distance Mode to devise a self-sufficient curriculum for each course offered by the Directorate of Open and Distance Learning (DODL), University of Kalyani.

Development of printed SLMs for students admitted to the DODL within a limited time to cater to the academic requirements of the Course as per standards set by Distance Education Bureau of the University Grants Commission, New Delhi, India under Open and Distance Mode UGC Regulations, 2020 had been our endeavour. We are happy to have achieved our goal.

Utmost care and precision have been ensured in the development of the SLMs, making them useful to the learners, besides avoiding errors as far as practicable. Further suggestions from the stakeholders in this would be welcome.

During the production-process of the SLMs, the team continuously received positive stimulations and feedback from Professor (Dr.) Manas Kumar Sanyal, Hon'ble Vice- Chancellor, University of Kalyani, who kindly accorded directions, encouragements and suggestions, offered constructive criticism to develop it within proper requirements. We gracefully, acknowledge his inspiration and guidance.

Sincere gratitude is due to the respective chairpersons as well as each and every member of PGBOS (DODL), University of Kalyani. Heartfelt thanks is also due to the Course Writers-faculty members at the DODL, subject-experts serving at University Post Graduate departments and also to the authors and academicians whose academic contributions have enriched the SLMs. We humbly acknowledge their valuable academic contributions. I would especially like to convey gratitude to all other University dignitaries and personnel involved either at the conceptual or operational level of the DODL of University of Kalyani.

Their persistent and co-ordinated efforts have resulted in the compilation of comprehensive, learner-friendly, flexible texts that meet the curriculum requirements of the Post Graduate Programme through Distance Mode.

All the Self Learning Materials are self-writing and collected from e-book, journals and websites.

Director
Directorate of Open and Distance Learning
University of Kalyani

Syllabus

Paper –GEO/CC/T-207: (Total Credit - 4, Total Marks – 50)

GEO/CC/T-207: Population and Settlement Geography
(Marks - 50: Internal Evaluation – 10, Semester-end Examination - 40)

Unit. 01	Changing scope and approaches to Population Geography; Population Geography as distinct from Demography
Unit. 02	Sources of population data
Unit. 03	Theories of population growth: Malthusian, Marxian, Neo-Malthusian
Unit. 04	Factors controlling fertility, mortality and migration
Unit. 05	Demographic Transition Model; Stable Population Growth and Equilibrium Population
Unit. 06	Population policies – Pro and Anti Natal, Comparative study of population policies between India and China
Unit. 07	Concept of Ekistics; Study on settlement hierarchies
Unit. 08	Theories and models of settlement study: Central Place Theory, Rank-size Rule and concept of Primacy
Unit. 09	Census categories of settlements in India; Rural-urban dichotomy and interaction
Unit. 10	Types, pattern and segregation of rural settlements in India
Unit. 11	Urbanization in India as multi-dimensional process; Urban Renewal in Indian context
Unit. 12	Megalopolis and Ecumenopolis; Urban Green Space

Contents Page No

**PAPER – GEO/CC/T-207: (TOTAL CREDIT - 4, TOTAL MARKS – 50) **

GROUP – GEO/CC/T-207: POPULATION AND SETTLEMENT GEOGRAPHY
(MARKS - 50: INTERNAL EVALUATION – 10, SEMESTER-END EXAMINATION - 40)

1.1 INTRODUCTION

We all have some ideas and experiences about the growing population, and sometimes we analyze, or discuss among ourselves, various issues related to it, like rising numbers, crowding, and congestion. We also try to analyse various consequences arising from overpopulation. Some of the major consequences are unemployment, poverty, lack of basic amenities, like housing and drinking water. Therefore, we can say that population and development have a very close relationship. There is a cause and effect relationship, i.e., development can affect population, and vice versa (Gould, 2009). Human beings are at the centre of the concerns for any developmental activities. This is because people are the most important and valuable resource of any nation. Consequently, the right to development must be fulfilled so as to equitably meet the population and development needs of present and future generations. In this unit, we will analyse the complexities that exist between population and development (https://egyankosh.ac.in/bitstream/123456789/48850/1/Block-1.pdf).

In the expression 'population geography', the term 'population' signifies the subject matter and 'geography' refers to the perspective of investigation. Population geography implies the investigation into human covering of the earth and its various facets with reference to physical and cultural environment. Although population geography is, in the early 21st century, a well-established subfield of human geography, this was not always the case. Population Geography is the geographic organization of population and how and why this matter to society. This often involves describing where population are found, how the size and composition of this population is regulated by the demographic processes of fertility, mortality and migration and what these patterns of population mean for economic development, ecological change and social issues. For example, sub urbanization in the developed global north has been linked back to the migration decisions of many families who have central cities and re – allocate on the urban fringe ((https://www.coursehero.com/file/98763385/BACAAN-TAMBAHAN-1-POPULATION-GEOGRAPHY-NATURE-and-SCOPEpdf/)).

1.2 LEARNING OBJECTIVES

After reading this self-learning material, the learners will be able

- To know the scopes and contents of Population Geography, sources of population data and how Population Geography makes it distinct from Demography.
- They will also be informed about the theories of population growth and be able to evaluate those theories at space-time scale.
- It will help them to explain the factors of population growth – fertility, mortality and migration.

- Learners will be able to know the different kinds of population policies rising from India and from China in a comparative mode.
- Conceptualize ekistics and settlement,
- Analyse the theories and models of settlement, Interpret the rank-size rule,
- Analyse the concept of primate city
- Know the central place theory
- Describe the different types and patterns of settlements & Define an Indian settlement to be urban
- Conceptualize different terms related to urban geography, such as million cities, mega cities, megalopolis, ecumenopolis & urban renewal (www.dodl.klyuniv.ac.in).

1.3 ASSESSMENT OF PRIOR KNOWLEDGE

To assess students' prior knowledge, they may be asked

- What are differences between population geography and demography?
- What are the principal components of population of an area?
- Why do population increase in a region? d) Why do population decrease in a region?
- What are the causes of population change in an area?
- What do they mean by fertility, fecundity, mortality and morbidity?
- What is a settlement?
- How settlements are formed?
- Why do we need to study settlement geography?
- Have you found any noticeable difference between town and village?

1.4 LEARNING ACTIVITIES

During the Personal Contact Programmes, students may be assigned to prepare project on India's population growth since the Independence. They may also be requested to prepare charts and thematic maps on different issues such as female-male ratio, migration trend, occupational characteristics, literacy, rural-urban differentials etc. based on recent census data at state level of India. Projects may also be assigned on district level demographic analysis of the state of West Bengal using District Level Facility and household Survey. For their successful learning programme, they may be assigned to prepare the thematic map of degree of urbanisation of West Bengal and of India based on latest census data. They can also be assigned to bring out different types and patterns of settlement from topographical sheets.

1.5 FEEDBACK OF LEARNING ACTIVITIES

Feedback of learning activities may be obtained through question-answering, project, group discussion, quiz on settlement geography etc & also class seminar on various topics may be arranged

1.6 EXAMPLES AND ILLUSTRATIONS

UNIT – 1

CHANGING SCOPE AND APPROACHES TO POPULATION GEOGRAPHY; POPULATION GEOGRAPHY AS DISTINCT FROM DEMOGRAPHY

INTRODUCTION

As a branch of human geography and a subset of population studies, population geography studies the ways in which spatial variations in the distribution, composition, characteristics and increase of populations are related to the nature of places. Population geography as a scientific field, engages in spatial and temporal discourses of the patterns and processes of variations in population distribution in any defined territory. As a result, the population geographer is concerned with several questions such as; what is the pattern of population of any area? What are the processes that lead to the observed pattern of population distribution? What are the relationships/linkages between the population of any place and the environmental conditions of the area? Subsequently, common concepts studied in population geography are population size, growth, density, distribution and composition. Others include migration, fertility, mortality, ethnicity, aging etc (https://www.coursehero.com/file/55358992/AS6546887477903371533101369525-content-1pdf/).

Definition of Population Geography

G. T. Trewartha, a U.S. Geographer, is known as the father of population geography. He has defined population geography in the context of the nature of geography. Trewartha stressed that 'population geography is concerned with the understanding of regional differences in the earth's covering of people.'

According to Wilbur Zelinsky, 'the sciences deals with how the geographic character of a, it's distribution and the changes taking place over some time. places are formed by and, in turn, reacts upon a set of population phenomena that vary within it through both space and time interacting one with another, and with numerous non-demographic phenomena.'

John I. Clarke, who is credited with bringing out the first textbook on the sub-discipline in 1965 suggested that population geography is mainly concerned with demonstrating how spatial variation in population and its various attributes like composition, migration and growth are related to the spatial variation in the nature of places (https://shikshabhumi.blogspot.com/2020/05/what-is-population-geography-nature-and.html).

Nature of Population Geography

1. Population Geography is a modern branch of Human Geography which has its roots in the mother regulation called the demography.

2 Population Geography tries to study population in the spatial context and seeks answers to areal differentiation patterns of population.

3. Population geography employs a lot of quantitative methods to predict population growth, computes lot of statistical operations like Crude Death Rate.

4. It is an empirical branch of Human geography which tries to study the problems based on some collected facts. It heavily depends on organization like census, NSS,CSO etc.

5. Population Geography tries to study the population behaviours by some spatially designed tools like age sex pyramid, Applies population growth models to different parts of the world and tries to form the pattern of the study.

6. Population geography tries to study the population dynamics like past and present trends in growth and its spatial manifestations (https://shikshabhumi.blogspot.com/2020/05/what-is-population-geography-nature-and.html).

SCOPE OF POPULATION GEOGRAPHY

Population geography is a separation of human geography. It is the study of the ways in which spatial variations in the distribution, composition, migration, and growth of populations are related to the nature of places. It focuses on the characteristics of population distributions that change in a spatial context. Population geography receives significant primary data from demography, which reveals the geographic aspects of natural and migration population change. Population geography also uses field teams for observation and investigation. It studies the physical forms of inhabitancy (types of residences according to spatial differences, the nature of planning and engineering for populated points, and so on), because all of these features are reflected in the regional characteristics of the physical makeup of cities and countryside settlements (https://ids-water.com/2019/05/02/what-is-scope-of-settlement-geography/).

The scope of population geography is quite wide. Population geography helps to understand the various facts about the spatial variation in the distribution of human population across the world concerning the physical, cultural, and socio-economic environment. It also helps in the planning for human development.

• Meaning of scope: - The meaning of scope is related to the three questions -

1. Where it is applied
2. How its knowledge is applied
3. The opportunity

Edward Ackerman indicates that the first set of problems in population geography involves the identification of generic relations, which includes the categorization, classification, and differentiation procedures. The next level of inquiry involves the establishment of genetic relationships or dynamic aspects (processes) of spatial distributions in which the secular variable is highly significant. The last step is the determination of co-variant relations, i.e. the search for understanding the space relations of spatial processes, which are expressed in terms of areal association and interaction between and among phenomena.

The main field of population geography is the areal differentiation which is help full for solving the problem of static relationships between variables. Population study by geographers should

lead to a improved understanding of the processes creating areal distribution as expressed in the concepts inherent in, and by the study of spatial interaction over time.

• According to G. T. Trewartha- The scope of population geography can be delineated as follows: -

1. Distribution of population
2. Density of populations
3. Migration (Movement of people across space)
4. Growth of population
5. Composition of population
6. Literacy and quality of the population

Population geography studies systems and structures—the forms of settlement in relation to the spatial nature of production, the characteristics of the geographical environment, the economic-geographical condition of population employment, and population migrations. Together with differences in the natural growth of population, migrations determine the course of territorial redistribution of population. A prominent place is given to the classification and typology of populated points. Therefore it is necessary to know about of the scope of population geography, there are (https://shikshabhumi.blogspot.com/2020/05/what-is-population-geography-nature-and.html):-

1. To search the trend of population growth
2. Effects of population upon natural resources
3. The role of population on environmental pollution
4. Analysis the role of population to eliminate food crisis.

POPULATION GEOGRAPHY VS DEMOGRAPHY

There is a difference between population geography and demography though both, population geography and demography are concerned with human population and its enlargement over the time. Both these can be regarded as sub-study fields of Sociology. Demography is the statistical study of the human population. Demography studies the growth of population and the size, structure and distribution of this growing population. Population geography is the study of the division of humans over geographical factors. This area is interested in studying the population growth patterns related to natural living places. However, both study fields focus on human population and its growth, in different dimensions.

What is Demography?

Demography is the study of the human population through examining the statistics over the time. The term “Demos” in Greek implies the meaning “the people” and “Grapho” means “description or measurement”. Both these words have joined together to form the word “Demography.” This study area focuses on factors like human birth, death, aging and migration and it studies the changing patterns of these factors. After collecting data for a year or two, we can analyse the patterns and variations of population growth over a specific period.

Demographic analyses can be applied to all the societies and, most commonly, the demographic data are collected annually. These demographic analyses not only show the population growth, but they also show the economic, social, cultural and biological processes behind population growth. Demography incorporates the criteria like nationality, education, religion and ethnicity, etc. in its data analysis. Some of the most common ratios of demography are crude birth rate, fertility rate, crude death rate, stationary population, net migration, etc. Demographic analyses are very important to a country in order to identify the population growth patterns (https://www.differencebetween.com/difference-between-population-geography-and-vs-demography/).

What is the Difference between Population Geography and Demography?

When we consider about both terms, it is clear that there are some similarities as well as differences in both. When we think of similarities, the main thing is that both these subject fields can be considered as subfields of Sociology, but they have developed to be separate fields in modern world context. Both subject areas are interested in human population growth and distribution. Also, both these subject fields incorporate similar criteria in their analyses.When we believe of the differences, we see that demography is more concerned with population growth, whereas population geography is more concerned in the distribution of the human population.

It is considered that "demographic analysis is confined to a study of the components of population variation and change", whereas "population studies are concerned not only with population variables but also with the relationships between inhabitants changes and other variables social, economic, political, biological, genetic, geographical and the like."

The term "demography" may be used in a narrow sense, as synonymous with "demographic analysis" or formal demography", which is "primarily concerned with quantitative relations among demographic phenomena in abstraction from their association with other phenomena." Demography may also be conceived in a broad sense to include, in addition to the quantitative study of population, the study of interrelationships between population and socioeconomic, cultural and other variables. Many population scholars do not approve of creating such an artificial distinction between demography and population studies. According to Lorimer, "a demographer limited to the merely formal treatment of changes in fertility, mortality, and mobility would be in a position like that of a 'formal chemist' observing the compression of mercury with no information about associated changes in temperature or the constitution of the fluid. The concept of 'pure demography' except as the carcass of science is therefore an illusion." Any meaningful study of population, therefore, has to be interdisciplinary (https://www.differencebetween.com/difference-between-population-geography-and-vs-demography/).

UNIT – 2

SOURCES OF POPULATION DATA

INTRODUCTION

Critical decisions for a nation, organization, or family are made based on population data. Population data contains various influential details such as birth, death, demographic information such as age, sex, annual income, occupation, language, etc. The overall socio-economic, economic, political, cultural development of a country is dependent on population data to a large amount (https://www.questionpro.com/blog/population-data/).

Answers to questions such as "How many of us are there in the country?", "On what basis are we divided?" "Do we possess enough food, land, and other such resources?" are obtained by evaluating population data. Demographers use demographic data taken from various sources to analyze population. A demographer is an expert in the study of statistics relating to the changing structure of human populations. It is well known that the three main sources of demographic and social statistics are censuses, surveys and administrative records. These three data sources are the major means of collecting basic demographic and social statistics as part of an integrated program of statistical data collection and compilation. Together they provide a comprehensive source of statistical information for policy formulation, development planning, administrative purposes, research and for commercial and other uses. While these three sources are complementary, many countries use a combination or all three methods for various reasons. Normally, countries select one of these sources to obtain statistics based on the needs of the respective data users; reliability and timeliness of the results; and practicality and cost-effectiveness of the method. In many countries, however, a particular method is used due to constitutional requirements.

Characteristics of Population Data

The amount of people in the population is not all that can be known about these. There are also data such as (https://www.questionpro.com/blog/population-data/):

Age: The age of a population can tell us a lot about what that population is doing and what it is going to do in the future.

Location: Finding out where people live is one of the main reasons why various countries conduct their census. Many government programs also base their funds on demographic patterns. The location data also inform us about the progress of people.

Socio-economic Data: They help us know the type of concentrations of people in some urban regions or the high concentrations of people with cancer near certain industrial zones.

Race: The demographic study of the breed is very controversial. Scientifically, there are no different "races" of human beings. The difference between Asians and blacks is the same as the difference between people with brown eyes and blue eyes. However, the thought of race continues to play an essential role in our societies. Many of us identify ourselves as part of a certain race for cultural reasons.

The below-mentioned resources are the most used for human population data classification: -

CENSUS DATA

Census is the basic data of population. Census is taken to generate data on demography, socio-economic status of residents of the country. Census taking was reported since biblical times and survival of such systems in India, Egypt, Babylonia, Palestine and Rome was reported in ancient times. Existence of such systems in those days was meant for taxation, selecting eligible persons for military or forced work. In third century, Kautilya in 'Arthashashtra', mentioned the collection of data on populations to be used for taxation purpose. In Aini-i-Akbari, an administrative report of Emperor Akbar in 16th century, described data on population, wealth and industry. Greeks conducting census at the time of food shortage; preparation of inventory of land and population in England during 1085-86; census of residents of Nuremberg, Germany in 1449; attempts of census in 15th and 16th century in Switzerland; and enumeration of population in the provinces of France in 1715 were reported in history (https://www.questionpro.com/blog/population-data/).

Characteristics of Census

Individual enumeration: Each citizen is enumerated only once and his/her characteristics such as age, sex, education, marital status and occupation are separately documented (https://www.questionpro.com/blog/population-data/).

Universality within a defined territory: Census covers entire country and all its residents only once. If this is not achieved due to some reasons such as war or non-cooperation, the coverage done should be reported. Methods of data collection include 1.dejure (counting individuals as per original place of dwelling) and 2. defacto (counting of persons as per the residence at the time of census).

Simultaneity: Census should be completed on day of census which refers up to the midnight of the day. Some categories of data refers to for example residence (preceding 5 years), labour force (preceding day) and income (preceding year) of the census.

Periodicity: Census is taken fixed regular time interval. For example, in India every 10 years data collection has been done.

Applications of Census Data

1) Useful for administrative purposes, socio-economic planning and investigate.

2) To know the trends in the growth of population, demographic changes (age, sex, fertility, mortality, urbanization, migration, composition of occupations, and followers of different religions, industries, languages spoken and understood), literacy levels, instructive status, standard of living and availability of amenities in the population.

3) Census data can be used as the basis for conducting other surveys.

4) Using census data, birth and death rates can be calculated, life tables are constructed and economic development can be evaluated.

5) Census data may be used for predicting future population growth, growth of cities, demographic changes (age, sex, need of manpower (doctors, police, military and paramedical staff etc.,), amenities and public infrastructure (transportation, safe drinking, hospitals, police stations, street lights and electricity connection, internet broadband facilities etc.,) and number of voters (https://www.questionpro.com/blog/population-data/).

Problems/ Challenges in Census taking

Increasing costs
Intrusiveness, privacy concerns, and response burden
Lower public cooperation and participation
Difficulties in accessing
More complex living arrangements
Timelines
Corruption
Insufficient number of professionals with the knowledge and experience of conducting census

CIVIL REGISTRATION SYSTEM

Civil Registration is the process government uses to record the vital events such as birth, death, marriage, and/or divorce that are required by the laws and regulations of the country. The primary purpose of civil registration is to establish the legal documents required by law. The goal of civil registration is to record all vital events that occur in a country as they occur. The United Nations defines civil registration as “the continuous, permanent, compulsory and universal recording of the occurrence and characteristics of vital events pertaining to the population as provided through decree or guideline in accordance with the legal requirement

in each country."1-1 The civil registration system includes all of the processes and procedures involved in the recording, maintenance and storage of vital events as required by law (WHO, 2010).

Characteristics of Civil Registration Systems

As a reminder, the United Nations defines civil registration as "the continuous, permanent, compulsory and universal recording of the occurrence and characteristics of vital events pertaining to the population as provided through decree or guideline in accordance with the legal requirement in each country." Thus, the primary purpose of civil registration is to establish the legal documents required by the laws and regulations of the country. The goal of civil registration is to record all vital events required by law, such as births, deaths, marriages, divorces, etc., that occur in a country as they occur (WHO, 2010).

Legal Framework: - The legal framework for the civil registration system should contain all of the requirements for civil registration in a nation. Ideally, the laws and regulations should require that records of all vital events occurring in the country be recorded. In addition to specifying which vital events are to be reported, the laws should include the time period in which they must be reported and who is responsible for reporting each type of vital event. The law should also specify which organization or government agency is authorized to register the vital events. Some civil registration laws contain a requirement for tabulation and/or publication of vital statistics, although not all countries have this in their law. In order to enforce the requirements of civil registration, the law should also contain some penalties on authorities or officials who fail to comply with the law. A good civil registration rule provides the fundamental structure for the efficient administration of a country's civil registration system.

Full Coverage of the Population: - In an ideal situation, the civil registration system should provide full coverage of the population of the entire country. That is, all vital events as specified in the civil registration law should be reported for the entire geographic area of the country. However, this may not be possible in all countries due to economic or cultural conditions. In some countries, only certain provinces, states or cities have legal requirements for full coverage reporting of all vital events. In other countries, just some vital events may have requirements for full reporting. Generally if all vital events cannot be registered in a country, emphasis is given to reporting of births and deaths since these are most often needed for legal purposes and also provide the basic information for public health analyses.

Continuous and Permanent: - As stated in the United Nations definition, civil registration is continuous and permanent. This means that new records of vital events must be continually added to the system, preferably as the events occur. In addition, records of all vital events must be maintained in a secure and permanent way so they will be available when needed for administrative or individual purposes in the future. Methods and procedures must be established by the government agency responsible for civil registration to ensure that current records are added to the civil registration system in an appropriate manner and that all records of vital events are preserved and maintained for future use.

Confidentiality of Personal Information: - Many civil registration laws also provide for confidentiality of personal information collected on individuals by limiting release of

information from vital records. Often detailed information on vital records could be sensitive, potentially embarrassing, or very personal. For example, birth records may contain information on legitimacy of the child or information about the mother's pregnancy, or death records may have a cause of death that could be embarrassing to the family of the deceased. Many believe that restricting release of information on vital records will help to improve reporting of vital events and increase accuracy and completeness of items collected on the records. Ideally safeguards should be available to protect the confidentiality of individual information from vital records. However, in some countries information from vital records is not restricted, and some or all vital records are open to public inspection.

Applications of Civil Registration System

1) Birth certificate is required for school admissions and death certificate for disbursement of pensions to the dependents and for conversion of properties to the regal heirs.
2) To know fertility levels and late births using data such as registration, date of birth, sex, place of birth, order of live births, and type of attention at delivery
3) Sex-wise data is used to calculate sex ratio and to allocate resources for promotion of female child birth/education/health; to know social and cultural factors influencing preference for particular sex and to stop female foeticide.
4) Place of birth can be used to know available facilities whereas order of births for evaluating fertility level, status of women, type of health care available and the coverage of family planning programmes of the Government.
5) Type of attention at deliveries can indicate the facilities available for pre and postnatal care; characteristics of parents on the brought up of the child; date of death registration on the time lag in registration; cause of death on type of disease, success or breakdown of surgeries and lack of sanitation; type of medical attention on attempts of doctors in saving the deceased; and characteristics of deceased on socio-economic and demographic differences in the mortality rates (egyankosh.ac.in).

SAMPLE REGISTRATION SYSTEM (SRS)

The SRS was conceived during the 1960s, as an interim measure to generate vital statistics until fully fledged development of the CRS. The primary objective of the system is to provide reliable annual estimates of vital rates for the states and the country on the basis of a probability sample (RGI, 1971).Pilot studies were taken up in various states from 1964, onwards. By the middle of 1971, the system had established throughout India. The SRS is based on a system of dual recording of births and deaths in fairly representative sample units spread all over the country. Sampling design, registration and validation methodology of the SRS has been published (RGI, 1972; RGI 1993). The sampling frame is revised every ten years and old sample clusters are replaced by new ones. Replacement of existing sample clusters with newly identified clusters usually takes place gradually over a period of 2-3 years. Recently, after the 2001 Census, the RGI has replaced old clusters with new ones in one go. The sample size of SRS has also increased over time (http://www.ihs.org.in/IHS-html-11-06-10/IHS-html-08-06-10/html/PMahapatra-SRSInIndiaAnOverview.pdf).

Overall quality and usefulness of the Indian SRS

The Assessment framework for vital statistics developed by the Monitoring of Vital Events writing group of the Health Metrics Network (HMN) in the World Health Organization (WHO) includes many aspects affecting usefulness of vital statistics, in addition to completeness of registration. I examine characteristics of the Indian SRS along these dimensions, based on available data and my personal experience in accessing and using the SRS.
Accuracy: - Coverage, completeness and incidence of missing data are three key contributors to accuracy of estimates produced by any statistical system. Although, the SRS covers about 0.6% of India's population, itsrepresentative character allows for estimation of vital statistics for the country and major states.Completeness of registration of events has been, by and large, around 90% or more upto 1980s. Interstate differences also narrowed down by mid 1980s. However, completeness appears to have worsened during the 1990s and after. Interstate differences in completeness appear to have widened also. The annual reports describe system of gathering and reporting of data. But no specific information is reported about missing data. It is generally believed that missing data in SRS is rare. However, it will be useful to start documentation of missing data elements, such as age, sex of vital events. The annual reports should include a table showing the number of births and deaths for which age or sex information was not available, and how the events were treated through the tabulation process. In case there is no missing data, the report should make a positive mention of the fact (http://www.ihs.org.in/IHS-html-11-06-10/IHS-html-08-06-10/html/PMahapatra-SRSInIndiaAnOverview.pdf).
Relevance: - Routine tabulations by the SRS are adequate (See table-3). Population composition and age specific death rates are available in five year age groups. Distribution of live births, by mothers' age, birth –order and -interval, are provided in a consistent format over the years. However, the SRS cannot provide small area statistics at the district and sub-district level. State level estimates are available only for major states. Recently, SRS sample size has been increased to allow for IMR estimates by NSSO normal divisions, which are usually a group of districts within a state. But the sample size will have to increase enormously, if district level estimates are to be produced
Comparability: - Definition of terms, administrative guidelines and data collection methods of the SRS are consistent overtime, allowing for comparability of over time. Similarly, uniform definition of terms, administrative guidelines and data collection methods across the country, makes the SRS statistics comparable across space.
Timeliness: - Timeliness has two important sub-dimensions, namely, (a) promptness (production time), and (b) regularity. The SRS Annual Reports do not show their publication date, to allow for direct computation of production time. However, publication date can be inferred from the date shown in the preface written by the Registrar General, India for each report. The actual publication date would be later than this date. For example; preface of 1999 report is dated Jan 2002. The report was published in 2003 as can be inferred from the printing date shown on the back cover. Thus the actual production time would be more than what is estimated here, at least by about six months. The median production time from inception of SRStill production of latest annual report (2007) is about 2½ years. The production time was

6½ years in the1970s, 2½ years during 1980s, 2 years during 1990s and about 22 months for the years 2000 - 07.

The SRS brings out a half yearly bulletin which is published in April and October, usually within about six to nine months. For example, as of Jan 2010, the latest SRS Bulletin available at the RGI website is for October, 2009. The bulletins contain selected collective vital statistics such as infant mortality, birth and death rates by rural, urban area but no disaggregation by age or sex. However, sometimes, scheduled issues of the bulletin may not be released at al. For example; no bulletin is listed at the RGI website for October 2005, and April, 2007-09.

Accessibility: - Accessibility of SRS reports can be characterized by its performance in terms of (a) the media of publication, (b) availability of metadata, and (c) the quality of user service. Annual reports are available in print form only. The half yearly bulletins are available in print as well as portable document format (pdf) files through the Internet since April 1999. But SRS data sets are not released, although the RGI has made significant progress in other areas of its operation, for example, release of census data sets through Rom. The annual reports could also be released in pdf file format over the internet.

NATIONAL SAMPLE SURVEYS (NSS)

The Agency responsible for NSS is National Sample Survey Organization (NSSO) which was established in 1950. This organization collects information on socio-economic aspects of India and its citizens. NSSO was brought under the guidance of governing council in 1970. NSSO consists of non-official chairman, headed by Director General and Chief Executive officer and members drawn from academia, officers of Central and State Governments and Ministry of Statistics and Programme Implementation. NSSO conduct surveys mainly on enterprise, village facilities, households and land and livestock holdings besides these surveys, defined surveys (special surveys and open round surveys once, unorganized surveys, unorganized manufacturing, social spending on health and education, urban frame surveys and consumer expenditure, employment and unemployment (twice) over a period of ten years. Till now NSSO conducted 76th rounds of surveys and brought 586 reports on various subjects (egyankosh.ac.in).

Importance of NSS

The data provided by NSS serves an important tool for Indian economy.At independence and much after, the country was faced with a subsistence production structure (mainly in agriculture) characterized by mass poverty and hunger. Systematic data on the extent, magnitude, and patterns of poverty, as well as on household consumption patterns and trends, were not readily available for informed policy interventions. To remedy this, the GOI launched the NSS to gather nationally representative information on household structure, consumption, and production (https://www.encyclopedia.com/social-sciences/applied-and-social-sciences-magazines/national-sample-survey-india).

Weakness of NSS data

1. The NSS has sometimes changed its data collection methodology midstream, and this has affected the comparability of NSS estimates over time. This was particularly the case in the fifty-fifth round, when the NSS adopted a different reporting period for certain types of consumption expenditures, rendering consumption and poverty estimates from that survey non-comparable to those from earlier periods.
2. Another weakness of the data is that, unlike some other national socioeconomic surveys (notably the National Socio-Economic Household Survey, or SUSENAS, of Indonesia), there is no fixed rotation schedule for the special-interest modules that are attached to the core consumption-employment module of the NSS. As a result, it is difficult to obtain nationally representative data on important topics such as health and education on a regular, ongoing basis. For instance, the NSS included a health-care module in the fifty-second round conducted in 1995–1996, but this was not repeated until the sixtieth round in 2004. Likewise, the topic of rural assets and indebtedness was covered in the forty-eighth round in 1992 and only revisited in 2003 in the fifty-ninth round. It would be helpful if a regularrotation schedule were established whereby important topics such as health,schooling, and assets could be covered every three or four years (https://www.encyclopedia.com/social-sciences/applied-and-social-sciences-magazines/national-sample-survey-india).

NATIONAL FAMILY HEALTH SURVEY (NFHS)

The National Family Health Survey (NFHS) is a large-scale, multi-round survey conducted in a representative sample of households throughout India. Three rounds of the survey have been conducted since the first survey in 1992-93. The survey provides state and national information for India on fertility, infant and child mortality, the practice of family planning, maternal and child health, reproductive health, nutrition, anemia, utilization and quality of health and family planning services. Each successive round of the NFHS has had two specific goals: a) to provide essential data on health and family welfare needed by the Ministry of Health and Family Welfare and other agencies for policy and programme purposes, and b) to provide information on important emerging health and family welfare issues. The Ministry of Health and Family Welfare (MOHFW), Government of India, designated the International Institute for Population Sciences (IIPS) Mumbai, as the nodal agency, responsible for providing coordination and technical guidance for the survey. IIPS collaborated with a number of Field Organizations (FO) for survey implementation. Each FO was responsible for conducting survey activities in one or more states covered by the NFHS (rchiips.org).

Technical assistance for the NFHS was provided mainly by ICF (USA) and other organizations on specific issues. The funding for different rounds of NFHS has been provided by USAID, DFID, the Bill and Melinda Gates Foundation, UNICEF, UNFPA, and MOHFW, GOI.

Details	**NFHS-1**	**NFHS-2**	**NFHS-3**	**NFHS-4**

Period	*1992-93*	*1998-99*	*2005-2006*	*2015-2016*
Age group	13-49	15-49	Women:15-49 Men:15-54	Women :15-49 and Men:15-54
Sample size/ unit	89,777 ever married women of 24 States and National Capital Territory of Delhi	89,199 ever married women of 25 States	124,385 never + ever married women and 74,369 men, 29 States	699,686 women and112,122 men of 29 States
Information collected	Fertility, family planning, mortality, maternal and child Health	NFHS-1 information + reproductive health, women's autonomy, domestic violence, nutrition, anaemia and salt iodization	NFHS-2 information + HIV-related knowledge, nutrition, health, and health care perinatal mortality, male involvement in maternal health care, adolescent reproductive health, higher-risk sexual behaviour, family life education, safe injections, and knowledge about tuberculosis and seroprevalence of HIV	NFHS-3 information+ malaria prevention, migration, water, sanitation, health insurance, information of deaths, children's immunization, contraception, fertility preferences, prevalence of malnutrition, hypertension, high blood glucose

Source: http://rchiips.org/nfhs/index.shtml

Applications of National Family Health Surveys

1) NFHS provide data on health and family welfare

2) NFHS data can be used to investigate the progress of health sector and efficacy of current health programmes.

ANNUAL HEALTH SURVEYS (AHS)

For monitoring and evaluation of National Rural Health Mission (NRHM) of Government of India, annual health surveys were started. AHS are brought under the control of NRHM, Ministry of Health and Family Welfare, Government of India. The mandate of AHS is to report information on vital health indicators such prevalence of injuries, disabilities, acute and chronic illnesses and access to the family planning/maternal and child health care services, infant mortality rate, maternal mortality rate and total fertility rate at the District level annually.

Two hundred eighty four districts of nine States (Bihar, Rajasthan, Assam, Jharkhand, Uttarakhand, Madhya Pradesh, Odisha, Uttar Pradesh and Chhattisgarh) were brought under the coverage of AHS. A total of 20,694 sampling units were selected within 284 districts of nine States. These units include census enumeration blocks in urban areas, villages or part of the villages in rural areas. Staff of the Registrar General of India (RGI), identify the sample units, draw boundaries, limit the localities and prepare a map of sampling units. In each district, 73 sampling units, 71000 population and 14.5 thousand households were included in AHS. The field work is carried out by outsourcing agencies and they are guided by the staff of RGI. In AHS, district-wise data is generated annually (Lutz et, al. 2019).

Applications of Annual Health Surveys

1) These surveys provide data on demographic, characteristics of population and health aspects at National, State and District level.

2) These surveys are useful for planning, policy making, implementation and assessment of current programmes of State and Central Government.

DISTRICT LEVEL HOUSEHOLD SURVEYS (DLHS) (REPRODUCTIVE AND CHILD HEALTH)

In order to monitor and evaluate Reproductive and Child Health programme launched during 1996-97, the need of database at district level was felt by Government of India. For this, District Level Household Survey (DLHS) was under taken first in 1998-99 in 504 districts and again in 2002-04 in 593 districts. The International Institute for Population Sciences was designated as the nodal agency for carrying out the surveys. For the purpose of conducting the survey, all the states and union territories were grouped into 16 regions. A total of twelve research organizations including Population Research Centre (PRCs) were involved in conducting the survey in 16 regions. The fieldwork for RCH Round - II was done in two phases. The survey for Phase-I of the DLHS covering 295 districts of the India was covered from March 2002 to December 2002, except in some districts of Bihar and Jharkhand where the fieldwork got extended to 2003. The survey for Phase-II covering the remaining 298 districts of the country carried out from January 2004 to October 2004, except in some districts of Bihar and Jharkhand where the fieldwork continued also in 2005. The focus of the survey was on: i) Coverage on

ante natal care (ANC) and immunization services, ii) Extent of safe deliveries, iii) Contraceptive prevalence rate and unmet need for family planning, iv) Awareness about RTI/STI and HIV/AIDS and v) Utilization of government health services and users' satisfaction (nipccd.nic.in).

Details	**DLHS-1**	**DLHS-2**	**DLHS-3**	**DLHS-4**
Period	*1998-89*	*2002-2004*	*2007-2008*	*2012-2013*
Age group	Women:15- 44 Men:20-54	Women:15- 44 Men: 20-54	Ever married women:15-49 Unmarried men:15-24	Women: 15-49
Sample size/ unit	474,463 currently married women and 198,586 men of 25 States and five Union Territories.	5,07,622 currently married women and 3,30,820 men of 25 States	Used multi stage stratified probability proportion to size sampling design. 643944ever married and166260 unmarried women of all districts of country	45690 ever married women of 26 States
Information collected	Antenatal cover, Child immunization, awareness on reproductive tract infections/ sexually transmitted infections (STI) and HIV/AIDS, unmet need of family planning and utilization Government run health care facilities.	DLHS-1 information + Extent of safe deliveries and prevalence of contraception and user's satisfaction.	DLHS-2 information + Estimates on maternal and Child health, number of marriages and deaths in the household, fertility preferences. For unmarried women awareness on reproductive health and STI. Manpower,	DLHS-3 information+ Manpower, facilities and services in community health centres, district hospitals and subdivisional hospitals. Clinical, anthropometric and biochemical tests were introduced.

			facilities and services in Primary, sub centres and community Health centres.	

Source: http://rchiips.org/PRCH-1.html

POPULATION REGISTERS

In the Scandinavian countries and some other European countries like the Netherlands, Belgium and Finland the local registration bureaus maintain registers in which details about each individual are continuously recorded. These registers are known as population registers and they provide a comprehensive account of the changes that take place in the population. In this system, a separate card for each individual is maintained from the time of his/her birth (or immigration) to his/her death (or emigration).

Sweden is said to be the first country to have started this system in the seventeenth century In India, it is known as National Population Register (NPR). It is a Register of usual residents of the country. It is being prepared at the local (Village/sub-Town), sub-District, District, State and National level under provisions of the Citizenship Act 1955 and the Citizenship (Registration of Citizens and issue of National Identity Cards) Rules, 2003. It is mandatory for every usual resident of India to register in the NPR. A usual resident is defined for the purposes of NPR as a person who has resided in a local area for the past 6 months or more or a person who intends to reside in that area for the next 6 months or more (https://www.yourarticlelibrary.com/population-geography/5-major-sources-of-collecting-population-data/43086/).

INTERNATIONAL PUBLICATIONS

The United Nations and its various organs, along with other international agencies such as the World Bank, publish population data for the world as a whole and for different countries separately at regular interval. The most important of them is the Demographic Year Book, published by the UN.

It provides data on such wide ranging topics as population size, area, density, urban population, population growth, age-sex composition, number of births and birth rate, number of deaths and death rate etc. Sometimes, the volume is devoted to special topics, which include fertility, mortality, marriage, divorce, migration, and population census statistics.

The special volume includes detailed statistics regarding a particular topic. Besides, the UN also publishes the Population and Vital Statistics Report quarterly which includes latest data on total population, total mid-year population and estimate of population for a recent reference year (Srinivasan, 1998:56). Information on vital events includes total number of births, deaths, infant deaths, crude birth rates and crude death rates.

The United Nations Development Programme (UNDP) also publishes data on various social, economic and demographic aspects for the world and for different countries in its annual Human Development Report. Other international publications on world population data

include Production Year Book of FAO, Year Book of Labor Statistics of ILO, Statistical Year Book of UNESCO, and World Health Statistics Annual of WHO. While the FAO publication provides information on agricultural population, the publication of ILO gives detailed data on the economically active population.

Similarly, the UNESCO publication provides data on education, literacy and school attendance for different countries of the world. The monthly periodical of WHO presents data on public health and mortality for different countries of the world. Apart from the above sources, the World Bank also publishes data on various demographic, social and economic aspects in its annual World Development Report (https://portal.abuad.edu.ng/lecturer/documents/1586464460DEMOGRAPHIC_STATISTICS.doc).

UNIT – 3

THEORIES OF POPULATION GROWTH: MALTHUSIAN, MARXIAN, NEO-MALTHUSIAN

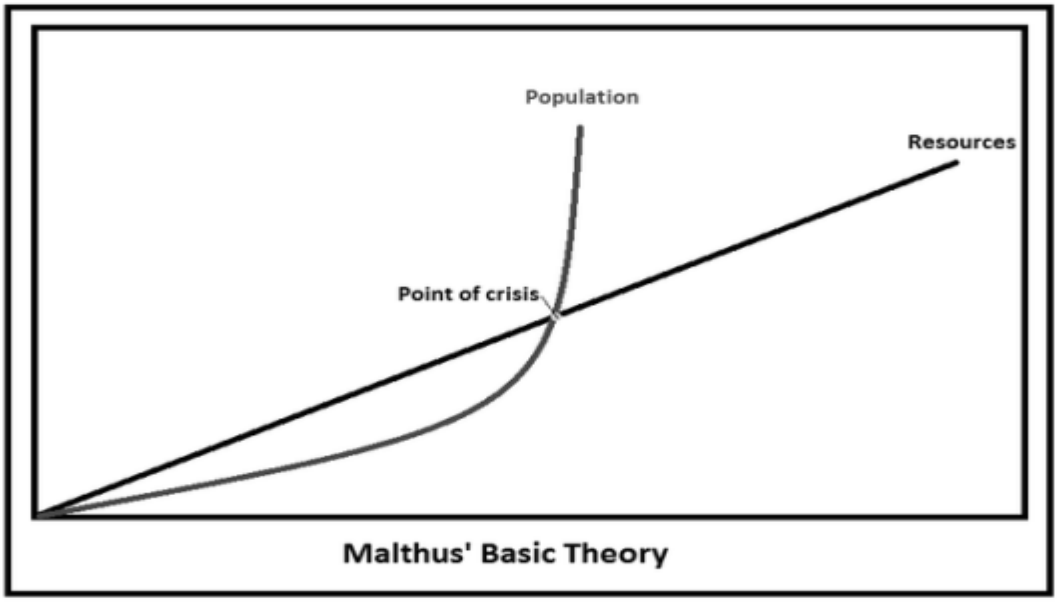
INTRODUCTION

Population growth is the rise in the number of individuals in a population that reside in a state, country or city. Identifying underlying causes for population growth helps to make better predictions about future changes in population rising and growth rates. Population growth appears today as the major factor determining underdevelopment and population control is advocated as the most urgent and necessary step if development is to be eventually achieved. Theorizing about population size and change has remained an important discipline since long back. Many of the philosophers from history like Confucius (China), Kautilya (India) and modern thinkers like Adam Smith, David Richard etc. have made significant contribution on population rising, where there was no consensus. Following were the population theories proposed by various scholars and philosophers (epgp.inflibnet.ac.in).

MALTHUSIAN THEORY OF POPULATION GROWTH

Thomas Robert Malthus (1766-1834 was the first economist to propose a systematic theory of population. He articulated his views regarding population in his famous book, Essay on the Principle of Population (1798), for which he collected empirical data to support his theory. His expression on population was a landmark in the history of population theories, where he generalized the relationship among population factors and social change. Malthus proposes the principle that human populations grow exponentially (i.e., doubling with each cycle) while food production grows at an arithmetic rate (i.e. by the repeated addition of a uniform increment in each uniform interval of time) in Essay on the Principle of Population. Thus, while food output was likely to increase in a series of twenty-five year intervals in the arithmetic progression 1, 2, 3, 4, 5, 6, 7, 8, 9, and so on, population was capable of increasing in the geometric progression 1, 2, 4, 8, 16, 32, 64, 128, 256, and so forth. This scenario of arithmetic food growth with simultaneous geometric human population growth predicted a future when humans would have no resources to survive on. Malthus urged controls on population growth to avoid such a catastrophe (epgp.inflibnet.ac.in).

On the basis of a hypothetical world population scenario which was of one billion in the early nineteenth century along with an adequate means of subsistence at that time, Malthus proposed that there was a potential for a population to increase to 256 billion within 200 years whereas the means of subsistence were only capable of being increased enough for nine billion to be fed at the level prevailing at the beginning of the period. He therefore considered that the population increase should be kept down to the level at which it could be supported by the operation of various checks on population growth, which he categorized as "preventive" and "positive" checks.



Source: - https://lotusarise.com/malthusian-theory-of-population-upsc/

Preventive Checks: - Preventive checks exercise their influence on the growth of population by bringing down the birth rate. Preventive checks are those checks which are applied by man. Preventive checks arise from man's fore-sight which enables him to see distant consequences He sees the distress which frequently visits those who have large families. He thinks that with a large number of children, the standard of living of the family is bound to be lowered. He may think that if he has to support a large family, he will have to subject himself to greater hardships and more strenuous labour than that in his present state. He may not be able to give proper education to his children if they are more in number. Further, he may not like exposing his children to poverty or charity by his inability to provide for them. These considerations may force man to limit his family. Late marriage and self-restraint during married life are the examples of preventive checks applied by man to limit the family.

Positive Checks: - Positive checks are applied by nature, which exert their influence on the growth of population by increasing the death rate. There are various positive checks to population which include every cause, whether arising from vice or misery, which in any degree contributes to shorten the natural duration of human life. Insubstantial occupations, hard labour, exposure to the seasons, extreme poverty, bad nursing of children, common diseases, wars, plagues and famines ire some of the examples of positive checks. They all shorten human life and increase the death rate. Malthus recommended the use of preventive checks if mankind was to escape from the impending misery. If preventive checks were not effectively used, positive checks like diseases, wars and famines would come into operation. As a result, the population would be reduced to the level which can be sustained by the available quantity of food supply.

Applicability of this Theory

Despite this weakness, the Malthusian doctrine contains much truth. The Malthusian doctrine may not be applicable to the Western Europe and England but its principal tools have become the part and parcel of the people of these countries. If these lands do not face the problems of overpopulation and misery, it is all due to the bogey and pessimism of Malthusianism. In fact, the people of Europe were made wiser by Malthus who forewarned them of the evils of over-population and they started adopting measures to ward it off. The very fact that people use preventive checks, like late marriage and various contraceptives and birth control measures on an extensive scale proves the vitality of the Malthusian law. Even famous economists like Marshall and Pigou and sociologists like Darwin were influenced by this principle when they incorporated it in their theories. And Keynes, initially overawed by the Malthusian fears of over population, later wrote about "Some Economic Consequences of Declining Population." Is it not the fear of Malthusianism that has created the problem of declining population in France? The Malthusian doctrine may not be applicable now to its place of origin, but its influence spreads over two-third of this universe inhabited by under -developed countries. As Mrs. Joan Robinson wrote: "of all economic doctrines, the one most relevant to the under-developed countries is that associated with Malthus." Excluding Japan, the whole of Asia. Africa and South America come under its purview.

In the least developed countries of Africa, population is growing faster than the food supply. There are deaths by starvation. Positive checks like floods, wars, droughts, earthquakes, epidemics. etc. operate in all the under -developed countries. Malthus wrote: —the poor are themselves the Cause of their poverty." This is very true because it is the poor people who are responsible for the rapid growth of population in these countries. Thus the Malthusian theory is fully applicable to under - developed countries. Walker was right when he wrote: "The Malthusian theory is applicable to all communities without any consideration of colour and place. Malthusianism has stood unsheltered, impregnable amid all the controversy that has raged around it" (http://magadhmahilacollege.org/wp-content/uploads/2020/05/Maltus-Population-Theory.pdf)

So far as India is concerned, it is not an exception. Certain aspects of the Malthusian theory are applicable even though we have overcome the problem of food supply. The birth rate is high, but the death is on the decline. As a result, the growth rate of population is high at 1.9 per cent per annum. The country is trying to control the phenomenon of over -population by preventive checks by family planning devices like late marriages, by raising the age of marriage for males and females, and the use of contraceptives, etc. Positive checks like war, droughts, floods, earthquakes, famines, pestilences, etc. are in operation. One-third of the population is below the poverty line and unemployment and disguised unemployment are widespread due to over -population. The high growth rate of population keeps the per capita income at a low level this has kept India among the low income countries despite its stupendous progress in agricultural, industrial and services sectors. Haunted by the Malthusian fear. India has adopted the population policy of family welfare which aims at reducing poverty and unemployment so as to raise per capita income through population control.

Criticism of this Theory

(1) Mathematical form of the theory wrong: The mathematical formulation of Malthus' doctrine that food supply increases in arithmetical progression and population increase in geometrical progression in 25 years has not been proved empirically.

(2) Failed to Foresee the opening up of New Areas: Malthus had a narrow vision and was particularly influenced by local conditions in England. He failed to foresee the opening up of new areas of Australia, the United States and Argentina where extensive farming of virgin lands led to increased production of food.

(3) Applied a Static Economic Law to a Period of Time: Malthus could not foresee the unprecedented increase in scientific knowledge and agricultural inventions over a period of time which have stayed the law of diminishing returns.

(4) Neglected the Manpower Aspect in Population: He forgot that an increase in population' means an increase in manpower which may tend to increase not only agricultural but also industrial production and thus make the country rich by an equitable distribution of wealth and income.

(5) Population not related to Food Supply but to Total Wealth: The Malthusian theory rests on a weak relationship between population and food supply.

(6) Importance given to only Food grains for Livelihood: Malthus gave importance to only food grains for livelihood. But for livelihood, food grains alone are not enough. Fruits, meat, fish, milk, Eggs, etc. can also be used as food.

(7) Increase in Population the Result of declining Death Rate. The Malthusian theory is one sided. It takes the increase in population as the result of a rising birth rate, whereas population has grown considerably the world over due to decline in death rate.

(8) Empirical Evidence proves this Theory Wrong. Empirically, it has been proved by demographists that population growth is a function of the level of per capita income. When per capita income increases rapidly, it lowers the fertility rate and the rate of population growth declines.

(9) Preventive Checks do not pertain to Moral Restraint. Malthus was essentially a religious man who laid emphasis on moral restraint to control population. But he could not visualise that human beings would invent contraceptives and other family planning devices for birth control.

(10) Positive Checks not due to Over-population. Malthus' pessimism and religious education led him to believe that over-population was a heavy burden on the earth which was automatically lessened by God in the form of misery, wars, famines, floods, diseases, pestilence, etc. But all these are natural calamities which are not peculiar to over-populated countries. They visit even those countries where the population is on the decline or stationary, such as France and Japan.

(11) Malthus a False Prophet. The Malthusian theory is not applicable to countries for which it was propounded. In the West European countries, the bogey and pessimism of Malthus has been overcome.

(12) Not Relevant to Modern Population Problems. The Malthusian theory of population is not of much relevance to modem population problems because it does not explain the reasons for declining birth rate in developing countries, the relationship between birth rate and death rate, the effects of migration and urbanisation, etc (https://magadhmahilacollege.org/wp-content/uploads/2020/05/Maltus-Population-Theory.pdf).

MARXIAN THEORY OF POPULATION GROWTH

The debate about the Malthusian theory has continued down to the present. Economists such as J.S. Mill and J.M. Keynes supported his theory whereas others, especially, sociologists, have argued against it. According to them, the widespread poverty and misery of the working-class people were, not due to an eternal law of nature as propounded by Malthus but to the misconceived organization of society.

Karl Marx went one step further and argued that starvation was caused by the unequal distribution of wealth and its accumulation by capitalists. It has nothing to do with the population. The population is dependent on economic and social organization. The problems of overpopulation and limits to resources, as enunciated by Malthus, are inherent and inevitable features associated with the capitalist system of production. Marx's contention that food production could not increase rapidly was also debated when new technology began to give farmers much greater fields. French sociologist E. Dupreel (1977) argued that an increasing population would spur rapid innovation and development to solve problems, whereas a stable population would be complacent and less likely to progress. The Marxian approach is also referred as Historical Determinism. His theory of population growth is implicit and is implied in his general theory of communism (https://lotusarise.com/marxian-theory-of-population-growth-upsc/).

Main Theory (Marxian) of Population Growth

The impact of the writings of Karl Marx (1818-1883) on political and economic developments in this century is well known. But Marx also wrote about population. Not only was he one of Malthus's main nineteenth-century critics, but his own "law of population" is interesting in its own right.

Marx did not believe that the growth of human population was controlled by any natural law, as Malthus's theories suggested. His ideas are complex, and since they are related to nineteenth-century capitalism they don't fit today's circumstances very well. Briefly, Marx believed that the creation of a surplus population of unemployed "is a necessary product of accumulation or of the development of wealth on a capitalist basis, this surplus population also becomes, conversely, the lever of capitalist accumulation, indeed it becomes a condition for the existence of the capitalist mode of production. It forms a disposable industrial reserve army, which belongs to capital just as absolutely as if the latter had bred it at its own cost." Within the working class, the capitalist system, according to Marx, requires a pool or army of unemployed. This reserve puts pressure on those who are employed by making them submit to over work and a low level of wages. The numbers in this reserve army fluctuate with business or trade cycles. During times when business is depressed, workers are laid off and eventually profits begin to rise again.

Thus business (capitalism) benefits by exploiting labour. While wages are kept low everywhere, the members in this surplus labour army are destined to have the lowest wages. Thus the working class produces wealth (capital), but because there is a constant oversupply of labour, it will never share in much of the wealth it produces. Since this means that most working people are kept poor, their birth rates will remain high and the labour surplus will continue to grow.

Thus for Marx, high levels of population growth were not the cause of poverty (as Malthus believed). Rather, it was the other way around. Marx believed that capitalism was an unjust economic system that profited at the expense of those who laboured in it, and by keeping its

workers poor also caused high rates of population growth. His answer was revolution, replacing capital- ism with what he believed was a more just economic system.

Marx believed that society, particularly feudal and capitalist society is divided into two broad economic classes, namely, rich and poor. The wealthy were people who possessed means of production and profited by exploiting the poor. The poor, on the other hand, were individuals who sold their energy and willingness to labor to these affluent people in return for wages (https://hyattractions.wordpress.com/2015/08/17/karl-marxs-theory-of-population/).

Fig: -Marxian Theory of Population Growth

SOURCE: - https://prepp.in/news/e-492-marxian-theory-theories-of-population-growth-geography-notes

Criticism of Marxian Theory

The theory of Marx was criticized on the following grounds –

1. An increase in population does not necessarily lead to a decrease in wages. There are many socio-economic factors which are responsible.
2. Population growth does not necessarily increase due to a decrease in wages, this may occur due to improved medical facilities.
3. The theory of Marx is applicable only in capitalist society and not in other societies.
4. According to Marx, the higher the wages, the lower the birth rate, but faith and religion may also play a significant role. This he did not consider.
5. It is true to a great extent that in a capitalist society there is a surplus population on account of unemployment. But it is not to presume that under a socialist system there will be no need to check population growth at any stage.
6. Even in communist countries, population growth is checked on the plea that no mother should have more children so that their mother so that their health does not deteriorate.
7. In the erstwhile USSR, factory workers were provided contraceptives in their factories so that the birth rate was kept low.
8. If economic inequality is the main cause of the birth rate then in these countries rates should not differ. Because these inequalities have come to an end. The necessity of

family planning is felt in these countries (https://lotusarise.com/marxian-theory-of-population-growth-upsc/).

Marxism, named after Karl Marx, is a social, political, and economic ideology. It investigates the impact of capitalism on labor, productivity, and economic progress, and it advocates for a worker revolution to demolish capitalism and replace it with communism. The Marxian method is also known as Historical Determinism. His notion of population expansion is embedded in his overall theory of communism (https://www.coursehero.com/file/112779876/reaction-paperdocx/).

NEO-MALTHUSIANS THEORY OF POPULATION GROWTH

The term neo-malthusianism was first used in 1877 by Dr. Samuel Van Houten, one of the vice- presidents of the Malthusian League. Neo- Malthusianism was not just a campaign in favour of birth control; it was particular perspective on the effects of population on human conduct and behaviour. The neo-Malthusian movement therefore was different from conventional Malthusian position on two counts: it stressed on birth control methods and also identified the working class with the problem of overpopulation. The overcrowded industrial slums were identified as sites of moral degeneration.

This diverted the debate on population from issues of poverty and unequal access to resources, to birth control per se. In fact, the assumption was that access to commons or availability of resources would give the poor little reason to abstain from having more children. Neo-Malthusianism thereby reinforced the ideology of private property, individualism and capitalism. The neo-Malthusian position found favour with the elite sentiments on the issue of overpopulation. The elite, threatened by the growing numbers of commoners, considered birth control as an important means of checking future conflict over their property.

The French delegates tried to maintain a stance of ambivalence though they were wary of contraception on the grounds that it encouraged the idea of seeking sexual pleasure without taking the responsibility of the consequences of the act. According to them, it devalued the institution and sanctity of marriage and family values. For the Catholic Church, birth control was illicit and immoral and went against the basic tenet of Christianity. Till the 1920s, most medical opinion was also against birth control, as it considered it unhealthy and immoral.

The attitude started changing subsequently, as evidenced by the effort made by the British medical professionals in 1921 to appeal to the Anglican Church to reconsider their position on birth control in the light of existing medical knowledge. In America too, after a court ruling in 1929 that upheld the right of doctors to prescribe contraceptives for health reasons, birth control was included in medical curricula. Birth control clinics were set up in different parts of Europe and America and marked the new phase of the birth control movement. Birth control came to be popularised by taking recourse to the less “offensive” and more “social” terms like “family planning” or “planned parenthood”, and the emphasis was on spacing of children and women’s health.

In its bid to control sexuality and the domestic sphere of a person’s life, birth control went against the modern values of individual freedom and the right of an individual to her/his privacy. On the other hand, it also questioned the orthodoxy of the times and presented birth control as an attempt to present a choice to the individual to have a child or not. However, the

source of the birth control debate was not whether individual freedom should be protected or not, but on how to control overpopulation, depopulation or under population and its consequent effect on the world. Central to the debate were the issues of migration, availability of labour, conflict over resources, and poverty. The concerns were developmental and political (http://www.sociologydiscussion.com/population/notes-on-neo-malthusian-theory-of-population/1119).

UNIT – 4

FACTORS CONTROLLING FERTILITY, MORTALITY AND MIGRATION

INTRODUCTION

Today, some six millennia after the first census was taken, population data are more important than ever and constitute a vital tool for business and political leaders, researchers, planners, and others. For the last 90 years, Population Reference Bureau (PRB) has been analyzing and translating population data. We published the first edition of this guide, then titled "Population: A Lively Introduction," back in 1991. Authored by Joseph A. McFalls Jr., this popular work's goal of providing readers with a basic understanding of demography and demographic processes remains relevant today. We have retitled this sixth edition "Population: An Introduction to Demography" and thoroughly revised it for today's audiences. All revisions were handled by PRB demographers and staff, who are solely responsible for the content of this work.

Fertility, mortality and migration are principal determinants of population growth (or its inverse). In the absence of technological intervention, one might say almost the sole determinants, but improvements in contraceptive techniques, increasing acceptance of abortion, and slackening of some traditional religious and cultural traditions has in many parts of the world reduced the role of fertility (https://www.scribd.com/document/249985814/Assignment-On-Demography).

FACTORS CONTROLLING THE FERTILITY

Fertility is one of the most important components of sociological studies affecting almost all aspects of human life. Fertility is the only way for biological replacement of human being in order to continue its existence on earth. Fertility is the ability to become pregnant and bear children. Fertility is the ability to reproduce but it is not free from biological and social or environmental factors (www.ijhsr.org).

The study of human fertility is of paramount importance in population studies. Human fertility is responsible for the biological replacement and maintenance of the human species, since every society replenishes itself and grows through the process of fertility. Therefore, in context of population dynamics it is important to note that fertility is one of the major counteractive forces that aids in overcoming mortality. Contrary to this, an increased level of fertility more than desired might result in population explosion.

Studies have reported that there are plethora of factors that affect the fertility pattern of a population, either directly or indirectly. Age at menarche, age at marriage, age at first conception, and number of conceptions and live births are some of the biological factors that determine fertility. In contrast to this, the educational status, occupation status, household per capita annual income, family type, and use of birth control measures are the social factors that affect the fertility pattern of a population. Among the social factors that affect the fertility status

of a population, preference for male child is one of the most important. The preference for a male child among the parents in the Indian society is one of the most important reasons leading to the explosion of population in the society (https://core.ac.uk/download/208551367.pdf).

Number of socio-demographic factors influences on fertility, in general. The fertility rate of any population is always influenced by various factors, directly or indirectly. The degree of influence of these factors on fertility may differ from population to population or from society to society. The direct factors affecting fertility are oral pills, condoms, abortion, infanticide and intra uterine devices (IUDs). The indirect factors affecting fertility are age at marriage, spouse age, separation, divorce, and widowhood, consumption of food, economic status, occupation, family system, education and attitude (https://www.ijhsr.org/IJHSR_Vol.8_Issue.10_Oct2018/11.pdf).

The list of factors which controls the level of fertility is given below (http://www.dodl.klyuniv.ac.in/download/DODL%20M.A_M.Sc%20SLMs/DODL_M.A_M.Sc_%20SLMs_%20SEM-II/SLM_geography_Sem-II.pdf): -

1. Social Factors: - son preference, women's week status in society, age at marriage, social norms and values, uses of contraceptive measures and family planning.
2. Economic factors: - women's employment rate, occupational distribution, per capita income and child labor force.
3. Cultural factors: - exposure to mass media and religious and ethnic identity.

Social factors: -Among the social factors that affect the fertility status of a population, preference for male child is one of the most important. The preference for a male child among the parents in the Indian society is one of the most important reasons leading to the explosion of population. Among the social attitudes that have a bearing on fertility, directly or indirectly, is the status accorded to women in the society. In Indian societies, the women were assigned a submissive and secondary role and it was thought that women do not deserve independence. Women's status is singled out as the most determining factor in controlling the fertility pattern of a country. Some societies limit girls' access to formal education, thereby limiting future employment and economic freedom. Girls' education often ends with an early marriage. It is found that in countries such as USA, Sweden etc. where women's education is high, fertility is low. On the other hand, in countries such as Afghanistan, Niger where women are less educated, fertility rate is high.

Marriage is universal in most of the societies, but its type and the custom vary depending upon the religious and other cultural practices of the communities. Age at marriage is influenced by the socioeconomic condition. It is usually low among the women who belong to the lower socioeconomic status. It is assumed that longer the duration of reproductive span, higher is the number of children. Therefore, lower the age at marriage, higher is the fertility.

The differences in social norms are of profound influences in Indian societies determining the fertility pattern in the country. Reproduction is not only a biological factor but also a social matter. It is guided by different social institutions including the family. The social norms are often influenced by religious factors. In places where the social norms are very rigid, fertility rate is generally higher.

Economic Factors: -Reproductive factor is often found to be sensitive to the geographical and economic factors. Exposure to putative hazardous substances in environmental and occupational settings lowers down the fertile rate. Over the last few decades, one of the most important demographic changes has been the constant increase in female labor force participation, which has been a generalized tendency around the world. The changing role of women has produced several transformations of the family structure. Their increased propensity to enter the labor force, and thus increased independence, imply changes in childbearing practices. There is a negative relation between per capita income and fertility. The decreasing relationship between the two variables demonstrates the connection between fertility choices and economic considerations.

Cultural factors: - There is a long tradition of addressing religious affiliation as a determinant of demographic behavior. Particularly, the interest has long been focused on fertility differentials by religious denomination. Some religions promote large families. Emphasis on the importance of family and a positive evaluation of large families may favor higher fertility. It also leads to thinking that the practice of family limitation is contrary to their religious belief. In India, Muslims have highest fertility rate (2.61 per woman). Muslim women are less receptive to family planning than Hindu women. Besides, Islamic beliefs, in contrast to Hindu beliefs, support polygamy, allow for easy divorce in case of infertility, and allow widows to remarry.

Measurements of Fertility

Crude Birth Rate (CBR): -Crude birth rate is a common measure of human fertility. It is obtained by dividing the number of births recorded in a population during a specified year by its total number. This rate is called crude because the differences in the composition, such as age and sex, are ignored in calculating it. It is expressed in terms of the number of births in a year per thousand of the mid-year population. It is calculated as follows (https://study-assistant.com/health/question19953430):

Crude Birth Rate (CBR) = Total number of children born in a year/ Mid – year population x 1000. The CBR is only a rough estimate of fertility. It does not specify why birth rates are different in different years and between different populations at the same time (https://www.proquest.com/docview/2606862296).

General fertility rate (GFR): -General fertility rate is the number of births per 1000 women of reproductive ages. This number of women of childbearing age is taken as a base for calculating the birth rate, instead of the total population. Crude birth rate is a common measure of human fertility. It is obtained by dividing the number of births recorded in a population during a specified year by its total number. This rate is called crude because the differences in the composition, such as age and sex, are ignored in calculating it. It is expressed in terms of the number of births in a year per thousand of the mid-year population.

This method is an improvement over CBR, as it takes, into account only the population in the reproductive age group, i.e., only the females in the age group 15-49, since it is only these

females who can bear children(https://www.stat.go.jp/info/meetings/cambodia/pdf/c13ana07.pdf).

Bogue (1969) has defined general fertility rate as the 'number of births in a year per 1000 women if child bearing age'. Barclay states, 'General Fertility Rate or General Fertility Ratio is the ratio of total yearly registered births to the population of women of childbearing age.

The purpose is to restrict the denominator of the rate to potential mothers by excluding all men and large groups of women not exposed to the risk of child bearing by reason of age'. It is calculated by taking into account only the females in the reproductive age group. It is expressed in terms of the number of children below five years of age per 1000 females of reproductive age.

It is calculated as:
General Fertility Rate = Total number of live births in a year/Mid – year population of women in reproductive age group.

Total Fertility Rate (TFR): -The total fertility rate refers to the average number of children that each woman will have during her lifetime. It is an average of the ASFR because, of course, some women will have more, some fewer and some no children at all. It is an average of the ASFR, and is calculated by summing up the birth rates of each age group for women in the reproductive age. It is an estimate of the number of children a cohort of 1000 women would bear if they all went through their reproductive years exposed to the age-specific fertility rates in effect at a particular time (https://www.proquest.com/docview/2599055252).

Age Specific Fertility Rate: - The age-specific fertility rate (ASFR) is the number of live births per 1,000 women in specified (e.g. five year) age groups per year.

For multiple decades in Simcoe Muskoka and Ontario, there has been an overall trend toward older women having babies. Women with increased maternal age are more likely to develop health problems that could affect their pregnancy. They are also more likely to experience complications during pregnancy including high blood pressure, diabetes, preterm birth, fetal growth restriction and low lying placenta.On the other hand, women who delay childbearing often have a higher level of education and socioeconomic status, which decreases some of the health problems associated with their pregnancy. So women who have their first baby at an older age and who have no chronic conditions, generally have healthy pregnancies and healthy babies (https://www.simcoemuskokahealthstats.org/topics/pregnancy-and-before/birth-and-fertility-rates/total-general-fertility-rates#:~:text=The%20Total%20Fertility%20Rate%20).

Fertility Trends in India: -Fertility in India has declined substantially, from a total fertility rate (TFR) of 5.7 children per woman in the mid-1960 to 3.3 children in 1997. Since the mid-1960's, India has covered two-thirds of the distance to the replacement fertility of just over two births per woman. Fertility varies widely among States; it is significantly below the national average in the southern and western States and higher in the others. With a TFR of 5.2 in 1993,

Uttar Pradesh clearly stands out as having especially high fertility, nearly 50 per cent above the national level.

Contraceptive Prevalence The national family planning program, which was established in 1952, has played an important role in India's fertility decline. When the program began, there was little awareness or use of modern birth control methods. Four decades later, the 1992-93 National Family Health Survey (NFHS) found nearly universal knowledge of family planning, with 96 percent of married women ages 13 to 49 years having heard of at least one modern method, and almost 41 per cent, or almost 70 million women, using contraception. Eighty-nine per cent of married women who practiced family planning in India relied upon modern contraceptive methods. Female sterilization, the method which is strongly promoted by India's family planning program, was by far the most widely used method.

Nearly 67 per cent of married women who were using contraception, or 47 million women, had been sterilized compared with an average of only 30 per cent for the entire world. Spacing methods, primarily available through the private sector, were used by a small proportion of users: the pill by 3 per cent, IUD by 5 per cent, and condom by 6 per cent. Education, religion, place and State of residence are among the factors that strongly correlate with contraceptive use in India. Nearly half of the married women with some primary schooling use contraception compared with one third of illiterate women. Differentials by religion are also strong. Higher prevalence rates (48 to 63 per cent) are found among small minority religions (Jains, Sikhs, Buddhists, and Christians) than among Hindus (42 per cent), and the lowest use (28 per cent) is found among Muslims. A higher proportion of urban married women (51 per cent) than rural married women (37 per cent) use contraceptives (https://www.proquest.com/docview/2606862296).

FACTORS CONTROLLING THE MORTALITY

The following are the basic determinants of Mortality

Demographic Structure

Age Structure: Age structure is considered as a prominent demographic factor governing the incidence of mortality. Mortality rates tend to decline as the child matures and tends to increase when a person is in the middle age. Hence, high mortality rates are observed in those countries that have a large number of people falling in the middle and old ages.

Sex Composition: It has been found out that the Mortality rates of males and females are different due to varying resistance power of the two sexes. In case of females, the mortality rates increases due to variety of reasons like malnutrition, high maternal mortality rate, low status of women, neglect of female children etc.

Degree of urban Development: In the historic past, it has been observed that the mortality rate in urban areas to be higher than that of the rural areas. But at the present, this gap is increasingly getting narrowed down and in some cases the positions have got reversed. In the least developed countries, urban mortality rate is found to be lower than the rural areas. But in case of the developed countries, reverse is more true. Generally, the factors like high per capita income, high literacy, and enhanced awareness about diseases have helped to lower down the mortality rate in urban areas (https://www.simcoemuskokahealthstats.org/topics/pregnancy-

and-before/birth-and-fertility-rates/total-general-fertility-rates#:~:text=The%20Total%20Fertility%20Rate%20).
.

Social Factors

1. Incidence of infanticide: The prevalence of infanticide increases the mortality rate in a society.
2. Availability of medical facilities: Mortality rate has a positive correlation with the number of persons per physician.
3. General conditions of nutrition, housing and sanitation,
4. Literacy level of the population: Mortality rate is inversely correlated with literacy standards.

Economic Development

Standard of living: Rich people tend to have balanced diet and has the capacity to avail medical facilities. Once, the medical facilities are made universally available then the inequalities in the mortality rates will decrease.

Other factors

Apart from the above factors, other factors like naturalcalamities, wars, epidemics etc. tend to cause large scale deaths.

Causes of Decline in Mortality Rates in Developing Countries

Mortality rates have declined considerably in developing countries in recent years due to the following reasons:

(1) Disease Control Medicines
(2) Public Health Programs
(3) Medical Facilities
(4) Spread of Education
(5) Status of Women
(6) Food Supply
(7) Life Expectancy

Measurements of Mortality

Crude Death Rate: - The crude death rate is calculated by dividing the number of registered deaths in a year by the mid-year population for the same year. The rate is expressed as per 1,000 populations.

Crude Death rate = Total Number of Deaths/Total Mid-year population * 1000

This rate has a simple interpretation, for it gives the number of deaths that occur, on the average, per 1,000 people in the community. Further, it is relatively easy to compute, requiring only the total population size and the total number of deaths. Besides, it is a probability rate in the true sense of the term. It represents an estimate of the chance of dying for a person belonging to the

given population, because the whole population may be supposed to be exposed to the risk of dying of something or the other (https://www.coursehero.com/file/148057016/Epidemiologic-measuresdocx/).

Specific Death Rate: - The crude death rates for specific causes of death are calculated in a similar way by selecting deaths due to specific cause as the numerator and mid-year population as the denominator. Thus,

Cause specific Death rate = Total Number of Deaths due to some particular Cause/Total Mid-year population.

The rates could be made specific to sex by selecting the numerator and the denominator for each sex of the population.

Age Specific Death Rates (ASDR): - The age-specific death rates are calculated from deaths and population both specific to each age (or age group) of the population. Thus,

Age Specific Death rate = nDx/nPx* 1000

Where 'x' indicates the age and 'n' the class interval of age.

The age-cause-specific death rates are obtained by selecting deaths in specific age and cause group of the population as the numerator It should be noted that the sum of the cause-specific rates over all causes equals the crude death rate. Similarly, the sum of the age-cause-specific death rates equals the age-specific death rate at a given age. Standardization is a technique, which provides a summary measure of the rates (similar to the crude rates) while controlling for the compositional variation between the populations being compared. Thus, a comparison of the standardized rates gives a 'true' comparison of the phenomenon studied. We shall illustrate the calculations of the standardized rates with the help of the death rates (https://www.coursehero.com/file/148057016/Epidemiologic-measuresdocx/).

Infant Mortality Rate (IMR): -The mortality of live born under one year of age is known as infant mortality. Infant Mortality Rate is defined as, “the number of infant deaths occurring in a community within a specified calendar year per 1000 live births in the same community during the same calendar year” (GOI 2015). It is a good indicator of the health status of a given area or population, since it tends to reflect the population’s socio-economic condition and status of health services. It can be calculated as follows (https://india.unfpa.org/sites/default/files/pub-pdf/TrainingManualonDemographicsTechniques%28forwebsite%29.pdf):

IMR= Number of deaths of infants under 1 year of age/total live births * 1000

Maternal Mortality: - Maternal death is defined as, “the death of a woman while pregnant or within 42 days of termination of pregnancy irrespective of the duration and site of the pregnancy, from any causes related to, or aggravated by the pregnancy or its management, but not from accidental or incidental causes.” (WHO 2018) Given below are two equations, one on the maternal mortality rate, and the second on the maternal mortality ratio. The differences are

outlined after the equation (http://lifesavingcommodities.org/wp-content/uploads/2014/08/Integrated-Maternal-Newborn-Health-Training-Manual-2009.doc).

Maternal Mortality Rate: **-** Number of maternal deaths in 15-49 age group/number of women in 15-49 age*100000

Maternal mortality Ratio: **-** Number of maternal deaths in 15-49 age group/number of live births *100000

FACTORS CONTROLLING THE MIGRATION

The concept of migration involves the process whereby individuals leave their own countries and become permanent residents of other countries. Annually, millions of people from around the world immigrate to other countries to become citizens. Trends on migration rates continue to increase over time. In 2012, the Gallup survey estimated that there were an approximated 640 million individuals willing to migrate to other countries. Many of the migrants preferred the US (up to 23%) as their desired residence. Other destinations of choice for global immigrants included countries such as the UK, UAE, Romania, Germany, Spain, Italy and other European countries (https://www.mdpi.com/2227-7099/10/1/21/htm).

Environmental Factors: - Migration caused by environmental factors is increasingly involuntary. Environmental factors cause *displacement*, or the forced movement of people by social or environmental factors. Crop failure for example, often results in both food scarcity and a drop in agricultural jobs, prompting people to move to a place with better job opportunities and climate. Pollution of water, air and soil in both urban and rural settings can also create a serious health risk to locals, forcing them to look for a better life for themselves and their children.

Devastating natural disasters such as tsunamis, hurricanes and earthquakes are environmental factors that the news most often covers. In January 2010 for example, a deadly earthquake hit Haiti, claiming the lives of over 90,000 people, and displacing over 1.5 million others. Despite humanitarian aid, many suffered from disease and a lack of proper shelter and basic supplies. Likewise, recent studies cite global warming as a cause for the increase in violent conflict around the world (https://justiceforimmigrants.org/what-we-are-working-on/immigration/root-causes-of-migration/).

Social Factors: - Social factors motivating migration grow from the human needs and desires to achieve a better quality of life. Migrants often move to ensure better opportunities for themselves or their family, like sending their child to a better, safer school or finding a job that would have not only a sufficient salary, but also important benefits and career growth prospects. In terms of education, the United States graduate programs have been a particularly strong attraction for young, talented individuals around the world. Individuals can also migrate in search of services**,** such as life-saving surgery and medical treatment that are inaccessible in their home area.

Economic Factors: -Economic factors relate to the labor standards of a country, its unemployment situation and the overall health of its economy. If economic conditions are not favorable and appear to be at risk of declining further, a greater number of individuals will probably emigrate to one with a better economy. Often this will result in people moving from rural to urban areas while remaining within the confines of their state borders. As the low- and middle-income countries of today continue to develop and the high-income countries experience slower economic growth, migration from the former could decline.

Economic migrants are drawn towards international migration because of the prospect of higher wages, better employment opportunities and, often, a desire to escape the domestic social and political situation of their home country. These migrants are most likely to come from middle-income countries where the population is becoming increasingly well educated. Salaries and wages, however, are likely to remain relatively low compared to those of individuals with a similar educational background in other, higher-income countries. This disparity has the potential to lead to some highly skilled individuals from developing countries migrating to more developed countries. This form of migration is known as south-north migration and has historically been the main form of economic migration.

Technological advancement, both in communications and transport, in addition to the liberalization of labor markets, has the potential to increase the rate of circular migration. This form of migration occurs when individuals migrate between an origin and a destination on several separate occasions. Generally, economic forces motivate individuals to move to countries where employment prospects are better before returning to their country of origin. Studies have shown that circular migration can have positive development outcomes. Most importantly, circular migrants are more likely to send larger remittances back to their country of origin than those who permanently settle within their destination country. Furthermore, issues relating to brain drain and a hollowing out of the labor force are largely averted.6 Problems of exploitation still remain, suggesting that efforts need to be made to ensure that standardized regulations are adopted to protect the rights of circular migrants (https://dodl.klyuniv.ac.in/download/DODL%20M.A_M.Sc%20SLMs/DODL_M.A_M.Sc_%20SLMs_%20SEM-II/SLM_geography_Sem-II.pdf).

Safety Factors: - Safety factors can cause danger to individuals, prompting them to migrate. Persecution and discrimination based on nationality, race, religion, political beliefs, or membership status in a particular social group will prompt people to move large distances in search of a safer living location where they can have freedom over their lives. Danger can be imposed upon individuals by something formal, like **war**, or informal, such as widespread gang activity. In 2016, the Northern Triangle, composed of Guatemala, Honduras and El Salvador, was named one of the most violent regions in the world. All three Northern Triangle countries record thousands of crimes by local and international gangs and armed criminal groups, and most crimes are met with impunity. It is estimated that 10% of the Northern Triangle's population has already left, and it is likely that many more will flee in part due to extreme violence (https://justiceforimmigrants.org/what-we-are-working-on/immigration/root-causes-of-migration/).

Types of Migration

Migration could come in different forms depending on the nature and the reason of the movement (https://www.eartheclipse.com/geography/what-is-migration.html).

The first – and the most common – classification of migration refer to the nature of movement. This would include immigration and emigration. Immigration refers to the movement of persons or population to another country. Emigration, on the other hand, refers t o the movement of persons or populations from one country. For example, immigration of Filipinos to the United States and emigration of Indians from India.

The second classification of migration refers to permanence. Under permanence, we have permanent, temporary, voluntary, and forced. Permanent migration refers to the movement from one area to another without plans of returning to the place of origin. Temporary migration refers to the migration done on a limited time. Forced migration involves migrants leaving without any choice. Voluntary migration is the opposite of forced.

The third classification of migration refers to the nature of location. Under such classification, we have internal and international. Internal migration refers to a chance of residence within the country. It is also known as internal migration. International migration, on the other hand, refers to the change of residence to different nations or countries. It is also known as external migration.

There are other types of migration. Here are as follows.

1. Gross migration refers to the total number of arrivals of immigrants and the departures of emigrants.

2. Net migration refers to the difference between the total number of people coming in and the sum of people living out. It could also refer to the difference between the number of immigrants and the number of emigrants.

3. Impelled migration refers to the movement of people from a country or area because of unfavorable instances.

4. Step migration refers to the progressive migration from a shorter distance to a father destination.

5. Chain migration refers to ta series of migration which a defined group of people.

6. Rural-urban migration refers to the movement of people from the rural areas to a specific region in the urban area of a country. This could be brought about by the presence of better opportunities for work in the urban areas.

7. Interregional migration refers to the movement of populations from a region to another region in a country.

8. Intercontinental migration refers to the movement of people between and among different continents. For example, people from Asia would move to Europe.

9. Intercontinental migration refers to the movement of people between and among countries within the same continent. For example, people from the Thailand would move to Japan. Both countries are found in Asia.

10. Seasonal migration refers to the movement of people or animals due to climate or seasonal reasons. For instance, some people would move to another place in order to plants crops or harvest. Animals, on the other hand, would migrate to prepare for the winter season.

11. Return migration refers to the return of people to their country of origin after leaving the country which they went at.

Pull and Push Factors of Migration

People migrate to other places because of different reasons. Lee's laws divide these reasons into two factors: pull factors and push factors.

Pull factors are the factors that would attract or encourage the persons to leave their place of origin. These would include better living conditions, job opportunities, enjoyment, better medical care, and feeling of having religious or political freedom, education, attractive climates, and better chances of marrying, among others.

Push factors are the factors that could force the persons to move their place of origin. These would include few or not enough job opportunities, inadequate conditions, famine, political fear, and poor medical care, desire for freedom, poor housing, condemned housing, war, death threats, and natural disasters, among others.

Impacts of Migration

Migration is becoming a very important subject for the life of cities. Many opportunities and attraction of big cities pull large numbers of people to big cities. Migration can have positive as well as negative effects on the life of the migrants (https://triumphias.com/blog/addressing-the-needs-of-migrant-workers/).

Positive Impact

- Unemployment is reduced and people get better job opportunities.
- Migration helps in improving the quality of life of people.
- It helps to improve social life of people as they learn about new culture, customs, and languages which helps to improve brotherhood among people.
- Migration of skilled workers leads to a greater economic growth of the region.
- Children get better opportunities for higher education.
- The population density is reduced and the birth rate decreases.

Negative Impact

- The loss of a person from rural areas, impact on the level of output and development of rural areas.
- The influx of workers in urban areas increases competition for the job, houses, school facilities etc.
- Having large population puts too much pressure on natural resources, amenities and services.
- It is difficult for a villager to survive in urban areas because in urban areas there is no natural environment and pure air. They have to pay for each and everything.
- Migration changes the population of a place, therefore, the distribution of the population is uneven in India.
- Many migrants are completely illiterate and uneducated, therefore, they are not only unfit for most jobs, but also lack basic knowledge and life skills.
- Poverty makes them unable to live a normal and healthy life.
- Children growing up in poverty have no access to proper nutrition, education or health.
- Migration increased the slum areas in cities which increase many problems such as unhygienic conditions, crime, pollution etc.
- Sometimes migrants are exploited.
- Migration is one of the main causes of increasing nuclear family where children grow up without a wider family circle.

Theories of Migration

Ravenstein Laws of Migration

Although migration phenomena have been studied by social scientists, thinkers, reformers and others from the very beginning of human civilization, the theoretical and empirical knowledge of migration has not developed to a considerable extent. That is why; even today this study needs migration theories, laws and models taking into consideration its spatial and temporal variations. Unlike physical laws, migration laws cannot be made rigid. Some hypothesis have been developed by social scientists and scholars, they have formulated a few theories and laws and have also suggested migration models.

It was in 19th century that theories concerning migration flow and other processes related appeared. There were three eminent scholars of population who made important contributions to population theory and analysis, they were: Robert Malthus (1766-1834), William Farr (1807-83), and Ernest George Ravenstein (1834-1913). Among these Malthus was the grand theorist, Farr was the statistical demographer and public health reformer and Ravenstein was inductive empiricist. Ravenstein was the empiricist who formulated laws concerning migration stream. According to him, "the laws of population and economic laws generally have not he rigidity of physical laws". Most important statements of Ravenstein that appeared as laws or hypothesis of migration are as follows:

(1) Most of the migrants move only a short distance. Because of this drift nearby areas are only affected and not far off places. Long distance shift is characterized by a special case like a specialized job, technical education etc.

(2) The direction of migration is from agricultural to industrial areas. Rural and urban areas are specialized in different economic activities. Rural areas are dominated by the primary sectors whereas urban areas are specialized in secondary and tertiary occupations and because of this reason these two areas have distinct socioeconomic conditions.

(3) Most of the long distance migration is due to the major industrial and commercial center. Because major industrial and commercial establishments need skilled labor and professionals, since they are not available locally, these persons travel from distant places.

(4) Migration occurs in a series of stages. A group of people residing very near to the developed area will enter into it and thus the gap created by them at rural area will be filled by people from more remote areas.

(5) Females are more migratory over short distances than males. There is predominance of males over long distance migration. Families rarely migrate over long distances.

(6) Internal migration is predominated by females whereas males dominate international migration. Many scholars are of the view that Ravenstein's statements are not universally applicable, for example: he emphasized on predominance of short distance migration but now-a- days because of the development of the transport facilities; long distance migration is being encouraged. Again, he stressed upon the fact that migration increases with the development of industries and commerce but this relationship is not linear. Despite of all these criticisms, Ravenstein's laws of migration have proved to be of considerable stimulus because he has given simple statements about migration, which migrates, where they come from and go to

(https://dodl.klyuniv.ac.in/download/DODL%20M.A_M.Sc%20SLMs/DODL_M.A_M.Sc_%20SLMs_%20SEM-II/SLM_geography_Sem-II.pdf).

Gravity Model of Migration

Gravity models have long been popular for analysing economic phenomena related to the movement of goods and services, capital, or even people; however, data limitations regarding migration flows have hindered their use in this context. With access to improved bilateral (country to country) data, researchers can now use gravity models to better assess the impacts of migration policy, for instance, the effects of visa restriction policies on migration flows. The specification, estimation, and interpretation of gravity models are illustrated in different contexts and limitations of current practices are described to enable policymakers to make better informed decisions.

The simplest versions of gravity models relate bilateral migration to the relative size of the origin and destination countries and the distance between them; however, there are additional factors that can affect migration flows. For this reason, gravity models are enlarged with variables related to different migration pull and push factors; for instance, better economic opportunities in the destination country (i.e. prospects for higher wages or lower unemployment rates), safer conditions, and higher political freedom, among others. Gravity models have been used to understand the role of exogenous factors such as distance or linguistic proximity, while also being used to assess policy impacts such as visa restrictions. In fact, the use of gravity models has been growing extensively during the last decades, although there are still some limitations in terms of data availability and other technical issues.

In this context, gravity models have also been applied to consider the impact of policies affecting migration flows between origin and destination countries. The aim is to quantify the effect of a specific policy on flows, controlling for the remaining pull and push factors. For instance, in a longitudinal data framework, the impact of bilateral policies (such as, the elimination of visa restrictions between two countries) can be considered by including a variable that allows for the identification of the policy's impact by exploiting variations over time (before and after the policy) and across countries (those affected and not affected by the policy). However, depending on data availability and the manner in which the policy is defined, this is not an easy task. We have already established that it is important to control for multilateral resistance to migration, as most policies not only have a direct effect on the flows between the two countries in question, but will also alter the relative attractiveness of alternative destinations. The method of controlling for multilateral resistance to migration (such as the inclusion of origin-year dummies or destination-year dummies) could create an identification problem between the fixed effects and the policy variable. For instance, if a particular migration policy is adopted by a country during the entire time period under consideration, then there will be a multi-collinearity problem (a statistical association between different explanatory variables) in our model due to the inclusion of the policy variable and the origin-year fixed effects, which will be difficult to disentangle (e.g. if migration increases

between two countries after they have signed a visa agreement, but at the same time, the economic situation worsens in the origin country compared to the destination one).

A possible solution is to apply bound analysis (i.e. set minimum and maximum values for the variable in question) when analyzing the impact of visa policies in explaining bilateral migration flows. Previous literature has not found any significant effects of visa policies on migration flows. However, after controlling for multilateral resistance to migration and calculating average bounds, the introduction of a visa requirement lowers incoming flows by between 40% and 47%. The policy also had some indirect effects that were not previously considered. In particular, the introduction of a visa requirement by one destination increases flows toward other countries by between 2.8% and 16.9% (pdfs.simanticsholar.org)

Limitations and Gaps

The primary limitation to gravity models within the context of migration analysis has been the limited availability of bilateral migration data; however, the situation is improving quickly. Nowadays, the main concerns are related to issues such as multilateral resistance to migration or the frequent presence of zero observations. Data limitations are also more evident when the focus is not on international migration, but on internal migration, a topic that is receiving increasing attention, and where micro data from censuses are becoming the most relevant source for this kind of analysis.

Some authors have also used gravity models to estimate potential future migration flows between different pairs of countries. For instance, a 2010 study specified and estimated a gravity model that could be included as part of a demographic projection model. Taking this objective into account, the authors selected explanatory variables that could easily be projected in terms of demographic scenarios. Although this analysis can provide some insights to help predict migration flows, the use of gravity models from this perspective will provide only limited utility in assessing the impact of different policy scenarios. In particular, although gravity models could be used to perform counterfactual evaluations of the evolution of migration flows after policy changes, counterfactuals need to be performed carefully, and must properly take into account the impact of multilateral resistance to migration. As previously mentioned, one relevant assumption of the RUM model is that the attractiveness of a destination is not supposed to be affected by migration, which may not always be the case in reality. Researchers using gravity models to calculate migration potentials should be aware of this limitation (https://wol.iza.org/articles/gravity-models-tool-for-migration-analysis/long).

UNIT – 5

DEMOGRAPHIC TRANSITION MODEL; STABLE POPULATION GROWTH AND EQUILIBRIUM POPULATION

INTRODUCTION

In demography, demographic transition is a phenomenon and theory which refers to the historical shift from high birth rates and high infant death rates in societies with minimal technology, education (especially of women) and economic development, to low birth rates and low death rates in societies with advanced technology, education and economic development, as well as the stages between these two While this change has occurred in many developed countries, due to particular social, political and economic factors affecting specific populations, the theory and model are often imprecise when applied to individual countries. It is important to consider the history of demographic change globally in order to understand the variety of demographic regimes found around the world.
A generalized explanation of the evolving trend of mortality, fertility and growth rates as societies shift from one demographic regime to another is the demographic transition theory (https://wikimili.com/en/Demographic_transition).

The phenomenon and theory of the demographic transition refers to the historical shift in demographics from high birth rates and high infant death rates in societies with minimal technology, education (especially of women) and economic development, to demographics of low birth rates and low death rates in societies with advanced technology, education and economic development, as well as the stages between these two scenarios. Although this shift has occurred in many industrialized countries, the theory and model are frequently imprecise when applied to individual countries due to specific social, political and economic factors affecting particular populations (https://lisbdnet.com/what-do-demographers-study/#What_Do_Demographers_Study) .

History of the Demographic Transition Theory

The theory is based on an interpretation of demographic history developed in 1929 by the American demographer Warren Thompson (1887–1973). Adolphe Landry of France made similar observations on demographic patterns and population growth potential around 1934. In the 1940s and 1950s Frank W. Notestein developed a more formal theory of demographic transition. By 2009, the existence of a negative correlation between fertility and industrial development had become one of the most widely accepted findings in social science.

As with all models, this is an idealized picture of population change in these countries. The model is a generalization that applies to these countries as a group and may not accurately describe all individual cases. The extent to which it applies to less-developed societies today remains to be seen. Many countries such as China, Brazil and Thailand have passed through

the Demographic Transition Model (DTM) very quickly due to fast social and economic change. Some countries, particularly African countries, appear to be stalled in the second stage due to stagnant development and the effects of under-invested and under-researched tropical diseases such as malaria and AIDS to a limited extent (Lee & Reher, 2011).

As per Thompson classification

Stage one: -In pre-industrial society, death rates and birth rates were both high, and fluctuated rapidly according to natural events, such as drought and disease, to produce a relatively constant and young population. Family planning and contraception were virtually non-existent; therefore, birth rates were essentially only limited by the ability of women to bear children. Emigration depressed death rates in some special cases (for example, Europe and particularly the Eastern United States during the 19th century), but, overall, death rates tended to match birth rates, often exceeding 40 per 1000 per year. Children contributed to the economy of the household from an early age by carrying water, firewood, and messages, caring for younger siblings, sweeping, washing dishes, preparing food, and working in the fields. Raising a child cost little more than feeding him or her; there were no education or entertainment expenses. Thus, the total cost of raising children barely exceeded their contribution to the household. In addition, as they became adults they become a major input to the family business, mainly farming, and were the primary form of insurance for adults in old age. In India, an adult son was all that prevented a widow from falling into destitution. While death rates remained high there was no question as to the need for children, even if the means to prevent them had existed.

Stage two: - This stage leads to a fall in death rates and an increase in population. The changes leading to this stage in Europe were initiated in the Agricultural Revolution of the eighteenth century and were initially quite slow. In the twentieth century, the falls in death rates in developing countries tended to be substantially faster. Countries in this stage include Yemen, Afghanistan, the Palestinian territories and Iraq and much of Sub-Saharan Africa (but do not include South Africa, Zimbabwe, Botswana, Swaziland, Lesotho, Namibia, Kenya, Gabon and Ghana, which have begun to move into stage three.

The decline in the death rate is due initially to two factors:

- First, improvements in the food supply brought about by higher yields in agricultural practices and better transportation reduce death due to starvation and lack of water. Agricultural improvements included crop rotation, selective breeding, and seed drill technology.

- Second, significant improvements in public health reduce mortality, particularly in childhood. These are not so many medical breakthroughs (Europe passed through stage two before the advances of the mid-twentieth century, although there was significant medical progress in the nineteenth century, such as the development of vaccination) as they are improvements in water supply, sewerage, food handling, and general personal

hygiene following from growing scientific knowledge of the causes of disease and the improved education and social status of mothers.

A consequence of the decline in mortality in Stage Two is an increasingly rapid growth in population growth (a.k.a. "population explosion") as the gap between deaths and births grows wider and wider. Note that this growth is not due to an increase in fertility (or birth rates) but to a decline in deaths. This change in population occurred in north-western Europe during the nineteenth century due to the Industrial Revolution. During the second half of the twentieth century less-developed countries entered Stage Two, creating the worldwide rapid growth of number of living people that has demographers concerned today. In this stage of DT, countries are vulnerable to become failed states in the absence of progressive governments.

Another characteristic of Stage Two of the demographic transition is a change in the age structure of the population. In Stage One, the majority of deaths are concentrated in the first 5–10 years of life. Therefore, more than anything else, the decline in death rates in Stage Two entails the increasing survival of children and a growing population. Hence, the age structure of the population becomes increasingly youthful and starts to have big families and more of these children enter the reproductive cycle of their lives while maintaining the high fertility rates of their parents. The bottom of the "age pyramid" widens first where children, teenagers and infants are here, accelerating population growth rate. The age structure of such a population is illustrated by using an example from the Third World today (Kirk, 1996).

Stage three: - In Stage 3 of the Demographic Transition Model (DTM), death rates are low and birth rates diminish, as a rule accordingly of enhanced economic conditions, an expansion in women's status and education, and access to contraception. The decrease in birth rate fluctuates from nation to nation, as does the time span in which it is experienced. Stage Three moves the population towards stability through a decline in the birth rate. Several fertility factors contribute to this eventual decline, and are generally similar to those associated with sub-replacement fertility, although some are speculative:

- In rural areas continued decline in childhood death means that at some point parents realize they need not require so many children to be born to ensure a comfortable old age. As childhood death continues to fall and incomes increase parents can become increasingly confident that fewer children will suffice to help in family business and care for them in old age.

- Increasing urbanization changes the traditional values placed upon fertility and the value of children in rural society. Urban living also raises the cost of dependent children to a family. A recent theory suggests that urbanization also contributes to reducing the birth rate because it disrupts optimal mating patterns. A 2008 study in Iceland found that the most fecund marriages are between distant cousins. Genetic incompatibilities inherent in more distant outbreeding make reproduction harder.

- In both rural and urban areas, the cost of children to parents is exacerbated by the introduction of compulsory education acts and the increased need to educate children so they can take up a respected position in society. Children are increasingly prohibited under law from working outside the household and make an increasingly limited contribution to the household, as school children are increasingly exempted from the expectation of making a significant contribution to domestic work. Even in equatorial Africa, children (age under 5) now required to have clothes and shoes, through the body, and may even require school uniforms. Parents begin to consider it a duty to buy children(s) books and toys, partly due to education and access to family planning, people begin to reassess their need for children and their ability to grow them.

The resulting changes in the age structure of the population include a decline in the youth dependency ratio and eventually population aging. The population structure becomes less triangular and more like an elongated balloon. During the period between the decline in youth dependency and rise in old age dependency there is a demographic window of opportunity that can potentially produce economic growth through an increase in the ratio of working age to dependent population; the demographic dividend (Kirk, 1996).

Stage four: - This occurs where birth and death rates are both low, leading to total population stability. Death rates are low for a number of reasons, primarily lower rates of diseases and higher production of food. The birth rate is low because people have more opportunities to choose if they want children; this is made possible by improvements in contraception or women gaining more independence and work opportunities. The DTM is only a suggestion about the future population levels of a country, not a prediction.

Countries that are at this stage (2 < Total Fertility Rate < 2.5 in 2015) include: Antigua and Barbuda, Argentina, Bahrain, Bangladesh, Bhutan, Cabo Verde, El Salvador, Faroe Islands, Grenada, Guam, India, Indonesia, Kosovo, Libya, Malaysia, Maldives, Mexico, Myanmar, Nepal, New Caledonia, Nicaragua, Palau, Peru, Seychelles, Sri Lanka, Suriname, Tunisia, Turkey and Venezuela (Kirk, 1996).

Stage five: - The original Demographic Transition model has just four stages, but additional stages have been proposed. Both more-fertile and less-fertile futures have been claimed as a Stage Five. Some countries have sub-replacement fertility (that is, below 2.1–2.2 children per woman). Replacement fertility is generally slightly higher than 2 (the level which replaces the two parents) both because boys are born more often than girls (about 1.05–1.1 to 1) and to compensate for deaths prior to full reproduction. Many European and East Asian countries now have higher death rates than birth rates. Population aging and population decline may eventually occur, assuming that the fertility rate does not change and sustained mass immigration does not occur (https://wikimili.com/en/Demographic_transition).

In an article in the August 2009 issue of Nature, Myrskylä, Kohler and Francesco Billari argue that the previously negative relationship between "development", as measured by the Human

Development Index (HDI), and birth rates has become J-shaped. The HDI is a composite of life expectancy, income, and level of education. Development promotes fertility decline at HDI levels below 0.9 but further advances in HDI cause a small rebound in birth rate. In many countries with very high levels of development, fertility rates are now approaching two children per woman — although there are exceptions, notably Germany, Italy and Japan.

From the point of view of evolutionary biology, wealthier people having fewer children is unexpected, as natural selection would be expected to favor individuals who are willing and able to convert plentiful resources into plentiful fertile descendants. This may be the result of a departure from the environment of evolutionary adaptedness. Most models posit that the birth rate will stabilize at a low level indefinitely. Some dissenting scholars note that the modern environment is exerting evolutionary pressure for higher fertility, and that eventually due to individual natural selection or due to cultural selection, birthrates may rise again. Part of the "cultural selection" hypothesis is that the variance in birthrate between cultures is significant; for example, some religious cultures have a higher birthrate that isn't accounted for by differences in income (Kirk, 1996).

Criticisms of the Theory of Demographic Transition

Despite its usefulness as a theory describing demographic transition in Western Countries, it has been criticized on the following grounds:

1. Sequences of Stages not uniform: Critics point out that the sequences of the demographic stages have not been uniform. For instance, in some East and South European countries, and in Spain in particular, the fertility rates declined even when mortality rates were high. But in America, the growth rate of population was higher than in the second and third stage of demographic transition.

2. Birth Rate not declined initially in Urban Areas: Not been supported by empirical evidence. Countries like Sweden and France with predominantly rural populations experienced decline in birth rates to the same extent as countries like Great Britain with predominantly urban populations.

3. Explanations of Birth Rate decline Vary;

The theory fails to give the fundamental explanations of decline in birth rates in Western countries. In fact, the causes of decline in birth rate are so diverse that they differ from country to country. Thus the theory of demographic transition is a generalization and not a theory. Not only this, this theory is equally applicable to the developing countries of the world. Very backward countries in some of the African states are still in the first stage whereas the other developing countries are either in the second or in the third stage. India has entered the third stage where the death rate is declining faster than the birth rate due to better medical facilities and family welfare measures of the government (www.haldiagovtcollege.org.in).

Conclusion

The theory of demographic transition is the most acceptable theory of population growth. It does not lay emphasis on food supply like the Malthusian theory, nor does it develop a pessimistic outlook towards population growth. It is also superior to the optimum theory which lays an exclusive emphasis on the increase in per capita income for the growth of population and neglects the other factors which influence it. The biological theories are also one-sided because they study the problem of population growth simply from the biological angle. Thus the demographic transition theory is superior to all the theories of population because it is based on the actual population growth trends of the developed countries of Europe. Almost all the European countries have passed through the first three stages of this theory and are now in the fourth stage (https://idoc.pub/documents/mljhingantheeconomicsofdevelopmenpdf-vnd5989p2glx).

STABLE POPULATION GROWTH

The concept of a stable population was first introduced into demography by Alfred J. Lotka as a particular case of a Malthusian population. Lotka went on to demonstrate that a stable population could also be considered as a limit state towards which populations with unchanging mortality and fertility tended, and it is primarily this second aspect which has received attention from demographers. The distinction between the two different approaches is not very clear in Lotka's work, however, and it seemed worthwhile to define it more precisely at the beginning of the present work (https://www.un.org/esa/population/techcoop/DemMod/concept_stablepop/chapter1.pdf).

A Malthusian population is a population whose mortality and age-sex structure are constant. It is important to note that these characteristics are not assumed to be known. The only assumption is that they are constant. Various properties of Malthusian populations follow from this assumption.

(1) As the age structure and mortality are constant, it follows that the age distribution of deaths is also constant.

(2) If a represents the age, C(a) the age structure for both sexes together, and b the crude birth rate, we have:

$$C(O) = b$$ The crude birth rate is therefore constant.

(3) As both the mortality and the age structure are constant, it follows that the crude death rate d is also constant.

(4) The rate of natural variation r = b - d is therefore also constant.2 Thus for the total numbers of population, of births and of deaths at time t, we have the following expressions in which A is a constant equal to the total number of the population at the initial condition:

$$N(t) = Ae^{rt} = N(O)e^{rt}$$

$$B(t) = bN(O)e^{rt}$$

$$D(t) = dN(O)e^{rt}$$

(5) If p(a) is the survivorship function for both sexes, the number of persons of age a at time t is:

$$B(t - a)p(a) = Abe^{rt}e^{-ra}p(a)$$

They also number:

$$N(t)C(a) = Ae^{rt}e(a)$$

so that we have: $C(a) = be^{-ra}p(a)$

(6) If (U represents the upper limit age of life, as C(a) is a distribution, it follows from the definition.

(7) It was stated above that in a Malthusian population the sex distribution is constant. In fact, however, it is sufficient to assume that the masculinity at birth is constant. If this masculinity-the ratio of male births to female births-is represented by m, the expressions for female and male births will be respectively (https://www.un.org/esa/population/techcoop/DemMod/concept_stablepop/chapter1.pdf).

Problems in Stable Population Theory

As a part of his work in physical biology, Lotka gave a dynamic treatment to the age structure of a closed population having a fixed schedule of age specific fertility and mortality rates. He showed that ultimately such a population, termed a stable population, would be growing geometrically, with a fixed age distribution determined by the schedules of rates and independent of the initial age distribution. These results gave a tool that was extensively used by some demographers, though others argued that the conditions postulated precluded its utility in human population analysis. Lotka's work was also a stimulus for extensive and rigorous analysis in the more general field of renewal theory, and this analysis raised for consideration the conditions under which Lotka's proof was valid.

In the first part of the present book, Dr. Lopez treats analytical questions related to Lotka's proof, the first two of his five chapters being concerned primarily with the theory of stable populations. He restates Lotka's proof with appropriate recognition of the conditions of continuity and gives a proof that the exponential series used by Lotka is convergent over the necessary range. He follows this with a proof of the stable population theorem under discrete conditions, following the method developed by Feller for treating renewal theory. Thus he answers the mathematical questions that had been raised with regard to Lotka's proof and concludes that "we must accept the fact that Lotka's exposition of his continuous stable model was after all correct and that all his formulae can be used in actual practice without fear of being wrong"

EQUILIBRIUM POPULATION

The definitions of equilibrium discussed so far all share the feature that something is in balance. The balanced state, however, takes on different forms in the various scientific disciplines. In statics dynamics, chemistry, and thermodynamics the Terni equilibrium is applied to closed systems. The elements that form the balanced state are part of the closed system. And input of other elements cm be regulated and their effects calculated. The forces governing the equilibrium state are important because they determine whether an equilibrium can be manipulated or achieved. The focus in statics, dynamics and chemistry is on the equilibrium state itself.

In thermodynamics a balance of nature is seen as more or less inevitable. Systems exchange energy until al1 differences between the systems are evened out. In open systems a constant influx of energy occurs. This requires a more dynamic notion of balance, the steady state. The thermodynamic concept emphasizes the mechanisms that idea to the steady States and the focus is on the exchange processes between systems. The equilibrium state is not a starting point with which to measure the influence on equilibria, but an end point to which the system tends. An attractor state of the system. This means the equilibrium state just happens and. according to the statistical interpretation, it is the most probable result of an energy exchanging process. Because in natural processes energy is exchanged. Al1 of nature follow the path of statistical equilibrium (https://www.collectionscanada.gc.ca/obj/s4/f2/dsk2/ftp03/NQ57352.pdf).

In population ecology the concept of balance is related to the regulation of animal populations. The basic question is how, for example the rapid increase of a fast population can be predicted. The claim that a mechanism exists that is responsible for the regulation of populations was made by the Australian ecologist A. J. Nicholson. According to him populations are related by their own density through intraspecific competition. With this claim Nicholson provided a causal mechanism for an equilibrium state, which was the outcome of the regulation. Nicholson's reasoning has been criticized ever since. For critics of the equilibrium concept the assumption of regulating factors acting in a density dependent fashion is misguided. Critics admit that populations are stabilized, but according to them, this is due to environmental

factors. They argue that density-dependence is too weak to be acting in a heterogeneous environment.

Equilibrium in a population exists when the birth and death rates are equal; net growth rate is zero (MacArthurand Wilson, 1967). Such an ideal prevails only momentarily in stochastic environments, but here equilibrium will exist when population size fluctuates with a steady average variance around an average population size (May,1973). Stable populations will have low variance, and unstable populations will have high variance. The concepts of equilibrium and stability dominate theoretical ecology today as they have dominated this science and general biology since their beginnings.

A population in a non-equilibrium state may be defined as one that does not fluctuate within a typical probability range around an average population size. Steady population growth following colonization with rapid extinction yields no indication of an equilibrium. Population size during tenure of a site in which carrying capacity changes stochastically also reveals no equilibrium. In the absence of an identifiable equilibrium the terms stable and unstable as used above become derelict. Where "stable" non-equilibrium behavior of populations has been identified, the term has been more closely allied to the concepts of persistence and resilience in populations (May, 1973).

UNIT: - 6

POPULATION POLICIES – PRO AND ANTI NATAL, COMPARATIVE STUDY OF POPULATION POLICIES BETWEEN INDIA AND CHINA

INTRODUCTION

Population dynamics play a critical role in the achievement of social, economic and environmental development. Changes in the growth, age structures and the distribution of the population determine and influence the implementation and achievement of the goals and targets agreed by the international community in the 2030 Sustainable Development Agenda. Population dynamics can pose both challenges and opportunities to development efforts. While one country may be struggling to ensure universal access to services in a context of rapid population growth, another may see the realization of demographic dividend derived from the decline of fertility and mortality. Whether demographic changes can be harnessed for the success and sustainability of development strategies at the international, regional and national levels, is determined by the implementation of effective population policies that are rights-based, evidence informed and gender responsive.

In this context, the need to monitor population policies and programmes remains crucial. The systematic monitoring of population policies at the international level began after the World Population Plan of Action–the first global intergovernmental instrument on population policy–was adopted in the World Population Conference held in 1974. Subsequent population conferences, including the Programme of Action of the International Conference on Population and Development (ICPD) held in 1994, have emphasized the need to monitor population policies and programmes. Various internationally agreed development plans, including the 2030 Agenda for Sustainable Development, have also included a number of targets and indictors to monitor population-related policies and programmes (https://www.collectionscanada.gc.ca/obj/s4/f2/dsk2/ftp03/NQ57352.pdf).

POPULATION POLICIES – PRO AND ANTI NATAL

Pro-natal

'Control over our bodies' is more than a feminist slogan; it is a revolutionary concept. In order to be assured of control over reproduction, women, at a minimum, must have economic independence, they must have the freedom to bear or not to bear children regardless of their marital status, and they must be in control of much of society. And having gained control over reproduction, women will possess enormous political and economic power. This is a central dilemma of the feminist movement. On the one hand, the control of fertility by women as individuals is necessary for full and equal opportunity in society. On the other hand, the aggregate level of fertility is so important that no society can allow the individual full freedom of choice regarding reproduction. A woman's shackles are also her strength, and this is what makes the 'woman problem' so intractable. The major questions emerge from this dilemma. First, can birth control be separated from population control? And second, if not, how can women achieve maximum individual reproductive freedom?

All societies intervene in procreation. The processes of giving birth and raising children are too important for societies to leave uncontrolled, though controls do not always work. Aggregate fertility ultimately determines the survival of a given population (which, statistically speaking, depends upon excess of births over deaths), the growth and structure of the economy, the structure of the family or kin group (especially dependency ratios), and national economic, political and military power. All these in turn are critical factors in most international and sub-national, especially ethnic, relationships (http://link.springer.com/10.1007/978-1-349-07162-3).

Prolonged fertility decline also introduces some significant changes in the frequency and structure of diseases, which can alter aggregate demand for particular health and social services. For example, fertility of 1-3 children per woman, concentrated in her early adult reproductive years, decreases obstetrical and neonatal risk. As well, an overall decline in births tends to reduce employment opportunities for paediatricians and obstetricians and corresponding nursing specialties, while an ageing population tends to increase social demand for geriatric care, because the elderly tend to suffer from the 'more expensive' chronic diseases much more frequently, and in greater proportions, than children. However, the existence of a demographic need does not in itself guarantee that it will be socially met. Public expenditures on particular social services are related to political pressures that tend to determine the proportion of the gross national product (GNP) that can be distributed by the central government for social purposes. These processes also tend to determine the social standards of care and quality as well as the provision of trained personnel, all of which can vary over time as well as cross-culturally (http://link.springer.com/10.1007/978-1-349-07162-3).

Reproductive rights vs. pro-natalist population policy agenda

Contemporary concept of reproductive rights encompasses series of rights and freedoms related to human reproduction, based on the principle of self-determination of individuals in respect to whether, when and how many children they will have. An important segment of these rights demands the highest possible standard of sexual and reproductive health, including sexual education, fertility treatment, safe pregnancy and delivery. Some authors extend the interpretation of the right to give birth to encompass the right to alimony, family allowance, and paid maternity and parental leave. In case when the right to not give birth is exercised, high standard of sexual and reproductive health is obtained through the right to contraception and safe abortion. As the so-called second generation of human rights, reproductive rights and freedoms involve a set of institutional guarantees by the state agencies providing access to all the relevant information and creating the necessary conditions, primarily concerning socio-economic position of women, for their enactment.

In its turn population policy, to the extent to which it is concerned with the magnitude of population, claims access to the means of fertility regulation so that it could modify reproductive behavior in the socially desirable direction. Depending on its objective, population policy could take a course of population control – representingthe attempt to reduce fertility rates in the population or in its particular groups– or of pro-natalist population policy – representing the attempts to enhance the fertility rates in the population as a whole or in some

of its groups. The latter course of population policy was particularly actualized in Serbia in the late 1980s and during the 1990s (http://doiserbia.nb.rs/).

After 2000, with the regime change, Serbia entered a period of comprehensive constitutional, political, economic and social reform involving diverse actors striving to place their interests on political agenda. How do the defenders of reproductive rights of women fare in this respect, in this period? Do they get enough exposure in mass media in terms of influencing public opinion and policy-makers themselves in relation to the relevant policy issues? We particularly focus on possible threat to the reproductive rights of women stemming from a pro-natalist population policy to the extent in which it is framed in terms of a selective concern for fertility rates and population growth of just one national group, with regard to a "proper" family form, and with a postulated either "natural" role or social responsibility (duty) of women as mothers. Regarding policy recommendations, the objectives immanent in the complex of reproductive rights of women and in the pro-natalist population policy are not necessarily conflicting in themselves. If the state chooses to enhance the fertility rates by actively creating social, economic and cultural conditions which enable individuals to bear and care for children if they want them and when they want them, but at the same time equally eagerly guarantees and facilitates the right to not give birth to the individuals who do not want children and when they do not want them, the two agendas are not at odds. From the perspective of feminist scholars the best family planning is based on exercising reproductive rights without any social or legal coercion – allowing giving birth to wanted children and avoiding giving birth to the unwanted ones (Đorić & Gavrilović, 2006).

Challenges and Prospects

Due to the "explosive" demographic transition in sub-Saharan Africa, Africa's share of the world population will increase dramatically. Asia's population will also continue to increase, whereas the European population is poised to decrease slowly until 2050, and more rapidly between 2050 and 2100.The reshuffling of the demographic weight among the different regions of the world will inevitably have significant geopolitical consequences for Europe, not the least because of potentially increasing migratory flows toward European and EU countries. Europe also faces the challenge of population aging, which in some countries (e.g., Germany) translates already into labor force shortages. To be sure, the three main challenges that the European countries are facing, i.e., sub-replacement fertility, population aging, and immigration, are quite difficult to address. Nevertheless, policy responses to these demographic challenges will have important consequences for the sustainability of the socioeconomic achievements of European countries (United Nations, 2015).

In many European countries population issues have not yet received the priority they deserve. India terence and lack of concern about demographic issues have often prevailed. As mentioned, the debate, if and when it occurs, is marred by controversy and passion. Non-interventionists are opposed by those who wish to take action. Demographic problems are not analyzed in a pragmatic way, free of political or ideological agendas. Too often, demographic issues are framed by the traditional opposition between Left and Right. A further complicating

factor is that information sources and relevant stakeholders are fragmented (i.e., public administrations dealing with population issues).

Many policymakers, demographers, and intellectuals do not see the need to intervene on demographic patterns and trends and in particular to design policies to increase fertility. Some demographers have even dubbed a "demographic obsession" any interest into future population trends. On the contrary, others have highlighted dire scenarios should fertility remain below replacement levels, promising that soon an aging Europe would be overwhelmed by waves of immigrants. The constituencies call for immediate actions, in particular to increase low levels of fertility and regulate migration in flows.

With respect to the policies and regulations that are needed, one of the most pressing concerns is to obtain a policy consensus on which interventions to propose and implement. This is necessary in order to muster the goodwill and commitment of policy constituencies, namely political leaders, public authorities, the media, and the general public. In addition, one should enlist the support of demographers, political scientists, and intellectuals, whose contribution is important to inform the public debate and help design adequate policy responses. Finally, the support of all these constituencies will also be necessary for the implementation of the policies, as well as their proper monitoring and evaluation (https://www.studyvillae.com/2019/07/gawp-phase-2-day-5-synopsis/).

Anti-natal

The meaning of population policy is complex and ill-defined. Different governments treat their 'population problem' and its eventual consequences with varying degrees of urgency. One point which seems to be common to the rationale behind all population policies — despite some eugenic, nationalist or even racialist elements in the discussion — is that measures are generally a response to assumed future manpower requirements. Since the late 1960s, anti-natalist ideas have prevailed in many Western countries, largely because the natural increase of population has not been regarded as relevant to future manpower requirements; in large measure, the current advocacy of population control and zero growth appears as a response to the fear of shortage of resources brought on by the population explosion.

The intend of anti-natalist policies is to decrease the total fertility rate, as well as the crude birth rate, in order to sluggish the population growth. It encourages families to have fewer children. It is also termed as restrictive population strategy. Human consumption is depleting the Earth's natural resources impairing the capacity of life supporting ecosystems. Human beings have changed ecosystems more rapidly and extensively over the past 50 years than during any other period, primarily to meet increasing demands for food, fresh water, timber, fibre and fuel. Such consumption, together with world population increasing from 2.6 billion in 1950 to 6.8 billion in 2009, are the major contributors to ecological damage (Ye & Huang, 2016).

Population Policy in China

Improving the living conditions of the population was a priority of the Communist government when they took power in 1949, but such rapid growth made any improvement in people's living standards difficult. As a response to this rapid growth, the government introduced a series of extreme family planning programmes.

Why control population?

1. Food production: - One of the major challenges for China is to produce sufficient food, mostly grain, to feed its expanding population. The idea was stated in the early years of Communist rule in China, that the doubling of the population in the eighteenth and nineteenth centuries was 'creating an unbearable pressure on the land' However, Mao Zedong's rebuttal of this American statement was that 'people were the most precious of all things'. Mao disputed the Malthusian argument that food production could not keep pace with population increase and maintained that " it is a very good thing that China has a big population. Even if China's population multiplies many times, she is fully capable of finding a solution; the solution is production." Total and per capita food production has been increasing steadily since 1950. However, production during recent years was unable to match this steady growth and has fluctuated around the 450 billion kilogram figure. This fluctuation of grain production poses a real problem as the population continues to grow. The population of China is forecast to grow by 375 million over the period 1995 –2040 - more than the total population of the USA and Japan
(http://www.thegeographeronline.net/uploads/2/6/6/2/26629356/55_population_policy.pdf).

2. Unemployment: -Unemployment and underemployment are serious problems that China could face as its population increases. The recent development of urban based industries has provided many employment opportunities, and surplus agricultural workers have migrated to urban areas. However, unemployment within China has grown from 1.8% in 1985 to 2.9% in 1995. This figure may increase into the next century. It is estimated that the working age population of China will increase by 30% between 1995 and 2020.

Recent population policies in China: -In the 1970s, the government introduced a population policy with the explicit objective of reducing population growth. The measures implemented to reduce fertility were summed up in the slogan 'later, longer, fewer'. This signified later marriages and pregnancies, longer intervals between children and fewer children. During the 1970s, in less than 10 years, fertility levels declined at a rate not seen before in an agricultural nation. By the end of the decade, women were having half as many children as before. There had been a decline in total fertility rates from 5.81 in 1970 to 2.72 in 1978. However, despite the relatively low total fertility rate, population increase will continue for many years to come as a consequence of population momentum - the very high numbers of young people in the population producing large numbers of children as soon as they reach child-bearing age. The demographic population policy target set in 1979 was to limit population numbers to 1200 million and to reach zero growth by the year 2000. In 1986, when it was obvious that this ambitious target was not likely to be achieved, the limit was adjusted to 1300 million.

The one-child policy: -In 1978, the most harsh and controversial family planning policy to date was introduced, the one-child policy. There has been widespread rural resistance to this programme, because rural families consider children, especially boys, a necessity for labour and old-age security. This has now been recognised politically which means that in practice, the one-child policy is not implemented nationally, but only in urban areas. Roughly half of China's population lives in the countryside, so a significant proportion of families are permitted

to have a second child. A major consequence of the one-child policy has been the changing sex ratio within the country, itself a consequence of the higher mortality rates for female children. Between 1954 and 1964, roughly the same number of males and females were born. There will always be slightly more males born, but male mortality at birth is slightly higher than female. However, in 1982, the ratio of girls to boys born in China was 100:110. In 1990, the problem had got worse and the sex ratio had risen to 100:111.7 at birth. In addition to this, there were more females than males dying in the first year after birth.

There are several suggested explanations for the sex-ratio imbalance.

1. Female births are under-reported. Couples whose first child is female are allowed to have a second child. However, couples whose first child is male are not allowed to have a second child. To get around this, it is suggested that many couples fail to tell the authorities if their first child is male.
2. Female babies are killed at birth (female infanticide).
3. The use of ultrasound equipment allows couples to selectively abort female foetuses.

Age-related problems

The baby boom of 1962-1973 will, in time, produce a retirement bulge in the 2030s. By this time, the over 65s could constitute more than 25% of the total population and thus, within a lifetime, the number of retired will have increased from one in twenty of the population to one in four. This degree of dependency is far greater than that seen in western countries with their 'greying' population and may well be a hindrance to the further economic development of China, especially if the present retirement ages, of 55 for women and 60 for men, remain.

Successes of China's One Child Policy

1. The total fertility rate has fallen from nearly 6 to about 1.7
2. Population growth rate has fallen from a peak of 2.61% in the late 1960's to about 0.65%
3. Today birth rates have fallen from highs of 45 to about 13 today.
4. The availability of contraception has increased
5. Up to 250 million births have been prevented since 1979
6. China's population should peak in the first half of the 2030's (however, it might be as much as 1.45 billion)

China's family planning policy has prevented 400 million births. This policy is a success as this added amount in China today would cause a serious strain on resources. However, the policy has severely changed the traditional Chinese family, from having many children to only one. There are still many Chinese people who do not and will not agree to only having one child, but overall, the policy has been very successful in stabilizing China's population (Greenhalgh, 1986).

Failures of China's One Child Policy

1. There have been criticisms about human rights, not only over freedom of choice, but forced abortions and sterilisations.

2. Female infanticide has taken place, where the boys have been favoured.
3. There is now a sex imbalance in China (117:100).
4. Many children have been abandoned for adoption.
5. There is an ageing population and an increased dependency ratio.
6. There has been shortage of workers in some areas.
7. The so called 'little emperors' syndrome where only children are spoilt.

The penalties for having more than one child were very harsh and many have criticized the One Child Policy for its claimed abuses of individual rights. There have been many reports of the use of ultrasound foetus sex determination and selective terminations, as boys are still seen to be of more value than girls, especially in rural areas of China. Female infanticide has also been common, as well as child trading and infant abandonment. Many of the family planning providers have been accused, following the birth of the first child, of forcing both late terminations and sterilization. Due to female infanticide, the number of men is thought to outnumber women in China by more than 60 million, which means that by 2020, there may be 30 million men of marriageable age who will not be able to find a wife. This will cause major problems for the population. Because couples acknowledge that they will only have one child; they aim to bring them up in the best possible way, leading to many young boys being classed as 'Little Emperors' as they are failed by their parents. China now has an increasingly ageing population, which means that the elderly need to be provided for, for longer. With only one child to support both elderly parents, this is going to reason economic problems (Arid, 1982).

INDIA'S ANTI-NATAL POPULATION POLICY

India is one of the most populous countries of the world, next only to China. The National Population Policy-2000 aims at stabilizing the population by the year 2045. The UN report, 2005, however paints a gloomy picture for India in its document 'Population Challenges and Development Goals'. As per the current UN projections, India will overtake China by the year 2030, though as per the earlier UN reports India had been projected to overtake China by the year 2050. With the fast depleting resources it becomes mandatory to control the population growth within limits so as to ensure better standard of living and to conserve its resources for the generations to come. It therefore becomes imperative to have an objective analysis of the population growth in India as per its immediate past trends and socio cultural perspectives, so as to formulate an effective population control policy.

India's brief flirtation with coercive family planning is over. The programme suffered a major setback during the Emergency, and it will be some time before new initiatives can be mounted. Meanwhile, it is important to analyse past experience with the aim of identifying major issues and options that confront the policy-maker in the population field. This is the major purpose of this paper which is mainly concerned with fertility and not with mortality, migration or other topics which might conceivably fall under the heading of population policy. Its object is not to add to the large volume of scholarly research on the analysis of past trends in the birth rate or to make future projections. It takes for granted the need to reduce Indian fertility in the interest of economic and social development; this point has been argued convincingly in many places. Given this objective, the present paper focuses on the policy instruments deployed in the past and proposed for the future (https://www.ijrcog.org/index.php/ijrcog/article/view/176).

The next section looks at the major demographic facts - the rise in marriage age and decline in marital fertility - that lie behind the decline in the birth rate during the last two decades. An attempt is made to analyse the contributions to declining fertility of the family planning (F.P.) programme and of socio-economic changes at national, state and household levels. The following section dissects recent population policy statements and evaluates their feasibility and effectiveness. Finally, Section III takes up a number of questions which appear to be important but which have been neglected in these policy pronouncements. Now that the Government and major political parties have re-asserted the voluntary principle, it is essential to examine all avenues of reform compatible with that principle which can help in rehabilitating India's F.P. programme.

The main features of this policy were

(a) Renaming the family planning programme into family welfare programme.
(b) Fixing the marriage age for girls at 18 years and for boys at 21 years. This has been implemented by the Child Marriage Restraint (Amendment) Act, 1978.
(c) Making sterilisation voluntary.
(d) Including population education as part of normal course of study.
(e) Monetary incentive to those who go in for sterilization and tubectomy.
(f) Private companies to be exempted in corporate taxes if they popularise birth control measures among employees.
(g) Use of media for spreading family planning in rural areas, etc. this policy put an end to compulsory sterilisation and laid emphasis on voluntary sterilization. This slowed down the family planning programme. As a result, the number of sterilizations fell from 82.6 lakh in 1976-77 to 9 lakhs in 1977-78.

The Sixth Plan laid down the long-term demographic goal of reducing the net reproduction rate (NRR) to 1 by 2000 by reducing crude birth rate to 21, crude death rate to 9, infant mortality rate to less than 60 per 1000, and couple protection rate (CPR) to 60 per cent. The goal of attaining NRR of 1 was revised to 2006-11 in the Seventh Plan by reducing crude birth rate to 29, crude death rate to 10.4, infant mortality rate to 90 per 1000, and couple protection rate to 42 per cent. Further, the Seventh Plan laid emphasis on the two-child family norm. To make it successful, it intensified family planning and maternity and child health programmes. To achieve the goal of NRR of 1, the Eighth Plan extended it to the period 2011 -16.

The targets laid down during the Plan were crude birth rate at 26, infant mortality at 70 per 1000 and couple protection rate to 56 per cent. To achieve these, the Government replaced the earlier Population Control Approach by the Reproductive and Child Health Approach in October 1997 to stabilise population and improve quality of life. The focus of this approach was on decentralised area specific macro-planning. It led to several new schemes for improving quality and coverage of welfare services for women, children and adolescents such as child survival, safe motherhood programme, and universal immunisation programme (UIP), reproductive tract infections (RTI), etc. During the Ninth Plan, the earlier approach of using NRR (Net Reproduction Rate) of 1.0 was changed to a Total Fertility Rate (TFR) of 2.1. This level of TFR had been projected to be achieved by 2026 in the Plan.

INDIA'S NATIONAL POPULATION POLICY (2000)

The overriding objective of economic and social development is to improve the quality of lives that people lead, to enhance their well-being, and to provide them with opportunities and choices to become productive assets in society. In 1952, India was the first country in the world to launch a national programme, emphasizing family planning to the extent necessary for reducing birth rates "to stabilize the population at a level consistent with the requirement of national economy" After 1952, sharp declines in death rates were, however, not accompanied by a similar drop in birth rates. The National Health Policy, 1983 stated that replacement levels of total fertility rate(TFR) should be achieved by the year 2000.

On 11 May, 2000 India was projected to have 1 billion (100 crore) people, i.e. 16 percent of the world's population on 2.4 percent of the globe's land area. If current trends continue, India may overtake China in 2045, to become the most populous country in the world. While global population has increased threefold during this century, from 2 billion to 6 billion, the population of India has increased nearly five times from 238 million (23 crores) to 1 billion in the same period. India's current annual increase in population of 15.5 million is large enough to neutralize efforts to conserve the resource endowment and environment. Stabilising population is an essential requirement for promoting sustainable development with more equitable distribution. However, it is as much a function of making reproductive health care accessible and affordable for all, as of increasing the provision and outreach of primary and secondary education, extending basic amenities including sanitation, safe drinking water and housing, besides empowering women and enhancing their employment opportunities, and providing transport and communications (Agarwal, 2001).

Objectives

There are three types of objectives of National Population Policy (NPP) 2000 (https://www.yourarticlelibrary.com/essay/population-policy-of-india-with-statistics/39572/):

1. The Immediate Objective: The immediate objective is to address the unmet needs for contraception, health care infrastructure and health personnel and to provide integrated service delivery for basic reproductive and child health care.

2. The Medium-Term Objective: The medium-term objective is to bring the Total Fertility Rate (TFR) to replacement level by 2010 through vigorous implementation in inter-sectorial operational strategies.

3. The Long-Term Objective: The long-term objective is to achieve a stable population by 2045 at a level consistent with the requirements of sustainable economic growth, social development, and environment protection.

National Population Policy 2000 highlights

1. It reiterated the government's resolve to push for voluntary and informed choice and agreeability of citizens to get maximum benefit from reproductive health services.

2. It embarks on a policy outline for the government for next ten years to improve the reproductive and child health needs of people of India which include issues like child survival, maternal health, contraception, etc.
3. School education upto age of 14, to be made free and mandatory. This will also include plan to check drop-out rate of boys and girls.
4. The policy also aims at curbing the IMR to less than 30 per 1000 live births.
5. The Maternal Mortality Rate will also be brought down to less than 100 per 1, 00,000 live births. A high MMR is a symbol of economic and social disparity of the fairer sex. It also points to heightened inequities in terms of healthcare and nutrition.
6. Another important feature of the policy is to attain universal immunization of all children against preventable diseases.
7. The policy will also act against child marriage and promote 20 years as the right marriageable age for girls. The legal age for same is 18 years.
8. The policy will actively support a target of 80% institutional deliveries and 100 % deliveries by trained persons.
9. It also seeks to achieve 100 % registration of births, deaths, marriages and pregnancies.
10. Preventing and controlling all communicable diseases.
11. It will also strive to Integrate Indian Systems of Medicine to provide reproductive and child health services by reaching out to households.
12. It thus will seek to integrate and converge all related social sector programmes so that complete family welfare and health can be taken care of and properly maintained.
13. NPP 2000 also emphasizes the role of Ayurveda, Yoga, Unani, Siddh and Homeopathy (AYUSH) medicine system to serve the goals of public health.
14. The NPP 2000 strived to change the mindsets of people from base level. Its intense focus on women empowerment has led to improvement in many national statistics. However, there has been a great upsurge in the number of institutional deliveries but there has not been a parallel increase in the healthcare staff. This has led to immense pressure on health facilities and officials and an obvious degradation of quality of services. Also, at many places there is an acute shortage of medicines, staff and other related materials (https://www.gktoday.in/gk/national-population-policy-2000/).

Critical Assessment of India's Population Policy

India's national population policies have failed to achieve their objectives as we remain world's second largest populated country. The population of India in 1951 was 35 crore, but by 2011, it had increased to 121 crore. There have been few shortcomings. Firstly, the NPP have a narrow perspective, give much importance to contraception and sterilisation. The basic prerequisite of meaningfully controlling population include poverty alleviation, improving the standards of living and the spread of education. Secondly, on national scale the policy was not

publicised and failed to generate mass support in favour of population control. Thirdly, we have insufficient infrastructure owing to the lack of trained staff, lack of adequate aptitude among the staff and limited use or misuse of the equipment for population control resulted in failure of the policy. Lastly, the use of coercion during the Emergency (1976-77) caused a serious resentment among the masses. This made the very NPP itself very unpopular (Agarwal, 2001).

UNIT: - 7

CONCEPT OF EKISTICS; STUDY ON SETTLEMENT HIERARCHIES

INTRODUCTION

"Health is the state of complete physical, mental, and social well-being and not merely the absence of disease... These well-worn lines from the WHO charter sum up our cities: diseases decline, man decays physically, mentally, and socially. If Public Health approaches the crisis ecologically, five elements must be taken into account: nature, in all its resources and its ecological processes, as these affect man, who is himself the most ubiquitous aspect of our environment; shells, meaning houses, buildings and structures of every kind; society in all its social, cultural, economic, political, and legal aspects; networks of communication, transport, and land use which relate man and space. The formulation of these five elements and the comprehensive analytical system which relates them to man and his communities comprise the work of an architect and planner, C. A. Doxiadis. He calls it "Ekistics," the science of human settlements. It is a coined word from good Greek roots; it is ecology applied to "the well-being of man" as an urbanizing animal.

As head of an architectural and planning firm with world-wide operations, as founder of the Athens Technological Institute, and the organizer of the Athens Centre for Ekistics, Mr.Doxiadis has had vast opportunity to test his science and to persuade. The dialogue he has generated has involved legal scholars and legislators, historians, economists, sociologists, physicians, geneticists, as well as planners and architects: 39 disciplines in one recent conference. So far it has involved too few public health professionals; one hopes that it will involve more, for the author is asking the essential questions. This volume is the most comprehensive statement of a theme upon which Mr.Doxiadis has written and lectured for more than a quarter of a century. It should be in very public health library and on the bookshelf of scholars and practitioners (https://books.bk.tudelft.nl/press/catalog/book/505).

Ekistics and Human Settlements

The Ekistics Theory drawn up by Doxiadis focused on city growth. “Human settlements are no longer satisfactory for their inhabitants”, he said in the introduction of his book “Ekistics: an introduction to the science of human settlements” in 1968. He considered that in contemporary cities there was an imbalance between elements such as transportation, zoning and communication. In the preface of his “Architecture in Transition” in 1963, the author stated that the decision to publish this book before another one entirely focused on the Ekistics Theory was due to the implications of architecture in current times. According to him, his ideas at the time were aimed at architects and not urban planners. In addition to offering “a new approach” that provided a framework for the architect’s work, this theory coordinated other disciplines and assigned architects with a new role.

Fig: 1 - Ekistics and the interface with other disciplines.

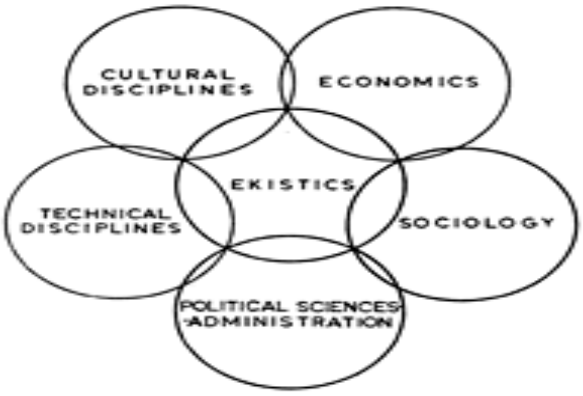
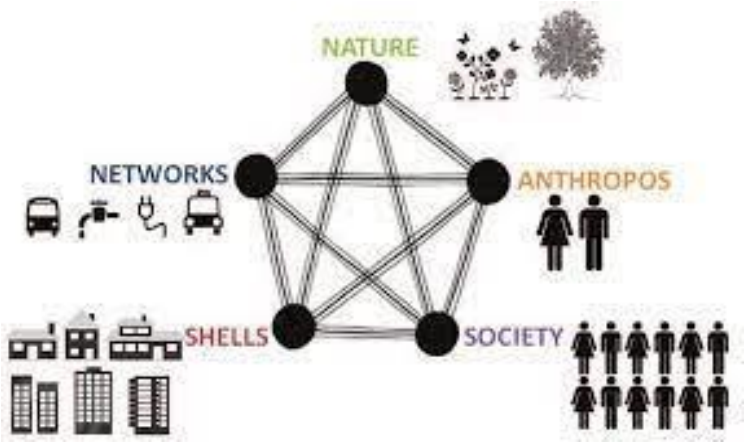


Fig: 2 - The Network of Five Elements



Source: -(Figure 1 and 2) Farizkha et al., IOP Conference series, 2019

Ekistics (from oikos the ancient Greek word for house or dwelling) is the science of human settlements. It combines economics, sociology, political sciences, administration, technology and aesthetics within a coherent group, thus resulting in the creation of a new human habitat. The essential knowledge provided by Ekistics would encourage architects to understand space in an innovative manner. For example, he said that the plan for Greater Mussayb, in Iraq, bore a stronger resemblance to natural calcium carbonate formations than to an architectural product. The intent to create a type of science was not only present in Ekistics but also in architecture, as it claimed to foresee the ecumenical architectural zones that would prevail in the future of mankind. “He needs to be a scientist and also carry out research”, he would say about architects. This assumption was close to the ideals of the International Congress of Modern Architecture (CIAM), which aimed at setting a universal paradigm (Hein, 2016).

According to Doxiadis, the development of a scientific approach or the elevation of Ekistics to the category of science would provide the necessary international recognition, including from the United Nations. His views on cities were based on man and human unity (“the human

sector"), which expanded in a parabolic manner and resulted in Dynapolis (https://journals.open.tudelft.nl/iphs/article/view/1332).

1. Nature: - The initial element, represents the ecosystem within which rural settlements must subsist. It involves a figure of module processes including the hydrologic cycle, bio-systems, air-sheds, climatic zones, etc. Archaeological studies illustrate that even primitive man with limited tools made profound changes in natural systems. Over-cultivation in the Thar Desert of the Indian subcontinent and overgrazing in the Middle East are two examples of how early cultivations weighted the natural balance and tipped it towards an uninhabitable landscape. If such significant changes in the natural system could be brought about by such limited numbers of men, it seems logical to suppose that today's 6,000 million persons must have far greater effectiveness in fouling the planet. And, if the earth is to support 30,000 million people in the future, the interrelationships and ranges of adaptability of human settlements and natural processes should be very clearly understood and observed, for neither can survive without the other. At another level we cannot forget man's psychological and physical needs for contact with the world of environment.

2. Anthropos: -The man himself is also constantly adapting and changing. The medicinal profession, in its move from "barbarism" to concepts of the constitution of the healthy individual, can contribute many important inputs to the better organization of urban life. Studies have shown that certain physical and psychological diseases are directly associated with urbanization. These include fatness, respiratory ailments and alienation (anomie). This gives rise to lots of questions, such as whether it is possible for mankind to adapt to a completely urban world with no rural escapes; what urban densities "are tolerable"; and how the metropolis may be made a satisfactory environment for the growing child. Thus, just as forward-looking medical and public health schools find a need to study the city, city builders must turn to study man.

3. Society: - Comprises all those aspects of the urban or rural scene that are commonly dealt with by sociologists, economists and administrators: population trends, social customs, income and occupations, and the systems of urban administration. One of the most urgent aspects of society seems to be the problem of the retention, or reorganization, of values inherent in independent small communities after these have become incorporated in megalopolis — in other words, the place of the neighbourhood in megalopolis.

4. Shell: - The built surroundings, is the traditional domain of the architectural and engineering professions. Here a central problem is how mass-produced, anonymous housing can cater for the needs of very diverse individuals and family groupings. Where can man make his own mark? Where can he leave the touch of his own hand?

5. Networks: - provide the glue for all systems of urbanization. Their changes profoundly affect urban patterns and urban scale. We have only to think of the effect of the advent of the railroad, or of piped water supplies, or of the telephone, upon the extent, the texture and the densities of human settlements. The increasingly rapid developments of all types of networks — coupled with population pressures — have been the most potent heralds of megalopolis. The enormous growth in the uses of energy for the communication of ideas has whetted man's appetite for participating in all sorts of things that were formerly outside his ken. The television screen has stimulated desires both to participate in new sports, such as skiing, etc., and to

participate in debates — political representation, etc. To respond to man's demands, transportation, communication and utility networks must all expand even faster than the anticipated growth of settlements (http://plannerspace.blogspot.com/2017/11/human-settlement.html).

STUDY ON SETTLEMENT HIERARCHIES

Any place where human beings have established a community, especially one that was previously uninhabited, is considered a settlement. All communities, from small individual dwellings of a few people to large conurbations with millions of people, are considered settlements. Like many other aspects of human society, all the different types of settlements around the world can be organized into a hierarchy, or a formal ranking from top to bottom, in a concept known as settlement hierarchy. The definition of settlement hierarchy is that settlements can be divided into groups based on their population and access to certain services, as well as the frequency to which they can be found in the world. Geographers around the world use settlement hierarchy theory to understand the history of the development of certain areas, and planners in countries such as the United Kingdom use it to determine which places require which services, like transportation or medical infrastructure.

The idea of hierarchy was introduced by Walter Christaller (1933), a German Economic Geographer in his well-known Central Place Theory. The word 'Hierarchy' is not a geographical term. Hierarchy is a universal phenomenon due to variation in size and functions. The gradation and grouping the settlement centres into the size of classes is termed as hierarchy. The concept of hierarchy is fundamental to the central place theory. A character of central places to serve their respective surrounding, region in terms of cultural, commercial and administrative requirements. Over the past 50 years, location, allocation analyses have developed a variety of models termed 'hierarchical' in that they incorporate multiple levels of either goals or facilities. Several researchers have used 'hierarchy' to mean incorporation of a set of goals organised by priority to determine the best facility configuration for one service. Since the appearance of the central place models, a number of studies have appeared in different parts of the world. Most of the work consists simply of identification and investigations of settlement hierarchy in various areas. All hierarchical service systems involve a set of sites operating in a coordinated manner. Systems differ in the relationship between the upper and the lower service levels (Bevan & Wilson, 2013).

The idea of Urban Organisation was introduced by Brian J.L. Berry (1964) in his remarkable work "Cities as systems within systems of cities". Urban places do not occur in isolation. There is a whole series of different types of relationship between separate towns and cities and we use the term urban system to indicate that the individual urban centres are linked to each other. The urban centres play a significant role in social and economic alteration, and geographic shift of population. With the increase of population globally, towns and cities have become magnets of economic, social and political processes. „At national level cities are part of a complex system of interrelated urban places and the key elements in economic, social and political organisation of regions and nations. The interdependence among towns and cities makes it important to view a country as a structure of urban places rather than as a series of independent settlements'.

Function of a Settlement Hierarchy

Settlement hierarchy can be visualized as a pyramid. The settlements with the lowest population, like a small village or even a homestead of only a single person, are at the bottom. These settlements are the most common in the world and require the least number of expected services. Moving up the pyramid, the size of the settlements in each category gets larger, from town to city to conurbation, while at the same time getting less and less common in society. There are comparatively few cities in the world, and many small dwellings of only a few people.

Fig: - Settlement Hierarchies

As you move up the settlement hierarchy the size of the settlement increases, as does the population and the range of services available. Smaller settlements tend to provide only low order services such as a post office and newsagents. Whereas, larger settlements have more high order services such as leisure centres and chain stores. As a result of this the larger the settlement, the greater the range of services and therefore the market area or sphere of influence. This is the market area that a settlement services (the distance people will travel to use services).High order services usually have a high threshold. This means they need a higher number of people to use the service in order to remain profitable. This means high order service

such as department stores need a greater number of customers than a low order service such as a newsagent. This is why there are so few department stores in villages!

The size of a sphere of influence will depend on factors such as:

- the number and types of services it provides
- the accessibility of the settlement including transport facilities
- the amount of competition from surrounding areas

Services and goods have a threshold population to support them. Examples of threshold populations include (https://www.internetgeography.net/topics/what-is-a-settlement-hierarchy/):

- a village shop needs 350 customers
- a doctor needs 3500 patients
- a secondary school or Boots chemist needs 10,000 people
- a Marks and Spencer store requires 50,000
- a large, national supermarket chain such as Tesco or Asda needs 60,000.

Urban Agglomeration

Cities are the central locations for capital, labor and information. They have long attracted the attention of researchers from a wide variety of disciplines. The development, spatial evolution and spatial organization of urban forms are major research themes in the urban studies and human geography communities. Studies on the spatial clustering of cities began as early as the 1920s, with various terms used to describe this particular urban spatial organization. These terms include megalopolis, urban agglomeration, city group, and city cluster. Studies on urban agglomeration have increased over the past three decades.

Urban agglomeration is a highly developed spatial form of integrated cities. It occurs when the relationships among cities shift from mainly competition to both competition and cooperation. Cities are highly integrated within an urban agglomeration, which renders the agglomeration one of the most important carriers for global economic development. Studies on urban agglomerations have increased in recent decades. In the research community, a consensus with regard to what an urban agglomeration is, how an urban agglomeration is delineated in geographic space, what efficient models for urban agglomeration management are, etc. is not reached. The current review examines 32,231 urban agglomeration-related works from the past 120 years in an attempt to provide a theoretically supported and practically based definition of urban agglomeration. In addition, through this extensive literature review and fieldwork in China, the current research identifies the four stages of an urban agglomeration's spatial expansion and further proposes operable approaches and standards to define urban agglomerations. The study aims to provide a scientifically sound basis for the healthy and sustainable development of urban agglomerations (Fang & Yu, 2017).

Out Growths (OG)

Urban growth is defined as the rate at which the population of an urban area increases. This result from urbanization which is the movement of people from rural areas to urban areas. Urban growth may lead to a rise in the economic development of a country. Urban growth is also referred to as the expansion of a metropolitan or suburban area into the surrounding environment. An Out Growth (OG) is a viable unit such as a village or a hamlet or an enumeration block made up of such village or hamlet and clearly identifiable in terms of its boundaries and location. Some of the examples are railway colony, university campus, port area, military camps, etc., which have come up near a statutory town outside its statutory limits but within the revenue limits of a village or villages contiguous to the town. While determining the outgrowth of a town, it has been ensured that it possesses the urban features in terms of infrastructure and amenities such as pucca roads, electricity, taps, drainage system for disposal of waste water etc. educational institutions, post offices, medical facilities, banks etc. and physically contiguous with the core town of the UA. Examples: Central Railway Colony (OG), Triveni Nagar (N.E.C.S.W.) (OG), etc. Each such town together with its outgrowth(s) is treated as an integrated urban area and is designated as an 'urban agglomeration' (https://planningtank.com/urbanisation/urbanisation-urban-growth).

UNIT: - 8

THEORIES AND MODELS OF SETTLEMENT STUDY: CENTRAL PLACE THEORY, RANK-SIZE RULE AND CONCEPT OF PRIMACY

INTRODUCTION

Geography is an interdisciplinary subject with multi-disciplinary applications. It has five themes as location, place, human, movement and region. The subject deals with the study of Earth and its lands, features, inhabitants, phenomena, processes and interaction of humans and their environment. By nature it is a field of inquiry. There are several key concepts underlying the geographical perspectives as location, space, place, scale, pattern, regionalization and globalization. It deals with human population, culture and settlements as well. Human Geography and Physical Geography are the two major branches of geography. Human Geography is the study of human use and understanding of the world and the processes which have affected it. It focuses on the built environment and also on how the space is created, viewed and managed by humans as well as the influence of humans on the space they occupy.

Human beings invariably need food, clothes and shelter for normal living. These three are the basic necessities. Shelter is the place for a safe rest and comfortable stay. Shelter is also a place for human cultural activities and social linkages. The word "shelter" may denote houses, dwellings, group of dwellings and habitations. The word hamlet was also used for a small groups of shelters, in the rural areas. Archeologists and Geographers have both studied the ancient world. Geographers have analysed the land use, identified the merits and demerits of settlements during early civilizations and their functional relationships with other geographic factors. Geographers have also evaluated the sequence of evolution of settlements in various zones, with reference to their forms and purposes. They also found the role of population on settlements and the socio-cultural aspects behind them. It is under these context subject settlement Geography got originated as one of the branches of Geography. The Human Settlement Systems are the basics in understanding the subject. In this episode, the following aspects are highlighted: a) Definition and Formation of settlements b) Approaches to study and Analyse Settlements c) Classification of settlements d) Kinds of settlements & e) Significance of studying settlements (https://moam.info/geography-of-settlements_5ca6b593097c47e8648b45cd.html).

Definition of Settlements

Referring to Stone (1960), settlement geography is the description and analysis of the distribution of buildings by which people attach themselves to the land. Further, that the geography of settling designate the action of erecting buildings in order to occupy an area temporarily or permanently. It should be understood that buildings are one tangible expression of man-land relationships and that specification of this focus assumes study may be at any scale from quite general to most specific; there is no restriction to large-scale study of individual building plans or architectural details. Buildings are simply one representation of the process

of people living in an area they are a map able division of the landscape to which attention needs direction (https://handwiki.org/wiki/Engineering:Settlement_geography).

Settlement Geography can help cities in their economic transitions. It can make recommendations about land use, how to encourage or discourage settlement activity in a given region. There is also a possibility to combat the effects of unsustainable population growth, while analyzing settlements. If a city arose due to one particular industry and that industry has failed or faced problems, settlement geographers can help overcoming the problems, by offering alternative solutions. It is seen in some countries that cities shifted their focus from industry to another like culture, tourism, and finance and information technology (https://moam.info/geography-of-settlements_5ca6b593097c47e8648b45cd.html).

CENTRAL PLACE THEORY

The role of urban places as service centres for the farming regions surrounding them largely determines the character of the major economic activities carried on within the city, town, or village. They will be activities whose continued economic well-being in the urban centre is largely dependent on the location of the place somewhere central to the region of farm population demand. These central place functions will generally be service activities and will not include those branches of manufacturing that serve more distant markets and are unrelated to the needs of the rural region. This is not to say that central locations are not sought after by such manufacturing activities, for indeed they are; but their location in an urban centre is not an expression of the complementarity in function that exists between that place as a central place and the surrounding rural region and its inhabitants.

In many studies of central places, as will be noted later, the list of such functions has approached one hundred or so. The list typically includes such activities as "grocery and food provision," "laundering," "sale of hardware," "sale of clothes," "doctors," "dentists," and so on. Often the list is expanded to include social and cultural activities such as schools, churches, and clubs. In most urban places any one central function will generally be offered by more than one business or unit. There may be, for example, many food stores, several doctors and dentists, and two or three churches. Each business unit offering a central function is counted as one functional unit. Obviously, the number of these must at least equal the number of central functions and it will usually be greater. Furthermore, any one building or establishment in the urban centre may involve more than one function and functional unit. For example, a general store that sells mainly food might also have a hardware section and serve as a post office. In this case, there is one establishment, three functions (sale of food, sale of hardware, post office), and three functional units. This distinction between establishment and functional unit is important in certain cases, but on the whole, it does not warrant much emphasis (https://researchrepository.wvu.edu/cgi/viewcontent.cgi?article=1007&context=rri-web-book).

Christaller's Central Place Theory

Central place theory is a spatial theory in urban geography that attempts to explain the reasons behind the distribution patterns, size, and a number of cities and towns around the world. It

also attempts to provide a framework by which those areas can be studied both for historical reasons and for the locational patterns of areas today.

Central Place Theory was given by Walter Christaller in 1933, which is one of the most appreciated theories that tries to explain the spatial arrangements and distribution of human settlements and their number based on population and distance from another human settlement. Christaller submitted his dissertation on "The Structure of Settlements in the Southern Germany" in 1932 to the University of Erlangen in 1932. His work was published in 1933. He found that in spite of the even distribution of settlements one may find a regular pattern in them, There is some sort of relationship between distribution, size and number of settlements and on the basis of this relationship he called these laws as 'spatial economic geographical laws' or 'the laws of geography of settlements'. His theory was based on the study of settlement patterns in southern Germany made by Christaller. This study included the analysing the relationships between settlements of different sizes and related their economic activities (market) with the population. Central place theory explains (https://old.amu.ac.in/emp/studym/100010995.pdf).

- Relationship between the size, the number and the geographic distribution of cities.
- Central place has the main function to supply goods and services to the surrounding population (Market Area)
- Based on concept of Range (it is economic, not mathematical)

Christaller explained why the highest order settlement has very peculiar activities which can only be supported by them and the reason behind those activities taking place only in those particular highest order settlements, he also explained the nature of activities in different order of settlements. Central place theory is of great importance even after decades and forms the basis of various present-day theories used in urban planning.

- The theory is essentially static, explaining the existence of a regional spatial structure but failing to explain how that structure has evolved and it might change in the future.
- It serves a useful role identifying important concepts such as the interdependence of a city and region, a hierarchy of functions and centres, and market range and threshold populations.
- Range also depends on the type of demand of the central good. If the demand is inelastic (urgent, non-substitutable; e.g. Hospital), then the range is large and if the demand is elastic then range is smaller (e.g. Cinema).
- Larger the central place, the greater will be the range as compared to smaller central places. (lower production cost leads to larger amount of sales).
- Higher the population density implies greater range, as again higher density make production cheaper.

In Christaller's model, each settlement is situated in the centre of the region it serves. Logically (assuming no restrictions), this should result in a circular complementary (market or service) region. If we assume that the threshold for customers who shop in hardware stores is fifty miles, then it would follow (in keeping with Christaller’s assumptions) that on a flat plane, we should be able to find hardware stores in centres located fifty miles apart. Such an arrangement on the landscape, however, would leave areas that are not served by any hardware facilities. Thus, the most efficient shape for a service area (in the Christaller model) is not a circle, but a hexagon.

Assumptions of Christaller's Central place theory

Christaller made some assumptions to make his theory easy to understand and form the basis for other theories. These assumptions were necessary and hold good to explain the structure of settlements. These also take into account the growth and development of towns, human behaviour and fundamentals of economics. Walter Christaller made following assumptions:

- An even (flat) terrain – A hilly and uneven terrain poses difficulty in development thus a flat area which promotes the growth of the town
- Evenly distributed population – residents are not concentrated at one particular place and no preference exists for a particular town
- Evenly distributed resources – no place has an advantage of resources, all placed will compete under perfect market conditions
- Similar purchasing power – along with the population and resources, wealth is also fairly distributed. Because of this people have similar purchasing power
- Preference for the nearest market – people will buy products from the nearest market and avoid the long commute. This keeps price constant as per other assumptions
- Equal transportation cost (proportional to distance) - the cost incurred in transporting of goods is equal for all and is proportional to the distance
- Perfect competition – price is decided on basis of demand and supply. People will buy at the lowest price which market has to offer; no seller has an advantage over another seller.

"German geographer Walter Christaller developed Central Place Theory, concerning the development of cities as hubs for goods and services serving smaller, surrounding areas, and the size, number and distribution of urban areas. He first put his theory to practical use in planning the occupation of Poland".

These assumptions when combined, results in place offering different services. In these places in which people enjoy the perfect market and purchase from the nearest place to save on money and time. Different services locate themselves on the basis of the threshold population. The minimum number of people required to sustain that service/activity. In addition to this, there is no preference for a particular shop. All people have access to equal resources and do not enjoy any advantage over its competitor. The demand for goods consumed & used on daily basis will be used more and vice versa.

Explanation of terms: Central Place definition, low order, high order, sphere of influence

1. A Central Place is a settlement which provides one or more services for the population living around it.
2. Simple basic services (e.g. grocery stores) are said to be of low order. Specialized services (e.g. universities) are said to be of high order.
3. Having a high order service implies there are low order services around it, but not vice versa.
4. Settlements which provide low order services are said to be low order settlements
5. Settlements that provide high order services are said to be high order settlements.
6. The sphere of influence is the area under the influence of the Central Place.

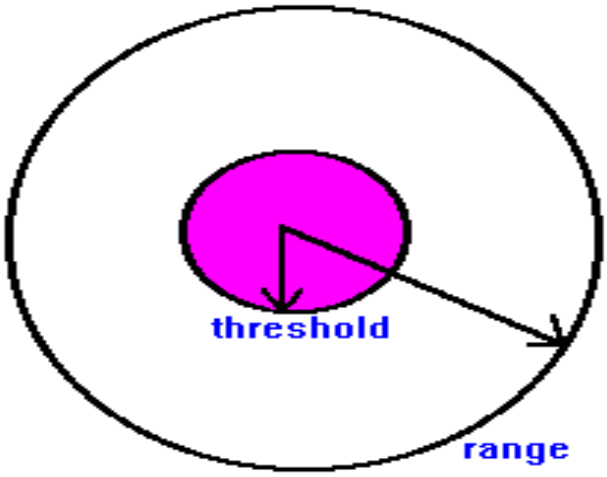
Towns act as central places for the country side. They come into being to carry out at a central, accessible place. Christaller acknowledges that this basic assumption is derived from former work of Gradman (1916), who contended that the distinctive role of the town was to be the Centre of its rural surroundings and a facilitator of local commerce with the neighbouring areas, collecting and exporting the local products, importing and distributing the necessary goods and services which the countryside demands. Though the population of town may be important by virtue of its size but it cannot be a measure of centrality.

Therefore, four major principles underlie Central Place Theory (CPT): Centrality, Complementary areas, Threshold and Range of goods and services.

It is the minimum population which is required for the sale of good or to sustain any service. Some goods and services need large population and others a small population to achieve their threshold values. In an ideal case of uniform income, consumption and taste it can be stated in terms of population numbers. For example, a minimum varying population is needed to retain a doctor, bank or a post office. Also, a grocery shop needs a relatively small local population to keep up its business while jewellery or a car which is irregularly purchased needs a larger threshold population. The Range of goods is the maximum distance that a consumer is willing to travel to obtain certain goods or services.

At some range from the Centre the inconvenience of travel measured in time, cost and trouble will outweigh the value or the needs for the good or alternative nearer Centre becomes available. Like a length of the journey to buy bread, will be very small and hence frequent trips may be afforded as against a journey to buy a coat or a car or jewellery. The maximum range of goods and service is the farthest distance calculated in terms of time and money that a consumer would travel to provide it. So a consumer who has to travel all the way to central place to buy a good has less money available than the one living at close proximity to central place because the former has incurred transport costs and so will be able to purchase less. After a certain distance, people cannot afford to buy good at all because transport exhausts them of money. It is every day for something cheap and frequently needed like bread or daily newspaper; people do not spend much time and money travelling to obtain it. Therefore, it has a small range. As against, for goods which cost more and are less frequently required, people are prepared to travel longer distance. But one cannot ignore the reality that most journeys fulfil multiple purposes, one can buy the bread and the coat on the same trip, but have been excluded from theoretical considerations (https://www.openj-gate.com/site/www.afsahighschool.com).

Fig: - Threshold and range (Central Place Theory)



Source:

https://www.afsahighschool.com/site/handlers/filedownload.ashx?moduleinstanceid=3998&dataid=9583&FileName=Central%20Place%20Theory.pdf

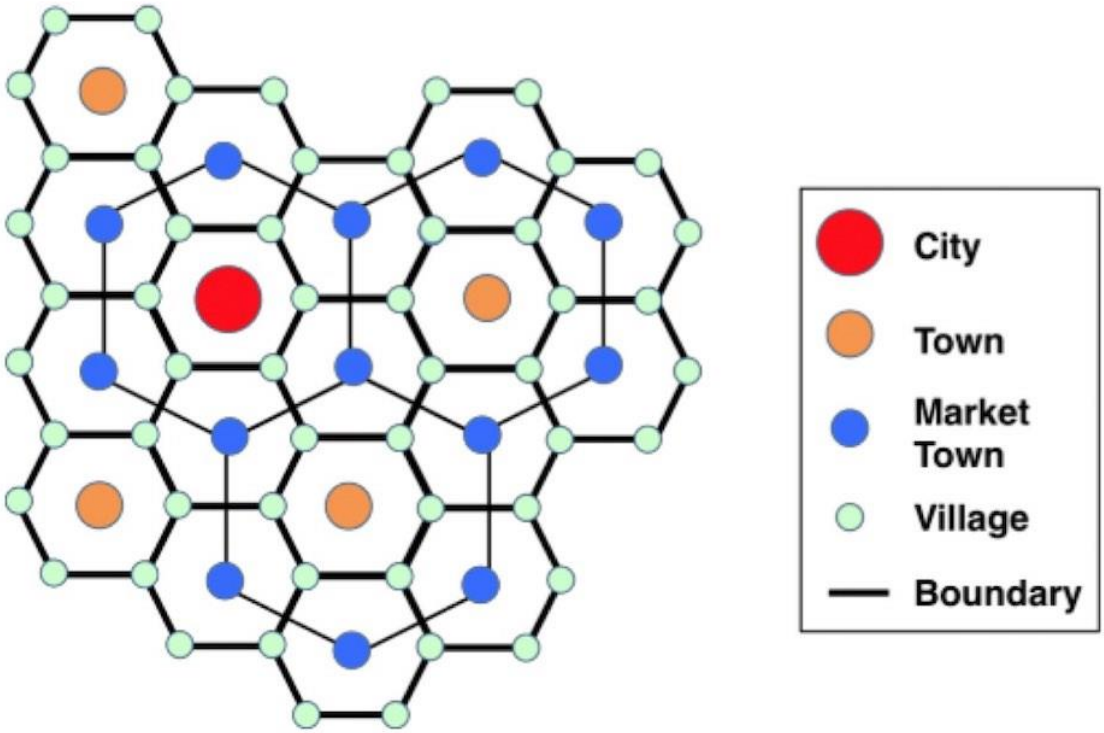
If the population is evenly distributed, the market areas determined by the minimum range will remain as small as possible and maximum number of firms will find space in the area served by the system. The marker area is circular because the transport costs increase proportionately with distance from the Centre (Fig.3). Goods with low thresholds and small market areas are low order goods and will occupy low order centers; goods with high thresholds termed as high order goods and will occupy high order centers. In between the high order and low order centers are the intermediate order centers selling middle order goods. This denotes that the central places are graded according to the level of goods and services they offer. Therefore, high order Centre will cater services of high, middle and low order; middle order centers may provide functions of middle order and low order while, low order centers delivers the functions of only low order.

Sizes of Settlements, Communities as per Central Place Theory

Walter Christaller gave a system with FIVE sizes of settlements based on the population. The smallest unit is Hamlet which is considered a rural community and the largest unit is Regional Capital. The rank order of central places in ascending order include: 1. Hamlet 2. Village 3. Town 4. City 5. Regional Capital / Metropolis

Markets and Services tend to be nested hierarchies with smaller towns serving smaller markets. However, transportation and border effects can shift the distribution of towns away from theoretical uniformity (https://old.amu.ac.in/emp/studym/100010995.pdf).

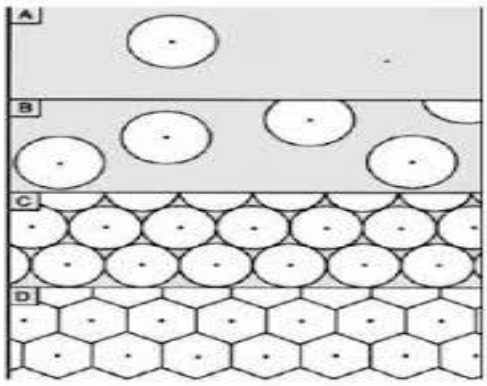
Fig: - Christaller's Hexagonal Arrangement



The Arrangement of the Central Places/ Settlements

As transport is equally easy in all direction, each central place will have a circular market area as shown in C in the following diagram: However, the circular shape of the market areas results in either un-served areas or over-served areas. To solve this problem, Christaller suggested the hexagonal shape of the markets as shown in D in the above diagram. Within a given area there will be fewer high order cities and towns in relation to the lower order villages and hamlets. For any given order, theoretically, the settlements will be equidistant from each other. The higher order settlements will be further apart than the lower order ones (https://planningtank.com/settlement-geography/central-place-theory).

Fig: - Arrangement of Settlements



Principles in the Arrangement of the Central Places

Christaller's theory gives THREE principles which are the marketing principle, transport principle and administrative principle for orderly arrangements and the formation of hierarchy. Settlements are regularly spaced – equidistant spacing between same order centers, with larger centers farther apart as compared to smaller centers. The market area is hexagonal shaped as it is free from overlapping, most efficient in both number and function. Three Principles of Christaller for determining distribution of central places in a region.

• Marketing Principle: If the distribution is entirely based on the range of the good, then it would result in evenly spaced central places with hexagonal markets area.

• Traffic Principle: If any central place (city) is smaller in size than expected than it be because of lower accessibility (not falling on major transport route) and vice-versa

• Separation Principle: Spacing and sizing of Central places can sometimes be distorted due to socio-political consideration.

The different layouts predicted by Christaller have K- values which show how much the Sphere of Influence of the central places takes in - the central place itself counts as ONE and each portion of a satellite counts as its portion (https://planningtank.com/settlement-geography/central-place-theory):

1. Marketing Principle (K=3)
2. Transport Principle/ Traffic Principle (K=4)
3. Administrative Principle (K=7)

Three Principles of Central Place Theory are as Follows

These are described below (https://planningtank.com/settlement-geography/central-place-theory): -

1. Marketing Principle (K=3): -As per this the market area of a higher order occupies one-third (1/3 part) of the market area of each of the consecutive lower size place(node) which lies on its neighbor. The lower size nodes (6 in numbers and 2nd larger circles) are located at the corner of the largest hexagon around the high-order settlement. Each high-order settlement gets 1/3rd of each satellite settlement (which are 6 in total), thus $K = 1 + 6 \times 1/3 = 3$. With K=3 the transport network is not efficient even when the distance travelled is reduced. This is because of the absence of transport links (network) between the larger places (nodes).

2. Transport Principle (K=4): - This provides for most efficient transport network. High order place half of the market area of 6 neighboring lower order places located on the edge of the hexagon formed by high order settlement. There are maximum central places possible. These are located on the main transport routes connecting the higher order center. The transportation principle involves the minimization of the length of roads connecting central places at all hierarchy levels. In this system of nesting, the lower order centers are all located along the roads linking the higher order centers. This alignment of places along a road leads to minimization of road length. However, for each higher order center, there are now four centers of immediate lower order, as opposed to three centers under the marketing principle.

3. Administrative Principle (K=7): - According to K = 7 administrative principle (or political-social principle), settlements are nested according to sevens. The market areas of the smaller

settlements are completely enclosed within the market area of the larger settlement. Since tributary areas cannot be split administratively, they must be allocated exclusively to a single higher-order place. Efficient administration is the control principle in this hierarchy.

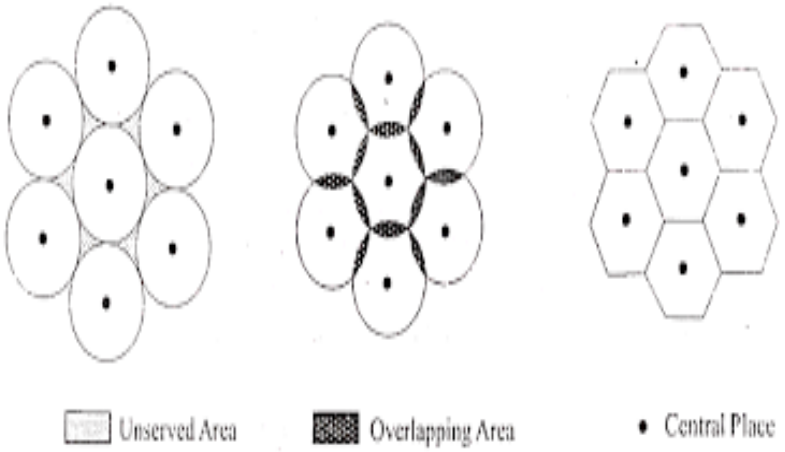
Hierarchy of Central Places

Christaller suggested that the central places, providing goods and services to the surrounding areas would form a hierarchy. A large number of widely distributed small places would provide lower order goods and services to service regular widespread demand. There would be a smaller number of larger centers providing both lower-order and higher-order goods and services. Successive steps of the hierarchy would consist of larger central places providing even higher-order goods and services.

Complementary Regions

Each town or city exerts its influence over surrounding areas. People come from the surrounding area to the town for goods, services, and jobs. The area over which the town exerts its influence has been termed complementary region. The term market area used in the context of specific goods and services. The larger the town, the larger is its complementary area. The larger the city, the greater the likelihood of very specialized goods and services. This attracts people from all over the world. For example, the largest cities like New York, Paris London, and Rome attract people from across the globe. Their complementary areas are international.

Fig: - Theoretical Shape of Complimentary Area



Source: - https://old.amu.ac.in/emp/studym/100010995.pdf

Disapproval

1. The Central place theory is majorly criticized for its oversimplification of the real world by making a number of assumptions.
2. Large areas of flat land are rare.
3. The positioning of settlements is generally random and not evenly spaced contrary to even spacing of settlements suggested by Christaller.

4. The hexagonal pattern is suited for theoretical development but in the real world many other complicated factors are at work.
5. The concept of perfect competition is untrue in reality with some firms making more money than others.
6. A hierarchy of central places. Central places are grouped into order (second, third, and fourth) but these do not match with the theoretical expectations as there is a definite and clear ranking of centers within each other.
7. Equal sized sphere of influence. As per the theory it is expected that two third order centers will have equal sized squares of influence. Central place theory suggests that each center's sphere of influence for its activities at any specific level will be equal in size to every other center's sphere of influence. But in reality this has rarely been the case.
8. Every higher order center also functions as a lower order center in the CPT, but often lower centers have some activities which some higher centers have in Central place theory.
9. Consumer travel behavior cannot be projected. Affluence, changes in taste, and preferences and greater mobility enabling people to travel farther to do their shopping and obtain required services have altered demand patterns for services and goods.
10. Technological change has also brought about changes in the ways provision of goods and services are organized and located. Examples supermarkets, mall culture, online shopping.
11. The government intervention (setting up of economic or residential base), planning and policy making (decentralization) and legislation (environmental, housing laws etc.) affect future growth of various settlements outside the town.
12. Christaller envisaged each Centre with a particular function whereas they have many which also changes over time.
Central place theory may not have a universal validity. It also cannot be pressed to explain a settlement pattern in any region. The purpose of the Central Place Theory is to identify a few salient features, found in certain types of settlement patterns and tools available when seeking to describe and understand a particular pattern found in the real world (http://www.dspmuranchi.ac.in/pdf/Blog/CentralPlaceTheory-final_P_G_SEM_IV.pdf).

Applicability and Use

1. It provides a rationale for selective location and efficient space and functions.
2. In terms of functional and behavioral dimensions it has drawn attention to country and inter-town interdependence.
3. It encourages order in the spacing and inter-relatedness of settlements where settlements are seen in wider contexts.
4. The central place theory seeks to analyze the functional and hierarchical orderliness in the settlement landscape.
5. Settlements vary in size, function and number but the centralistic function is sought in the location economies, social and administrative structure and their visible and not so visible forms and is evident in location of the structures like church, community hall or university.

6. The central place theory helps us to identify more clearly the role of settlements as places of trade exchange and the extent to which this has influenced the nature of emerging settlement pattern in region.
7. The Central place theory has been used as a guideline for relocation policy and this was incorporated as an integral part of regional planning in Germany, in north east polders, location of settlements, population size, linkages, hierarchy and allocation of market and service functions were determined by central place principle.

Applicability of Central Place Systems in India

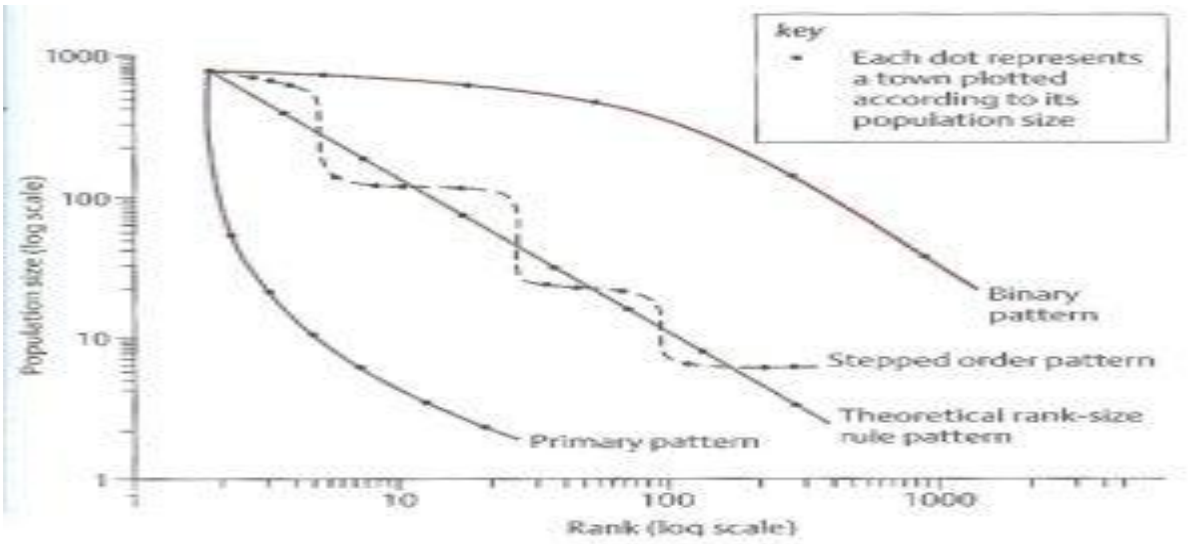
CPT is a normative in character and so limited in empirical applicability. No real world settlement system can be expected to conform to all the propositions of the Central Place. India's hierarchy system is represented from the point of view of administration and demography. India has six level hierarchies of settlements at administrative level. At the top of the hierarchy is the national capital followed by state capitals, district headquarters, tehsil towns, block development centers and gram panchayat centers.
The national and the state capitals are in reality important metropolitan cities, headquarters of district and even tehsils are recognized urban places. At a block level, block headquarters are large villages but not recognized as urban places. Gram panchayats as per their definition are rural in nature, though provides wide variety of service to hamlets, they can be said to be central places of lowest order. The administrative hierarchy of settlements in India differs considerably from the central place system under the administrative principle as pointed by Christaller. Theoretically, there is a ratio of 1;7 between the number of settlements of higher and lower orders. In India, ratio of districts to state is almost 1:19, where gram panchayat per community development block may reach up to 40 in number. Also, the number of tehsil per district is slightly over six and this corresponds to administrative principle quite closely.

RANK-SIZE RULE

The rank-size rule is an empirical proposition that the distribution of the population scale and the scale ranking of cities produce a straight line when both are shown on a logarithmic scale. This empirical finding was first pointed out by Auerbach in 1913 and formulated by Zipf as early as 1949. Assessments based on statistical analyses are continuing, even in recent years.
Presuming that the scale ranking is y, and presuming that the population scale of the city is x, then a rank-size rule can be represented as follows.
$\log y = \log A - \alpha \log x$,
In that equation α is called a power coefficient representing the concentration of the city; A is a constant to be regressed. A small power coefficient α reflects that a population is accumulated in a few cities; a large coefficient signifies a dispersed population among many cities.
The monopolistic concentration of population and economical activities on the primal metropolitan area (frequently the national capital), and concurrent out-migration from and decline of remotely located rural areas have become important policy issues in many countries. If the rank-size rule were strictly true, then the feasibility of national development policies

aimed at development of rural cities might be problematic because, by the rank-size rule, the number of cities possessing population greater than a certain threshold is already fixed. The development policy might become no different to a children's game of musical chairs.
The rank-size rule addresses itself to two vital questions:
1. Why larger settlements are fewer in number?
2. What is the relationship between larger and smaller settlements?
The explanation to both these questions is based on the appreciation of forces of diversification and unification (http://www.dspmuranchi.ac.in/pdf/Blog/Rank_size_Rule..pdf).

Fig: - Rank-size Rule



Source: - https://pangeography.com/rank-size-rule-by-gk-zipf/

Forces of Diversification

The location of small settlements is generally determined by nearness to the source of raw materials. In such a situation, where primary economic activates predominate, land becomes the basic raw material or resource. Land is tilled by farmers to produce food and other basic necessities of life. A present society rooted to the land merges with a large number of village settlements within walking distance of each other. Similarly, apart from agriculture, other primary activities such as mining, fishing and forestry also generate dispersed settlements of small size at regular intervals of distance. As society advances, secondary production makes it possible to locate settlements of greater distances from the source of raw materials. Thus, the settlements specializing in secondary production can be located farther apart, and also be larger in terms of population. Nevertheless, a wide range of secondary economic activities must be located near the source of raw materials so that the costs of transportation can be minimized. Secondary economic activities generate settlements of large size and greater distances apart as compared to primary activities.

Forces of Unification

In contrast to the forces of diversification, the forces of unification result in the emergence of few large settlements. Here, the focus is on tertiary economic activities. Nearness to the market, rather than the source of raw materials, is the determining factor in the location of settlements. The size of market is measured by the population of the settlement itself. Thus, a large settlement in itself constitutes a large market. Tertiary activities, such as education, health and administration, are all consumer-oriented and tend to be concentrated in large cities. In recent times, a wide range of secondary activities have acquired a market orientation (for example, electronic and engineering goods and information technology industries). These secondary economic activities also tend to concentrate in large metropolitan cities. These forces lead to the emergence of a few very large cities.

Higher degree of primacy suggests the presence of strong centripetal forces and hence greater tendency towards agglomeration and unification. ($i>1$.) Absence of primacy suggests the existence of centrifugal forces and their greater tendency towards diversification. ($i>0$, $i<1$).

A balance between the two forces i.e. of unification and diversification could result into the creation of an ideal urban system ($i=0$), which is possibly desirable and may be aimed at by the urban planners and policy makers (https://dodl.klyuniv.ac.in/download/DODL%20M.A_M.Sc%20SLMs/DODL_M.A_M.Sc_%20SLMs_%20SEM-II/SLM_geography_Sem-II.pdf).

Rank-size Relationship in India

The rank-size relationship is absent in India at the national level as the population size of Mumbai, Kolkata and Delhi is very close to each other. Moreover, a great majority of states in India also do not conform to the rank-size rule. In fact, primacy exists in at least 15 out of the 29 states of India and in another eight states (Bihar, Kerala, M.P., Punjab, Orissa, Goa, Arunachal Pradesh and Nagaland) the leading city is only just larger than the second city. In Kerala, the three cities of Cochin, Calicut, and Thiruvananthapuram (Trivandrum) have nearly the same population size; this is also the case with cities of Indore, Jabalpur and Bhopal in Madhya Pradesh, and Ludhiana, Amritsar and Jalandhar in Punjab. Rank-size relationships appear to hold good in the state of Rajasthan. In brief, rank-size rule in India is an exception rather than a rule.

Merits and Demerits of rank-size Rule

Zipf proposed his theory in a homogenous country of urbanization. This situation may take place when there is justice in development in a province. However, almost all the countries are characterized by uneven expansion pattern and the city-sizes are not equally distributed. The theory of rank-size rule fails to explain the Indian built-up scenario. Since Indian urbanization is characterized by the colonial legacy, there is maximum concentration of urban population in fewer pockets of the country. Thus the mega cities such as New Delhi, Kolkata and Mumbai are characterized by huge urban population. On the other hand, the smaller city centres are very few in number. Thus Indian urbanization is considered by primacy not by rank-size rule.

CONCEPT OF PRIMACY

Urban Primacy is when one city is dominantly large in a group of cities. Usually when a largest city is over twice as large as the next city, this would constitute urban primacy. Other measures are more rigorous whereby a city is only primate when it is at least 3 times larger than the next two cities combined. Primacy is almost always calculated using this kind of population-size ratio. Ideally metropolitan level populations are used so as to avoid dividing the largest city by an adjacent centre.

The concept of primate city and city primacy was developed to focus attention on the relationship in size between the largest city and other cities of a closed urban system. City size distribution refers to the frequency distribution of settlements in different size categories. The observed distributions for urban distributions are compared with the theoretical or empirical model such as Central Place Theory, Hoyt Model or Sector Model, the rank size rule, Primate city concept and the mercantilist model.

The idea of primacy was first introduced by mark Jefferson in 1939. His proposition was that nationalism crystallizes in primate cities which are super eminent in both size and national influence. He assessed the degree of primacy by computing the ratio of the size of the second and third ranking cities to that of the largest one. He found that in the forty-six countries of the world the largest cities were two or three times as large as the next largest city. The ratio of the population of the three largest cities approximated the sequence 100:30:20 (i.e. the third largest is one-fifth the six of the largest). According to him there are various reasons for a city to exceed its neighbours in size, but once it did so the process became cumulative giving it an impetus to grow and draw away from all other cities in character as well as size. The particular ratio sequence has been later ignored, though the concept of the primate city and primacy is widely used (https://rashidfaridi.com/).

Characteristics of Primate City

1. Most dominant city
2. Degree of primacy is $1/\alpha$ (measured by the size of the 2nd largest city)
3. Less developed countries have higher degree of primacy and more developed countries have lower degree of primacy
4. Simpler political systems less interference of govt. In economic activities
5. Industrial agglomerations
6. Rapidly expanding population and high density
7. High rate of urbanization
8. Recent colonial history

After Jefferson two more studies were done by Fryer (1953) and Murphey (1957). Fryer isolated the million cities of Southeast Asia and analysed their site, morphology, and pattern of growth. Murphey traced the growth of capital cities in Asia, most of which were ports. Only in the 1950s explicit studies were made regarding the phenomenon of urban primacy.

Smith pointed out the difference between two kinds of primacy:

1. One in which the first ranking or the largest deviates from a regular distribution of cities (i.e. the rank size or log normal which according to him is a "mature distribution") by being over large.
2. One in which the first ranking or the largest city is much larger than all others which may not conform to a regular rank size pattern. In this case the secondary cities are too small in relation to the rank size distribution. The primate may or may not be too large in relation to that distribution. He called this an "immature distribution" which is likely to be linked to poorly develop urban trade. The immature urban system has to be differentiated from the mature one because the forces producing a overly large city in the two systems are different with different policy and implications (https://planningtank.com/settlement-geography/primate-city-primacy-concept).

Factors Affecting Primacy

Attempts were made by Linsky to classify in more accurate terms the factors probable to produce an elevated degree of primacy or tough domination by the primate city. He further demonstrated that countries with an elevated level of primacy have a tendency to exhibit the subsequent characteristics:

1. Small territorial extent
2. Relatively high population density
3. Low per capita incomes
4. A high degree of dependence upon agricultural exports
5. High rate of population growth and 6. In many cases, a former colonial status

The mature distributions refer to the system which conforms to the rank-size rule. Rank-size rule is an empirical rule used to describe the city size distribution of many countries and was proposed by Zipf. According to the rule the population of any settlement in an urban system can be determined from

- The population of the largest place in that system.
- The position of the settlement being considered in a rank-ordering of all the settlements in that system.

The ranking is in descending order, 1 denoting the position of the largest settlement. The population of each settlement is defined as the population of the largest divided by the rank of the settlement under consideration. If the largest city in a country contains 1,000,000 people, the second largest contain 500,000, the third largest 333,333 and so on, which produces an inverted –shaped relationship between rank and population.

This curve has the following form:

$Pr = P1/r$

Where P is the population, r is rank order position and 1 is the rank order position. In logarithmic form $\log Pr = \log P1 - \log r$ (http://www.dspmuranchi.ac.in/pdf/Blog/Rank_size_Rule..pdf).

Primate city and Economic development

The role of primate city in economic development was initiated by Hoselitz who argued that urbanization need not always be "generative" of economic growth and cited the case of the colonial cities which were enclaves and contributed to stagnation. According to Lampard in such cities the profits of trade, capital accumulation in agriculture and other primary pursuits were used for urban construction. This resulted in migration of labour and enterprise to larger cities which might otherwise have been invested in some form of manufacturing or processing in the hinterland. Stopler suggested that the cities in the developing countries were parasitic because their physical hinterland is neither their market nor their supply area.

Regional Primacy in India

The four largest urban places of India Mumbai, Kolkata, Delhi and Chennai are located in four regions: Western, Eastern, Northern and Southern region correspondingly. Each state wants the development of its own metropolitan city. In this Situation the regional level primacy subsists in Indian urban system. The four mega cities are the largest in their respective regions. In western region Mumbai remained the largest city and the second largest city is Ahmadabad. In Northern region Delhi remained the largest city and Kanpur was the second largest city. In eastern and Southern regions, the second ranked cities have changed positions. In the southern region Hyderabad was the second largest city in 1951,1961,1971, while Bangalore fail to notice it in 1981,1991 and 2001. Kolkata is exhibiting the situation of urban primacy in eastern region. Till 2001 Kolkata was almost seven times bigger than the second largest city of eastern region. At regional level, Kolkata remained a primate city and experienced an increase in primacy level in 2011. It was argued by Ramachandaran (1989), that the case of primacy of Calcutta is even comparable to that of the United Kingdom or other cities of world with primate city characteristics. West Bengal's second largest city, Asansol, was indeed very small in relation to Calcutta: it was 1/25th the size of Calcutta in 1981 (Ramachandaran 1989). Kolkata was established by the colonizers as a strategic location for the administrative, military and business activities. It became the chief reason for primacy of Kolkata. For so many years it remained the most industrialized metropolis of India and hence there was a continuous flow of population towards this city. Kolkata merged as the largest city of Eastern region: it further produced the agglomerative effect to the whole region.

Being the largest urban place of the region, Kolkata became an important city in terms of employment, education and a centre of many such opportunities for the migrants. These processes contributed to Kolkata's emergence as a primate city. The high level of primacy of Kolkata show the way to the situation of scarcity of other big towns in the eastern regions and at the same time resulted in the low level of urbanization in Eastern India. In fact, is was observed by Ramachandran (1989) that in Calcutta's hinterland there are so few towns. And cities that one town of at least 20,000 populations serves a rural population of 500,000 or more. Calcutta remained the only million-plus metropolis in the region until 1981.

Each of the three other regions of India, North, West and south had at least two million-plus cities in 1981. Kolkata historically got very slight competition from any other city of eastern region because of its economic and administrative importance and this made Kolkata the largest city of eastern region. The case of Kolkata also explains the relationship between primacy and low level of urbanization in the region (Das and Dutt 1993). Primacy exists in the Western

region, although comparatively less than that of the eastern region. The level of urbanization in western region is much higher in comparison to the eastern region. Since 1961 there is a slow decline in the primacy of Mumbai in western region, the exception was period 1991 when the primacy value increased, but it decreased again in 2001.

This is primarily because of the increasing number and size of million plus cities in this region. In western region Ahmadabad and Pune are the two major million plus cities which are competing with Mumbai. In the southern region Chennai was never a primate city, although the relative primacy of Chennai has declined after 1981. The other two major cities of this region are giving close competition to Chennai, these cities are Bangalore and Hyderabad. These two cities became very significant in this region because of their importance as IT hub in post liberalization period. Delhi in the Northern region is continuously rising as the primate city. It is the only city among the four largest cites whose primacy index has not declined since 1951. Delhi is the capital city of India and the central government is focusing more for the infrastructure, industrial and over all development of the city. Delhi also has many educational institutions, all these leading to its increasing steps towards primacy (http://www.dspmuranchi.ac.in/pdf/Blog/Rank_size_Rule..pdf).

UNIT: - 9

CENSUS CATEGORIES OF SETTLEMENTS IN INDIA; RURAL-URBAN DICHOTOMY AND INTERACTION

INTRODUCTION

We all live in clusters of houses. You may call it a village, a town or a city, all are examples of human settlements. The study of human settlements is basic to human geography because the form of settlement in any particular region reflects human relationship with the environment. A human settlement is defined as a place inhabited more or less permanently. The houses may be designed or redesigned, buildings may be altered, functions may change but settlement continues in time and space. There may be some settlements which are temporary and are occupied for short periods, may be a season.

Though we use this term very frequently, but when it comes for defining, it is very difficult to give a clear cut definition. In simpler term we can define settlement as any form of human habitation which ranges from a single dowelling to large city. The word settlement has another connotation as well as this is a process of opening up and settling of a previously uninhabited area by the people. In geography this process is also known as occupancy. Therefore, we can say settlement is a process of grouping of people and acquiring of some territory to build houses as well as for their economic support (http://docplayer.net/30293460-29-1-what-is-a-settlement.html).

CENSUS CATEGORIES OF SETTLEMENTS IN INDIA

Classification of Towns in India

Classification of towns can be done on a number of basis and different countries and organizations use different classification of towns. It can be on basis of income level, education level, according to per capita income etc.

Classification of Towns as per census of India

1. All places with a municipality, corporation, cantonment board or notified town area committee, etc.
2. All other places which satisfied the following criteria:
    a. A minimum population of 5,000;
    b. At least 75 per cent of the male main working population engaged in non-agricultural pursuits; and
    c. A density of population of at least 400 persons per sq. km.

The first category of urban units is known as Statutory Towns. These towns are notified under law by the concerned State/UT Government and have local bodies like municipal corporations, municipalities, municipal committees, etc., irrespective of their demographic characteristics as reckoned on 31st December 2009. Examples: Vadodara (M Corp.), Shimla (M Corp.) etc.

The second category of Towns (as in item 2 above) is known as Census Town. These were identified on the basis of Census 2001 data.

The Census of India has classified towns into six categories on the basis of their population:

1. Class 1 towns with more than 1, 00,000 population,
2. Class II towns with 50,000 to 99,999 population,
3. Class III towns with 20,000 to 49,999 population
4. Class IV towns with 10,000 to 19,999 population,
5. Class V towns with 5000 to 9,999 population
6. Class VI towns with less than 5,000 population (https://planningtank.com/demography/classification-of-towns-cities-india).

RURAL-URBAN DICHOTOMY AND INTERACTION

Economic disparities between urban and rural areas have been discussed widely in recent years, with larger metro areas seeing remarkably stronger growth, on average, than their smaller or more rural counterparts. The Richmond Fed's district, the Fifth Federal Reserve District, encompasses many points along this spectrum, from the Appalachian region of West Virginia to the Low country of South Carolina, and from large metro areas such as Washington, D.C., and Charlotte to the sparsely populated Highland County in the western mountain region of Virginia. What is the nature of the disparities across those regions? Do we see what is commonly called an urban-rural divide? And how is it influenced by the definition of urban or rural? This article will take a look at some commonly used ways to define urban and rural areas from agencies such as the U.S. Department of Agriculture (USDA), the National Centre for Health Statistics (NCHS), and the Census Bureau to see what the current data tell us about disparities across measures of demography, education, employment, and poverty (https://www.richmondfed.org/publications/research/econ_focus/2018/q3/district_digest).

Production, a growing agricultural sector needs technical inputs of fertiliser, seeds, herbicides, equipment and repair services either produced or distributed by non- farm enterprises. Increased agricultural production also stimulates forward production linkages by providing raw materials to further value-adding activities like milling, processing and distribution by non-farm firms.

Consumption linkages arise when increasing farmer income, as a result of growing agriculture, boosts the demand for basic consumer goods. Such a demand typically increases over time as the rising per capita income induces the diversification of consumption into non-food items. Much of the overall increase in demand for inputs, services, distribution and many basic consumer goods can be serviced by firms operating in rural and semi-urban areas.

Rising agricultural wages in the rural areas have raised the opportunity cost of labour in the non-farm activities. This has induced a shift in the composition of non-farm activities from labour intensive, low-return ones to those that require more skilled labour and higher investment and produce higher returns. Thus increasing farm productivity could be instrumental in inducing a structural transformation of the rural non-farm economy.

They also include flow of people moving between rural and urban settlements, either commuting on a regular basis, for occasional visits to urban-based services and administrative centres, or migrating temporarily or permanently. Flow of information between rural and urban areas include information on employment opportunities for potential migrants. Financial flow include, primarily, remittances from migrants to relatives and communities in sending areas and transfers such as pensions to migrants returning to their rural homes and also investments and credit from urban-based institutions (http://www.yojana.gov.in/Kuru%20February%202015.pdf).

Rural–urban Linkages and Livelihood Strategies

Most individuals or households in low-income countries straddle the rural–urban linkages through income and occupational diversification and migration. Time devoted to, as well as the income derived from, non-farm and off-farm activities are therefore substantial parts of the lives of rural households. The most successful rural households use urban opportunities and exploit urban niches in addition to agricultural land resources. Most of the poor as well as rich households combine agricultural production with non-farm and off-farm income-generating activities to increase their income. The access of rural people into non-farm activities has only been possible where there is availability of non-farm employment opportunities that arise from urbanisation, innovations and sectoral transformations. In addition, new investments in non-farm sectors take place with an increase in farm incomes and rural savings. As farm income grows, the demand for non-farm goods and services increases in rural areas. To meet this demand, rural economic activities are diversified into production of rural non-farm goods and services. Thus, the rural non-farm economy provides economic opportunities for the rural poor. However, this requires investments in agricultural technology and innovations, rural human capital, health, communications, transportation and electrification (http://www.yojana.gov.in/Kuru%20February%202015.pdf).

Livelihood diversification and Migration

For increasing their income individuals can engage in multiple activities, some of which can be seasonal (and therefore depending on changes in the labour demands of different activities) or temporary or informal or can be related to the individuals' life courses such as women, different demands on their time from childcare, caring for older people, etc. Transformations in the ways in which households and individuals make a living are perhaps the most striking aspect of rural– urban linkages and in many cases, involve multiple occupations ranging from farming to services. The rural households rely on non-farm and off-farm activities as well as migrant members' remittances. The non-farm activities of rural households are part of a survival strategy that aims to reduce risk, overcome seasonal income fluctuations and respond to external and internal shocks and stresses – e.g., economic and financial crises.

Emerging employment opportunities in urban areas in combination with affordable transportation services, have increased mobility or migration, which has facilitated income diversification. Gender and generational relations are also important in shaping rural–urban linkages, as reflected by the higher levels of multi-activity among the younger generations.

A rise in the income levels of the rural population due to the diversification of their livelihoods would not only increase demand for manufactured goods and services among these populations, which would in turn stimulate the growth of local towns and urban areas, it would also trigger agricultural growth. Thus, the existence of the rural- urban linkages can increase the level of economic growth and development, reduce poverty and improve livelihoods, but the scale, strength and sustainability of economic growth and development, poverty reduction and livelihood improvements depend not only on local but also on global interactions and international trade linkages.

At the local level, the nature and scope of rural–urban interactions is influenced by several factors, ranging from geographical and demographic characteristics including the nature of agricultural land, population density and distribution patterns of farming systems to the availability of roads and transport networks, linking local settlements to a number of urban centres where markets and other services are located. Local government and other local actors are best placed to identify local needs and priorities and provide an adequate response to them. Local decision-making can help avoid the neglect of forward and backward linkages between agriculture and services and manufacturing. It can also negotiate and regulate the use of natural resources by rural and urban residents and enterprises, which can otherwise become a major cause for conflict (http://www.yojana.gov.in/Kuru%20February%202015.pdf).

Provision of Urban Amenities in Rural Areas (PURA): Rural Urban Linkage in India

Lack of livelihood opportunities, modern amenities and services, necessary for decent living in rural areas result in a sense of deprivation and dissatisfaction amongst a large percentage of population and lead to migration of people to urban areas. This is primarily due to the big differences in the availability of physical and social infrastructure in rural and urban areas. In order to address these issues, the government has, in the past, launched various schemes at different points of time. However, due to several reasons, the impact has not been very visible. The deliveries of these schemes were not simultaneous and although huge sums were earmarked for capital expenditure, very little resources were spent on the operation and maintenance of the assets. Also, each of these schemes operated autonomously and the standards set for infrastructure services delivery in the rural areas were far below those set for the urban population. Hence, in spite of several schemes, there continued to be a substantial flow of migration from the rural to urban areas. In order to catalyse the convergence between different infrastructure schemes and create a new model for management of urban services in the rural areas, the Provision for Urban Amenities in Rural Areas (PURA) Scheme has been developed (http://www.yojana.gov.in/Kuru%20February%202015.pdf).

About PURA

To make the basic amenities like good roads, drinking water etc. accessible to people even in remote villages, The Ministry of Rural Development (MoRD), Government of India has re-launched the scheme Provision of Urban Amenities in Rural Areas (PURA) as a Central Sector scheme during the remaining period of the eleventh five year Plan. PURA aims to achieve

"holistic and accelerated development of compact areas around a potential growth centre in a Panchayat (or group of Panchayats) through PPP by providing livelihood opportunities and urban amenities to improve the quality of life in rural areas." The PURA Scheme envisages rapid growth of rural India given enhanced connectivity and infrastructure, the rural population would be empowered and enabled to create opportunities and livelihoods for themselves on a sustainable and growing basis. The key characteristics of the scheme are:

[1] Simultaneous delivery of key infrastructure in villages leading to optimal use of resources.

[2] Provision of funds for O&M of assets for 10 years post-construction, along with capital investment for creation of assets.

[3] Transformation of several schemes into a single project, to be implemented as per set standards in a defined timeframe, with the requirements of each scheme being kept intact.

[4] Combining livelihoods creation with infrastructure development.

[5] Enforcement of standards of service delivery in rural areas almost at par with those obtaining in urban areas.

[6] Enforcement of service standards through a legally binding arrangement. The speed of urbanisation poses an unprecedented policy change yet India has barely engaged in a national discussion about how to handle this seismic shift in the make-up of the nation. The population of India residing in urban areas will increase from 340 million to 590 million by 2030. Urbanisation is expected to speed up across India, impacting almost every state. As India expands, India's economic make-up will also change. In 1995, India's GDP split almost evenly between its rural and urban economies. In 2008, its urban GDP was accounting for 58 per cent of its overall GDP and if the current trend continues it is expected that urban India will generate 70 per cent of India's GDP by 2030 (http://www.yojana.gov.in/Kuru%20February%202015.pdf).

Livelihoods and the Rural-urban Continuum	
Rural	**Urban**
Livelihoods drawn from agriculture, forest, fishing or from other natural resources.	Livelihoods drawn from labour markets through marketing of goods and services.
Access to natural capital like mountains, forests, mines, etc.	Reliance on space for production and access to income generating opportunities
Land availability is more and easy to build a house on cheaper rates.	Access to land is very difficult and land markets are highly commercialised
Huge gap in the awareness about the services provided by the governments for their welfare and benefits.	People are more aware about the facilities but highly venerable to governance deficit

Access to various public facilities is limited because of distance criteria and limited capacity to pay except few	Access to infrastructure and other services is difficult to low income people because of high prices and commercialisation
Fewer rely on cash as they depend more on agricultural products that is prone to climatic conditions	Greater reliance on cash for availing the things for day to day requirements

UNIT: - 10

TYPES, PATTERN AND SEGREGATION OF RURAL SETTLEMENTS IN INDIA

INTRODUCTION

Shelter is one of the most important basic necessities of human being. Even the naked saints and pygmies need a shelter to sound sleep (the physiological need of living being) at some place. After food, it is most important need of man. People construct houses and develop settlements to protect themselves against the vagaries of weather and to enjoy social life. In fact, settlement is man's first steps towards adopting himself to his physical environment. Settlement is a place where people live and interact with each other through various activities. It is basically an occupance unit, comprising of the grouping and arrangement of two basic elements viz., houses and roads. It is a concrete expression of the changing relationship between man and environment. It is a space-bound social organization, varying from an isolated house or a rural hamlet to a metropolis/megacity and responding variously to environment, economic, cultural, technological and historical condition.

Depending on the size, the rural settlements are classified as Hamlets is rural settlement comprising of few houses only), true village communities, villages and large villages. True village community are just ancient and long settled villages where in extreme cases, no personal property exists and everything belongs to community of peasants. Such village communities are seen in India, Malaya and France (https://baadalsg.inflibnet.ac.in/bitstream/10603/136515/10/10_chapter%201.pdf).

APPROACHES OF RURAL SETTLEMENT STUDIES

Three basic approaches of studies are employed in rural settlement geography.

A. Genetic Approach

The genetic approach of settlement studies was pioneered by Meitzen (1895). In the 20th International Geographical Congress Symposium (London, 1964), it was emphasized that the scientific study of settlements must be founded on an appreciation of the nature and limitation of historical perspective, whether archaeological or documentary. As the core concern of settlement geography is the spatial arrangement and sequent occupance, the histogenetic approach is most appropriate for studying the degree of continuity of territorial organization and problems of interaction between man and environment. Three basic attributes, i.e., retrogressive, retrospective and prospective are very common for historical perspectives of rural settlement studies. Bloch advocated the first attributes in this context. According to him, retrogressive method is focused upon the past on the basis of the evidences gathered from the recent past." The second approach, i.e., retrospective, advocated by Roger Dion focuses upon the present, the past conditions regarding settlements being considered for better understanding of the existing state. The third approach, i.e., prospective, concerns itself with the future, the past and present settlement forms being regarded as relict features for adjustment with future probable needs (http://ir.amu.ac.in/5983/1/T%205730.pdf).

B. Spatial Approach

Spatial organization approach is a form of system approach, which helps in comprehending the settlements as a whole. It may be analysed through different concepts, among which very pertinent in rural settlement geography are (i) type, pattern and classification, (ii) functional integration and hierarchy, (ill) local identity (e.g., village structure), and (iv) planning and rationalization." Demangeon actually developed the concept of spatial organization in context to morphological structure. He presented the classification of French grouped settlements into different types according to shape. His works paved the way for geographers to produce regional classification of rural settlement types. Schaefer^ initiated the modern orientation following the works of German geographers. Modern geographers are following him in the study of settlements through the analysis of patterns and processes as they express the spatial organization in environmental space. Through this approach the interrelationship of man, nature and society is better expressed in any cultural landscape. A number of studies on morphology, size and shape of settlements speak some sort of organization of space ranging from a room, hamlet, and town to the far off settled megalopolis (http://ir.amu.ac.in/5983/1/T%205730.pdf).

C. Ecological Approach

The ecological-cultural approach finds its strength through the study of plant ecologists. Plant ecology theories are being applied to explain the process of change in human behaviour and settlements over time. Radha Kamal Mukerjee regarding adaptation of human society and ecology produced a fundamental work." The settling process as described by Hudson^ includes three phases-colonization, spread and competitionsimilar to plant communities in space. He concluded that this process follows a cyclic way temporarily. Since much of the human behaviour is of sub-optimal nature, people in various habitats are often with less than the Ideal. Such habitats have been studied by many geographers including Kayasthaand Singh.' The most significant theoretical framework of settlement formation has so far been developed by C.A. Doxiadis. He sets five principles, illustrated with hypothetical diagrams. The first principles is the maximization of man's potential contact with natural elements, (e.g., water, trees, etc.), with other people cultural elements (e.g., buildings, roads, etc.). The second principle is the minimization of efforts required for the achievement of man's actual and potential contacts, according to the general principle of least effort. The third principle is the optimization of man's protective space at every movement individually or in a group, in any situation or locality, whether it is temporary or permanent, whether he is alone or part of a group. The fourth principle is the optimization of the quality of man relationship with his environment, consisting of nature, society, shell (building and houses of all sorts), and networks (lanes, street, road, communications, etc.). The fifth principle is that man organizes his settlements in an attempt to achieve an optimum synthesis of the previous four principles. This optimization works naturally through time and space, as well as the prevailing conditions and man's ability to create a synthesis (http://ir.amu.ac.in/5983/1/T%205730.pdf).

FACTORS AFFECTING THE TYPES OF RURAL SETTLEMENTS

While studying the factors affecting the organization of rural settlements, the land is significant because any types of occupations are concerned to land. As man has developed more and more, advanced techniques or methods of living , he is able to depend more and more on a single place to provide his livelihood, but the basic requirements must be present. If these needs are provided the factor such as planning can play an important role and affecting the site of settlements.

It is a complicated matter for the siting of rural settlements because there are various factors such as physical and socio-economic etc. But these are inter- related to each other to form the types of rural settlements. In physical factors the water supply, cultivable land, dry land, shelter and defence are included while in, socio-economic factors the land use, land tenure, crop associations, means of transportation and density of population are included.

Many people have studied settlement types. Demanageon (1962) tried to explain why rural settlements are dispersed or agglomerated. According to him, on plains settlements tended to the concentration where as in rugged or broken area disperse settlements are more common. The physical aspects are the significant or more influenced the pattern of settlements. In general, river side settlements are in the form of linear types settlements, availability of resources are formed the nucleated settlement types, around the dam or lake, it is sited in the manner of cluster type. The river and its tributaries (nallas) where fertile land is available, it gives rise to disperse type of settlements.

Socio -economic factors such as land tenure, transport network and density of population also control the settlement types. Along the road and railway route the linear types of rural settlements are formed. The density of population concerned mostly with the organization of agglomerated type of settlements. When the above factors control the types of rural settlements, the development of technology accelerate the development in agriculture which influences on the rural settlement types in the study region. Similarly political, religious and social considerations are also important in the study ofrural settlement types (http://ir.unishivaji.ac.in:8080/jspui/bitstream/123456789/2200/12/12_Chapter%205.pdf).

TYPES OF RURAL SETTLEMENT IN INDIA

Any settlement in which most of the people are engaged in agriculture, forestry, mining and fishing is known as rural settlement. A rural settlement is often been called an agricultural workshop. It cannot be separated from the land whose use it ensures. Its type, shape and pattern are generally in accordance with the kind of work, the agricultural techniques and the way the soil is used. Most of the rural settlements of the world are stable and permanent. The rural areas are dominated by open countryside, extensive land uses, relatively low population densities and simple mode of life. It is opposite of urban settlement. Most of the world settlements are

rural. Rural Settlement is of following Types (https://www.shareyouressays.com/knowledge/8-factors-responsible-for-human-settlements-in-a-particular-region/111244) –

1. Compact settlement

2. Semi- Compact Settlement

3. Dispersed Settlement

4. Hamleted settlement.

(1) Compact Settlement

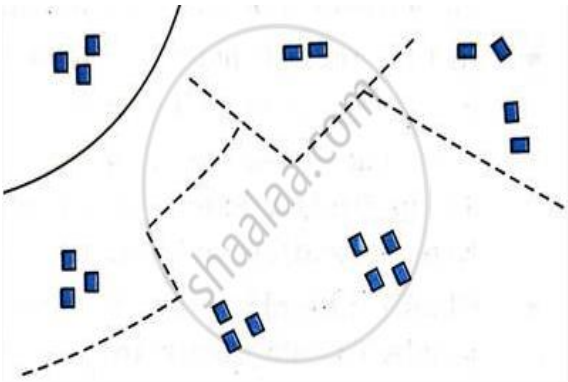
A compact settlement is based on farming and its allied activities. These are mostly found in highly productive alluvial plains like Indo-Gangetic Plains, the Hwang Ho Valley of China, and Valley of Nile. The houses are compact and congested with narrow plains. The size of these settlements depends on nature and resources of surrounding country. They have a high degree of segregation and differentiation of the upper and lower castes. Compact settlements are also found in hunting and fishing communities. This model has a centre where several public buildings are located such as the community hall, bank, commercial complex, school, and church. This centre is surrounded by houses and farmland. Small garden plots are located in the first ring surrounding the houses, continued with large cultivated land areas, pastures, and woodlands in successive rings. The compact villages are located either in the plain areas with important water resources or in some hilly and mountainous depressions. In some cases, the compact villages are designed to conserve land for farming, standing in sharp contrast to the often isolated farms of the American Great Plains or Australia (https://old.amu.ac.in/emp/studym/100018367.pdf).

(2) Semi – Compact Settlement

Semi-Compact is a transitional phase in the growth of compact settlement. The emergence is because of the difference of semi-arid regions from humid regions and marginal productive land to that of fertile land. Increase in population cause villages to grow in number of houses. These houses occupy open spaces and lead to semi-compact settlement which ultimately acquires a nucleated settlement. Semi – compact settlement certainly lacks the bond of cultural cohesion and unity which finds its expression in a compact village, for here the scattered nature of the settlements widens the social distance (https://old.amu.ac.in/emp/studym/100018367.pdf).

(3) Dispersed Settlements

This is also known as isolated settlements. Here the settlement is characterized by units of small size which may consist of a single house to a small group of houses. It varies from two to seven huts. Therefore, in this type, hamlets are scattered over a vast area and does not have any specific pattern. Such type of settlements are found in tribal areas of central part of India covering Chhota Nagpur plateau, Madhya Pradesh, Rajasthan, etc. Such patterns are also common in the hills of north Bengal, Jammu & Kashmir, Tamil Nadu and Kerala (http://docplayer.net/30293460-29-1-what-is-a-settlement.html).



(4) Hamleted Settlements

Hamlets are tiny settlements. They are just a collection of houses, perhaps cantered around a few farms and may be without even a shop. These types of settlements are fragmented into several small units. The main settlement does not have much influence on the other units. Very often the original site is not easily distinguishable and these hamlets are often spread over the area with intervening fields and the main or central settlement is either absent or has feeble influence upon others. The hamlets are locally named. In India, these types of settlements are found in West Bengal, eastern Uttar Pradesh, Madhya Pradesh and coastal plains. On the basis of their socioeconomic condition two sub – types of hamlets may be distinguished. Traditional hamlet and latifundium type. Traditional Hamlet belongs to primitive people or aboriginal tribes like those of Tharus, Bhills etc. The latifundium type hamlets are associated with agricultural farm estates or plantations (https://researchspace.ukzn.ac.za/handle/10413/17587).

PATTERNAND SEGREGATIONOF RURAL SETTLEMENT IN INDIA

Pattern of settlement is defined as the relationship between one house and building to another. It can be identified by reading and observing a local scale map. The patterns of settlement deals with compact and semi-compact only, as dispersed has its own shape. The socio-cultural factors like caste structure or a functional need of people has a close bearing on its shape and size. The rural settlements are classified under following patterns: Rectangular, Linear, Circular, Semi-circular, Star-like, Triangular, and Nebular Pattern. The settlements is linear in valleys and mountainous areas, rectangular in fertile plains, circular near the lakes and ponds, triangular at cross roads and in exceptional cases it resembles the nebular form and on river terraces it is star-type (https://old.amu.ac.in/emp/studym/100018367.pdf).

Patterns of rural settlements indicate the way the houses are placed in relation to each other. The position of the village, the neighbouring topography and terrain impact the size and shape of a village. Rural settlements may be classified based on some criteria:

* Based on the setting: The main classes are plain villages, coastal villages, plateau villages, desert villages and forest villages.

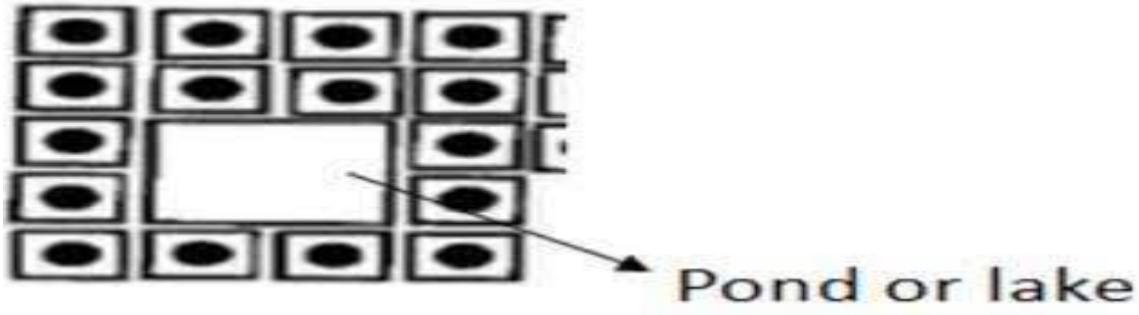
* Based on functions: There may be farming villages, lumberjack villages, fisherman's villages, pastoral villages etc.

* Based on forms or configurations of the settlements: These may be a number of geometrical patterns and shapes such as Linear, rectangular, T-shaped village, a circular star-like village, double village, cross-shaped village etc (https://www.sscollegejehanabad.org/study-material/65210137PATTERNS%20OF%20RURAL%20SETTLEMENT.pdf).

Patterns of Rural Settlements

(1) Square Pattern

The square pattern is divided into two sub types I) completely covered and ii) hollow square pattern. This form of rural settlement is normally found in the plains at the crossing of cart-tracks or roads, having strong agglomeration with prosperous of agricultural region. The entire village is divided into small squares of houses occupying the people of different castes. In Khandala,Taluka,Pawarwadi, and Padegaon have the similar pattern of settlement. Hollow square pattern is similar to square pattern, only difference between the two lines in the centre of the village. The centre of the village in a hollow square patterns occupied by square, tank, temple, mosque, or an open market space. Jhagalwadi is the best example of hollow square pattern of rural settlement (http://ir.unishivaji.ac.in:8080/jspui/bitstream/123456789/2200/12/12_Chapter%205.pdf).

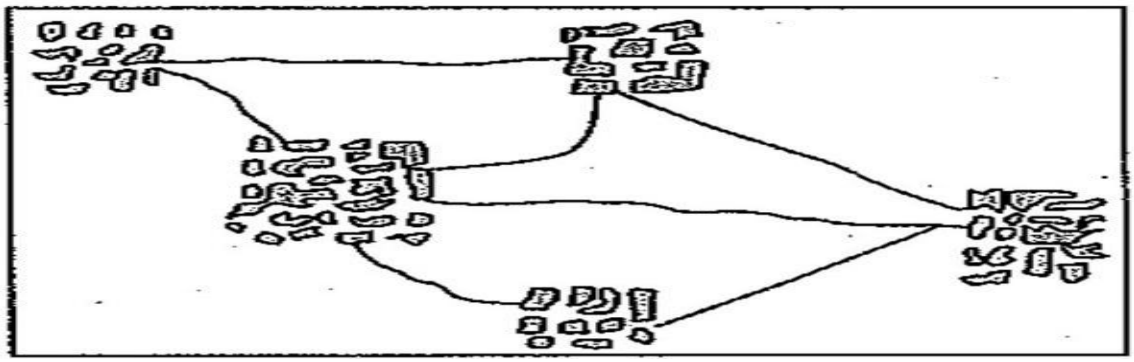


(2) Rectangular Pattern

The rectangular figure is common in the areas where settlements are agglomerated and compact. Some settlements have quadrilateral procedure both in the internal arrangement of lanes and houses and in the exterior outline. Some rectangular settlements have interior arrangements which are not perfectly rectangular but largely imitate to it. The rectangular compact settlements patterns are found usually in plain uniform surfaces where agriculture is uniformly carried out. There is an obvious relationship between the field patterns and the nature of the village. This fact is accurate in the Ganga plains and its adjoining areas. In the whole of the northern plain areas the unit of measurement is 'bigha' which is a square unit of land. The fields also have boundaries north-south and east-west to give a rectangular shape to the villages. The lanes connecting these fields also run in the same direction and hence form a rectangular pattern. The rectangular and square forms are easy to design and measure. With the Aryans who developed sound knowledge of geometrical figures which are proportioned, these two

types seem to be the most favoured ones. The Aryan houses are also four cornered, four walled and rectangular in shape. The ancient villages depicted on sculptures, and described in Silpa Sutras also give details of village shapes. Manasaras also refer to the eight common plans of the villages all of which are rectangular.

The religion played a very noteworthy role in determining the role alignment of the village. The Arthashastra is also full of plentiful plans of Aryan villages and towns containing four principal gates dedicated to four principal gods. The eastern gate was dedicated to Brahma, southern to Indra, the western to Yama, the lord of Death, northern to Kartikeya etc (http://ir.unishivaji.ac.in:8080/jspui/bitstream/123456789/2200/12/12_Chapter%205.pdf).

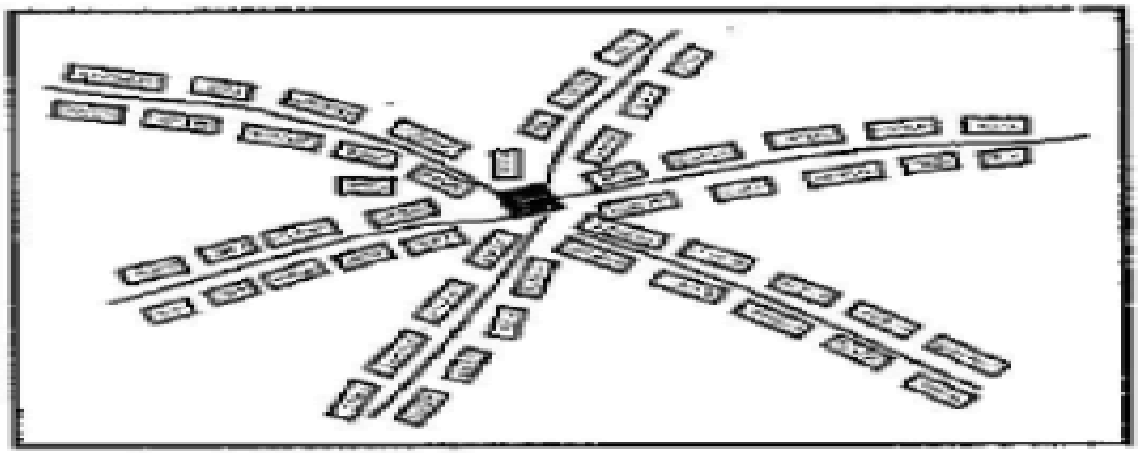


(3) Circular Pattern

Circular villages develop around lakes, tanks and sometimes the village is planned in such a way that the central part remains open and is used for keeping the animals to protect them from wild animals. In the upper Doab and Trans – Yamuna districts, Malwa region, Punjab and Gujarat, large villages are characterized by a very high degree of compactness. The outer walls of dwellings adjoin each other and present a continuous front so that when viewed from outside, the villages look like a walled and fortified enclosure pierced by a few openings. The round form was a natural outcome of maximum aggregation for the purpose of defence during the past (https://old.amu.ac.in/emp/studym/100018367.pdf).

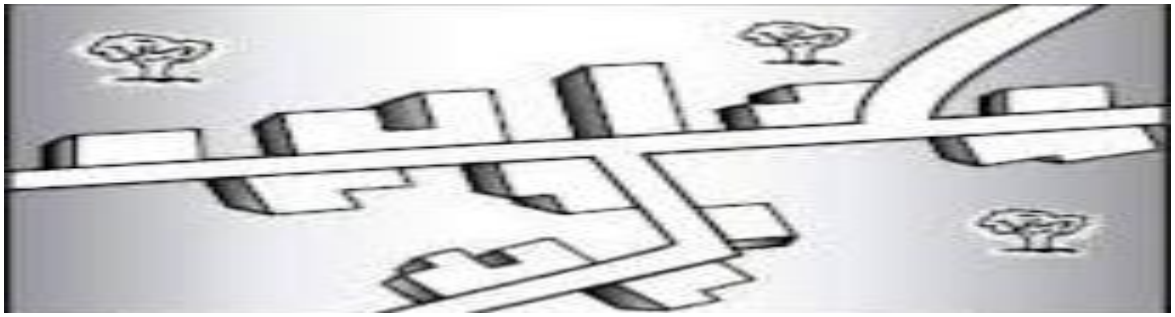
(4) Radial Pattern

In this type, a number of streets converge on one centre which may be a source of water (pond, well), a temple or mosque, a centre of commercial activity or simply an open space. Thus, the streets seem to be radiating from a common centre. Examples are settlements near Gurushikar, Mount Abu in Rajasthan, Vindhyachal in Uttar Pradesh, etc (https://old.amu.ac.in/emp/studym/100018367.pdf)



(5) T-shaped Pattern

T-shaped settlements progress at tri-junctions of the roads. Triangular, villages have tri-bounding lanes one of them runs perpendicular from the peak to the base. Some of triangular villages are sited on the triangular inter-fluvial plains. The bases of such triangular settlements lie upstream while the apex points towards the convergence. The internal arrangement of lanes is rectangular and external outline sometimes resembles fan shaped settlements. In the case of fan plan village the pivotal points are the road turning, road terminus, a river bend or a tank. Some of the rural settlements originally having 'T' shape overgrowth to a triangular shape, particularly when both the sides of T-villages have equally significant linear features (http://ir.unishivaji.ac.in:8080/jspui/bitstream/123456789/2200/12/12_Chapter%205.pdf).



(6) Fan Pattern

The fan pattern of village develops in fan shape with a focal point. This focal point is road or a river side. This pattern also develops at the convergence of roads or rivers. In the study area Khed Bk. is the best example of fan pattern settlement.

(7) Amorphous Pattern

The amorphous form ofrural settlement is found in the areas where several ‘wadi’ settlements and farmstates found which scattered and connected by foot- paths and cart tracks, such as irregular pattern is known as amorphous pattern of settlements. In the study area amorphous pattern is found at Nimbodi, Ahire, Sukhed and Bori. Other than above patterns of rural settlements ‘T’ shape pattern is found at Chavanvasti, radial pattern at Shivajinagar, triangular pattern at Kanhawdi. It is observed that compact and composite types of rural settlements show variety of patterns as compared to disperse and fragmented type of rural settlements. In spite of physical factors the dominance of caste system, the patterns of land holding, development of canal irrigation and transport network also play an important role in shaping village patterns in the study region.

Problems of Rural Settlement

1. Rural settlements in the developing countries are large in number and poorly equipped with infrastructure. They represent a great challenge and opportunity for planners.
2. Supply of water to rural settlements in developing countries is not adequate. People in villages, particularly in mountainous and arid areas have to walk long distances to fetch drinking water. Water borne diseases such as cholera and jaundice tend to be a common problem.
3. The countries of South Asia face conditions of drought and flood very often. Crop cultivation sequences, in the absence of irrigation, also suffer.
4. The general absence of toilet and garbage disposal facilities cause health related problems
5. The design and use of building materials of houses vary from one ecological region to another. The houses made up of mud, wood and thatch, remain susceptible to damage during heavy rains and floods, and require proper maintenance every year.
6. Most house designs are typically deficient in proper ventilation. Besides, the design of a house includes the animal shed along with its fodder store within it. This is purposely done to keep the domestic animals and their food properly protected from wild animals
7. Unmetalled roads and lack of modern communication network creates a unique problem. During rainy season, the settlements remain cut off and pose serious difficulties in providing emergency services.
8. It is also difficult to provide adequate health and educational infrastructure for their large rural population.

UNIT: - 11

URBANIZATION IN INDIA AS MULTI-DIMENSIONAL PROCESS; URBAN RENEWAL IN INDIAN CONTEXT

INTRODUCTION

Urbanization is a form of social transformation from traditional rural societies to modern urban communities. It is long term continuous process. The objective of this paper is to understand the extent, trend and pattern of urbanization and also the consequences in the socio-economic context in India by using data from Census of India 1901-2001, NSSO etc. It is an attempt to outline urban growth process and its consequences which have severe implications on policy issues. Before attempting an analysis of pattern and trends in urbanization in India, it becomes imperative to trace the process of urbanization in India through history because what distinguished India most, from many other countries of the world is its long tradition of urbanization dating back as far back as about five thousand years, when Indus Valley Civilization saw the birth of the earliest urban settlement in human history. In India, the urban tradition continued throughout these centuries and during the ancient period of our history there were many well planned, big and beautiful cities in different parts of the country. In ancient and medieval times it was a cultural phenomenon and many a times it happens due to political development because the rise and fall of new dynasties and kingdoms but in recent times, it is complementary of industrialization and socio-economic transformation,hence it becomes a socio- economic phenomenon (http://docplayer.net/33039229-Urbanization-in-india-dynamics-consequences.html).

Urbanization is not a side effect of economic growth; it is an integral part of the process. As in most countries, India's urban areas make a major contribution to the country's economy. Indian cities contribute to about 2/3 of the economic output, host a growing share of the population and are the main recipients of FDI and the originators of innovation and technology and over the next two decades are projected to have an increase of population from 282 million to 590 million people. India's towns and cities have expanded rapidly as increasing numbers migrate to towns and cities in search of economic opportunity.

Salient Features of Indian Urban Centres

A sociological analysis of urban community contains several salient features. They are as follows:

➢**Size:** As a rule, in the same country and at the same period, the size of an urban community is much larger than that of a rural community. In other words, urban it and size of a community are positively correlated.

➢**Marriage:** In case of urban community there is a preponderance of love marriages and inter-caste marriages. One also comes across a greater number of divorces. Sons and daughters enjoy considerable freedom in choosing their life partners.

➢**Class extremes:** In the words of Bogardus, "Class extremes characterize the city." A town and a city house the richest as well as the poorest of people. In a city, the slums of the poor exist alongside the

palatial bungalows of the rich, amidst the apartments of the middle class members. The most civilized modes of behavior as well as the worst racketeering are found in the cities.

➢**Social heterogeneity:** If villages are the symbol of cultural homogeneity, the cities symbolize cultural heterogeneity. The cities are characterized by diverse peoples, races and cultures. There is great variety in regard to the food habits, dress habits, living conditions, religious beliefs, cultural outlook, customs and traditions of the urbanites.

➢**Social distance:** Social distance is the result of anonymity and heterogeneity. Most of one's routine social contacts in a town or city are impersonal and segmentary in character. In the urban community social responses are incomplete and half-hearted. There is utter lack of personal involvement in the affairs of others.

➢**System of interaction:** Georg Simmel held that the social structure of urban communities is based on interest groups. The circles of social contact are wider in the city than in the country. There is a wider area of interaction system per man and per aggregate. This makes city life more complex and varied. The city life is characterized by the predominance of secondary contacts, impersonal, casual and short-lived relations. Man, at any rate, the man in the street, virtually loses his identity being treated as a "number" having a certain "address".

➢**Mobility:** The most important feature of urban community is its social mobility. Inurban areas the social status of an individual is determined not by heredity or birth but by his merit, intelligence and perseverance. Urbanity and mobility are positively correlated.

➢**Materialism:** In the urban community the social existence of man revolves round wealth and material possessions. The worth of an urbanite today is being judged not by what he is but by what he has. Status symbols in the form of financial assets, salaries, costly home appliances count a lot for the urbanites.

➢**Individualism:** The urbanites attach supreme importance to their own welfare and happiness. They hesitate to think or act for the good of others ((https://www.researchgate.net/publication/340102124_Urbanisation_in_India_Causes_Growth_Trends_Patterns_Consequences_Remedial_Measures)).

➢**Rationality:** In urban community there is emphasis on rationality. People are inclined to reason and argue. Their relationship with others is governed, for the most part, by the consideration of gain or loss. Relationship takes place on a contractual basis. Once the contract is over, human relationship automatically comes to a close.

➢**Anonymity:** As Bogardus observes, the "Urban groups have a reputation for namelessness." By virtue of its size and population, the urban community cannot be a primary group. Here nobody knows anybody and nobody cares for anybody. The urbanites do not care for their neighbors and have nothing to do with the pleasures.

➢**High Population & Density:** The urban areas comprise of the cities and the towns and they have the higher density of population as compared to other areas. Since urban areas are considered to be developed regarding education, medical and health care, employment opportunities and so forth, therefore, individuals migrate from rural areas to the urban. People belonging to rural and tribal communities, who are residing in the conditions of poverty and backwardness, possess this viewpoint that they will be able to enhance their living conditions by migrating to urban areas. The primary feature of urban areas is characterized by higher population density

and vast human features in comparison to the area surrounding it. Urban areas are created and developed by the process of urbanization (Indian Society and Social Change, 2011).

➢**Cultural Heterogeneity:** In urban areas, cultural heterogeneity is commonly found. This is due to the fact that individuals migrate to urban areas on a large scale. The main aspects that lead to migration of the individuals are education, employment opportunities and health care and medical facilities.

➢**Non-Agricultural Economy:** The occupations and the employment opportunities of the individuals in urban areas are based on the non-agricultural sector. Individuals are professionals such as doctors, lawyers, researchers, teachers, educationists and so forth. The other occupations include manufacturing, trade and commerce, professional and governance.

➢**Higher Social Mobility:** In the urban areas, more social mobility is found amongst the individuals. Individuals get easily adapted to the class structure, which can be upper, middle or lower class on the basis of the economic criteria. The development of urbanization has contributed in the enhancement of skills and capabilities of the individuals, training of the managers and the administrators, distribution of technology and other innovative techniques and methods. With the development of industrial economies, people have become resourceful, inventive and conscientious in their workings. With the advent of industrialization, there has been expansion of employment opportunities amongst the individuals.

➢**Higher Social Communication:** Communication is considered to be an imperative area for the progress and welfare of the individuals. Individuals are required to communicate with each other in order to implement all the activities of their daily lives. For instance, people interact with each other at home, in the offices, on the roads, at market places and so forth. In urban areas, interaction amongst the individuals is based on secondary contact and not primary contact. It means people normally communicate with each other through technology and making use of other technical devices, such as emails, messaging, texts and so forth. Faceto face interaction and individual to individual interaction is not possible to a much greater extent in urban areas. In other words, technology is more commonly used.

➢**Telecommunication Services:** In urban areas, the role of telecommunications has played an imperative role in the growth and advancement of the economy. There is a broad potential for leading to an increase in the telecommunication services within the country. Advanced communication services such as, fax, data transmission and leased circuits are becoming increasingly common.

➢**Technological area:** In urban areas, the usage of technology in the implementation of all kinds of transactions and operations has largely led to progression of the individuals. In offices, individuals make use of technology to prepare reports, documents and create communication links with the other individuals.

➢**Self-living:** In urban areas, individuals normally remain occupied with their own lives. They normally adopt an urban way of life. Individuals, who are working and are engaged in full time jobs, normally leave their homes in the mornings and come back in the evenings. Full time employment opportunities are six days in a week and individuals are required to work eight to ten hours each day. Formal interaction, impersonal behavioral traits, non-kinship relationships, is some of the attributes that the individuals possess.

➢**Nuclear Families:** In urban areas, individuals mostly reside in nuclear families and family disintegration is considered to be an important feature. In the present existence, there are number of individuals who are migrating to foreign countries. In the local urban areas, too, individuals may live separately from their parents. The family system within the urban areas is characterized as unstable. Individuals normally move out of their homes to other regions with the main purposes of education or employment opportunities. Moving away from the family is not considered to be negative when one has the objective of looking for a better living opportunity.

➢**Rapid social and cultural change:** Rapid social and cultural change characterizes urban life. The importance attached to traditional or sacred elements has been relegated to the background. The benefits of urban life have effected changes in respect of norms, ideologies and behavior patterns.

➢**Voluntary associations:** The urban community is characterized by impersonal, mechanical and formal social contacts occurring among the people. Naturally they have a strong desire for developing genuine social relationships to satisfy their hunger for emotional warmth and sense of security. They form associations, clubs, societies and other secondary groups.

➢**Formal social control:** Social control in urban community is essentially formal in nature. Individual's behavior is regulated by such agencies as police, jails, law courts etc.

➢**Secularization of outlook:**In cities ritual and kinship obligations are diluted. Caste and community considerations yield to economic logic. This results in secularization of outlook.

➢**Modernization:** Urban areas provide impulses for modernization in society as a whole (https://www.yourarticlelibrary.com/sociology/20-important-characteristics-of-urban-community-sociology/4873).

Urbanization in India: A Colonial Legacy and in Post-Independence period

The story of urbanization in India needs to be studies in an historical context; a story of spatial and temporal discontinuities (Ramachandran, 1989). The earliest urban developments were confined to the Indus Valley and its adjoining regions. Other parts of the country were untouched by this process. In the early-historical period it was experienced in the Middle Ganga plains and the southern parts of the Indian Peninsula. Similar picture us seen even in the historical period where large parts of the country were hardly affected by urbanization. In modern times these spatial discontinuities continue to be a dominant characteristic of urbanization in India.

The factors responsible for urbanization varied from time to time. In the prehistoric period urbanization was synonym to the origin and rise of civilization thus can be termed as a cultural process. From historical periods to the British regime, urbanization was related to the rise and fall of kingdoms, dynasties and empires; thus a political process. In modern times, urbanization is perceived as a process which is closely related to economic development and industrialization; thus an economic process. On the basis of these temporal discontinuities in the process of urbanization in India the urban history of India can be divided into five time periods. These are (http://ebooks.lpude.in/arts/ba/year_2/DSOC201_SOCIAL_STRUCTURE_AND_SOCIAL_CHANGE_ENGLISH.pdf):

i) The pre-historic period (2350-1800 BC)
ii) The early-historic period (600 BC to 500 AD)
iii) The medieval period (600 AD to 1800 AD)
iv) The British period (1800 to 1947)
v) The post-Independence Period (after 1947)

In this module, we will be concentrating only on the last two time periods, as to understand the process of urbanization in present times, it is important to consider the factors that lead to this lop-sided urbanization. The urbanization of post-Independence is characterized with over burden on class I and metropolitan cities that is metropolization where the top has become heavy (http://ir.amu.ac.in/8563/1/DS%203710.pdf).

The British Period (1800 -1947)

The British had a negative impact on the Indian urban morphology as the pre-British cities were on decline as they were hardly interested in the traditional industries of India. Moreover, introduction of railways resulted in the diversion of trade routes into different channels as every railway station became a point of export of materials for its hinterland, thus depriving earlier trade centres of their monopoly. Whatever the reason may be in a nutshell it can be said that India's urban landscape went through a transformation during the 150 years of the British rule. The main features of this period include:

a) The creation of the three metropolitan port cities which emerged as the leading colonial cities of the world. All the older cities which were prominent in the Mughal period were reduced to small towns. These three cities became the leading administrative, commercial and industrial cities. The entire cultural landscape of these cities was of British taste which was of a sharp contrast to the urban designs of the Mughal period.

b) The creation of hill stations in the Himalayan foothills and in South India along with the introduction of tea and coffee plantations which resulted in the emergence of number of smaller settlements with distinct urban characteristics. Between 1815 and 1870 over 80 hill stations were developed in four different regions of the country to serve the four metropolitan cities of Delhi, Calcutta, Bombay and Madras. These were – Shimla - Mussorie – Nainital near Delhi; Darjeeling – Shillong near Calcutta; Mahabaleshwar near Bombay and the Nilgiri – Kodaikanal area near Madras. The plantation settlements were another significant feature as although they were not large in size they had distinct urban features because of processing plants, residences of workers and associated commercial establishments.

c) The modification of the existing urban landscape through the introduction of civil lines and cantonments. These modifications were most noticed in the administrative centres of the British like the provincial capitals, the district headquarters and the tehsil level urban administrative town. The 'civil lines' was a new addition which was made of administrative centres, courts and the residences of the officers. Cantonments were fewer in number; built exclusively for the British officers and the army men. These modifications segregated the city and the gap between rural and urban increased many fold.

d) The introduction of the railways and the modern industry which lead to the development of new industrial townships like Jamshedpur, Asansol and Dhanbad. The introduction of railways had an indirect influence on urbanization. Though, it led to the emergence of the metropolitan cities as the primary foci, it even brought unplanned urbanization as the city started growing in an unplanned manner towards the railway station. Industrial development as such during this period was very modest. Most of the industries were concentrated near the metropolitan cities with exceptions like Jamshedpur which emerged as towns after the establishment of Iron and steel plant.

e) The improvements in urban amenities and administration during the British rule were one of the major benefits that cities experienced during this time. The facilities like piped water supply, street lighting, domestic electrification, sewerage system, shopping areas, green spaces in the form of parks and playing grounds were roped in; though these were restricted to the civil lines and the cantonment areas. Most of the cities were deprived of these facilities. Municipal bodies were set up in number of cities in 1881 but again these were found only in areas where British population was residing. This again brought segregation within the cities.

The above account clearly depicts that cities became the primary foci during the British period. Even the centres of education were established in the form of schools, colleges and universities. As a result an urban elite emerged which was soaked in westernization. This led to the widening of gap between the rural and the urban which continues to plague the social and political system of India even today (https://shodhganga.inflibnet.ac.in:8443/jspui/pdfToThesis.jsp?toHandle=https://shodhganga.inflibnet.ac.in/handle/10603/165865&toFile=https://shodhganga.inflibnet.ac.in/bitstream/10603/165865/8/08_chapter_02.pdf).

The Post – Independence Period (after 1947)

The process of urbanization in the post-Independence period witnessed a new phase. In this period this process was characterized with rapid urbanization which was dominated with the mushrooming of one lakh and million plus cities. The major changes that India has witnessed during this period can be summarized as follows (https://mohua.gov.in/pdf/582d95bfb0169Annual%20Report%20English%202013-14.pdf):

a) The influx of refugees and their settlement in the urban areas of northern part of the country

b) The establishment of new planned administrative centres like Chandigarh and Bhubneshwar

c) The construction of new industrial cities and new industrial townships near major cities.

d) The rapid growth of one-lakh and million cities

e) The stagnation and in some cases the decline of small towns

f) The proliferation of slums and squatter settlements in the big cities and the emergence of urban-rural fringe

g) The introduction of urban planning through Five Year Plans and the improvement in urban governance through the 74th Amendment Act.

The process of urbanization in India in not at all different from other developing countries of the world; it is also characterized with uneven pattern of development of small towns and big cities within the system. According to the 2011 Census, the urban population grew to 377 million showing a growth rate of 2.76% per annum during 2001- 2011. The level of urbanization in the country as a whole increased from 27.7% in 2001 to 31.1% in 2011 – an increase of 3.3 percentage points during 2001-2011 compared to an increase of 2.1 percentage points during 1991-2001. It may be noted that the Indian economy has grown from about 6% per annum during the 1990s to about 8% during the first decade of the 2000s (Ahluwalia 2011). This clearly reflects the power of economic growth in bringing about faster urbanization during 2001-2011. Thus in recent years urbanization in India has acted more as an economic process than a social or political one. The levels of urbanization and the pattern of urbanization is discussed in the next section (http://mzuir.inflibnet.ac.in:8080/jspui/bitstream/123456789/438/1/R.%20Lalthankima%20PA%29.pdf).

Trends of Urbanization in India (1901-2011)

Urbanization in India has been relatively slow compared to many developing countries. The percentage of annual exponential growth rate of urban population reveals that in India, it grew at faster pace from the decade 1921-31 to until 1951. Thereafter it registered a sharp drop during the decade 1951-61. The decades 1961-71 and 1971- 81 showed a significant improvement in the growth rate. But 1981-1991 shows decreasing trend which continued even in 1991-2001; in 2001-11 it shows a very small increase an over turn of the last two decades to the present rate (2.76%). The reason for the sharp drop in urban rate during 1951-61 was declassification of large number of towns during that decade.

When seen from the perspective of number of towns the data reveals that the number of urban agglomeration /town has grown from 1827 in 1901 to 7935 in 2011. This process of urbanization in India reflects that in India there is an increasing trend of urbanization depicting that India is at stage of acceleration as the proportion of population in urban areas has reached to 31.16 per cent in spite of growth rate showing decline in the trend (https://www.researchgate.net/publication/279310884_URBANIZATION_PROCESS_TREND_PATTERN_AND_ITS_CONSEQUENCES_IN_INDIA).

Table: - Process of Urbanization in India

Census Years	No. of Urban Agglomerations / Towns	Urban Population In Per Cent	Annual exponential Growth rate of Urban Population
1901	1827	10.84	
1911	1825	10.29	0.03
1921	1949	11.18	0.79

1931	2072	11.99	1.75
1941	2250	13.86	2.77
1951	2843	17.29	3.47
1961	2363	17.97	2.34
1971	2590	19.91	3.21
1981	3378	23.33	3.83
1991	3768	25.72	3.09
2001	5161	27.78	2.74
2011	7935	31.16	2.76

Source: - Census of India (1901nto 2011)

Before we proceed we have to know why there has been such a tremendous increase in the number of towns. This can be related to the definition used in India. Scholars are of the view that India's definition of urban areas is not something out of the box rather it is restrictive in nature when compared to countries like Australia, France, the Philippines and so on where the population limit is between 2000 and 3000. Even if the cut-off limit is reduced will it provide the solution? In my opinion no because relaxation either in the population figure or in the density figures would just increase the percentage to a higher amount but that cannot be counted as urban growth. This is because in India there are large numbers of towns which have population more than 5000, but they fail in other criteria. Thus in India urbanization cannot be explained through definitions. The answer is in the colonial period where the urban process was restricted to port cities and administrative towns. The data clearly shows that till 1981 the trend was on the higher side but after that it has decreased; only to be increased fractionally in 2011. During this period the natural growth rate has shown declining trends. This means that the higher percentages are not the result of growth of towns rather the push to urban areas is from other sources, i.e., rural to urban conversion and rural-urban migration.

An analysis of the distribution of urban population across different class size urban areas reveal that urbanization in India has been top heavy or tilting towards large cities. The percentage of the urban population in 5-million-plus or million-plus cities here is higher than in most other countries of the region and has gone up relatively faster in the last three decades. An increasing concentration of urban population in Class I cities (those of population above 100,000) can also be observed over the past several decades. The percentage share of urban population in Class I cities has gone from in 26.0 in 1901 to 68.7 in 2001 to nearly 70 percent in 2011. It is often said that this is the result of faster growth rate experienced by these cities; but another reason that has been often ignored is that the number of class I cities in India has increased many fold. In 1901, there were only 24 Class I cities, increasing to 465 in 2011. Concentration of urban population in metropolitan (or metro) cities – cities having population of a million or more – is even greater. In 1901 there was just one city with over a million people with just 6 per cent of the total urban population. The number rose to 2 in 1911 and was so until 1941; though their

percentage share in urban population went up from 10.6 to 12.0 in 1941. In 1981, the share was 26.4 which has been continuously increasing to 32.5 in 1991; 37.8 in 2001 and 42.6 in 2011(53 million plus cities).

In 1947, after independence our country witnessed structural changes both politically as well as economically. In the initial plans especially the Second and Third Five Year Plans enormous public-sector investment was done which restricted the urban hierarchy. However, regional disparities still persisted, despite the public sector playing a major role in backing the development process in the backward areas through proper investments ((http://sdeuoc.ac.in/sites/default/files/sde_videos/II%20Sem%20PG%20Sociology-Urban%20Sociology.pdf)). This was because in these regions a viable system of urban settlements could not be created that left their hinterland virtually untouched. The transformation of large cities from colonial to national capitals meant only an increasing concentration of low productive manufacturing and service activities that could find a foothold more easily due to the changed political economy. The pace of urban growth was rapid during the first three decades after Independence, but that led to in formalisation of the urban economy and increasing deprivation in terms of basic amenities (Kundu, 2011).

To sum up the post-independence the urban scenario is characterized with dualism. The economically developed states attracted population in urban areas due to industrialization and infrastructural investment but only in and around large cities and upcoming industrial centres. An interesting feature which crops up is that even in the backward states the urban growth was rapid especially with regard to small and medium towns. This was the result of government investment in the district and taluka headquarters, programmes of urban industrial dispersal, and transfer of funds from the states to urban local bodies through a needs-based or what is popularly known as “gapfilling‟ approach. Another reason for the rural–urban migration into smaller towns from their rural hinterland in backward states can be explained in terms of push factors, owing to the lack of diversification in the agrarian economy (https://baadalsg.inflibnet.ac.in/bitstream/10603/133058/10/10_chapter%202.pdf).

Different terms related to Urbanization

Census Town

The Census of 2011 illustrates a huge augmentation in census towns, i e, urbanisation outside documented urban local bodies. Pradhan (2012) has studied the spatial blueprint of these settlements using an unexploited foundation prepared by the Census of India, which lists all geographical units in 2011 and its mapping with the 2001 Census.10 Using the population of these settlements from the 2001 Census, it is probable to approximation their contribution to the increase in urbanisation and using their geocodes, study whether they are located in proximity to existing towns. Pradhan finds that 26% to 29.5% of the urban growth from 2001 to 2011 can be attributed to the recognition of new census towns, varying from a high of nearly 90% in Kerala and 60% in West Bengal to fewer than 10% in states like Karnataka and Gujarat.

By dissimilarity, only 8.4% of the growth in built-up population over 1991 to 2001 was due to novel census towns. Not all of this growth of census towns is occurring approximately existing

large towns. Using a differentiated spatial buffer around towns above 1,00,000,12 he finds that only 37.2%, or 926 (of 2,489) of settlements and 33.6% of the population fall within these buffers, indicating that much of this growth is outside the peripheries of existing large towns. The spatial distribution of new census towns shows that while there is a high concentration in certain districts close to metropolitan cities, the formation of census towns is also widely spread across the country. This indicates that the process of spontaneous transformation of settlements reflected in the expansion of census towns beyond metros, is a comparatively widespread geographical occurrence (https://www.tandfonline.com/doi/abs/10.1080/10225706.2001.9684079).

Million Cities

The term 'million cities' was coined in the Indian context by Mishra (1978) to indicate those large urban centres having a resident population of one million or more. In his recent work however, Mishra (1998) has used the term 'metropoliton agglomerations'. Bose (1993) ha=d used the term 'M+' cities in his critique of urbanization in India but, afterwards, several hierarchies within the million plus city were recognized on the basis of population size. We use the term 'Million city' in his paper to imply urban centres or agglomerations with over one million population reported in the Indian Census.

At the beginning of the 20th century, there was only one million city- Calcutta-with a population of 1488323. This metropolis of India celebrated his 300th birth anniversary in 1993. Greater Bombay (now known as Briham Mumbai), itself not older than Calcutta, joined the list of million cities in 1911. Since the Independence in 1947, the numbers of million cities have grown at a tremendous pace but during the last two decades they have multiplied manifolds (https://abhipedia.abhimanu.com/Article/MPGK/MzEzNTA1/Social-Structure-I-Economic-and-S).

Mega Cities

A megacity is a very large city, typically with a metropolitan population in excess of 10 million people. A megacity can be a single metropolitan area or two or more metropolitan areas that converge. In India there are 4 megacities- Delhi, Mumbai, Kolkata and Bengaluru. In India about 377 million that is 31.16 % of the total population of the country are living in the urban area according to 2011 Census compared to 28.6 % in 2001Census. The number of metropolitan cities and its contribution to the total urban population are also on the rapid increase. In 1991, census the total number of million plus cities was 26 which increased to 35 in 2001.

Now as per 2011 Census, there are 53 million plus cities. Also, the eight metropolitan cities have crossed the mark of five million to qualify as mega cities. Out of four mega cities, Calcutta is the only one which is situated in the eastern part of India, left behind in the pace development. Kolkata is the oldest among all metropolitan/mega cities which achieved the mark of one million in 1901. The Kolkata urban agglomeration is spread over an area of 1,033 sq. km. The urban agglomeration is formally administered by several local governments including 3 municipal corporations, 37 local municipalities, and one cantonment Board area. The Kolkata

UA also consists of 75 census towns and 6 outgrowths according to Census 2011. Altogether there are a total 122 cities and towns in Kolkata UA (http://ebooks.lpude.in/arts/ba/year_2/DSOC201_SOCIAL_STRUCTURE_AND_SOCIAL_CHANGE_ENGLISH.pdf).

Kolkata lagged behind in the story of development after the Independence, but still not lost its importance as culturally, economically and strategically this is the nucleus of eastern and north-east India. The unique feature of Kolkata's regional location is that; there is no other major urban centre within a100 km from Kolkata in the eastern India unlike other regions of the country. Thus, growth of Kolkata UA assumes special significance for the development of eastern and north-east India.

Impact of Urbanisation in the Rural Areas

In India, urbanisation along with westernisation and modernisation has furthered the process of rapid social change both in the rural and in the urban areas. One of the important results of urbanisation is the rural to urban migration. Migration has become a continuous process affecting the social, economic and cultural lives of the villagers widely. Rao (1974) distinguishes three different situation of urban impact in the rural areas. In the villages from where large number of people migrate to the far off cities, urban employment becomes a symbol of higher social prestige. Villages, which are located near the towns, receive influx of immigrant workers and face the problems of housing, marketing and social ordering. Lastly, in the process of the growth of metropolitan cities some villages become the rural-pockets in the city areas. Hence the villagers directly participate in the economic, political, social and cultural life of the city.

As a result of migration there has been a flow of urban money into the rural areas. Emigrants regularly send money to their native villages. Such money facilitates the dependants to clear off loans, build houses and educate children. The urban centres of India have become the centres of national and international linkages. At present, many cultural traits are diffused from cities to the rural areas. For example, dress patterns like pants, shirts, ties, skirts, jeans etc. diffuse from cities to the rural areas. Besides these, new thoughts, ideologies are also diffused from the cities to the rural areas due to increase in communication via radio, television, newspaper, computer, the Internet and telephone. The urbanism, which emerges in the cities gradually, reaches to the rural areas, depending on their proximity to the cities.

The process of urbanisation has not been an isolated phenomenon. At present, along with the whole gamut of occupational diversification, spread of literacy, education, mass communication etc., continuity between rural and urban areas has increased. Urban jobs and other amenities of living have become status symbols in the rural areas. Many modern techniques of agricultural development and many of the institutional frameworks for rural development also generate from the urban centres. The large-scale commercialisation of agriculture has also been facilitated by the process of urbanisation. Similarly, agricultural requirements for machinery have generated the growth of manufacturing units in urban areas (http://ebooks.lpude.in/arts/ba/year_2/DSOC201_SOCIAL_STRUCTURE_AND_SOCIAL_CHANGE_ENGLISH.pdf).

Positive Effects of Urbanization

Urbanization yields several positive effects if it happens within the appropriate limits.
Some of the positive implications of urbanization therefore include creation of employment opportunities, technological and infrastructural advancements, improved transportation and communication, quality educational and medical facilities, and improved standards of living (https://www.conserve-energy-future.com/causes-effects-solutions-urbanization,php).

I. Migration of rural people to urban areas.
II. Employment opportunities in urban centers
III. Transport and communication facilities.
IV. Educational facilities.
V. Increase in the standard of living.

Urban Challenges

The built environment: the supply of both land and infrastructure is falling behind demand (https://www.worldbank.org/en/news/feature/2011/09/22/india-urbanization).

• Out of date and static master plans immobilize the supply of serviced land and buildable space, blocking efficient and productive development. While important laws have been revoked to remove land restrictions and rent controls, many of the legal instruments to operationalize those reforms are still lacking;
• Inappropriate FSI, zoning and development control regulations inhibit development and trunk infrastructure;
• Fractured planning structures are incapable of integrated planning for land use, infrastructure planning, and finance across metropolitan areas;
• The legal, regulatory and institutional basis for land management is generally lacking, hindering the capacity of the private sector to be competitive and the ability of the public sector to use land based financial instruments to finance infrastructure investments.
• Urban services, including water & wastewater, and solid waste, do not reach many residents, and those they do serve receive sporadic, unreliable services. And, in the case of non-notified slums, service providers are prohibited from serving residents.
• Public transport services provide inadequate services, and non-motorized transit for pedestrians, bicycles, and handcarts is limited, forcing this traffic to compete with cars, trucks and motorcycles for space on the streets.
• The proliferation of slums is largely the result of failures in land markets and regulations, compounded by limited access to housing finance.
• Rigid master plans and restrictive zoning regulations limit the land available for building, constricting cities' abilities to grow in accordance with changing needs.

URBAN RENEWAL IN INDIAN CONTEXT

Transformation is the single most consistent factor in the life of a city. How to control or direct that transformation to get the best combination of benefits from renewal and redevelopment is

perpetual for the planner, as how to decide for the spatial sustainability as per its available potentials, they are also dynamic in nature and inevitable for change. The problem that planners have today are too complex to be solved either by speculative approach based upon experience, intuition and imagination, or by an inductive analytical approach based on the detailed study of particular parts of problem concerned. Regarding urban settlements as complex systems; the planners is faced with prime need of understanding the work of them, so that the diagnose problems and assessment of alternative designs can be done effectively. One fact of this revolution in approach involves the development of mathematical models, which attempts to simulate the structure of land uses and activities in cities and region. The recent launching of Jawaharlal Urban Renewal Mission (JNNURM) is a landmark in the history of post independent urban planning scenario as it has brought in a paradigm shift in the role of government form provider to facilitator.

Urban Renewal in India is a inclusive appearance of the theoretical, strategic and technical aspects of urban renewal. The expression 'urban renewal' implies redevelopment of built-up areas to make sure growth of infrastructure, promotion of tourism and better quality of life. It has been identified across the world as one of the most crucial processes for ensuring optimal development of urban spaces (http://www.isca.in/IJSS/Archive/v2/i7/6.ISCA-IRJSS-2013-101.pdf).

A. Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

According to the 2001 census, India has a population of 1027 million with approximately 28per cent or 285 million people living in urban areas. As a result of the liberalization policies adopted by the Government of India is expected to increase the share of the urban population may increase to about 40 per cent of total population by the year 2021. It is estimated that by the year 2011, urban areas would contribute about 65 per cent of gross domestic product (GDP). However, this higher productivity is contingent upon the availability and quality of infrastructure services. Urban economic activities are dependent on infrastructure, such as power, telecom, roads, water supply and mass transportation, coupled with civic infrastructure, such as sanitation and solid waste management.

The aim is to encourage reforms and fast track planned development of identified cities. Focus is to be on efficiency in urban infrastructure and service delivery mechanisms, community participation, and accountability of Urban Local Bodies/ Parastatal agencies towards citizens (https://idl-bnc-idrc.dspacedirect.org/handle/10625/47973).

Objectives of the Mission (JNNURM)

The objectives of the JNNURM are to ensure that the following are achieved in the urban sector (https://ranchimunicipal.com/jnnurm.aspx);

(a) Focussed attention to integrated development of infrastructure services in cities covered under the Mission;

(b) Establishment of linkages between asset-creation and asset-management through a slew of reforms for long-term project sustainability;

(c) Ensuring adequate funds to meet the deficiencies in urban infrastructural services;

(d) Planned development of identified cities including peri-urban areas, outgrowths and urban corridors leading to dispersed urbanisation;

(e) Scale-up delivery of civic amenities and provision of utilities with emphasis on universal access to the urban poor;

(f) Special focus on urban renewal programme for the old city areas to reduce congestion; and

(g) Provision of basic services to the urban poor including security of tenure at affordable prices, improved housing, water supply and sanitation, and ensuring delivery of other existing universal services of the government for education, health and social security.

Scope of the Mission

The Mission shall comprise two Sub- Missions, namely:

(1) Sub-Mission for Urban Infrastructure and Governance: This will be administered by the Ministry of Urban Development through the Sub- Mission Directorate for Urban Infrastructure and Governance. The main thrust of the Sub-Mission will be on infrastructure projects relating to water supply and sanitation, sewerage, solid waste management, road network, urban transport and redevelopment of old city areas with a view to upgrading infrastructure therein, shifting industrial and commercial establishments to conforming areas, etc.

(2) Sub-Mission for Basic Services to the Urban Poor: This will be administered by the Ministry of Urban Employment and Poverty Alleviation through the Sub-Mission Directorate for Basic Services to the Urban Poor. The main thrust of the Sub-Mission will be on integrated development of slums through projects for providing shelter, basic services and other related civic amenities with a view to providing utilities to the urban poor.

Strategy of the Mission (JNNURM)

The objectives of the Mission shall be met through the adoption of the following strategy:

(1) Preparing City Development Plan: Every city will be expected to formulate a City Development Plan (CDP) indicating policies, programmes and strategies, and financing plans.

(2) Preparing Projects: The CDP would facilitate identification of projects. The Urban Local Bodies (ULBs) / parastatal agencies will be required to prepare Detailed Project Reports (DPRs) for undertaking projects in the identified spheres. It is essential that projects are planned in a manner that optimises the life-cycle cost of projects. The life-cycle cost of a project would cover the capital outlays and the attendant O&M costs to ensure that assets are in good working condition. A revolving fund would be created to meet the O&M requirements of assets created, over the planning horizon. In order to seek JNNURM assistance, projects would need to be developed in a manner that would ensure and demonstrate optimisation of the life-cycle costs over the planning horizon of the project.

(3) Release and Leveraging of Funds: It is expected that the JNNURM assistance would serve to catalyse the flow of investment into the urban infrastructure sector across the country. Funds from the Central and State Government will flow directly to the nodal agency designated by the State, as grants-in-aid. The funds for identified projects across cities would be disbursed to the ULB/Parastatal agency through the designated State Level Nodal Agency (SLNA) as soft loan or grant-cum-loan or grant. The SLNA / ULBs in turn would leverage additional resources from other sources.

(4) Incorporating Private Sector Efficiencies: In order to optimise the life-cycle costs over the planning horizon, private sector efficiencies can be inducted in development, management, implementation and financing of projects, through Public Private Partnership (PPP) arrangements.

Duration of the Mission (JNNURM)

The duration of the Mission would be seven years beginning from the year 2005-06. Evaluation of the experience of implementation of the Mission would be undertaken before the commencement of Eleventh Five Year Plan and if necessary, the program calibrated suitably.

Expected Outcomes of the JNNURM

On completion of the Mission period, it is expected that ULBs and parastatal agencies will have achieved the following:

(1) Modern and transparent budgeting, accounting, financial management systems, designed and adopted for all urban service and governance functions

(2) City-wide framework for planning and governance will be established and become operational

(3) All urban residents will be able to obtain access to a basic level of urban services

(4) Financially self-sustaining agencies for urban governance and service delivery will be established, through reforms to major revenue instruments

(5) Local services and governance will be conducted in a manner that is transparent and accountable to citizens

(6) E-governance applications will be introduced in core functions of ULBs/Parastatal resulting in reduced cost and time of service delivery processes.

B. Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

AMRUT is a scheme launched by the Government of India to provide basic services to urban households and develop modern civic amenities in cities. The scheme replaces the erstwhile Jawaharlal Nehru National Urban Renewal Mission (JNNURM). Under the AMRUT, the Ministry of Urban Development will approve a State Annual Action Plan each year. 500 cities are to be covered under the scheme and this would include all cities with a population above

100000 as well as capital cities not covered under the previously mentioned criteria. AMRUT aimed to provide universal coverage of water supply by providing 1.39 crore household tap connections. Likewise, coverage of sewer/ septage connections were proposed to increase from 31% to 62% by providing 1.45 crore connections. So far, 1.12 crore tap connections and 87 lakh sewer connections have been provided. Sewage treatment plants of capacity 1,800 MLD have been created; out of this 907 MLD is being reused. This Mission has decreased disease load and improved quality of life of all, especially women in terms of time and energy saved to be put to constructive use.

Sustainable Development Goal 6.4 aims to substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity, by 2030. In order to meet (SDG 6), and to extend ease of living in water sector from 500 to all statutory towns, Atal Mission for Rejuvenation and Urban Transformation 2.0 (AMRUT 2.0) has been launched. This will also ensure 100% coverage of sewerage/ septage management in 500 AMRUT cities. AMRUT 2.0 is a step towards Aatma Nirbhar Bharat with aim of making the cities 'water secure' and providing functional water tap connections to all households. This will be achieved through circular economy of water by effecting water source conservation, rejuvenation of water bodies and wells recycle/ reuse of treated used water, and rainwater harvesting by involving community at large. This Mission will be run as people's program i.e. Jan Aandolan. Mission also targets to provide 100% sewage/ septage management in 500 AMRUT cities (https://en.wikipedia.org/wiki?curid=54072069).

C. Smart Cities Mission (SCM)

National Smart Cities Mission is an urban renewal and retrofitting program by the Government of India with the mission to develop smart cities across the country, making them citizen friendly and sustainable. The Union Ministry of Urban Development is responsible for implementing the mission in collaboration with the state governments of the respective cities. The mission initially included 100 cities, with the deadline for completion of the projects set between 2019 and 2023. The effective combined completion of all projects as of 2019 is at 11%.As of March 2022, 3577 projects out of total 6939 tendered projects have been completed, utilizing ₹60,073 crore out of total tendered amount of ₹191,294 crore. Smart Cities Mission envisions developing an area within the cities in the country as model areas based on an area development plan, which is expected to have a rub-off effect on other parts of the city, and nearby cities and towns. Cities will be selected based on the Smart Cities challenge, where cities will compete in a countrywide competition to obtain the benefits from this mission. As of January 2018, 99 cities have been selected to be upgraded as part of the Smart Cities Mission after they defeated other cities in the challenge (https://mohua.gov.in/upload/uploadfiles/files/AMRUT-Operational-Guidelines.pdf).

India's Smart Cities Mission

Against this backdrop of urban inequality and inadequate living conditions, the Smart Cities Mission (SCM) was launched by the Government of India in June 2015 to create 100 'smart

cities' in the country (initially by the year 2020 but now revised to 2023). As of June 2018, the Ministry of Housing and Urban Affairs (MoHUA) has chosen 99 cities to be developed as 'smart cities' in India, on the basis of the Smart City Proposals submitted by them under the competition framework of the India Smart Cities Challenge. New Town Kolkata has withdrawn from the Mission and the proposed hundredth city, Shillong, is yet to be confirmed as an official part of the Mission. As the Mission completes three years on 25 June 2018, Housing and Land Rights Network, India (HLRN) has published this report to assess its progress and contributions to urban development in India as well as its impacts on the most marginalized among the urban population. The study undertaken by HLRN consists of an analysis of all 99 selected Smart City Proposals as well as an extensive review of media, government, and other reports about the Mission (https://www.hlrn.org.in/documents/Smart_Cities_Report_2018.pdf).

Progress

- After three years of the announcement, 89 cities have been selected, but with little to show in urban transformation.

- There are a few cities that have taken the task seriously. Pune has begun by raising funds through the issuance of municipal 'smart city' bonds.

- Bhubaneswar has launched a railway multi-modal hub, a hi-tech transport signal system and an urban knowledge centre.

- The New Delhi Municipal Corporation has started implementation of mini-sewerage plants, wi-fi activated 'smart' street lights and city surveillance systems through a command and control centre.

- But, most cities are still struggling at a primary planning stage, and financial closure to projects is still a long way off.

- More importantly private investment – has hardly been identified and defined (https://www.insightsonindia.com/wp-content/uploads/2017/07/Smart-Cities-Mission.pdf).

Concerns / Challenges

- Smart cities function as special purpose vehicles diverged from regular urban governance structures. It can create islands of development rather than an inclusive all round development of the city.

- State and local governments lack fine-grained data or the capability to analyse them in order to understand the evolving needs of their communities.

- Although India's Smart Cities Mission has identified more than 20 priority areas, interventions by the respective agencies are weak.

- There is an inadequate emphasis on the functioning of urban local bodies.

- The Area Based Development approach – development of a sewage system somewhere or a web of roads in another city – will cover just about three per cent of the urban areas associated with these smart cities.

- Urban local bodies lack both technical and human capacity and professionalism (https://www.insightsonindia.com/wp-content/uploads/2017/07/Smart-Cities-Mission.pdf).

The New Urban Agenda (NUA) and SCM

- The NUA is a landmark vision document that calls for a paradigm shift in addressing urban issues, rooted in concerns of sustainability.

- "Sustainability" and "inclusivity" are the core principles of the NUA.

- NUA requires that countries involve municipal, state and federal governments to form a basic framework for implementation of urban reforms.

- Both the NUA and SCM guidelines pay close attention to infrastructure and services such as solid waste management, compact urban planning and energy resources.

- Paying attention to the aspects of resilience and local governance outlined in the NUA can ensure that Indian cities respond to more than just competitive sub-federalism (https://www.insightsonindia.com/wp-content/uploads/2017/07/Smart-Cities-Mission.pdf).

Way Forward

- Smart cities cannot be a solution to urban crisis happening in India. It needs understanding of problem rationally through data collected systematically.

- If Chicago city is taken as an example, Array of Sensors are installed on streets for people to download raw data on air quality, pedestrian movement and standing water.

- Similarly India also shall develop transport, waste management data for improving urban governance based on evidence.

- When one has limited funds, an easier and speedier route is to take five big cities or 10 small ones at a time, and transform them comprehensively.

- Building of these cities cannot come only with government spending. The funding has to happen through private sector's involvement.

- Since the smart cities programme aims at affordable housing and modern transportation, government has to facilitate smoother land acquisition with appropriate rehabilitation and resettlement

- We see cutting of trees for widening of roads and highways. Care has to be taken to protect the environment while making cities smart.

• Citizen participation is important right from policy inputs, implementation and execution because citizens are the ultimate beneficiaries of smart cities.

• Smart cities development requires smart leadership which has to come from all the three tiers of the government (https://www.insightsonindia.com/wp-content/uploads/2017/07/Smart-Cities-Mission.pdf).

D. Swachh Bharat Mission (SBM)

To significantly accelerate the efforts to achieve universal sanitation, the Prime Minister of India launched the Swachh Bharat Mission on October 2, 2014. The Mission aimed to achieve a Swachh Bharat by October 2, 2019, as a fitting tribute to Mahatma Gandhi on his 150th birth anniversary, by eliminating the practice of open defecation. The SBM has two sub-Missions, the Swachh Bharat Mission (Grameen) under the Department of Drinking Water and Sanitation (formerly the Ministry of Drinking Water and Sanitation), and the Swachh Bharat Mission (Urban) [SBM(U)] under the Ministry of Housing and Urban Affairs. The overall Mission is coordinated by the Department of Drinking Water and Sanitation. In rural areas, the programme aimed towards achieving Open Defecation Free (ODF) villages and improve the levels of overall cleanliness through SLWM activities (https://jalshakti-ddws.gov.in/sites/default/files/SBM_Ph_II_Guidelines.pdf).

The objectives of this mission

• Elimination of open defecation

• Eradication of Manual Scavenging

• Modern and Scientific Municipal Solid Waste Management

• To effect behavioural change regarding healthy sanitation practices

• Generate awareness about sanitation and its linkage with public health

• Capacity Augmentation for ULB's

• To create an enabling environment for private sector participation in Capex (capital expenditure) and Opex (operation and maintenance).

UNIT-12

MEGALOPOLIS AND ECUMENOPOLIS; URBAN GREEN SPACE

INTRODUCTION

The urban development of the twentieth century can be characterized by the rise of the metropolitanization process. However, since 1950, it has occurred a real change of scale in this growth: the infinite growth of metropolitan peripheries, encouraged by the process of urban sprawl, has increased the urbanization of rural environments in the interstices between cities and metropolitan areas. Previously isolated urban systems have been caught in the web of urbanization and generated new urban spaces characterized by increasing complexity. Megacities, intuited in the early twentieth century by precursors of contemporary urbanism, have come true.

Although most of the work oriented to identifying the megalopolitan agglomerations agrees to use hybrid methodologies for delimitation that combine understanding of the regional mega cities as places space as well as spaces of flows, the true is that few efforts have been made in this sense, prevailing in the literature the sectorial work. In this regard the main contributions have focused on four key methodologies, depending on the determinant of analysis: functional relationships; the density of human settlements; the morpholog of urban development, especially the contiguity of urbanization; and, more diffuse, what we might be called local knowledge (Ramos & Roca, 2015).

MEGALOPOLIS

A megalopolis is typically defined as a series of roughly neighbouring metropolitan areas. The expression was used by Patrick Geddes in his 1915 book Cities in Evolution. A megalopolis, also identified as a mega-province, is a clustered network of cities. Gottmann defined its population as 25 million. It is the bloated city, where textile wealth dominates life. This stage marks the beginning of the decline, e.g., Rome in the second stage. There is little doubt that the metropolitan area is becoming the dominant form of settlement all over the world. There is a growing concentration in the largest ’Primate" cities. The questions that arise are; how did the concept of 'Metropolitan area' evolve? How did the traditional distinction between "City" and "Suburb" become obsolete and meaningless? Both the city and suburbs have merged into a new and much more extended form of human settlement. In its 1950 census, the United States recognized this fact under the name of the "Metropolitan area." As accepted by the researchers that there is no limit to the size and growth of the urban area, further growth of the "metropolitan area" has created a gigantic agglomeration all over the world. It is seen that the large share of the urban population has concentrated in a few gigantic urban metropolis which is called the "Megalopolis." The term Megalopolis became popular when it was used by Jean Gottmann in 1960s, in his study, "The urbanized North-eastern seaboard of the United States", being 500 miles long and 30 to 100 miles wide (measuring total geographical area about 53,575 sq. Miles). A highly urbanized area in 1960 was called “Megalopolis" by Jean Gottmann. The word ‘Megalopolis’ has been used in different sense by various people. The WEBSTER dictionary defines it as, 'a very large city” and therefore sometimes it is just used in its literal

meaning of "big city". Others use it to denote a cluster or string of metropolitan areas. The late Konstantions Doxiadis and his followers believed that these constitute a new type of human settlement, which is different from the metropolis (Ramos & Roca, 2015).

Megalopolises in an Urban Future

We live an increasingly urbanised world. By 2030 60% of the global population will live in cities. While smaller cities are growing the most rapidly, the largest cities will remain important. By 2015 there will be 23 cities with a population of more than 10 million. Some of these, together with surrounding smaller urban areas, will take the complex form of megalopolises. Examining the sustainability of these megalopolises – particularly in terms of the climate change agenda – is therefore highly pertinent (https://www.ucl.ac.uk/btg/downloads/Megalopolises_and_Sustainability_Report.pdf).

Energy use in Megalopolises

In high consumption countries, there is an urgent need to change infrastructure so as to reduce the environmental burden of that consumption. An equivalent imperative exists in low consumption countries to create infrastructure systems that meet the social and economic needs of their populations. However, there is no requirement to replicate the carbon-intensive approaches adopted in major urban areas so far. Rather there is scope, particularly at the urban scale, for innovation in infrastructure to deliver low carbon living.

Transport within Megalopolises

The interaction between urban development and transport is a complex one, influenced by a number of interconnected factors: industrialisation, demand for housing, transport technology, fare levels and structure, strong leadership, national and local politics, economic growth, ownership and regulation and car ownership. History tells us that governmental involvement and subsidy is essential for delivering transport systems that are sustainable, although this need not always extend to public ownership and delivery.

Flooding and Storm Damage

Flooding – from inundation and sea-level rise – is already a major impact of climate change but its incidence will increase. Cities, particularly the largest cities are vulnerable, often because of their coastal locations. The economic as well as social costs of flooding will be immense but the wealthier cities are best placed to cope with these threats. It is the already vulnerable communities within cities that are most at risk of total loss.

Heat Waves

By 2040 average summer temperatures in Europe are expected to be those experienced in the heat-wave of 2003 in which between 30,000 and 35,000 people died in Northern Europe, while heat-waves in 2040 will be twice as hot as those we experience now. These impacts of climate change are exacerbated by the Urban Heat Island effect, suggesting the importance of planning new urban development with this enhanced risk in mind.

Water Security

While increased water scarcity is a common impact of climate change across many urban areas, there is a significant difference between those cities with reticulated systems – where the very infrastructure promotes a disregard for the need to conserve water – and those cities (or parts of cities) where private water vendors, illegal connections and communal standpipes dominate. Across these very different circumstances though, arguments can be made for the value of citizen involvement in policy development and even in co-production schemes.

Disease and Public Health

Much attention has been paid to influenza pandemics and obesity as aspects of urban health, but the most significant public health issue is the availability of clean water and sanitation facilities to poorer urban communities. Established infrastructure systems such as reticulated water systems have a place but again the importance of community involvement and local innovation should not be under-estimated.

Modelling Change

There is great potential in building models using the latest techniques to understand change in urban systems and then develop policy recommendations. Such models can highlight path dependencies in urban change as well as rapid 'phase transitions'. However, there remain questions over how far resources should be devoted to very fine-grained data collection and model-building in context where there is an urgent need to take policy steps to deliver sustainability, as in lower income countries and especially vulnerable cities.

Governance for Sustainability

Considering the governance of major urban areas such as megalopolises throws up many dilemmas, such as the appropriate scale for governmental units, the allocation of responsibilities across governmental tiers and the different ways of financing governmental action. But the key issue in delivering action for sustainability is the way that this goal intersects with different political interests and priorities and how these conflicts may inhibit collective action.

Urban Culture and Sustainability

If sustainability is to become part and parcel of the megalopolis then it has to have meaning within that urban culture and in terms of how people live within the urban area. Sustainability is often couched in culturally conservative terms, drawing on nostalgia. However, this is a choice and the prospect remains of a more progressive cultural engagement with sustainability, opening up more options for urban change.

ECUMENOPOLIS

Man is beginning to understand that he is confused about life in his cities and worried about the path he is following into an unknown future. This confusion started some generations ago when man moved from the countryside and the small traditional cities into the large cities and

the metropolis, but the understanding and the worrying began only very recently and in official circles only in the present decade. This is why man is not prepared to face the problems of life in his cities in a systematic way. The time has come, though, for man to try to understand the great confusion that surrounds him in his city and to solve the problems that he himself has created during the last few generations. He cannot achieve this if he thinks that he will change the cities of the present-- it is too late for that. He can achieve it only if he thinks of the cities of the future, for what we conceive today can be a plan tomorrow and a reality in the future (http://docplayer.net/46764916-Articles-ecumenopolis-tomorrow-s-city-introduction.html).

Man does not think of the cities of the future for the first time today. He has always been doing so, from ancient Greek days to the Renaissance to our times. He was concerned with Utopias and ideal cities and he even thought of the bad places, the dystopias (sometimes wrongly called the anti-utopias).i What characterizes our efforts today is that they are no longer as satisfactory as the conceptions of the past; and the reason is that in the past both Utopias and ideal cities were dealing with communities of a certain size, the size of the existing cities which had economic, social, political, and physical dimensions known to everyone. Plato was thinking of a city of 30,000 to 50,000 people like his city of Athens, and Thomas More of a city of 60,000 to 90,000, like many of his contemporary cities. Today we live in cities of millions, which grow into tens of millions, and we dream of isolated islands as did Aldous Huxley or of garden cities such as those proposed by Ebenezer Howard. We feel that something is wrong, we become dissatisfied, and in the end we are even more confused (https://www.scribd.com/doc/14074292/Ecumenopolis-Tommorrows-City).

Like dynapolis, ecumenopolis was primarily based on the conviction in the comprehensive capacity of science to control urbanization, plan industrialization, and manage resources. The logic of hierarchically structured communities connected with transportation and communication systems was now reproduced on a global scale. In its entirety, the ecumenopolis constituted a community class XII, which was broken down to 6-7 communities class XI, each of which would be broken down to 40 communities' class X, etc. until they were broken down to human communities class IV-the largest urban sub-unit which maintained the human scale. As in dynapolis, class IV communities would usually have the size of 6-15,000 inhabitants. 16 Functional separations was also taken to new heights (https://studylib.net/doc/11014364/).

It is estimated that in 2000 about 50 per cent of the world population was living in cities and that this percentage is constantly increasing. This figure applies not only to almost completely urbanized Western countries, where even farming is completely mechanized, industrialized, and marketdriven, but also to Latin America and particularly to Asia and Africa. Their levels of urbanization may yet be substantially lower but these regions nowadays contain the world's largest cities, the magnitude of which completely ridicules earlier scientific debates on the optimum size of cities. Notwithstanding the great difficulties that can be envisaged in creating a sustainable Ecumenopolis that honours human needs while respecting environmental capacity, I am convinced that this Ecumenopolis is positive in principle. The city figures prominently among great human inventions, such as the use of fire, the invention of the wheel, and the use of steam and electric energy in industry. Generally speaking, by means of high

levels of population density cities create opportunities for increased human cooperation and specialization, potentially leading to high levels of production, diversity of life styles and subcultures, and openness to innovation, intercultural contact, and interethnic relations. So, whether we like it or not, less than half a century from now the Ecumenopolis will have become reality. The present airline, telephone, fax, and email network that connects all the centres, is nowadays conceived to consist of mega-urban areas of different levels, but should rather be appreciated as Ecumenopolis. The emerging Ecumenopolis and related forms of region-based urbanization with highly discontinuous patterns of land use cannot be explained by means of traditional concepts using, for example, an urban-rural dichotomy or delineating a continuum from village, via town, to city (https://www.iias.asiaiiasn/31/IIASN31_05.pdf).

Toward Ecumenopolis

Such cities, growing dynamically over the next two or three generations, will finally be interconnected, in one continuous network, into one universal city which we call the ecumenic city, the city of the whole inhabited earth, or Ecumenopolis. If we speak, therefore, of the cities of the future one century from now, we can state that they will have become one city, the unique city of mankind. This evolution corresponds to an age-old dream of man who, very early, started thinking of cosmopolis -- not as a physical entity, but as the ideal state in which all people will be equal and united into one world. In the Greek tradition, cosmopolis, unlike paradise, was on the surface of the earth, and unlike Utopias it had a specific place and in some vague way was supposed to be a good place for man, aeutopia. The idea of cosmopolis has been important throughout human history. In the West it began, in the first half of the 4th century B.C., with the Cynics in Greece, who did not believe in the world-city (as their word cosmopolis has gradually come to imply) but, on the contrary, believed that man should have no city of his own -- the whole cosmos should be his dwelling place.

At the same time, other Greek philosophers were trying to find a meaning in the whole cosmos. The Stoics in the 3rd century B.C. connected the concept of a world state with the external universe of man. Similar ideas were developed during the period of the Roman Empire, although nobody regarded the empire itself as cosmopolis. In China, where philosophers dreamed of a universal state, a great empire was created in the 3rd century B.C.; another appeared in India at the time of the great Buddhist Emperor Asoka (3rd century B.C.) when, according to W. Wagar, “Utopia and Cosmopolis merge in a single splendid image.” In the Christian West the idea of a universal state was as appealing as the idea of paradise: during the period of the Roman and Byzantine empires it coincided with political goals; during feudal times it was related to the notion of one church. Similarly, the Arabs were moved to create their empires by the dream of an Islamic world.

In the modern world, several proposals for a unified Europe appeared in the 17th century, and the 19th century produced “more prophets of world integration than any other in history, but more than ever they were voices in the wilderness, scattered and impotent.” This was true in many countries, especially in Europe and Russia, and it is useful to remember that the greatest number of Utopias was produced in the same century. In the 20th century, which begins with H. G. Wells and his "world brain," Arnold Toynbee, Lewis Mumford, Aldous Huxley, and

Erich Kahler, among others, have defended the necessity of a world order and a world state, that is, of a cosmopolis. Teilhard de Chardin speaks of the noo-sphere or sphere of ideas -- in a different sense, the brain of cosmopolis.

By now we can see that the idea of cosmopolis tends to take on a physical expression as the Ecumenopolis of the 21st century. This city already exists in terms of the transmission of news, which has reduced the earth to the dimensions of a city; it is gradually coming to be expressed in terms of air transportation, as the major airports become the busy squares of Ecumenopolis; and it tends to be expressed in many other ways. There is no doubt about it, this city of the future is already under construction. The big question that arises is not about its dimensions, structure, and form, but about the function of Ecumenopolis, the type of life that will be created within it, and the quality that Ecumenopolis will offer to man. This cannot be foreseen, because we do not know what kind of imagination and courage modern man will have to develop in order to create a high quality of life within an Ecumenopolis of such dimensions.

What we can foresee is that if the existing forces continue to develop as they do at present and if man reacts as he has so far, Ecumenopolis with its extra-human dimensions will turn into an inhuman city where all the weaknesses of today's cities will be multiplied manifold. Under such conditions, Ecumenopolis will choke itself -- and man as a civilized being -- to death. Ecumenopolis will then turn into the city of death or, as Lewis Mumford called the city in such situations, into the Necropolis. It now becomes clear that man is facing two alternate roads: either to allow the extra-human Ecumenopolis to become inhuman, leading to its virtual death; or to turn it, in spite of its extra-human dimensions, into a very human city. This is his great challenge and he can meet it if he takes it seriously (https://www.iias.asiaiiasn/31/IIASN31_05.pdf).

Ecumenopolis, The Real City of Man

Ecumenopolis, which mankind will have built 150 years from now, can be the real city of man because, for the first time in history, man will have one city rather than many cities belonging to different national, racial, religious, or local groups, each ready to protect its own members but also ready to fight those from other cities, large and small, interconnected into a system of cities. Ecumenopolis, the unique city of man, will form a continuous, differentiated, but also unified texture consisting of many cells, the human communities. Depending on how well these cells are formed, we can have a very human or an inhuman city at the level of greatest interest of man, the place where he spends most of his time. Depending on how well these cells are interconnected into an organic whole, we can have a successful system that will provide man with much greater facilities and benefits than his small cell, opening new horizons for him and giving new dimensions to his life. Depending on how well man can understand that he belongs to all units of Ecumenopolis, to himself, his family, his cell, his region, and to the whole, we can have a happy man or not. Unless we achieve this last goal; unless everybody understands that he belongs to all scales, to the whole, that no matter where he lives he is responsible for famine in Bengal; that at the same time he belongs to himself, with all the rights and privileges of a free citizen, we cannot have a successful city of man (http://docplayer.net/46764916-Articles-ecumenopolis-tomorrow-s-city-introduction.html).

Physical Appearance: If we fly high above the earth in a satellite, Ecumenopolis will appear as bands of built-up areas crossing the open landscape, which will be cultivated or left in its natural form. Probably 5% of the habitable part of the earth will be developed as urban areas, 4.5% will be cultivated, and 50% will be natural. At night, against a dark background, we will see several tones of lighted areas, depending on the degree of their development. Electricity will light the world. When our satellite begins its descent, we will be able to recognize the branches of Ecumenopolis along the coasts, spread around the big port, along the valleys and the rivers and then in different, much thinner bands over the mountain passes. Descending even farther, we will recognize the major sectors of Ecumenopolis, those parts that correspond to present-day metropolises, with the major urban center in a key location, near the centre of gravity; with a major axis of development serving the whole urban region with all its sectors and subsectors. From even lower altitudes, and before turning in the direction of the rocket port where we will land, we will be able to recognize the typical cells of the huge Ecumenopolis, which each one of us will call his city; these will be the units where the family will grow and live until the time when its component members become independent (http://docplayer.net/46764916-Articles-ecumenopolis-tomorrow-s-city-introduction.html).

Transportation and Communications: The systems of transportation and communications will be the circulatory and nervous systems of Ecumenopolis. More than anything else, they can unify the universal city or break its inhabitants. The question is often asked whether people in the cities of the future will fly, sail, drive, or walk. The answer is that they will do all these things, in a balanced way. The basic principle will be for man to walk over short distances (not losing this natural ability and what goes with it), to drive over the longer ones, to sail for pleasure, and to fly -- by new planes and rockets -- over the longest distances. The second principle is that the interconnections between the systems of walking, driving, sailing and flying should be such that no time is lost at all. The third principle is that the different lines of movement should not cross, except in the case of pedestrian paths; pedestrians are self-regulating organisms of the highest flexibility, and not only do they find no need to avoid crossing each other's paths, they want to, for they are social animals (http://docplayer.net/46764916-Articles-ecumenopolis-tomorrow-s-city-introduction.html).

Energy: More and more, man will use the natural, primary resources of energy upgraded into secondary energy, mostly in the form of electricity. No action that can be carried out by electric power or any other type of secondary energy will be carried out by man unless it is necessary for his satisfaction and development. Man will still walk and climb mountains, take part in sports for exercise, and build his small houses with gardens -- not because he has to do it, but because he enjoys it; children will still run -- not to sell newspapers on the city streets, but because they like it. More and more, man will do all the tasks that present an interest and a challenge and leave everything else to automated process. Such an evolution will mean a great network of electricity infiltrating every single part of the inhabited space, with lines located underground and beneath the surfaces of walls and machines so that they can never hurt man, but only provide him with all the energy and power that he needs, where and when and how he needs it (https://archive.org/stream/in.ernet.dli.2015.147388/2015.147388.Britannica-Book-Of-The-Year-1968_djvu.txt).

Residence and Employment: These are the two primary needs of every individual, in the past and in the future, and they must be properly served and properly interconnected. Residences of all sorts will exist, from single-family houses, mostly for families with children, to multi-storey apartment buildings. The great difference between these dwellings and the ones existing at present will be that each single-family house will have a garden surrounded by high walls, so that residents can have complete privacy in the open, and their picture windows - if any - will overlook their own courtyard, swimming pool, tennis court, or thickly planted garden instead of streets leading to small squares, planted, paved, with statues and ponds designed or selected by the inhabitants of the neighbourhood, rather than by a distant metropolitan authority. Here the new generations of children can grow physically, intellectually, and morally, in accordance with the ideals of the democratic society inhabiting Ecumenopolis.

Education and Leisure: While the ancient Greek city gave only its free male citizens freedom for their education and leisure, Ecumenopolis will tend to give it to everybody, regardless of sex, race, religion, nationality, or beliefs. Education and leisure, separately and combined, will absorb a large part of the time of its citizens who, in this way, will be further developed, especially when they understand that they do not need a society of leisure but a society for their development and evolution through education and leisure. To achieve this, Ecumenopolis will not rely merely on special institutions and areas for education and leisure, labelled as such, surrounded by compound walls, and charging entrance fees. Education and leisure will start in every home. They will continue through the street and square, where people will learn what nature is and how to live in it; through the nursery, primary and secondary school, college, university, and research institution; through the mosaic pavements of the streets, the statues in the small squares, and the series of art galleries in all sorts of public buildings; and finally through the corner jukebox, the restaurants, theatres, and nightclubs (http://docplayer.net/46764916-Articles-ecumenopolis-tomorrow-s-city-introduction.html).

URBAN GREEN SPACE

Urbanization results in an increasing proportion of the population living in cities. In Europe it is expected that around three quarters of the population will live in urban settings by 2020. Urban living limits access to nature and can increase exposure to certain environmental hazards, such as air and noise pollution. Many urban areas face increasing pressure from expanding populations, limited resources and growing impacts of climate change. These challenges must be addressed in order for cities to provide healthy and sustainable living environments (http://thesis.univ-biskra.dz/5333/).

Urban Green Spaces (UGS) are essential constituents of the urban structure that enhance residents' quality of life and behaviour. This study introduces a process of analysing UGS using landscape metrics and identification of potential expansion areas through suitability checklist and proximity buffering done in a GIS environment. Central Nairobi was selected as the representative study area, whose UGS were found to be unevenly distributed, lacking in size, character and most out of public access. A final composite potential map was formulated, that if its identified high potential areas are adopted for expansion of UGS, the above shortcomings could be rectified (https://s3.amazonaws.com/prod-ucs-content-store-us-

east/content/pii:S1877042812004223/MAIN/application/pdf/999341235b7b77b3b9d1a00b1249ca78/main.pdf). The quality of a city's environment manifested in its Urban Green Spaces (UGS) reflects in many ways the quality of life and societal behaviour found in it. A city devoid of quantity and quality UGS becomes a concrete jungle or a polluted city vulnerable to calamities, behavioural vices, and low liveability index. UGS provide benefits to the city that helps mitigate these negative effects (https://baadalsg.inflibnet.ac.in/bitstream/10603/136224/10/10_chapter%202.pdf).

Green spaces and other nature-based solutions offer innovative approaches to increase the quality of urban settings, enhance local resilience and promote sustainable lifestyles, improving both the health and the well-being of urban residents. Parks, playgrounds or vegetation in public and private places are a central component of these approaches and can help to ensure that http://thegreencity.com/world-health-organization-brief-for-action-about-the-relevance-for-urban-green-spaces/):

1. Urban residents have adequate opportunities for exposure to nature;
2. Urban biodiversity is maintained and protected;
3. Environmental hazards such as air pollution or noise are reduced;
4. The impacts of extreme weather events (heat waves, extreme rainfall or flooding) are mitigated;
5. The quality of urban living is enhanced;
6. The health and well-being of residents is improved.

Urban green space is a component of "green infrastructure". It is an important part of public open spaces and common services provided by a city and can serve as a health-promoting setting for all members of the urban community. It is therefore necessary to ensure that public green spaces are easily accessible for all population groups and distributed equitably within the city.

Opportunities

Opportunities to involve urban green space interventions in urban planning include (https://www.euro.who.int/__data/assets/pdf_file/0010/342289/Urban-Green-Spaces_EN_WHO_web3.pdf):

1. Development of new residential neighbourhoods, community facilities, business parks or transport infrastructure projects;
2. Regeneration projects and urban renewal initiatives;
3. Brownfield development and rehabilitation of industrial areas;
4. Urban gardening/agriculture projects;
5. Initiatives to enhance biodiversity.

Benefits

Through improved air and water quality, buffering of noise pollution and mitigation of impacts from extreme events, urban green spaces can reduce environmental health risks associated with urban living. In addition, they support and facilitate health and well-being by enabling stress

alleviation and relaxation, physical activity, improved social interaction and community cohesiveness. Health benefits include improved levels of mental health, physical fitness and cognitive and immune function, as well as lower mortality rates in general. Everyone can benefit from urban green space interventions, but they can be of particular relevance for socially disadvantaged or underserved community groups, which often have least access to high-quality green spaces (https://www.euro.who.int/__data/assets/pdf_file/0010/342289/Urban-Green-Spaces_EN_WHO_web3.pdf). Urban settlements transform the natural environment so greatly that people tend to see the city only as an employment site, and economic and cultural centre. Thus a growing number of people prefer to reside in greener suburbs or rural areas. This results in increased automobile commuter traffic, accompanied by traffic jams, accidents, stress, and ever more damage to the environment. Concepts of sustainable development or the ecological city represent strategies for changing these negative trends. The purpose for doing so is principally the well-being of a city's residents. Often this entails bringing more of the natural environment back into the city, because urban green space fulfils several critical functions in an urban context that benefit people's quality of life. There is a broad consensus about the importance, and therefore the value, of urban green space in cities as currently constructed, in addition to its value in planning ecological cities (Carreiro et., al., 2007).

Steadily growing traffic and urban heat not only damage the environment, but also incur social and economic costs. As we explain further, we can save costs even by making small changes to existing situations. Furthermore, we maintain and show that an integrated approach is needed for designing and maintaining urban green space. The main thesis of this chapter, therefore, is as follows: To provide sufficient quality of life in high-density cities, it is important to maintain and restore an urban green space system; moreover, urban green space and a comfortable urban climate also produce social and economic benefits (Carreiro et., al., 2007) .

Challenges towards Management of Urban Green Spaces

A. Socio-economic and demographic aspects
B. Quantitative aspects
C. Qualitative aspects

A. Socio-economic and demographic aspects: High urbanization and high pace of social and economic development in Asia resulting from increase of population of cities, lack of infrastructure, congested traffic, environment degradation and a housing shortage are major issues faced by cities in Asia in their sustainable development. The great threat to health and safety in cities comes from water and air pollution. Those who are poor and do not have adequate ventilation system, air pollution is hazardous for them women and children because they expose regularly and water borne disease are found most commonly in low income groups because of inadequate sanitation, drainage and solid waste collection services. Another most important challenge facing in Asia region due to over urbanization is conversion of agricultural land and forest for urban uses and development of infrastructure in urban areas. As a result widespread removal of vegetation to support urban ecosystem, ground water overdraft and put additional pressure on nearly areas may be ecologically more sensitive and may even increase

the higher frequency of flooding in urban areas (http://www.ijarse.com/images/fullpdf/1519016347_IIMT4078ijarse.pdf).

B. Quantitative aspects: Understanding relationship between urban population and amount of green spaces is particularly important in evaluating their functionality and of course future planning for population density and cities has a loss of natural areas and natural resources. In addition to medium size cities have relatively high score on natural green factor due to availability of natural green areas. It is important to preserve the green areas either urban green or natural green. As most cities especially in developing world, continue to grow in population there is seeming continued decrease in urban space at expense of built up areas. Despite the trend studies shows that people are willing to pay high prices for green space increment (http://www.ijarse.com/images/fullpdf/1519016347_IIMT4078ijarse.pdf).

C. Qualitative aspects: - The evaluation of recreational green space has to be cantered on variety of qualities available, sufficiently satisfying and interesting place to stay and enjoy being there. A study conducted in western Canada(USA) shows that people enjoyed varied physical and social opportunities in green space. The benefits people desire can directly be linked to a particular recreational activity and physical, social and management for their provision. Commonly used terms to refer to quantity of green spaces or green space ratio, green space coverage and green space area per capita. It is difficult to measure appropriate amount of required land and allocation of land and calculate distance from residential areas and especially to implement the measurement can building up urban green space with proper services in highly populated countries (http://www.ijarse.com/images/fullpdf/1519016347_IIMT4078ijarse.pdf).

SUMMARIES AND KEY POINTS

This section introduces the concept and various types of population concepts and it deals with different population change parameters.Population studies is broadly defined as the scientific study of human populations. Major areas studied include broad population dynamics; fertility and family dynamics; health, aging, and mortality; and human capital and labor markets. The crude death rate, applied to a whole population, can be misleading. For example, the number of deaths per thousand people can be higher for developed nations than for less-developed countries, despite standards of health being better in developed countries. Future population growth is difficult to predict. Birth rates are declining on average, but vary greatly between developed countries (where birth rates are often at or below replacement levels) and developing countries. Death rates can change unexpectedly due to disease, wars and catastrophes, or advances in medicine. Population pyramids, graphs that display a population's age and sex composition, are often used to provide information about future population growth or decline (https://www.encyclopedia.com/social-sciences-and-law/sociology-and-social-reform).

This domain also deals with different types and patterns of settlement and also various settlement related theories, like central place theory, rank-size rule and primacy. Here,

significant concepts like urbanization, urban renewal processes are also described. Although the two concepts are sometimes used interchangeably, urbanization should be distinguished from urban growth. Urbanization refers to the *proportion* of the total national population living in areas classified as urban, whereas urban growth strictly refers to the *absolute* number of people living in those areas.

STUDY TIPS

- Agrawal, S. (2009). India's National Population Policy (2000): An Evaluation.
- Aird, J. S. (1982). Population studies and population policy in China. *Population and Development Review*, 267-297.
- Allison, G. 2017. Destined for War. Houghton Mifflin Harcourt, Boston, MA.
- Balk, D. (1994). Individual and Community Aspects of Women's Status and Fertility in Rural Bangladesh. Population Studies, 48, 21-45.
- Balasubramanian, K. (1984). Hindu-Muslim differentials in fertility and population growth in India: role of proximate variables. Artha-Vijnana, 26, 189-216.
- Basu, B. 2000. Rural-urban migration, urban unemployment, and the structural transformation of a dual economy, Journal of International Trade and Economic Development, 9, 137-149.
- Bevan, A., & Wilson, A. (2013). Models of settlement hierarchy based on partial evidence. *Journal of Archaeological Science*, *40*(5), 2415-2427.
- Bhalotra, S. and A. V. Soest (2008). Birth Spacing, Fertility and Neonatal Mortality in India: Dynamics, Frailty and Fecundity. Journal of Econometrics, 143(2), 274-90.
- Bhat P. N. Marri ; Preston Samuel H., and Dyson Tim. Vital rates in India 1961-1981. Washington DC: National Academy Press; 1984.
- Bongaarts, J. (2017). The effect of contraception on fertility: Is sub-Saharan Africa different? Demographic Research, 37 (6): 129-46.
- Brass William. Methods for estimating fertility and mortality from limited and defective data. Chapel Hill, NC: Carolina Population Center; 1975. Occasional Pulbication. International Program of Laboratories for Population Statistics.
- Carreiro, M. M., Song, Y. C., & Wu, J. (Eds.). (2007). *Ecology, planning, and management of urban forests: International perspective*. Springer Science & Business Media.
- Chandna, R.C. (1980). Population Geography. Kalyani Publishers, New Delhi.
- Christaller, W. 1933. Central Places in Southern Germany. Fischer, Jena, Germany.
- Đorić, G., & Gavrilović, D. (2006). Between pro-natalist population policy and women's reproductive rights: The analysis of exposure of the two discourses in press media after 2000. *Sociologija*, *48*(1), 73-95.
- Fang, C., & Yu, D. (2017). Urban agglomeration: An evolving concept of an emerging phenomenon. *Landscape and urban planning*, *162*, 126-136.
- George, P. (1951). "IntroductiónaL'étudegeographique de la population du monde", 288 pp. Paris: INED.
- Greenhalgh, S. (1986). Shifts in China's population policy, 1984-86: Views from the central, provincial, and local levels. *Population and Development Review*, 491-515.
- GunasekharanSubbiah and Palmore James A. Regression Estimates of the Gross Reproduction Rate Using Moments of the Female Age Distribution. Asian and Pacific Census Forum. 1984; 10(4):5-10.
- Gupta, M.R. 1993. Rural-urban migration, informal sector, and development policies: A theoretical analysis, Journal of Development Economics, 41, 137-151.

- Hein, C. (2016, July). History, Urbanism, Resilience. In *Proceedings of the 17th International Planning History Society Conference, Delft, The Netherlands* (pp. 2016-1).
- Hoem, J. M. (2005). Why Does Sweden Have Such High Fertility? MPIDR Working Paper WP 2005- 009
- Kabir, A., G. Jahan and R. Jahan (2001). Female Age at Marriage as a Determinant of Fertility. Journal of Medical Sciences, 1(6), 372-76.
- Kaplan, D. H., Wheeler, J. O. and Holloway, S. R. (2008) Urban Geography, JohnWiley.
- Kirk, D. (1996). Demographic transition theory. *Population studies*, *50*(3), 361-387.
- Kundu, A. (2011). Trends and processes of urbanisation in India.
- Lahariya, C. (2014). A Brief History of Vaccines and Vaccination in India. Indian Journal of Medical Research, 139(4), 491-511.
- Lee, R. D., & Reher, D. S. (2011). Demographic transition and its consequences.
- Losch, A. 1954. Economics of Location. Yale University Press, New Haven, CT.
- Mandal, R. B. (2001) Urban Geography, Concept Publications, New Delhi.
- McIntosh, C.A. (1986). Recent Pronatalist Policies in Western Europe. Population and Development Review, 12, 318-24.
- Mitra, Ashok, "House Types in India, The Illustrated Weekly of India, November 10, (1968).
- Mondal, M. N. I., M. K. Hossain and M. K. Ali (2009). Factors Influencing Infant and Child Mortality: A Case Study of Rajshahi District, Bangladesh, J Hum Ecol, 26(1): 31-39.
- Prasad, N,,"Evolution, growth and distribution of settlements in Dehradun",/nd/an Geographical Journal, Vol.50,No.2, (1975
- Rabbi, A. M. F. (2012). Mass Media Exposure and its Impact on Fertility: Current Scenario of Bangladesh. Journal of Scientific Research, 4(2), 383-95.
- Ramos, B. A., & Roca, J. (2015). Megalopolis: An assay for the identification of the world urban mega-structures.
- Sen, A. 2001. Beyond the crisis: Development strategies in Asia, in A. Chowdhury and I. Islam (Eds.), Beyond the Asian Crisis, 30-49. Edward Elgar, Cheltenham, UK.
- Sen, Jyotirmoy and Bhattacharya, R. "Evolution of Rural Settlements in Birbhum District", Geographical Review of India, Vol.37, (1975).
- Sharma, R.C. "Western Rajasthan, A Study of House types", National Geographer, Vol. 3, (1969)
- Singh R. L. – Readings in Settlement Geography. The National Geographical Society of India.
- Singh, R. Y. (2005) The Geography of Settlement, Rawat Publication, Jaipur.
- Singh, Rana S.P.S. and Majumdar, K., "Spatial Analysis of Rural Settlement in an Indian Environment, Case of Eastern Gujrat Region, Geographical Review of India, Vol. 4, No. 2, (1978).
- Singh, S.P., "Morphology of Compact Rural Settlements in Upper Ganga Yamuna Doab, "National Geographical Journal of India", Vol. 18, Part 3 & 4, (1972).
- Sonis, M. (2007, April). Central place theory after Christaller and Lösch: some further explorations. In *Space-Structure-Economy: A Tribute to August Lösch* (pp. 229-287). Nomos Verlagsgesellschaft mbH & Co. KG.
- Speidel, J.J., D.C. Weiss, S.A. Ethelston and S.M. Gilbert (2009). Population policies, programmes and the environment. Philosophical Transactions B, The Royal Society. 364(1532), 3049-65.
- Srinivasan, T.N. 2003. Indian economic reforms: A stocktaking, Working Paper No. 190, Stanford Center for International Development, Stanford University, Palo Alto, CA.
- Srivastava, V.K. and Richard, Ivon, "Spatial Distribution of Settlement and analytical study" UttarBharat BhogolPatrika, Vol. 11, No. 2, (1975).

- Stone, K.H., "The Development of a Focus for Geography of Settlements, "Economic Geography, Vol. 41, (1965
- Tiwari, R.C. "Spatial Distribution and Types of Rural Settlements in the Lower-Ganga-Yamuna Doab, National Geographer, Vol. 14, No. 2, (1979
- Vashishtha, V. M. V and P. Kumar (2013). 50 Years of Immunization in India: Progress and Future. Indian Pediatrics, 50, 111-8, January 16.
- World Health Organization. (2010). *Rapid assessment of national civil registration and vital statistics systems* (No. WHO/IER/HSI/STM/2010.1). World Health Organization.
- Ye, F., & Huang, J. (2016). Antenatal care for women in their second pregnancies in China. *The Lancet Global Health*, *4*(5), e303.
- Zakir, M. & P. V. Wunnava (1999). Factors Affecting Infant Mortality Rates: Evidence from Cross– Sectional Data, Applied Economics Letters, 6:5, 271-273, DOI: 10.1080/135048599353203.

DISCLAIMER

This self-learning material is based on different books, journals and web-sources.

Post Graduate Degree Programme (CBCS) in Geography

Semester – II

Paper Code: GEO/CC/T-208

Paper: Research Methodology

University of Kalyani
Kalyani
Nadia – 741235
West Bengal

Course Materials Compiled by:	
Dr. Ayan Rudra Directorate of Open and Distance Learning University of Kalyani, West Bengal	**Group – GEO/CC/T-208: Research Methodology (Unit - 1 to Unit – 6)**
Dr. Sayan Choudhary Directorate of Open and Distance Learning University of Kalyani, West Bengal	**Group – GEO/CC/T-208: Research Methodology (Unit - 7 to Unit – 12)**

July 2022

Published by the Directorate of Open and Distance Learning,

University of Kalyani, Kalyani-741235, West Bengal.

Disclaimer: This self-learning material is based on different books, journals and web-sources.

Director's Message

Satisfying the varied needs of distance learners, overcoming the obstacle of distance and reaching the unreached students are the threefold functions catered by Open and Distance Learning (ODL) systems. The onus lies on writers, editors, production professionals and other personnel involved in the process to overcome the challenges inherent to curriculum design and production of relevant Self Learning Materials (SLMs). At the University of Kalyani a dedicated team under the able guidance of the Hon'ble Vice-Chancellor has invested its best efforts, professionally and in keeping with the demands of Post Graduate CBCS Programmes in Distance Mode to devise a self-sufficient curriculum for each course offered by the Directorate of Open and Distance Learning (DODL), University of Kalyani.

Development of printed SLMs for students admitted to the DODL within a limited time to cater to the academic requirements of the Course as per standards set by Distance Education Bureau of the University Grants Commission, New Delhi, India under Open and Distance Mode UGC Regulations, 2020 had been our endeavour. We are happy to have achieved our goal.

Utmost care and precision have been ensured in the development of the SLMs, making them useful to the learners, besides avoiding errors as far as practicable. Further suggestions from the stakeholders in this would be welcome.

During the production-process of the SLMs, the team continuously received positive stimulations and feedback from Professor (Dr.) Manas Kumar Sanyal, Hon'ble Vice- Chancellor, University of Kalyani, who kindly accorded directions, encouragements and suggestions, offered constructive criticism to develop it within proper requirements. We gracefully, acknowledge his inspiration and guidance.

Sincere gratitude is due to the respective chairpersons as well as each and every member of PGBOS (DODL), University of Kalyani. Heartfelt thanks is also due to the Course Writers-faculty members at the DODL, subject-experts serving at University Post Graduate departments and also to the authors and academicians whose academic contributions have enriched the SLMs. We humbly acknowledge their valuable academic contributions. I would especially like to convey gratitude to all other University dignitaries and personnel involved either at the conceptual or operational level of the DODL of University of Kalyani.

Their persistent and co-ordinated efforts have resulted in the compilation of comprehensive, learner-friendly, flexible texts that meet the curriculum requirements of the Post Graduate Programme through Distance Mode.

All the Self Learning Materials are self-writing and collected from e-book, journals and websites.

Director
Directorate of Open and Distance Learning
University of Kalyani

Syllabus

Paper –GEO/CC/T-208: (Total Credit - 4, Total Marks – 50)

GEO/CC/T-208: Research Methodology
(Marks - 50: Internal Evaluation – 10, Semester-end Examination - 40)

Unit. 01 Spectrum of Geographical Research and its approaches: Inductive and Deductive

Unit. 02 Perspectives of Geographical Research: Objective andSubjective

Unit. 03 Methodological orientation: Quantitative and Qualitative

Unit. 04 Literature Review and identification of Research Gap

Unit. 05 Identification of Research Problem

Unit. 06 Preparation of Survey Questionnaire and Schedule

Unit. 07 Formulation of Research Questions and Hypothesis Building

Unit. 08 Methods of Sampling; Sample Size and Sample Design

Unit. 09 Methods of data collection, acquisition and treatment of data

Unit. 10 Research Ethics with special reference to Plagiarism

Unit. 11 Abstract, Summery and Synopsis: their differences

Unit. 12 Referencing style and preparation of Bibliography

Contents Page No.

**PAPER – GEO/CC/T-208: (TOTAL CREDIT - 4, TOTAL MARKS – 50) **

GROUP – GEO/CC/T-208: POPULATION AND SETTLEMENT GEOGRAPHY
(MARKS - 50: INTERNAL EVALUATION – 10, SEMESTER-END EXAMINATION - 40)

1.1 INTRODUCTION

Research methodology is transformative and central to an enhanced postgraduate research experience. Research methods courses offer students the opportunity to learn the various aspects of the research process, framing useful research questions, research design, data collection, analysis, writing and presentation. Research may be defined as the methodical process of discovering novel facts or of verifying old facts through series, inter-relationship, underlying explanations. It is an art of scientific exploration. There are hundreds of scientific fields and disciplines, ranging from the material Sciences, to the Life Sciences, to the Social Sciences. The fundamental governing foremost they all share in general, that distinguishes a science as a science is what's referred to as the scientific method. The method is expressed in the scientific research that constantly adds new knowledge and discoveries to the various realms and endeavours of the sciences. Research methodology is a systematic and organised way to solve the research problem.

1.2 LEARNING OBJECTIVES

After reading this self-learning material, the learners will be able

After reading this SLM, you will be able to

- Bear an idea of research – what it means, why a research is carried out or you may say, the significance of carrying out a research.
- It will also help you to know the different types of research with inductive deductive approach.
- This SLM will help you to gain the concepts of research methodologies as like objective or subjective or qualitative or quantitative method.
- You will also able to understand of research gap and problem with the preparation of survey schedule and questionnaire.
- You will be able to know different types of sampling procedures and this knowledge will guide you to choose the suitable sampling method to meet your research objectives.
- Finally, it will help you to explain the differences between reference and bibliography, research ethics, plagiarism, and abstract, summary and synopsis.

1.3 ASSESSMENT OF PRIOR KNOWLEDGE

To assess students' prior knowledge, they may be asked.

- What is research?

- What are the different types of research?
- What are the main objectives of research?
- What is research problem and research design?
- What is the difference between qualitative and quantitative research method?
- What do you mean by data collection and sampling procedure?

1.4 LEARNING ACTIVITIES

The learning process will involve Personal Contact Programmes, discussion, debate and interaction among students themselves, and students and teacher. During the Personal Contact Programmes, students may be assigned to prepare assignments on the issues of approaches of research, bibliography, referencing styles, hypothesis building etc. They can be asked to prepare charts on the differences between inductive and deductive mode of research, objective and subjective research, bibliography and references etc.

1.5 FEEDBACK OF LEARNING ACTIVITIES

Once the learning process is completed, internal assessments will be conducted. On the basis of evaluation reports of the internal assessments, some areas of the syllabus will be refocused depending on students' requirements.

1.6 EXAMPLES AND ILLUSTRATIONS

UNIT: - 1

SPECTRUM OF GEOGRAPHICAL RESEARCH AND ITS APPROACHES: INDUCTIVE AND DEDUCTIVE

INTRODUCTION

Searching it over and over again means Re-search. Research is defined as human movement based on scholarly application in the examination of matter. The mainprinciple for applied research is discovering, interpreting, and the development of methods and systems for the advancement of human knowledge on a wide variety of scientific matters of our world and the universe. Research can use the scientific method, but need not do so. Research is an art of scientific investigation. It is regarded as systematic efforts to gain new knowledge. The dictionary meaning of research is "a careful investigation or enquiry especially through search for new facts in any branch of knowledge". Definition of Research 'Research comprises defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organizing and evaluating data; making deductions and reaching conclusions; and at last carefully testing the conclusions to determine whether they fit the formulating hypothesis' (http://hdl.handle.net/10603/74214).

M Stephenson and D Slesinger defined research in the Encyclopedia of Social Sciences as "The manipulation of things, concepts or symbols for the purpose of generalizing to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of an art." "Research is an organized and systematic way of finding answers to questions" Systematic because there is a definite set of procedures and steps which you will follow. There are certain things in the research process which are always done in order to get the most accurate results (https://shodhganga.inflibnet.ac.in/bitstream/10603/74214/10/12-%20chapter-3.pdf).

Characteristics of Research

The characteristics of research include various points such as (https://subjectquery.com/what-is-research/):-

Research should be controlled-Objectives of Research It should be controlled because of the relation between two or more variables are affected by each other (whether it is internal or external). If the research is not controllable, then it will not be able to design a particular research report.

Research should be rigorous- It should be rigorous because it helps to follow the procedures to find out the answers related questions which are relevant and appropriate in nature. The research information consists of two types of sciences such as physical and social sciences. These two sciences are also varied from each other.

Research should be systematic- Research should be systematic because if a researcher wants to do a perfect research design or process then it will have to evaluate or obtained the necessary information from the market in a systematic manner. It takes various steps to do a perfect or systematic research process and all the steps of procedures are interlinked to each other.
Research should be valid- It means the information which is collected by the researcher can be the correct and verifiable by yourself (i.e, researcher himself). If our collected information is fair or valid, then our research will also be ethical in nature.
Research should be empirical- This means that any conclusion drawn is totally based upon ethical or hard evidence gathered information collected from observations and real-life experiences.
The foundation of knowledge- Research is the foundation of knowledge for the purpose of knowledge and an important source for providing guidelines or norms for solving different social, business, or governmental problems. It is a variety of formal training which enables us to understand the new developments in one's field in an efficient way.

Research Objectives

Research objectives help to identify the full purpose or attention of your research with the type of basic questions that will be noted. Explaining your research objectives means explaining what do I need to investigate and evaluate. The importance of research is also known as the objectives of the research. It includes various points such as (https://subjectquery.com/what-is-research/):-

To find out the real facts-As we know, every type of research has its own object but the basic aim of the research is always to find out or obtained the information from the markets and societies and their number of respondents. A researcher evaluates or finds the real or exact information for our problem-related questions.
To achieve the new thoughts-In this objective of the research**,** anybody can find new thoughts from the research. Research is the process of finding the exact information through proper observation, optimization, and experiments. These are the scientific methods to find out or evaluate the information which is very necessary for evaluating the problem task.
To evaluate the information- The first aim of the research is to find out the information and then evaluate them in an appropriate or efficient manner so that they can easily design the research problem and solve them also.
A researcher evaluates the information through various scientific approaches and methods, statistical analysis and procedures, and another type of tables and graphs.
To test a hypothesis- In this objective of the research, the researcher does the causal relationship between the variables (it can also be said that the hypothesis testing research studies). The hypothesis testing study represents the number of actions like these terms:

(a) Making a formal statement,

(b) Selecting a significance level,

(c) Deciding the distribution use,

(d) Selecting a random sample and computing an appropriate value,

(e) Calculation of the probability,

(f) Comparing the probability.

To design or implement the research- After the collection of all information, the researcher prepares the structure of a research design for the company so that they can easily describe or identify the structure of a particular research theme. The research designs can be broadcasted into two forms such as experimental designs and non-experimental designs.
After the structure of the research design, the researcher implements them in a problem and find out the optimum factor to solve them.
To improve the understanding- In this objective of the research, the researcher helps to improve the understanding of a particular topic by asking what else needs to be evidenced before the research is purposeful, or what knowledge could be assembled from a more focused investigation, or scrutiny of the existing findings.

What is Research Approach?

In the field of science different researchers may assign different meanings for the team research approach. In some publications you may see that research approach may imply methods of data collection and data analysis in general and differences between qualitative and quantitative methods in particular. Research approaches are plans and the procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation. This plan involves several decisions, and they need not be taken in the order in which they make sense to me and the order of their presentation here. The overall decision involves which approach should be used to study a topic. Informing this decision should be the philosophical assumptions the researcher brings to the study; procedures of inquiry (called research designs); and specific research methods of data collection, analysis, and interpretation. The selection of a research approach is also based on the nature of the research problem or issue being addressed, the researchers' personal experiences, and the audiences for the study. Thus, in this book, research approaches, research designs, and research methods are three key terms that represent a perspective about research that presents information in a successive way from broad constructions of research to the narrow procedures of methods (https://research-methodology.net/research-methodology/research-approach/).

Theory's structure and inform sociological research. So, too, does research structure and inform theory. The reciprocal relationship between theory and research often becomes evident to students new to these topics when they consider the relationships between theory and research in inductive and deductive approaches to research. In both cases, theory is crucial. But the relationship between theory and research differs for each approach. Inductive and deductive

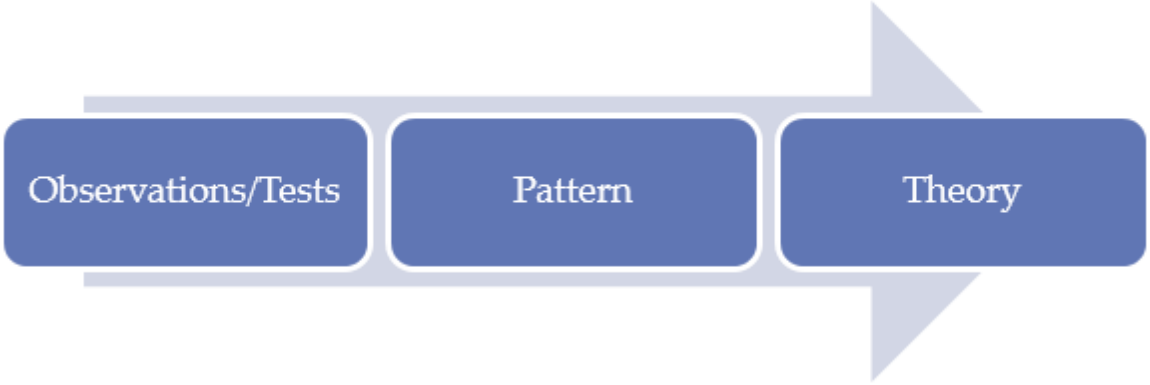
approaches to research are quite different, but they can also be complementary. Let's start by looking at each one and how they differ from one another. Then we'll move on to thinking about how they complement one another (https://www.opentextbooks.org.hk/ditatopic/28848).

Inductive Approaches and Some Examples

In addition to considering paradigms, researchers must also think about whether or not they plan to employ an inductive or a deductive approach. While each approach is quite different, they can also be complementary. In the following sections we will examine how these approaches are similar and dissimilar. In an inductive approach to research, a researcher begins by collecting data that is relevant to his or her topic of interest. Once a substantial amount of data has been collected, the researcher will then take a breather from data collection, stepping back to get a bird's eye view of her data. At this stage, the researcher looks for patterns in the data, working to develop a theory that could explain those patterns. Thus, when researchers take an inductive approach, they start with a set of observations and then they move from those particular experiences to a more general set of propositions about those experiences. In other words, they move from data to theory or from the specific to the general (https://www.opentextbooks.org.hk/ditatopic/28848).

It is important to stress that inductive approach does not imply disregarding theories when formulating research questions and objectives. This approach aims to generate meanings from the data set collected in order to identify patterns and relationships to build a theory; however, inductive approach does not prevent the researcher from using existing theory to formulate the research question to be explored. Inductive reasoning is based on learning from experience. Patterns, resemblances and regularities in experience (premises) are observed in order to reach conclusions (or to generate theory).

- Inductive reasoning works from specific observations to broader generalizations and theories.
- Informally, we sometimes call this a "bottom up" approach.
- Conclusion is likely based on premises.
- It involves a degree of uncertainty



Source: https://research-methodology.net/research-methodology/research-approach/

Referring to the example above, the effects of labour migration within the EU on the formation of multicultural teams in Dutch private sector organizations can be accessed through finding answers to the following research questions: Research question: How does labour migration within the EU effect the formation of multicultural teams in Dutch private sector organizations? The research process will focus on finding answer to this research question. Answer to the research question to be found by the end of the research process will imply generating a new theory related to the research problem (https://research-methodology.net/research-methodology/research-approach/).

Inductive Approach for Analysing Qualitative Evaluation Data

According to Thomas (2006), the following procedures are used for the inductive analysis of qualitative data:

1. Preparation of raw data files (data cleaning): Format the raw data files in a common format (e.g., font size, margins, questions or interviewer comments highlighted) if required. Print and/or make a backup of each raw data file (e.g., each interview).

2. Close reading of text: Once text has been prepared, the raw text is read in detail until the evaluator is familiar with its content and gains an understanding of the themes and events covered in the text.

3. Creation of categories: The evaluator identifies and defines categories or themes. The upper-level or more general categories are likely to be derived from the appraisal aims. The lower-level or specific categories will be derived from multiple readings of the raw data, sometimes referred to as in vivo coding. In inductive coding, categories are commonly created from real phrases or meanings in specific text segments. Several procedures for creating categories may be used. When using a word processor, marked text segments can be copied into the emerging categories. Specialist qualitative analysis software can be used to speed up the coding procedure when there are large amounts of text data (cf. Durkin, 1997).

4. Overlapping coding and uncoded text: Among the normally assumed rules that underlie qualitative encrypting, two are different from the rules typically used in quantitative coding:

> (a) one segment of text may be coded into more than one category, and
> (b) a considerable amount of the text (e.g.,50% or more) may not be assigned to any category, because much of the text may not be relevant to the evaluation objectives.

5. Continuing revision and refinement of category system: Within separate category, search for sub-topics, including contradictory points of opinion and original insights. Select appropriate quotations that convey the core theme or essence of a category. The categories may be combined or linked under a super ordinate category when the meanings are similar (Thomas, 2006).

Deductive Approach

Researchers taking a deductive approach take the steps described earlier for inductive research and reverse their order. They start with a social theory that they find compelling and then test its implications with data. That is, they move from a more general level to a more specific one. A deductive approach to research is the one that people typically associate with scientific investigation. The researcher studies what others have done, reads existing theories of whatever

phenomenon he or she is studying, and then tests hypotheses that emerge from thosetheories (https://socialsci.libretexts.org/Courses/Orange_Coast_College/SOC_200%3A_Introduction_to_Sociology_Research_Methods_(Ridnor)/02%3A_Inductive_or_Deductive_Two_Different_Approaches).

A deductive approach is concerned with "developing a hypothesis (or hypotheses) based on existing theory, and then designing a research strategy to test the hypothesis". It has been stated that "deductive means reasoning from the particular to the general. If a causal relationship or link seems to be implied by a particular theory or case example, it might be true in many cases. A deductive design might test to see if this relationship or link did obtain on more general circumstances". Deductive approach can be explained by the means of hypotheses, which can be derived from the propositions of the theory. In other words, deductive approach is concerned with deducting conclusions from premises or propositions. Deduction begins with an expected pattern "that is tested against observations, whereas induction begins with observations and seeks to find a pattern within them".

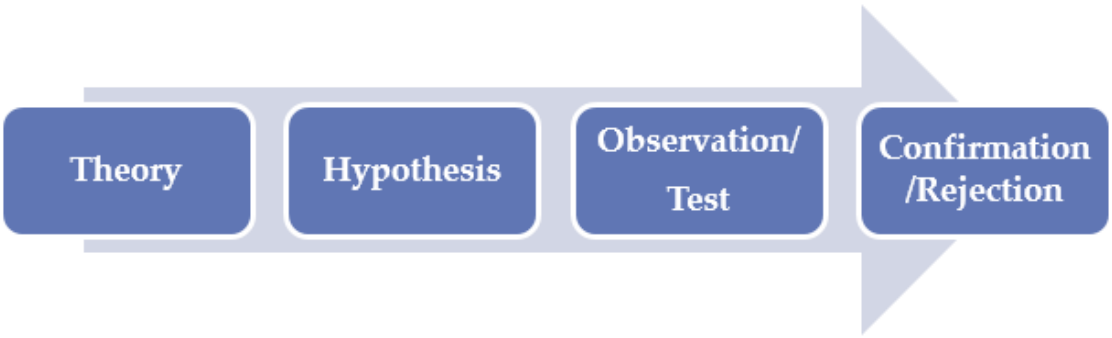
Deductive research approach explores a known theory or phenomenon and tests if that theory is valid in given circumstances. It has been noted that "the deductive approach follows the path of logic most closely. The reasoning starts with a theory and leads to a new hypothesis. This hypothesis is put to the test by confronting it with observations that either lead to a confirmation or a rejection of the hypothesis". Moreover, deductive reasoning can be explained as "reasoning from the general to the particular", whereas inductive reasoning is the opposite. In other words, deductive approach involves formulation of hypotheses and their subjection to testing during the research process, while inductive studies do not deal with hypotheses in any ways (https://galerie-louise.be/userfiles/files/49028482455.pdf).

Application of Deductive Approach

In studies with deductive approach, the researcher formulates a set of hypotheses at the start of the research. Then, relevant research methods are chosen and applied to test the hypotheses to prove them right or wrong.

Generally, studies using deductive approach follow the following stages (https://galerie-louise.be/userfiles/files/49028482455.pdf):

1. **Deducing hypothesis** from theory.
2. **Formulating hypothesis** in operational terms and proposing relationships between two specific variables
3. **Testing hypothesis** with the application of relevant method(s). These are quantitative methods such as regression and correlation analysis, mean, mode and median and others.
4. **Examining the outcome** of the test, and thus confirming or rejecting the theory. When analysing the outcome of tests, it is important to compare research findings with the literature review findings.
5. **Modifying theory** in instances when hypothesis is not confirmed.



Source: https://research-methodology.net/research-methodology/research-approach/

Advantages of Deductive Approach

Deductive approach offers the following advantages (https://www.coursehero.com/file/102213920/Q1docx/):

1. Possibility to explain causal relationships between concepts and variables
2. Possibility to measure concepts quantitatively
3. Possibility to generalize research findings to a certain extent

Importance of Inductive and Deductive Approaches in Geographical Researches

Likewise researches in other social sciences, geographical research also walk with inductive and deductive approaches of reasoning. In geographical research earlier studies were accompanied with deductive method, where conclusions were drawn out from the premises. There were no serious attempts, by any geographer, made in past to test the validity of the existing premises. This was because of the reliability of the geographers on metaphysical world views (teleological approaches). It was believed that the changes in the phenomena were caused by law of nature.

However, there were geographers who put emphasis on empirical observation and studied geography inductively. Modern geographical time period starts with two great German geographer's viz. Alexander von Humboldt and Carl Ritter. Both were contemporary to each other but each had different approach to explore the geography. Humboldt was a believer of inductive approach and considered scientific observation as the sole tool for exploring the nature. He made several expeditions and field works to many places of South America, North America, Europe and Asia and came with many theories in the field of climatology, geomorphology, zoology, botany, geology etc. His book *Kosmos* is a comprehensive account of his journeys and expeditions. On the contrary, Carl Ritter, through fieldworks and empirical observation, put emphasis on deducing new conclusions from fundamentals assumptions or from already established truths. Thus, his method was followed by deductive approach.

In geographical studies, there has always been methodological problem of dualism and dichotomy. Majority of the researches in the fields of geomorphology, climatology, oceanography and earth sciences are done using inductive approach, while specialized branches of geography rely on deductive methods. However, both the approaches are used in

researches irrespective of their fields in geography. It depends on the nature and objectives of the research.

While conducting research it is essential to determine whether to use and inductive or deductive approach. For this the researcher, geographer in this case, has to consider the purpose of the study first, and secondly the methods which are best suited for either testing hypothesis or to find answer of specific research questions (https://www.coursehero.com/file/102213920/Q1docx/).

UNIT: - 2

PERSPECTIVES OF GEOGRAPHICAL RESEARCH: OBJECTIVE AND SUBJECTIVE

INTRODUCTION

To live a happy and enjoyable life is probably the goal of all people in today's world. Scholars have discussed quality of life for many decades. In the early stages of quality of life research (mid-20th century), this topic was mainly associated with economic development—the term quality of life was first used by the English economist Cecil Pigou in the 1920s. Following the pioneering period in the formation of the concept of quality of life (comprehensive publications published, e.g., by Smith, Campbell et al. or Andrews. Objective evaluation uses indicators based on objective, quantitative values collected during statistical surveys or derived from other socio-economic or spatial data. The greatest strength of this group of indicators lies in their objectivity. They can be relatively easily quantified and defined without the necessity of examining personal feelings. The measured values can be extra reliably compared with each other. Overall, objective indicators describe the state of the environment and society, which can explain the potential for individuals to have good lives. Thus, a significant association between objective indicators and subjective life satisfaction is expected. The subjective evaluation approach is based on the assumption that to understand individual personal satisfaction, it is essential to examine the individual's feelings concerning the diverse parts of their life directly, within an individual's expected life standards. Subjective indicators are usually obtained through a questionnaire—a scale describing the degree of agreement with each question is most often used (for how to express subjective satisfaction through the use of a scale see, for example, Cantri (Mack ˚u et al., 2020, PP 1 & 2).

Key Differences between Objective and Subjective

Given below is a tabulated difference between objective and subjective. Candidates can refer to these points of difference to understand the terms better:

Objective	**Subjective**
Objective means making an unbiased, balanced observation based on facts which can be verified.	Subjective means making assumptions, making interpretations based on personal opinions without any verifiable facts.
Objective observations or assessments can be used before arriving at any decisions.	Subjective observations or information should not be used while taking any important decisions.
Objective information can be found in Scientific journals, research papers, textbooks, news reporting, encyclopedias etc.	Subjective observations can be found in biographies, blogs, editorials of newspapers etc.

An Objective observation or assessment is made after necessary information is verified.	A Subjective assessment is made without verifying the necessary information.
An objective statement is provable and can be easily measured.	A subjective statement is relative to the person in concern
This is a method of stating or storytelling the truth in a systematic manner from all perspectives	Any subjective information is derived from the opinion or interpretation of a character and may depend on personal beliefs.

Source: -

(https://byjus.com/free-ias-prep/difference-between-objective-and-subjective/)

Objective Research

Objective research tends to be modelled on the methods of the natural sciences such as experiments or large scale surveys. Objective research seeks to establish law-like generalisations which can be applied to the same phenomenon in different contexts. This perspective, which privileges objectivity, is called positivism and is based on data that can be subject to statistical analysis and generalisation. Positivist researchers use quantitative methodologies, which are based on measurement and numbers, to collect and analyse data. An objective research generally starts with a hypothesis and at the end, it test the hypothesis and explores the significance of the research.

Objective research tends to be modelled on the methods of the natural sciences such as experiments or large scale surveys. Objective research seeks to establish law-like generalisations which can be applied to the same phenomenon in different contexts. This perspective, which privileges objectivity, is called positivism and is based on data that can be subject to statistical analysis and generalisation. Positivist researchers use quantitative methodologies, which are based on measurement and numbers, to collect and analyse data. Interpretivists are more concerned with language and other forms of qualitative data, which are based on words or images. Having said that, researchers using objectivist and positivist assumptions sometimes use qualitative data while interpretivists sometimes use quantitative data. (Quantitative and qualitative methodologies will be discussed in more detail in the final part of this course.) The key is to understand the perspective you intend to adopt and realise the limitations and opportunities it offers. (https://www.open.edu/openlearn/money-business/understanding-different-research-perspectives/content-section-1).

According to, the term has only been used in this way in science from the mid-nineteenth century; before then, “objective” and “subjective” were used with meanings almost opposite from the current ones and did not play a strong role in discussions about science. The idea of independence of the individual subject can be applied in various ways. Megill (1994) listed four basic senses of objectivity: “absolute objectivity” in the sense of “representing the things as they really are” (independently of an observer), “disciplinary objectivity” referring to a consensus among experts within a discipline and highlighting the role of communication and

negotiation, “procedural objectivity” in the sense of following rules that are independent of the individual researcher, and “dialectical objectivity” (Daston and Galison, 2021).

Subjective Research

Subjectivity in research is a topic that has led more than once to much discussion and to many debates. For quantitative researchers, it is -and rightfully so- a variable needing to be controlled (see Gilbert, 1998, for review). For qualitative researchers, the answer does not appear to be as simple. Some suggest maintaining subjectivity at a near zero level by sticking to the text which is analyzed (e.g. Mucchieli, 1979), thus establishing a clear connection between qualitative and quantitative research through a search for objectivity and a near-positivist perspective (see Rennie, 2000a, for discussion). On the other hand, many researchers suggest making use of subjectivity and drawing on one's inner experience in order to better understand the subject of a study (Rennie, 1994; Schneider, 1999). For them, distancing themselves from the subject through the use of standardized or semi-standardized methods only keeps the subject… at a distance.

Subjectivity is generally conceptualized as the way research is influenced by the perspectives, values, social experiences, and viewpoint of the researcher. Traditional scientific discourse equates subjectivity with personal biases because, according to its empirical orientation, direct or indirect influence of the researcher on the collection, handling, interpretation, and reporting of data invalidates the research findings. For this reason, research reports from a scientific orientation make a claim to objectivity, a principle drawn from postpositivism that researchers should make every attempt to remain distanced from the phenomenon under investigation. This philosophical belief represents one way of managing subjectivity in research. Rather than attempt to diminish its potential influence, some scholars centralize the subjective position in the research process (DAVIS, 2019).

Unfortunately, such attempts also present certain risks such as projection on behalf of the researcher (Kahn, 1996), limitations due to the researcher's own blind spots (Drapeau&Letendre, 2001), and a sometimes unclear demarcation between what belongs to subjectivity and what belongs to delusions (Brillon, 1992). The question then is how to make use of subjectivity while avoiding these difficulties. In this article, I attempt to remind readers of a few elements which could help the researcher make better use of his subjectivity and to expand on one specific concept often referred to as the peer debriefer. I will then illustrate the possible use of this by giving an example taken from a previously completed study on pedophilic sexual abusers. As it will become clear for the reader, this effort aims at a certain reconciliation of modern and postmodern epistemology (see Rennie, 2000b, for discussion of the raging debate between the two positions).

UNIT: - 3

METHODOLOGICAL ORIENTATION: QUANTITATIVE AND QUALITATIVE

The research methodology that was traditionally used in social sciences for several decades was the quantitative methodology, which originated in the natural sciences such as biology, chemistry, physics, geology, and was concerned with investigating things which could be observed and measured in some way. Quantitative research was the generally accepted research paradigm in educational research until the early 1980s, when the "paradigm wars" between advocates of quantitative and qualitative research reached a new peak (Guba, 1994). All research is based on some underlying philosophical assumptions about what constitutes 'valid' research and which research method(s) is/are appropriate for the development of knowledge in a given study. The selection of research methodology depends on the paradigm that guides the research venture. The term paradigm originated from the Greek word paradeigma which means pattern and was first used by Kuhn (1962) to denote a conceptual framework shared by a community of scientists which provided them with a convenient model for examining problems and finding solutions. According to him, the term paradigm refers to a research culture with a set of beliefs, values, and assumptions that a community of researchers has in common regarding the nature and conduct of research (Kuhn, 1977).

Quantitative Research

Introduction of Quantitative Approach in Research Methodologies The process of conducting a quantitative study begins with a researcher selecting a topic. Quantitative researchers typically start with a general area of study or issue of professional or personal interest. Researchers must narrow it down to, or focus on, a specific research question that can be addressed in the study. Often this requires a careful review of the research literatures and developing hypotheses that frequently come from social theory. Designing the study requires making decisions about the type of case or samples to select how to measure relevant factors and what research techniques such as questionnaires or experiments to be employed. In addition, quantitative methods characteristically refer to standardized questionnaires that are administered to individuals or households, which are identified through various forms of sampling usually random sampling. Basically, probability or non-probability sampling approaches are required researchers to choose a proper way before drawing a sample size. Next is the data collection step (Carr, 2014).

A quantitative researcher will very carefully record and verify information, almost always in one form of numbers and usually transfer the data into computer-readable format. Quantitative data can help establish correlations between given variables and outcomes. Such data should allow others to validate original findings by independently replicating the analysis. After that, analyze data step will be replaced. Often the research ends up with a large quantity of computer-generated output that provides the researcher next has to give meaning to or interpret the data. To draw a theory, quantitative researchers have to look at the analyzed data, using background knowledge on the research topic and questions. A researcher also considers alternative

interpretation of the data compares the results of the study with previous studies and draws out its wider implications. The final step is to inform others means writing a report in a specific format for the study (Choy, 2014).

Advantages of Quantitative Research

The first advantage of this research approach is the use of statistical data as a tool for saving time and resources. (Bryman, 2001, p20) argue that quantitative research approach is the research that places emphasis on numbers and figures in the collection and analysis of data. Imperatively, quantitative research approach can be seen as being scientific in nature. The use of statistical data for the research descriptions and analysis reduces the time and effort which the researcher would have invested in describing his result. Data (numbers, percentages and measurable figures) can be calculated and conducted by a computer through the use of a statistical package for social science (SPSS) (Gorard, 2001, p3) which save lot of energy and resources.

Secondly, the use of scientific methods for data collection and analysis make generalization possible with this type of approach. Interaction made with one group can be generalized. Similarity, the interpretation of research findings need not be seen as a mere coincidence. The study of problem-solving instruction in secondary school science education within one particular area or zone can be reflective of the wider society in terms of samples, contents and patterns (Shank and Brown, 2007, p28).

Moreover, this research approach gives room for the use of control and study groups. Using control groups, the researcher might decide to split the participants into groups giving them the same teaching, but using different teaching methods, bearing in mind the factors that he is studying. At the end of the study teaching, the groups can be gathered and the researcher can then test the problem-solving ability of the students and be able to access the teaching method that best impacts the problem-solving abilities amongst the students. (Johnson and Christensen, 2012, p34).

Finally, Denscombe (1998, p173-176) describe quantitative research as "researcher detachment" research approach. When looking at the "researcher detachment", it may be seen as a strength of quantitative research approach from one angle, yet from another angle it may see as its weakness. The issue of researcher being bias with either his data collection or data analysis will be highly eliminated when the researcher is not in direct contact with the participants, that is, he collects his data through either telephone, internet or even pencil-paper questionnaire. There is full control for alternatives such as interpretations, explanations, and conclusions. In other words, the objectivity of the researcher will not be compromised. Secondly, this may perhaps guarantee respondent anonymity (Muijs, 2004, p7-45; Litchman, 2006, p8; Bryman, 2012, p408; Creswell, 2009, p4).

Disadvantages of Quantitative Research

Researcher detachment from the participants is also a weakness within the quantitative research approach. Researcher detachment means that he is an "observer" or an "outside looking in".

With this type of researcher/participant relationship, it will extremely difficult to get the in-depth study of the phenomena within its natural settings. He will neither understand the group or individuals working with him nor will he appreciate them (Shank and Brown, 2007, p63; Berg, 2007, p4).

In studying problem solving instructions for science education in secondary schools, the researcher need not be an observer nor detach himself from the participants. It is dehumanising as well as undermining life and mind (Cohen, 2011, p14). The experiences gathered may not be that of the participants mind and opinion (Berg and Howard, 2012, p61).Quality and quantity are very important in any educational research since research is an instrument of change. Those two words cannot be neglected when explaining phenomena (Dabbs, 1982 cited in Berg and Howard, 2012, p3). In the quantitative research approach, the participants have no room to contribute to the study. The researcher is at the "driver's seat" (Bryman, 2001, p286).The linear and non-flexibility nature of a quantitative approach demands that the researcher follow a certain order. He starts by setting the research question and hypotheses, conducts a literature review, collects data, analyses the data and summarises the result (Litchman, 2006, p7-15).

A quantitative research approach is characterized as being structured with predetermined variables, hypotheses and design (Denscombe, 1998, p173; Bryman, 2012, p408). As a result of using predetermined working strategies, the approach does not require or encourage imaginative, critical and creative thinking (De Vaus, 1996, p8). Any data collected is geared towards supporting or rejecting the predetermined paradigms. This, however, shows that the tool is effective for studying what is already known instead of assisting in unravelling the unknown and revamping the known. Perhaps, findings from the studies with this tool may lead to propounding laws and facts that can stand on their own regardless of it being true or not (Shank and Brown, 2007, p58).

When considering the existence of social differences in the society and schools in particular, a quantitative research approach is not well "suited to examine the complex and dynamic contexts of public education in its forms, sites and variations" (Denzin and Lincoln, 2005, pxi). But are there true experiments in educational research? Certainly there is no true experiment in educational research (Gorard, 2001, p2).

QUALITATIVE RESEARCH

The qualitative research methods introduced in this book are often employed to answer the whys and how's of human behavior, opinion, and experience— information that is difficult to obtain through more quantitatively-oriented methods of data collection. Researchers and practitioners in fields as diverse as anthropology, education, nursing, psychology, sociology, and marketing regularly use qualitative methods to address questions about people's ways of organizing, relating to, and interacting with the world. Despite the interdisciplinary recognition of the value of "qualitative research" (or perhaps because of it), qualitative research is not a unified field of theory and practice. On the contrary, a plethora of viewpoints, sometimes diametrically opposed to one another, exist on the subject. Scholars regularly debate about what qualitative research is, how and why it should be conducted, how it should be analyzed, and in

what form it should be presented. In fact, fundamental and often heated disagreements about philosophical assumptions and the nature of data exist among qualitative researchers. We don't pretend to be able to solve any of these controversies. Nor do we suggest one approach or viewpoint is superior to another in the grand scheme of things. How one approaches qualitative research, and research in general, depends on a variety of personal, professional, political, and contextual factors. Ultimately, there is no right or wrong way of conducting a qualitative research project. Nevertheless, some approaches and methods are more conducive to certain types of qualitative inquiry than are others. A key distinction in this regard is the difference between pure and applied research. It is the latter of these—applied research—for which the contents of this book will be most (though certainly not exclusively) relevant (Guest et al., 2013).

There are about as many definitions of qualitative research as there are books on the subject. Some authors highlight the research purpose and focus: Qualitative researchers are interested in understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world. (Merriam, 2009, p. 13) Others emphasize an epistemological stance: [Qualitative research is] research using methods such as participant observation or case studies which result in a narrative, descriptive account of a setting or practice. Sociologists using these methods typically reject positivism and adopt a form of interpretive sociology (Parkinson & Drislane, 2011).

Still other definitions focus on the process and context of data collection: Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that makes the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them. (Denzin & Lincoln, 2005, p. 3).

Qualitative and quantitative research approaches and methods are usually found to be utilised rather frequently in different disciplines of education such as sociology, psychology, history, and so on. Concerning the research approaches, there persist so-called paradigm wars in which researchers belong to the two distinct camps—interpretivism and positivism. The positivistic researchers' belief is that the social world consists of concrete and unchangeable reality which can be quantified objectively. Whereas, the interpretive researchers oppose the positivistic belief of reality; and argue that, instead, the reality is socially constructed by the humans which can be changed and understood subjectively (Corbetta, 2003).

Advantages of Qualitative Research

There are some benefits of using qualitative research approaches and methods. Firstly, qualitative research approach produces the thick (detailed) description of participants' feelings, opinions, and experiences; and interprets the meanings of their actions (Denzin, 1989). In terms of language testing, for example, Bachman (1998) showed in his study that qualitative research

results provide the relationship of information processing with performance specifically and deeply. Chalhoub-Deville and Deville (2008), too, argued that qualitative approaches are employed to achieve deeper insights into issues related to designing, administering, and interpreting language assessment. Secondly, there are some who argue that qualitative research approach (interpretivism) holistically understands the human experience in specific settings. Denzin and Lincoln (2002), for example, mentioned that qualitative research is an interdisciplinary field which encompasses a wider range of epistemological viewpoints, research methods, and interpretive techniques of understanding human experiences. From the perspective of epistemological position, any language assessment cannot be set apart from context, culture and values of where it was used (McNamara, 2001); and the language assessment researchers began to employ qualitative research methodology for focusing the issues that need an analysis of content-related variables such as the influences of test-takers' characteristics on test performance, the strategies used to respond to assessment tasks, and so on (Tsushima, 2015).

Thirdly, interpretivism research approach is regarded as ideographic research, the study of individual cases or events (Kelin & Myers, 1999); and it has abilities to understand different people's voices, meanings and events. So, the source of knowledge in this approach is the meaning of different events (Richardson, 2012). In language testing, the qualitative research techniques analyse the candidate behaviour, interviewer behaviour, interlocutor behaviour, and cross-cultural influences on behaviour during the speaking tests (Lazaraton & Taylor, 2007).

Fourthly, the qualitative research admits the researchers to discover the participants' inner experience, and to figure out how meanings are shaped through and in culture (Corbin & Strauss, 2008). Such as, in terms of assessing written assignments, "satisfactory", "good", or "60 marks out of 100" are used by the assessors, an investigation might be made in order to understand the meaning of "satisfactory" or "good" or to elicit the features of content or text displayed in the student scripts (Leung, 2012).

Disadvantages of Qualitative Research

Beyond the above advantages, some limitations are obvious. First, Silverman (2010) argues that qualitative research approaches sometimes leave out contextual sensitivities, and focus more on meanings and experiences. Phenomenological approach, for instance, attempts to uncover, interpret and understand the participants' experience (Wilson, 2014). Cumming (2001) focused on the participants' experience rather than any other imperative issues in the context. He engaged six countries (Australia, Canada, New Zealand, Hong Kong, Japan and Thailand) and experienced writing instructors of these countries in his jel.ccsenet.org Journal of Education and Learning Vol. 6, No. 1; 2017 105 research. He stated that, "This sampling was selective and purposive, focused on instructors with high levels of expertise in each setting, rather than aiming to be representative of educators in the particular countries or institutions." It seems that the contextual influence on the assessment is not taken into account at all in this research because it has looked at the writing instructors' expertise, and bypassed what impacts of these countries' cultures for example would be on writing assessment.

Second, policy-makers may give low credibility to results from qualitative approach. Sallee and Flood (2012) found that stakeholders frequently use quantitative research when research is called upon. In terms of educational practice in United States, national and state policymakers sought to quantify teacher's and student's performance (Ravitch, 2010), and in many social sciences, quantitative orientations are frequently given more regard (Berg, 2009). In addition, purely qualitative research may neglect the social and cultural constructions of the variables studied (Richards & Richards, 1994).

Finally, the analyses of the cases take a considerable amount of time, and one can generalise the results to the larger population in only a very limited way. For example, if a legislator needs to vote an issue, she/he cannot wait for three months for a qualitative study to be administered (Sallee& Flood, 2012). Similarly, in language testing and assessment research, in order to devise a new policy within a short period of time, the policy makers may demand quantitative research instead of qualitative research.

UNIT: - 4

LITERATURE REVIEW AND IDENTIFICATION OF RESEARCH GAP

INTRODUCTION

Writing a literature review in the pre- or post-qualification, will be required to undertake a literature review, either as part of a course of study, as a key step in the research process. A literature review can be just a simple summary of the sources, but it usually has an organizational pattern and combines both summary and synthesis. It demands a range of skills, such as learning how to define topics for exploration, acquiring skills of literature searching and retrieval, developing the ability to analyse and synthesize data as well as becoming adept at writing and reporting, often within a limited time scale. The aim of this article is to present a step-by-step approach to writing a literature review research paper to facilitate student and novice reviewers' understanding (Ramdhani et, al, 2014).

A literature review is an objective, thorough summary and critical analysis of the relevant available research and non-research literature on the topic being studied (Cronin,etal.,2008). Its goal is to bring the reader up-to-date with current literature on a topic and form the basis for another goal, such as the justification for future research in the area. A good literature review gathers information about a particular subject from many sources. It is well written and contains few if any personal biases. It should contain a clear search and selection strategy (Carnwelland Daly, 2001).

What Is a Literature Review?

A literature review is a review or discussion of the current published material available on a particular topic. It attempts to synthesize and evaluate the material and information according to the research question(s), thesis, and central theme(s). In other words, instead of supporting an argument, or simply making a list of summarized research, a literature review synthesizes and evaluates the ideas of others on your given topic. This allows your readers to know what is being said about your given topic, how these sources compare with one another, and what gaps there are in the research (Denney &Tewksbury, 2013).

What is a literature review and why is it necessary?

- Your dissertation is a substantial and lengthy piece of professional work that must satisfy a number of academic requirements. The literature review is one of these important academic requirements.
- The literature review is a critical discussion and summary of statistical literature that is of ‘general’ and ‘specialized’ relevance to the particular area and topic of the research problem in statistics.
- You should spend a lot of time on your literature review because if you do it well, you can use most of it in your dissertation.
- In a weak literature review, the Ph.D. student did a poor job of reviewing the relevant literature. It can be poor because there are too few references or the student does not

adequately summarize the important results in the cited references. Keeping organized notes will help prevent a weak literature review.

- Every statement in a literature review must be supported either by a reference to published statistical literature.
- In a literature review, you do not present all of the details found in the references. For example, you can state a theorem, but you do not have to present a proof of the theorem. That is, you can (in general) assume the results in the published statistical literature are established facts. By providing the source of the reference, your advisor and committee can go to the original reference for all of the details (Denney & Tewksbury, 2013).

What is the structure of a literature review?

In writing a literature review you need to demonstrate your intellectual ability to recognize relevant information and to synthesize and evaluate it according to the tentative guiding research question/thesis statement you have developed. Your reader wants to know: a) what literature exists, but also b) your informed evaluation of the literature (Knopf, 2006). While reviewing the literature, you need to be answering questions such as:

1. What are the main ideas and contributions that form the core of the literature?

2. Which papers are important and which ones are not?

3. Have there been controversies and how have they been resolved?

4. What are the common assumptions made in the papers you are reviewing?

5. What are the current deficiencies/mistakes and unresolved issues as you see them?

6. Are there important connections to other topics?

7. Has the emphasis been more empirical or theoretical? Why?

In your literature review you should:

- group research studies and other relevant literature according to a common theme
- summarize each item of the literature appropriately according to its significance
- compare and evaluate each item of the literature
- provide topic sentences at the beginning of paragraphs and summary sentences at the end of sections to help the reader understand what the main issues are.

Some students find that the most difficult part at this stage is to group the papers they have chosen for review so that their analysis weaves a logical story of how the literature fits together and has progressed over time. For this reason, I have provided below some general guidelines on how you might classify different writings on your topic. You may use the following sub-headings to classify what you have read, or you may narrow the focus of your review to deal with some of these categories only. Or there may be still other categories that are more appropriate for your research (Knopf, 2006). For example:

- research outcomes
- research methods
- theories
- applications
- integration of the works of others
- criticism of previous work
- building of bridges between related topics
- identification of central issue(s).

What makes a good literature review?

A good literature review:

- clearly delimits the subject matter to be reviewed
- covers all important relevant literature
- is up-to-date *f* provides an insightful analysis of the ideas and conclusions in the literature
- points out similarities and differences, strengths and weaknesses in the literature
- identifies gaps in the literature for future research
- identifies the context for which the literature is important (Kralik et. Al., 2006)

IDENTIFICATION OF RESEARCH GAP

If you are a Researcher, the first challenge is to identify an interesting and worthy research topic. Most researchers come up with a great research problem while others may struggle to get a worthy research problem, in such a case this is just for you. Research statement or a research topic is the first and most important step to initiate research work. The solution to this issue lies in the research gap. Identifying a research gap is a question or a problem on which enough existing research is not done or it is outdated and needs to be updated. For example: Impact on the psychology of corporate employees during and post-COVID 19. Another example may be the Impact of Television on the lives of the pre-internet era on the lives of children (Dissanayake, 2013).

Research work always starts with a research proposal, and finding a valid research gap is the precursor to writing a research proposal. Thus, a research gap is a topic or area for which missing or insufficient information limits the ability to conclude a question. A research need is defined as a gap that limits the ability of decision-makers (policy-makers, patients, practitioners) from making decisions. Research gap exists due to a question or a problem that has not been answered by any of the existing studies or research. Sometimes you'll find a research gap if all the existing research is outdated and in need of new/updated research.

A gap is something that remains to be done or learned in an area of research; it's a gap in the knowledge of the researcher in the field of research, un explored aspect in one's area of study; that which is still not answered by research; that body of knowledge that may still be lacking, undiscovered, not explored and void or leaving a vacuum which therefore raises certain

questions to be answered by yet another research above what is already known concerning a phenomenon (Robinson, K.A.).

Similarly, Robinson et. al (2011) defines research gap as a topic or area for which missing or insufficient information limits the ability to reach a conclusion for a question; thus, making it impossible for decision makers and/or policy makers and policy implementers etc to make decisions and/or take necessary action. Dissanayake (2013) also reiterates that research gap is "The missing piece or pieces in the research literature; the area that has not yet been explored or is under-explored", He goes on to say that the gap could go beyond selection of a research topic in to other research processes such as sample population (size, type, location etc), research methods used, data collection and/or analysis, as well as encamp using other research variables.

UNIT: - 5

IDENTIFICATION OF RESEARCH PROBLEM

INTRODUCTION

The first and most important step of a research is formulation of research problems. It is like the foundation of a building to be constructed. To solve a problem someone has to know about the problem. So, the problem identification and formulation is very crucial for the researcher before conducting a research, and this is perhaps one of the most difficult aspects of any research undertaking. The "problem" is stated in the opening passages of a study and, in effect, provides a reader the rationale for why the study is important and why it is necessary to read. This module discusses the concepts and activities for identifying, specifying, and stating a research problem in both quantitative and qualitative research and positioning it within a section that introduces a study, i.e., the "statement of the problem" section (Pardede, 2018).

Problems for research are everywhere. Take a good look around you. We might see various kinds of vending machines placed everywhere. But have you thought of having a more user-friendly vending machine that is much easier to use? Or, you might be frustrated waiting for a public transportation that never shows up on time and you wish somebody can come out with a better system that prioritises punctuality. These are examples of problems which need to be relooked and researched. That is why we say that the heart of every research is the problem. Research problem is paramount to the success of a research effort. In ICT, the problems are broad and technology-centric. According to Powers, Meenaghan &Twoomey (1985), potential research questions may occur to us on a regular basis but the process of formulating them in a meaningful way is not at all an easy task. As a beginner, it might be easy to formulate a problem but it requires considerable knowledge of both the subject of interest and research methodology. Once you examine a question more closely, you will realise the complexity of formulating a research problem into something that is researchable. It is essential for the problem you formulate to be able to withstand scrutiny in terms of the procedures required. Hence, a student should spend considerable time in thinking to formulate a researchable research problem (Leedy & Ormrod, 2001).

SOURCES OF IDENTIFYING A PROBLEM

A thorough understanding of known facts and ideas in the field of your interest as a researcher constitute the first and the most important step in selecting a problem for your study. A thorough knowledge of the research studies conducted in the field provides you with details about the problems which have remained unresolved. A survey of suggestions for further research given at the end of research reports and reviews of research would help you to get an idea about the gaps which exist in the knowledge pertaining to your field of educational research. Periodicals and bibliographies of educational research are helpful in keeping you informed about the research going on in the field in which you are interested and show competence. The choice and identification of a suitable problem is usually difficult. For a beginner to identify a research problem is always a very difficult task. This may be due to his/her limited knowledge of research processes or his/her unpreparedness for identifying the

problem. He/she may not be familiar with the problems in the field which need solution through research. Even an experienced researcher finds it difficult to list all the problems that need to be researched. Each researcher selects a problem because of his/her own needs and purposes. The following, are, however, some important sources which would help you identify a suitable and significant problem. There are various sources which are available to researcher and which help him to identify and specify the meaningful problem of research. These are mainly: Theory, Experience, Discussion, Dissatisfaction, & Literature (Shoket, 2014).

CHARACTERISTICS OF RESEARCH PROBLEM

As per good et al, 1941, he stated few characteristics of research problem: -

1. Clarity is the most important quality of any research topic. The topic should be clear so that others can simply understand the nature of research. The research topic should have a single explanation so that people cannot get diverted. The topic should have to be very obvious so that it can correctly be undertaken. The research topic should be free of any vagueness. Clarity also means that the research topic should be directional and it should set the whole research methodology in that direction.

2. Well-stated research topic is a half assurance of a successful research. Sometimes researchers phrase the research topic in such a way that it gives a double barrelled idea. The research topic should have to be well stated and it should be easy to interpret. It should carry a single meaning.

3. The language of the research topic should be easy. You should use technical terms only when it is needed, otherwise use simple language so that everyone can comprehend it. Keep the principles of writing in mind to avoid any unprincipled term. Do not bring in any sort of prejudice directly or indirectly, willingly or unwillingly in the research problem or in research topic.

4. The titling of the research problem should pursue the rules of titling. There are various already existed rules of titling. You can either use a sentence case or a title case but most of the titles follow title case. Read and follow the rules of titling titles before writing it down.

5. Current importance should also the consideration of the researcher while selecting a research topic. An out of date topic will not be helpful for anyone the topic should carry current importance. You should also measure how much the topic will provide help to the field in which you are conducting the study.

IDENTIFICATION OF A RESEARCH PROBLEM

Clear and concise identification of the problem is not an easy matter. Some research studies are pursued in such a way that it is difficult to determine what the researcher is trying to investigate. A most challenging situation for a researcher occurs when s/ he feels bewildered and suffers with diffused perceptions of the situations amenable to research. Identification of a research situation is an important phase of the entire research process. It demands a great deal of thinking, searching and speculating on the part of a researcher. It consumes a lot of energy, time and effort. A beginning researcher finds it very difficult as to how to locate the problem

situation. This may happen because she has limited knowledge of the research process. S/he may be unfamiliar with the areas in which research is needed and the procedures that he has to follow to identify a suitable area of research. Novice investigators have an unrealistic, glamorized conception of research problem. An investigator should follow the following major tasks in analyzing a problematic situation (VanDalen, 1973):

(1) Accumulating the facts that might be related to the problem,

(2) Settling by observation whether the facts are relevant,

(3) Tracing any relationship between facts that might reveal the key difficulty,

(4) Proposing various explanations for the cause of the difficulty,

(5) Ascertaining through observation and analysis whether these explanations are relevant to the problem,

(6) Tracing the relationship between explanations that may give an insight into the problem solution,

(7) Tracing the relationship between facts and explanations, and

(8) Questioning assumptions underlying the analysis of the problem.

Differentiating Quantitative from Qualitative Research Problems

After identifying a research problem, you should also consider if it better suits a quantitative or qualitative approach. Both approaches have merit, but since they differ in their essential characteristics, you need to decide which one is more appropriate to use for your specific research problem. Look once again at the study of the contribution of students' beliefs about language learning, learning styles, and language learning strategies on students' English achievement (Angelianawati, 2012). In this quantitative study, the researcher made a case that we knew about the role of the students' beliefs about language learning, learning styles, and language learning strategies in English learning. Her literature review on current relevant studies showed that someone's beliefs about language learning, language learning strategies and learning styles gave significant contribution toward his/her success of learning. Thus, the researcher predicted that the dependent variables (students' beliefs about language learning, learning styles, and language learning strategies) contributed to the independent variables (students' English learning achievement). To test this prediction, she measured both dependent and independent variables and tested their correlation (Pardede, 2018).

Writing the Problem Statement

After determining the research problem and deciding the research approach to use, it is time to begin writing about the "problem" in a statement of the problem section that introduces your research study. Bryman (2007) defined a problem as "a statement about an area of concern, a condition to be improved upon, a difficulty to be eliminated, or a troubling question that exists in theory or in practice those points to the need for meaningful understanding and deliberate

investigation." A problem statement concisely overviews the issues or problems existing in the investigation." A problem statement concisely overviews the issues or problems existing in the area which drives the researcher to do in-depth study and analysis in order to understand the issues and/or solve the problem.

Written in one or more concise paragraph (but not exceeds one page), a problem statement usually includes five aspects: (1) the actual research problem, (2) justification of the importance of the problem as found in current studies and practice, (3) deficiency (gap) in present literature about the problem, (4) method (timeframe, participants, location and trend), and (5) the organization, and/or the individuals that will benefit from a better understanding or solution to the problem. By including these aspects the problem statement clearly identifies the purpose of the proposed research project you will propose. It also serves as the basis for the introductory section of your proposal, which directs the reader's attention quickly to the issues to be addressed and provides the reader with a concise statement of the proposed project itself (Pardede, 2018).

UNIT: - 6

PREPARATION OF SURVEY QUESTIONNAIRE AND SCHEDULE

INTRODUCTION

A questionnaire can be a useful tool for gathering information. It can be used for survey research, gathering data or testing a hypothesis. For a questionnaire to be effective and give you the information you are looking for, you will need to design a survey that is easy to understand and easy to complete. A questionnaire is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents. The questionnaire was invented by Sir Francis Galton. A questionnaire refers to a device for securing answers to questions by using a form which the respondent fills in by himself. It consists of a number of questions printed or typed in a definite order. These forms are actually mailed to the respondent who was expected to read and understand the questions and reply to them by writing the relevant answers in the spaces provided. Ideally speaking respondent must answer to a verbal stimulus and give a written or verbal response. It is totally devoid of any table. Its purpose is to collect information from the respondents who are scattered over a vast area. Goode and Hatt have defined questionnaire as a device for securing answers to questions by using a form which the respondent fills himself. According to Barr, Davis and Johnson "A questionnaire is a systematic compilation of questions that are submitted to a sampling of population from which information is desired". In educational researches, the questionnaire consists of a sense of questions or statements to which individuals are asked to respond the questions frequently asked for facts or the opinions, attitudes or preferences of the respondents. Beginners are more commonly tempted to this tool, because they imagine that planning and using a questionnaire is easier than the use of other tools. It is also considered to be the most flexible of tools and possesses a unique advantage over others in collecting both qualitative and quantitative information. Critics speak of it as the lazy man's way of gaining information, because it is comparatively easy to plan and administer a questionnaire. As a matter of fact, preparation of a good questionnaire takes a great deal of time, ingenuity and hard work (Patten, 2016).

QUESTIONNAIRE

Questionnaire is an instrument of data collection. The researchers most commonly use this method for collecting data. In order to gather data on a particular research topic, the researcher lists the questions to which s/he requires answers. The list of questions arranged in some order is given personally, or sent / mailed to the target population. A questionnaire is a set of written questions for respondents to answer. These answers become primary data for investigation. According to Krishan Kumar (1992) "a questionnaire is a written document listing a series of questions pertaining to the problem under study, to which the investigator requires the answers". Schvaneveltd (1985) defined questionnaire as "a data-gathering device that elicits from a respondent the answers or reactions to printed (pre-arranged) questions presented in a specific order." Questionnaires are often used in surveys as the primary data collection instruments.

Types of Questions

What type of Questions should be included in the questionnaire for survey research? There is no unanimity on this issue. Each type has its own advantages and disadvantages. Numen (1997) asserts: “The crucial issue is not which form is best. Rather it is under which conditions a form is most appropriate”. The choice of questions also depends upon the topic of research, the target population, etc. Survey questions can be grouped into two categories i.e. open ended and close-ended questions.

Roberts (2015) classified the questionnaire open ended and closed ended: -

Open Ended Questions

Open-ended questions give liberty to the respondents to express their views. They give tremendous freedom to the respondents to answer according to their interpretation. Given below is an example of an open-ended question.

Advantages of Open Ended Questions

• Unanticipated answers can be obtained from the respondents.

• Researcher can get the real views of the respondents.

• Respondents can give their views in their own language reflecting creativity, self-expression and richness of detail.

• Such answers reveal the logic of the respondents.

Disadvantages of Open Ended Questions

• Responses can be vague, irrelevant or not to the point.

• Many interpretations of the same question may not lead to valuable analysis.

• Coding of the responses is not possible.

• Respondent needs more time to answer.

• More space is required for answers in the questionnaire.

• Respondents may use different terms for the same concept.

Close Ended Questions

Close ended questions are best suited for large-scale surveys. They are easier and quicker for the respondents as well as for the researcher. The Close-ended questions in the questionnaire may sometimes suggest strange results. This problem can be overcome by taking interviews, which can supplement the information on the close ended questions. There is another problem faced by the researcher while formulating different choices for a particular question. If the

choices are less the desired results cannot be achieved. If the choices are too many, it may confuse the participant and appropriate answers cannot be received.

Close-ended questions are provided with a list of accepted answers. A respondent has to pick and choose the right answers. The responses chosen by respondents may be best suited to them but they may not be the correct answers. There is a possibility that the list of alternative answers may not be sufficient for the respondent, hence, limiting his/her options. Given below is an example of a close-ended question.

Advantages of Close Ended Questions

• Cost effective.

• Answers of the respondents can be compared.

• Easy for respondents to answer. Questionnaire Method

• Easy to code and tabulate.

• Performance of the respondents is more reliable.

• Researcher can also reliably interpret the answers.

• Sensitive questions can be properly answered.

• Less number of confused answers.

• Less knowledgeable persons can also answer.

Disadvantages of Close Ended Questions

• Ideas of the researchers are imposed on the respondents.

• Less knowledgeable can also answer due to the availability of multiple choices.

• It is possible that respondents get frustrated by not getting the desirous options of their choice.

• Multiple choices from the researcher may be confusing for the respondents.

QUALITIES OF A GOOD QUESTIONNAIRE

Of course it is expected that the questionnaires should be printed on good papers and that the quality of printing should be good and also that printing errors should be avoided, but every question cannot be called a good question. That is the reason that structuring of questionnaire is considered a technique and that only few skillful persons can structure good questions. Of a good questionnaire it is expected that (Kabir, 2016)–

- Language of the question should be concise. It should be directed towards producing uniformity of understanding among the respondents. It is always essential that care should be taken to see that respondents should not interpret the language in different manner.

- Language should be clear and straightforward and long involved sentences which require extended concentration should be avoided.
- Such phrases and expressions which are understood by only few persons and are not in common use should be avoided.
- If the questionnaire is being mailed to a group of persons who are not experts in terminology then technical words and jargons should be avoided, otherwise the mortality rate will be high, because the informants will not understand the meaning of the terms.
- Questions and statements of leading character-ones that put replies into the mouth of the respondent should be guarded against. The wording of the questions should not make it easier to say yes or no or vice-versa.
- Units of questions should be precisely stated or defined in order to ensure proper orientation of respondent.
- When the information sought relates to definite time period, such as fiscal or calendar year, the specific period should be stated in the questionnaire. Phrases such as this year or last year will not do.
- Subjective words such as 'bad', 'good', 'fair' and the like do not lend themselves either to quantitative or qualitative and as such should be avoided.
- Questions themselves should be precise and long questions should be avoided.
- No single question should deal with more than one issue and as such the principle of one question, one issue should be followed.
- Vocabulary employed in the questions should be appropriate to the background of the
- respondents i.e., technical language should be used when the respondents have technical background.
- Sequence of questions should be such that it will make sense to the respondents. The questions should be so sequenced that the respondent is motivated and answers all questions.
- Non-sensitive and easily answerable questions should be kept in the beginning whereas difficult and sensitive questions should be kept at the bottom.
- Questions should be so worded that ego of the respondents is not injured in any way.
- All the questions should be analytical i.e., these should specifically deal with that aspect of the problem about which study is being made.
- Amount of writing required on the questionnaire should be kept to the minimum.
- It is always better to add few questions that will serve as checks on the accuracy and consistency of the answers being given.
- As far as possible such questions which call for responses towards socially accepted norms and values should be avoided.
- Complex questions that require the respondent to go through several steps of reasoning before answering are undesirable and as such should be avoided.
- Questions on controversial issues should be broken down into components, so that the tester can determine the respondent's feelings about many aspects of the problem, including those whom s/he refuses to comment upon. A series of specific questions is

needed, sometimes as filtered questions in order to gather adequately the reactions to all sides of the issue.

- When questions aim at seeking degree of intensity or feeling, it is better to find out the extent to which the respondent's attitudes have been crystallized towards the subject.
- Only such questions should be asked about which it is believed that the people have sufficient information. If questions on such subjects are asked about which respondent no information has these should not be asked.
- While deciding about the length of the questions and statements, respondent's comprehension should be taken into account. If the question is too long it should be split up in the best possible manner.

SCHEDULE

The scheduling method is one more important method for the study of social problems. This method is in many respects close to the questionnaire method but the major difference between the two is that where as in the questionnaire method there is none to assist the respondent in filling in the questionnaires. In this method, there is an investigator who assists the informants and gives them necessary clarifications as and when required. Two methods, in many respects, are different in so far as the collection of data is concerned. A schedule is a tool or device for obtaining answers to a set of questions from the respondents or informants. The researcher or the interviewer generally fills it in himself, who sits with the informant face to face, and fills up the information supplied by him on the prescribed schedule. Both questionnaires and schedules are very similar, but they also differ in some respects. A questionnaire is sent to the respondents by mail, whereas a schedule is used directly in interviews (Connell & Farrington1996).

Types of Interview Schedule

There are various types of interview schedule.

1. **Observation Schedule.** This is a type of schedule having questions which guide an observer systematically.
2. **Rating Schedule.** It is also a set of questions helps to guide a psychologist or sociologist to measure the attitude and behavior of an individual.
3. **Survey Schedule.** This type of schedule is formulated for a surveyor to guide him for his information's collection.
4. **Interview Schedule.** It is a set of questions with structured answers to guide an interviewer.

Advantages of Interview Schedule

1. It leads to more responses.
2. Accurate information's can be collected.
3. It is free from biasness.
4. Personal contact b/w the investigator and respondent.
5. More difficult situation can be studied.
6. It is used for educated as well as uneducated respondents.

Disadvantages of Interview Schedule

1. It is more expensive and costly.
2. It is more time consuming.
3. It required skilled and experienced investigators.
4. Wide-range coverage is not possible.
5. It case of more interviewers, less uniformity found.

Similarities between Questionnaire and Schedule

The major similarities between Questionnaire and Schedule are (Kumar, 2011):

- Both are set of related items having questions relating to a central problem.
- Both use mainly structured questions and these questions are so phased and interlocked that they have a built-in mechanism for testing the reliability and validity of the response.
- In both the same set of questions is administered to all the respondents and comparable results are obtained.
- Both these instruments have to be used with the same general principles of designs and have to take into account the same problems and basic difficulties they have to be limited in lend.
- In both, the central problem has to be concentrated upon the following considerations involved in the problem of evolving the questionnaire and a schedule as a unit.
    - Drawing the responding into a situation through awake and interest.
    - Proceeding from simple to complex questions.
    - No early and sudden request for information of a personal and embracing intimate nature.
    - Not asking embarrassing questions without giving the respondent an opportunity to explain himself.
    - Moving smoothly from one item to another.
- In both certain types of questions have to be eliminated such as vague and ambiguous questions, emotionally changed questions, loaded and leading questions, questions eliciting no response and questions having a structured response to the queries, violence to the existing facts.
- In both pilot studies and pre-tests are necessary for formulating the instrument and for bringing them to the final form. They have to go through the same stages of development.

Difference between Questionnaire and Schedule

The major differences between Questionnaire and Schedule are (Gillham, 2008):

Questionnaire	Schedule
Questionnaire is one of the methods used for data collection. Questionnaire will have many questions, with each question having multiple choices.	Schedule is also one of the methods of data collection. It will have a set of statements, questions and space given to note down the answers.
Questionnaire method of data collection is preferred when the respondents are willing to cooperate. In addition, to deploy this method the respondents need to be literate	The Schedule method of data collection can be utilised irrespective of the respondents literacy. It can be used when the respondents are literate and can be used even when the respondents are illiterate.
The type of technique used in the Questionnaire method is Quantitative.	The type of technique used in the Schedule method is Qualitative.
In the Questionnaire method, grouping is made on the basis of different categories like location, age, gender etc.	In the schedule method of data collection, grouping may exist or may not exist.
Informants receive questionnaires through mails, posts and the answers will be given as per instructions given in the cover letter.	Answers in the Schedule method of data collection are filled by research workers/enumerators.

In the Questionnaire method, there is no scope for direct personal contact with the respondents.	In the Schedule method, there is direct personal contact of the respondents with the enumerators.
The cost incurred in the questionnaire method of data collection is economical in comparison with schedule. The cost is less even if the sample size used is very large. Predominantly the money is spent on preparing questionnaires only.	The cost incurred in the Schedule method of data collection is very expensive since there is cost involved in preparing the schedule, cost incurred on enumerators in addition to the training imparted to them.
The coverage of Questionnaire method is large as the questionnaires can even be sent to respondents who are not easily accessible.	The coverage of this method is relatively small as there are constraints in sending enumerators to larger areas.
In the questionnaire there is a higher possibility of collecting wrong or incomplete information when respondents are unable to have a clear understanding of the given question.	The possibility of receiving inaccurate answers or incomplete answers due to difficulties in understanding the question can be ruled out in this method of data collection as the enumerators will be present and they can resolve any doubts and queries of respondents.
In the Questionnaire method, respondents will get sufficient time to think before answering questions.	The time available for respondents while answering questions is limited in Schedule method when compared to the Questionnaire method.
In Questionnaires, responses are filled by the respondents.	In Schedule method responses are filled by the enumerators themselves.
The response rate of the Questionnaire method is low compared to the Schedule method.	The response rate in the Schedule method of data collection is high.
In the Questionnaire method, the identity of the respondent is not known.	In the Schedule method, the identity of the respondent is known.
The Questionnaire quality determines the success of the questionnaire method of data collection.	The success of Schedule method of data collection is dependent on the efficiency, integrity and honesty of the Schedule method of data collection.

UNIT: -7

FORMULATION OF RESEARCH QUESTIONS AND HYPOTHESIS BUILDING

The definition of a hypothesis

The second important consideration in the formulation of a research problem in quantitative research is the construction of a **hypothesis**. Hypotheses bring clarity, specificity and focus to a research problem, but are not essential for a study. You can conduct a valid investigation without constructing a single formal hypothesis. On the other hand, within the context of a research study, you can construct as many hypotheses as you consider being appropriate. Some believe that one must formulate a hypothesis to undertake an investigation; however, the author does not hold this opinion. Hypotheses primarily arise from a set of 'hunches' that are tested through a study and one can conduct a perfectly valid study without having these hunches or speculations. However, in epidemiological studies, to narrow the field of investigation, it is important to formulate hypotheses. The importance of hypotheses lies in their ability to bring direction, specificity and focus to a research study. They tell a researcher what specific information to collect, and thereby provide greater focus.

RESEARCH QUESTIONS AND HYPOTHESES

Let us imagine you are at the races and you place a bet. You bet on a hunch that a particular horse will win. Only after the race will you know if your hunch was right. To take another example, suppose you have a hunch that there are more smokers than non-smokers in your class. To test your hunch, you ask either all or just some of the class if they are smokers. You can then conclude whether your hunch was right or wrong. Now let us take a slightly different example. Suppose you work in the area of public health. Your clinical impression is that a higher rate of a particular condition prevails among people coming from a specific population subgroup. You want to find out first whether or not your hunch is right, and second what are the probable causes of this condition. There could be many causes. To explore every conceivable possibility would require an enormous amount of time and resources. Hence, to narrow the choice, based on your knowledge of the field, you could identify what you assume to be the most probable cause. You could then design a study to collect the information needed to verify your hunch. If on verification you were able to conclude that there is a prevalence of the assumed condition in the population subgroup and that the assumed cause really is the reason, your assumptions would be proved right. In these examples, you started with a superficial hunch or assumption. In one case (horse racing) you waited for the event to take place, and in the other two instances you designed a study to assess the validity of your assumption, and only after careful investigation did you arrive at a conclusion about the validity of your assumptions. Hypotheses are based upon similar logic. As a researcher you do not know about a phenomenon, a situation, the prevalence of a condition in a population or the outcome of a programme, but you do have a hunch to form the basis of certain assumptions or guesses. You test these by collecting the information that will enable you to conclude whether or not your hunch was right. The verification process can have one of three outcomes. Your hunch may prove to be right, partially right or wrong. Without this process of verification, you cannot

conclude anything about the validity of your assumption. Hence, a hypothesis is a hunch, assumption, suspicion, assertion or an idea about a phenomenon, relationship or situation, the reality or truth of which you do not know. A researcher refers to these assumptions, assertions, statements or hunches as hypotheses, and they become the basis of an enquiry. In most studies the hypothesis will be based upon either previous studies or your own or someone else's observations. There are many definitions of a hypothesis. According to Kerlinger (1986: 17), 'A hypothesis is a conjectural statement of the relationship between two or more variables'. Webster's Third New International Dictionary (1976) defines a hypothesis as:

a proposition, condition, or principle which is assumed, perhaps without belief, in order to draw out its logical consequences and by this method to test its accord with facts which are known or may be determined.

Black and Champion (1976: 126) define a hypothesis as 'a tentative statement about something, the validity of which is usually unknown'. In another definition, Bailey (1978: 35) defines a hypothesis as:

a proposition that is stated in a testable form and that predicts a particular relationship between two (or more) variables. In other words, if we think that a relationship exists, we first state it as a hypothesis and then test the hypothesis in the field.

According to Grinnell (1988: 200):

A hypothesis is written in such a way that it can be proven or disproven by valid and reliable data – it is in order to obtain these data that we perform our study.

From the above definitions it is apparent that a hypothesis has certain characteristics:

1. It is a tentative proposition.

2. Its validity is unknown.

3. In most cases, it specifies a relationship between two or more variables.

The functions of a hypothesis

While some researchers believe that to conduct a study requires a hypothesis, having a hypothesis is not essential, as already mentioned. However, a hypothesis is important in terms of bringing clarity to the research problem. Specifically, a hypothesis serves the following functions:

• The formulation of a hypothesis forces you to precisely specify what you want to find out about, thus bringing specificity and clarity to your study.

• The specificity and clarity needed to construct a hypothesis ensure you only collect the information you need, thereby providing focus to the study. This also enhances the validity of your study as it ensures you are measuring what you set out to measure.

• As it provides a focus, the construction of a hypothesis enhances objectivity in a study.

• The testing of a hypothesis enables you to specifically conclude what is true or what is false, thus enabling you to contribute towards theory formulation.

The testing of a hypothesis

To test a hypothesis you need to go through a process that comprises three phases: (1) constructing the hypothesis; (2) gathering appropriate evidence; and (3) analysing evidence to draw conclusions as to the validity of the hypothesis. Figure 6.1 shows this process diagrammatically. It is only after analysing the evidence that you can conclude whether your hunch or hypothesis was true or false. Conventionally, when drawing your conclusion about a hypothesis, you specifically make a statement about the correctness or otherwise of a hypothesis in the form of 'the hypothesis is true' or 'the hypothesis is false'. It is therefore imperative that you formulate your hypotheses clearly, precisely and in a form that is testable. In arriving at a conclusion about the validity of your hypothesis, the way you collect your evidence is of central importance and it is therefore essential that your study design, sample, data collection method(s), data analysis and conclusions, and communication of the conclusions be valid, appropriate and free from any bias. Testing and drawing conclusions about the validity of a hypothesis become meaningless if the study design, sampling, methods of data collection etc. used in testing the hypothesis are inappropriate. You need to be certain about the appropriateness of the whole research process when testing a hypothesis.

The characteristics of a hypothesis

There are a number of considerations to keep in mind when constructing a hypothesis, as they are important for valid verification. The wording of a hypothesis therefore must have certain attributes that make it easier for you to ascertain its validity. First, a hypothesis should be simple, specific and conceptually clear. There is no place for ambiguity in the construction of a hypothesis, as ambiguity will make the verification of your hypothesis almost impossible. It should be 'unidimensional' – that is, it should test only one relationship or hunch at a time. To be able to develop a good hypothesis you must be familiar with the subject area (the literature review is of immense help). The more insight you have into a problem, the easier it is to construct a hypothesis. For example:

The average age of the male students in this class is higher than that of the female students.

The above hypothesis is clear, specific and easy to test. It tells you what you are attempting to compare (average age of this class), which population groups are being compared (female and male students), and what you want to explore (whether male students have higher average age). Let us take another example:

Suicide rates vary inversely with social cohesion. (Black & Champion 1976: 126)

This hypothesis is clear and specific, but a lot more difficult to test. There are three aspects of this hypothesis: 'suicide rates'; 'vary inversely', which stipulates the direction of the relationship; and 'social cohesion'. To find out the suicide rates and to establish whether the relationship is inverse or otherwise are comparatively easy, but to ascertain social cohesion is a lot more difficult. What determines social cohesion? How can it be measured? This problem makes it more difficult to test this hypothesis. Second, a hypothesis should be capable of verification. Methods and techniques must be available for data collection and analysis. There is no point in formulating a hypothesis if it cannot be subjected to verification because there are no techniques to verify it. However, this does not necessarily mean that you should not formulate a hypothesis for which there are no methods of verification. You might, in the process of doing your research, develop new techniques to verify it. Third, a hypothesis should be related to the existing body of knowledge. It is important that your hypothesis emerges from the existing body of knowledge, and that it adds to it, as this is an important function of research. This can only be achieved if the hypothesis has its roots in the existing body of knowledge. Finally, a hypothesis should be operationalisable. This means that it can be expressed in terms that can be measured. If it cannot be measured, it cannot be tested, and hence no conclusions can be drawn.

Types of hypothesis Theoretically there should be only one type of hypothesis that is the research hypothesis – the basis of your investigation. However, because of the conventions in scientific enquiry and because of the wording used in the construction of a hypothesis, hypotheses can be classified into several types. Broadly, there are two categories of hypothesis:

1. research hypotheses;

2. alternative hypotheses.

The formulation of an **alternative hypothesis** is a convention in scientific circles. Its main function is to explicitly specify the relationship that will be considered as true in case the research hypothesis proves to be wrong. In a way, an alternate hypothesis is the opposite of the research hypothesis. Conventionally, a null hypothesis, or hypothesis of no difference, is formulated as an alternate hypothesis. Let us take an example. Suppose you want to test the effect that different combinations of maternal and child health services (MCH) and nutritional supplements (NS) have on the infant mortality rate. To test this, you adopt a two-by-two factorial experimental design. Within the framework of this study you can formulate a hypothesis in several ways. For example:

1. There will be no difference in the level of infant mortality among the different treatment modalities (Null hypothesis usually written as H0).

2. The MCH and NS treatment groups will register a greater decline in infant mortality than the MCHonly treatment group, the NS-only treatment group or the control group.

3. Infant mortality in the MCH treatment group will reach a level of 30 per 1000 over 5 years.

4. Decline in the infant mortality rate will be three times greater in the MCH treatment group than in the NS group only over 5 years.

Let us take another example. Suppose you want to study the smoking pattern in a community in relation to gender differentials. The following hypotheses could be constructed:

1. There is no significant difference in the proportion of male and female smokers in the study population.

2. A greater proportion of females than males are smokers in the study population.

3. A total of 60 per cent of females and 30 per cent of males in the study population are smokers.

4. There are twice as many female smokers as male smokers in the study population.

In both sets of examples, the way the first hypothesis has been formulated indicates that there is no difference either in the extent of the impact of different treatment modalities on the infant mortality rate or in the proportion of male and female smokers. When you construct a hypothesis stipulating that there is no difference between two situations, groups, outcomes, or the prevalence of a condition or phenomenon, this is called a **null hypothesis** and is usually written as H0.

NULL HYPOTHESIS The second hypothesis in each example implies that there is a difference either in the extent of the impact of different treatment modalities on infant mortality or in the proportion of male and female smokers among the population, though the extent of the difference is not specified. A hypothesis in which a researcher stipulates that there will be a difference but does not specify its magnitude is called a **hypothesis of difference**.

A researcher may have enough knowledge about the smoking behaviour of the community or the treatment programme and its likely outcomes to speculate about the exact prevalence of the situation or the outcome of a treatment programme in quantitative units. Examine the third hypothesis in both sets of examples: the level of infant mortality is 30 per 1000 and the proportion of female and male smokers is 60 and 30 per cent, respectively. This type of hypothesis is known as a **hypothesis of point prevalence**.

The fourth hypothesis in both sets of examples posits a relationship between the impact of different combinations of MCH and NS programmes on the dependent variable (infant mortality) or the relationship between the prevalence of a phenomenon (smoking) among different populations (male and female).This type of hypothesis stipulates the extent of the relationship in terms of the effect of different treatment groups on the dependent variable (‘three times greater in the MCH treatment group than in the NS group over 5 years’) or the prevalence of a phenomenon in different population groups (‘twice as many female as male smokers’). This type of hypothesis is called a **hypothesis of association**.

Errors in testing a hypothesis

As already mentioned, a hypothesis is an assumption that may prove to be either correct or incorrect. It is possible to arrive at an incorrect conclusion about a hypothesis for a variety of reasons. Incorrect conclusions about the validity of a hypothesis may be drawn if:

• The study design selected is faulty;

• The sampling procedure adopted is faulty;

• The method of data collection is inaccurate;

• The analysis is wrong;

• The statistical procedures applied are inappropriate; or

• The conclusions drawn are incorrect.

Any, some or all of these aspects of the research process could be responsible for the inadvertent introduction of error in your study, making conclusions misleading. Hence, in the testing of a hypothesis there is always the possibility of errors attributable to the reasons identified above. Figure 6.4 shows the types of error that can result in the testing of a hypothesis. Hence, in drawing conclusions about a hypothesis, two types of error can occur:

• Rejection of a null hypothesis when it is true. This is known as a Type I error.

• Acceptance of a null hypothesis when it is false. This is known as a Type II error.

Hypotheses in qualitative research

One of the differences between qualitative and quantitative research is around the importance attached to and the extent of use of hypotheses when undertaking a study. As qualitative studies are characterised by an emphasis on describing, understanding and exploring phenomena using categorical and subjective measurement procedures, construction of hypotheses is neither greatly advocated nor significantly practised. In addition, as the degree of specificity needed to test a hypothesis is deliberately not adhered to in qualitative research, the testing of a hypothesis becomes difficult. This does not mean that you cannot construct hypotheses in qualitative research; however non-specificity of the problem as well as methods and procedures make the convention of hypothesis formulation far less practicable and advisable. Even within quantitative studies the importance attached to and the practice of formulating hypotheses vary markedly from one academic discipline to another. For example, hypotheses are most prevalent in epidemiological research and research relating to the establishment of causality of a phenomenon, where it becomes important to narrow the list of probable causes so that a specific cause-and-effect relationship can be studied. In the social sciences formulation of hypotheses is mostly dependent on the researcher and the academic discipline, whereas within an academic discipline it varies markedly between the quantitative and qualitative research paradigms.

Summary Hypotheses, though important, are not essential for a study. A perfectly valid study can be conducted without constructing a single hypothesis. Hypotheses are important for bringing clarity, specificity and focus to a research study.

A hypothesis is a speculative statement that is subjected to verification through a research study. In formulating a hypothesis it is important to ensure that it is simple, specific and conceptually clear; can be verified; is rooted in an existing body of knowledge; and can be operationalised.

There are two broad categories of hypothesis: a research hypothesis and an alternative hypothesis. A research hypothesis can be further classified, based upon the way it is formulated, as a null hypothesis, a hypothesis of difference, a hypothesis of point-prevalence and a hypothesis of association.

One of the main differences in qualitative and quantitative research is the extent to which hypotheses are used and the importance attached to them. In qualitative research, because of the purpose of an investigation and methods used to obtain information, hypotheses are not used and almost no importance is given to them. However, in quantitative research, their use is far more prevalent though it varies markedly from one academic discipline to another and from researcher to researcher. On the whole it can be said that if the aim of a study is to explore where very little is known, hypotheses are usually not formulated; however, if a study aims to test an assertion by way of causality or association, validate the prevalence of something or establish its existence, hypotheses can be constructed.

The testing of a hypothesis becomes meaningless if any one of the aspects of your study – design, sampling procedure, method of data collection, analysis of data, statistical procedures applied or conclusions drawn – is faulty or inappropriate. This can result in erroneous verification of a hypothesis: Type I error occurs where you reject a null hypothesis when it is true and should not have been rejected; and Type II error is introduced where you accept a null hypothesis when it is false and should not have been accepted (Kumar, 2014).

References:

Kumar, R. (2014). *Research Methodology: A Step by Step Guide for Beginners.* New Delhi: SAGE.

UNIT: - 8

METHODS OF SAMPLING; SAMPLE SIZE AND SAMPLE DESIGN

CENSUS AND SAMPLE SURVEY

All items in any field of inquiry constitute a 'Universe' or 'Population.' A complete enumeration of all items in the 'population' is known as a census inquiry. It can be presumed that in such an inquiry, when all items are covered, no element of chance is left and highest accuracy is obtained. But in practice this may not be true. Even the slightest element of bias in such an inquiry will get larger and larger as the number of observation increases. Moreover, there is no way of checking the element of bias or its extent except through a resurvey or use of sample checks. Besides, this type of inquiry involves a great deal of time, money and energy. Therefore, when the field of inquiry is large, this method becomes difficult to adopt because of the resources involved. At times, this method is practically beyond the reach of ordinary researchers. Perhaps, government is the only institution which can get the complete enumeration carried out. Even the government adopts this in very rare cases such as population census conducted once in a decade. Further, many a time it is not possible to examine every item in the population, and sometimes it is possible to obtain sufficiently accurate results by studying only a part of total population. In such cases there is no utility of census surveys. However, it needs to be emphasised that when the universe is a small one, it is no use resorting to a sample survey. When field studies are undertaken in practical life, considerations of time and cost almost invariably lead to a selection of respondents i.e., selection of only a few items. The respondents selected should be as representative of the total population as possible in order to produce a miniature cross-section. The selected respondents constitute what is technically called a 'sample' and the selection process is called 'sampling technique.' The survey so conducted is known as 'sample survey'. Algebraically, let the population size be N and if a part of size n (which is $< N$) of this population is selected according to some rule for studying some characteristic of the population, the group consisting of these n units is known as 'sample'. Researcher must prepare a sample design for his study i.e., he must plan how a sample should be selected and of what size such a sample would be.

IMPLICATIONS OF A SAMPLE DESIGN

A sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting items for the sample. Sample design may as well lay down the number of items to be included in the sample i.e., the size of the sample. Sample design is determined before data are collected. There are many sample designs from which a researcher can choose. Some designs are relatively more precise and easier to apply than others. Researcher must select/prepare a sample design which should be reliable and appropriate for his research study.

STEPS IN SAMPLE DESIGN

While developing a sampling design, the researcher must pay attention to the following points:

(i) **Type of universe:** The first step in developing any sample design is to clearly define the set of objects, technically called the Universe, to be studied. The universe can be finite or infinite. In finite universe the number of items is certain, but in case of an infinite universe the number of items is infinite, i.e., we cannot have any idea about the total number of items. The population of a city, the number of workers in a factory and the like are examples of finite universes, whereas the number of stars in the sky, listeners of a specific radio programme, throwing of a dice etc. are examples of infinite universes.

(ii) **Sampling unit:** A decision has to be taken concerning a sampling unit before selecting sample. Sampling unit may be a geographical one such as state, district, village, etc., or a construction unit such as house, flat, etc., or it may be a social unit such as family, club, school, etc., or it may be an individual. The researcher will have to decide one or more of such units that he has to select for his study.

(iii) **Source list:** It is also known as 'sampling frame' from which sample is to be drawn. It contains the names of all items of a universe (in case of finite universe only). If source list is not available, researcher has to prepare it. Such a list should be comprehensive, correct, reliable and appropriate. It is extremely important for the source list to be as representative of the population as possible.

(iv) **Size of sample:** This refers to the number of items to be selected from the universe to constitute a sample. The size of sample should neither be excessively large, nor too small. It should be optimum. An optimum sample is one which fulfils the requirements of efficiency, representativeness, reliability and flexibility. While deciding the size of sample, researcher must determine the desired precision as also an acceptable confidence level for the estimate. The size of population variance needs to be considered as in case of larger variance usually a bigger sample is needed. The size of population must be kept in view for this also limits the sample size. The parameters of interest in a research study must be kept in view, while deciding the size of the sample. Costs too dictate the size of sample that we can draw. As such, budgetary constraint must invariably be taken into consideration when we decide the sample size.

(v) **Parameters of interest:** In determining the sample design, one must consider the question of the specific population parameters which are of interest. For instance, we may be interested in estimating the proportion of persons with some characteristic in the population, or we may be interested in knowing some average or the other measure concerning the population. There may also be important sub-groups in the population about whom we would like to make estimates. All this has a strong impact upon the sample design we would accept.

(vi) **Budgetary constraint:** Cost considerations, from practical point of view, have a major impact upon decisions relating to not only the size of the sample but also to the type of sample. This fact can even lead to the use of a non-probability sample.

(vii) **Sampling procedure:** Finally, the researcher must decide the type of sample he will use i.e., he must decide about the technique to be used in selecting the items for the sample. In fact, this technique or procedure stands for the sample design itself. There are several sample designs

(explained in the pages that follow) out of which the researcher must choose one for his study. Obviously, he must select that design which, for a given sample size and for a given cost, has a smaller sampling error.

CRITERIA OF SELECTING A SAMPLING PROCEDURE

In this context one must remember that two costs are involved in a sampling analysis viz., the cost of collecting the data and the cost of an incorrect inference resulting from the data. Researcher must keep in view the two causes of incorrect inferences viz., systematic bias and sampling error. A *systematic bias* results from errors in the sampling procedures, and it cannot be reduced or eliminated by increasing the sample size. At best the causes responsible for these errors can be detected and corrected. Usually a systematic bias is the result of one or more of the following factors:

1. Inappropriate sampling frame: If the sampling frame is inappropriate i.e., a biased representation of the universe, it will result in a systematic bias.

2. Defective measuring device: If the measuring device is constantly in error, it will result in systematic bias. In survey work, systematic bias can result if the questionnaire or the interviewer is biased. Similarly, if the physical measuring device is defective there will be systematic bias in the data collected through such a measuring device.

3. Non-respondents: If we are unable to sample all the individuals initially included in the sample, there may arise a systematic bias. The reason is that in such a situation the likelihood of establishing contact or receiving a response from an individual is often correlated with the measure of what is to be estimated.

4. Indeterminacy principle: Sometimes we find that individuals act differently when kept under observation than what they do when kept in non-observed situations. For instance, if workers are aware that somebody is observing them in course of a work study on the basis of which the average length of time to complete a task will be determined and accordingly the quota will be set for piece work, they generally tend to work slowly in comparison to the speed with which they work if kept unobserved. Thus, the indeterminacy principle may also be a cause of a systematic bias.

5. Natural bias in the reporting of data: Natural bias of respondents in the reporting of data is often the cause of a systematic bias in many inquiries. There is usually a downward bias in the income data collected by government taxation department, whereas we find an upward bias in the income data collected by some social organisation. People in general understate their incomes if asked about it for tax purposes, but they overstate the same if asked for social status or their affluence. Generally in psychological surveys, people tend to give what they think is the 'correct' answer rather than revealing their true feelings. *Sampling errors* are the random variations in the sample estimates around the true population parameters. Since they occur randomly and are equally likely to be in either direction, their nature happens to be of compensatory type and the expected value of such errors happens to be equal to zero. Sampling

error decreases with the increase in the size of the sample, and it happens to be of a smaller magnitude in case of homogeneous population. *Sampling error* can be measured for a given sample design and size. The measurement of sampling error is usually called the 'precision of the sampling plan'. If we increase the sample size, the precision can be improved. But increasing the size of the sample has its own limitations viz., a large sized sample increases the cost of collecting data and also enhances the systematic bias. Thus the effective way to increase precision is usually to select a better sampling design which has a smaller sampling error for a given sample size at a given cost. In practice, however, people prefer a less precise design because it is easier to adopt the same and also because of the fact that systematic bias can be controlled in a better way in such a design. In brief, *while selecting a sampling procedure, researcher must ensure that the procedure causes a relatively small sampling error and helps to control the systematic bias in a better way*.

CHARACTERISTICS OF A GOOD SAMPLE DESIGN

From what has been stated above, we can list down the characteristics of a good sample design as under: (a) Sample design must result in a truly representative sample. (b) Sample design must be such which results in a small sampling error. (c) Sample design must be viable in the context of funds available for the research study. (d) Sample design must be such so that systematic bias can be controlled in a better way. (e) Sample should be such that the results of the sample study can be applied, in general, for the universe with a reasonable level of confidence.

DIFFERENT TYPES OF SAMPLE DESIGNS

There are different types of sample designs based on two factors viz., the representation basis and the element selection technique. On the representation basis, the sample may be probability sampling or it may be non-probability sampling. Probability sampling is based on the concept of random selection, whereas non-probability sampling is 'non-random' sampling. On element selection basis, the sample may be either unrestricted or restricted. When each sample element is drawn individually from the population at large, then the sample so drawn is known as 'unrestricted sample', whereas all other forms of sampling are covered under the term 'restricted sampling'. The following chart exhibits the sample designs as explained above. Thus, sample designs are basically of two types viz., non-probability sampling and probability sampling. We take up these two designs separately.

Non-probability sampling: Non-probability sampling is that sampling procedure which does not afford any basis for estimating the probability that each item in the population has of being included in the sample. Non-probability sampling is also known by different names such as deliberate sampling, purposive sampling and judgement sampling. In this type of sampling, items for the sample are selected deliberately by the researcher; his choice concerning the items remains supreme. In other words, under non-probability sampling the organisers of the inquiry purposively choose the particular units of the universe for constituting a sample on the basis that the small mass that they so select out of a huge one will be typical or representative of the whole. For instance, if economic conditions of people living in a state are to be studied, a few towns and villages may be purposively selected for intensive study on the principle that they can be representative of the entire state. Thus, the judgement of the organisers of the study plays an important part in this sampling design. In such a design, personal element has a great chance of entering into the selection of the sample. The investigator may select a sample which shall yield results favourable to his point of view and if that happens, the entire inquiry may get vitiated. Thus, there is always the danger of bias entering into this type of sampling technique. But in the investigators are impartial, work without bias and have the necessary experience so as to take sound judgement, the results obtained from an analysis of deliberately selected sample may be tolerably reliable. However, in such a sampling, there is no assurance that every element has some specifiable chance of being included. Sampling error in this type of sampling cannot be estimated and the element of bias, great or small, is always there. As such this sampling design in rarely adopted in large inquires of importance. However, in small inquiries and researches by individuals, this design may be adopted because of the relative advantage of time and money inherent in this method of sampling. *Quota sampling* is also an example of non-probability sampling. Under quota sampling the interviewers are simply given quotas to be filled from the different strata, with some restrictions on how they are to be filled. In other words, the actual selection of the items for the sample is left to the interviewer's discretion. This type of sampling is very convenient and is relatively inexpensive. But the samples so selected certainly do not possess the characteristic of random samples. Quota samples are essentially judgement samples and inferences drawn on their basis are not amenable to statistical treatment in a formal way.

Probability sampling: Probability sampling is also known as 'random sampling' or 'chance sampling'. Under this sampling design, every item of the universe has an equal chance of inclusion in the sample. It is, so to say, a lottery method in which individual units are picked up from the whole group not deliberately but by some mechanical process. Here it is blind chance alone that determines whether one item or the other is selected. The results obtained from probability or random sampling can be assured in terms of probability i.e., we can measure the errors of estimation or the significance of results obtained from a random sample, and this fact brings out the superiority of random sampling design over the deliberate sampling design. Random sampling ensures the law of Statistical Regularity which states that if on an average the sample chosen is a random one, the sample will have the same composition and characteristics as the universe. This is the reason why random sampling is considered as the best technique of selecting a representative sample. Random sampling from a finite population refers to that method of sample selection which gives each possible sample combination an

equal probability of being picked up and each item in the entire population to have an equal chance of being included in the sample. This applies to sampling without replacement i.e., once an item is selected for the sample, it cannot appear in the sample again (Sampling with replacement is used less frequently in which procedure the element selected for the sample is returned to the population before the next element is selected. In such a situation the same element could appear twice in the same sample before the second element is chosen). In brief, the implications of random sampling (or simple random sampling) are: (a) It gives each element in the population an equal probability of getting into the sample; and all choices are independent of one another. (b) It gives each possible sample combination an equal probability of being chosen. Keeping this in view we can define a simple random sample (or simply a random sample) from a finite population as a sample which is chosen in such a way that each of the *NCn* possible samples has the same probability, 1/*NCn*, of being selected. To make it more clear we take a certain finite population consisting of six elements (say *a, b, c, d, e, f*) i.e., $N = 6$. Suppose that we want to take a sample of size $n = 3$ from it. Then there are $6C3 = 20$ possible distinct samples of the required size, and they consist of the elements *abc, abd, abe, abf, acd, ace, acf, ade, adf, aef, bcd, bce, bcf, bde, bdf, bef, cde, cdf, cef,* and *def*. If we choose one of these samples in such a way that each has the probability 1/20 of being chosen, we will then call this a random sample.

HOW TO SELECT A RANDOM SAMPLE?

With regard to the question of how to take a random sample in actual practice, we could, in simple cases like the one above, write each of the possible samples on a slip of paper, mix these slips thoroughly in a container and then draw as a lottery either blindfolded or by rotating a drum or by any other similar device. Such a procedure is obviously impractical, if not altogether impossible in complex problems of sampling. In fact, the practical utility of such a method is very much limited. Fortunately, we can take a random sample in a relatively easier way without taking the trouble of enlisting all possible samples on paper-slips as explained above. Instead of this, we can write the name of each element of a finite population on a slip of paper, put the slips of paper so prepared into a box or a bag and mix them thoroughly and then draw (without looking) the required number of slips for the sample one after the other without replacement. In doing so we must make sure that in successive drawings each of the remaining elements of the population has the same chance of being selected. This procedure will also result in the same probability for each possible sample. We can verify this by taking the above example. Since we have a finite population of 6 elements and we want to select a sample of size 3, the probability of drawing any one element for our sample in the first draw is 3/6, the probability of drawing one more element in the second draw is 2/5, (the first element drawn is not replaced) and similarly the probability of drawing one more element in the third draw is 1/4. Since these draws are independent, the joint probability of the three elements which constitute our sample is the product of their individual probabilities and this works out to $3/6 \times 2/5 \times 1/4 = 1/20$. This verifies our earlier calculation. Even this relatively easy method of obtaining a random sample can be simplified in actual practice by the use of random number tables. Various statisticians like Tippett, Yates, Fisher have prepared tables of random numbers which can be used for selecting a random sample. Generally, Tippett's random number tables are used for the

purpose. Tippett gave10400 four figure numbers. He selected 41600 digits from the census reports and combined them into fours to give his random numbers which may be used to obtain a random sample. We can illustrate the procedure by an example. First of all we reproduce the first thirty sets of Tippett's numbers 2952 6641 3992 9792 7979 5911 3170 5624 4167 9525 1545 1396 7203 5356 1300 2693 2370 7483 3408 2769 3563 6107 6913 7691 0560 5246 1112 9025 6008 8126 Suppose we are interested in taking a sample of 10 units from a population of 5000 units, bearing numbers from 3001 to 8000. We shall select 10 such figures from the above random numbers which are not less than 3001 and not greater than 8000. If we randomly decide to read the table numbers from left to right, starting from the first row itself, we obtain the following numbers: 6641, 3992, 7979, 5911, 3170, 5624, 4167, 7203, 5356, and 7483. The units bearing the above serial numbers would then constitute our required random sample. One may note that it is easy to draw random samples from finite populations with the aid of random number tables only when lists are available and items are readily numbered. But in some situations it is often impossible to proceed in the way we have narrated above. For example, if we want to estimate the mean height of trees in a forest, it would not be possible to number the trees, and choose random numbers to select a random sample. In such situations what we should do is to select some trees for the sample haphazardly without aim or purpose, and should treat the sample as a random sample for study purposes.

RANDOM SAMPLE FROM AN INFINITE UNIVERSE

So far we have talked about random sampling, keeping in view only the finite populations. But what about random sampling in context of infinite populations? It is relatively difficult to explain the concept of random sample from an infinite population. However, a few examples will show the basic characteristic of such a sample. Suppose we consider the 20 throws of a fair dice as a sample from the hypothetically infinite population which consists of the results of all possible throws of the dice. If the probability of getting a particular number, say 1, is the same for each throw and the 20 throws are all independent, then we say that the sample is random. Similarly, it would be said to be sampling from an infinite population if we sample with replacement from a finite population and our sample would be considered as a random sample if in each draw all elements of the population have the same probability of being selected and successive draws happen to be independent. In brief, one can say that the selection of each item in a random sample from an infinite population is controlled by the same probabilities and that successive selections are independent of one another.

COMPLEX RANDOM SAMPLING DESIGNS

Probability sampling under restricted sampling techniques, as stated above, may result in complex random sampling designs. Such designs may as well be called 'mixed sampling designs' for many of such designs may represent a combination of probability and non-probability sampling procedures in selecting a sample. Some of the popular complex random sampling designs are as follows:

(i) Systematic sampling: In some instances, the most practical way of sampling is to select every *i*th item on a list. Sampling of this type is known as systematic sampling. An element of

randomness is introduced into this kind of sampling by using random numbers to pick up the unit with which to start. For instance, if a 4 per cent sample is desired, the first item would be selected randomly from the first twenty-five and thereafter every 25th item would automatically be included in the sample. Thus, in systematic sampling only the first unit is selected randomly and the remaining units of the sample are selected at fixed intervals. Although a systematic sample is not a random sample in the strict sense of the term, but it is often considered reasonable to treat systematic sample as if it were a random sample. Systematic sampling has certain plus points. It can be taken as an improvement over a simple random sample in as much as the systematic sample is spread more evenly over the entire population. It is an easier and less costlier method of sampling and can be conveniently used even in case of large populations. But there are certain dangers too in using this type of sampling. If there is a hidden periodicity in the population, systematic sampling will prove to be an inefficient method of sampling. For instance, every 25th item produced by a certain production process is defective. If we are to select a 4% sample of the items of this process in a systematic manner, we would either get all defective items or all good items in our sample depending upon the random starting position. If all elements of the universe are ordered in a manner representative of the total population, i.e., the population list is in random order, systematic sampling is considered equivalent to random sampling. But if this is not so, then the results of such sampling may, at times, not be very reliable. In practice, systematic sampling is used when lists of population are available and they are of considerable length.

(ii) Stratified sampling: If a population from which a sample is to be drawn does not constitute a homogeneous group, stratified sampling technique is generally applied in order to obtain a representative sample. Under stratified sampling the population is divided into several sub-populations that are individually more homogeneous than the total population (the different sub-populations are called 'strata') and then we select items from each stratum to constitute a sample. Since each stratum is more homogeneous than the total population, we are able to get more precise estimates for each stratum and by estimating more accurately each of the component parts, we get a better estimate of the whole. In brief, stratified sampling results in more reliable and detailed information. The following three questions are highly relevant in the context of stratified sampling: (a) How to form strata? (b) How should items be selected from each stratum? (c) How many items be selected from each stratum or how to allocate the sample size of each stratum? Regarding the first question, we can say that the strata be formed on the basis of common characteristic(s) of the items to be put in each stratum. This means that various strata be formed in such a way as to ensure elements being most homogeneous within each stratum and most heterogeneous between the different strata. Thus, strata are purposively formed and are usually based on past experience and personal judgement of the researcher. One should always remember that careful consideration of the relationship between the characteristics of the population and the characteristics to be estimated are normally used to define the strata. At times, pilot study may be conducted for determining a more appropriate and efficient stratification plan. We can do so by taking small samples of equal size from each of the proposed strata and then examining the variances within and among the possible stratifications, we can decide an appropriate stratification plan for our inquiry. In respect of the second question, we can say that the usual method, for selection of items for the sample from

each stratum, resorted to is that of simple random sampling. Systematic sampling can be used if it is considered more appropriate in certain situations. Regarding the third question, we usually follow the method of proportional allocation under which the sizes of the samples from the different strata are kept proportional to the sizes of the strata. That is, if *Pi* represents the proportion of population included in stratum *i*, and *n* represents the total sample size, the number of elements selected from stratum *i* is *n* . *Pi*. To illustrate it, let us suppose that we want a sample of size $n = 30$ to be drawn from a population of size $N = 8000$ which is divided into three strata of size $N1 = 4000$, $N2 = 2400$ and $N3 = 1600$. Adopting proportional allocation, we shall get the sample sizes as under for the different strata: For strata with $N1 = 4000$, we have $P1 = 4000/8000$ and hence $n1 = n \cdot P1 = 30\ (4000/8000) = 15$ Similarly, for strata with $N2 = 2400$, we have $n2 = n \cdot P2 = 30\ (2400/8000) = 9$, and for strata with $N3 = 1600$, we have $n3 = n \cdot P3 = 30\ (1600/8000) = 6$. Thus, using proportional allocation, the sample sizes for different strata are 15, 9 and 6 respectively which is in proportion to the sizes of the strata viz., 4000 : 2400 : 1600. Proportional allocation is considered most efficient and an optimal design when the cost of selecting an item is equal for each stratum, there is no difference in within-stratum variances, and the purpose of sampling happens to be to estimate the population value of some characteristic. But in case the purpose happens to be to compare the differences among the strata, then equal sample selection from each stratum would be more efficient even if the strata differ in sizes. In cases where strata differ not only in size but also in variability and it is considered reasonable to take larger samples from the more variable strata and smaller samples from the less variable strata, we can then account for both (differences in stratum size and differences in stratum variability) by using disproportionate sampling design by requiring:

(iii) Cluster sampling: If the total area of interest happens to be a big one, a convenient way in which a sample can be taken is to divide the area into a number of smaller non-overlapping areas and then to randomly select a number of these smaller areas (usually called clusters), with the ultimate sample consisting of all (or samples of) units in these small areas or clusters. Thus in cluster sampling the total population is divided into a number of relatively small subdivisions which are themselves clusters of still smaller units and then some of these clusters are randomly selected for inclusion in the overall sample. Suppose we want to estimate the proportion of machine parts in an inventory which are defective. Also assume that there are 20000 machine parts in the inventory at a given point of time, stored in 400 cases of 50 each. Now using a cluster sampling, we would consider the 400 cases as clusters and randomly select '*n*' cases and examine all the machine parts in each randomly selected case. Cluster sampling, no doubt, reduces cost by concentrating surveys in selected clusters. But certainly it is less precise than random sampling. There is also not as much information in '*n*' observations within a cluster as there happens to be in '*n*' randomly drawn observations. Cluster sampling is used only because of the economic advantage it possesses; estimates based on cluster samples are usually more reliable per unit cost.

(iv) Area sampling: If clusters happen to be some geographic subdivisions, in that case cluster sampling is better known as area sampling. In other words, cluster designs, where the primary sampling unit represents a cluster of units based on geographic area, are distinguished as area sampling. The plus and minus points of cluster sampling are also applicable to area sampling.

(v) Multi-stage sampling: Multi-stage sampling is a further development of the principle of cluster sampling. Suppose we want to investigate the working efficiency of nationalised banks in India and we want to take a sample of few banks for this purpose. The first stage is to select large primary sampling unit such as states in a country. Then we may select certain districts and interview all banks in the chosen districts. This would represent a two-stage sampling design with the ultimate sampling units being clusters of districts. If instead of taking a census of all banks within the selected districts, we select certain towns and interview all banks in the chosen towns. This would represent a three-stage sampling design. If instead of taking a census of all banks within the selected towns, we randomly sample banks from each selected town, then it is a case of using a four-stage sampling plan. If we select randomly at all stages, we will have what is known as 'multi-stage random sampling design'. Ordinarily multi-stage sampling is applied in big inquires extending to a considerable large geographical area, say, the entire country. There are two advantages of this sampling design viz., (a) It is easier to administer than most single stage designs mainly because of the fact that sampling frame under multi-stage sampling is developed in partial units. (b) A large number of units can be sampled for a given cost under multistage sampling because of sequential clustering, whereas this is not possible in most of the simple designs.

(vi) Sampling with probability proportional to size: In case the cluster sampling units do not have the same number or approximately the same number of elements, it is considered appropriate to use a random selection process where the probability of each cluster being included in the sample is proportional to the size of the cluster. For this purpose, we have to list the number of elements in each cluster irrespective of the method of ordering the cluster. Then we must sample systematically the appropriate number of elements from the cumulative totals. The actual numbers selected in this way do not refer to individual elements, but indicate which clusters and how many from the cluster are to be selected by simple random sampling or by systematic sampling. The results of this type of sampling are equivalent to those of a simple random sample and the method is less cumbersome and is also relatively less expensive. We can illustrate this with the help of an example.

(vii) Sequential sampling: This sampling design is somewhat complex sample design. The ultimate size of the sample under this technique is not fixed in advance, but is determined according to mathematical decision rules on the basis of information yielded as survey progresses. This is usually adopted in case of acceptance sampling plan in context of statistical quality control. When a particular lot is to be accepted or rejected on the basis of a single sample, it is known as single sampling; when the decision is to be taken on the basis of two samples, it is known as double sampling and in case the decision rests on the basis of more than two samples but the number of samples is certain and decided in advance, the sampling is known as multiple sampling. But when the number of samples is more than two but it is neither certain nor decided in advance, this type of system is often referred to as sequential sampling. Thus, in brief, we can say that in sequential sampling, one can go on taking samples one after another as long as one desires to do so.

CONCLUSION

From a brief description of the various sample designs presented above, we can say that normally one should resort to simple random sampling because under it bias is generally eliminated and the sampling error can be estimated. But purposive sampling is considered more appropriate when the universe happens to be small and a known characteristic of it is to be studied intensively. There are situations in real life under which sample designs other than simple random samples may be considered better (say easier to obtain, cheaper or more informative) and as such the same may be used. In a situation when random sampling is not possible, then we have to use necessarily a sampling design other than random sampling. At times, several methods of sampling may well be used in the same study (Kothari, 2004).

References:

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques.* New Delhi: New Age International (P) Limited Publishers.

UNIT: - 9

METHODS OF DATA COLLECTION, ACQUISITION AND TREATMENT OF DATA

Research tools are administered on the sample subjects for collecting evidences or data. Most educationalresearch will lead to the gathering of data by means of some standardized test or self-constructed research tools. It should provide objective data for interpretation of results achieved in the study. The data may be obtained by administering questionnaires, testing, personal observations, interviews and many other techniques of collecting quantitative and qualitative evidence.

The researcher must know how much and what kind of data collection will take place and when. He must also be sure that the types of data obtainable from the selected instruments will be usable in whatever statistical model he will latter use to bring out the significance of the study. The data collection is the accumulation of specific evidence that will enable the researcher to properly analyse the results of all activities by his research design and procedures. The main purpose of data collection is to verify the research hypotheses.

NEED FOR DATA COLLECTION

The data are needed in a research work to serve the following purposes:

1. Collection of data is very essential in any educational research to provide a solid foundation for it.

2. It is something like the raw material that is used in the production of data. Quality of data determines the quality of research.

3. It provides a definite direction and definite answer to a research inquiry. Whatever inquiry has to give a definite answer to an investigation. Data are very essential for a scientific research.

4. The data are needed to substantiate the various arguments in research findings.

5. The main purpose of data collection is to verify the hypotheses.

6. Statistical data are used in two basic problems of any investigation:

(a) Estimation of population parameters, which helps in drawing generalization.

(b) The hypotheses of any investigation are tested by data collection procedure.

7. The qualitative data are used to find out the facts and quantitative data are employed to formulate new theory or principles.

8. Data are also employed to ascertain the effectiveness of new device for its practical utility.

9. Data are necessary to provide the solution of the problem.

MEANING OF DATA

Data means observations or evidences. The scientific educational researches require the data by means of some standardized research tools or self-designed instrument. Data are both qualitative and quantitative in nature.

Score is the numerical description of an individual with regard to some characteristics or variables. Measurement process is employed to quantify a variable. Data are collected for both variables as well as attributes. These are gathered in terms of frequency and scores. It depends on the type of instrumentemployed for its measurement. Generally tests yield the data in the form of scores and questionnaires provide the data in the form of frequency. Data are things with which we think of.

Data and facts are used in educational research, therefore, it is essential to understand them clearly.

DIFFERENCE BETWEEN FACTS AND DATA

The facts and data have been distinguished in the following manner:

1. The facts are organized in their original form whereas data are organized in systematic order.
2. The facts do not have any coherence of system whereas data have an organic unity like body.
3. The facts are difficult to interpret. The interpretation of facts is usually subjective and employs the imagination of the researcher. Data can be interpreted easily and most objectively.
4. The facts are mysterious in nature we have to explore the facts but data have no mystery at all.
5. The facts are descriptive in nature whereas data are explanatory.
6. The facts are not amenable to objective statistical treatments whereas data can be easily subjected to in objective statistical treatment.
7. The facts may not be directly the basis of findings or research conclusions, but data are directly linked with research conclusions.
8. The facts are usually too broad and are not linked and a purposive way whereas data are always collected with a sense of purpose.
9. The facts are collected in historical or survey research whereas data are gathered in a scientific and experimental research.

NATURE OF DATA

The research studies in behavioural science or mainly concerned with the characteristics or traits. Thus, tools are administered to quantify these characteristics, but all traits or characteristics can not be Quantified.

The data can be classified into two broad categories:

1. Qualitative data or attributes.

2. Quantitative data or variables.

1. Quantitative Data or Attributes: The characteristics or traits for which numerical value can not be assigned, are called attributes, e.g. motivation, confidence, honesty integrity etc.

2. Quantitative Data or Variables: The characteristics or traits for which numerical value can be assigned, are called variables, e.g. Achievement Intelligena, Aptitude Height, Weight etc.

The distinction is based on the process of measurement rather than on the properties inherent in the phenomenon or trait, for generally properties considered qualitative can be made quantitative by measuring them with an instrument designed to assign numerical values to the various degrees to which they exist.

The decision to research a given phenomenon on the basis of its attributes or on the basis of its quantitative aspects is frequently a matter of choice, depending on such considerations as the need of precision and the ease of manipulation of data.

In fact, the quantification of phenomenon is generally considered essential to the progress of a science particularly at the more advanced levels. Quantification provides a greater refinement and possesses definite advantages by virtue of its statistical treatment.

The quantitative data provide the nature of the characteristic or trait. They have the verbal exposition of the trait. There is much scope for logical manipulation is the interpretation of result. The trait is not quantifiable.

The qualitative data provide the extent and nature of the distribution of the trait or variable measured.The tools are available to measure the variable. In the experimental research data are collected in the controlled situation to study the functional relationship of variables.

Quantification is the process of assigning numerical values to the trait of the subjects of sample which normally would be quantitative. This can be done by:

(a) Observations or information by first hand experience. It is used in small children and animals.

(b) Systematic collection and analysis of factual data. This is done in historical research.

(c) Scales and inventories are designed to explore or reveal the interests, attitude and personality.

It is used in the case of study and survey research.

(d) Questionnaire, interview and opinionnaire are designed to gain information. This is employed in survey research.

(e) Educational and psychological tools are administered to quantify the variables more accurately. These tools are used in scientific research studies.

Various types of research tools are employed to collect the data. These tools yield different typesof data.

CONSTANTS

A constant is all characteristic or condition that is the same for all the observed units or sample subjects of a study.

A variable, on the other hand is a characteristic which takes on different values for different sample subjects or for all the observed units.

The use of variable and constant has been illustrated with the help of the following example. Suppose a study is conducted for determing the effect of three different teaching methods upon the achievement in secondary mathematics. Each of three ninth grade maths sections in the same school, are taught by the same teacher, is taught using one of the methods. Both boys and girls are included in each method.

In this study grade level, school and teacher are recognized as constants. It assumes that the teacher can hold constant teaching effectiveness except for the method. The independent variable in the study is the teaching method and achievement in maths is known as the dependent variable or criterion variable.

A dependent variable is the consequent of the independent variable. The functional relationship is analysed between the two variables. The precision of the data is governed by the constants, if these conditions remain unchanged during experimentation. A researcher should be careful or conscious enough about the constants of his investigation.

VARIABLES

The variables are those which vary from person to person and can be quantified by employing measuring instrument. The sample or group variation can be ascertained in terms of numerical values. The characteristic or the trait in the behavioural science which can be quantified is termed as variable.

Variables can be classified into two categories:

1. Continuous variables.

2. Discrete variables.

1. Continuous variables are those for which fractional value exists and have meaning e.g. age, weight, achievement, where 14.5 years, 62.75 kgs and 45.50 scores or any other fractional of a whole unit is logical and measurable within the precision of the instrument used.

2. Discrete variables are those on the other hand, which exist only in units not the fractional value (usually units of one) e.g. 30 boys, 25 girls, 40 Indians and 24 Americans.

This distinction is somewhat more complicated in practice. The typical problem in educational research deals with test scores. These are generally reported as discrete variable though they are often fundamentally continuous. Intelligence is recorded in terms of I.Q.s. as discrete thought by their very computation they are technically continuous.

In research, where the concern is with group measures which almost invariably are fractional, continuous variables appear somewhat more acceptable than discrete variables.

The variables can be classified with regard to their roles or functions In particular study. The assumptions of an investigation determine the role of the variables. The following are the types of variables: independent, dependent or criterion, experimental, control, moderator and intervening variables. When the investigator is concerned with the teachers attitude toward teaching in relation to their classroom verbal interaction. The teaching attitude is the independent variable. In another study the investigator intends to analyse the relationship between classroom interaction and student's achievement. The classroom interaction is the independent variable (whereas in earlier study it is dependent variable) and student's achievement is the dependent variable. Thus, this type of classification is important froma particular research point of view. Every research worker must understand his variables and their roles in his investigation.

VARIATE

The variable is quantified by using an instrument. The quantified variable is termed as variate. When sample subjects I.Q.s or scores of achievement are collected, it is known as variate. The statistical analysis involves variate analysis: uni-variate, bi-variate, multi-variate analysis. It is evident that data collection means to convert variables into variates so that data can be subjected to an appropriate statistical analysis for obtaining the results.

QUANTIFICATION OF VARIABLE

Quantification is the process of assigning numeral value to the extend or amount of a variable of an individual. The quantification is done by employing the process of measurement. This process yields data and scores.

Many studies in education produce data for the verification of research hypotheses so as to

draw conclusions. Some other studies in education produce evidences that require evaluation by subjective methods which do not readily permit the use of statistical analysis are termed as qualitative data. These qualitative data may be converted first into their quantitative data. The statistical techniques may be applied to test the significance of data. If qualitative data cannot be converted into quantitative data, a descriptive interpretation is done.

CHARACTERISTICS OF QUANTITATIVE DATA

The quantitative data are collected by administering the research tools. These should possess thefollowing characteristics:

1. The quantitative data should be collected through standardized tests. If self-made test is used it should be reliable and valid.
2. They are highly reliable and valid. Therefore, generalization and conclusions can be made easily with certain level of accuracy.
3. The obtained results through quantitative data can be easily interpreted with scientific accuracy. The level of significance can also be determined.
4. The scoring system of quantitative data is highly objective.
5. The use of quantitative data is always based upon the purpose of the study. The specific psychometric tests are used in difficult investigation.
6. The inferential statistical can be used with the help of quantitative data.
7. The precision and accuracy of the results can be obtained by using quantitative data in an educational research.

TYPES OF DATA

There are four basic ways of quantifying the variables. They are also called levels of measurement or scales of measurement. These are commonly referred to as:

1. Nominal scale,
2. Ordinal or rank scale,
3. Equal-interval scale, and
4. Ratio scale.

1. Nominal Scale

The nominal scale is the least precise or crude of the four basic scales of measurement. It simply

implies the classification of an item into two or more categories without any extent or magnitude. There is no particular order assigned to them. The frequency or numbers are used to give a name to something that may be used for determining per cent, mode. For example boys and girls; pass and fail;rural and urban.

In classroom observation the measurement is done at nominal scale. The teaching and instruction are organized considering the mode of the students, because teacher cannot pace with each and every student in his teaching and learning process.

2. Ordinal Scale

The ordinal scale is more precise scale than the nominal scale. It allows the teacher to assign values byplacing of arranging the observations in relative rank order. No value is assigned to the distances to the positions of ranking. This scale assigns observations to categories by number and arranges them in some logical order. It does not require the relationship of equivalence but also requires one observation to be greater or lesser than the other.

This scale is used frequently in the schools for prize distribution and to provide the motivation bythe technique of competition. In asking the questions teacher considers the place of students in the class.

3. Equal Interval Scale

The equal interval scale is more precise and refined scale than nominal and ordinal scales. This scale has all the characteristics and relationship of the ordinal scale, besides which distances between any two numbers on the scale are known. The zero point and the unit of measurement used on the scale arearbitrary assumed. A linear relationship is established in the equal-interval scale.

The equal-interval scale has the greater use in teaching-learning situation, educational administration, educational guidance and counselling and educational research. The effectiveness of any instructional procedure, can be evaluated precisely by collecting the data on this scale. The measurement in education is usually done on equal interval scale. The dependable inferences are drawn in educational research by collecting evidences on equal interval scale.

These three types of data are mainly used in behavioural researches. These have been illustrated in the following table:

Subject	*Nominal Sex*	*Ordinal Achievement in ranks*	*Equal-interval Achievement in scores*
A	Boy	3rd	64
B	Girl	1st	76
C	Girl	2nd	68

D	Boy	5th	58
E	Girl	4th	60

These scales have not absolute 'zero'. The group performance is the reference point.

4. Ratio Scale

Ratio scale has the properties of equal-interval scale plus two additional characteristics:

(a) This scale has a true, rather than arbitrary 'zero'. It is possible to indicate the complete absence of property. The zero point on a centimeter scale indicates the absence of height. However, the zero point on a Fahrenheit temperature scale does not indicate the absence of temperature; this is a scale with zero defined arbitrarily.

(b) The ratio scale numerals have the qualities of real numbers, and can be added, subtracted, multiplied; or divided. A may be so many units greater than B and may also be so many times as great as B. Fifteen grams is three times five grams and fifteen grams is ten more than five grams.

Proceeding from nominal to ratio scale in order each type makes possible more information about the property described. If the variable permit its application, the type of scale provide the maximum amount of information should be used.

DATA COLLECTION

In the behavioural science data are collected by administering various types of research tools of the human sample subjects. The different traits and characteristics are quantified by using measurable instruments. These research tools provide different types of data. It is very essential for a research worker to understand the trait, tools and type of data. This has been illustrated with the help of the following table:

No.	*Level*	*Properties*		*Assumptions*	*Examples*	*Statistics*
1.	Nominal Scale	Classification Equate Non-equate	(1)	All members of a set are assigned the same numeral, and no two sets are assigned the same numeral.	Car registration plate numbers Simple questionnaire and interviews data gathered on an all or	Mode Coefficient of association

					none basis	
2.	Ordinal Scale	Classification Order Equate Non-equate	(1) (2)	As above Objects can be rank ordered on the basis of an operationally defined characteristic or property	Moh's scale of hardness Most psychological and educational test scores.	Mode Median Percentiles Coefficient of association Ranking coefficient
3.	Interval Scale	Classification Order equal Units Equate Non-equate Add subtract Multiply divide	(1) (2) (3)	As above As above Distances on the scale represent equal intervals	Temperature scales Very well validated intelligence tests, etc.	Mode Median Mean Percentile Range Standard Deviation Average deviation
4.	Ratio Scale	Classification Order Equal Units Absolute Zero Equate Non-equate Add subtract Multiply divide	(1) (2) (3) (4)	As above As above As above Scale has an absolute or natural Zero	Common, scales of length, Mass and time Some scale of loudness	Standard score Coefficient of association Ranking Coefficient Simple partial and

						multiple correlation.

A Classification of Scales of Measurement and Common Statistics Types of Data With Reference to the Traits

Trait	*Tool*	*Type of Data*
1. Intelligence	Psychological tests	Equal-interval scale
2. Achievement	Educational tests	”
3. Aptitude	Psychological tests	”
4. Attitude	Scales	Ordinal scale
5. Interest	Inventories	Equal interval scale
6. Personality	”	”
7. Adjustment	”	”
8. Opinions of feelings	Questionnaire orOpinionnaire	Nominal scale

There are other types of research tools which are used to collect’ the data. For example, ‘observation technique’ is most frequently used to collect the data which yields the data at nominal scale and also at equal-interval scale.

In the following table research tools have been classified with regard to scale for measurement and types of statistics may be employed of analysis purpose.

Classification of Tools and Research with Regard to the Level of Measurement

Scale	*Tools of Research*	*Statistics*
1. Nominal Scale	Questionnaire Interview Schedule Observation	Model, frequency percentage Simple statistics X_2-Test and ‘C’
2. Ordinal scale	Scale observation Rank scale	Median, Spearman’s rank correlation X^2 test Median test etc.
3. Equal-interval scale	Psychological and educational tests Observation scale	Mean, Sd. Pearson’s correlation‘t’ test and ‘f’ test etc.

4. Ratio scale	Physical measurement	Arithmetic mean Pearson's correlation Mathematics is used.

The types of data depend on nature of research tool employed for this purpose. Statistical techniquesare virtually selected by considering the nature of research tool and data collected at nominal, ordinal or equal interval scales. It is not the statistical technique but type data which determine the fate of research project.

Ethical considerations in Collection of Data

Any researcher who involves human sample subjects in his research has certain responsibilities towards them. Since the activities of the sample subjects are often closely associated with data collection process, it is appropriate to consider ethical considerations here.

The following points have to be considered in process of data collection:

1. The researcher must protect the dignity and welfare of human sample subjects.
2. The human sample subjects freedom to decline participation must be respected, and the confidentially of research data must be maintained.
3. The researcher must guard against violation or invasion of privacy.
4. The responsibility for maintaining ethical standard remains with the individual researcher and the principal investigator or supervisor is also responsible for actions of his scholars.

Any researcher anticipating "the use of human sample subjects should consult on 'ethics' statements such as those mentioned above. A researcher should not mention the name of subjects anywhere in thereport. If possible name of institutions where sample subjects have selected for data collection should not be mentioned even in the appendix. The code number should be used for this purpose. As a general rule, he must respect the human sample subjects selected in his specific research study.

Precautions in Data Collection

In the data collection the following precautions should be observed:

1. The data must be relevant to the research problem.
2. It should be collected through formal or standardized research tools.
3. The data should be such as these can be subjected to statistical treatment easily.
4. The data should have minimum measurement error.
5. The data must be tenable for the verification of the hypotheses.

6. The data should be such as parameters of the population may be estimated for inferential purpose.

7. The data should be complete in itself and also comprehensive in nature.

8. The data should be collected through objective procedure.

9. The data should be accurate and precise.

10. The data should be reliable and valid.

11. The data should be such that these can be presented and interpreted easily.

12. The scoring procedure of the research tool should be easy and objective.

ORGANIZATION OF DATA

After the data have been collected. it must be organized and analyzed to draw proper inferences.

The mass of data collected through the use of various tools, however reliable, valid and adequateit may be is yet but raw. It needs to be systematized and organized i.e. edited classified and tabulated. before it can serve any worthwhile purpose. Editing implies the checking of gathered data for accuracy, utility and completeness. Classifying refers to the dividing of the information into different categories classes or heads, for the use. Tabulating denotes the recording of the classified material in accurate mathematical terms e.g. marking and counting frequency tallies for different items on which Information is gathered. Tabulation is a tedious and painstaking process and must be accurate. Before, tabulating all raw data should be tested on the basis of the purpose for which they are gathered and only the useful and usable data should be tabulated. Tabulating machines and other mechanical aids for tabulating are becoming current.

Once the data have been collected through the use of the measuring instruments, some type of tabulation and possibly a transformation of data in preparation for the analysis may be necessary. if answer sheets are to be hand scored routine precautions should be taken to practice for scores and accuracy checks while the actual scoring is being done.

Research study which includes the collection of considerable data using standardized tests should make provision for machine scoring.

There are IBM answer sheets with space of responses upto 150 items. Test scoring machines provide for obtaining the actual scores, they commonly provide tabulations, summaries, and conversions to various types of standard score. If some cases the machines are connected to a computer to provide certain kinds of analysis.

Machine scoring of tests is usually less expensive than hand scoring. Other advantages of

machine scoring are its accuracy and its preparation of the data for computer analysis if necessary. Not all educational “research data are collected in a form that can be machine is not to be used to transmit data from the answer sheet to the computer is an important part of the research procedure.

The data should be so organized that minimum effort is required to transmit the data from its original form to the IBM card. The format data card, indicating the information that enters into each column, must be defined by the researcher. Information is commonly of two types: identification and responses of the subject. Any confusion should be eliminated to minimize the number of copy errors. The computations on the calculator should be so performed in such a manner that several internal checks can be made during the calculation (Singh, 2006).

References:

Singh, Y. K. (2006). *Fundamentals of Research Methodology and Statistics.* New Delhi: New Age International (P) Limited Publishers.

UNIT: - 10

RESEARCH ETHICS WITH SPECIAL REFERENCE TO PLAGIARISM

What is Research Ethics?

- Ethics are the set of rules that govern our expectations of our own and others' behaviour.
- Research ethics are the set of ethical guidelines that guides us on how scientific research should be conducted and disseminated.
- Research ethics govern the standards of conduct for scientific researchers It is the guideline for responsibly conducting the research.
- Research that implicates human subjects or contributors rears distinctive and multifaceted ethical, legitimate, communal and administrative concerns.
- Research ethics is unambiguously concerned in the examination of ethical issues that are upraised when individuals are involved as participants in the study.
- Research ethics committee/Institutional Review Board (IRB) reviews whether the research is ethical enough or not to protect the rights, dignity and welfare of the respondents.

Objectives of Research Ethics:

- The first and comprehensive objective – **to guard/protect human participants, their dignity, rights and welfare.**
- The second objective – **to make sure that research is directed in a manner that assists welfares of persons, groups and/or civilization as a whole.**
- The third objective – **to inspect particular research events and schemes for their ethical reliability,** considering issues such as the controlling risk, protection of privacy and the progression of informed consent

The general principles of research ethics are:

Honesty	Being honest with the beneficiaries and respondents. Being honest about the findings and methodology of the research. Being honest with other direct and indirect stakeholders.
Integrity	Ensuring honesty and sincerity. Fulfilling agreements and promises. Do not create false expectations or make false promises.
Objectivity	Avoiding bias in experimental design, data analysis, data interpretation, peer review, and other aspects of research.
Informed consent	▪ Informed consent means that a person knowingly, voluntarily and intelligently gives consent to participate in a research.

	▪ Informed consent is related to the autonomous right of the individual to participate in the research. ▪ Informing the participant about the research objective, their role, benefits/harms (if any) etc.
Respect for person/respondent	It includes: ▪ autonomy, which requires that those who are capable of deliberation about their personal goals should be treated with respect for their capacity for self-determination; and ▪ protection of persons with impaired or diminished autonomy, which requires that those who are dependent or vulnerable be afforded security against harm or abuse.
Beneficence	Maximize the benefits of the participants. Ethical obligation to maximize possible benefits and to minimize possible harms to the respondents.
Non-malfeasance/ Protecting the subjects (human)	Do no harm. Minimize harm/s or risks to the human. Ensure privacy, autonomy and dignity.
Responsible publication	Responsibly publishing to promote and uptake research or knowledge. No duplicate publication.
Protecting anonymity	It means keeping the participant anonymous. It involves not revealing the name, caste or any other information about the participants that may reveal his/her identity.
Confidentiality	Protecting confidential information, personnel records. It includes information such as: ▪ Introduction and objective of the research ▪ Purpose of the discussion ▪ Procedure of the research ▪ Anticipated advantages, benefits/harm from the research (if any) ▪ Use of research ▪ Their role in research ▪ Right to refuse or withdraw

	▪ Methods which will be used to protect anonymity and confidentiality of the participant ▪ Freedom to not answer any question/withdraw from the research ▪ Who to contact if the participant needs additional information about the research.
Non-discrimination	Avoid discrimination on the basis of age, sex, race, ethnicity or other factors that are violation of human rights and are not related to the study.
Openness	Be open to sharing results, data and other resources. Also accept encouraging comments and constructive feedback.
Carefulness and respect for intellectual property	Be careful about the possible error and biases. Give credit to the intellectual property of others. Always paraphrase while referring to others article, writing. Never plagiarize.
Justice	The obligation to distribute benefits and burdens fairly, to treat equals equally, and to give reasons for differential treatment based on widely accepted criteria for just ways to distribute benefits and burdens.

(Wagle, 2020)**.**

Plagiarism:

Plagiarism is the representation of another author's language, thoughts, ideas, or expressions as one's own original work. In educational contexts, there are differing definitions of plagiarism depending on the institution. Plagiarism is considered a violation of academic integrity such as truth and knowledge through intellectual and personal *honesty* in learning, teaching, research, fairness, respect and responsibility, and a breach of journalistic ethics. It is subject to sanctions such as penalties, suspension, expulsion from school or work, substantial fines and even imprisonment.

Generally, plagiarism is not in itself a crime, but like counterfeiting, fraud can be punished in a court for prejudices caused by copyright infringement, violation of moral rights, or torts. In academia and industry, it is a serious ethical offense. Plagiarism and copyright infringement overlap to a considerable extent, but they are not equivalent concepts, and many types of plagiarism do not constitute copyright infringement, which is defined by copyright law and may be adjudicated by courts.

Not all countries hold the same beliefs about personal ownership of language or ideas. While some, such as India and Poland, consider plagiarism to be a crime liable for imprisonment, in other countries the reiteration of another professional's work can be a sign of respect or flattery. Students who move to the United States and other Western countries from countries where plagiarism is not frowned upon may find the transition difficult.

In Academia and Journalism

Within academia, plagiarism by students, professors, or researchers is considered academic dishonesty or academic fraud, and offenders are subject to academic censure, up to and including expulsion. Some institutions use plagiarism detection software to uncover potential plagiarism and to deter students from plagiarizing. However, plagiarism detection software does not always yield accurate results and there are loopholes in these systems. Some universities address the issue of academic integrity by providing students with thorough orientations. The orientation required writing courses, and clearly articulated honor codes. Indeed, there is a virtually uniform understanding among college students that plagiarism is wrong. Nevertheless, each year students are brought before their institutions' disciplinary boards on charges that they have misused sources in their schoolwork. However, the practice of plagiarizing by use of sufficient word substitutions to elude detection software, known as rogeting. Rogetting has rapidly evolved as students and unethical academics seek to stay ahead of detection software.

An extreme form of plagiarism, known as "contract cheating", involves students paying someone else, such as an essay mill, to do their work for them. The student enters into an agreement with a contract cheating provider because very few parts of the world have legislation that prohibits the operation or the promotion of contract cheating services. In librarianship, *Plagiarism* is a vexing issue for Higher *Education*, affecting student transition, retention, and attainment. Librarians of different types are addressing the issue of *plagiarism* at the institutional levels.

In journalism, plagiarism is considered a breach of journalistic ethics, and reporters caught plagiarizing typically face disciplinary measures ranging from suspension to termination of employment. Some individuals caught plagiarizing in academic or journalistic contexts claim that they plagiarized unintentionally, by failing to include quotations or give the appropriate citation. While plagiarism in scholarship and journalism has a centuries-old history, the development of the Internet, where articles appear as electronic text, has made the physical act of copying the work of others much easier.

Predicated upon an expected level of learning and comprehension having been achieved, all associated academic accreditation becomes seriously undermined if plagiarism is allowed to become the norm within academic submissions.

Academia

No universally adopted definition of academic plagiarism exists. However, this section provides several definitions to exemplify the most common characteristics of academic plagiarism. It has been called, "The use of ideas, concepts, words, or structures without appropriately acknowledging the source to benefit in a setting where originality is expected."

This is an abridged version of Teddi Fishman's definition of plagiarism, which proposed five elements characteristic of plagiarism. According to Fishman, plagiarism occurs when someone:

- Uses words, ideas, or work products
- Attributable to another identifiable person or source
- Without attributing the work to the source from which it was obtained
- In a situation in which there is a legitimate expectation of original authorship
- In order to obtain some benefit, credit, or gain which need not be monetary[57]

Furthermore, plagiarism is defined differently among institutions of higher learning and universities:

- Stanford defines plagiarism as the "use, without giving reasonable and appropriate credit to or acknowledging the author or source, of another person's original work, whether such work is made up of code, formulas, ideas, language, research, strategies, writing or other form".
- Yale views plagiarism as the "... use of another's work, words, or ideas without attribution", which includes "... using a source's language without quoting, using information from a source without attribution, and paraphrasing a source in a form that stays too close to the original".
- Princeton describes plagiarism as the "deliberate" use of "someone else's language, ideas, or other original (not common-knowledge) material without acknowledging its source".
- Oxford College of Emory University characterizes plagiarism as the use of "a writer's ideas or phraseology without giving due credit".
- Brown defines plagiarism as "... appropriating another person's ideas or words (spoken or written) without attributing those word or ideas to their true source".
- The U.S. Naval Academy defines plagiarism as "the use of the words, information, insights, or ideas of another without crediting that person through proper citation".

Forms of academic plagiarism

Different classifications of academic plagiarism forms have been proposed. Many classifications follow a behavioral approach, i.e., they seek to classify the actions undertaken by plagiarists.

For example, a 2015 survey of teachers and professors by Turnitin,[64] identified 10 main forms of plagiarism that students commit:

- Submitting someone's work as their own.
- Taking passages from their own previous work without adding citations (self-plagiarism).
- Re-writing someone's work without properly citing sources.
- Using quotations but not citing the source.
- Interweaving various sources together in the work without citing.
- Citing some, but not all, passages that should be cited.
- Melding together cited and uncited sections of the piece.
- Providing proper citations, but failing to change the structure and wording of the borrowed ideas enough (close paraphrasing).
- Inaccurately citing a source.
- Relying too heavily on other people's work, failing to bring original thought into the text.

A 2019 systematic literature review on academic plagiarism detection deductively derived a technically oriented typology of academic plagiarism from the linguistic model of language consisting of lexis, syntax, and semantics extended by a fourth layer to capture the plagiarism of ideas and structures. The typology categorizes plagiarism forms according to the layer of the model they affect:

- Characters-preserving plagiarism
    - Verbatim copying without proper citation
- Syntax-preserving plagiarism
    - Synonym substitution
    - Technical disguise (e.g. using identically looking glyphs from another alphabet)
- Semantics-preserving plagiarism
    - Translation

    - Paraphrase
- Idea-preserving plagiarism
    - Appropriation of ideas or concepts
    - Reusing text structure
- Ghostwriting
    - Collusion (typically among students)
    - Contract cheating

Sanctions for student plagiarism

In the academic world, plagiarism by students is usually considered a very serious offense that can result in punishments such as a failing grade on the particular assignment, the entire course, or even being expelled from the institution. The seriousness with which academic institutions address student plagiarism may be tempered by a recognition that students may not fully understand what plagiarism is. A 2015 study showed that students who were new to university study did not have a good understanding of even the basic requirements of how to attribute sources in written academic work, yet students were very confident that they understood what referencing and plagiarism are. The same students also had a lenient view of how plagiarism should be penalised.

For cases of repeated plagiarism, or for cases in which a student commits severe plagiarism (e.g., purchasing an assignment), suspension or expulsion may occur. There has been historic concern about inconsistencies in penalties administered for university student plagiarism, and a plagiarism tariff was devised in 2008 for UK higher education institutions in an attempt to encourage some standardization of approaches.

However, to impose sanctions, plagiarism needs to be detected. Strategies faculty members use to detect plagiarism include carefully reading students work and making note of inconsistencies in student writing, citation errors and providing plagiarism prevention education to students. It has been found that a significant share of (university) teachers do not use detection methods such as using text-matching software. A few more try to detect plagiarism by reading term-papers specifically for plagiarism, while the latter method might be not very effective in detecting plagiarism – especially when plagiarism from unfamiliar sources needs to be detected. There are checklists of tactics to prevent student plagiarism.

Plagiarism education

Given the serious consequences that plagiarism has for students, there has been a call for a greater emphasis on learning in order to help students avoid committing plagiarism. This is especially important when students move to a new institution that may have a different view of the concept when compared with the view previously developed by the student. Indeed,

given the seriousness of plagiarism accusations for a student's future, the pedagogy of plagiarism education may need to be considered ahead of the pedagogy of the discipline being studied The need for plagiarism education extends to academic staff, who may not completely understand what is expected of their students or the consequences of misconduct. Actions to reduce plagiarism include coordinating teaching activities to decrease student load; reducing memorization, increasing individual practical activities; and promoting positive reinforcement over punishment.

Factors influencing students' decisions to plagiarize

Several studies investigated factors that influence the decision to plagiarize. For example, a panel study with students from German universities found that academic procrastination predicts the frequency plagiarism conducted within six months followed the measurement of academic procrastination. It has been argued that by plagiarizing, students cope with the negative consequences that result from academic procrastination such as poor grades. Another study found that plagiarism is more frequent if students perceive plagiarism as beneficial and if they have the opportunity to plagiarize. When students had expected higher sanctions and when they had internalized social norms that define plagiarism as very objectionable, plagiarism was less likely to occur. Another study found that students resorted to plagiarism in order to cope with heavy workloads imposed by teachers. On the other hand, in that study, some teachers also thought that plagiarism is a consequence of their own failure to propose creative tasks and activities.

Journalism

Since journalism relies on the public trust, a reporter's failure to honestly acknowledge their sources undercuts a newspaper or television news show's integrity and undermines its credibility. Journalists accused of plagiarism are often suspended from their reporting tasks while the charges are being investigated by the news organization.

Self-plagiarism

The reuse of significant, identical, or nearly identical portions of one's own work without acknowledging that one is doing so or citing the original work is sometimes described as "self-plagiarism"; the term "recycling fraud" has also been used to describe this practice. Articles of this nature are often referred to as duplicate or multiple publication. In addition there can be a copyright issue if copyright of the prior work has been transferred to another entity. Self-plagiarism is considered a serious ethical issue in settings where someone asserts that a publication consists of new material, such as in publishing or factual documentation. It does not apply to public-interest texts, such as social, professional, and cultural opinions usually published in newspapers and magazines.

In academic fields, self-plagiarism occurs when an author reuses portions of their own published and copyrighted work in subsequent publications, but without attributing the previous publication. Identifying self-plagiarism is often difficult because limited reuse of

material is accepted both legally (as fair use) and ethically. Many people (mostly, but not limited to critics of copyright and "intellectual property") do not believe it is possible to plagiarize oneself. Critics of the concepts of plagiarism and copyright may use the idea of self-plagiarism as a reduction ad absurdum argument.

Contested definition

Miguel Roig has written at length about the topic of self-plagiarism and his definition of self-plagiarism as using previously disseminated work is widely accepted among scholars of the topic. However, the term "self-plagiarism" has been challenged as being self-contradictory, an oxymoron, and on other grounds.

For example, Stephanie J. Bird argues that self-plagiarism is a misnomer, since by definition plagiarism concerns the use of others' material. Bird identifies the ethical issues of "self-plagiarism" as those of "dual or redundant publication". She also notes that in an educational context, "self-plagiarism" refers to the case of a student who resubmits "the same essay for credit in two different courses." As David B. Resnik clarifies, "Self-plagiarism involves dishonesty but not intellectual theft."

According to Patrick M. Scanlon, "self-plagiarism" is a term with some specialized currency. Most prominently, it is used in discussions of research and publishing integrity in biomedicine, where heavy publish-or-perish demands have led to a rash of duplicate and "salami-slicing" publication, the reporting of a single study's results in "least publishable units" within multiple articles (Blancett, Flanagin, & Young, 1995; Jefferson, 1998; Kassirer & Angell, 1995; Lowe, 2003; McCarthy, 1993; Schein & Paladugu, 2001; Wheeler, 1989). Roig (2002) offers a useful classification system including four types of self-plagiarism: duplicate publication of an article in more than one journal; partitioning of one study into multiple publications, often called salami-slicing; text recycling; and copyright infringement.

Codes of ethic

Some academic journals have codes of ethics that specifically refer to self-plagiarism. For example, the *Journal of International Business Studies*. Some professional organizations such as the Association for Computing Machinery (ACM) have created policies that deal specifically with self-plagiarism. Other organizations do not make specific reference to self-plagiarism such as the American Political Science Association (APSA). The organization published a code of ethics that describes plagiarism as "...deliberate appropriation of the works of others represented as one's own." It does not make any reference to self-plagiarism. It does say that when a thesis or dissertation is published "in whole or in part", the author is "not ordinarily under an ethical obligation to acknowledge its origins." The American Society for Public Administration (ASPA) also published a code of ethics that says its members are committed to: "Ensure that others receive credit for their work and contributions," but it makes no reference to self-plagiarism.

Factors that justify reuse

Pamela Samuelson, in 1994, identified several factors she says excuse reuse of one's previously published work, that make it not self-plagiarism. She relates each of these factors specifically to the ethical issue of self-plagiarism, as distinct from the legal issue of fair use of copyright, which she deals with separately. Among other factors that may excuse reuse of previously published material Samuelson lists the following:

- The previous work must be restated to lay the groundwork for a new contribution in the second work.
- Portions of the previous work must be repeated to deal with new evidence or arguments.
- The audience for each work is so different that publishing the same work in different places is necessary to get the message out.
- The author thinks they said it so well the first time that it makes no sense to say it differently a second time.

Samuelson states she has relied on the "different audience" rationale when attempting to bridge interdisciplinary communities. She refers to writing for different legal and technical communities, saying: "there are often paragraphs or sequences of paragraphs that can be bodily lifted from one article to the other. And, in truth, I lift them." She refers to her own practice of converting "a technical article into a law review article with relatively few changes—adding footnotes and one substantive section" for a different audience.

Samuelson describes misrepresentation as the basis of self-plagiarism. She also states "Although it seems not to have been raised in any of the self-plagiarism cases, copyrights law's fair use defense would likely provide a shield against many potential publisher claims of copyright infringement against authors who reused portions of their previous works."

Organizational publications

Plagiarism is presumably not an issue when organizations issue collective unsigned works since they do not assign credit for originality to particular people. For example, the American Historical Association's "Statement on Standards of Professional Conduct" (2005) regarding textbooks and reference books states that, since textbooks and encyclopedias are summaries of other scholars' work, they are not bound by the same exacting standards of attribution as original research and may be allowed a greater "extent of dependence" on other works. However, even such a book does not make use of words, phrases, or paragraphs from another text or follow too closely the other text's arrangement and organization, and the authors of such texts are also expected to "acknowledge the sources of recent or distinctive findings and interpretations, those not yet a part of the common understanding of the profession" (Wikipeadia, 2022)

References:

Wagle, K. (2020). *Research Ethics: Definition, Principles and Advantages*. Retrieved from Public Health Notes: https://www.publichealthnotes.com/research-ethics-definition-principles-and-advantages/

Wikipeadia. (2022). *Plagiarism*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Plagiarism

UNIT: - 11

ABSTRACT, SUMMARY AND SYNOPSIS: THEIR DIFFERENCES

ABSTRACT:

An **abstract** is a brief summary of a research article, thesis, review, conference proceeding, or any in-depth analysis of a particular subject and is often used to help the reader quickly ascertain the paper's purpose. When used, an abstract always appears at the beginning of a manuscript or typescript, acting as the point-of-entry for any given academic paper or patent application. Abstracting and indexing services for various academic disciplines are aimed at compiling a body of literature for that particular subject.

The terms ***précis*** or ***synopsis*** are used in some publications to refer to the same thing that other publications might call an "abstract". In management reports, an *executive summary* usually contains more information (and often more sensitive information) than the abstract does.

Purpose and Limitations:

Academic literature uses the abstract to succinctly communicate complex research. An abstract may act as a stand-alone entity instead of a full paper. As such, an abstract is used by many organizations as the basis for selecting research that is proposed for presentation in the form of a poster, platform/oral presentation or workshop presentation at an academic conference. Most bibliographic databases only index abstracts rather than providing the entire text of the paper. Full texts of scientific papers must often be purchased because of copyright and/or publisher fees and therefore the abstract is a significant selling point for the reprint or electronic form of the full text.

The abstract can convey the main results and conclusions of a scientific article but the full text article must be consulted for details of the methodology, the full experimental results, and a critical discussion of the interpretations and conclusions.

An abstract allows one to sift through copious numbers of papers for ones in which the researcher can have more confidence that they will be relevant to his or her research. Once papers are chosen based on the abstract, they must be read carefully to be evaluated for relevance. It is generally agreed that one must not base reference citations on the abstract alone, but the content of an entire paper.

According to the results of a study published in *PLOS Medicine*, the "exaggerated and inappropriate coverage of research findings in the news media" is ultimately related to inaccurately reporting or over-interpreting research results in many abstract conclusions. A study published in *JAMA* concluded that "inconsistencies in data between abstract and body and reporting of data and other information solely in the abstract are relatively common and that a simple educational intervention directed to the author is ineffective in reducing that frequency." Other "studies comparing the accuracy of information reported in a journal abstract

with that reported in the text of the full publication have found claims that are inconsistent with, or missing from, the body of the full article."

Copyright:

Abstracts are protected under copyright law just as any other form of written speech is protected. However, publishers of scientific articles invariably make abstracts freely available, even when the article itself is not. For example, articles in the biomedical literature are available publicly from MEDLINE which is accessible through PubMed.

Structure:

Abstract is often expected to tell a complete story of the paper, as for most readers, abstract is the only part of the paper that will be read. It should allow the reader to give an Elevator pitch of the full paper.

An academic abstract typically outlines four elements relevant to the completed work:

- The research focus (statement of the problem(s)/specific gap in existing research/research issue(s) addressed);
- The research methods (experimental research, case studies, questionnaires, etc) used to solve the problem;
- The major results/findings of the research; and
- The main conclusions and recommendations (i.e., how the work answers the proposed research problem).

It may also contain brief references, although some publications' standard style omits references from the abstract, reserving them for the article body (which, by definition, treats the same topics but in more depth).

Abstract length varies by discipline and publisher requirements. Typical length ranges from 100 to 500 words, but very rarely more than a page and occasionally just a few words. An abstract may or may not have the section title of "abstract" explicitly listed as an antecedent to content. Abstracts are typically sectioned logically as an overview of what appears in the paper, with any of the following subheadings: Background, Introduction, Objectives, Methods, Results and Conclusions. Abstracts in which these subheadings are explicitly given are often called **structured abstracts**. Abstracts that comprise one paragraph (no explicit subheadings) are often called **unstructured abstracts**.

Abstract Types:

Informative

The **informative abstract,** also known as the **complete abstract,** is a compendious summary of a paper's substance and its background, purpose, methodology, results, and conclusion. Usually between 100 and 200 words, the informative abstract summarizes the paper's structure, its major topics and key points. A format for scientific short reports that is similar to an informative abstract has been proposed in recent years. Informative abstracts may be viewed as standalone documents.

Descriptive:

The **descriptive abstract,** also known as the **limited abstract** or the **indicative abstract,** provides a description of what the paper covers without delving into its substance. A descriptive abstract is akin to a table of contents in paragraph form.

Graphical Abstract:

During the late 2000s, due to the influence of computer storage and retrieval systems such as the Internet, some scientific publications, primarily those published by Elsevier, started including graphical abstracts alongside the text abstracts. The graphic is intended to summarize or be an exemplar for the main thrust of the article. It is not intended to be as exhaustive a summary as the text abstract, rather it is supposed to indicate the type, scope, and technical coverage of the article at a glance. The use of graphical abstracts has been generally well received by the scientific community Moreover; some journals also include video abstracts and animated abstracts made by the authors to easily explain their papers. Many scientific publishers currently encourage authors to supplement their articles with graphical abstracts, in the hope that such a convenient visual summary will facilitate readers with a clearer outline of papers that are of interest and will result in improved overall visibility of the respective publication. However, the validity of this assumption has not been thoroughly studied, and a recent study statistically comparing publications with or without graphical abstracts with regard to several output parameters reflecting visibility failed to demonstrate an effectiveness of graphical abstracts for attracting attention to scientific publication (Wikipedia, 2022).

SUMMARY:

The Research Summary is used to report facts about a study clearly. You will almost certainly be required to prepare a research summary during your academic research or while on a research project for your organization.

If it is the first time you have to write one, the writing requirements may confuse you. The instructors generally assign someone to write a summary of the research work. Research summaries require the writer to have a thorough understanding of the issue.

This article will discuss the definition of a research summary and how to write one.

What is a research summary?

A research summary is a piece of writing that summarizes your research on a specific topic. Its primary goal is to offer the reader a detailed overview of the study with the key findings. A research summary generally contains the article's structure in which it is written.

You must know the goal of your analysis before you launch a project. A research overview summarizes the detailed response and highlights particular issues raised in it. Writing it might be somewhat troublesome. To write a good overview, you want to start with a structure in mind. Read on for our guide.

Why is an analysis recap so important?

Your summary is going to tell readers everything about your research project. This is the critical piece that your stakeholders will read to identify your findings and valuable insights. Having a good and concise research summary that presents facts and comes with no research biases is the critical deliverable of any research project.

We've put together a cheat sheet to help you write a good research summary below.

Research Summary Guide

1. **Why was this research done?** – You want to give a clear description of why this research study was done. What hypothesis was being tested?
2. **Who was surveyed?** – The what and why or your research decides who you're going to interview/survey. Your research summary has a detailed note on who participated in the study and why they were selected.
3. **What was the methodology?** – Talk about the methodology. Did you do face-to-face interviews? Was it a short or long survey or a focus group setting? Your research methodology is key to the results you're going to get.
4. **What were the key findings?** – This can be the most critical part of the process. What did we find out after testing the hypothesis? This section, like all others, should be just facts, facts. You're not sharing how you feel about the findings. Keep it bias-free.
5. **Conclusion** – What are the conclusions that were drawn from the findings? A good example of a conclusion. Surprisingly, most people interviewed did not watch the lunar eclipse in 2022, which is unexpected given that 100% of those interviewed, knew about it before it happened.
6. **Takeaways and action points** – This is where you bring in your suggestion. Given the data you now have from the research, what are the takeaways and action points? If you're a researcher running this research project for your company, you'll use this part to shed light on your recommended action plans for the business (Prachi, 2022) (Prachi, 2022).

SYNOPSIS:

A synopsis is a brief summary which gives readers an overview of the main points. In an academic context, this is usually a summary of a text (a journal article, book, report etc) but in

some instances you might be writing a synopsis of a talk, film or other form of presentation. A synopsis is a neutral summary, objectively capturing the main points, rather than your own perspective or critique, and it focuses directly on the text you're summarising rather than being a wider discussion of a topic, as an essay might be.

A synopsis aims to give the reader a full, if brief, account of the whole text so that they can follow its main points without having to read it themselves. It's not a 'trailer' designed to tempt your audience to read the text itself, so you don't have to worry about 'hooking' them in with hints and high points or 'spoiling the ending' - give the whole text equal coverage, including the conclusions. You could add some commentary which gives the reader a bit of context about the text, including the authors and circumstances it was written in (for example, if it is part of a debate, particular school of thought or its significance and what impact it's had).

Challenges

Writing a good synopsis is a skill, and there are a number of challenges:

- Separating the main points from the minor detail
- Knowing what to leave out as well as what to include
- Giving a sense of the overall narrative as well as listing the key points
- Covering the whole text within a small word limit
- Knowing how closely to stick to the original, especially in terms of the wording
- Whether to give all key points equal treatment, or cover some more briefly, even combining them
- Rephrasing things concisely without losing the meaning or misrepresenting it
- Not leaving out anything crucial to understanding the whole overall message

A good synopsis will allow the reader to feel as if they'd skim read the whole text themselves, understanding the overall gist and highlighting what they need to know. A poor synopsis will get bogged down in detail, giving a confused account of the whole story by just listing points, miss out major points or give an inaccurate or one-sided account or stick so closely to the original that it becomes plagiarism without demonstrating a real understanding by the person summarising it.

How to prepare a synopsis

Boiling down the key points and overall narrative of the original means good reading and note-taking skills which aim to identify and boil down key points to their essence. You could try some of the following approaches:

- Read the whole text, and afterwards, without re-reading, jot down your first initial summary in 50 words to capture its overall point. You can check it back for accuracy or anything you left out, but stick within ca 50 words
- Read the introduction and first line of each paragraph to get a sense of the overall structure and key points within it
- Highlight one sentence in each paragraph that you think is essential detail to understanding that section
- Alternatively, with a marker pen, cross out anything that isn't essential to an understanding of the whole section or text
- Jot down only key words as a summary of each point rather than whole sentences

- Read each paragraph and summarise it without looking, in one sentence of your own
- Consider how many points you can make within your word count, and reduce or combine your list of summarised points down to this number

You could start small, identifying just keywords or sentences at first and then work them up into phrases, bullet points and sentences as a rough plan or draft, or you could start big with the original text and reduce each section, paragraph and sentence summary again and again until you have boiled it down to its essence.

When you start to prepare your first plan or draft, try to use your notes or memory and step away from the original as much as you can. You can go back and check it afterwards, but you need to create some distance to be able to create your own account and have confidence in the points you have identified as essential.

Writing a synopsis

The main decisions facing you as you write up your summary are about how closely to stick to the original in terms of structure and style, and how much attention to give to each point.

- You could begin your synopsis with a brief context, explaining who the authors are, the context and significance of their work, as well as anything you think might help the reader to understand the following summary
- The most common structure is to follow that of the original text, to give a sense of its narrative flow as well as the key points within it. You could choose to depart from it a little though, perhaps glossing over some points faster than others, combining two sections which go together or aren't enough in their own right, possibly even changing the order a little where it helps to combine two similar points. Careful use of signposting language will help the reader clearly follow the structure (and note anywhere you've changed it from the original) so they can identify the bit you're talking about in the original if they want to
- The style will naturally be strongly influenced by the original wording, but you should phrase it in your own words wherever possible. It's harder to nibble away words from a much longer original than it is to start again and use your own concise phrasing, and you want to demonstrate your own understanding to the reader. You could use the odd original phrase or quotation here or there, but the synopsis needs to be more than a collage of quotations; it's a thing in its own right rather than a cut-down version of the original
- You can also show your own response to the text in the way you use language to guide the reader to what you feel are the key points and (briefly) why. Your own voice doesn't need to be very obvious in the synopsis, as it's about the text rather than your reaction to it, but you have made analytical decisions about what is important, and might want to explain to the reader why these points are significant in understanding the whole
- Keep in mind your reader's questions, either jotting down beforehand what you would want from the synopsis, or as you write and edit. What might the reader be asking? This isn't necessarily your structure, but might prompt you to see it from your reader's perspective and their needs, rather than that of the original writers. For example:
    - What is the main purpose of this text? What did it aim to discover, explain or prove?

- Why was this research done? How significant is it?
- How was the research conducted? What kind of research is it?
- What were the three (or four, five) main things I should be aware of from this paper?
- What is their line of argument?
- What is their overall conclusion, recommendation, finding? Why is that important?

Managing word count

The trick to writing a concise synopsis which keeps within your word limit is not to start from the much bigger original text, but from your own boiled down notes. If you're over the word count, you could start cutting out words that don't seem essential, but if you go too far, you end up with a text which does not read well and doesn't hang together. It might be better to remove whole sentences and perhaps whole points, than nibble away at words here and there(Writing a Synopsis, 2022).

References:

Prachi, A. (2022). *Research Summary: What is it & how to write one*. Retrieved from QuestionPro: https://www.questionpro.com/blog/research summary

Wikipedia. (2022). *Abstract*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Abstract_(summary)

Writing a Synopsis. (2022). Retrieved from NewCastle University: https://www.ncl.ac.uk/academic-skills-kit/assessment/assignment-types/writing-a-synopsis

UNIT: - 12

REFERENCING STYLE AND PREPARATION OF BIBLIOGRAPHY

A referencing style is a set of rules on how to acknowledge the thoughts, ideas and works of others in a particular way. Referencing is a crucial part of successful academic writing, avoiding plagiarism and maintaining academic integrity in your assignments and research.

Examples of reference lists and how to cite different formats

Guides and information	Full name	About the style
ACS	American Chemical Society	Widely used in chemistry and related disciplines.
AGLC (4th edition)	Australian Guide to Legal Citation	The standard Australian guide for referencing in law.
AMJ	Academy of Management Journal style	Based on the style guide for the Academy of Management Journal.
APA (7th edition) **APA (6th edition)**	American Psychological Association	The standard style used in psychology, but it is also widely used in other disciplines, especially in the social sciences.
Chicago (17th edition) notes and bibliography **Chicago (17th edition) Author-Date**	Chicago Manual of Style	The Chicago Manual's footnote referencing system is widely used in the arts and humanities.
CSE	Council of Science Editors	Widely used in the life sciences, and its provisions are also applicable to other scientific disciplines.

Guides and information	Full name	About the style
UQ Harvard		"Harvard style" is not an official referencing style. The UQ Harvard Style is based on the Style manual for authors, editors and printers 6th ed.
IEEE	Institute of Electrical and Electronics Engineers	Widely used in the fields of electrical engineering and computer science.
MLA (9th edition) **MLA (8th edition)**	Modern Language Association of America	Widely used in the fields of modern literature and linguistics.
Vancouver		Vancouver is a generic term for a style of referencing widely used in the health sciences.

Style and essay guides for particular schools and disciplines

The following schools have their own official referencing guides or preferred styles.

Note: You should still check which referencing style your lecturer prefers.

- Business — AMJ (Academy of Management Style) referencing style
- Dentistry — ADJ (Australian Dental Journal) referencing style
- Journalism — Use the ABC Style Guide with the preferred copy edit style for your School
- Music — Style guide for music assignments
- Social Science — Essay Writing Guide
- Veterinary Science - UQ AVJ (Australian Veterinary Journal) referencing style

Other referencing styles

These styles do not have a UQ Library referencing style guide but we have included links to key resources:

ACS (American Chemical Society)

Guide with examples

ACS Style guide from Murdoch University Library - based on the 3rd ed (2006)

Books available via the Library

- ACS guide to scholarly communication, 2020 - online
- The ACS style guide: effective communication of scientific information, 3rd ed (2006) - print

About the style

The style manual of the American Chemical Society (ACS) is in its third edition. It is widely used in chemistry and related disciplines. The ACS manual gives instructions for numbered referencing and also for in-text (Harvard style) referencing.

CSE (Council of Science Editors)

Book and PDF available via the Library

- Scientific style and format: the CSE manual for authors, editors, and publishers, **8th** ed - print book
- CSE **7th** ed, References - full details (PDF, 14 MB) - log in to UQ eSpace to access the PDF

About the style

The manual of the Council of Science Editors (CSE) is in its eighth edition. It was first issued in 1960 by the Council of Biology Editors and is still sometimes referred to as the CBE manual. It is widely used in the life sciences, and its provisions are applicable to other scientific disciplines also. The CSE manual recommends a numbered referencing system, where the reference list is arranged alphabetically by author and numbered accordingly.

IEEE (Institute of Electrical and Electronics Engineers)

Guides with examples

- IEEE Reference Guide (PDF, 1.33 MB) - Version 01-29-2021. The guide outlines how to cite a variety of references

- IEEE Editorial Style Manual - a comprehensive editorial style manual, with a formal set of editorial guidelines, and other guides.

About the style

The Institute of Electrical and Electronics Engineers (IEEE) is the major professional body and publisher in the fields of electrical engineering and computer science. Their style manual is widely used in those disciplines. It uses a numbered reference list (Queensland, 2022).

References:

Queensland, T. U. (2022). *Library*. Retrieved from Referencing Style Guides: https://guides.library.uq.edu.au/referencing

1.7 SELF ASSESSMENT QUESTIONS

2. Define research. How are research methods different from research methodology?
3. Discuss different approaches of research.
4. Differentiate between inductive and deductive; objective and subjective; quantitative and qualitative methods.
5. When deductive approach is used?
6. Discuss the different methods of sampling.
7. Make differences between reference and bibliography.
8. How is summary different from an abstract.
9. What is APA method of referencing?

1.8 STUDY TIPS

- BERG, B. L. (2007). Qualitative Research Methods for the Social Sciences. (6th ed). USA: Pearson Educational Inc
- Berg, B. L. (2009). Qualitative research methods for the social sciences (7th ed.). Pearson International.
- Brillon, M. (1992). Recherchecliniqued'inspirationpsychanalytique: Essaiméthodologique. Revue de l'Association pour la Recherche Qualitative, 7, 7-20.
- Bryman, A. (2001). Social Research Methods. New York: Oxford University Press.
- Carnwell, R., &Daly, W. (2001) Strategies for the Construction of a Critical Review of the LiteratureNurse EducPract1: 57-63.
- Carr, L. T. (2014) The Strengths and Weaknesses of Quantitative and Qualitative Research: What Method for Nursing, Journal of Advanced Nursing, No.20, pp. 716-721.
- Choy, L. T. (2014). The strengths and weaknesses of research methodology: Comparison and complimentary between qualitative and quantitative approaches. *IOSR journal of humanities and social science*, *19*(4), 99-104.
- Cohen, L., Manion, L. & Morrison, K. (2011). Research Methods in Education. (7th ed). London: Routledge.
- Connell, A., & Farrington, D. P. (1996). Bullying among incarcerated young offenders: Developing an interview schedule and some preliminary results. *Journal of Adolescence, 19*(1), 75-93.
- Corbetta, P. (2003). Social research: Theory, methods and techniques. London: SAGE.
- Corbin, J., & Strauss, A. (2008). Basics of qualitative research. London: SAGE Publications Ltd.
- Cronin, P., Ryan, F., & Coughlan,M.(2008). Undertaking a literature review: a step-by-stepapproach. British Journal of Nursing, 17(1): 38-43.
- Cumming, A. (2001). ESL/EFL instructors' practices for writing assessment: Specific purposes or general purposes? Language Testing, 18(2), 207-224. http://dx.doi.org/10.1177/026553220101800206
- Davis, S. M. (2019). When sistahs support sistahs: A process of supportive communication about racial microaggressions among Black women. *Communication Monographs, 86*(2), 133-157.
- Daston, L., &Galison, P. (2021). *Objectivity*. Princeton University Press.
- De Vaus, D. A. (1996). Surveys in Social Research. (4th ed). Australia: UCL Press.

- Denney, A. S., & Tewksbury, R. (2013). How to write a literature review. *Journal of criminal justice education*, *24*(2), 218-234.
- Denscombe, M. (1998). The Good Research for Small –Scale Social Research Project. Philadelphia: Open University Press.
- Denzin, N. K., & Lincoln, Y. S. (2002). The qualitative inquiry reader. London: Sage Publications.
- Denzin, N., & Lincoln, Y. (Eds.). (2005). Handbook of qualitative research (3rd ed.). Thousand Oaks, CA: Sage.
- Dissanayake, D. M. N. S. W. (2013). Research, research gap and the research problem.
- Drapeau, M. (2002). Subjectivity in research: Why not? But…. *The Qualitative Report*, *7*(3), 1-15.
- Drapeau, M., &Letendre, R. (2001). La recherche qualitative d'inspirationpsychanalytique: Quelques propositions pour en augmenter la rigueur. Revue de l'Association pour la Recherche Qualitative, 22, 73-92.
- Gilbert, S. (1998). L'idéal de l'objectivité et objectivitéidéale. Revue de l'Association pour la Recherche Qualitative, 18, 43-170.
- Gillham, B. (2008). *Developing a questionnaire*. A&C Black.
- Good, C. V., Barr, A. S., &Scates, D. E. (1941). *Methodology of educational research*. D Appleton Century Company, New York.
- Gorard, S. (2001). Quantitative Methods in Educational Research: The role of numbers made easy. London: The Tower Building.
- Guba, E. & Lincoln, Y. (1994), "Competing paradigms in qualitative research". In N. Denzin and Y. Lincoln (eds.), Handbook of Qualitative Research (pp. 105-117). California: Sage.
- Guest, G., Namey, E. E., & Mitchell, M. L. (2013). Qualitative research: Defining and designing. *Collecting qualitative data: A field manual for applied research*, 1-40.
- Johnson, B. & Christensen, L. (2012). Educational Research, Qualitative, Quantitative and Mixed Approach. (4th ed). California: SAGE Publication.
- Kabir, S. M. S. (2016). Basic guidelines for research: An introductory approach for all disciplines. *Book Zone Publication*.
- Kahn, W. A. (1996). Comment on "Understanding researcher "projection" in interpreting case study data: The South Canyon fire tragedy. Journal of Applied Behavioral Science, 32(1), 62-69.
- Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. MIS Quarterly, 23(1), 67-93. http://dx.doi.org/10.2307/249410.
- Knopf, J. W. (2006). Doing a literature review. *PS: Political Science & Politics*, *39*(1), 127-132.
- Kothari, C. R. (2004). *Research Methodology: Methods and Techniques.* New Delhi: New Age International (P) Limited Publishers.
- Kralik, D., Visentin, K., & Van Loon, A. (2006). Transition: a literature review. *Journal of advanced nursing*, *55*(3), 320-329.
- Kuhn, T. S. (1977). Objectivity, value judgment, and theory choice. *Arguing about science*, 74-86.
- Kumar, Ranjit. Research Methodology: A Step-by-Step Guide for Beginners. Los Angeles: SAGE, 2011. Print.
- Kumar, R. (2014). *Research Methodology: A Step by Step Guide for Beginners.* New Delhi: SAGE.

- Lazaraton, A., & Taylor, L. (2007). Qualitative research methods in language test development and validation. In Fox et al. (Eds.), Language Testing Reconsidered (pp. 113-130). Ottawa: University of Ottawa Press.
- Leedy P. D., &Ormrod J. E. (2001). Practical research: Planning and design. Merrill: Prentice Hall.
- Leung, C. (2012). Qualitative research in language assessment. The Encyclopedia of Applied Linguistics. http://dx.doi.org/10.1002/9781405198431.wbeal0979.
- Lichtman, M. (2006). Qualitative Research in Education: A User's Guide. London: SAGE Publication.
- McNamara, T. (2001). Language assessment as social practice: Challenges for research. Language Testing, 18(4), 333-349. http://dx.doi.org/10.1177/026553220101800402
- Merriam, S. (2009). Qualitative research: A guide to design and implementation. San Francisco, CA: Jossey-Bass.
- Mucchieli, R. (1979). L'analyse de contenu des documents et des communications. Paris: Éditions ESF.
- Muijs, D. (2004). Doing Qualitative Research in Education with SPSS. London: SAGE Publication.
- Pardede, P. (2018). Identifying and formulating the research problem. *Res. ELT, 1*, 1-13.
- Parkinson, G., &Drislane, R. (2011). Qualitative research. In Online dictionary of the social sciences. Retrieved from http://bitbucket.icaap.org/dict.pl.
- Patten, M. (2016). *Questionnaire research: A practical guide*. Routledge.
- Prachi, A. (2022). *Research Summary: What is it & how to write one*. Retrieved from QuestionPro: https://www.questionpro.com/blog/research summary
- Queensland, T. U. (2022). *Library*. Retrieved from Referencing Style Guides: https://guides.library.uq.edu.au/referencing.
- Ramdhani, A., Ramdhani, M. A., & Amin, A. S. (2014). Writing a Literature Review Research Paper: A step-by-step approach. *International Journal of Basic and Applied Science*, *3*(1), 47-56.
- Ratner, C. (2002, September). Subjectivity and objectivity in qualitative methodology. In *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research* (Vol. 3, No. 3).
- Ravitch, D. (2010). The death and life of the great American school system: How testing and choice are undermining education. New York, NY: Basic Books.
- Rennie, D. L (1994). Human science and counselling psychology: Closing the gap between research and practice. Counselling Psychology Quarterly, 7, 235-250.
- Rennie, D. L. (2000a). Anglo-American counselling and psychotherapy qualitative research. Paper presented at the meeting of the Society for Psychotherapy Research, Chicago, USA.
- Richards, T. J., & Richards, L. (1994). Using computers in qualitative research. In N. Denzin, & Y. Lincoln (Eds.), Handbook of Qualitative Research (pp. 445-462). London: Sage Publications
- Richardson, A. J. (2012). Paradigms, theory and management accounting practice: A comment on Parker (forthcoming) "Qualitative management accounting research: Assessing deliverables and relevance". Critical Perspectives on Accounting, 23(1), 83-88. http://dx.doi.org/10.1016/j.cpa.2011.05.003.
- Roberts, F. S. (2015). The questionnaire method. In *Structure of decision: The cognitive maps of political elites* (pp. 333-342). Princeton University Press.
- Robinson, K. A.,Saldanha, I. J., & Mckoy, N. A. (2011). Frameworks for determining
- research gaps during systematic reviews. Agency for Healthcare Research and Quality.

- Sallee, M. W., & Flood, J. T. (2012). Using qualitative research to bridge research, policy, and practice. Theory Into Practice, 51(2), 137-144. http://dx.doi.org/10.1080/00405841.2012.662873.
- Singh, Y. K. (2006). *Fundamentals of Research Methodology and Statistics.* New Delhi: New Age International (P) Limited Publishers.
- Shank, G. & Brown, L. (2007). Exploring Educational Research Literacy. New York: Routledge.
- Shoket, M. (2014). Research problem: identification and formulation. *International Journal of Research, 1*(4), 512-518.
- Tsushima, R. (2015). Methodological diversity in language assessment research: The role of mixed methods in classroom-based language assessment studies. International Journal of Qualitative Methods, 14(2), 104-121. http://dx.doi.org/10.7748/nr.21.6.28.e1251.
- Wagle, K. (2020). *Research Ethics: Definition, Principles and Advantages*. Retrieved from Public Health Notes: https://www.publichealthnotes.com/research-ethics-definition-principles-and-advantages/
- Wilson, A. (2014). Being a practitioner: An application of Heidegger's phenomenology. Nurse Researcher, 21(6), 28-33. http://dx.doi.org/10.7748/nr.21.6.28.e1251
- Wikipedia. (2022). *Abstract*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Abstract_(summary).
- Wikipeadia. (2022). *Plagiarism*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Plagiarism
- *Writing a Synopsis*. (2022). Retrieved from NewCastle University: https://www.ncl.ac.uk/academic-skills-kit/assessment/assignment-types/writing-a-synopsis.

1.9 DISCLAIMER

This self-learning material is based on different books, journals and web-sources.

Post Graduate Degree Programme (CBCS) in Geography

Semester – II

Paper Code: GEO/CC/T-209

Paper: Cartography and Geoinformatics

Self Learning Material

Directorate of Open and Distance Learning (DODL)
University of Kalyani
Kalyani, Nadia
West Bengal, India

Course Material Compiled By: Dr. S. Choudhary, DODL, K.U.

Published by the Directorate of Open and Distance Learning (DODL),

University of Kalyani, Kalyani-741235, Nadia, West Bengal

July, 2022

Disclaimer: This self-learning material is compiled from different books, journals and web-sources.

Director's Message

Satisfying the varied needs of distance learners, overcoming the obstacle of distance and reaching the unreached students are the threefold functions catered by Open and Distance Learning (ODL) systems. The onus lies on writers, editors, production professionals and other personnel involved in the process to overcome the challenges inherent to curriculum design and production of relevant Self Learning Materials (SLMs). At the University of Kalyani a dedicated team under the able guidance of the Hon'ble Vice-Chancellor has invested its best efforts, professionally and in keeping with the demands of Post Graduate CBCS Programmes in Distance Mode to devise a self-sufficient curriculum for each course offered by the Directorate of Open and Distance Learning (DODL), University of Kalyani.

Development of printed SLMs for students admitted to the DODL within a limited time to cater to the academic requirements of the Course as per standards set by Distance Education Bureau of the University Grants Commission, New Delhi, India under Open and Distance Mode UGC Regulations, 2020 had been our endeavour. We are happy to have achieved our goal.

Utmost care and precision have been ensured in the development of the SLMs, making them useful to the learners, besides avoiding errors as far as practicable. Further suggestions from the stakeholders in this would be welcome.

During the production-process of the SLMs, the team continuously received positive stimulations and feedback from Professor (Dr.) Manas Kumar Sanyal, Hon'ble Vice- Chancellor, University of Kalyani, who kindly accorded directions, encouragements and suggestions, offered constructive criticism to develop it within proper requirements. We gracefully, acknowledge his inspiration and guidance.

Sincere gratitude is due to the respective chairpersons as well as each and every member of PGBOS (DODL), University of Kalyani. Heartfelt thanks is also due to the Course Writers-faculty members at the DODL, subject-experts serving at University Post Graduate departments and also to the authors and academicians whose academic contributions have enriched the SLMs. We humbly acknowledge their valuable academic contributions. I would especially like to convey gratitude to all other University dignitaries and personnel involved either at the conceptual or operational level of the DODL of University of Kalyani.

Their persistent and co-ordinated efforts have resulted in the compilation of comprehensive, learner-friendly, flexible texts that meet the curriculum requirements of the Post Graduate Programme through Distance Mode.

All the Self Learning Materials are self writing and collected from e-book, journals and websites.

Director
Directorate of Open and Distance Learning
University of Kalyani

Syllabus

Semester –II

Paper Code: GEO/CC/T-209

Paper: Cartography and Geoinformatics

Internal Evaluation/ Assessment – 10; Examination/Report/ Viva Voce – 40 (Semester end Examination); Credit – 4; Marks -50

Unit-1: Cartography and Geoinformatics: nature and scope

Unit-2: Concept of Geoid

Unit-3: Spheroids with special reference to Everest and WGS-84

Unit-4: Principles and properties of UTM Projection

Unit-5: Nature of EMR, EMS, and interaction with atmosphere and surface materials

Unit-6: Resolution of satellite data: types and significance

Unit-7: Remote Sensing Platforms and Sensors: Landsat, IRS and Sentinel series

Unit-8: Digital Image Processing – Radiometric correction, Georeferencing and mosaicking

Unit-9: FCC preparation and Image Classification

Unit-10: Digital Elevation Model: types and sources

Unit-11: Analytical Modelling in GIS, GNSS-GIS integration

Unit-12: Concept of bigdata, machine learning and deep learning

Contents

1.1. Introduction

This paper aims to introduce Cartography and Geoinformatics to the students of Geography of the second semester. It is one of the most dynamic disciplines and also one of the most relevant in the current scenario. Hence, this paper will help the students to get an exposure to the latest techniques of map making.

1.2. Learning Objectives

- Cartography and Geoinformatics: nature and scope
- Concept of Geoid
- Spheroids with special reference to Everest and WGS-84
- Principles and properties of UTM Projection
- Nature of EMR, EMS, and interaction with atmosphere and surface materials
- Resolution of satellite data: types and significance
- Remote Sensing Platforms and Sensors: Landsat, IRS and Sentinel series
- Digital Image Processing – Radiometric correction, Georeferencing and mosaicking
- FCC preparation and Image Classification
- Digital Elevation Model: types and sources
- Analytical Modelling in GIS, GNSS-GIS integration
- Concept of bigdata, machine learning and deep learning

1.3. Assessment of Prior Knowledge

- Discussions regarding Survey of India Topographical maps, Open Series Maps
- Discussions regarding Projections, Datums and scale

1.4. Learning activities

Classroom seminars/ discussions regarding various topics covered under this paper may be done

1.5. Feedback of learning activities

Class tests may be arranged.

1.6. Examples and Illustrations

Unit-1: Cartography and Geoinformatics: nature and scope

The meaning of the term 'cartography' has changed fundamentally since 1960. Before this time cartography was generally defined as 'manufacturing maps'. The change in the definition has originated from the fact that the subject has been put in the field of communication sciences and by the advent of the computer. Under the influence of the former cartography nowadays is seen as '*the conveying of geospatial information by means of maps*'. This results in the view that not only the manufacturing of maps but also their use is regarded as belonging to the field of cartography. And it is indeed evident that only by investigating the use of maps and the processing of the mapped information by their beholders is it possible to check whether the information in the maps was represented in the best way.

The unsatisfactory aspect in the definition above of 'the conveying of geospatial data by means of maps' is that the concept '*map*' has not yet been defined. The elements that belong in a definition of maps are geospatial information, graphic representation, scale and symbols. A possible definition of a map runs as follows: '*a graphic model of the geospatial aspects of reality*'. According to French cartographers the map is '*a conventional image, mostly on a plane, of concrete or abstract phenomena which can be located in space*'. By 'conventional' it is meant that one works with conventions, such as the fact that the sea is represented in blue, that the north is at the top of the map, or that some graded series of circles denotes settlements with increasing population numbers. By 'image' the graphic character of a map is stressed. But not all maps are printed on a sheet of paper: relief models and globes are also considered to be maps. It is, of course, also possible to map phenomena that are not physically tangible, such as political preferences or language borders. And it is obvious that it must be possible to locate the phenomena in space.

Under the influence of the rise of the computer and geographic information systems in the field of mapping, new definitions of cartography have gradually emerged: '*the information transfer that is centered about a spatial data base which can be considered in itself a multifaceted model of geographic reality. Such a spatial data base then serves as the central core of an entire sequence of cartographic processes, receiving various data inputs and dispersing various types of information products*' (Guptill and Starr, 1984).

Taylor (1991) defines cartography as *'the organisation, presentation, communication and utilisation of geoinformation in graphic, digital or tactile form. It can include all stages from data preparation to end use in the creation of maps and related spatial information products'*. Hence, we can define cartography as: making accessible spatial data, emphasizing its visualization and enabling interaction with it, aimed at dealing with geospatial issues. Taylor's definition still requires 'map' to be defined, and therefore the map definition by Board (1990) is quoted: *'a representation or abstraction of geographic reality. A tool for presenting geographic information in a way that is visual, digital or tactile'*. In the current strategic plan of the International Cartographic Association the map is defined as: *'A symbolised representation of a geographical reality, representing selected features and characteristics, resulting from the creative effort of its author's execution of choices, and designed for use when spatial relationships are of primary relevance'*.

The usefulness of a map depends not only on its contents but also on its scale. The map scale is the ratio between a distance on a map and the corresponding distance in the terrain. There are several possibilities to indicate the map scale. Next to a verbal description (such as one inch to the mile), a representative fraction (like 1:1000) or a graphic representation can be used. The representative fraction means that 1 cm on the map corresponds to 1000 cm (10 m) in the terrain. The scale bar represents a distance of 10 km. When the representative fraction is small, a map is considered to have a large scale. Confusion exists about the concepts *large scale* and *small scale*. In everyday linguistic usage, small scale is linked with small areas; in mapping this is used in the reverse sense: small scales in cartography are linked with large areas that are represented on a small map area. A large scale in cartography is connected with a small area, about which detailed data are presented on a relatively large map area. Technically the linguistic usage in cartography is correct: a large scale is represented as a fraction which has a relatively small figure in the denominator: a smaller scale represents a smaller value, thus a bigger figure in the denominator.

When scales are changed, generalization becomes necessary, as not all the information from large-scale maps can be incorporated in small-scale maps in a legible way. In socio-economic thematic maps this generalization usually takes the form of aggregation: smaller enumeration units are taken together to form larger units. If the last grouping had been effectuated according to nodal regions (groups of municipalities oriented on the same large towns) then these differences would have been even less outspoken.

Traditionally, the main division of maps is between topographic and thematic maps. Topographic maps supply a general image of the Earth's surface: roads, rivers, houses, often the nature of the vegetation, the relief and the names of the various mapped objects. Thematic maps represent the distribution of one particular phenomenon. In order to illustrate this distribution properly every thematic map, as a basis, needs topographic information; often this would be provided by a thinned-out version of a topographic map.

A thematic map would also emerge, if one aspect of the topographic map – such as motorways or windmills – is especially highlighted, so that the other data categories on the map could be perceived as ground.

In a digital environment the differentiation between topographic maps and thematic maps grows less relevant, as both map types consist of a number of layers – a topographic map would be a combination of separate road and railway layers, a settlement layer, hydrography, a contour lines layer, a geographical names layer and a land cover layer. Each of these would be a thematic map in itself; a combination of these layers in which each data category had the same visual weight would be a topographic map. When one category is graphically emphasized or highlighted, and the others thereby relegated the status of ground, then it would again change into a thematic map.

The topographic base of a thematic map can even be far more schematic than an excerpt from a topographic map. In the representation of socio-economic phenomena, the data are gathered for enumeration areas instead of at individual locations (as would be the case for physical

phenomena), the boundary files are usually strongly generalized, so as to distract from the map theme as little as possible.

People form for themselves a mental model of reality. For example, after living in a village for some time one would operate, while transversing the village for one's daily chores, on the basis of this mental construct, which operates like a *virtual map*; when someone else asks for directions, one would consult this mental construct in order to provide an answer. Answering the request could also be done by drawing a sketch map, a '*mental map*' which is a permanent print-out from our mental construct of reality, designed for answering a specific request for directions from and to random locations. Such a mental construct (we could also call it a cognitive map) can be generated not only from one's contact with reality but also through consulting a proper, tangible paper map (a '*permanent map*', or hardcopy map in computer talk). When one is an experienced map user, one would be able to grasp the essential information from a paper map and store this in one's mind. This process can also take place from a map displayed temporarily on a monitor screen (a '*temporal map*', which is visible but not tangible). This temporal map can have been generated from a geospatial database stored in the computer, from which a specific selection has been made in order to answer specific requirements or objectives. This geospatial database, which can also be used to produce other maps, functions as a *virtual map* therefore, in the same way as different sketch maps can be produced from one's mental perception of reality.

Maps can be said to show three dimensions of the phenomena represented: the nature or the value of the objects and their location. The location is defined at the hand of the *x*- and *y*-coordinates; the nature or value is considered as the *z*-coordinate. It is one of the tasks of cartography to have the *z*-coordinate stand out sufficiently to provide map readers an adequate vision of the mapped area's relief (Jan Kraak & Ormeling, 2010).

References:

Jan Kraak, M., & Ormeling, F. (2010). *Cartography: Visualization of Geospatial Data.* Essex: Pearson Education Limited.

Unit-2: Concept of Geoid

An even more faithful figure of the earth, called the geoid (meaning earthlike), deviates ever so slightly from the ellipsoid in an irregular manner. The geoid is the three-dimensional shape that would be approximated by mean sea level in the oceans and the surface of a series of hypothetical sea-level canals crisscrossing the continents. In more technical terms, it is a sea level equipotential surface-the surface on which gravity is everywhere equal to its strength at mean sea level. If the earth were of uniform geological composition and de void of mountain ranges, ocean basins, and other vertical irregularities, the geoid surface would match the ellipsoid exactly. However, due primarily to variations in rock density and topographic relief, the geoid surface deviates from the ellipsoid by up to 300 ft. (100 m.) in certain locations. Note that the "hills and valleys" on the geoid do not correspond with continents and oceans. Indeed, the highest point on the geoid is 75 meters above the ellipsoid in New Guinea, and the lowest point is 104 meters below at the southern tip of India.

Cartographic Use of the Sphere, Ellipsoid, and Geoid

Cartographers use these three approximations to the earth's true shape in different ways. The authalic sphere is the reference surface of for small-scale maps countries, continents, and larger areas. This is because the difference between sphere and ellipsoid is negligible when mapping large areas in a general manner on page-size maps. There is also a significant increase in the complexity of map projection equations for the ellipsoid. In addition, the spherical and spheroidal equations for a particular map projection give essentially the same results for small-scale maps. Thus, it makes sense to use the sphere for these small-scale maps. With large scale maps, however, it's a different story. With detailed, large-scale maps of small areas, such as topographic maps and nautical charts, the differences between locations on the spherical and ellipsoidal approximations can be significant, and we need to take the earth's oblateness into account. Distances, directions, and areas measured on these detailed maps would be incorrect at individual locations if the authalic sphere were used. Therefore, cartographers use the ellipsoid as the reference surface for these large-scale maps. Using the ellipsoid also ties in well with modern data collection methods for large-scale mapping. Global positioning satellite receivers for example, compute latitude, longitude, and elevation using the WGS 84 ellipsoid as the reference surface. The geoid is the reference surface for ground surveyed horizontal and vertical positions. Horizontal positions are adjusted to the ellipsoid sur face, however, since the irregularities on the would make geoid map projection and other mathematical computations extremely complex. On the other hand, elevations are determined relative to the mean sea level geoid (Robinson, Morrison, Muehrcke, Kimberling, & Guptill, 2009).

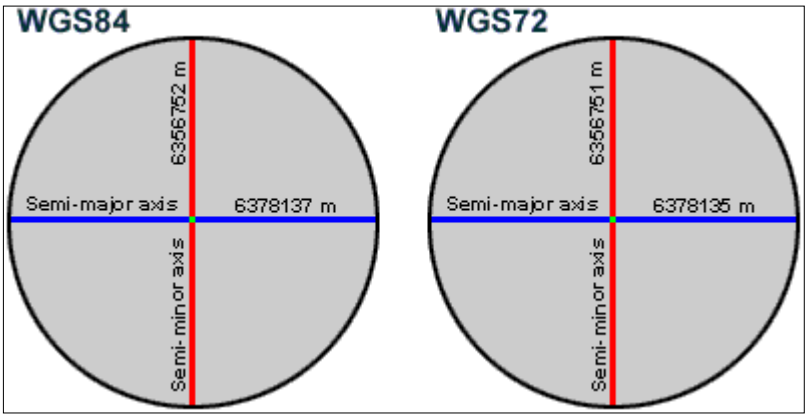
References:

Robinson, A. H., Morrison, J. L., Muehrcke, P. C., Kimberling, A. J., & Guptill, S. C. (2009). *Elements of Cartography.* Wiley.

Unit-3: Spheroids with special reference to Everest and WGS-84

The earth's shape is a spheroid

Although the earth's shape is technically an ellipsoid, its major and minor axes do not vary greatly. In fact, its shape is so close to a sphere that it is often called a spheroid rather than an ellipsoid.



A spheroid is simply an ellipsoid that approximates a sphere. These examples are two common world spheroids used today with their values rounded to the nearest meter. For each spheroid, the difference between its major axis and its minor axis is less than 0.34 percent.

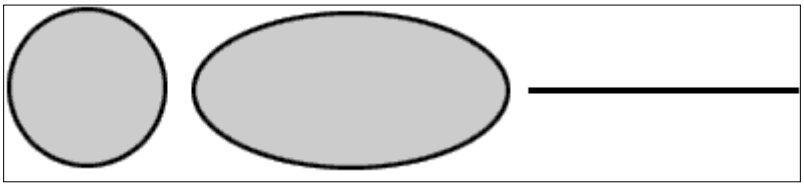
The terms "spheroid" and "ellipsoid" are often used interchangeably and have caused confusion for many GIS users. Most map projection authorities consider both terms equally correct. Specific definitions for exactly what a spheroid is can vary, but the two most common definitions for a spheroid are:

1. An ellipsoid that approximates the shape of a sphere
2. An ellipsoid created by rotating an ellipse about either its major axis (called a *prolate spheroid*) or its minor axis (called an *oblate spheroid*)

The second definition is generally considered a more precise geometric definition because it doesn't involve any subjectivity. Using this definition, the earth's shape would be described as an oblate spheroid. To most people, however, the first spheroid definition better describes the earth's shape, so that will be the definition used in this course.

Defining ellipticity

The degree of ellipticity, or flattening, of an ellipse, ellipsoid, or spheroid can be expressed as a fraction or decimal measuring the difference in the length of the two axes. For example, if you assign two axes to a circle, and measure both of them, the resulting difference will be 0. A circle's ellipticity is therefore 0. As an ellipse becomes more elongated its ellipticity increases. Eventually, it approaches the shape of a line, which has an ellipticity of 1.



A circle has an ellipticity equal to 0 because the length of both axes is the same. The example ellipse above has an ellipticity of 0.5 because the major axis is twice as long as the minor axis. A line has an ellipticity of 1 because it has length but no height.

Large elliptical values describe narrow ellipses or ellipsoids and small elliptical values represent almost circular ellipses or spheroids. Earth's ellipticity is approximately 0.003353 because it bulges slightly at the equator and is flattened at the poles. While this difference doesn't seem like much, it can greatly affect large-scale maps.

Why do we need different spheroids?

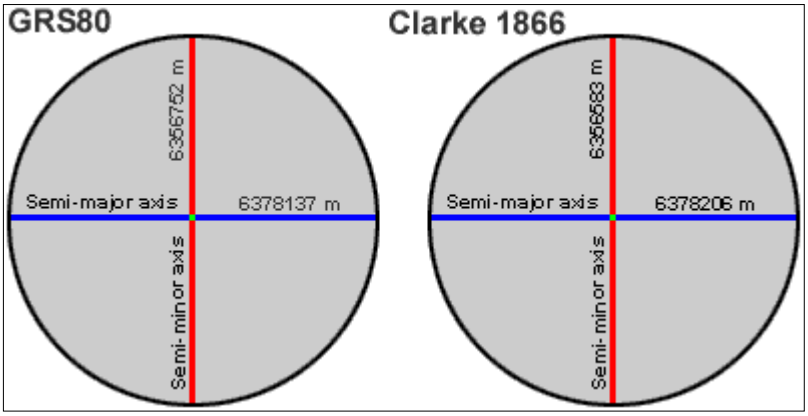
Now you know that the earth is a spheroid (which is another word for ellipsoid). As you may have suspected, however, it is not a perfect spheroid. The earth's surface is not perfectly symmetrical, so the semi-major and semi-minor axes that fit one geographical region do not necessarily fit another one.

Satellite technology has revealed several elliptical deviations. For one thing, the most southerly point on the minor axis (the South Pole) is closer to the major axis (the equator) than is the most northerly point on the minor axis (the North Pole). In addition, the earth's spheroid deviates slightly for different regions of the earth.

Many different spheroids are used throughout the world to account for these deviations. For example, the International 1924 and the Bessel 1841 spheroids are used in Europe while in North America the GRS80 spheroid is the most common. Ignoring deviations and using the same spheroid for all locations on the earth could lead to errors of several meters, or in extreme cases hundreds of meters, in measurements on a regional scale.

Because of improvements in technology, refinements in measurements, or for political reasons, you may see different spheroids used for the same geographic area. For example, until recently,

the Clarke 1866 spheroid was the most commonly used spheroid for North America. Today, the GRS80 spheroid is replacing Clarke 1866 in most geographic databases. However, just because a spatial database covers North America, you cannot assume it uses the GRS80 spheroid. Many North American databases have not yet been converted from Clarke 1866.



Spheroids created using satellite information, such as GRS80, are starting to replace traditional ground-measured spheroids, such as Clarke 1866. In this example, measurements for both spheroids have been rounded to the nearest meter.

As technology improves, more spheroids of higher local accuracy will be developed. Remember that changing spheroids changes the location values for the features you are mapping. Because of the complexity of changing spheroids, ground-measured spheroids will remain in use for several years.

When to use a sphere

Although a spheroid best represents the earth's shape, the earth is sometimes treated as a sphere to make mathematical calculations easier.

You can use a variety of methods to define a sphere that approximates the earth's shape. For instance, you could base your sphere on either the major axis or the minor axis of the earth (as defined by a particular spheroid). The most commonly accepted method, however, is to create a sphere that has the same surface area as the spheroid. Such a sphere is called an *authalic sphere*. Although there are discrepancies between authalic spheres, the most common authalic sphere diameter used is 12,741.994 kilometers or 7,912.778 miles.

While difference between the semi-major and semi-minor axes must be considered in regional applications, for most world maps the difference can be ignored and the world can be treated as a sphere. In fact, the difference is so small that for this graphic it would be undetectable.

If your mapping scales are smaller than 1:5,000,000 (small-scale maps), you can use an authalic sphere to define the earth's shape. To give you some perspective, a 1:5,000,000 scale map of the coterminous United States would be approximately 122cm (48") wide. At this scale, the difference between a sphere and a spheroid is not significant. If your applications use scales that are larger than this, you may need to choose a spheroid (Geohunter).

Everest and WGS-84 Spheroid

India and other countries of the world made measurements in their countries and defined reference surface to serve as Datum for mapping. In India the reference surface was defined by Sir George Everest, who was Surveyor General of India from 1830 to 1843. It has served as reference for all mapping in India. Indian system can be called Indian Geodetic System as all coordinates are referred to it. The reference surface was called Everest Spheroid.

The initial point for mapping on the surface of the Earth was chosen at Kalyanpur in Central India. On realization of the system it was found that our system is in error and the assumptions have not been fully met. It is estimated that centre of Everest Spheroid is nearly a kilometre from the centre of gravity of the Earth. It is also realized that minor axis is not parallel to polar axis but inclined to it by a few seconds. The system is therefore a local one and needs to be redefined, as it is not suitable for defence and scientific applications. The system will not be suitable for launching Inter Continental Ballistic Missiles.

WGS 84 is an accurate system as its center is estimated to be only + or – 2 meters away from the center of gravity of the Earth. It will be fair to assume that assumptions in this case are almost met. The system is therefore most suitable for higher defence and scientific applications (Agrawal).

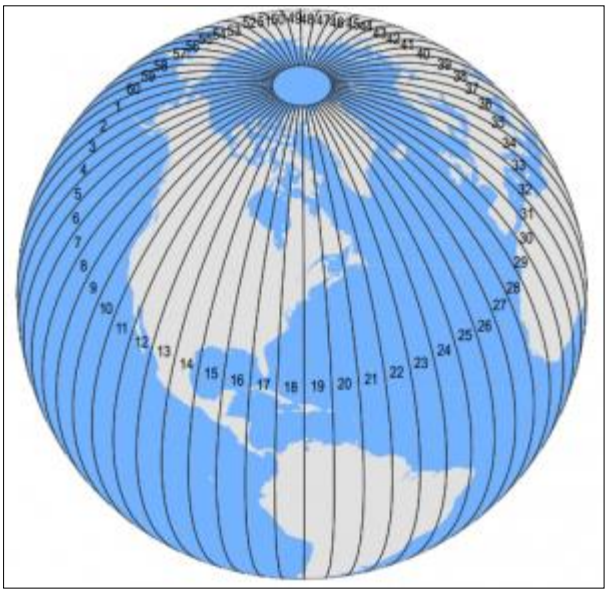
References:

Agrawal, N. K. *Coordinates*. Retrieved from https://mycoordinates.org

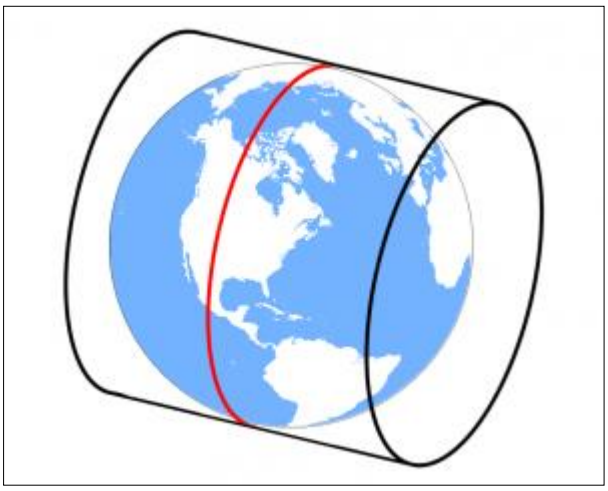
Geohunter. Retrieved from Geohunter: http://www.geo.hunter.cuny.edu

Unit-4: Principles and properties of UTM Projection

It's one of the most common **map projections** today. But how does the Universal Transverse Mercator work? A UTM zone is a 6° segment of the Earth. Because a circle has 360°, this means that there are 60 UTM zones on Earth (360 ÷ 6 = 60).



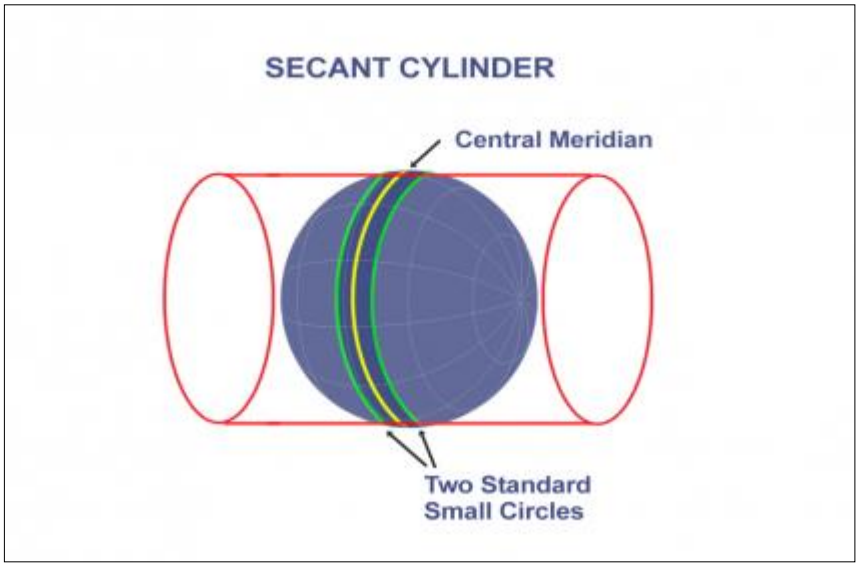
The Mercator uses an upright cylinder for its map projection. The Transverse Mercator takes a cylinder and places it on its side (rotates it 90°), as pictured below – which is how the term "transverse" is derived. However, the Universal Transverse Mercator places this cylinder **60 times for each UTM zone**. This means that all 60 wedges are flattened out with a transverse cylinder. Each time it's slightly rotated using a different meridian as a central line.



UTM applies a secant cylinder that intersects the ellipsoid along two small circles parallel to the **central Meridian**. This means that scale is constant north-south along the Meridians. But

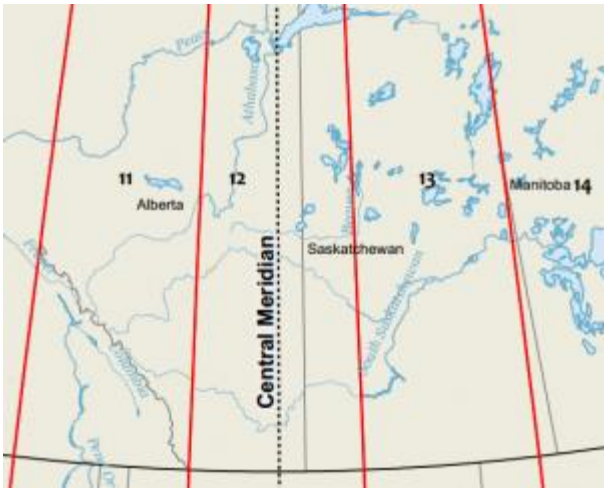
scale varies east-west along parallels. The two small circles are 180 kilometers east and west of the central Meridian at the Equator. The small circles have a scale factor of 1, meanindistance of 100 meters in the ellipsoid would be the same on the map projection.

The centerline of a UTM grid zone has a scale factor of 0.9996. This means that a distance of 100 meters on an ellipsoid would be 99.96 meters on a map.



False Easting and Northing

Instead of using **latitude and longitude coordinates**, each 6° wide UTM zone has a **central meridian of 500,000 meters**. This central meridian is an arbitrary value convenient for avoiding any negative easting coordinates. All easting values east and west of the central meridian will be positive. If you're in the northern hemisphere, the equator has a northing value of 0 meters. In the southern hemisphere, the equator starts at 10,000,000 meters. This is because all values south of the equator will be positive. This is called a "false-northing" because y-coordinates in the southern geographic region will avoid negative values.



UTM Projection Distortions

The UTM projection minimizes distortion within that zone. So this means that when you want to show features in **several UTM zone**, it starts becoming a poor choice of map projection. Distortion is small near the central meridian, and as you move away it worsens. So this makes it **most fitting for narrow regions** and not well-suited for world maps.

Just like every map projection, the Universal Transverse Mercator has its strength and weaknesses. It is up to the map-maker to determine what projection is most favorable for its purpose. The Universal Transverse Mercator was really meant to map features in **one UTM zone at a time** (GISGeography).

Latitude bands

Each zone is segmented into 20 latitude bands. Each latitude band is 8 degrees high, and is lettered starting from "C" at 80°S, increasing up the English alphabet until "X", omitting the

letters "I" and "O" (because of their similarity to the numerals one and zero). The last latitude band, "X", is extended an extra 4 degrees, so it ends at 84°N latitude, thus covering the northernmost land on Earth.

Latitude bands "A" and "B" do exist, as do bands "Y" and "Z". They cover the western and eastern sides of the Antarctic and Arctic regions respectively. A convenient mnemonic to remember is that the letter "N" is the first letter in "northern hemisphere", so any letter coming before "N" in the alphabet is in the southern hemisphere, and any letter "N" or after is in the northern hemisphere.

Notation

The combination of a zone and a latitude band defines a grid zone. The zone is always written first, followed by the latitude band. For example, (see image, top right), a position in Toronto, Ontario, Canada, would find itself in zone 17 and latitude band "T", thus the full grid zone reference is "17T". The grid zones serve to delineate irregular UTM zone boundaries. They also are an integral part of the military grid reference system.

A note of caution: A method also is used that simply adds N or S following the zone number to indicate North or South hemisphere (the easting and northing coordinates along with the zone number supplying everything necessary to geolocate a position except which hemisphere). However, this method has caused some confusion since, for instance, "50S" can mean southern hemisphere but also *grid zone* "50S" in the northern hemisphere. There are many possible ways to disambiguate between the two methods, two of which are demonstrated later in this article (Wikipedia).

References:

GISGeography. (n.d.). *GISGeography*. Retrieved 08 01, 2022, from https://gisgeography.com/utm-universal-transverse-mercator-projection/

Wikipedia. (n.d.). *Universal Transverse Mercator coordinate system*. Retrieved 08 01, 2022, from Wikipedia: https://en.wikipedia.org/wiki/Universal_Transverse_Mercator_coordinate_system

UNIT 5: NATURE OF EMR, EMS, AND INTERACTION WITH ATMOSPHERE AND SURFACE MATERIALS

Energy Sources and Radiation Principles

Remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation.

Visible light is only one of many forms of electromagnetic energy. Radio waves, ultraviolet rays, radiant heat, and X-rays are other familiar forms. All this energy is inherently similar and propagates in accordance with basic wave theory. The distance from one wave peak to the next is the wavelength λ, and the number of peaks passing a fixed point in space per unit time is the wave frequency υ.

From basic physics, waves obey the general equation (1.1)

$$\boldsymbol{c = \upsilon\lambda}$$

Because c is essentially a constant (3×10^8 m/sec), frequency ν and wavelength λ for any given wave are related inversely, and either term can be used to characterize a wave.

The "visible" portion of electromagnetic spectrum is an extremely small one, because the spectral sensitivity of the human eye extends only from about 0.4 μm to approximately 0.7 μm. The colour "blue" is ascribed to the approximate range of 0.4 to 0.5 μm, "green" to 0.5 to 0.6 μm, and "red" to 0.6 to 0.7μm. Ultraviolet (UV) energy adjoins the blue end of the visible portion of the spectrum. Beyond the red end of the visible region are three different categories of infrared (IR) waves: near IR (from 0.7 to 1.3 μm), mid IR (from 1.3 to 3 μm; also referred to as shortwave IR or SWIR), and thermal IR (beyond 3 to 14 μm, sometimes referred to as longwave IR). At much longer wavelengths (1 mm to 1 m) is the microwave portion of the spectrum.

Although many characteristics of electromagnetic radiation are most easily described by wave theory, another theory offers useful insights into how electromagnetic energy interacts with matter. This theory—**the particle theory**—suggests that electromagnetic radiation is composed of many discrete units called photons or quanta. The energy of a quantum is given as (Eq. 1.2)

$$\boldsymbol{Q = h\upsilon}$$

where

Q = energy of a quantum*;* joules (J)

h = Planck's constant, 6.626×10^{-34} J sec

v = Frequency

We can relate the wave and quantum models of electromagnetic radiation behaviour by solving Eq. 1.1 for $\boldsymbol{v}$ and substituting into Eq. 1.2 to obtain (Eq. 1.3)

$$\boldsymbol{Q = \frac{hc}{\lambda}}$$

Thus, we see that the energy of a quantum is inversely proportional to its wavelength. The longer the wavelength involved, the lower its energy content. This has important implications in remote sensing from the standpoint that naturally emitted long wavelength radiation, such as microwave emission from terrain features, is more difficult to sense than radiation of shorter wavelengths, such as emitted thermal IR energy. The low energy content of long wavelength radiation means that, in general, systems operating at long wavelengths must "view" large areas of the earth at any given time in order to obtain a detectable energy signal.

The sun is the most obvious source of electromagnetic radiation for remote sensing. However, all matter at temperatures above absolute zero (0 K, or - 273^0C) continuously emits electromagnetic radiation. Thus, terrestrial objects are also sources of radiation, although it is of considerably different magnitude and spectral composition than that of the sun. How much energy any object radiates is, among other things, a function of the surface temperature of the object. This property is expressed by the **Stefan–Boltzmann law**, which states that (1.4)

$$\boldsymbol{M = \sigma T^4}$$

where

M = total radiant exitance from the surface of a material*;* watts $(W)^{-2}$

σ = *Stefan–Boltzmann constant*, 5. 6697×10^{-8} W m^{-2} K^{-4}

T = absolute temperature (K) of the emitting material

It is important to note that the total energy emitted from an object varies as T^4 and therefore increases very rapidly with increases in temperature. Suffice it to say for now that the energy emitted from an object is primarily a function of its temperature, as given by Eq. 1.4.

The dominant wavelength, or wavelength at which a blackbody radiation curve reaches a maximum, is related to its temperature by **Wien's displacement law** (1.5)

$$\boldsymbol{\lambda m = \frac{A}{T}}$$

where,

λm = Wavelength of maximum spectral radiant exitance, μm

A = 2898 μm K

T = temperature, K

Thus, for a blackbody, the wavelength at which the maximum spectral radiant exitance occurs varies inversely with the blackbody's absolute temperature. We observe this phenomenon when a metal body such as a piece of iron is heated. As the object becomes progressively hotter, it begins to glow and its colour changes successively to shorter wavelengths—from dull red to orange to yellow and eventually to white.

The earth's ambient temperature (i.e., the temperature of surface materials such as soil, water, and vegetation) is about 300 K (27°C). From Wien's displacement law, this means the maximum spectral radiant exitance from earth features occurs at a wavelength of about 9.7 μm. Because this radiation correlates with terrestrial heat, it is termed "thermal infrared" energy. This energy can neither be seen nor photographed, but it can be sensed with such thermal devices as radiometers and scanners. By comparison, the sun has a much higher energy peak that occurs at about 0.5 μm.

Energy Interactions in the Atmosphere

The atmosphere can have a profound effect on, among other things, the intensity and spectral composition of radiation available to any sensing system. These effects are caused principally through the mechanisms of atmospheric scattering and absorption.

Scattering

Atmospheric scattering is the unpredictable diffusion of radiation by particles in the atmosphere. Rayleigh scatter is common when radiation interacts with atmospheric molecules and other tiny particles that are much smaller in diameter than the wavelength of the interacting radiation. The effect of **Rayleigh scatter** is inversely proportional to the fourth power of wavelength. Hence, there is a much stronger tendency for short wavelengths to be scattered by this mechanism than long wavelengths.

Another type of scatter is **Mie scatter**, which exists when atmospheric particle diameters essentially equal the wavelengths of the energy being sensed. Water vapour and dust are major causes of Mie scatter. This type of scatter tends to influence longer wavelengths compared to Rayleigh scatter. Although Rayleigh scatter tends to dominate under most atmospheric conditions, Mie scatter is significant in slightly overcast ones.

A more bothersome phenomenon is **nonselective** scatter, which comes about when the diameters of the particles causing scatter are much larger than the wavelengths of the energy being sensed. Water droplets, for example, cause such scatter. They commonly have a diameter in the range 5 to 100 μm and scatter all visible and near- to mid-IR wavelengths about equally. Consequently, this scattering is "nonselective" with respect to wavelength. In the visible wavelengths, equal quantities of blue, green, and red light are scattered; hence fog and clouds appear white.

Absorption

In contrast to scatter, atmospheric absorption results in the effective loss of energy to atmospheric constituents. This normally involves absorption of energy at a given wavelength. The most efficient absorbers of solar radiation in this regard are water vapour, carbon dioxide, and ozone. Because these gases tend to absorb electromagnetic energy in specific wavelength bands, they strongly influence the design of any remote sensing system. The wavelength ranges in which the atmosphere is particularly transmissive of energy are referred to as atmospheric windows.

Energy Interactions with Earth Surface Features

When electromagnetic energy is incident on any given earth surface feature, three fundamental energy interactions with the feature are possible. Various fractions of the energy incident on the element are reflected, absorbed, and/or transmitted. Applying the principle of conservation of energy, we can state the interrelationship among these three energy interactions as (1.6)

$$E_I(\lambda) = E_R(\lambda) + E_A(\lambda) + E_T(\lambda)$$

where

E_I = incident energy

E_R = reflected energy

E_A = absorbed energy

E_T = transmitted energy

with all energy components being a function of wavelength λ.

Spectral Response Patterns

Because spectral responses measured by remote sensors over various features often permit an assessment of the type and/or condition of the features, these responses have often been referred to as **spectral signatures**.

Although it is true that many earth surface features manifest very distinctive spectral reflectance and/or emittance characteristics, these characteristics result in spectral "**response patterns**" rather than in spectral "signatures." The reason for this is that the term signature tends to imply a pattern that is absolute and unique. This is not the case with the spectral patterns observed in the natural world. Spectral response patterns measured by remote sensors may be quantitative, but they are not absolute. They may be distinctive, but they are not necessarily unique.

Atmospheric Influences on Spectral Response Patterns

The atmosphere affects the "brightness," or radiance, recorded over any given point on the ground in two almost contradictory ways. First, it attenuates (reduces) the energy illuminating a ground object (and being reflected from the object). Second, the atmosphere acts as a reflector itself, adding scattered, extraneous path radiance to the signal detected by the sensor.

Geometric Influences on Spectral Response Patterns

The geometric manner in which an object reflects energy is an important consideration. This factor is primarily a function of the surface roughness of the object. **Specular reflectors** are flat surfaces that manifest mirror-like reflections, where the angle of reflection equals the angle of incidence. **Diffuse** (or **Lambertian**) reflectors are rough surfaces that reflect uniformly in all directions. Most earth surfaces are neither perfectly specular nor perfectly diffuse reflectors. Their characteristics are somewhat between the two extremes.

Diffuse reflections contain spectral information on the "colour" of the reflecting surface, whereas specular reflections generally do not. Hence, in remote sensing, we are most often interested in measuring the diffuse reflectance properties of terrain features.

(Lillesand, Kiefer, & Chipman, 2015).

References:

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote Sensing and Image Interpretation.* USA: Wiley.

UNIT-6: RESOLUTION OF SATELLITE DATA: TYPES AND SIGNIFICANCE

Remote sensing images are characterised by their spectral, spatial, radiometric, and temporal resolutions.

Spatial resolution refers to the smallest features in the scene that can be separated (resolved) (Pushkar, Younan, & King, 2008).

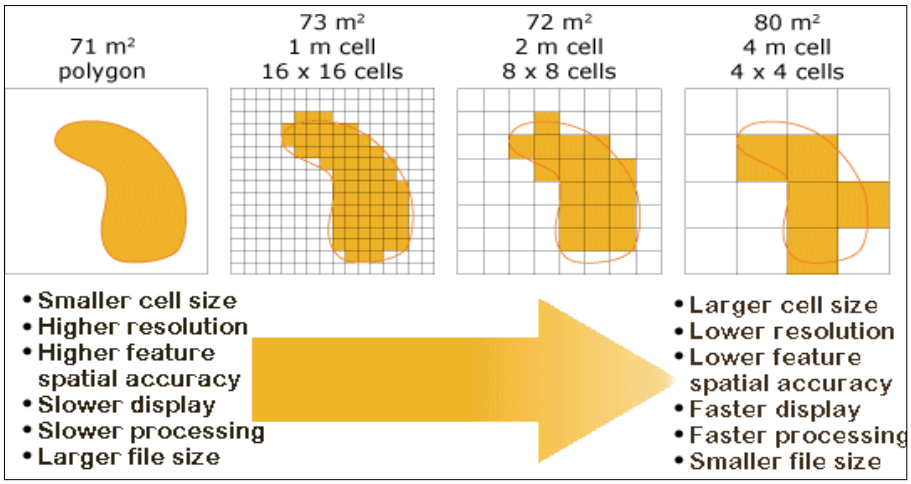


Figure 6.1: Spatial resolution (Image Cortsey ESRI)

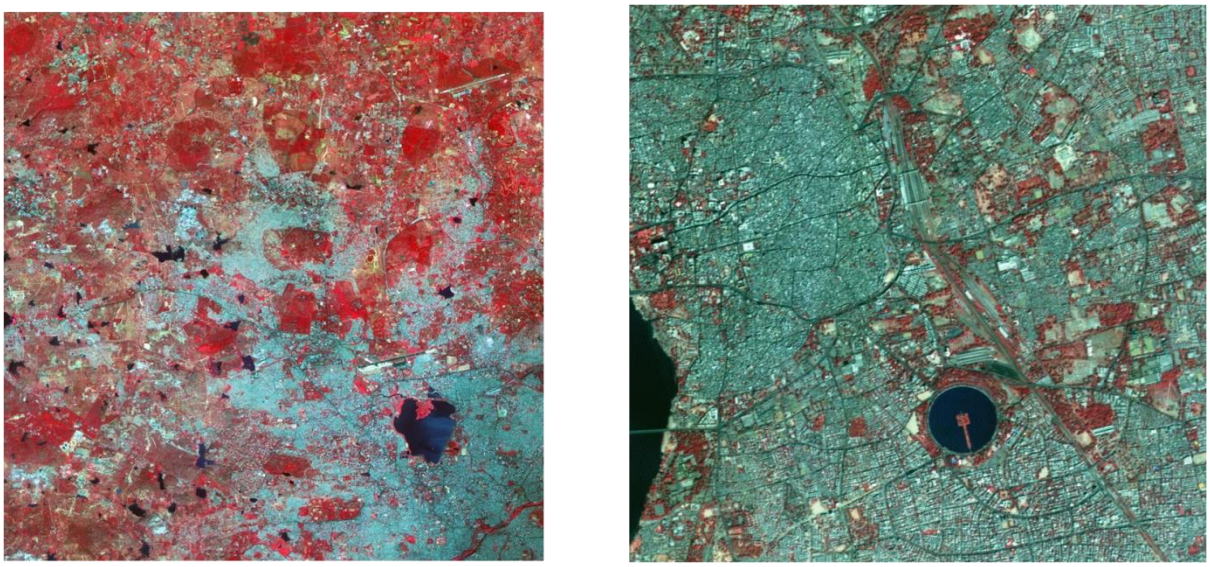


Figure 6.2: IRS –P6: LISS –III Image of part of Hyderabad City (23 m) Vs. IRS –P6: LISS – IV

Image of part of Ahmedabad City (5.8 m) (Image Courtsey – IIRS, ISRO).

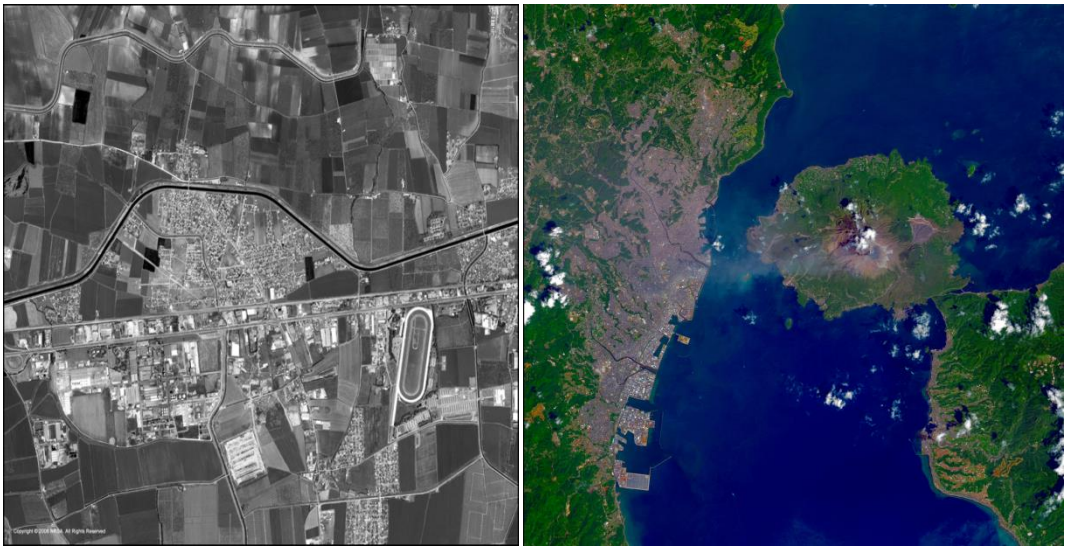


Figure 6.3: CARTOSAT-1 (2.5m) Adana, Turkey (Left) Landsat8 (15m) Sakurajima Volcano Kyushu, Japan (Right)

Figure 6.4: Worldview-2 (0.5m)- Fukushima Daiichi Nuclear Facility- Tsunami Damage, March 14, 2011(Left) ; GeoEye-1 (0.5 m)- Pearl Harbor, December 07, 2011 (Right)

Figure 6.5: IKONOS Satellites (0.8 m), Tadco Farms, Saudi Arabia, September 15, 2004 (Left); QuickBird (0.61 m)- FIFA World Cup Stadium 2010 (Right)

Spectral resolution refers to the bandwidth and the sampling rate over which the sensor gathers information about the scene. High spectral resolution is characterised by a narrow bandwidth (Pushkar, Younan, & King, 2008).

The **radiometric resolution** refers to the dynamic range or the total number of discrete signals of particular strengths that the sensor can record. A larger dynamic range for a sensor results in more details being discernible in the image. The Landsat 7 sensor records 8-bit images; thus it can measure 256 unique grey values of the reflected energy while Ikonos-2 has an 11-bit radiometric resolution (2048 grey values). In other words, a higher radiometric resolution allows for simultaneous observation of high and low contrast objects in the scene.

The **temporal resolution** refers to the time elapsed between consecutive images of the same ground location taken by the sensor. Satellite-based sensors, based on their orbit, may dwell continuously on an area or revisit the same area every few days. The temporal characteristic is helpful in monitoring land use changes (Pushkar, Younan, & King, 2008).

Due to system tradeoffs related to data volume and signal-to-noise ratio (SNR) limitations, remote sensing images tend to have either a high spatial resolution and low spectral resolution or vice versa (Pushkar, Younan, & King, 2008).

Landsat 8-9 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)		
Bands	**Wavelength (micrometers)**	**Resolution (meters)**
Band 1 - Coastal aerosol	0.43-0.45	30

Landsat 8-9 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)		
Bands	**Wavelength (micrometers)**	**Resolution (meters)**
Band 2 - Blue	0.45-0.51	30
Band 3 - Green	0.53-0.59	30
Band 4 - Red	0.64-0.67	30
Band 5 - Near Infrared (NIR)	0.85-0.88	30
Band 6 - SWIR 1	1.57-1.65	30
Band 7 - SWIR 2	2.11-2.29	30
Band 8 - Panchromatic	0.50-0.68	15
Band 9 - Cirrus	1.36-1.38	30
Band 10 - Thermal Infrared (TIRS) 1	10.6-11.19	100
Band 11 - Thermal Infrared (TIRS) 2	11.50-12.51	100

(USGS, 2022)

References:

Pushkar, P., Younan, N. H., & King, R. L. (2008). Concept of Image Fusion in Remote Sensing Applications. In T. Stathaki, *Image Fushion.* Academic Press.

USGS. (2022). *Landsat 9 data Users Handbook.* South Dakota: USGS.

UNIT-7: REMOTE SENSING PLATFORMS AND SENSORS: LANDSAT, IRS AND SENTINEL SERIES

Landsat Missions Overview

Landsat 1, originally known as ERTS-1 was launched July 23, 1972, with two Earth-viewing imagers – a Return Beam Vidicon (RBV) and an 80-m, 4-band Multispectral Scanner (MSS). Landsat 2 and Landsat 3, launched January 22, 1975, and March 5, 1978, respectively, were configured similarly. On July 16, 1982, Landsat 4 was launched with the MSS and the new Thematic Mapper (TM) instrument, which included improved ground resolution at 30-m and better defined spectral characteristics. In addition to using an updated instrument, Landsat 4 made use of the Multi-Mission Modular Spacecraft (MMS), which replaced the Nimbus-based spacecraft design employed for Landsat 1 – Landsat 3. Landsat 5 (L5), launched March 1,1984, also carried the TM and MSS sensors. The satellite long outlived its original three-year design life, delivering Earth imaging data for nearly 29 years – setting a Guinness World Record For 'Longest Operating Earth Observation Satellite'. The L5 TM sensor collected over 2.9 million scenes that are held within in the USGS Landsat archive. Landsat 6, carried the Enhanced Thematic Mapper (ETM) that included a 15-m panchromatic (Pan) band, failed to achieve orbit on October 5, 1993. Landsat 7 (L7) was launched April 15, 1999, and performed nominally until the ETM Plus (ETM+) sensor's Scan Line Corrector (SLC) failed in May 2003, which led to about 22 percent data loss in each scene. Since that time, L7 has acquired data in the "SLC-off" mode. All L7 SLC-off data are of the same high radiometric and geometric quality as data collected prior to the SLC failure. Landsat 8, launched February 11, 2013, represented an evolutionary advance in technology. The Operational Land Imager (OLI), a push-broom sensor with a four-mirror telescope and 12-bit quantization, collects data for visible, near infrared, and short wave infrared spectral bands as well as a panchromatic band, while providing data in two additional spectral bands — one tailored especially for detecting cirrus clouds and the other for coastal zone observations. The Thermal Infrared Sensor (TIRS) collects data for two more narrow spectral bands in the thermal region formerly covered by one wide spectral band on Landsats 4–7. Landsat 9, launched September 27, 2021, carries nearly identical sensors as LANDSAT 8 — the OLI-2, and the TIRS-2 (USGS, 2022).

Landsat 9

The primary objective of the LANDSAT 9 mission is to generate a global high-quality observational record of land image data in continuity with the Landsat satellite series. All interfaces related to Earth image scheduling use the Worldwide Reference System-2 (WRS-2) path/row coordinate system convention. The size of a LANDSAT 9 scene measures 185-kilometer (km) cross-track by 180 km along-track and includes a five percent overlap of the preceding and subsequent scenes. LANDSAT 9 is available to collect at least 838 WRS-2 scenes per 24-hour period, over a 16-day repeat cycle.

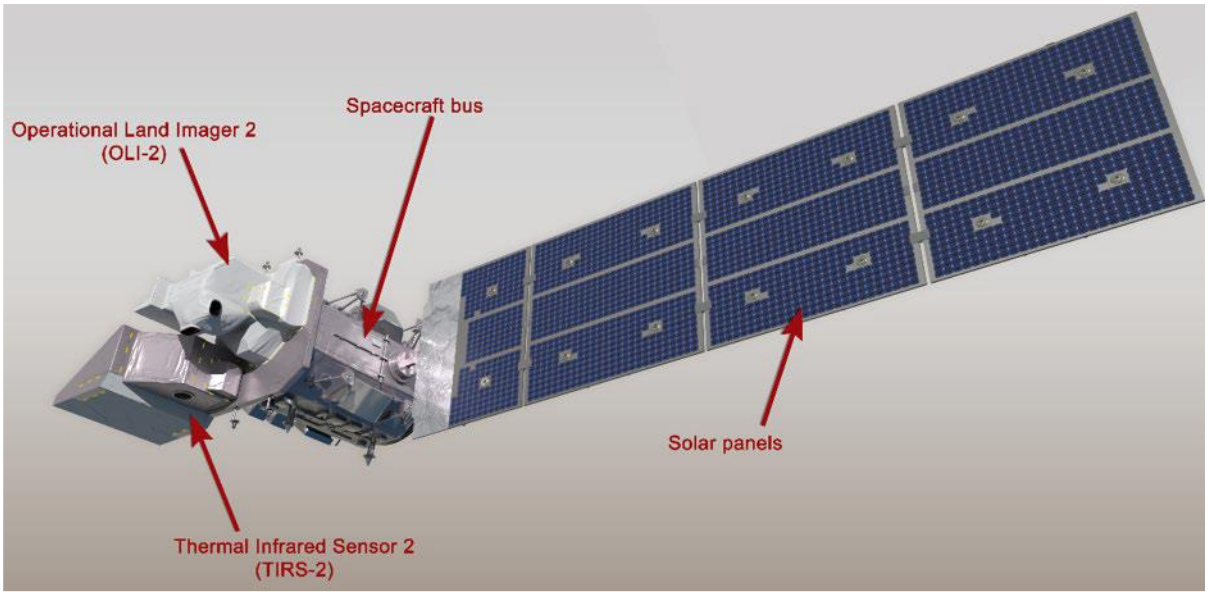


Illustration of Landsat 9 Observatory with bus and solar panels

The LANDSAT 9 Observatory operates in a 705 +1-km near-polar, sun-synchronous orbit, completely orbiting the Earth every 98.9 minutes, with a 16-day ground track repeat cycle, and a Mean Local Time (MLT) equatorial crossing of the descending node within required 10:00 a.m. +15 minutes. This allows imaging sensor data to be referenced to the WRS-2 path/row coordinate system convention as part of ground processing. LANDSAT 9 acquires data at an 8-day offset from LANDSAT 8 for each WRS-2 path. LANDSAT 9 has a design life of 5 years and carries 10 years of fuel consumables (USGS, 2022).

Worldwide Reference System-2 (WRS-2)

In this system each orbit within a cycle is designated as a path. Along these paths, the individual nominal sensor frame centres are designated as rows. Thus, a scene can be uniquely identified by specifying a path, row, and date.

WRS-2 is made up of 233 paths, numbered 001 to 233, east to west, with path 001 crossing the equator at longitude 64°36’ W. The rows are numbered such that row 60 coincides with the equator on the orbit’s descending node. Row 1 of each path starts at 80°47’N latitude.

The WRS-2 system was also used for Landsat-4, -5, and -7. There is an eight-day offset between Landsat-7 and Landsat-8 coverage of each WRS-2 path. (Having a different orbital pattern, Landsat-1, -2, and -3, are catalogued using WRS-1. WRS-1 has 251 paths and the same number of rows asWRS-2.) (Lillesand, Kiefer, & Chipman, 2015).

Concept of Operations The OLI-2 and TIRS-2 data for each WRS-2 scene are merged to create a single file containing the data from both sensors. The data from both sensors are radiometrically corrected and co-registered to a cartographic projection, with corrections for

terrain displacement resulting in a standard orthorectified digital image called the Level 1 product. Data processed to Level 1 are used as inputs to Level 2 and Level 3 science products.

Operational Land Imager 2 (OLI-2)

The OLI-2 sensor collects image data in nine spectral bands over a 185 km swath with a maximum ground sampling distance (GSD), both in-track and cross track, of 30-meters(m) (98 feet) for all bands except the panchromatic band, which has a 15-meters (49 feet) GSD. Like Landsat 8's OLI sensor, the widths of several OLI-2 bands were refined to avoid atmospheric absorption features that were apparent within earlier Landsat sensors. The OLI-2 is a push-broom sensor. Data generated by OLI-2 are quantized to 14 bits compared to LANDSAT 8's 12-bit data transmission.

Thermal Infrared Sensor 2 (TIRS-2)

The TIRS-2 sensor has a 5-year design life and collects image data for two thermal bands with a 100 m spatial resolution over a 185-km swath. TIRS-2 is a push-broom sensor employing a focal plane with long arrays of photosensitive detectors (USGS, 2022).

True Colour Composite of Landsat9; Path/Row (138/044); Date acquired: 2022/05/06 (Image Courtesy USGS).

IRS Series:

Starting with IRS-1A in 1988, ISRO has launched many operational remote sensing satellites. Today, India has one of the largest constellations of remote sensing satellites in operation. Currently, *thirteen* operational satellites are in Sun-synchronous orbit – RESOURCESAT-1, 2, 2A CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2, Megha-Tropiques, SARAL and SCATSAT-1, and *four* in Geostationary orbit- INSAT-3D, Kalpana & INSAT 3A, INSAT -3DR. Varieties of instruments have been flown onboard these satellites to provide necessary data in a diversified spatial, spectral and temporal resolutions to cater to different user requirements in the country and for global usage. The data from these satellites are used for several applications covering agriculture, water resources, urban planning, rural

development, mineral prospecting, environment, forestry, ocean resources and disaster management (ISRO).

Sl No.	Name	Launch Date	Launch Mass	Launch Vehicle	Orbit Type	Application
1.	Bhaskara-I	Jun 07, 1979	442 kg	C-1Intercosmos	GSO	Earth Observation, Experimental
2.	Rohini Satellite RS-D1	May 31, 1981	38 kg	SLV-3D1	LEO	Earth Observation
3.	Bhaskara-II	Nov 20, 1981	444 kg	C-1 Intercosmos	LEO	Earth Observation, Experimental
4.	Rohini Satellite RS-D2	Apr 17, 1983	975 kg	SLV-3	LEO	Earth Observation
5.	IRS-1A	Mar 17, 1988	975 kg	Vostok	SSPO	Earth Observation
6.	SROSS-2	Jul 13, 1988	150 kg	ASLV-D2	SSPO	Earth Observation
7.	IRS-1B	Aug 29, 1991	975 kg	Vostok	SSPO	Earth Observation
8.	IRS-1E	Sep 20, 1993	846 kg	PSLV-D1	LEO	Earth Observation
9.	IRS-P2	Oct 15, 1994	804 kg	PSLV-D2	SSPO	Earth Observation
10.	IRS-1C	Dec 28, 1995	1250 kg	Molniya	SSPO	Earth Observation
11.	IRS-P3	Mar 21, 1996	920 kg	PSLV-D3 / IRS-P3	SSPO	Earth Observation

12.	IRS-1D	Sep 29, 1997	1250kg	PSLV-C1/IRS-ID	SSPO	Earth Observation
13.	Oceansat(IRS-P4)	May 26, 1999	1050 kg	PSLV-C2/IRS-P4	SSPO	Earth Observation
14.	The Technology Experiment Satellite (TES)	Oct 22, 2001		PSLV-C3 / TES	SSPO	Earth Observation
15.	IRS-P6 / RESOURCESAT-1	Oct 17, 2003	1360 kg	PSLV-C5 / RESOURCESAT-1	SSPO	Earth Observation
16.	CARTOSAT-1	May 05, 2005	1560 kg	PSLV-C6/ CARTOSAT-1/HAMSAT	SSPO	Earth Observation
17.	CARTOSAT-2	Jan 10, 2007	650 kg	PSLV-C7 / CARTOSAT-2 / SRE-1	SSPO	Earth Observation
18.	IMS-1	Apr 28, 2008	83 kg	PSLV-C9 / CARTOSAT – 2A	SSPO	Earth Observation
19.	CARTOSAT – 2A	Apr 28, 2008	690 Kg	PSLV-C9 / CARTOSAT – 2A	SSPO	Earth Observation
20.	RISAT-2	Apr 20, 2009	300 kg	PSLV-C12 / RISAT-2	SSPO	Earth Observation
21.	Oceansat-2	Sep 23, 2009	960 kg	PSLV-C14 / OCEANSAT-2	SSPO	Climate & Environment, Earth Observation
22.	CARTOSAT-2B	Jul 12, 2010	694 kg	PSLV-C15/CARTOSAT-2B	SSPO	Earth Observation

23.	RESOURCESAT-2	Apr 20, 2011	1206 kg	PSLV-C16/RESOURCESAT-2	SSPO	Earth Observation n
24.	Megha-Tropiques	Oct 12, 2011	1000 kg	PSLV-C18/ Megha-Tropiques	SSPO	Climate & Environment, Earth Observation
25.	RISAT-1	Apr 26, 2012	1858 kg	PSLV-C19/RISAT-1	SSPO	Earth Observation
26.	SARAL	Feb 25, 2013	407 kg	PSLV-C20/SARAL	SSPO	Climate & Environment, Earth Observation
27.	INSAT-3D	Jul 26, 2013	2060 Kg	Ariane-5 VA-214	GSO	Climate & Environment, Disaster Management System
28.	CARTOSAT-2 Series Satellite	Jun 22, 2016	737.5 kg	PSLV-C34 / CARTOSAT-2 Series Satellite	SSPO	Earth Observation
29.	INSAT-3DR	Sep 08, 2016	2211 kg	GSLV-F05 / INSAT-3DR	GSO	Climate & Environment, Disaster Management System
30.	SCATSAT-1	Sep 26, 2016	371 kg	PSLV-C35 / SCATSAT-1	SSPO	Climate & Environment
31.	RESOURCESAT-2A	Dec 07, 2016	1235 kg	PSLV-C36 / RESOURCESAT-2A	SSPO	Earth Observation
32.	Cartosat -2 Series Satellite	Feb 15, 2017	714 kg	PSLV-C37 / Cartosat -2 Series Satellite	SSPO	Earth Observation

33.	Cartosat-2 Series Satellite	Jun 23, 2017	712 kg	PSLV-C38 / Cartosat-2 Series Satellite	SSPO	Earth Observation
34.	Cartosat-2 Series Satellite	Jan 12, 2018	710 Kg	PSLV-C40/ Cartosat-2 Series Satellite Mission	SSPO	Earth Observation
35.	HysIS	Nov 29, 2018		PSLV-C43 / HysIS Mission	SSPO	Earth Observation
36.	RISAT-2B	May 22, 2019	615 Kg	PSLV-C46 Mission	LEO	Disaster Management System, Earth Observation
37.	Cartosat-3	Nov 27, 2019		PSLV-C47 / Cartosat-3 Mission	SSPO	Earth Observation
38.	RISAT-2BR1	Dec 11, 2019	628 Kg	PSLV-C48/ RISAT-2BR1	LEO	Disaster Management System, Earth Observation
39.	EOS-01	Nov 07, 2020		PSLV-C49/ EOS-01	LEO	Disaster Management System, Earth Observation
40.	EOS-04	Feb 14, 2022		PSLV-C52/ EOS-04 Mission		Earth Observation

(Source: ISRO)

Resourcesat 2:

The Indian Space Research Organisation's (ISRO) Polar Satellite Launch Vehicle (PSLV-C16) placed three satellites in orbit – India 's Resourcesat-2, the Indo-Russian Youthsat and the X-Sat from the Nangyang Technological University of Singapore on Wednesday, 20th April, 2011. The Resourcesat-2 with enhanced capabilities is a follow on of Resourcesat-1, launched on 17th October 2003.

Cameras:

It has three cameras mounted on a single platform with a high resolution sensors LISS-IV, medium resolution LISS-III and a coarse resolution AWiFS. It provides continuity of remote sensing data for various national and international projects.

Applications:

The core objective of this mission is to support remote sensing data for integrated land and water resources management at micro level, with improved spectral and spatial coverage.

This data also supports many projects in diversified fields of applications like

- Agricultural crop discrimination and monitoring, crop acreage / yield estimation,
- Precision farming, water resources, forest mapping,
- Infrastructure development, disaster management,
- Snow and glacier studies,
- Coastal zone management,
- Urban landscape, locating groundwater potential zones etc.

The improvements over Resourcesat-1 are:

- LISS-IV MX operation with 70 km swath for Indian foot print and flexibility to operate in 23 km swath.
- AWiFS data with 12 bit radiometric resolution.
- LISS-III and LISS-IV data with 10 bits radiometric resolution.
- Enhanced power to facilitate increased operations per orbit.
- Improved SSR (Solid State Recorder) capacity of 200GB and an extra of 200 GB only for 70 km MX data.

Orbit Design:

- The orbit is similar to that of Resourcesat-1 i.e., the satellite operates in a circular, sun-synchronous, near polar orbit with an inclination of 98.69 deg, at an altitude of 817 Km. The satellite takes 101.35 minutes to complete one revolution around the earth and completes about 14 orbits per day. The entire earth is covered by 341 orbits during a 24 day cycle. The Referencing Scheme for Resourcesat-2 is identical to that of Resourcesat-1.

Semi-major axis	7195.12 Km
Altitude	817 Km
Inclination	98.69 deg
No. of orbits per day	14 5/24
Orbit period	101.35 min
Eccentricity	0.001
Repetivity (LISS-III)	24 days
Revist (LISS-IV)	5 days
Repetivity (AWiFS)	5 days
Distance between adjacent tracks	117.5 Km
Ground Trace Velocity	6.65 Km/Sec
Equatorial Crossing Time	10:30 AM ± 10 min (at descending node)

Orbit Design

Payloads:

- The three payloads are Advanced Wide Field Sensor (AWiFS), Linear Imaging Self Scanning sensor (LISS-III) and a high resolution multi-spectral sensor LISS-IV, along with an on-board solid state recorder (OBSSR).

- LISS-III and AWIFS sensors acquire data in four identical spectral bands ie VIS-NIR-SWIR range, while LISS-IV is a high resolution sensor with three spectral bands in VIS-NIR range.

- The payloads can be operated either in real time mode by direct transmission to ground station or in record and playback mode using 400 GB capacity on board solid state recorder.

- The satellite is premeditated to provide both multi-spectral and panchromatic imagery of the Earth's surface. All the sensors will be working on the 'pushbroom scanning' concept using linear arrays of Charged Coupled Devices (CCDs).

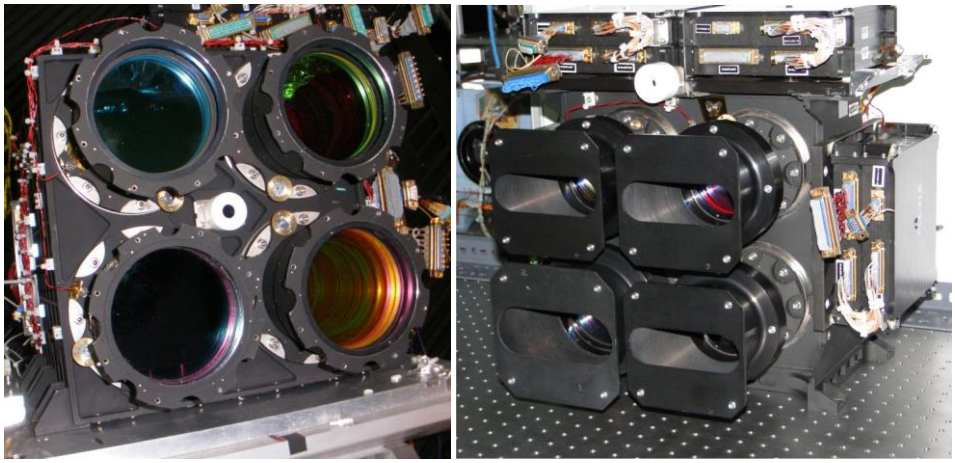
AWiFS (Advanced Wide Field Sensor):

- The AWiFS sensor on-board Resourcesat-2 has enhanced capabilities compared to the AWiFS of Resourcesat-1 in terms of radiometric resolution (12 bits vs 10 bits) with revisit period of 5 days.

- The data is acquired in four spectral bands, three in the visible and in NIR (VNIR B2, B3 and B4) and one in the short wave infrared (SWIR B5).

- The AWiFS camera is realized in two electro-optic modules viz. AWiFS-A and AWiFS-B, providing a combined swath of 740 Km.

- Each camera consists of four lens assemblies, detectors and associated electronics pertaining to the four spectral bands B2, B3, B4 and B5.



LISS III Payload (Left) AWiFS Payload (Right)

LISS III (Linear Imaging Self Scanning)

- The medium resolution multi-spectral sensor, LISS-III is similar to that of LISS-III of Resoucesat-1 and operates in four spectral bands - B2, B3, B4 in visible near infrared (VNIR) and B5 in Short Wave Infrared (SWIR) providing data with 23.5m resolution.

- The camera electronics is same as in Resoucesat-1 except for 10 bit digitisation as against 7 bit digitisation.

LISS IV (Linear Imaging Self Scanning):

- The LISS-IV sensor is a multispectral high resolution camera with a spatial resolution of 5.8 m at nadir.

- The payload provides multispectral imagery covering a swath of 70 Km as compared to 23 km swath of Resourcesat-1.

- The LISS-IV camera has the additional feature of off-nadir viewing capability by tilting the camera by +/- 26 degrees using which, 5 days revisit is possible for any given ground area.

- The data is acquired in three spectral bands namely visible and near infrared (B2, B3 and B4).

- It has both MX Mode (1/3rd swath) and Mono Mode (full swath) of operation as in Resourcesat-1.

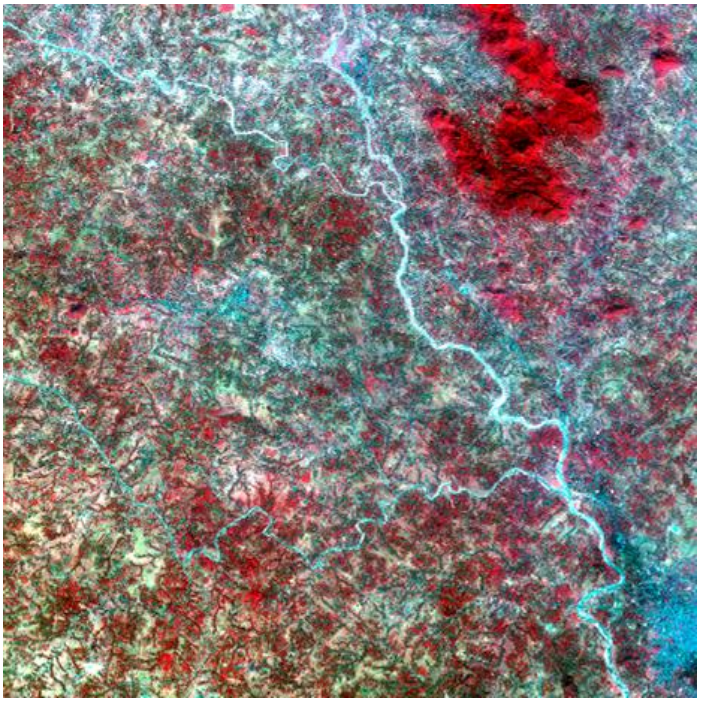
- The system has 10-bit quantization.

SPECIFICATIONS	AWiFS	LISS-III	LISS-IV
No. of Bands	4	4	1 (mono), 3 (MX)
Spectral Bands (μ)	B2 0.52 – 0.59 B3 0.62 – 0.68 B4 0.77 – 0.86 B5 1.55 – 1.70	B2 0.52 – 0.59 B3 0.62 – 0.68 B4 0.77 – 0.86 B5 1.55 – 1.70	B2 0.52 – 0.59 B3 0.62 – 0.68 B4 0.77 – 0.86 B3-default band for mono
Resolution (m)	56	23.5	5.8
Swath (Km)	740	140	70 / 23
Revisit (days)	5	24	5
Data Rate (Mbs per stream)	105	105	105
Qunatisation	12-bit	10-bit	10-bit
Gains	100% Albedo No Gain setting	100% Albedo No Gain setting	100% Albedo No Gain setting

Specifications of the AWiFS, LISS III and LISS IV Sensors

Sensor	Product type	Area Coverage KM	Correction Level	Accuracy
AWiFS	Path-Row scene based	370 x 370	Geo-referenced & Geo-Ref + RPC	200 m
			Orthorectified	Better than 50m
LISS-3	Path-Row scene based	140 x 140	Geo-Referenced & Geo-Ref + RPC	150 m
			Orthorectified	Better than 24m
	Geocoded 15' x 15'	28 x 28	Orthorectified	Better than 24m
LISS-IV MX	Path-Row scene based	70 x 70/23 x 23	Geo-Referenced & Geo-Ref + RPC	100 m
			Orthorectified	Better than 05m
	Geocoded 7.5' x 7.5'	14 x 14	Orthorectified	Better than 05m

Product characteristics of the AWiFS, LISS III and LISS IV Sensors (NRSC, 2011)



Standard false colour composite prepared using Resourcesat-2 LISS III data (Image Courtesy NRSC, ISRO).

SENTINEL SERIES:

The European Space Agency (ESA) is developing a new family of missions called Sentinels specifically for the operational needs of the Copernicus programme.

Each Sentinel mission is based on a constellation of satellites to fulfil revisit and coverage requirements, providing robust datasets for Copernicus services.

These missions carry a range of technologies, such as radar and multi-spectral imaging instruments for land, ocean and atmospheric monitoring:

- **Sentinel-1** is a polar-orbiting, all-weather, day-and-night radar imaging mission for land and ocean services. Sentinel-1A was launched on 3 April 2014 and Sentinel-1B on 25 April 2016. Both were taken into orbit on a Soyuz rocket from Europe's Spaceport in French Guiana. The mission ended for Sentinel-1B in 2022 and plans are in force to launch Sentinel-1C as soon as possible.

- **Sentinel-2** is a polar-orbiting, multispectral high-resolution imaging mission for land monitoring to provide, for example, imagery of vegetation, soil and water cover, inland waterways and coastal areas. Sentinel-2 can also deliver information for emergency services. Sentinel-2A was launched on 23 June 2015 and Sentinel-2B followed on 7 March 2017.

- **Sentinel-3** is a multi-instrument mission to measure sea-surface topography, sea- and land-surface temperature, ocean colour and land colour with high-end accuracy and reliability. The mission supports ocean forecasting systems, as well as environmental and climate monitoring. Sentinel-3A was launched on 16 February 2016 and Sentinel-3B joined its twin in orbit on 25 April 2018.

- **Sentinel-5 Precursor** – also known as Sentinel-5P – is the forerunner of Sentinel-5 to provide timely data on a multitude of trace gases and aerosols affecting air quality and climate. It has been developed to reduce data gaps between the Envisat satellite – in particular the Sciamachy instrument – and the launch of Sentinel-5. Sentinel-5P was taken into orbit on 13 October 2017 on a Rockot launcher from the Plesetsk Cosmodrome in northern Russia.

- **Sentinel-4** is a payload devoted to atmospheric monitoring that will be embarked upon a Meteosat Third Generation-Sounder (MTG-S) satellite in geostationary orbit.

- **Sentinel-5** is a payload that will monitor the atmosphere from polar orbit aboard a MetOp Second Generation satellite.

- **Sentinel-6** carries a radar altimeter to measure global sea-surface height, primarily for operational oceanography and for climate studies. The first satellite was launched into orbit on 21 November 2020 on a SpaceX Falcon 9 rocket from the Vandenberg Air Force Base in California, US.

Looking to the future, six Sentinel Expansion missions are being developed to address EU policy and gaps in Copernicus user needs, and to expand the current capabilities of the Copernicus Space Component (The European Space Agency).

References:

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote Sensing and Image Interpretation.* USA: Wiley.

NRSC. (2011). *Resourcesat 2 Data Users Handbook.* Hyderabad: NRSC.

USGS. (2022). *Landsat 9 data Users Handbook.* South Dakota: USGS.

UNIT-8: DIGITAL IMAGE PROCESSING – RADIOMETRIC CORRECTION, GEOREFERENCING AND MOSAICKING

Digital image processing refers to the manipulation of digital images with the aid of a computer. However, it was not until the launch of Landsat-1 in 1972 that digital image data became widely available for land remote sensing applications. At that time, not only was the theory and practice of digital image processing in its infancy, but also the cost of digital computers was very high, and their computational efficiency was very low by modern standards. Today, access to low-cost, efficient computer hardware and software is commonplace, and the sources of digital image data are many and varied. These sources range from commercial and governmental earth resource satellite systems, to the meteorological satellites, to airborne scanner data, to airborne digital camera data, to image data generated by photogrammetric scanners and other high resolution digitizing systems. The central idea behind digital image processing is quite simple. One or more images are loaded into a computer. The computer is programmed to perform calculations using an equation, or series of equations, that take pixel values from the raw image as input. In most cases, the output will be a new digital image whose pixel values are the result of those calculations. This output image may be displayed or recorded in pictorial format or may itself be further manipulated by additional software. The possible forms of digital image manipulation are seemingly infinite.

RADIOMETRIC CORRECTIONS:

The radiance measured by any given system over a given object is influenced by such factors as changes in scene illumination, atmospheric conditions, viewing geometry, and instrument response characteristics. Some of these effects, such as viewing geometry variations, are greater in the case of airborne data collection than in satellite image acquisition. Also, the need to perform correction for any or all of these influences depends directly upon the particular application at hand. Over the course of the year, there are systematic, seasonal changes in the intensity of solar irradiance incident on the earth's surface. If remotely sensed images taken at different times of the year are being compared, it is usually necessary to apply a sun elevation correction and an earth–sun distance correction. The sun elevation correction accounts for the seasonal position of the sun relative to the earth. Through this process, image data acquired under different solar illumination angles are normalized by calculating pixel brightness values assuming the sun was at the zenith on each date of sensing. The correction is usually applied by dividing each pixel value in a scene by the sine of the solar elevation angle (or cosine of the solar zenith angle) for the particular time and location of imaging (Lillesand, Kiefer, & Chipman, 2015).

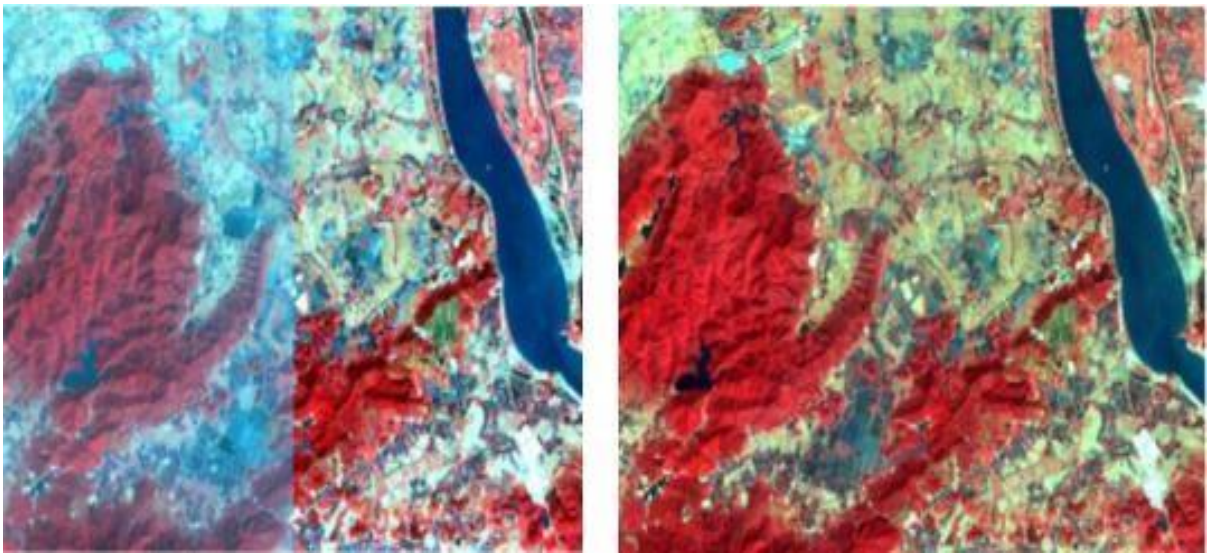


Figure 8.1 Two Images with different Sun-angles (Left); Corrected Mosaic (Right) (Image Courtesy – IIRS, ISRO)

GEOREFERENCING

Maps and aerial photographs in hard copy have a lot of valuable data on them. When this data needs to be brought into a GIS, they are digitally scanned to produce raster imagery. The scanned imagery needs to be georeferenced to a real-world coordinate system before it can be used in a GIS. Georeferencing is the process of transforming the **coordinate reference system** (**CRS**) of a raster dataset into a new coordinate reference system. Often, the process transforms the CRS of a spatial dataset from a local coordinate system to a real-world coordinate system. Regardless of the coordinate systems involved, we'll call the coordinate system of the raster to be georeferenced the source CRS and the coordinate system of the output the destination CRS. The transformation may involve shifting, rotating, skewing, or scaling the input raster from source coordinates to destination coordinates. Once a data set has been georeferenced, it can be brought into a GIS and aligned with other layers.

Understanding ground control points:

Georeferencing is done by identifying **ground control points** (**GCP**). These are locations on the input raster where the destination coordinate system is known. Once a set of ground control points has been created, a transformation equation is developed and used to transform the raster from the source CRS to the destination CRS. Ideally, GCPs are well distributed across the input raster. One should strive to create GCPs near the four corners of the image (Menke, Smith, Pirelli, & Hoesen, 2016).

Figure 8.2 Topographical map (Sheet No NG 45-15 Berhampore, U. S. Army) georeferenced on Landsat8 imagery (Path 139/ Row 43)

MOSAICKING

Opposite to image subsetting, image mosaicking is the process of stitching multiple adjacent images together to form a larger image. It is activated when the study area is covered by multiple images.

Prior to mosaicking it is possible to unify the radiometric properties of all component images through some kind of image processing. However, the images will not resemble each other radiometrically because the ground features covered vary in their proportion. It is also rare that the mosaic will have a uniform tone. The task of unifying image radiometry is much more challenging with colour images as colour has three dimensions of hue, saturation, and brightness, as against tone of a black-and-white photograph. Unless the radiometry of all images can be unified to an acceptable level, it is recommended that the mosaicked image not be used for any quantitative analyses (Gao, 2009).

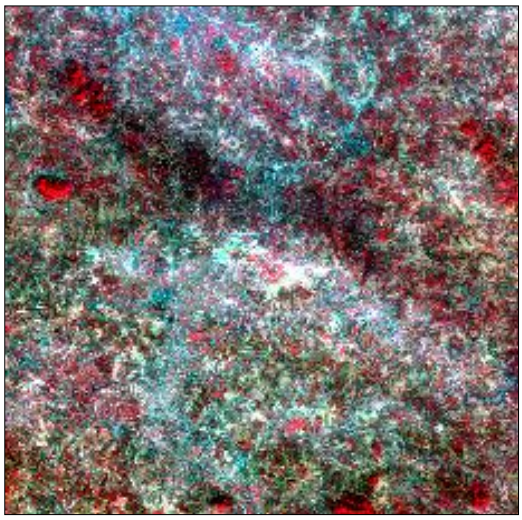


Figure 8.3 shows false colour composite prepared using Resourcesat 2 LISS III data (L3-NG45V02-106-054-14Nov18)

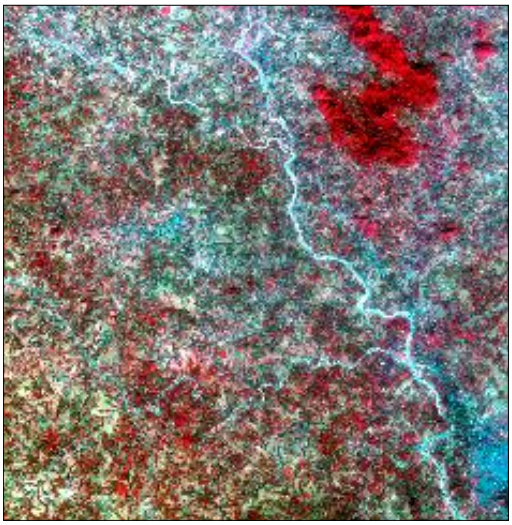


Figure 8.4 shows false colour composite prepared using Resourcesat 2 LISS III data (L3-NG45V03-106-055-14Nov18)

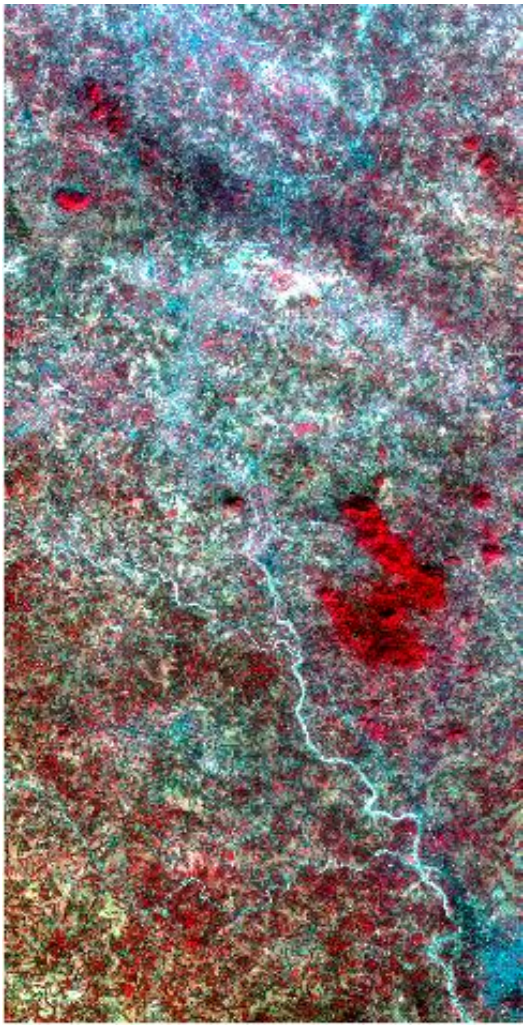


Figure 8.5 - Two adjacent raster images of Resourcesat 2 LISS III (L3-NG45V02-106-054-14Nov18) and (L3-NG45V03-106-055-14Nov18) mosaiced as one raster image

References:

Gao, J. (2009). *Digital Analysis of Remotely Sensed Data.* New York: Mc Graw Hill.

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote Sensing and Image Interpretation.* USA: Wiley.

Menke, K., Smith, R., Pirelli, L., & Hoesen, J. V. (2016). *Mastering QGIS.* Birmingham: Packt Publishing.

UNIT-9: FCC PREPARATION AND IMAGE CLASSIFICATION

Satellite imageries consist of several individual raster bands e.g. Landsat 9 consists of 11 bands and Resourcesat 2 LISS 3 consists 4 bands. Depending upon the purpose of enquiry, individual bands are merged to create a colour composite image. Depending upon the bands, several combinations can be created. To create a **standard false colour composite** (FCC), green band, red band and Near Infrared (NIR) bands are merged in such a manner that green band assigned is blue channel, red band is assigned green channel and NIR is assigned red channel.

- Open QGIS
- To merge raster bands, click on **Raster** and navigate to **Miscellaneous.**
- Click on **Merge**.
- Click on **Input layer** ellipsis button and click on **Add Files** to select multiple files.
- Click on the check box **Place all input bands into separate band**.
- Select **Output data type** as **Float 64**.
- Click on **Merged** ellipsis button and click on **Save to File**.
- Click on **Run**.
- Right click on the merged layer in the **Layers** panel and click on **Properties**.
- Click on **Symbology**. Select **Render type** as **Multiband colour**.
- Assign the Red band, Green band and Blue band to Band 3, Band 2 and Band 1to produce a standard false colour composite.
- **Contrast enhancement** can be set to MinMax.
- Click on OK.

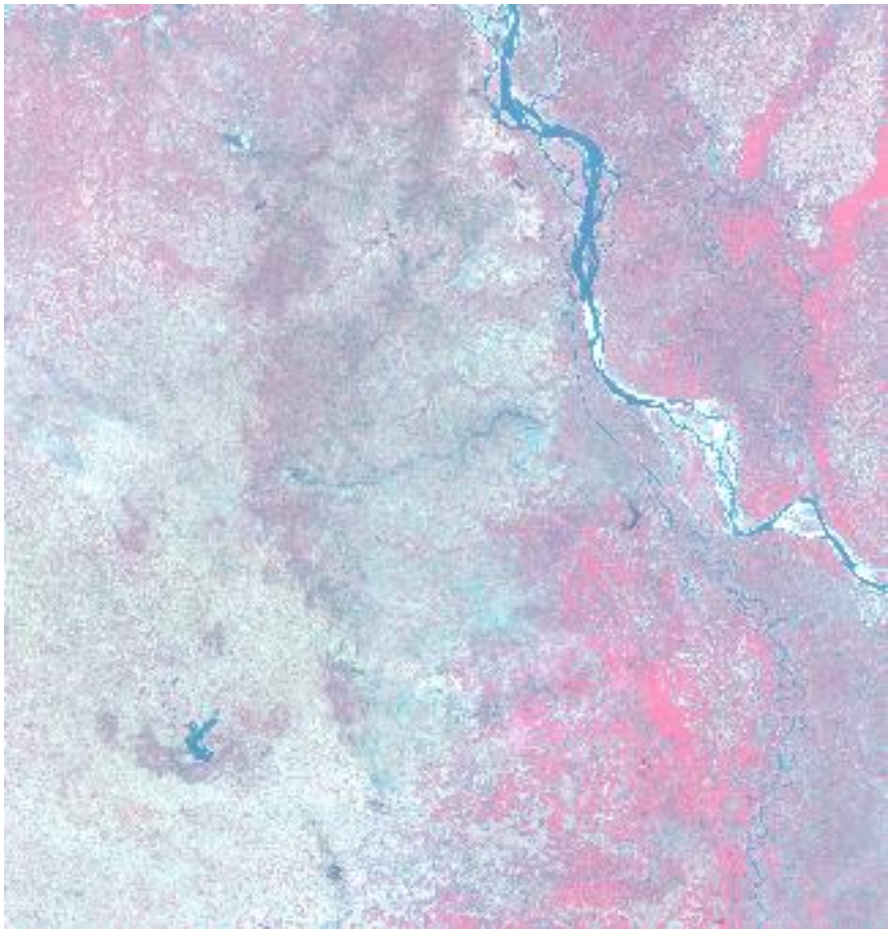


Figure 9.1- shows merged band of Landsat8. Green band is assigned to blue channel, red band is assigned to green channel and NIR is assigned to red channel to create a standard false colour composites

IMAGE CLASSIFICATION:

The overall objective of image classification procedures is to automatically categorize all pixels in an image into land cover classes or themes.

Spectral Patterns Recognition

In this approach, pixels that share similar combinations of spectral reflectance or emissivity are grouped together in classes that are assumed to represent particular categories of surface features.

Spatial pattern recognition

- It involves the categorization of image pixels on the basis of their spatial relationship with pixels surrounding them.
- Spatial classifiers might consider such aspects as image texture, pixel proximity, feature size, shape, directionality, repetition, and context.

- These types of classifiers attempt to replicate the kind of spatial synthesis done by the human analyst during the visual interpretation process. Accordingly, they tend to be much more complex and computationally intensive than spectral pattern recognition procedures.

- These two types of image classifiers may be used in combination in a hybrid mode. For example, object-based image analysis (OBIA) involves combined use of both spectral and spatial pattern recognition.

Supervised vs Unsupervised Image Classification

- The fundamental difference between these techniques is that supervised classification involves a training step followed by a classification step.

- In the unsupervised approach the image data are first classified by aggregating them into the natural spectral groupings, or clusters, present in the scene. Then the image analyst determines the land cover identity of these spectral groups by comparing the classified image data to ground reference data.

Supervised Classification

- In the training stage, the analyst identifies representative training areas and develops a numerical description of the spectral attributes of each land cover type of interest in the scene.

- in the classification stage, each pixel in the image data set is categorized into the land cover class it most closely resembles. If the pixel is insufficiently similar to any training data set, it is usually labeled "unknown."

- After all pixels in the input image have been categorized, the results are presented in the output stage.

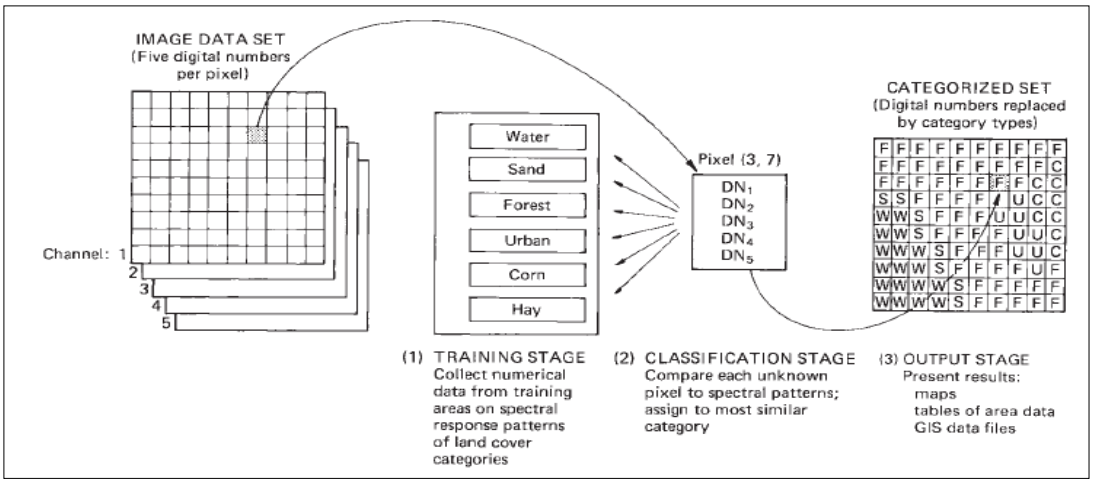


Figure 9.2 - Basic steps in supervised classification (Lillesand, Kiefer, & Chipman, 2015)

The Classification Stage

Minimum-Distance-to-Means Classifier

- First, the mean, or average, spectral value in each band for each category is determined. A pixel of unknown identity may be classified by computing the distance between the value of the unknown pixel and each of the category means.

- After computing the distances, the unknown pixel is assigned to the "closest" class, in this case "corn." If the pixel is farther than an analyst-defined distance from any category mean, it would be classified as "unknown."

- The minimum-distance-to-means strategy is mathematically simple and computationally efficient, but it has certain limitations. Most importantly, it is insensitive to different degrees of variance in the spectral response data.

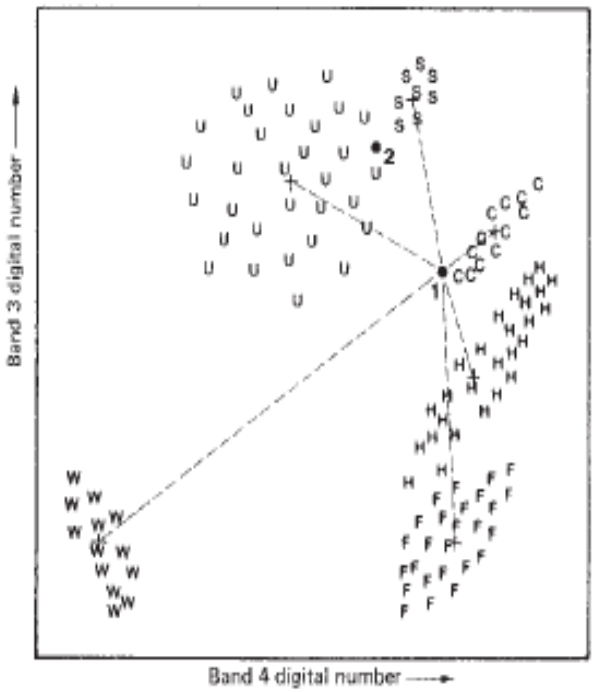


Figure 9.3 - Minimum distance to means classification strategy (Lillesand, Kiefer, & Chipman, 2015)

Parallelepiped Classifier

- Sensitivity to category variance may be introduced by considering the range of values in each category training set. This range may be defined by the highest and lowest digital number values in each band and appears as a rectangular area in our two-channel scatter diagram.

- An unknown pixel is classified according to the category range, or decision region, in which it lies or as "unknown" if it lies outside all regions. The multidimensional analogs of these rectangular areas are called parallelepipeds.

- However, difficulties are encountered when category ranges overlap. Unknown pixel observations that occur in the overlap areas will be classified as "not sure" or be arbitrarily placed in one of the two overlapping classes. Overlap is caused largely because category distributions exhibiting correlation or high covariance are poorly described by the rectangular decision regions.

- Covariance is the tendency of spectral values to vary similarly in two bands, resulting in elongated, slanted clouds of observations on the scatter diagram.

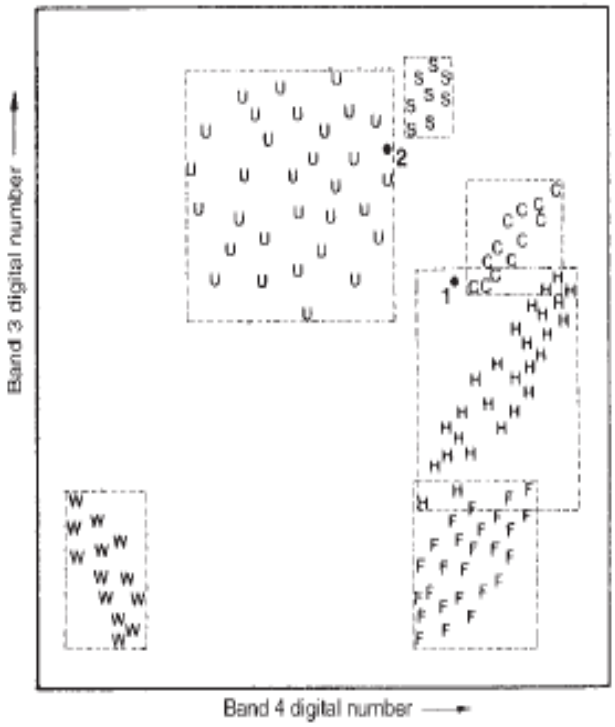


Figure 9.4 - Parallelepiped classification strategy (Lillesand, Kiefer, & Chipman, 2015)

Gaussian Maximum Likelihood Classifier

- The maximum likelihood classifier quantitatively evaluates both the variance and covariance of the category spectral response patterns when classifying an unknown pixel.

- An extension of the maximum likelihood approach is the Bayesian classifier. This technique applies two weighting factors to the probability estimate.

- First, the analyst determines the "a priori probability," or the anticipated likelihood of occurrence for each class in the given scene. For example, when classifying a pixel, the

probability of the rarely occurring “sand” category might be weighted lightly, and the more likely “urban” class weighted heavily.

- Second, a weight associated with the “cost” of misclassification is applied to each class. Together, these factors act to minimize the “cost” of misclassifications, resulting in a theoretically optimum classification.

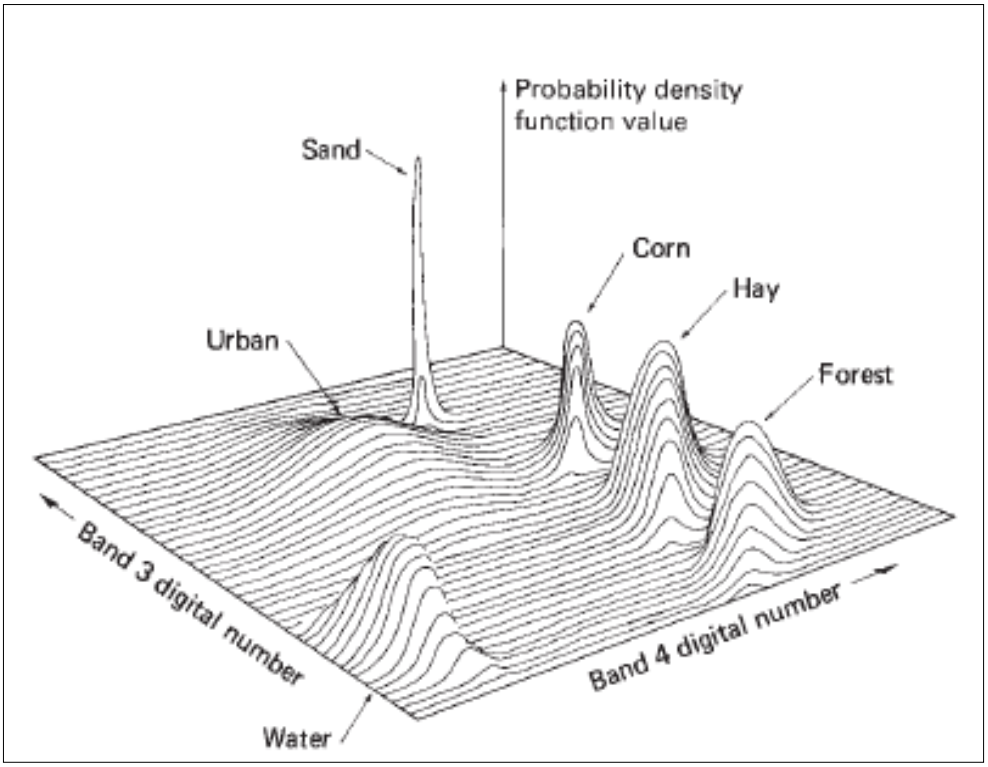


Figure 9.5 – Probability density functions defined by a maximum likelihood classifier (Lillesand, Kiefer, & Chipman, 2015)

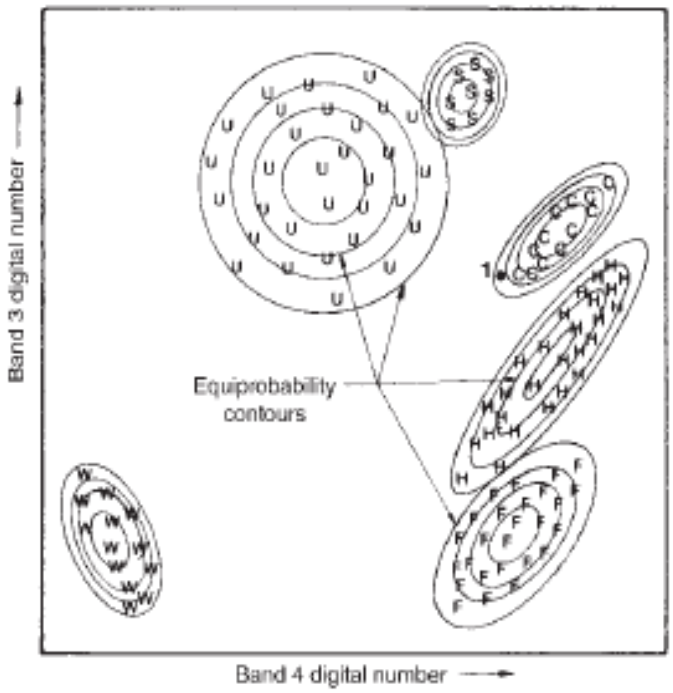


Figure 9.6 Equiprobability contours defined by a maximum likelihood classifier (Lillesand, Kiefer, & Chipman, 2015)

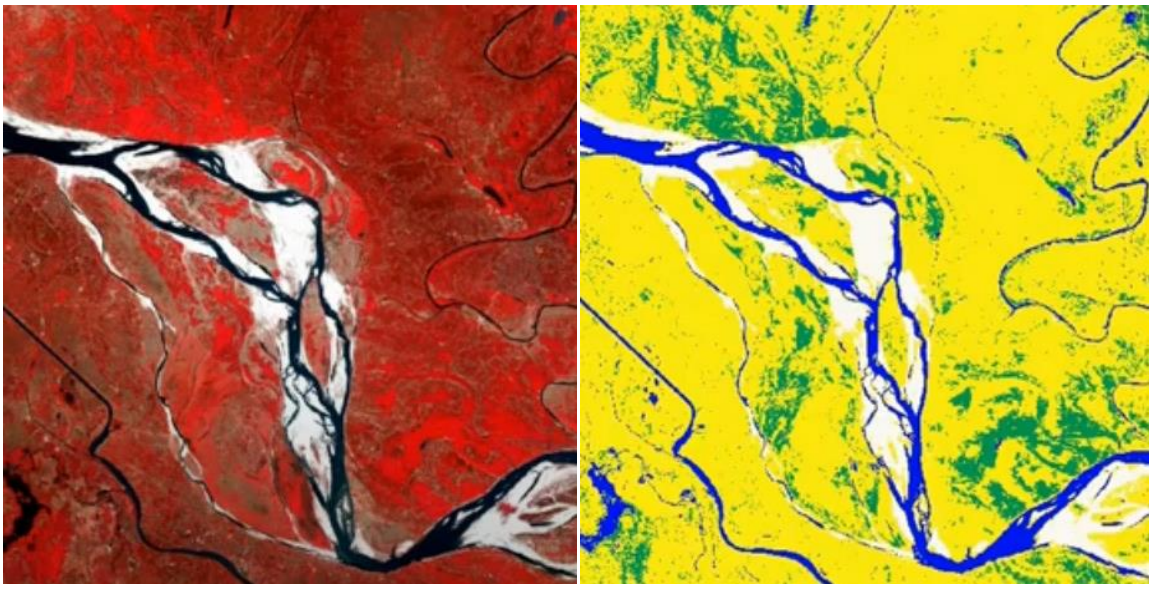


Figure 9.7 Standard false colour composite (left) and image derived through supervised classification (right)

Unsupervised Classification

- Unsupervised classifiers do not utilize training data as the basis for classification. Rather, this family of classifiers involves algorithms that examine the unknown pixels

in an image and aggregate them into a number of classes based on the natural groupings or clusters present in the image values.

- The basic premise is that values within a given cover type should be close together in the measurement space, whereas data in different classes should be comparatively well separated.

- The classes that result from unsupervised classification are spectral classes. Because they are based solely on the natural groupings in the image values, the identity of the spectral classes will not be initially known.

- The analyst must compare the classified data with some form of reference data (such as larger scale imagery or maps) to determine the identity and informational value of the spectral classes.

- Thus, in the supervised approach we define useful information categories and then examine their spectral separability; in the unsupervised approach we determine spectrally separable classes and then define their informational utility.

K-means approach

- There are numerous clustering algorithms that can be used to determine the natural spectral groupings present in a data set. One common form of clustering, called the K-means approach, accepts from the analyst the number of clusters to be located in the data. The algorithm then arbitrarily "seeds," or locates, that number of cluster centers in the multidimensional measurement space.

- Each pixel in the image is then assigned to the cluster whose arbitrary mean vector is closest.

- After all pixels have been classified in this manner, revised mean vectors for each of the clusters are computed. The revised means are then used as the basis to reclassify the image data.

- The procedure continues until there is no significant change in the location of class mean vectors between successive iterations of the algorithm. Once this point is reached, the analyst determines the land cover identity of each spectral class.

Iterative Self-Organizing Data Analysis Techniques A, or ISODATA

- A widely used variant on the K-means method for unsupervised clustering is an algorithm called Iterative Self-Organizing Data Analysis Techniques A, or ISODATA.

- This algorithm permits the number of clusters to change from one iteration to the next, by merging, splitting, and deleting clusters (Lillesand, Kiefer, & Chipman, 2015).

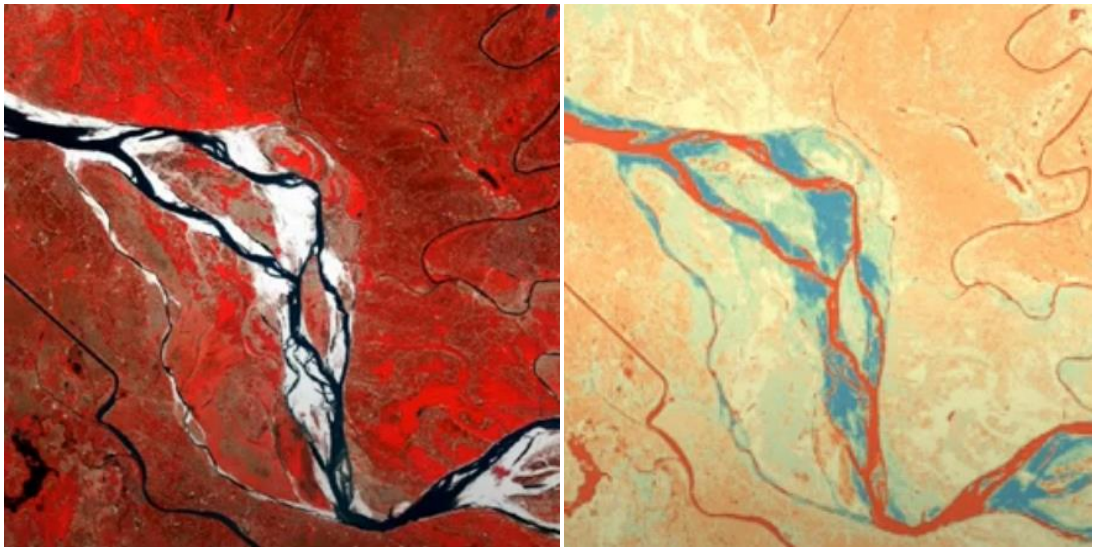


Figure 9.8 Standard false colour composite (left) and image derived through unsupervised classification (right)

References:

Hafen, K. (n.d.). *Open Source Options*. Retrieved 08 17, 2022, from Open Source Options: https://opensourceoptions.com/blog/how-to-make-a-false-color-satellite-image-in-qgis/

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote Sensing and Image Interpretation.* USA: Wiley.

UNIT-10: DIGITAL ELEVATION MODEL: TYPES AND SOURCES

Increasingly, remote sensing instruments are used to collect three-dimensional spatial data, in which each observation has a Z coordinate representing elevation, along with the X and Y coordinates used to represent the horizontal position of the pixel's column and row. Particularly when collected over broad areas, these elevation data may represent the topography, the three-dimensional shape of the land surface. In other cases (usually, at finer spatial scales), these elevation data may represent the three-dimensional shapes of objects on or above the ground surface, such as tree crowns in a forest, or buildings in a city. Elevation data may be derived from the analysis of raw measurements from many types of remote sensing instruments, including photographic systems, multispectral sensors, radar systems, and LiDAR systems.

Elevation data may be represented in many different formats. Flat areas will have uniform tone in a shaded relief map. Slopes facing toward the simulated light source will appear bright, while slopes facing away from the light will appear darker. To aid in visual interpretation, it is often preferable to create shaded relief maps with illumination from the top of the image, regardless of whether that is a direction from which solar illumination could actually come in the real world. When the illumination is from other directions, particularly from the bottom of the image, an untrained analyst may have difficulty correctly perceiving the landscape; in fact, the topography may appear inverted. It is possible to "drape" other types of imagery over a DEM; perspective views created using an aerial photograph or high-resolution satellite image may appear quite realistic. Animation of successive perspective views created along a user-defined flight line permits the development of simulated "fly-throughs" over an area.

The term "digital elevation model" or DEM can be used to describe any image where the pixel values represent elevation (Z) coordinates. Two common subcategories of DEMs are a digital terrain model (DTM) and a digital surface model (DSM). A DTM (sometimes referred to as a "bald-earth DEM") records the elevation of the bare land surface, without any vegetation, buildings, or other features above the ground. In contrast, a DSM records the elevation of whatever the uppermost surface is at every location; this could be a tree crown, the roof of a building, or the ground surface (where no vegetation or structures are present). Each of these models has its appropriate uses. For example, a DTM would be useful for predicting runoff in a watershed after a rainstorm, because streams will flow over the ground surface rather than across the top of the forest canopy. In contrast, a DSM could be used to measure the size and shape of objects on the terrain, and to calculate intervisibility (Lillesand, Kiefer, & Chipman, 2015).

In the following section three types of DEMs are discussed i.e. ASTER DEM, SRTM DEM and CartoDEM. These DEMs are freely available from their respective websites.

ASTER DEM

The United States National Aeronautics and Space Administration (NASA) and the Ministry of Economy, Trade, and Industry (METI) of Japan today jointly released Version 3 of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) The ASTER GDEM is available atno charge to users worldwide via electronic download from Japan Space Systems and from NASA's Land Processes Distributed Active Archive Center (LP DAAC).

The ASTER instrument was built by Japan's Ministry of Economy, Trade and Industry(METI) and launched aboard NASA's Terra spacecraft in December 1999. It has an along-track stereoscopic capability using its near infrared spectral band and its nadir- viewing and backward-viewing telescopes to acquire stereo image data with a base-to-height ratio of 0.6. The spatial resolution is 15 meters in the horizontal plane, with a 60 kilometer-by-60 kilometer ground area.

The methodology used to produce the ASTER GDEM involved automated processing of 2.3-million-scenes from the ASTER archive, including stereo-correlation to produce individual scene-based ASTER DEMs, masking to remove cloudy pixels, stacking all cloud-screened DEMs, removing residual bad values and outliers, averaging selected datato create final pixel values, and then correcting residual anomalies before partitioning the data into 1^0-by-1^0 tiles.

The ASTER GDEM covers land surfaces between 83^0N and 83^0S and comprises 22,912 1^0-by-1^0 tiles. Tiles that contain at least 0.01% land area are included. The ASTER GDEM is distributed in GeoTIFF file format with Geographic lat/long coordinates and a 1 arc-second (30 m) grid of elevation postings. It is referenced to the WGS84/EGM96 geoid. Studies to validate and characterize the ASTER GDEM confirm that accuracies for this global product are 20 meters at 95 % confidence for vertical data and 30 meters at95% confidence for horizontal data.

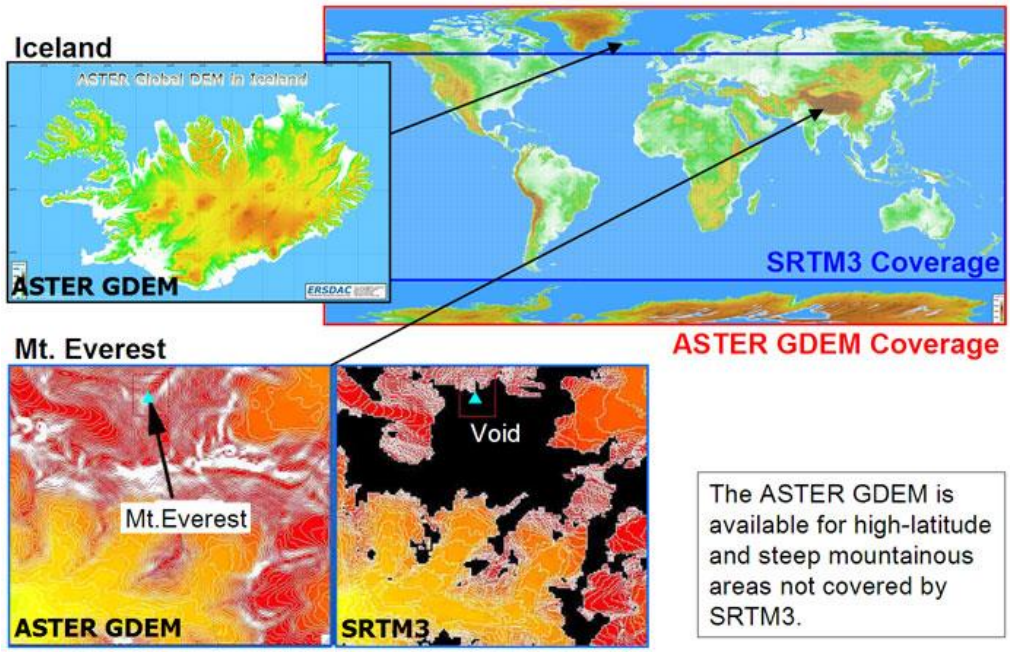


Figure 10.1 - Comparisons between ASTER GDEM and SRTM3

(Image courtesy of METI and NASA)

Areas of DEM application:

- Stereographic visualization of satellite and other two – dimensional images
- Automated calculation of slope, direction and angles, catchment area, fault etc (jspacesystems)

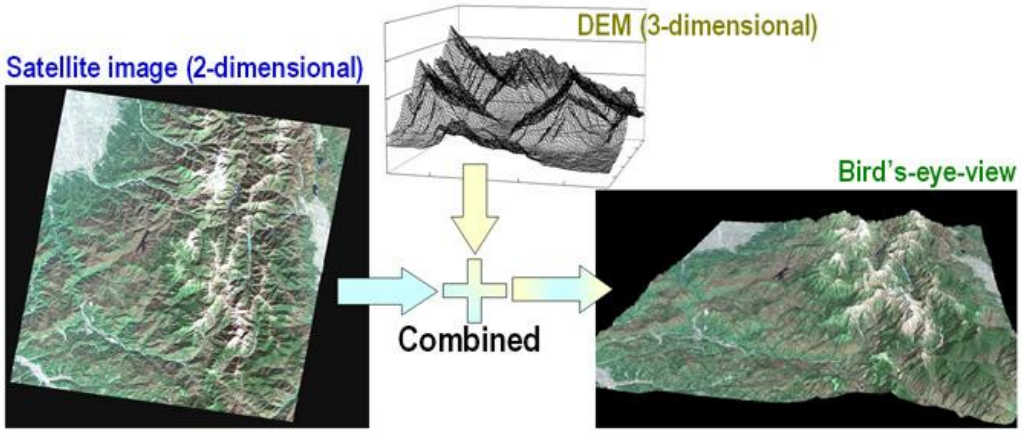


Figure 10.2- Stereographic visualization (Image courtesy of METI and NASA)

SRTM DEM

The Shuttle Radar Topography Mission (SRTM) was flown aboard the space shuttle *Endeavour* February 11-22, 2000. The National Aeronautics and Space Administration

(NASA) and the National Geospatial-Intelligence Agency (NGA) participated in an international project to acquire radar data which were used to create the first near-global set of land elevations.

The radars used during the SRTM mission were actually developed and flown on two *Endeavour* missions in 1994. The C-band Spaceborne Imaging Radar and the X-Band Synthetic Aperture Radar (X-SAR) hardware were used on board the space shuttle in April and October 1994 to gather data about Earth's environment. The technology was modified for the SRTM mission to collect interferometric radar, which compared two radar images or signals taken at slightly different angles. This mission used single-pass interferometry, which acquired two signals at the same time by using two different radar antennas. An antenna located on board the space shuttle collected one data set and the other data set was collected by an antenna located at the end of a 60-meter mast that extended from the shuttle. Differences between the two signals allowed for the calculation of surface elevation.

Endeavour orbited Earth 16 times each day during the 11-day mission, completing 176 orbits. SRTM successfully collected radar data over 80% of the Earth's land surface between 60° north and 56° south latitude with data points posted every 1 arc-second (approximately 30 meters).

SRTM Data Products

The level of processing and the resolution of the data will vary by SRTM data set.

SRTM Non-Void Filled elevation data were processed from raw C-band radar signals spaced at intervals of 1 arc-second (approximately 30 meters) at NASA's Jet Propulsion Laboratory (JPL). This version was then edited or finished by the NGA to delineate and flatten water bodies, better define coastlines, remove spikes and wells, and fill small voids. Data for regions outside the United States were sampled at 3 arc-seconds (approximately 90 meters) using a cubic convolution resampling technique for open distribution.

SRTM Void Filled data are the result of additional processing to address areas of missing data or voids in the SRTM Non-Void Filled collection. The voids occur in areas where the initial processing did not meet quality specifications. Since SRTM data are one of the most widely used elevation data sources, the NGA filled the voids using interpolation algorithms in conjunction with other sources of elevation data. The resolution for SRTM Void Filled data is 1 arc-second for the United States and 3 arc-seconds for global coverage.

SRTM 1 Arc-Second Global elevation data offer worldwide coverage of void filled data at a resolution of 1 arc-second (30 meters) and provide open distribution of this high-resolution global data set. Some tiles may still contain voids. Users should check the coverage map in EarthExplorer to verify if their area of interest is available. Please note that tiles above 50° north and below 50° south latitude are sampled at a resolution of 2 arc-second by 1 arc-second.

SRTM File Formats

EarthExplorer offers SRTM data with a regularly spaced grid of elevation points in three file formats:

- Digital Terrain Elevation Data (DTED) is a standard mapping format designed by the NGA. Each file or cell contains a matrix of vertical elevation values spaced at regular horizontal intervals measured in geographic latitude and longitude units. File size is approximately 25 MB for 1-arc-second data files and approximately 3 MB for 3-arc-second data files.

- Band interleaved by line (BIL) is a binary raster format with an accompanying header file which describes the layout and formatting of the file. File size is approximately 7 MB for 1-arc-second data files and approximately 1 MB for 3- arc-second data files.

- Georeferenced Tagged Image File Format (GeoTIFF) is a TIFF file with embedded geographic information. This is a standard image format for GIS applications. File size is approximately 25 MB for 1-arc-second data files and approximately 3 MB for 3-arc-second data files.

SRTM elevation data are intended for scientific use with a Geographic Information System (GIS) or other special application software.

Product Specifications

Projection	Geographic
Horizontal Datum	WGS84
Vertical Datum	EGM96 (Earth Gravitational Model 1996)
Vertical Units	Meters
Spatial Resolution	1 arc-second for global coverage (~30 meters) 3 arc-seconds for global coverage (~90 meters)
Raster Size	1 degree tiles
C-band Wavelength	5.6 cm

Additional SRTM Products are available through collaborating agencies:

Research grade SRTM (C-band) data are available through NASA JPL. These data were sampled at 3 arc-seconds using a nearest neighbour resampling technique for global coverage.

The German and Italian space agencies operated the X-band hardware and processed the data independently into a separate elevation data set. The SRTM/X-SAR data may be obtained through the German Aerospace Center (USGS).

CartoDEM

CartoDEM is generated using Augmented Stereo Strip Triangulation (ASST) - indigenously developed software by Space Application Centre, ISRO. The seamless CartoDEM generation is an automatic process and makes use of limited Ground Control Points (GCPs) in long stereo strip pairs using dense feature matching, Triangulated Irregular Network (TIN) modeling and automatic long strip mosaicing. The generated DEM and ortho images of each Cartosat-1 segment are cut into tiles of 7.5'x7.5' extents. The entire Indian region is covered by approximately 500 Cartosat-1 segments with a total number of around 20,000 tile pairs. Every tile is subjected to quality verification process through panning and 2.5D draped visualization to identify and demarcate distortions in Quality Verification (QV) system for further improvement. The automatic generation of DEM has inherent problems like water-body irregularities, hill-top distortions, plain-area sinks and residual mosaics; and these are corrected

in the Tile Editing (TE) system. Qualified CartoDEM tiles are formatted and archived systematically in database Dissemination System (DS).

CartoDEM Specifications

Parameters - Specifications

- Image Format - Geo-Tiff
- Data Type (DEM) -Signed short (2 bytes)
- Data Type (Ortho-image) -Unsigned short (2 bytes)
- Datum (planimetric and height) -WGS84
- Projection - Geographic
- Ortho Image Resolution - 1/12 arc sec ~ 2.5 m
- Posting - 1/3 arc sec ~ 10 m
- DEM type - Digital Surface Model
- Absolute accuracy (Planimetric) -15m (CEP 90)
- Absolute accuracy (Vertical) - 8 m (LE 90)
- Relative accuracy (Vertical)- > 5 m (LE 90)
- Ellipsoidal height Units - Meters
- Tile Extents (Size) - 7.5'x7.5'
- Generating Agency - NRSC / ISRO
- Copyright- NRSC / ISRO

CartoDEM Applications

CartoDEM products are extremely useful in -

- Contour generation;
- Drainage network analysis;
- Quantitative analysis of run-off and soil erosion;
- Volume-area calculations; design of hydraulic structures;

- Design of new road, rail and pipeline alignments;
- Watershed planning;
- Urban utility planning;
- Landslide zonation;
- River configuration studies and flood proofing;
- Fly through visualization; etc (NRSC).

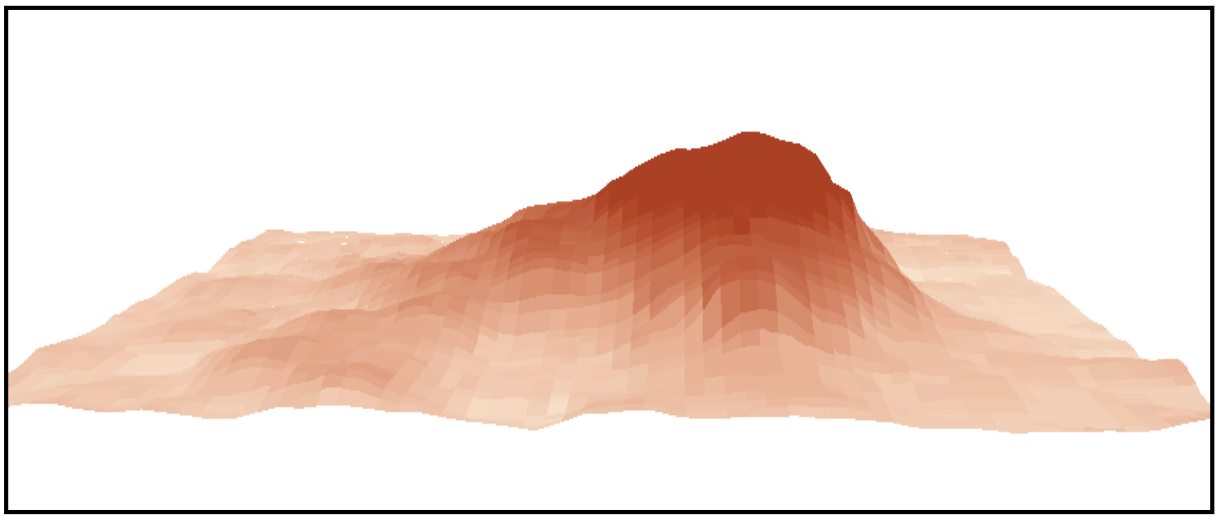


Figure 10.3 - A domed inselberg (Bornhardt) in 3D using ASTER DEM

References:

https://www.jspacesystems.or.jp/ersdac/GDEM/E/2.html

https://www.usgs.gov/centers/eros/science/usgs-eros-archive-digital-elevation-shuttle-radar-topography-mission-srtm-1

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote Sensing and Image Interpretation.* USA: Wiley.

NRSC. *CartoDEM - a national digital elevation model from Cartosat - 1 stereo data.* Hyderabad: NRSC.

Unit-11: Analytical Modelling in GIS, GNSS-GIS integration

Defining GIS:

A GIS is a computer-based system that provides the following four sets of capabilities to handle geo- referenced data:

- Data Input
- Data management (storage and retrieval)
- Manipulation and analysis
- Output.

Sources of Data

- Geospatial data can be acquired from any number of sources such as printed maps, geospatial databases, or data acquired with the Global Positioning System (GPS).
- Geospatial data is generally grouped into two types: raster and vector.

Geographic Data Models

All GIS data attempts to define abstract real-world features in a data model, or format that can be understood by a computer.

- In the GIS world, there are two main data models used to represent features: the vector data model and the raster data model.
- The vector data model represents discrete objects on the surface of the earth—such as trees, rivers, or lakes—as point, line, and polygon features with well-defined boundaries.
- A raster data model represents the surface of the earth as a grid of equally sized cells. An individual cell represents a portion of the earth such as a square meter or a square mile.

Vector Data Model Vs Raster Data Model

- The vector data model represents geographic features with exactly defined boundaries, while the raster data model represents them as cells of the same value.
- Both the vector and raster data models are useful for representing geospatial data, but one may be more appropriate than the other when it comes to representing a particular type of geospatial data or answering different kinds of questions.

- In general, the vector data model is useful for representing features that have discrete boundaries, while the raster data model is most useful for representing continuous geospatial data—phenomena such as elevation, precipitation, and temperature—which do not have well-defined boundaries and which usually change gradually across a given area.

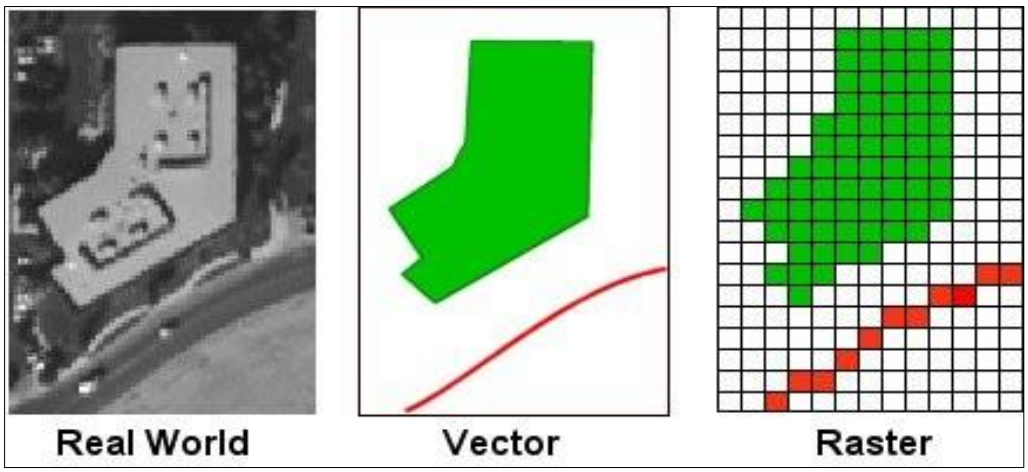


Fig. 11.1 Representation of real world features through vector and raster data models

Raster Data

A raster is made up of a grid of square cells where all the cells are the same size. (Pixels is another term for cells. Short for "picture element," pixels usually refers to image cells.)

- Thus, an individual raster cell represents a portion of the earth such as a square meter or square mile.
- Each cell has a given value, depending on the type of dataset. In general, these cells are squares and are organized in rows and columns to form a rectangular dataset.
- The number of rows and columns in a raster does not have to be the same. For example, your raster may have 2000 rows and 1857 columns.
- The cell is the basic spatial unit of a raster. Each cell has a numeric value. Colors or shades are used to display the different cell values, yielding an image or a map of some kind.
- Raster datasets can represent non-geographic or geographic information. When rasters represent geographic information, they store the location and characteristics of each cell.
- Rasters may be categorized as one of two types: image rasters and thematic rasters. Image rasters are typically produced by an optical or electronic device such as a camera or scanner. Digital photographs or images are a type of raster dataset.

- Each cell represents a specific location on the earth.
- Thematic rasters represent geographic features or phenomena with either discrete or continuous data. Digital elevation models (DEM) are a common type of thematic raster dataset.
- Each of the cells in a DEM raster represents the elevation of that point on the earth's surface.
- Together, imagery and DEMs can provide a wealth of information about the topography of a region.

Raster Values

Raster datasets represent data using either integers (whole numbers) or floating points (numbers with decimals).

- Integer rasters are used to represent discrete data, such as landuse, and floating point rasters are used to represent continuous data, such as like elevation or slope.

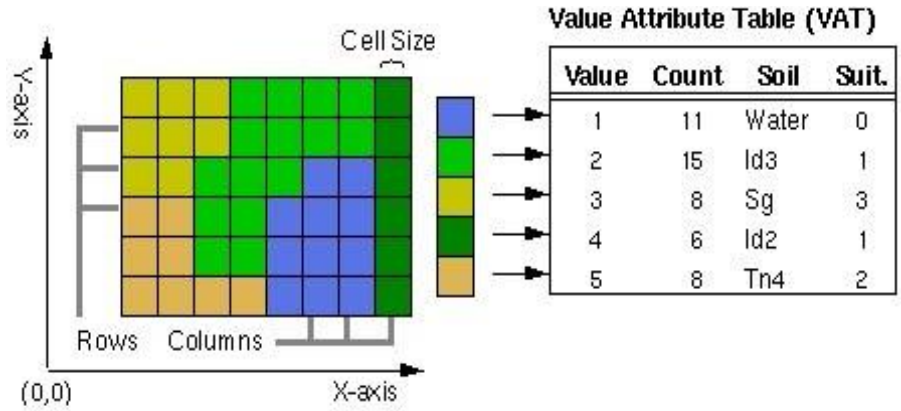


Fig. 11.2 A VAT has one record for each unique value in the grid.

- A discrete raster dataset contains cells whose values are integers, often code numbers for a particular category. Cells can have the same value in a discrete raster dataset. Integer raster datasets have a value attribute table (VAT) that stores the cell values and their associated attributes.
- Unlike discrete raster datasets, continuous raster datasets (floating point raster datasets) do not have an attribute table because each cell in a continuous raster dataset can have a different floating point value. Cells in this type of raster dataset do not fall neatly into discrete categories.

Comparing Raster Formats

TIFF format

TIFF (tagged image file format) files are one of the preferred raster file types for geospatial data because they are suitable for representing multi-color images, but can also support black and white and gray-scale images.

- The TIFF format is based on lossless compression so it can be stored in a compressed or decompressed format without losing any of its original data.
- Another advantage of the TIFF format is its ability to store reference tags in the file that establishes a spatial reference for the TIFF file; such a tagged file is generally referred to as a "GeoTIFF".

PNG format

Another popular image format is the PNG (portable network graphic) format, which is sometimes thought of as the successor to the GIF (graphics interchange format). This format is excellent for simple raster images and compresses well.

- The PNG is commonly found on the Internet, where it is quickly replacing the GIF as the standard image format. It is also used for exporting maps and maintaining raster attributes in geodatabases.
- Its increased support of transparency, lossless data compression, and increased color depth all make this an ideal format for web-based applications.
- It is important to note, however, PNG files do not support the CMYK color space, so they are rarely used in professional printing.
- Note, however, that the file sizes demonstrate that the PNG's lossless compression technique is minimally effective, as it produces a file only 7% smaller than the uncompressed TIFF.

JPEG format

JPEG (joint photographic experts group) files are commonly used on the Internet and produced by default on most digital cameras.

- JPEG format uses "lossy" compression to create as small a file size as possible while maintaining the overall quality of the image; that is, the image will look much like a raw, uncompressed image, but will not be a precise bit-by-bit copy.
- This works well for photographs, where minute changes are, for all practical purposes, imperceptible to the human eye. However, for applications that require precise data values, the JPEG format is not the best choice.
- The low-quality JPEG brings the file size down considerably, but at a high cost to quality. The high-quality JPEG compression works quite well, however, as the file size is drastically reduced while the quality of the image remains basically unchanged.

GIS raster formats

Some GIS-specific raster formats are MrSID (multiresolution seamless image database), a proprietary format developed by LizardTech;

- ASCII-Grid format, which stores a raster dataset in a human-readable text-file format
- Esri's own proprietary Esri GRID format.
- ERDAS IMAGINE uses IMG files to store raster data, and is supported as one of the standard ArcGIS files. The contents of an IMG file are not fixed. Because of the open nature of the file format, other developers may create and add new types of items to the file.
- Another common format is ECW (enhanced compression wavelet), which is a proprietary wavelet compression image format optimized for aerial and satellite imagery. This lossy compression format efficiently compresses large images with fine alternating contrast.
- The raster file format you choose to use will depend on desired quality versus desired file size or available disk space, as well as the intended use of the file, whether it be for a website (PNG or JPEG) or to transfer high-quality geospatial data (TIFF).

Raster bands

A raster dataset can be either simple (one layer) or composite (a collection of multiple layers). These raster layers are referred to as bands.

- Thematic rasters and panchromatic images are examples of simple raster datasets. Many types of imagery such as multispectral satellite imagery, are composite rasters.
- When there are multiple bands, every cell location has more than one value associated with it.
- A raster dataset can have multiple bands. For example, each band in a multispectral image represents different parts of the electromagnetic spectrum. Every cell in the image has a data value for each band.
- Cell values in single-band rasters are usually displayed using a gray-scale or a colour map.
- In gray-scale, shades range between black and white. In a colour map, cell values are arbitrarily matched to particular colours.

Spatial Reference for Rasters

- A dataset's spatial reference describes where features are located in the real world. The spatial reference includes a coordinate system for x-, y-, and z-values as well as resolution and tolerance values for x-, y-, z-, and m- values.

Coordinate systems

All geospatial raster datasets are in some coordinate space. This coordinate space may be a real-world coordinate system such as latitude and longitude, or one based on the raster's cells.

- In the raster, cells are referenced by their row and column position. The rows and columns are numbered from the top left corner of the raster, starting with zero. The cell in the top left corner has row and column coordinates of 0,0. This cell is known as the raster's cell origin.

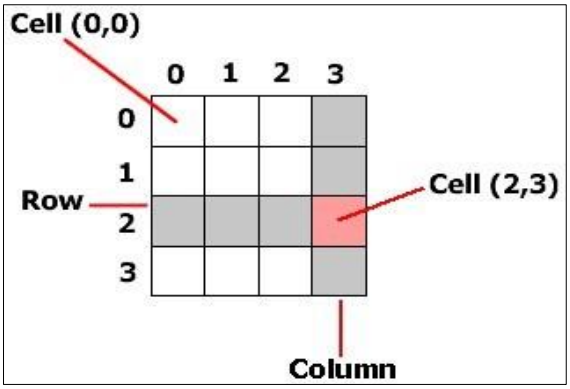


Fig. 11.3 every cell in a raster can be uniquely identified by its row and column position. For example, the red cell is at row 2 and column 3.

A raster that represents geographic information uses a Cartesian coordinate system to reference cells to a location on the earth.

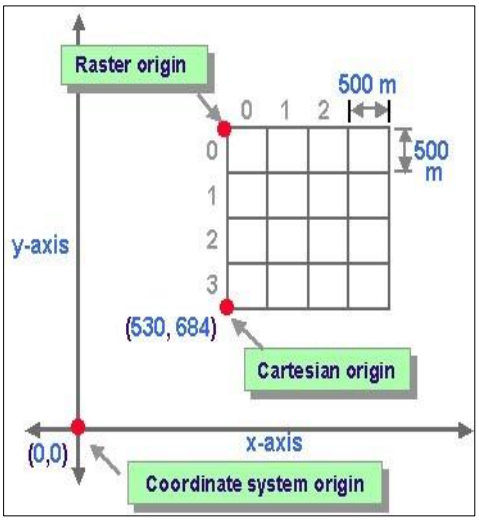


Fig. 11.4 A raster that represents geographic information has a second origin for the Cartesian coordinate system, the bottom left corner.

Spatial Resolution or Cell Size

Spatial resolution refers to the area of the real world represented by one cell in the raster. A high-resolution dataset will have cells that represent relatively small areas in the real world, thereby providing more detail. A low-resolution dataset will have cells that represent a large area and provide a "summary" of the area in question.

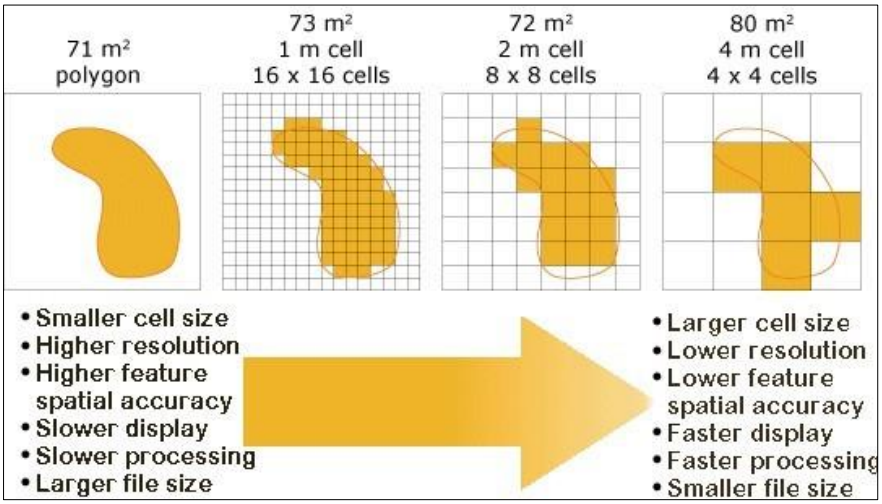


Fig. 11.5 the level of detail (of features/phenomena) represented by a raster is often dependent on the cell size, or spatial resolution, of the raster. The cell must be small enough to capture the required detail but large enough so computer storage and analysis can be performed efficiently.

Vector data

- The vector format is an excellent way to store information about discrete geographical locations, features, or regions.
- While rasters often represent data that is continuous or thematic (e.g., images, temperature, precipitation), vector data is used more often to represent discrete objects such as trees, streets, or buildings.
- In geodatabases, a vector object is known as a feature, and related features are organized into groups called feature classes. Unlike rasters, where information is stored within each cell of the raster, the attributes of vector data are associated with features.
- ArcMap displays what are called layers. A layer references the information contained in a feature class or raster, rather than actually storing it.

Vector data model

- The vector data model is based on the assumption that the earth's surface is composed of discrete objects such as trees, rivers, and lakes.
- Objects are represented as point, line, and polygon features with well-defined boundaries.
- Feature boundaries are defined by x,y coordinate pairs, which reference a location in the real world.
- Points are defined by a single x,y coordinate pair.
- Lines are defined by two or more x,y coordinate pairs.
- Polygons are defined by lines that close to form the polygon boundaries.
- In the vector data model, every feature is assigned a unique numerical identifier, which is stored with the feature record in an attribute table.

Feature attributes

- On a GIS map, there is more to a feature than its location and shape. There is all the information associated with that feature. For a road, this might include its name, speed limit, and whether it is one-way or two-way. For a city, this might include its population, demographic characteristics, number of schools, and average monthly temperatures.
- Information associated with a feature in a GIS is called an attribute. For example, population can be an attribute of a city, country, continent, and other features. Feature attributes are stored in an attribute table.
- In an attribute table, each feature is a record (row) and each attribute is a field (column). The attributes for all the features in a layer are stored in the same attribute table.
- Each feature in a feature class—essentially, a group of related features—may have any given number of attributes. Each attribute value can be categorized as one of four levels of measurement: nominal (such as ID numbers or names), ordinal (rankings), interval (on a scale with no "natural" zero), or ratio (on a scale with a "natural" zero).

Vector formats

- As with the raster data formats, there are a number of file formats for storing vector data.
- Shapefiles are universal exchange files (unlike the geodatabase). The term "shapefile" is somewhat misleading, as a shapefile actually comprises a group of separate files.
- ArcMap and ArcCatalog make these separate files invisible to the end user by displaying them as a single file with a SHP extension.
- Another format that has become popular is the Keyhole Markup Language (KML) file. KML files have either a KML file extension or a KMZ file extension (for compressed and zipped KML files).
- Each KML file is composed of a collection of graphic elements, images, and settings. KML is used to do the following:
- Symbolize and display GIS data as elements within Google Earth and Google Maps using symbols, color, images, and balloon-style information pop-ups.
- Provide access to attribute information about geographic features—for example, by presenting attribute information when you click a feature's symbol.

There are a number of other vector formats that are occasionally used. Two of the more common formats are the

- AutoCAD Drawing Exchange Format (.DXF) and
- The United States Geological Survey (USGS) Digital Line Graph (.DLG) format.

Attribute tables

- A feature on a GIS map is linked to its record in the attribute table by a unique numerical identifier (ID). Every feature in a layer has an identifier.
- When you select a record in the table, the linked feature on the map is automatically selected as well.

Using attribute queries

- To find features that meet specific attribute criteria, you create a query expression.

- A query expression is a logical statement consisting of three parts: a field name (attribute), an operator, and an attribute value.
- Query expressions can be linked together to include multiple criteria. Expressions that contain multiple criteria are called compound expressions.

Accessing more attributes

- Not all feature attributes are stored in a layer attribute table. In many GIS databases, user- defined attributes (as opposed to software-generated attributes) are stored in separate, nonspatial tables.
- When you want to find features based on their attributes, sometimes you will need to associate a nonspatial table to the layer attribute table before you can perform the query.
- You can associate a nonspatial table to a layer attribute table if they share a common field; that is, a field that stores the same data.
- The names of the common field do not have to be the same, but the field types (e.g., text, short integer) must be.

Raster model	Vector model
• Simple data structure • Easy and efficient overlaying • Compatible with Remote Sensing imagery • High spatial variability is efficiently represented Simple for programming by user • Same grid cell definition for various attributes • Inefficient use of computer storage Errors in perimeter and shape Difficult to perform network analysis Inefficient projection transformations • Loss of information when using large pixel sizes Less accurate and less appealing map output	• Complex data structure Difficult to perform overlaying • Not compatible with RS imagery • Inefficient representation of high spatial variability • Compact data structure Efficient encoding of topology • Easy to perform network analysis • Highly accurate map output

Spatial Analysis: Raster and Vector Based

VECTOR BASED ANALYSIS

- **Map Overlay**
  - Union, Intersect
  - Point in Polygon, Line in Polygon, Polygon on Polygon
- **Map manipulation**
  - Dissolve, Clip, Append, Eliminate, Update, Erase, Split
- **Proximity Analysis**
  - Buffer, Multiple Ring Buffer, Point Distance
- **Pattern Analysis**
  - Nearest Neighbour Analysis, Spatial Autocorrelation
- **Network Analysis**
  - Shortest route

RASTER BASED ANALYSIS

- **Functions**
  - Local, Focal , Zonal , Global
- **Map Algebra**
  - Operators: Boolean, Relational and Arithmetic
  - Functions: Mathematical, Logarithmic, Arithmetic, Trigonometric, Power
- **Terrain Analysis**
  - Derivatives: Contour, Slope, Aspect, Hillshade, Viewshed
- **Hydrology Analysis**
  - Flow Directions, Flow Accumulation, Stream Order, Watershed etc.
- **Reclassification**

Creating Buffer

Buffer tools are used to create a new polygon vector layer using the input feature. It represents certain distance from the input features. There are several applications of this tool in both physical science and social sciences. e.g. it can be used to demarcate flood prone areas along both sides of a river using average distance derived from records previous flood events. Similarly it can be used to demarcate area of influence of a market place or a shopping mall etc.

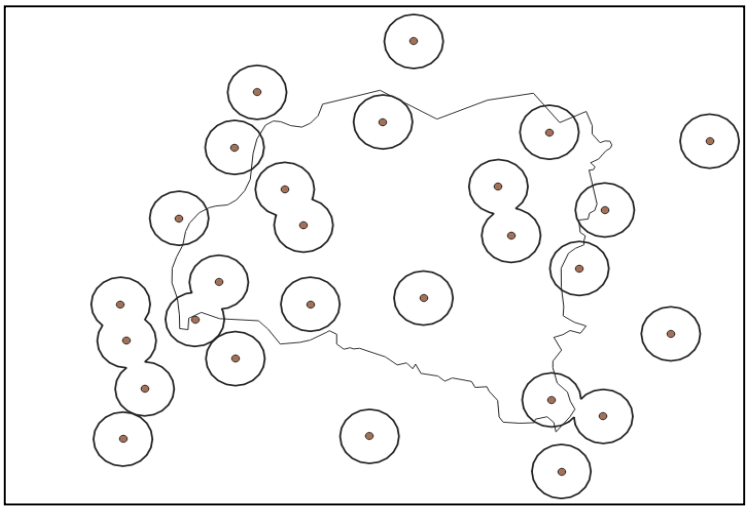


Fig. 11.6 a buffer distance of 2 Km. has been set to create a buffer polygon around various place of Kalyani subdivion and surroundings.

Using Clip

In the following diagram input layer which represents places around Kalyani subdivision has been clipped using Kalyani subdivision overlay layer. Below is the clipped layer which excludes the places outside its boundary.

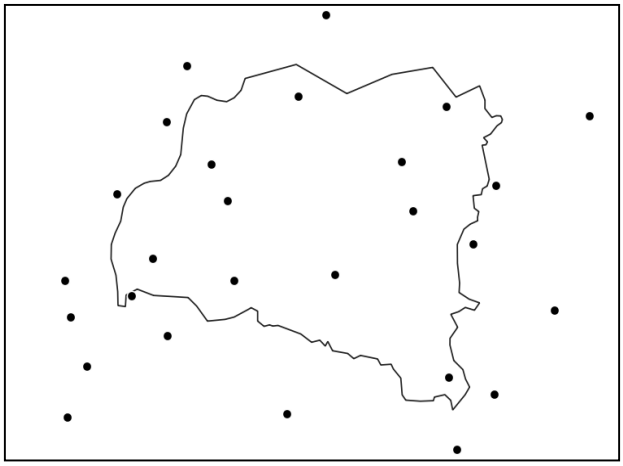


Fig. 11.7 places around Kalyani subdivision

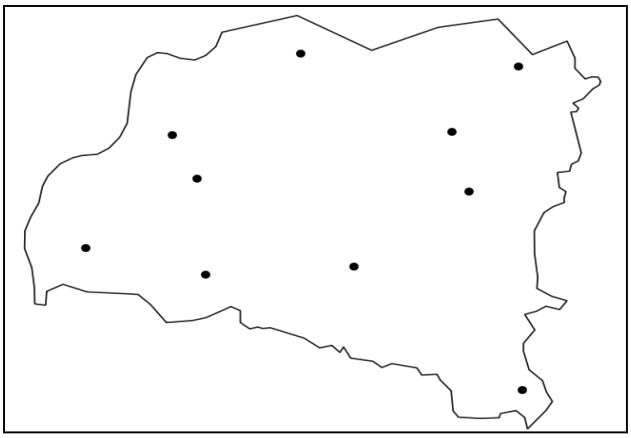


Fig. 11.8 clipped layer which excludes the places outside its boundary

Dissolve

This algorithm merges all the feature of vector layer into a new vector layer. One or more similar attributes can be selected to dissolve or alternatively all attributes can be dissolved into a single one.

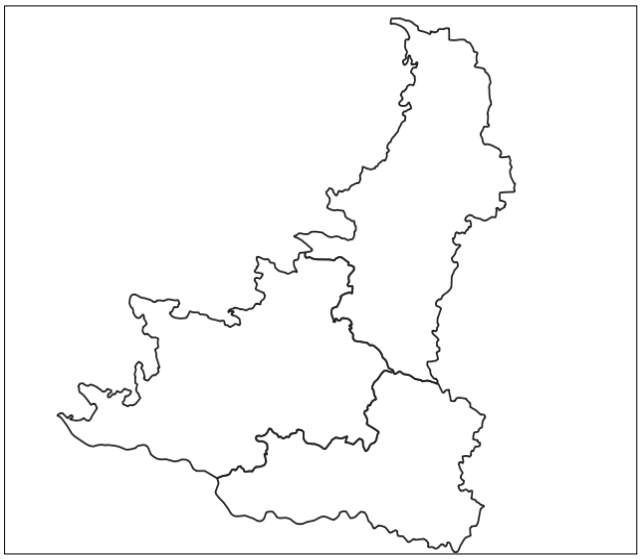


Fig. 11.9 three subdivisions of the Birbhum district

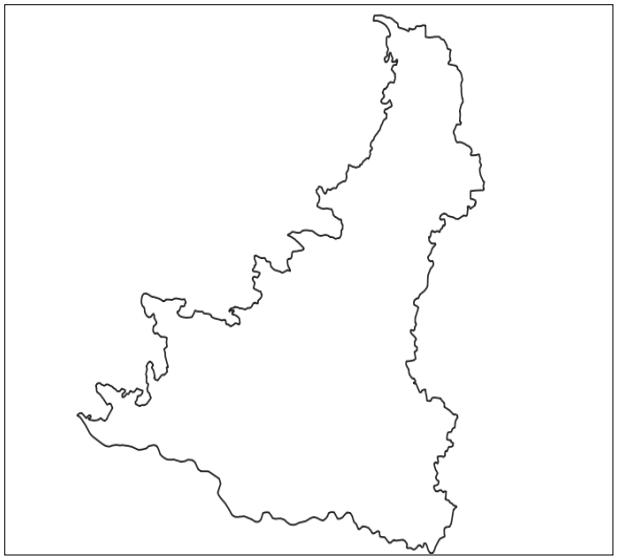


Fig. 11.10 dissolved vector layer representing only the boundary of the Birbhum district

References:

Burrough, P. A., & Mc Donnel, R. A. (1998). *Principles of Geographical Information Systems.* New York: Oxford University Press.

Environmental Systems Research Institute (ESRI)

UNIT-12: CONCEPT OF BIGDATA, MACHINE LEARNING AND DEEP LEARNING

Big data analytics is the process of collecting and analyzing a large volume of data sets (called Big Data) to discover useful hidden patterns and other information like customer choices, and market trends that can help organizations make more informed and customer-oriented business decisions. Big data is a term that describes the data characterized by 3Vs: the extreme volume of data, the wide variety of data types, and the velocity at which the data must be processed. Big data can be analyzed for insights that lead to better decisions and strategic business moves. **Machine learning** is a field of AI (Artificial Intelligence) by using which software applications can learn to increase their accuracy for the expecting outcomes. In layman's terms, Machine Learning is the way to educate computers on how to perform complex tasks that humans don't know how to accomplish. Machine Learning field is so vast and popular these days that there are a lot of machine learning activities happening in our daily life and soon it will become an integral part of our daily routine. So, have you noticed any of these machine learning activities in your everyday life? You know those movie/show recommendations you get on Netflix or Amazon? Machine learning does this for you. How does Uber/Ola determine the price of your cab ride? How do they minimize the wait time once you hail a car? How do these services optimally match you with other passengers to minimize detours? The answer to all these questions is Machine Learning. How can a financial institution determine if a transaction is fraudulent or not? In most cases, it is difficult for humans to manually review each transaction because of its very high daily transaction volume. Instead, AI is used to create systems that learn from the available data to check what types of transactions are fraudulent. Ever wondered what's the technology behind the self-driving Google car? Again the answer is machine learning. Key Differences Between Big Data and Machine Learning Following is the key difference between Big Data and Machine Learning: Both data mining and machine learning are rooted in data science. They often intersect or are confused with each other. They superimpose each other's activities and the relationship is best described as mutualistic. It is impossible to see a future with just one of them. But there are still some unique identities that separate them in terms of definition and application. Here's a look at some of the differences between big data and machine learning and how they can be used. Usually, big data discussions include storage, ingestion & extraction tools commonly Hadoop. Whereas machine learning is a subfield of Computer Science and/or AI that gives computers the ability to learn without being explicitly programmed. Big data analytics as the name suggest is the analysis of big data by discovering hidden patterns or extracting information from it. So, in big data analytics, the analysis is done on big data. Machine learning, in simple terms, is teaching a machine how to respond to unknown inputs and give desirable outputs by using various machine learning models. Though both big data and machine learning can be set up to automatically look for specific types of data and parameters and their relationship between them big data can't see the relationship between existing pieces of data with the same depth that machine learning can. Normal big data analytics is all about extracting and transforming data to extract information, which then can be used to fed to a machine learning system in order to do further analytics for predicting output results. Big data has got more to do with High-Performance Computing, while Machine Learning is a part of Data Science. Machine learning performs tasks where human interaction doesn't matter. Whereas, big data analysis comprises the structure and

modeling of data which enhances decision-making system so require human interaction (Pedamkar, 2022).

DEEP LEARNING

Deep learning attempts to mimic the human brain—albeit far from matching its ability—enabling systems to cluster data and make predictions with incredible accuracy. **What is deep learning?** Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to "learn" from large amounts of data. While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimize and refine for accuracy. Deep learning drives many artificial intelligence (AI) applications and services that improve automation, performing analytical and physical tasks without human intervention. Deep learning technology lies behind everyday products and services (such as digital assistants, voice-enabled TV remotes, and credit card fraud detection) as well as emerging technologies (such as self-driving cars). **Deep learning vs. machine learning** If deep learning is a subset of machine learning, how do they differ? Deep learning distinguishes itself from classical machine learning by the type of data that it works with and the methods in which it learns. Machine learning algorithms leverage structured, labeled data to make predictions—meaning that specific features are defined from the input data for the model and organized into tables. This doesn't necessarily mean that it doesn't use unstructured data; it just means that if it does, it generally goes through some pre-processing to organize it into a structured format. Deep learning eliminates some of data pre-processing that is typically involved with machine learning. These algorithms can ingest and process unstructured data, like text and images, and it automates feature extraction, removing some of the dependency on human experts. For example, let's say that we had a set of photos of different pets, and we wanted to categorize by "cat", "dog", "hamster", et cetera. Deep learning algorithms can determine which features (e.g. ears) are most important to distinguish each animal from another. In machine learning, this hierarchy of features is established manually by a human expert. Then, through the processes of gradient descent and back propagation, the deep learning algorithm adjusts and fits itself for accuracy, allowing it to make predictions about a new photo of an animal with increased precision. Machine learning and deep learning models are capable of different types of learning as well, which are usually categorized as supervised learning, unsupervised learning, and reinforcement learning. Supervised learning utilizes labelled datasets to categorize or make predictions; this requires some kind of human intervention to label input data correctly. In contrast, unsupervised learning doesn't require labelled datasets, and instead, it detects patterns in the data, clustering them by any distinguishing characteristics. Reinforcement learning is a process in which a model learns to become more accurate for performing an action in an environment based on feedback in order to maximize the reward. For a deeper dive on the nuanced differences between the different technologies, see "AI vs. Machine Learning vs. Deep Learning vs. Neural Networks: What's the Difference?" For a closer look at the specific differences between supervised and unsupervised learning, see "Supervised vs. Unsupervised Learning: What's the Difference?" **How deep learning works** Deep learning neural networks, or artificial neural

networks, attempts to mimic the human brain through a combination of data inputs, weights, and bias. These elements work together to accurately recognize, classify, and describe objects within the data. Deep neural networks consist of multiple layers of interconnected nodes, each building upon the previous layer to refine and optimize the prediction or categorization. This progression of computations through the network is called forward propagation. The input and output layers of a deep neural network are called *visible* layers. The input layer is where the deep learning model ingests the data for processing, and the output layer is where the final prediction or classification is made. Another process called backpropagation uses algorithms, like gradient descent, to calculate errors in predictions and then adjusts the weights and biases of the function by moving backwards through the layers in an effort to train the model. Together, forward propagation and backpropagation allow a neural network to make predictions and correct for any errors accordingly. Over time, the algorithm becomes gradually more accurate. The above describes the simplest type of deep neural network in the simplest terms. However, deep learning algorithms are incredibly complex, and there are different types of neural networks to address specific problems or datasets. For example, *Convolutional neural networks (CNNs),* used primarily in computer vision and image classification applications, can detect features and patterns within an image, enabling tasks, like object detection or recognition. In 2015, a CNN bested a human in an object recognition challenge for the first time. *Recurrent neural network (RNNs)* are typically used in natural language and speech recognition applications as it leverages sequential or times series data. **Deep learning applications** Real-world deep learning applications are a part of our daily lives, but in most cases, they are so well-integrated into products and services that users are unaware of the complex data processing that is taking place in the background. Some of these examples include the following: **Law enforcement** Deep learning algorithms can analyze and learn from transactional data to identify dangerous patterns that indicate possible fraudulent or criminal activity. Speech recognition, computer vision, and other deep learning applications can improve the efficiency and effectiveness of investigative analysis by extracting patterns and evidence from sound and video recordings, images, and documents, which helps law enforcement analyze large amounts of data more quickly and accurately. **Financial services** Financial institutions regularly use predictive analytics to drive algorithmic trading of stocks, assess business risks for loan approvals, detect fraud, and help manage credit and investment portfolios for clients. **Customer service** Many organizations incorporate deep learning technology into their customer service processes. Chatbots—used in a variety of applications, services, and customer service portals—are a straightforward form of AI. Traditional chatbots use natural language and even visual recognition, commonly found in call center-like menus. However, more sophisticated chatbot solutions attempt to determine, through learning, if there are multiple responses to ambiguous questions. Based on the responses it receives, the chatbot then tries to answer these questions directly or route the conversation to a human user. Virtual assistants like Apple's Siri, Amazon Alexa, or Google Assistant extends the idea of a chatbot by enabling speech recognition functionality. This creates a new method to engage users in a personalized way. **Healthcare** The healthcare industry has benefited greatly from deep learning capabilities ever since the digitization of hospital records and images. Image recognition applications can support medical imaging specialists and radiologists, helping them analyze and assess more images in less time. **Deep learning hardware requirements** Deep

learning requires a tremendous amount of computing power. High performance *graphical processing units (GPUs)* are ideal because they can handle a large volume of calculations in multiple cores with copious memory available. However, managing multiple GPUs on-premises can create a large demand on internal resources and be incredibly costly to scale (IBM, 2022).

References:

IBM. (2022). *Deep Learning*. Retrieved from IBM: https://www.ibm.com/cloud/learn/deep-learning

Pedamkar, P. (2022). *Big Data Vs Machine Learning*. Retrieved from EDUCBA: https://www.educba.com/big-data-vs-machine-learning/

1.7. Self Assessment Test

- Discuss the nature and scope of cartography.
- What is geoid?
- Highlight the application of spheroids in map making.
- Discuss the salient features of UTM projection.
- What is spectral signature?
- What is radiometric resolution of remotely sensed data?
- What is georeferencing?
- Distinguish between supervised classification and unsupervised classification.
- Highlight the salient features of CartoDEM.
- Discuss the advantages and disadvantages of raster data model and vector data model.

1.8 Study Tips

Agrawal, N. K. *Coordinates*. Retrieved 08 10, 2022, from https://mycoordinates.org

Burrough, P. A., & Mc Donnel, R. A. (1998). *Principles of Geographical Information Systems.* New York: Oxford University Press.

Gao, J. (2009). *Digital Analysis of Remotely Sensed Data.* New York: Mc Graw Hill.

Geohunter. Retrieved from Geohunter: http://www.geo.hunter.cuny.edu

GISGeography. (n.d.). *GISGeography*. Retrieved from https://gisgeography.com/utm-universal-transverse-mercator-projection/

Hafen, K. (n.d.). *Open Source Options*. Retrieved 08 17, 2022, from Open Source Options: https://opensourceoptions.com/blog/how-to-make-a-false-color-satellite-image-in-qgis/

IBM. (2022). *Deep Learning*. Retrieved from IBM: https://www.ibm.com/cloud/learn/deep-learning

Jan Kraak, M., & Ormeling, F. (2010). *Cartography: Visualization of Geospatial Data.* Essex: Pearson Education Limited.

jspacesystems. *jspacesystems*. Retrieved from https://www.jspacesystems.or.jp/ersdac/GDEM/E/2.html

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote Sensing and Image Interpretation.* USA: Wiley.

Menke, K., Smith, R., Pirelli, L., & Hoesen, J. V. (2016). *Mastering QGIS.* Birmingham: Packt Publishing.

NRSC. *CartoDEM - a national digital elevation model from Cartosat - 1 stereo data.* Hyderabad: NRSC.

NRSC. (2011). *Resourcesat 2 Data Users Handbook.* Hyderabad: NRSC.

Pedamkar, P. (2022). *Big Data Vs Machine Learning*. Retrieved from EDUCBA: https://www.educba.com/big-data-vs-machine-learning/

Pushkar, P., Younan, N. H., & King, R. L. (2008). Concept of Image Fusion in Remote Sensing Applications. In T. Stathaki, *Image Fushion.* Academic Press.

Robinson, A. H., Morrison, J. L., Muehrcke, P. C., Kimberling, A. J., & Guptill, S. C. (2009). *Elements of Cartography.* Wiley.

USGS. (2022). *Landsat 9 data Users Handbook.* South Dakota: USGS.

USGS. Retrieved, from https://www.usgs.gov/centers/eros/science/usgs-eros-archive-digital-elevation-shuttle-radar-topography-mission-srtm-1

Wikipedia. *Universal Transverse Mercator coordinate system*.

Disclaimer: This self-learning material is compiled from different books, journals and web-sources.

Post Graduate Degree Programme (CBCS) in Geography
Semester – II

Paper Code: GEO/GEC/T-212
Paper: Elements of Geography (Open Course)

Self Learning Material

Directorate of Open and Distance Learning (DODL)
University of Kalyani
Kalyani, Nadia
West Bengal, India

COURSE MATERIALS COMPILED BY:

Units	Compiled By
Unit-1:Layering of the earth with special reference to crust	Dr. S. Choudhary, DODL, K.U.
Unit-2:Fluvialprocesses and landforms	Dr. S. Choudhary, DODL, K.U.
Unit-3: Indian Monsoon	Dr. S. Choudhary, DODL, K.U.
Unit-4:Soil Profile development; physical and chemical properties of soil	Dr. S. Choudhary, DODL, K.U.
Unit-5: Factors of population growth; Types of migration	Dr. A. Rudra, DODL, K.U.
Unit-6: Rural and urban settlements and its classification	Dr. A. Rudra, DODL, K.U.
Unit-7:Major economic activities- primary, secondary and tertiary	Dr. A. Rudra, DODL, K.U.
Unit-8:Types of agriculture	Dr. A. Rudra, DODL, K.U.
Unit-9:Indian industries: Iron and Steel and Tourism	Dr. A. Rudra, DODL, K.U.
Unit-10:Crisis, conservation and management of resource; Sustainable development	Dr. A. Rudra, DODL, K.U.
Unit-11: Concept and types of scale and map; Land survey instruments and their uses	Dr. S. Choudhary, DODL, K.U.
Unit-12:Concept and classification of hazards; Natural hazards in West Bengal: Flood and Landslide	Dr. S. Choudhary, DODL, K.U.

Published by the Directorate of Open and Distance Learning (DODL),
University of Kalyani, Kalyani-741235, Nadia, West Bengal
July, 2022

Disclaimer: This self-learning material is compiled from different books, journals and web-sources.

Director's Message

Satisfying the varied needs of distance learners, overcoming the obstacle of distance and reaching the unreached students are the threefold functions catered by Open and Distance Learning (ODL) systems. The onus lies on writers, editors, production professionals and other personnel involved in the process to overcome the challenges inherent to curriculum design and production of relevant Self Learning Materials (SLMs). At the University of Kalyani a dedicated team under the able guidance of the Hon'ble Vice-Chancellor has invested its best efforts, professionally and in keeping with the demands of Post Graduate CBCS Programmes in Distance Mode to devise a self-sufficient curriculum for each course offered by the Directorate of Open and Distance Learning (DODL), University of Kalyani.

Development of printed SLMs for students admitted to the DODL within a limited time to cater to the academic requirements of the Course as per standards set by Distance Education Bureau of the University Grants Commission, New Delhi, India under Open and Distance Mode UGC Regulations, 2020 had been our endeavour. We are happy to have achieved our goal.

Utmost care and precision have been ensured in the development of the SLMs, making them useful to the learners, besides avoiding errors as far as practicable. Further suggestions from the stakeholders in this would be welcome.

During the production-process of the SLMs, the team continuously received positive stimulations and feedback from Professor (Dr.) Manas Kumar Sanyal, Hon'ble Vice- Chancellor, University of Kalyani, who kindly accorded directions, encouragements and suggestions, offered constructive criticism to develop it within proper requirements. We gracefully, acknowledge his inspiration and guidance.

Sincere gratitude is due to the respective chairpersons as well as each and every member of PGBOS (DODL), University of Kalyani. Heartfelt thanks is also due to the Course Writers-faculty members at the DODL, subject-experts serving at University Post Graduate departments and also to the authors and academicians whose academic contributions have enriched the SLMs. We humbly acknowledge their valuable academic contributions. I would especially like to convey gratitude to all other University dignitaries and personnel involved either at the conceptual or operational level of the DODL of University of Kalyani.

Their persistent and co-ordinated efforts have resulted in the compilation of comprehensive, learner-friendly, flexible texts that meet the curriculum requirements of the Post Graduate Programme through Distance Mode.

All the Self Learning Materials are self writing and collected from e-book, journals and websites.

Director
Directorate of Open and Distance Learning
University of Kalyani

Syllabus

Semester-II

Paper Code: GEO/GEC/T-212

Paper: Elements of Geography (OpenCourse)

Internal Evaluation/ Assessment – 10; Examination/Report/ Viva Voce – 40 (Semester end Examination); Credit – 4; Marks -50

Unit-1: Layering of the earth with special reference to crust

Unit-2: Fluvial processes and landforms

Unit-3: Indian Monsoon

Unit-4: Soil Profile development; physical and chemical properties of soil

Unit-5: Factors of population growth; Types of migration

Unit-6: Rural and urban settlements and its classification

Unit-7: Major economic activities- primary, secondary and tertiary

Unit-8: Types of agriculture

Unit-9: Indian industries: Iron and Steel and Tourism

Unit-10: Crisis, conservation and management of resource; Sustainable development

Unit-11: Concept and types of scale and map; Land survey instruments and their uses

Unit-12: Concept and classification of hazards; Natural hazards in West Bengal: Flood and Landslide

CONTENTS:

1.1. Introduction

This paper aims to introduce Geography to the students of different subjects who have opted Geography as a choice paper under CBCS curriculum in their second semester. Hence, it is a gentle introduction to the subject. It comprises different units from different branches of Geography, both physical and human geography, and gives an overall view of the nature and scope of the subject.

1.2. Learning Objectives

This paper aims to introduce the following topics –

- Layering of the earth with special reference to crust
- Fluvial processes and landforms
- Indian Monsoon
- Soil Profile development; physical and chemical properties of soil
- Factors of population growth; Types of migration
- Rural and urban settlements and its classification
- Major economic activities- primary, secondary and tertiary
- Types of agriculture
- Indian industries: Iron and Steel and Tourism
- Crisis, conservation and management of resource; Sustainable development
- Concept and types of scale and map; Land survey instruments and their uses
- Concept and classification of hazards; Natural hazards in West Bengal: Flood and Landslide

1.3. Assessment of Prior Knowledge

The following points to be discussed -

- Introduction to Geography as discipline
- Nature, scope and branches of Geography
- Relevance of Geography

1.4. Learning activities

Classroom seminar/discussions on various topics covered under this paper may be arranged.

1.5. Feedback of learning activities

Class test may be arranged.

1.6. Examples and Illustrations

UNIT-01: LAYERING OF THE EARTH WITH SPECIAL REFERENCE TO CRUST

Earth's Planetary Structure

Most of what we have learned about Earth's internal structure and composition has been deduced through indirect means. The most important evidence that scientists have used to gain such indirect knowledge is the behaviour of earthquake waves and other shock waves (generated by controlled explosions) as they pass through Earth. A sensitive instrument called a **seismograph** can record these seismic waves, even when the earthquake is centered thousands of kilometers away or even on the opposite side of the planet.

There are two major types of seismic waves, which travel at different speeds in materials of varying densities and states. These are P (primary) waves, which travel fastest and arrive first at the seismograph recording an earthquake, and S (secondary) waves, which travel more slowly. Repeated seismograph records of P and S waves suggest that these waves are refracted, or bent, as they pass through boundaries of major density change between zones within Earth's interior. The waves speed up in denser material and slow down in material that is less dense. P waves also pass through molten rock, but S waves do not. By analyzing worldwide patterns of many earthquake waves for decades, scientists have developed a general model of Earth's interior. Such information, supplemented by studies of Earth's magnetism and gravitational pull, suggests a series of layers, or zones, in Earth's internal structure. These zones, from the innermost to the surface, are known as the core, the mantle, and the crust.

Earth's Core

The **core** forms one third of Earth's mass and has a radius of about 3360 kilometers (2100 mi). Earth's core is under enormous pressure—several million times atmospheric pressure at sea level (more than 100 million pounds per square inch).The core is believed to be composed primarily of iron and nickel in two distinct sections.

The **outer core** is 2400 kilometers (1500 mi) thick and is made of iron and nickel. Because the outer core blocks the passage of seismic S waves that will not travel through fluids, Earth scientists assume that the outer core is molten.

The **inner core** of Earth, however, appears to be solid iron. Scientists have an explanation for why it is solid. The melting point of mineral material depends not only on temperature but also on pressure. The pressure on this innermost part of Earth is so great that the inner core remains solid; that is, its melting point has been raised to a temperature above even the high temperatures found there. The outer core, though its temperatures are lower, is under less pressure and can exist in a molten state. Estimates of internal temperatures are 4800°C (8643°F) at the core–mantle boundary with an increase to 6900°C (12,423°F) at the very center of Earth. Density at the boundary between the core and the mantle is estimated at 10 grams per cubic centimeter, increasing to 13 grams per

cubic centimeter at Earth's center. These high core densities contrast with the lower densities of Earth's mantle (3.3–5.5 g/cm3) and crust (2.7–3.0 g/cm3) and give our planet an average density of 5.5 grams per cubic centimeter. The high density of Earth's core is one reason that scientists believe that iron is its primary component; the density and composition of meteorites also support this theory.

Earth's Mantle

The **mantle** is about 2885 kilometers (1800 mi) thick and constitutes about two thirds of Earth's mass. Earthquake waves that pass through the mantle indicate that this zone of Earth's interior is composed of dense rocky material that is solid, in contrast to the molten outer core that lies beneath it. Although most of the mantle is solid, part of the upper mantle material has the characteristics of a **plastic solid,** meaning that it can easily deform and can "flow" a few centimetres per year (an inch or two per year). Scientists agree that the mantle consists of dark, heavy silicate rocks that are high in iron and magnesium. The mantle contains several layers, or zones, of differing strength and rigidity.

The uppermost layer of the mantle is solid and together with the crust forms the **lithosphere.** The term *lithosphere* has traditionally been used to describe the entire solid Earth. In recent decades, the term *lithosphere* has been used in an important and more precise way to refer to the solid outer shell of Earth, including the crust and the rigid upper mantle down to the plastic layer.

Beneath the lithosphere at a depth of about 100–700 kilometers (62–435 mi), in the upper mantle, is the **asthenosphere** (from Greek: *asthenias,* without strength), a thick layer of plastic mantle material. The material in the asthenosphere flows both vertically and horizontally, dragging segments of the overlying, rigid lithosphere along with it. Many Earth scientists now believe that the energy for tectonic forces that break and deform the crust comes from movement within the asthenosphere produced by thermal convection currents originating within the mantle and heated by decaying radioactive materials in the planet's interior.

The interface between the crust and upper mantle is marked by a significant change of density, or a discontinuity, as indicated by an abrupt increase in the velocity of earthquake waves descending through this internal boundary. Scientists have labeled this zone the **Mohorovicic discontinuity,** or **Moho** for short, after the Croatian geophysicist who first detected it in 1909.The Moho does not lie at a constant depth but generally mirrors the surface topography, being deepest under mountain ranges where the crust is thick and rising to within 8 kilometers (5 mi) of the ocean floor. As of 2005, no geologic drilling has penetrated to the Moho and into the mantle. However, an international scientific partnership called the Integrated Ocean Drilling Program has come close and plans to drill to that depth in the near future.

Earth's Crust

Earth's solid and rocky exterior is the *crust*, which is composed of a great variety of rocks and minerals that respond in diverse ways and at varying rates to Earth- shaping processes. The crust is the only portion of the lithosphere of which Earth scientists have direct knowledge, yet its related surface materials form only about 1% of Earth's planetary mass. Earth's crust forms the exterior of the lithosphere and is of primary importance in understanding surface processes and landforms. Earth's deep interior components, the core and mantle, are of concern to physical geography because they are responsible for and can help explain changes in the lithosphere, particularly the crust that forms the ocean floors and continents. Earth's crust is less dense than either the core or the mantle. It is also thin in comparison to the size of the planet. Two kinds of Earth crust, oceanic and continental, can be distinguished by their thickness, location, and composition. Crustal thickness varies from 3 to 5 kilometers (1.9–3 mi) in the ocean basins to as much as 70 kilometers (43 mi) under some continental mountain systems. The average thickness of continental crust is about 32–40 kilometers (20–25 mi).The crust is relatively cold, rigid, and brittle compared to the mantle. It responds to stress by fracturing, wrinkling, and raising or lowering rocks into upwarps and downwarps.

Oceanic crust is composed of basaltic rocks, which are solidified, dark-colored, fine-grained, and iron-rich lavas. In comparison to the crust that forms the continents, oceanic crust is thinner, and because it is composed of darker, heavier, mafic rocks, it has a higher density (3.0 g/cm3). Forming the deep ocean floors, its most common minerals are compounds of silica (Si) that are relatively high in iron (Fe) and magnesium (Mg). Basalt is the most common rock on Earth and appears in great lava outflows on all of the continents as well as on the seafloor.

Continental crust forms the major landmasses; it is much thicker, less dense (2.7 g/cm3), more sialic, and lighter in colour than oceanic crust. Although rocks of every type and of all geologic ages exist on the continents, the average density of continental crust is similar to that of granite, a common coarse-grained intrusive igneous rock. Thus, continental crust is regarded as granitic, in contrast to the basaltic oceanic crust. Granite forms from a molten state deep underground, as opposed to basalt, which cools and solidifies at the surface. Where the surface elevation is high, such as where there are mountains or plateaus, the crust is thicker; at lower elevations, continental crust is thinner, but not as thin as the crust of the seafloor.

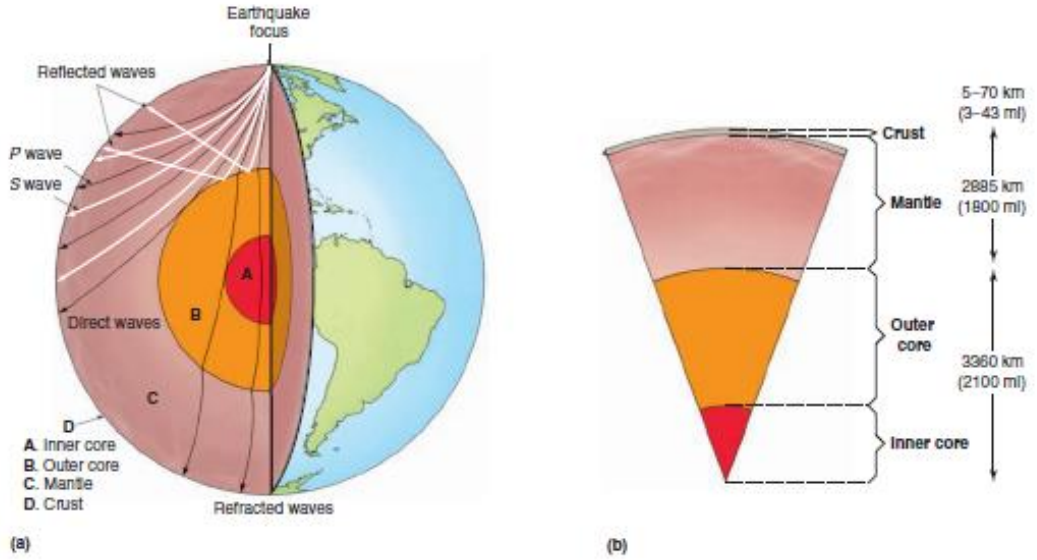


Figure 1.1: The internal structure of the Earth as revealed by seismic waves

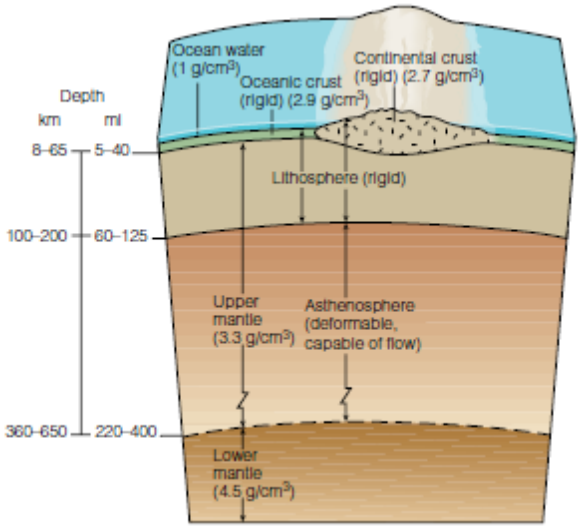


Figure 1.2: A cross section of the lithosphere, asthenosphere and lower mantle. The lithosphere is the solid outer part of earth including the crust and solid upper mantle, down to the asthenosphere (Gabler, Petersen, Trapasso, & Sack, 2009).

References:

Gabler, R. E., Petersen, J. F., Trapasso, L. M., & Sack, D. (2009). *Physical Geography*. Brooks/Cole CENGAGE Learning.

UNIT-2: FLUVIAL PROCESSES AND LANDFORMS

Flowing water is more influential in shaping the surface form of our planet than any other exogenic geomorphic process, primarily because of the sheer number of streams on Earth. Through both erosion and deposition, water flowing downslope over the land surface, particularly when concentrated in channels, modifies existing landforms and creates others. Nearly every region of Earth's land surface exhibits at least some topography that has been shaped by the power of flowing water, and many regions exhibit extensive evidence of stream action. Flowing water is the main geomorphic agent in arid as well as humid environments. Polar landscapes buried under thick accumulations of perennial ice are the major exception to Earth's extensive areas of stream-dominated topography. The study of flowing water as a land-shaping process, together with the study of the resulting landforms, is termed **fluvial geomorphology** (from Latin: *fluvius,* river). Fluvial geomorphology includes the action of both channelized and unchannelized flow moving downslope by the force of gravity.

Stream is the general term for natural, channelized flow. In the Earth sciences, the term *stream* pertains to water flowing in a channel of any size, although in general usage we describe large streams as rivers and use local terms, such as creek, brook, run, draw, and bayou, for smaller streams. The land between adjacent channels in a stream-dominated landscape is referred to as the **interfluve** (from Latin: *inter,* between; *fluvius,* river). Because of the common and widespread occurrence of stream systems and their key role in providing fresh water for people and our agricultural, industrial, and commercial activities, a substantial portion of the world's population lives in close proximity to streams. This makes understanding stream processes, landforms, and hazards fundamental for maintaining human safety and quality of life. Most streams occasionally expand out of the confines of their channel. Although these **floods** typically last only a few days at most, they reveal the tremendous—and often very dangerous—geomorphic power potential of flowing water. The long-term effects of stream flow, whether dominated by erosion or deposition, are sometimes also quite dramatic. Two prime examples in the United States that illustrate the effectiveness of flowing water in creating landforms are the Black Canyon of the Gunnison River, carved by long-term river erosion into the Rocky Mountains, and the Mississippi River delta where fluvial deposition is building new land into the Gulf of Mexico.

Surface Runoff Liquid water flowing over the surface of Earth, that is, **surface runoff,** can originate as ice and snow melt or as outflow from springs, but most runoff originates from direct precipitation. When precipitation strikes the ground, several factors interact to determine whether surface runoff will occur. Basically, runoff is generated when the amount, duration, and/or rate of precipitation exceed the ability of the ground to soak up the moisture. Because the process of water soaking into the ground is *infiltration,* the amount of water the soil and surface sediments can hold is known as the **infiltration capacity.** A portion of infiltrated water will seep (percolate) down to lower positions and reach the zone of saturation beneath the water table, while much of the rest will eventually return to the atmosphere by evaporation from the soil or by transpiration from

plants. When more precipitation falls than can be infiltrated into the ground, the excess water flows downslope by the force of gravity as surface runoff. Various factors act individually or together to either enhance or inhibit the generation of surface runoff. Greater infiltration to the subsurface, and therefore less runoff, occurs under conditions of permeable surface materials, deeply weathered sediments and soils, gentle slopes, dry initial soil conditions, and a dense cover of vegetation. **Interception** of precipitation by vegetation allows greater infiltration by slowing down the rate of delivery of precipitation to the ground. Vegetation also enhances infiltration when it takes up soil water and returns it to the atmosphere through transpiration. Given the same precipitation event, surface materials of low permeability and limited weathering, thin soils, steep slopes, preexisting soil moisture, and sparse vegetation each contribute to increased runoff by decreasing infiltration. Human activities can impact many of these variables, and in some places the generation of runoff has been greatly modified by urbanization, mining, logging, or agriculture. Once surface runoff forms, it first starts to flow downslope as a thin sheet of unchannelized water, known as **sheet wash,** or unconcentrated flow. Because of gravity, after a short distance the sheet wash will begin to move preferentially into any preexisting swales or depressions in the terrain. This concentration of flow leads to the formation of tiny channels, called **rills,** or somewhat larger channels, called **gullies.** Rills are on the order of a couple of inches deep and a couple of inches wide, whereas gully depth and width may approach as much as a couple of feet. Water does not flow in rills and gullies all the time but only during and shortly after a precipitation (or snowmelt) event. Channels that are empty of water much of the time like this are described as having **ephemeral flow.** As these small, ephemeral channels continue downslope, rills join to form slightly larger rills, which may join to make gullies. In humid climates, following these successively larger ephemeral channels downslope will eventually lead us to a point where we first encounter **perennial flow.** Perennial streams flow all year, but not always with the same volume or at the same velocity. Most arid region streams flow on an ephemeral basis although some may have **intermittent flow,** which lasts for a couple of months in response to an annual rainy season or spring snowmelt. Because of this contrast in flow duration, and other differences between arid and humid region streams, a full discussion of arid region stream systems appears in the separate chapter on arid region landforms,. Perennial streams flow throughout the year even if it has been several weeks since a precipitation event. In most cases, this is possible only because the perennial streams continue to receive direct inflow of groundwater) regardless of the date of most recent precipitation. Slow-moving groundwater seeps directly into the stream through the channel bottom and sides at and below the level of the water surface as **base flow.** Except in rare instances, it takes a humid climate to generate sufficient base flow to maintain a perennial stream between rainstorms. **The Stream System** Most flowing water becomes quickly channelized into streams as it is pulled downhill by the force of gravity. Continuing downslope, streams form organized channel systems in which small perennial channels join to make larger perennial channels, and larger perennial channels join to create even bigger streams. Smaller streams that contribute their water and sediment to a larger one in this way are **tributaries** of the larger channel, which is called the **trunk stream** (Gabler, Petersen, Trapasso, & Sack, 2009)**.**

Figure 2.1 Development of rills and gullies at Santiniketan, Birbhum, West Bengal

Figure 2.2 Gully landscape at Santiniketan, Birbhum, West Bengal

Figure 2.3 Deeply incised gully at the base of an inselberg, Dumka, Jharkhand

Figure 2.4 Baseflow of the Brahmani river during winter, Dumka, Jharkhand

Drainage Basins

Each individual stream occupies its own **drainage basin** (also known as **watershed,** or **catchment area**), the expanse of land from which it receives runoff. **Drainage area** refers to the measured extent of a drainage basin, and is typically expressed in square kilometers or square miles. Because the runoff from a tributary's drainage basin is delivered by the tributary to the trunk stream, the tributary's drainage basin also constitutes part of the drainage basin of the trunk stream. In this way, small tributary basins are nested within, or are *subbasins* of, a succession of larger and larger trunk stream drainage basins. Large river systems drain extensive watersheds that consist of numerous inset subbasins. Drainage basins are open systems that involve inputs and outputs of water, sediment, and energy. Knowing the boundaries of a drainage basin and its component subbasins is critical to properly managing the water resources of a watershed. For example, pollution discovered in a river almost always comes from a source within its drainage basin, entering the stream system either at the point where the pollutant was first detected or at a location upstream from that site. This knowledge helps us track, detect, and correct sources of pollution. The **drainage divide** represents the outside perimeter of a drainage basin and thus also the boundary between it and adjacent basins. The drainage divide follows the crest of the interfluve between two adjacent drainage basins. In some places, this crest is a definite ridge, but the higher land that constitutes the divide is not always ridge-shaped, nor is it necessarily much higher than the rest of the interfluve. Surface runoff generated on one side of the divide flows toward the channel in one drainage basin, while runoff on the other side travels in a very different direction toward the channel in the adjacent drainage basin. The *Continental Divide* separates North America into a western region where most runoff flows to the Pacific Ocean and an eastern region where runoff flows to the Atlantic Ocean. The Continental Divide generally follows the crest line of high ridges in the Rocky Mountains, but in some locations the highest point between the two huge basins lies along the crest of gently sloping high plains. A stream, like the Mississippi River, that has a very large number of tributaries and encompasses several levels of nested subbasins, will have some major differences from a small creek that has no perennial tributaries and lies high up in the drainage basin near the divide. Knowing where each stream lies in the hierarchical order of tributaries helps Earth scientists make more meaningful comparisons among different streams. The importance of quantitatively describing a stream or drainage basin's position in the hierarchy was realized long ago. In the 1940s, a hydrologist, Robert Horton, first proposed a system for determining this **stream order.** The stream-ordering system in most common use today is a modified version of what Horton suggested. In this system, *firstorder streams* have no perennial tributaries. Even though they are the smallest perennial channels in the drainage basin, first-order channels can be mapped on large-scale topographic maps. Most first-order streams lie high up in the drainage basin near the drainage divide, the **source** area of the stream system. Two first-order

streams must meet in order to form a *second-order stream,* which is larger than each of the first-order streams. It takes the intersection of two second-order channels to make a *third-order stream* regardless of how many first-order streams might independently join the second-order channels. The ordering system continues in this way, requiring two streams of a given order to combine to create a stream of the next higher order. The order of a drainage basin derives from the largest stream order found within it. For example, the Mississippi is a tenth-order drainage basin because the Mississippi River is a tenth-order stream. Stream ordering allows us to compare various attributes of streams quantitatively by relative size, which helps us better understand how stream systems work. Among other things, comparing streams on the basis of order has shown that as stream order increases, basin area, channel length, channel size, and amount of flow also increase. Water moves through a stream system via channels of everincreasing order as gravity pulls it downslope toward the downstream end, or **mouth** of the stream. The mouth of most humid region, perennial stream systems lies at sea level where the channel system finally ends and the stream water is delivered to the ocean. Drainage basins with channel systems that convey water to the ocean have **exterior drainage.** Many arid region streams have **interior drainage** because they do not have enough flow to reach the ocean but terminate instead in local or regional areas of low elevation. Every stream has a **base level,** the elevation below which it cannot flow. Sea level is the *ultimate base level* for virtually all stream action. Streams with exterior drainage reach ultimate base level; the low point of flow for a stream with interior drainage is referred to as a *regional base level*. In some drainage basins, a very resistant rock layer located somewhere upstream from the river mouth can act as *temporary base level,* temporarily controlling the lowest elevation of the flow upstream from it until the stream is finally able to cut down through it.

Fluvial Processes

Stream Erosion

Fluvial erosion is the removal of rock material by flowing water. Fluvial erosion may take the form of the chemical removal of ions from rocks or the physical removal of rock fragments (clasts). Physical removal of rock fragments includes breaking off new pieces of bedrock from the channel bed or sides and moving them as well as picking up and removing preexisting clasts that were temporarily resting on the channel bottom. Breaking off new pieces of bedrock proceeds very slowly where highly resistant rock types are found. Erosion is simply the removal of rock material; erosion of sediments from the bottom of a stream channel does not necessarily mean that the channel will occupy a lower position in the landscape. If the eroded rock fragments are replaced by the deposition of other fragments transported in from upstream, there will be no lowering of the channel bottom. Such lowering, or channel incision, occurs only when there is *net erosion* compared to deposition. Net erosion results in the lowering of the affected part of the landscape and is termed **degradation.** Net deposition of sediments results in a building up, or **aggradation,** of the landscape. One way that streams erode occurs when stream water chemically dissolves rock material and then transports the ions away in the flow. This fluvial erosion process, called

corrosion (or *solution,* or *dissolution*), has a limited effect on many rocks but can be significant in certain rock types, such as limestone. **Hydraulic action** refers to the physical, as opposed to chemical, process of stream water alone removing pieces of rock. As stream water flows downslope by the force of gravity, it exerts stress on the streambed. Whether this stress results in entrainment and removal of a preexisting clast currently resting on the channel bottom, or even the breaking off of a new piece of bedrock from the channel, depends on several factors including the volume of water, flow velocity, flow depth, stream gradient, friction with the streambed, the strength and size of the rocks over which the stream flows, and the degree of stream turbulence. **Turbulence** is chaotic flow that mixes and churns the water, often with a significant upward component, that greatly increases the rate of erosion as well as the load-carrying capacity of the stream. Turbulence is controlled by channel roughness and the gradient over which the stream is flowing. A rough channel bottom increases the intensity of turbulent flow. Likewise, even a small increase in velocity caused by a steeper gradient can result in a significant increase in turbulence. Turbulent currents contribute to erosion by hydraulic action when they wedge under or pound away at rock slabs and loose fragments on the channel bed and sides, dislodging clasts that are then carried away in the current. **Plunge pools** at the base of waterfalls and in rapids reveal the power of turbulenceenhanced hydraulic action where it is directed toward a localized point. As soon as a stream begins carrying rock fragments as load, it can start to erode by **abrasion,** a process even more powerful than hydraulic action. As rock particles bounce, scrape, and drag along the bottom and sides of a stream channel, they break off additional rock fragments. Because solid rock particles are denser than water, the impact of having clastic load thrown against the channel bottom and sides by the current is much more effective than the impact of water alone. Under certain conditions, stream abrasion makes distinctive round depressions called **potholes** in the rock of a bedrock streambed. Potholes generally originate in special circumstances, such as below waterfalls or swirling rapids, or at points of structural weakness, which include joint intersections in the streambed. Potholes range in diameter and depth from a few centimeters to many meters. If you peer into a pothole, you can often see one or more round stones at the bottom. These are the abraders, or *grinders*. Swirling whirlpool movements of the stream water cause such stones to grind the bedrock and enlarge the pothole by abrasion while finer sediments are carried away in the current. In a process related to abrasion, as rock fragments moving as load are transported downstream, they are gradually reduced in size, and their shape changes from angular to rounded. This wear and tear experienced by sediments as they tumble and bounce against one another and against the stream channel is called **attrition.** Attrition explains why gravels found in streambeds are rounded and why the load carried in the lower reaches of most large rivers is composed primarily of fine-grained sediments and dissolved minerals. Stream erosion widens and lengthens stream channels and the valleys they occupy. Lengthening occurs primarily at the source through **headward erosion,** accomplished partly by surface runoff flowing into a stream and partly by springs undermining the slope. The lengthening of a river's course in an upstream direction is particularly important where erosional gullies are rapidly dissecting agricultural land. Such gullying may be counteracted by soil conservation practices to reduce erosional soil loss. Channel

lengthening, which results in a decrease in stream gradient, also occurs if the path of the stream channel becomes more winding, or *sinuous*.

Stream Transportation

A stream directly erodes some of the sediment that it transports, and most chemical sediments are delivered to the channel in base flow, but a far greater proportion of its load is delivered to the stream channel by surface runoff and mass movement. Regardless of the sediment source, streams transport their load in several ways. Some minerals are dissolved in the water and are thus carried in the transportation processes of **solution.** The finest solid particles are carried in **suspension,** buoyed by vertical turbulence. Such small grains can remain suspended in the water column for long periods, as long as the force of upward turbulence is stronger than the downward settling tendency of the particles. Some grains too large and heavy to be carried in suspension bounce along the channel bottom in a process known as **saltation** (from French: *sauter,* to jump). Particles that are too large and heavy to move by saltation may slide and roll along the channel bottom in the transportation process of **traction.** There are three main types of stream load. Ions of rock material held in solution constitute the **dissolved load. Suspended load** consists of the small clastic particles being moved in suspension. Larger particles that saltate or move in traction along the streambed comprise the **bed load.** The total amount of load that a stream carries is expressed in terms of the weight of the transported material per unit time. The relative proportion of each load type present in a given stream varies with such drainage basin characteristics as climate, vegetative cover, slope, rock type, and the infiltration capacities and permeabilities of the rock and soil types. Dissolved loads will be larger than average in basins with high amounts of infiltration and base flow, and therefore limited surface runoff, because slow-moving groundwater that feeds the base flow acquires ions from the rocks through which it moves. Humid regions experience considerable weathering, which produces much fine-grained sediment, and thus humid region streams tend to have a large amount of suspended load. Rivers that are carrying a high suspended load look characteristically muddy. The Huang He in northern China, known as the "Yellow River" because of the color of its silty suspended load, carries a huge amount of sediment in suspension, with more than 1 million tons of suspended load per year. Compared to the "muddy" Mississippi River, the Huang He transports five times the suspended sediment load with only one fifth the discharge. Streams dominated by bed load tend to occur in arid regions because of the limited weathering rate in arid climates. Limited weathering leaves considerable coarsegrained sediment in the landscape available for transportation by the stream system.

Stream Deposition

Because the capacity and competence of a stream to carry material depend on flow velocity, a decrease in velocity will cause a stream to reduce its load through deposition. Velocity decreases over time when flow subsides—for example, after the impact of a storm—but it also varies from place to place along the stream. Shallow parts of a channel that in cross section lie far from the

deepest and fastest flow typically experience low flow velocity and become sites of recurring deposition. The resulting accumulation of sediment, like what forms on the inside of a channel bend, is referred to as a **bar.** Sediment also collects in locations where velocity falls due to a reduction in stream gradient, where the river current meets the standing body of water at its mouth, and on the land adjacent to the stream channel during floods. **Alluvium** is the general name given to fluvial deposits, regardless of the type or size of material. Alluvium is recognized by the characteristic sorting and/or rounding of sediments that streams perform. A stream sorts particles by size, transporting the sizes that it can and depositing larger ones. As velocity fluctuates due to changes in discharge, channel gradient, and roughness, particle sizes that can be picked up, transported, and deposited vary accordingly. The alluvium deposited by a stream with fluctuating velocity will exhibit alternating layers of coarser and finer sediment. When streams leave the confines of their channels during floods, the channel cross-sectional width is suddenly enlarged so much that the velocity of flow must slow down to counterbalance it ($Q = wdv$). The resulting decrease in stream competence and capacity cause deposition of sediment on the flooded land adjacent to the channel. This sedimentation is greatest right next to the channel where aggradation constructs channelbounding ridges known as **natural levees,** but some alluvium will be left behind wherever load settled out of the receding flood waters. **Floodplains** constitute the often extensive, low-gradient land areas composed of alluvium that lie adjacent to many stream channels. Floodplains are aptly named because they are inundated during floods and because they are at least partially composed of *vertical accretion deposits,* the sediment that settles out of slowing and standing floodwater. Most floodplains also contain *lateral accretion deposits.* These are generally channel bar deposits that get left behind as a channel gradually shifts its position in a sideways fashion (laterally) across the floodplain.

Features of the Upper Course

At the headwaters in the upper course of a river, the stream primarily flows in contact with bedrock. Over the steep gradient high above its base level, the stream works to erode vertically downward by hydraulic action and abrasion. Erosion in the upper course creates a steep-sided valley, gorge, or ravine as the stream channel in the bottom of the valley cuts deeply into the land. Little if any floodplain is present, and the valley walls typically slope directly to the edge of the stream channel. Steep valley sides encourage mass movement of rock material directly into the flowing stream. Valleys of this type, dominated by the downcutting activity of the stream, are often called **V-shaped valleys** because with their steep slopes they attain the form of the letter *V*. The effects of *differential erosion* can be significant in the upper course where rivers cut through rock layers of varying resistance. Rivers flowing over resistant rock have a steeper gradient than where they encounter weaker rock. A steep gradient gives the stream flow more energy, which the stream needs to erode the resistant rock. Rapids and waterfalls may mark the location of resistant materials in a stream's upper course. Where rocks are particularly resistant to weathering and erosion, valleys will be narrow, steep-sided gorges or canyons; where rocks are less resistant, valleys tend to be more spacious. Many streams spill from lake to lake in their upper courses, either over open

land (like the Niagara River at Niagara Falls, between Lake Erie and Lake Ontario) or through gorges. In either case, the lakes will eventually be eliminated if stream erosion lowers their outlets enough or if fluvial sediment deposited at the inflow points fills the lakes.

Features of the Middle Course

In the middle section of the ideal longitudinal profile, the stream flows over a moderate gradient and on a moderately smooth channel bed. Here the river valley includes a floodplain, but remaining ridges beyond the floodplain still form definite valley walls. The stream lies closer to its base level, flows over a gentler gradient, and thus directs less energy toward vertical erosion than in its upper course. The stream still has considerable energy, however, due to the downstream increase in flow volume and reduction in bed friction. The river now uses much of its available energy for transporting the considerable load that it has accumulated and toward lateral erosion of the channel sides. The stream displays a definite meandering channel pattern with its sinuous bends that wander over time across the valley floor. The stream erodes a **cut bank** on the outside of meander loops, where the channel is deep and centrifugal force accelerates stream velocity. The cut bank is a steep slope, and slumping may occur there particularly when there is a rapid fall in water level. Slumping on the outside of meander bends contributes to the effect of lateral erosion by the stream and adds load to the stream. In the low velocity and shallow flow on the inside of the meander bends, the stream deposits a **point bar**. Erosion on the outside and deposition on the inside of river meander bends result in the sideways displacement, or **lateral migration,** of meanders. This helps increase the area of the gently sloping floodplain when cut banks impact the confining valley walls. Tributaries flowing into a larger stream also aid in widening the valley through which the trunk stream flows. Although flooding of the valley floor is always a potential hazard, the richness of floodplain soils offers an irresistible lure for farmers.

Features of the Lower Course

The minimal gradient and close proximity to base level along the ideal lower river course make downcutting virtually impossible. Stream energy, now derived almost exclusively from the higher discharge rather than the downslope pull of gravity, leads to considerable lateral shifting of the river channel. The river meanders around helping to create a large depositional plain (see Map Interpretation: Fluvial Landforms). The lower floodplain of a major river is much wider than the width of its meander belt and shows evidence of many changes in course. The stream migrates laterally through its own previously deposited sediment in a channel composed exclusively of alluvium. During floods, these extensive floodplains, or **alluvial plains,** become inundated with sediment-laden water that contributes vertical accretion deposits to the large natural levees and to the already thick alluvial valley fill of the floodplain in general. Natural levees along the Mississippi River rise up to 5 meters (16 ft) above the rest of the floodplain. A common landform in this deposition-dominated environment provides evidence of the meandering of a river over time. Especially during floods, **meander cut-offs** occur when a stream seeks a shorter, steeper,

and straighter path; breaches through the levees; and leaves a former meander bend isolated from the new channel position. If the cut-off meander remains filled with water, which is common, it forms an **oxbow lake**. Sometimes people attempt to control streams by building up levees artificially in order to keep the river in its channel. During times of reduced discharge, however, when a river has less energy, deposition occurs in the channel. Thus, in an artificially constrained channel, a river may raise the level of its channel bed. In some instances, as in China's Huang He and the Yuba River in northern California, deposition has raised the streambed above the surrounding floodplains. Flooding presents a very serious danger in this situation with much of the floodplain lying below the level of the river. Unfortunately, when floodwaters eventually overtop or breach the levees, they can be even more extensive and destructive than they would have been in the natural case. The presence of levees—both natural and artificial—can prevent tributaries in the lower course from joining the main stream. Smaller streams are forced to flow parallel to the main river until a convenient junction is found. These parallel tributaries are called **yazoo streams,** named after the Yazoo River, which parallels the Mississippi River for more than 160 kilometers (100 mi) until it finally joins the larger river near Vicksburg, Mississippi (Gabler, Petersen, Trapasso, & Sack, 2009).

Figure 2.5 Shifting courses of the Bhagirathi –Hooghly River over Kalyani leading to the formation of oxbow lake. Image courtesy- Google Earth

Deltas

Where a stream flows into a standing body of water, such as a lake or the ocean, the flow is no longer confined in a channel. The current expands in width, causing a reduction in flow velocity and thus a decrease in load competence and capacity. If the stream is carrying much load, the sediment will begin to settle out, with larger particles deposited first, closer to the river mouth, and smaller particles deposited farther out in the water body. With continued aggradation, a distinctive landform, called a **delta** because the map view shapes of some resemble the Greek letter delta (D), may be constructed. Deltas form at the interface between fluvial systems and coastal environments of lakes or the ocean and therefore originate in part from fluvial and in part from coastal processes. Deltas have a subaqueous (underwater) coastal component, called the **prodelta,** and a fluvial part, the **delta plain,** that exists at, to slightly above, the lake level or sea level. Deltas can form only at those river mouths where the fluvial sediment supply is high, where the underwater topography does not drop too sharply, and where waves, currents, and tides cannot transport away all the sediments delivered by the river. Although these circumstances exist at the mouths of many rivers, not all rivers have deltas. Delta construction is a slow, ongoing process. A river channel that approaches its base level at a large standing body of water typically has a very low gradient. Lacking the ability to incise its channel below base level, the stream may divide into two channels, and may do so multiple times, to convey its water and load to the lake or ocean. These multiple channels flowing out from the main stream are called **distributaries,** are typical features of the delta plain, and help direct flow and sediment toward the lake or ocean. Natural levees accumulate along the banks of these distributary channels. Continued deposition and delta formation extend the delta plain and create new land far out from the original shoreline. Rich alluvial deposits and the abundance of moisture allow vegetation to quickly become established on these fertile deposits and further secure the delta's position. Delta plains, such as those of the Mekong, Indus, and Ganges Rivers, form important agricultural areas that feed the dense populations of many parts of Asia. Where it flows into the Gulf of Mexico, the Mississippi River has constructed a type of delta called a *bird's-foot delta*. Bird's-foot deltas form in settings where the influence of the fluvial system far exceeds the ability of waves, currents, and tides of the standing water body to rework the deltaic sediment into coastal landforms or to transport it away. Natural levee crests along numerous distributaries remain intact slightly above sea level and extend far out into the receiving water body. Occasional changes in the distributary channel system occur when a major new distributary is cut that siphons flow away from a previous one, causing the center of deposition to switch to a new location far from its previous center. The appearance in map view of the natural levees extending toward the present and former depositional centers leaves the delta resembling a bird's foot. Different types of deltas are found in other kinds of settings. An *arcuate delta,* like that of the Nile River, projects to a limited extent into the receiving water body, but the smoother, more regular seaward edge of this kind of delta shows greater reworking of the fluvial deposits by waves and currents than in the case of the bird's-foot delta. *Cuspate deltas,* like the Sao Francisco in Brazil, form where strong coastal processes push the sediments back toward the mainland and rework them into beach ridges on either side of the river mouth (Gabler, Petersen, Trapasso, & Sack, 2009).

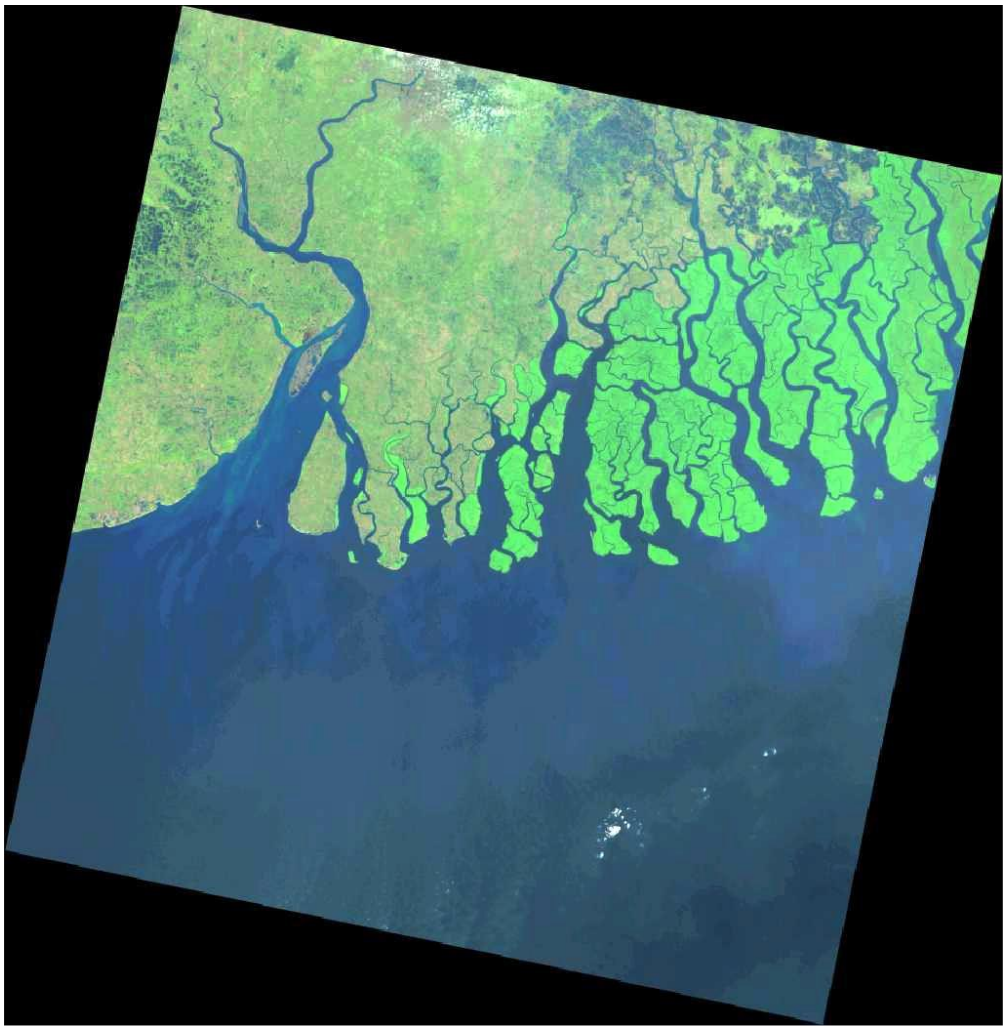


Figure 2.6 The Ganges delta as seen through the Landsat 8 data acquired on 2021/12/21

References:

Gabler, R. E., Petersen, J. F., Trapasso, L. M., & Sack, D. (2009). *Physical Geography.* Brooks/Cole CENGAGE Learning.

UNIT -3: INDIAN MONSOON

Introduction

The name *monsoon* is derived from the Arabic word *mausim*, which means season, referring to large-scale seasonal reversals of the wind regime. The Asiatic seasonal wind reversal is notable for its vast extent and the penetration of its influence beyond tropical latitudes (Barry & Chorley, 2003)

The Thermal Concept of Halley

Halley, a noted astronomer in 1686 hypothesised that the primary cause of the annual cycle ofthe Indian monsoon circulation was the differential heating effects of the land and the sea. According to this concept *monsoons are the extended land breeze and sea breeze on a large scale, produced by the differential heating of continents and ocean basins*. During the summer season in the Northern Hemisphere, when the sun's rays are vertical over the Tropic of Cancer, the huge landmass of Asia heats quickly and develops a strong low pressure centre near Lake Baikal (Siberia) and Peshawar (Pakistan). This thermal low extends up to 700 mb. Moreover, the pole-ward shift of the Inter-Tropical Convergence Zone (ITCZ) to a position over southern Asia reinforces the thermally induced low pressure centre. In comparison to this, the pressure over the adjacent water of the Indian and the Pacific Oceans is relatively high.

Under these conditions, a sea-to-land pressure gradient develops. Consequently, the surfaceair flow is from the high pressure over the oceans towards the low pressure areas over the heated landmass. Under the extreme low pressure condition on land, the wind from the southern part of the Indian Ocean (south of Equator) is attracted towards the subcontinent of India. The air coming from oceans towards land is warm and moist. When land barriers like mountain ranges and plateaus come in the way of the moisture-laden winds, they ascend and result into saturation, condensation, and precipitation.

Contrary to this, in the Northern Hemisphere during winter season, there develops high pressure areas near Baikal Lake (Siberia), and Peshawar (Pakistan). As compared to these high pressures, the Indian Ocean and the Pacific Ocean (south of Japan) remain relatively warm,having low pressure areas. Consequently, there is an outflow of air from the high pressure of the land to the low pressure areas of the oceans. The air blowing from high pressure areas of land towards the sea is cold and dry. This cold and 0dry air is incapable of giving precipitation unless it comes into contact with some water body (ocean/sea).

The thermal concept about the origin of monsoon has, however, not been accepted universally as it fails to explain the intricacies of monsoon. Besides differential heating, the origin and development of monsoon are also influenced by the shape of the continents, orography, and the conditions of air circulation in the upper troposphere. The Halley's concept has been criticised on more than one count as follows:

Criticism:

1. The low pressure areas that develop over the continents during the summer season inthe Northern Hemisphere are not stationary. These low pressure areas change theirposition (location) suddenly. This sudden change in the low pressure areas are not exclusively related to low thermal conditions. The low pressure areas stabilises in June in the north-eastern parts of the subcontinent. In fact, they represent the cyclonic lowsassociated with the dynamic factors, and therefore, these low pressure areas cannot be termed as only thermally induced.

2. Had the monsoon been thermally induced, there would be anti-monsoon circulation inthe upper air of the troposphere, which is lacking.

3. Although high temperature and the consequent low pressure takes the north-west in itsgrip from the middle of April, no rain starts in northern India till the middle of June.

4. The modern researches in meteorology have shown that the monsoon rainfall is not wholly orographic. They are an amalgamation of convectional, orographic and cyclonic rainfall.

5. Instead of two broad seasons (winter and summer) the monsoon climate has more seasons (four in India), due to the highly variable characteristics of temperature andprecipitation.

6. Halley did not take into consideration the Coriolis effect of rotation of the earth on its axis. On a rotating earth, the wind has a tendency to move towards its right in the Northern Hemisphere and towards its left in the Southern Hemisphere.

7. The role of latent heat passing into the atmosphere through water vapour was also not

considered by Halley; water vapour also plays an important role in the origin and development of monsoons.

The Dynamic Concept by Flohn

The dynamic concept about the origin of monsoons was put forward by Flohn in 1951. According to this concept, monsoon is the result of seasonal migration of planetary winds and pressure belts**.** The Inter-Tropical Convergence Zone (ITCZ) is formed due to the convergence of north-east and south-east trade winds near the equator. The northern and the southern boundaries of the ITCZ are called NITC (Northern Inter-Tropical Convergence) and SITC (Southern Inter-Tropical Convergence), respectively. There is a belt of doldrums within the Inter-Tropical Convergence, characterised by equatorial westerlies. At the time of the summer solstice (21st June), when the sun's rays are vertical over the Tropic of Cancer, the NITC is extended up to 30°N latitude, covering south and south-east Asia. Thus, equatorial westerlies are established over these areas. The equatorial westerlies become south-west or summer monsoons. On a rotating earth, the trade winds of the Southern Hemisphere after crossing the equator turn towards their right (Coriolis effect). The NITC is associated with numerous atmospheric storms (cyclones) which yield heavy rainfall during wet monsoon months (July to September). Similarly,the north-east or winter monsoon does not originate only due to low pressure in the Southern Hemisphere during winter solstice (when the Sun's rays are vertical over the Tropic of Capricorn). In fact, the north-east monsoons are north-east trade winds which are re-established over south-east Asia due to southward shifting of pressure and wind belts. It is obvious that dueto southward movement of the Sun at the time of winter solstice, the NITC is withdrawn from over south and south-east Asia, and north-east trade winds occupy their normal position. These north- east trades, thus, become winter monsoons. The north-east monsoons having their origin onland are generally dry and devoid of rains.

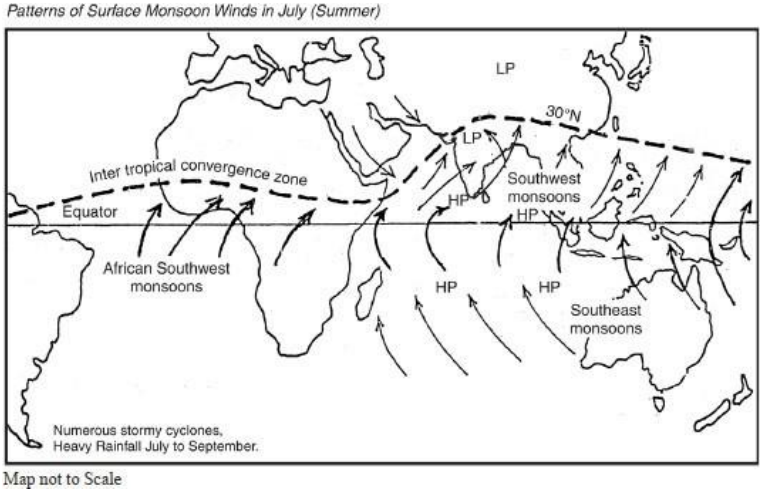


Fig. 3.1 South–West Monsoon (Patterns of Surface Monsoon Winds in July (Summer)

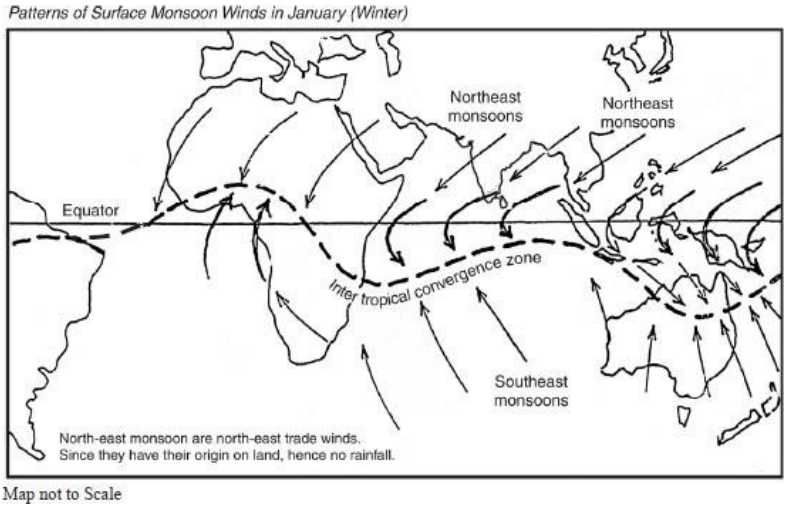


Fig. 3.2 North–East Monsoon (Patterns of Surface Monsoon Winds in January (Winter)

In brief, according to Flohn, the existence of monsoons in Asia, especially in the subcontinent of India, is not due to temperature contrasts between land and sea, but mainly due to the annual migration of thermally produced planetary winds and pressure belts. Despite the relative shifting of Inter-Tropical Convergence (thermal equator) and pressure belts, Flohn seems to have ignored the upper atmospheric circulation (jet streams) and the southern oscillation, which makethe Asiatic monsoon a fairly complex system. He also could not explain the causes of early arrival of Indian monsoons in the states of north-east India. The dynamic concept, therefore, was also not taken as the sole explanation of the origin of monsoons.

Recent Concepts about the Origin of Indian Monsoons

During the last five decades, the upper atmospheric circulation has been studied significantly, asa result of which meteorologists have raised certain doubts about the validity of the classical concept of the origin of Indian monsoon. It is now believed that the differential heating of landand sea cannot produce the monsoon circulation. More recent theories have laid greater emphasis on the circulation in atmosphere over the subcontinent and the adjoining areas. Apart from the upper atmospheric circulation, recent concepts rely heavily on the role of the Tibetan Plateau, jet streams, and the El-Nino (Southern Oscillation).

The data gathered by meteorologists after the Second World War have revealed that the origin and mechanism of monsoons are related to the following phenomena:

- The role of the Himalayas and Tibetan Plateau as a physical barrier and a source of high-level heat.

- The circulation of upper air jet streams in the troposphere.
- The existence of upper air circum-polar whirl over north and south poles in the troposphere.
- The differential heating and cooling of the huge landmass of Asia and the Indian and the Pacific Oceans.
- The occurrence of El-Nino in the South Pacific and Indian Oceans.

Indian Monsoon and the Tibet Plateau

In 1973, the Monsoon Expedition (Monex) was organised as a joint venture of the Soviet Unionand India. Under this expedition, four Russian and two Indian ships, equipped with modern scientific instruments were pressed into service in the Indian Ocean and the Arabian Sea to investigate the phenomenon of Indian monsoons. The period of investigation extended from the month of May to July, 1973. On the basis of the data obtained, the Soviet meteorologists arrived at the conclusion that the Tibet Plateau plays a crucial role in initiating the monsoon circulation over the Indian subcontinent. In 1958, Dr. P. Koteswaram, the Director General of the Indian Meteorological Observatories, while participating in the international symposium on "The Monsoons of the World" had expressed views that the summer-time heating of the Plateau ofTibet was the most important factor in the causation and maintenance of monsoonal circulation. The Indian as well as the Soviet scientists were unanimous in their views on this point.

The Plateau of Tibet is 600 km wide in the west and 1000 km in the east. Its length from west to east is about 2000 km. The average height of the plateau is about 4000 m. Thus, it is an enormous block of high ground acting as a formidable barrier. Due to its enormous height it receives 2°C to 3°C more insolation than the neighbouring areas. It is also one of the most important geographical controls on the general atmospheric circulation in the region. The Plateauof Tibet affects the atmosphere in two ways, acting separately or in combination: (i) as a physical barrier, and (ii) as a high-level heat source.

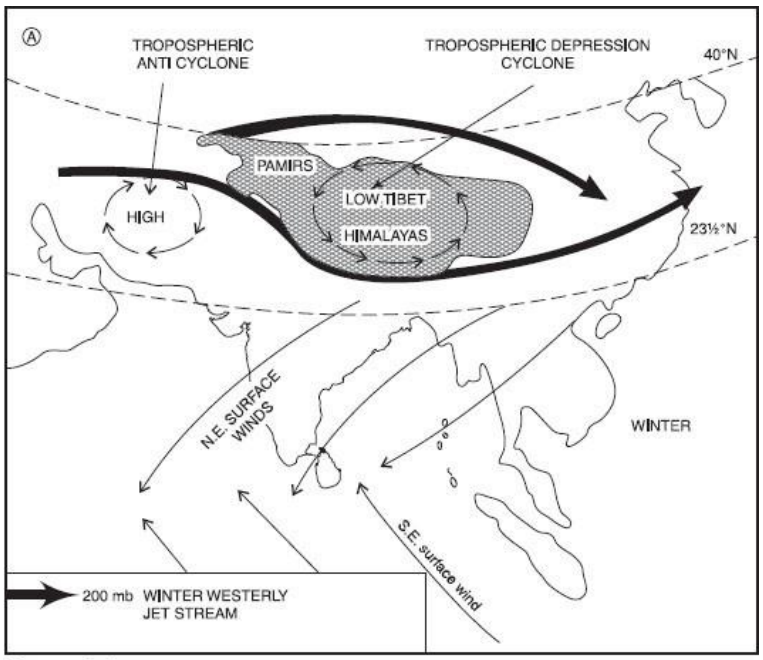


Fig. 3.3 Cross Section of the Indian Summer Monsoon

According to Maung Tun Yin, the Tibetan Plateau acts as a physical barrier. In the beginning of June, the subtropical jet stream disappears completely over northern India**.** At this time, the jet stream shifts to the north of the Himalayas and Tibet, and takes up a position at about 40°

N. Yin considers that there is a correspondence between the shifting of the jet and the slowing down of the westerlies over the whole of Eurasia. In fact, the Plateau of Tibet becomes very coldin winter, and proves to be the most important factor in causing the advance of the jet far to the south in the middle of October. Thus, he opines that the abrupt onset of summer monsoon at the beginning of June is prompted by the hydro-dynamic effect of the Himalayas and not by the thermally induced low pressure centre over northwest India. In the middle of October, the plateau proves to be the most important factor in causing the advance of the jet south of the Himalaya or bifurcate it into two parts.

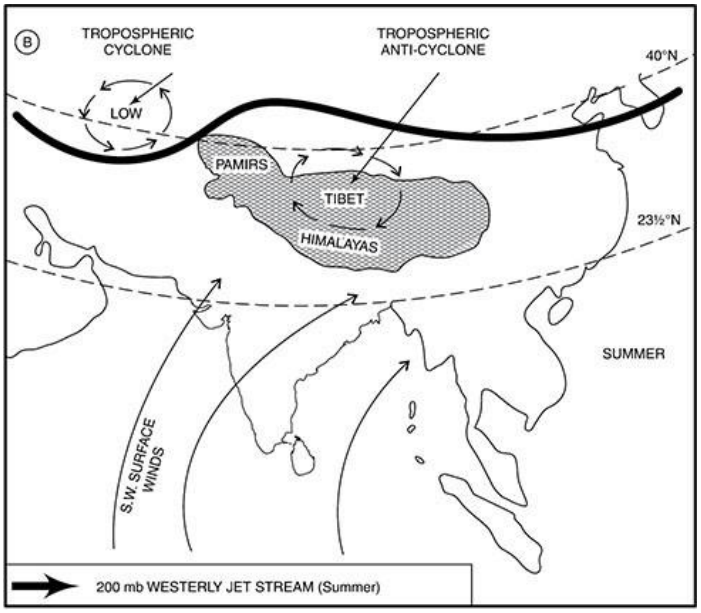


Fig. 3.4 Monsoon and the Tibetan-Himalayan Highlands

The summer-time heating of the Tibetan Plateau makes it a high-level heat source. This "Heat Engine" produces a thermal anticyclone over this region. A warm core anticyclone (high pressure) is formed over this plateau during the summer monsoon period. The formation of this anticyclone takes place in the middle part of the troposphere at 500 mb level. It is the result of a process called anti-cyclogenesis. The anticyclone at 500 mb at Tibet weakens the western sub-tropical jet-stream south of Himalayas, but produces tropical easterly jet on the southern side ofthe anticyclone. This tropical easterly jet stream first develops in longitudes east of India andthen extends westwards across India and the Arabian Sea to eastern Africa. Blowing along Kolkata-Bangalore axis the air under the easterly jet descends over the Indian ocean near Masscarness and Zanzibar Islands of Tanzania. and intensifies its high pressure cell, so as to finally move as south-west monsoon.

The data collected under Monex support that higher the inensity of the tropical easterly jet greater would be potency of the high pressure cell over the Indian Ocean and stronger would bethe impact of south-west monsoon.

Jet Stream and Indian Monsoon

Jet stream is the most prominent movement in upper level westerly wind flows; irregular, concentrated, meandering bands of geo-strophic wind, travelling at speeds of 300 to 400 kmph. The jet streams are high altitude (9000–12000 m) westerly winds between middle latitudes (summer 35°N–45°N; winter 20°N–35°N) in the Northern Hemisphere. Recent researches have shown that these winds exert considerable impact on surface weather conditions.

The influence of jet streams on the origin and development of Indian monsoons may be appreciated

from the following description of weather phenomena during the summer and thewinter seasons. The upper air westerly jet streams are extended upto 20°N–35°N (Nagpur, Raipur latitudes) due to equator-ward shift of upper air north polar whirl during northern winter (October to February). In the winter season, the upper air westerly jet streams are bifurcated into two branches due to physical obstruction of the Himalaya and Tibetan Plateau. One branch is located to the south of the Himalayas, while the second branch is positioned to the north of the Tibetan Plateau. The upper air high pressure and anticyclonic (with clockwise air circulation) conditions are developed in the troposphere over Afghanistan and Pakistan. Consequently, the winds tend to descend over the north-western parts of India, resulting into the development of atmospheric stability and dry conditions. Besides, the upper air westerly jet streams also cause periodic changes in general weather conditions because they lie over the temperate low pressure (cyclonic wave) which moves from west to east under the influence of upper air westerly jet streams across the Mediterranean Sea and reach Afghanistan, Pakistanand north-west India. These storms are not frontal cyclones, but waves which move at the heightof 2000 m from the mean sea level, while at the surface they are north-east trade winds.

The tropical easterly jet stream as stated above, extends far to the north of Tibet and the air flow is roughly along the Kolkata-Bangalore axis. These upper air easterlies descend into the permanent high pressure area formed over the southern Indian Ocean near the Masscarness Island (Tanzania). This naturally intensifies the "High" already present there. It is from this high pressure cell that the onshore winds start blowing towards the thermally induced low pressure area, developed in the northern part of the Indian subcontinent. After crossing theequator such winds become south-westerly and are known as the south-westerly summer monsoons. These surface winds have vast potentiality for south-westerly summer monsoon and precipitation. It is, therefore, clear that the strength of the easterly jet stream is directly related tothe intensification of permanent "High" formed over the southern Indian Ocean. Since this high pressure makes the pressure gradient steeper, so it is the main causative factor for determiningthe vigour of the summer monsoon.

During the summer season in the Northern Hemisphere, low pressure areas develop at the ground surface near Peshawar (Pakistan) and north-west India due to intense heating of ground surface during April, May, and June. But as long as the position of the upper air jet stream is

maintained above the surface low pressure (to the south of Himalayas), the dynamic cyclonic conditions persist over Iran, Afghanistan, Pakistan, and north-west India. The winds descending from the upper air high pressure obstructs the ascent of winds from the surface low pressure areas, with the result that the weather remains warm and dry. This is why the months of April and May are generally dry and rainless in spite of high temperatures (low pressure on land) and high evaporation. It may be pointed out that monsoon arrives in Myanmar and north east Indian states in May or early June. Upper-air low pressure (anticyclone) is formed to the east of the eastern limit of the Himalayas due to upper air easterly jet streams, with the result that the winds coming from the south of Myanmar are forced to ascend and yield copious rainfall. The Myanmar monsoon also affects Bangladesh and the hilly states of north-east India which receive pre-monsoon showers in the months of April, May, and the first week of June (Husain, 2020).

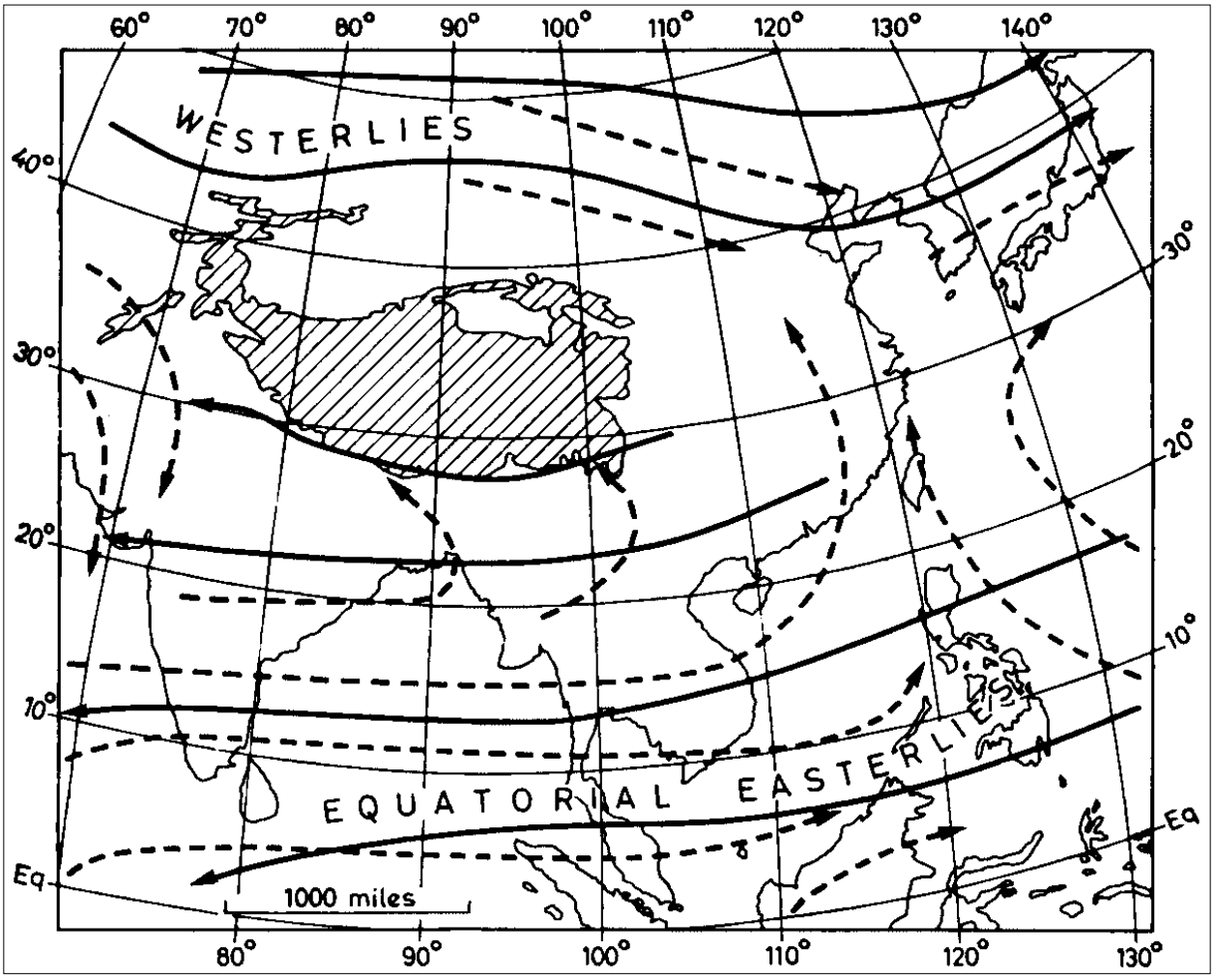


Fig. 3.5 The characteristic air circulation over South and East Asia in summer. Solid lines indicate airflow at about 6000 m and dashed lines at about 600 m (Barry & Chorley, 2003).

El Nino and the Indian Monsoon

The Indian monsoon is also influenced by El-Nino, Southern Oscillation and the Somalian Ocean Current. El-Nino, meaning "*Child Christ*", is a warm ocean current appearing along the Peru coast, generally in December. It replaces the cold Peru ocean current which flows along the Peru coast in normal years. Under normal conditions, the Peru is a cold water current, while over the western Pacific (Borneo, Indonesia and Eastern Australia) the ocean current is warm and deep**.** The appearance of El-Nino "*reverses the condition"* there, and develops warm conditions over the eastern Pacific (Peru and Chile coasts) and cool conditions in the western Pacific (Australia, New Guinea, and Indonesia). Whenever this warm ocean current (El-Nino) is produced near the Peru coast, the amount of precipitation along the coastal areas of (Peru and Chile) South America is usually high, while the eastern coast of Australia, New Guinea, and Indonesia record drought conditions.

As stated above, normally, the cool Peru (Humboldt) Current flows northward off the South American coast, and then at about equator it turns westward across the Pacific as the South Equatorial Current. The Peru Current is characterized by upwelling of cold, deep water, bringing with it nutrients that act as food for plankton. Fish feed on these high concentrations of plankton. The anchoveta, a small fish used commercially to produce fish meal for animal feed, thrives ingreat numbers and is harvested by the Peruvian fishermen. With the onset of El-Nino, upwelling ceases, the cool water is replaced by warm water from the west, and the plankton and their anchoveta predators disappear. Vast number of birds that feed on the anchoveta die of starvation.

The Southern Oscillation

The shifting of atmospheric circulation over the southern Pacific region is known as SouthernOscillation. It is a precursor to the occurrence of an El-Nino event. In an El-Nino year, a majorchange occurs across the entire stretch of the equatorial zone as far west as south-eastern Asia.Normally, low pressure prevails over northern Australia, New Guinea, and Indonesia, where thelargest and warmest body of ocean water can be found. This low pressure is associated with apool of warm water and a deep thermocline. Abundant rainfall normally occurs in this area duringDecember, which is the high sun period in the Southern Hemisphere. During El Nino event, the low pressure system is replaced by weak high pressure and drought ensues. In contrast, pressure becomes lower than normal in the equatorial zone of the eastern Pacific (Peru and Chile Coast), strengthening the equatorial trough. Rainfall is abundant in thisnew low pressure region along the coast of Peru, Chile, and Ecuador.

Surface winds and currents also change with this change in pressure. During normal conditions, the strong, prevailing trade winds blow westward, causing very warm ocean water to move to the western Pacific and to "pile up" near the western equatorial low. This westwardmotion causes the normal upwelling along the South America coast, as bottom water is carriedup to replace the water dragged to the west. During an El Nino event, the easterly trade wind die with the change in atmospheric pressure. A weak westerly wind flow sometime occurs, completely reversing the normal wind direction. Without the pressure of the trade winds to hold them back, warm water surge eastward. Sea-surface temperatures and actual sea levels rise offthe tropical western coast of the Americas.

The major change in sea-surface temperature that accompanies an El Nino can also shift rainfall patterns dramatically in large regions across the globe. During a typical El Nino event, southeastern and interior north western United States, southeastern South America, and the southern tip of India receive more rainfall. Intense rainfall can also occur along the southern California coast in winter and in the Andean highlands of Peru, Bolivia, Colombia, Chile, and Ecuador. Drought regions include the western Pacific, northern South America, southeast Africa, and northern India.

In brief, a positive value of Southern Oscillation (SOI) indicates:

- a cold Peru Current;
- strong trade winds;
- accumulation of warm water in western Pacific, which is balanced by the EquatorialCounter Current and high rate of evaporation;
- a rise in depth of thermo-cline as we proceed from the western half of the Pacific;
- an ascending branch of Walker Circulation over Australia and Indonesia with its descending branch over the western side of South America (coasts of Peru and

Chile). Such a normal condition leads to normal south-west monsoon.

La Nina: The strengthening of the normal circulation over the southern Pacific Ocean is knownas La Nina (the girl child). This event presents a situation roughly opposite to El-Nino. During La Nina period, sea surface temperature in the central and western Pacific Ocean fall to lower than average levels. This happens because the South Pacific subtropical high becomes very strongly developed during the high sun season. The result is abnormally strong south-east trade winds.The force of these winds drags a more than normal amount of warm water westward, bringing cooler water to the surface off western continental coasts. La Nina conditions were recognized during 1988 and may have been related to drought experienced in some parts of North America and Peru coast in summer 1988.

Duringthe normal and La Nina conditions, the cool water of the Peru current, moving northward alongthe coast of Chile and Peru, is carried westward into the Pacific in a long plume. Much cold, upwelling water is brought to the surface along the Chile and Peruvian coast. During an El Nino year, the eastward motion of warm water holds the Peru Current in check. Some light upwelling,but the amount is greatly reduced compared to normal or La Nina years. It adversely affects the planktons growth and marine food-web in the east Pacific Ocean.

El Nino and the Indian Ocean: According the meteorologists and oceanographers, the Indian ocean has been warming at a rate faster than thought before ($1.2^{O}C$ during the past century). Itis also the largest consistent contributor to the global ocean warming trends.

Recent studies show that a warm Indian Ocean can in turn modulate the Pacific conditions including the El Nino events. So basically, such large warming over the Indian Ocean has implications on the global climate.

The western Indian Ocean, traditionally thought to have cooler sea surface temperatures thanthe central and eastern Indian Ocean, is surprisingly showing an even stronger summer warming trend over the whole of the 20 century than the central and eastern Indian Ocean.

The warming is significantly so large that it may alter the monsoon circulation, monsoon rainfall, marine food web, and fisheries (western Indian Ocean is one of the most productive oceans) and global climate including the El Nino.

A recent study published in the *Journal of Climate* found that the western Indian Ocean becomes warmer mainly due to El Nino events, which are getting stronger and more frequent during recent decades, possibly due to changing climate.

These El Nino events weaken the summer westerly (blowing from west to east) winds over the Indian Ocean. Winds have the effect of cooling the sea surface. Strong winds cause evaporation and loss of latent heat from the ocean leading to cooling. When the winds are weak, the opposite happens, the ocean warms (because of less evaporation and less loss of latent heat from theocean leading to warming of the sea surface).

During El Nino, the wind direction reverses and the whole circulatory system shifts eastward

leaving only weak surface south-west monsoon winds in the western Indian Ocean. This resultsin further ocean warming in western Indian Ocean.

Unlike the Pacific or the Atlantic Oceans, the Indian Ocean is landlocked on the north. This means that the ocean circulation which carries the tropical heat towards the poles is restricted inthe Indian Ocean, withholding the piled up heat. This also helps in making the Indian Ocean relatively warmer and affecting the pattern of trade winds and weakening the south-west monsoon.

Moreover, the warm water of Humboldt (Peru) Current at the event of El Nino is carried to the south Indian Ocean by the West Wind Drift of the south Atlantic Ocean, resulting into relatively warm conditions or weak high pressure over the south Indian Ocean. The warm waterof the South Indian Ocean is not conducive for the successful summer monsoon in the sub- continent of India.

According to a study by the Indian Institute of Tropical Meteorology (IITM), the frequency and duration of heat waves in India is expected to increase. '*El-Nino Modoki*' could be responsible for this increase. Depletion of soil moisture (causes reduced evapo-transpiration) and the radiationof heat from the earth to atmosphere also contributes to the increase in heat waves. The regionsof southern India and coastal regions would be largely affected (Husain, 2020).

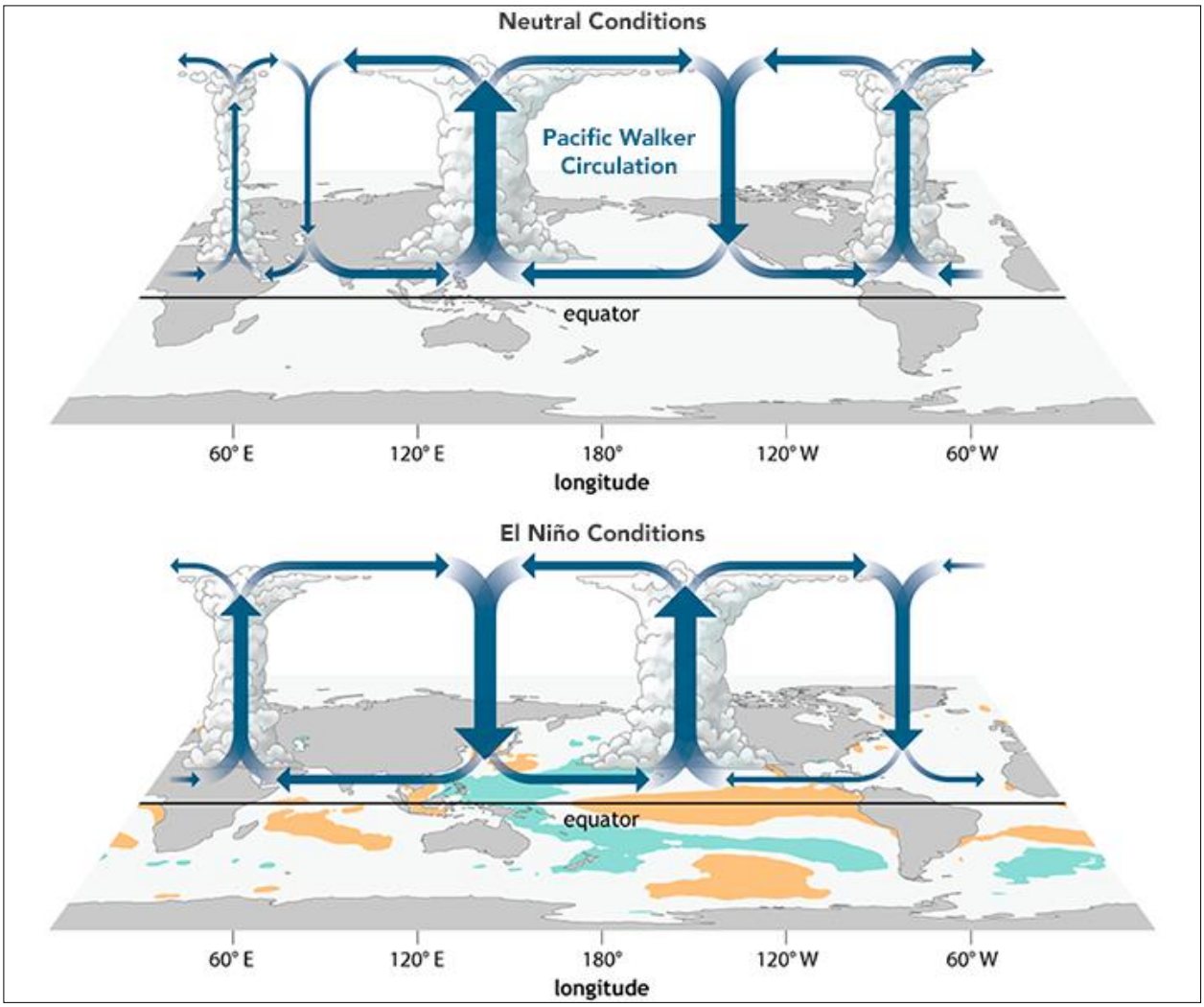


Fig. 3.6 Atmospheric circulation over the equator—the Walker circulation—changes substantially with the arrival of El Niño. (Image Courtesy of NOAA)

Possible Causes of El-Nino

What causes the El-Nino/Southern Oscillation (also known as ENSO)? At first, meteorologiststried to explain the changes in winds and pressures by the changes in ocean surface currents,while oceanographers tried to explain the changes in surface currents by changes in winds and pressures. It was not until the 1950s that scientists realized that the two phenomena were linked. One view is that the cycle is simply a natural oscillation caused by the way in which the atmosphere and oceans are coupled by energy exchange. Another possibility has been proposed by geologists, who have tried that volcanic activity along the East Pacific Rise (Ridge),an underwater zone of sea-floor spreading off the west coast of South America. Correlates withEl Nino events. They hypothesize that the emergence of upwelling lavas from the sea floorreleases vast quantities of heat into the ocean, and that this heat in some way triggers an El-Nino event. In any event, scientists now have good computer models that accept sea surface temperature along with air temperature and pressure data and can predict El Nino events reasonably well some months before they occur.

As stated above, the Southern Oscillation is closely linked with the Walker Circulation. With ahigh positive Southern Oscillation, there would be a zone of low atmospheric pressure overAustralia and Indonesian Archipelago. It will be accompanied by large convective clouds, heavy rainfall and raining air motion. This air eventually runs eastward, and after traversing the Pacificas a high level westerly wind at 200 mb, it descends over South America.

In terms of global winds, the Walker circulation suggests a strong belt of convergence between the trade winds of both the hemispheres at a location slightly to the north of the equator. These trade winds pile up a huge quantity of warm water in the western Pacific, produce equatorial counter-current from the Indonesian coast and facilitate upwelling of cold water from below, near Peru coast, giving rise to cold Peru current.

The appearance of El-Nino leads to a *warm phase* of the Pacific or negative SOI. The ascending branch of the Walker Cell shifts to the central regions of the Pacific Ocean and the descending air branch to the south-eastern parts of the ocean. As upwelling off the South American coast decreases, the sea surface temperature rises. This leads to weaker trade winds, less accumulation of warm water on the western half of the Pacific Ocean, weakening ofthe Equatorial under current, heavy rain and floods along the South American coast and poor monsoon or monsoon failure over the subcontinent (Husain, 2020).

References:

Barry, R. G., & Chorley, R. J. (2003). *Atmosphere, Weather and Climate.* London: Routledge.

Husain, M. (2020). *Geography of India.* New Delhi: McGraw Hill.

UNIT-4: SOIL PROFILE DEVELOPMENT; PHYSICAL AND CHEMICAL PROPERTIES OF SOIL

Soil is a very slowly renewable resource. Although many of our soils originated long ago, the forces that create them continue to operate. Some soils are hundreds of thousands of years old, while others just began to make their appearance yesterday. Soils grow, change, and develop. This chapter describes the soil-formation processes. **Pedology** is the study of soil formation, also known as **soil genesis**, and soil classification and mapping. We cover the latter subjects in the next chapter. Modern pedology dates to the eighteenth and nineteenth centuries in Germany, the United States, and especially Russia. These early researchers developed concepts of soil as an evolving body arising from weathered rocks of the crust under a variety of influences. V. V. Dokuchaev (1846–1903), a Russian often credited with laying the foundation of modern pedology, published a careful study of Russian soils in 1883 that applied these concepts. He identified soil-forming factors, developed an early soil classification system, and began naming the soil horizons we use today. Dokuchaev's and other Russian publications remained unknown in the United States until into the twentieth century. In the United States, Hans Jenny's publication of *Factors of Soil Formation* in 1941 further developed five factors of soil formation detailed in this text. Jenny continued to develop and quantify these factors throughout his career and connected them with ecological principles. Much of the information in this chapter comes from the work of Jenny and other soil scientists practicing in the United States in the twentieth century. Before describing how a body of soil forms, let us define what we mean by a soil body.

THE SOIL BODY

Soil is a collection of natural bodies of the earth's surface containing living matter that is able to support the growth of plants. It ends at the top where the atmosphere or shallow water begins. It ends at the bottom at the farthest reach of the deepest rooted plants. Soil varies across the landscape: In one area it may be mostly made of decayed plant parts, whereas in another place it may be mostly sand. It is not possible to learn everything about a soil just by standing on the surface. One must dig a hole to see what it looks like below the surface. Because a soil scientist cannot dig up acres of ground to study a whole body of soil, soil is divided into small parts that can be easily studied. This small body is called the **pedon**. A pedon is a section of soil, extending from the surface to the depth of root penetration, but generally examined to a depth of 5 feet. Generally, a pedon has dimensions of about 1 meter by 1 meter, and about 1.5 meters deep (about 3 feet 3 3 feet 3 5 feet). Soil scientists use the pedon as a unit of soil easily studied by digging a pit in the ground. The pedon is a human device for studying soil; it does not actually exist in nature. This soil body can be studied, classified, described in a soil survey report, and used. The traits of a pedon are set by the combination of factors that formed it. In the landscape near the pedon being studied are other pedons that are very similar. As one moves across the landscape, however, one will reach a pedon that is different, because the combination of factors that formed it was different. A collection of pedons that are much the same is called a **polypedon**. Later in this text, we will learn how these polypedons are mapped into units called soil series. How does a soil pedon form? Picture a section of bare rock that could someday become a soil pedon. In the process of soil formation, this rock is changed into

a layer of small, tiny mineral particles with some organic matter mixed in. Weather and plants are the major agents responsible for forming soil from rock, and the process is called **weathering**. **Physical weathering** is the disintegration of rock by temperature, water, wind, and other factors. Physical weathering reduces particle size; it does not alter the chemistry of the material. For instance, in cold climates, **frost wedging** occurs when water freezes and expands in rocks or in cracks in the rock, causing it to break apart. The alternate expansion and contraction of rock caused by heating and cooling cycles also stresses the fabric of rock. Both cause rock to fracture or outer layers to peel away. In some climates, salts may crystallize in cracks in rock, placing internal pressure on the rock and splitting it apart. Rain, running water, and wind-blown dust also wear away at rock surfaces. **Chemical weathering** changes the chemical makeup of rock and breaks it down.

A common process is **dissolution**. Some minerals simply dissolve slowly in water, as in the dissolution of gypsum.

In **hydrolysis**, minerals react with the hydrogen that is in the water molecule, splitting the water apart.

Hydration also involves water, but here the water molecule itself joins the crystalline structure of the mineral, again creating a softer, more easily weathered material, as in the hydration of hematite to ferrihydrite

Much of chemical weathering involves water interacting with crystalline minerals to create new materials by dissolution, hydrolysis, or hydration. Not surprisingly, moisture availability is an important variable in soil genesis. **Oxidation–reduction** and other reactions are also important in chemical weathering. Refer to Appendix 1 if you need help understanding these reactions. Plants also play an important role in rock crumbling. Roots can exert up to 150 pounds per square inch of pressure when growing into a crack in rock.

Root wedging from the pressure pries apart stone. Lichens growing on bare rock form mild acids that slowly dissolve rock. When a lichen dies, its dry matter is added to the slowly growing mixture of mineral particles and organic matter. When a small bit of soil forms in a rock crevice, plants begin to grow from seed that has blown into the crevice, continuing the cycle. Roots themselves release mild acids that further the process of soil genesis. Plants themselves actively promote soil genesis. Soil formation does not stop when a layer of young soil covers the surface. The new soil continues to age slowly and develop over thousands of years. Soil scientists state that five factors operate during the process of soil genesis and development: *parent material, climate, life, topography,* and *time*. One could say that over time, climate and living things act on parent material with a certain topography to create soil. Some have suggested that human activities might be named a sixth factor, because most soils have been modified to some degree by humans. Soil formation begins with rock, which supplies the parent materials for most soils. Before studying the five factors, let us look at the rocks of earth's crust.

ROCKS AND MINERALS

The original source of most soils is rock—the solid, unweathered material of the earth's crust. Solid rock breaks into smaller particles, which are the **parent materials** of soil. Rock is a mixture of minerals that, when broken down, supply plant nutrients. Geologists classify rock into three broad types: igneous, sedimentary, and metamorphic. **Igneous Rock** The basic material of the earth's crust is **igneous rock**, created by the cooling and solidification of molten materials from deep in the earth. Igneous rocks, such as granite, contain minerals that supply 13 of the 17 required plant nutrients. Igneous rock may be coarse grained, with grains and crystals large enough to easily see with the naked eye, such as granite. Basalt is an example of a fine-grained rock. Igneous rock can also be dark colored, like basalt, or lighter colored, like some granites. Darker-colored igneous rocks tend to weather more easily and contain more iron and calcium, important plant nutrients. Granite, which is mined for monuments and building material, is a hard, coarse-grained rock made of feldspar, quartz, and other minerals. Feldspar, a fairly soft mineral containing potassium and calcium, weathers easily to clay. Quartz, a very hard and resistant mineral, weathers slowly to sand. Granite tends to weather slowly to create acidic parent materials high in sand, while basalt, a softer, darker, finer-grained rock, weathers more quickly to less-acidic materials low in sand.

Sedimentary Rock Igneous rock comprises only about one-quarter of the earth's actual surface, even if most of the crust is igneous. This is because **sedimentary rock** overlays about three-quarters of the igneous crust. Sedimentary rock forms when loose materials such as mud or sand are deposited by water, wind, or other agents, slowly cemented by chemicals or pressure into rock. Much of the sedimentary rock covering North America was deposited in prehistoric seas. Sand deposits can solidify to form the gritty but often loosely cemented sandstone, a light-colored, coarsely grained rock. Loosely cemented sandstone weathers easily to release sand grains. Mud deposits form shale, a fine-grained light-colored rock. Limestone forms when calcium-rich grains of calcite settle out of ocean water. The parent materials of many American soils derive from sandstone and limestone. Sandstone, which consists of cemented quartz grains, weathers to sandy soils. Generally, these soils are infertile and droughty. Limestone is high in calcium and weathers easily to soils high in pH, calcium, and magnesium.

Metamorphic Rock If igneous and sedimentary rocks are subjected to great heat and pressure, they change to form **metamorphic rock**. For instance, limestone is a fairly soft, gritty rock. When subjected to heat and pressure, it changes to marble, which is harder and can be cut and polished. Sedimentary rocks tend to become much harder when metamorphosed, becoming slower to weather. Sandstone, for example, changes to the far harder rock quartzite. igneous, and metamorphic rocks.

PARENT MATERIAL

Soil genesis is the process of creating soil from parent material. These **residual soils**, formed in place from the residuum of broken-down bedrock, are actually less common than soils of parent materials carried from elsewhere by such pervasive agents of transport as wind, water, ice, or gravity. Residual soils form slowly, as solid rock must be weathered first. **Transported soils** develop from already weathered material, so they develop more quickly. **Glacial Ice**

Glacial drift - in the process, the glaciers left behind a distinctive landscape over much of northern United States and Canada, often rich in wetlands, lakes, and ponds. Glaciers deposited materials in many ways, so there are several kinds of glacial drift. During the melting process, some debris simply dropped in place to form deposits called **glacial till**. Some till dropped at the margins of the glacier, forming hills called moraines. Other kinds of till were deposited beneath advancing ice; these materials, crushed under the weight of the ice riding over them, are often extremely dense and compacted. In some areas such as parts of New England and Minnesota, they form dense hardpans. Because there was no sorting action in the deposition, glacial till is extremely variable, and so are the soils derived from it. Till soils often contain pebbles, stones, and even boulders. Other materials carried by the glacier washed away in meltwater to form sediments in streams and lakes. During the process, materials were sorted by size. Coarser material, being larger and heavier, was deposited near the glacier and in nearby streams and rivers to form **glacial outwash**. Outwash deposits tend to be sandy and gravelly, and are good sources of construction sands and gravels. Smaller particles often reached glacial lakes to form **lacustrine** deposits on the lake bottoms.

Wind Some parent materials were carried by wind, leaving **eolian deposits**. For example, some soils in Nebraska formed from sand dunes, deposits of sand carried by rolling in the wind. Most eolian soils in the United States are actually a result of the last glacial period. After the last glaciers melted and meltwaters subsided, large expanses of land were exposed to a dry climate with strong westerly winds. Winds picked up silt-sized (medium) particles and deposited them in the Mississippi and Missouri river valleys and elsewhere. These **loess** soils—wind-deposited silt—are important agricultural soils in much of Iowa, Illinois, and neighboring states. Loess often blankets other materials, so often forms the upper parts of a soil. Unlike other materials, wind-blown dust is global. For instance, dust blown from the Sahara Desert of Africa makes a significant contribution to soils of the Caribbean Islands as well as Central and South America.

Water

Alluvial soils are soils whose parent materials were carried and deposited in moving freshwater to form sediments. Alluvial materials can be deposited in several ways. **Alluvial fans** form below hills and mountain ranges where streams flowing down-slope deposit material in a fan shape at the base. As water speed slows abruptly at the foot of the slope, large particles drop out first. As a result, alluvial fans are generally sandy or gravelly. Finer materials are carried away in rivers. Flooding rivers also leave behind deposits. Coarser materials may be deposited in low ridges, or **levees**, along the river bank. Away from the river, floodwaters spread over large flat areas called **floodplains**. Here water will be shallow and slower moving; fine particles settle out. Repeated flood events tend to create multiple layers in floodplain soils, and they can be excellent agricultural soils when flooding can be controlled and drainage improved. Levees, being coarser and elevated, dry more quickly. Floodplain soils are especially important along the Mississippi and its tributaries and along rivers that flow into the ocean on the East and Gulf coasts. Many important soils of California are from river alluvium. Sometimes a river cuts deeply into its floodplain to flow at a lower elevation. This establishes a new riverbed and floodplain, while the old floodplain is left higher as a **river terrace**. An example of river terrace

soil is some soil of the San Joaquin Valley of California. Lacustrine deposits form under still freshwater. Most of our lacustrine soils remain from giant glacial lakes that have since dried up, including Glacial Lake Agassiz of northern Minnesota, North Dakota, and Canada, and Glacial Lake Bonneville of Utah. When glacial runoff water ran into the lake, the heaviest materials were left near the shore, while the smallest particles were carried to the center of the lake. Thus, lacustrine soils are sandy near the old shoreline and grade to soils with smaller particles toward the old lake center. Lacustrine soils, having flat terrain and being poorly drained, can host a rich agriculture with proper artificial drainage, but challenge the home and septic field builder. **Marine sediments** form in the ocean. Many scattered soils of the Great Plains and the Imperial Valley of California are beaches of prehistoric seas that once covered the United States. Other beach soils are common along the Atlantic coastline and the Gulf of Mexico. All these tend to be sandy soils. **Deltas**, in contrast, have very small particles and tend to be wet. Deltas form when rivers flowing into an ocean deposit sediments at the mouth of the river. The Mississippi River Delta of Louisiana is a prime example, as is the Rio Grande Valley of Texas and Mexico.

Gravity Some parent materials move simply by sliding or rolling down a slope. This material, called **colluvium**, is scattered in hilly or mountainous areas. An example of a colluvial material is a **talus**—sand and rocks that collect at the foot of a slope. Avalanches, mudslides, and landslides are other examples.

Volcanic Deposits The ash blown out of a volcano and deposited nearby or carried some distance by wind forms a chemically distinct, dark, and lightweight parent material. The Pacific Northwest, Hawaii, and Alaska are areas of the United States where such deposits are common.

Organic Deposits Characteristics of the soils formed from parent materials described so far are set by mineral particles in the soil. **Mineral soils** contain less than 20 percent organic matter, except for a surface layer of plant debris. **Organic soils**, containing 20 percent or more organic matter, form underwater as aquatic plants die. Low-oxygen conditions underwater retard decay of these dead plants, so partially decayed remains tend to pile up at the lake bottom. Eventually the lake fills in and is replaced by an organic soil. Organic soils are extensive in Minnesota, Wisconsin, Florida, Michigan, and Alaska.

CLIMATE While climate is extremely complex, we are speaking here primarily of temperature and precipitation. There are whole vocabularies for naming temperature and rainfall regimes, but let us mention only the terms *arid, semiarid,* and *humid.* Most simply put, these terms refer to climates that experience very low, low, and higher rainfall, respectively. Climate first affects soils by causing physical and chemical weathering of rock. However, climate continues to affect soil development long beyond this initial stage. The main effects are due to temperature and rainfall. Temperature affects the speed of chemical reactions in the soil—the higher the temperature, the faster a reaction. Chemical weathering in soils occurs mostly when the soil is warmer than 60°F. Thus, in cold areas, such as tundra, soils develop slowly. In warm areas, such as the tropics, soils develop more rapidly. Another result of temperature is its effect on organic matter. Warmth promotes greater vegetation, so more organic matter is added to the soil. However, warm temperatures also speed the decay and loss of organic matter. Thus, soils

of warm climates tend to be low in organic matter. In warm regions, warmth promotes dissolution of materials, so if climate is also humid, chemicals leach out of the soil more quickly. Warm climates also promote the weathering of clay minerals to forms that are less fertile. Water is a critical factor in soil genesis. Much chemical weathering involves water in such reactions as hydrolysis and hydration. In cold regions, water is needed for frost wedging. Water moving down through the soil moves dissolved materials with it by **leaching**, and can even translocate (move) fine solid particles such as clay. Translocated materials include clays, lime, salts, plant nutrients, and other chemicals. Thus, soils in moist climates tend to be different than those in drier climates. For instance, desert soils tend to be enriched in salts that would leach out of the soil in humid climates. Soils in high-rainfall areas also tend to grow more vegetation, so soils of humid areas tend to have more organic matter than soils of drier regions. However, this effect is often counteracted by vegetation effects discussed later in this chapter. As a broad summary of the effects of a higher-rainfall climate, soils tend to be deeper and have more organic matter in the topsoil. Clay particles and salts tend to move deeper into the soil, and the soil tends to be more acidic. The United States is a good example of the effects of climate on soil. The climate of the United States cools from south to north. This is reflected in an increase in average organic matter content from south to north. Also, the most weathered soils in the United States are in the south. The average rainfall of the United States increases from west to east. As a result, the organic matter content of the United States' soils also tends to increase from west to east, though vegetation effects tend to mask the trend. Soil color also follows north–south trends. Because organic matter is black, soils tend to appear darker as one moves from warmer to cooler climates. Because of changes in chemical reactions involving iron, soils tend to appear redder as one moves from cooler to warmer climates.

ORGANISMS

Organisms that live in soil—such as plants, insects, and microbes—actively affect soil formation. The actual properties of a developing soil are influenced especially by the type of plants growing on it. Mineral soils having the highest organic matter content form under grasslands. Grassland vegetation, mostly herbaceous, forms a deep, dense mat of fibrous roots, many of which die each year and contribute large amounts of organic matter to the soil. Indeed, most of the biomass of a prairie develops underground in the soil. This keeps the organic matter content high and the soil color dark. Prairie vegetation is the factor mentioned previously that masks the trend of higher moisture/ organic matter soil content in North America. However, the fact that the moist eastern prairies of the Corn Belt display higher organic matter content than the dry western prairies of, say, Colorado, supports the association between higher rainfall and more organic matter. In a forest, much of the biomass grows above ground in the trees. When leaves fall or the tree dies, the material falls to the soil where it creates a surface layer of organic matter that does not mix with deeper layers. As a result, forest soils have less organic matter than prairie soils and display shallower topsoils of lighter color. The type of trees also influences the soil. Compared to hardwoods (deciduous trees), softwood (conifer) foliage is acidic and resistant to decay; therefore their soils tend to be thinner, lower in organic matter, and more acidic. Deserts, with very sparse vegetation, have the least organic matter. Vegetation also affects the location of nutrients and other ions in the soil. Plants absorb ions in the roots

and carry them to the tops, where they are returned to the soil surface when leaves drop. This recycles ions from deeper in the soil to the surface and helps reduce their loss from leaching. Deep roots of deciduous trees, for instance, extract ions from deep in the soil, leaving the surface horizon of deciduous forest soils enriched in ions. We tend to stress vegetation as the main living factor in soil formation, but other life impacts soil as well, such as burrowing animals that mix the soil; earthworms that create large, deep pores and speed organic matter decay; or nitrogen-fixing bacteria.

TOPOGRAPHY

Topography, or the soil's position in the landscape, influences soil development mainly by affecting water movement and soil wetness. Major changes in soil type can occur over very small differences in elevation and distance due to topography. Water runs off slopes, making them drier, and collects in low areas, making them moister. This, in turn, affects chemical weathering that depends on moisture, types of vegetation, and other factors that influence soil formation. Two important features of topography are **slope** and **slope aspect**, or the direction the slope is facing. Slopes may be steep or shallow, long or short. Slope position strongly influences soil moisture. Soils on the shoulder of a slope mostly shed water and are dry; soils at the base of a slope mostly receive water from above, and tend to be moist. Soils at midslope shed water, but also receive water from above, and are in between in moisture content. Water tends to collect in depressions, creating a very wet position. In addition, the water table tends to be deepest near the shoulder and closest to the surface at the base of a slope and in depressions, also changing moisture content of the soil. The water table may even intersect the soil surface and create a wetland where organic matter accumulates. These differences affect chemical weathering of the soil. For instance, subsoil may be reddish high on the slope, the color of oxidized iron in a well-aerated soil, and gray at the base, the color of reduced iron in waterlogged soil. Slope aspect determines the amount of solar energy the slope receives. South-facing, and to a lesser degree west-facing, slopes receive more intense sunlight than north- and east-facing slopes, and are thus warmer and drier. This effect is often visible by the types of vegetation occupying different slopes. For instance, in the author's area, sugar maple forest may develop on cool and moist north slopes while oak forest grows on hotter, drier south slopes. Slope also affects erosion rates. Slopes tend to lose soil from erosion, while depressions tend to receive soil. Because soil particles are moved off slopes by erosion, such soils tend to be thinner and less well developed. Because running water tends to carry off smaller particles, soils in lower areas may be finer than those of higher areas. Depressions may also intersect the water table at least part of the year, keeping them wet for long periods. One could say that level and depressional lands tend to have drainage problems, while sloping terrain often suffers from erosion and dryness. In natural ecosystems, these differences often determine what plant communities grow where.

TIME

Soils change over time, undergoing an aging process. Initially, a thin layer of soil appears on the parent material. Such a young, immature soil takes as little as 100 years to form from well-weathered parent materials under warm, humid conditions. Under other conditions, it may take

hundreds of years. Weathering of the young soil continues, and many generations of plants live and die, so the young soil becomes deeper and higher in organic matter. If there is enough rainfall, leaching begins to carry some material deeper into the soil, creating the soil profile described later in this chapter. As soils age, biological processes tend to increase the nitrogen content, while leaching tends to reduce phosphorus. Thus, young soils tend to be low in nitrogen but high in phosphorus, while older soils are the opposite. Mature soils are generally productive, but as soils continue to age, they become more severely weathered, more highly leached, and often less productive. In general, as soil ages it becomes deeper, develops distinct layers, and becomes more acidic and leached. Over time, soils become less and less like their parent materials. Aging happens most rapidly in warm, humid climates, and most slowly in cold or dry climates, or where parent materials resist weathering. However, the aging process is not static. Time zero for a soil usually begins when some dramatic event such as landslides, glaciers, or piling of mining spoil changes everything and resets the clock. Such events can happen at any time. A soil might age through the years until it reaches some steady state and remains unchanged thereafter, but this is rare. Soils can erode away, be buried, or even become the parent material for a new soil. If soil factors change, the direction of soil development can be deflected into a new path. For instance, if forest invades prairie, the soil embarks on a new path toward a forest-type soil. We tend to think of soil development as progressive; that is, soil becomes deeper and more complex with more and better defined layers. If the combinations of soil forming factors change, soil can also regress, becoming shallower and less complex. Very old soils may have undergone repeated cycles of progression and regression.

HUMANS

Humans may be considered just another living entity that modifies soil, but their action can be so rapid, dramatic, and different from other life that they might be considered a separate, sixth soil-formation factor. Very few soils have been unaffected by human activities. Effects may be as subtle as the deposition of air pollutants distant from any human habitation to as massive as earthmoving during road construction. The latter resets the time clock for this new soil material to zero, and the earth moved by the machinery is the parent material for this new soil. Much of what people do to grow plants alters the soil, like cultivation or fertilization. Humans also enrich soils around them in phosphorus by fertilization and disposal of refuse. This effect is distinctive enough that archaeologists use phosphorus enrichment as evidence of early human habitation. Our system of soil classification also recognizes such enrichment in some soils.

THE SOIL PROFILE

Soils change over time in response to their environment, represented by the soilforming *factors.* Soil scientists have classified the causes of those changes into four soil-forming *processes:* ADDITIONS: Materials may be added to the soil; some examples are fallen leaves, alluvium, and humanmade materials such as air pollutants and compost. Deposition of nutrient-rich dust is a major contributor to the fertility of many soils. LOSSES: Materials may be lost from the soil, as a result of such mechanisms as deep leaching, erosion from the surface, or gases filtering out of the soil. TRANSLOCATIONS: Materials may be moved within the soil, by leaching deeper into (but not out of) the soil, by being carried upward with evaporating water,

by being moved by animals such as ants or earthworms, or by other action that moves soil material around. TRANSFORMATIONS: Materials may be altered in the soil; for example, organic matter decay, weathering of minerals to smaller particles, or chemical reactions. For example, some soils contain **caliche**, a hard subsoil layer cemented by lime. Its formation has been explained this way. Over long periods of time, lime-laden dust is deposited on the soil surface (*addition*). It is leached downward by percolating water (*translocation*), and precipitates out as solid lime at some depth (*transformation)* where it cements a soil layer. This process requires the correct amount of rainfall—enough to translocate the lime downward, but not so much as to move it out of the soil altogether (*loss*). Each of these processes occurs differently at different depths. For instance, organic matter tends to be added at or near the surface, not deep in the soil. Some material moves from high in the soil to be deposited lower. As a consequence, different changes occur at different depths, and horizontal layers develop as a soil ages. These layers are known as **soil horizons**, visible wherever the earth is dug deep enough to expose them. The **soil profile** is a vertical section through the soil extending into unweathered parent material and exposing all the horizons. Each horizon in the profile differs in some visible physical or chemical way from other horizons. In a very young soil, weathering and plant growth produce a thin layer of mixed mineral particles and organic matter atop parent material. The thin layer of soil is labeled the A horizon, a surface mineral horizon enriched with organic matter. The parent material below the A horizon of this young soil is termed the C horizon. It is defined as a subsurface mineral layer only slightly affected by soil-forming processes. Thus, this young soil has an AC soil profile. As the young soil ages, the soil increases in depth, and new horizons appear. For instance, clay-sized particles and certain chemicals may leach out of the A horizon, moving downward in the profile to create a new layer, the B horizon.

Master Horizons

The A, B, and C horizons are known as **master horizons**. They are part of a system for naming soil horizons in which each layer is identified by a code: O, A, E, B, C, and R. O The O horizon is an organic layer made of wholly or partially decayed plant and animal debris. The O horizon generally occurs in undisturbed soil because plowing mixes the organic layer into the soil. In a forest, decaying fallen leaves, branches, and other debris make up the O horizon.

A The A horizon, called **topsoil** by most growers, is the surface mineral layer where organic matter accumulates. It is darker than the horizons below. Over time, this layer loses clay, iron, and other materials in downward-moving water, a loss called **eluviation**. Materials resistant to weathering, such as sand, tend to remain in the A horizon as other materials elluviate out. The A horizon provides the best environment for the growth of plant roots, microorganisms, and other life.

The E horizon, the zone of greatest eluviation, is very depleted in clay, chemicals, and organic matter. Because chemicals that color soil have been leached out, the E layer is very light colored. Many soils have no E horizon; it is mostly likely to occur under forest vegetation in sandy soils in high-rainfall areas.

The B horizon, or **subsoil** (though associating the A horizon with topsoil and the B horizon with subsoil is not always, strictly speaking, accurate), is often called the "zone of accumulation" where chemicals leached out of the A and E horizons accumulate. The word for this accumulation is **illuviation**. The B horizon has a lower organic matter content than the topsoil and is often enriched in clay deposited by illuviation.

The C horizon lacks the properties of the A and B horizons. It is the soil layer little touched by soil-forming processes and is usually the parent material of the soil. It may also include very soft, weathered bedrock that roots can penetrate. R The R horizon is underlying hard bedrock, such as limestone, sandstone, or granite. It may be cracked and fractured, allowing some root penetration. The R is identified only if it is near enough the surface to intrude into soil.

Subdivisions of the Master Horizons

As soils age, they may develop more horizons than the basic master horizons. Some of these layers are between the master horizons both in position and properties. These transitional layers are identified by the two master letters, with the dominant one written first. Thus, an AB layer lies between the A and B horizons and resembles both, but is more like the A than the B. Figure 2–16 shows some of these layers. A soil layer can be further identified by a lowercase letter suffix that tells some trait of the layer. For instance, plowing would mix up an O, A, and AB horizon if they were all in the top 8 inches. The Ap horizon is the same as the **plow layer**, the top 7 or 8 inches of soil in a plowed field. A Bt horizon is a B horizon in which clay has accumulated by illuviation. Soils in arid climates often exhibit horizons enriched in materials like lime (calcium carbonate). A C horizon enriched in carbonates will be labeled Ck. Further subdivisions are noted by a number following the letters. Thus, one could have a soil with both a Bt1 and a Bt2 horizon. This means that the Bt horizon of the soil has two distinct layers in it, though they may be hard to separate by the untrained eye (Plaster, 2014).

References:

Plaster, E. J. (2014). *Soil Science and Management.* New York: Cenage Learning.

UNIT – 5
FACTORS OF POPULATION GROWTH; TYPES OF MIGRATION

INTRODUCTION

When demographers attempt to forecast changes in the size of a population, they typically focus on four main factors: fertility rates, mortality rates (life expectancy), the initial age profile of the population (whether it is relatively old or relatively young to begin with) and migration. In the case of religious groups, a fifth factor is switching – how many people choose to enter and leave each group, including how many become unaffiliated with any religion (Wormald, 2015).Human beings evolved under conditions of high mortality due to famines, accidents, illnesses, infections and war and therefore the relatively high fertility rates were essential for species survival. In spite of the relatively high fertility rates it took all the time from evolution of mankind to the middle of the 19th century for the global population to reach one billion. The

twentieth century witnessed an unprecedented rapid improvement in health care technologies and access to health care all over the world; as a result there was a steep fall in the mortality and steep increase in longevity. The population realized these changes and took steps to reduce their fertility but the decline in fertility was not so steep. As a result the global population has undergone a fourfold increase in a hundred years and has reached 6 billion (http://www.mcrhrdi.gov.in/FC2020/material/SELECT%20READINGS%20IN%20ECONOMICS.pdf).

Population growth is determined by fertility rates (the number of children per adult) – fatality rates. Birth rates and mortality rates are, in turn, determined by a combination of factors. Often economic growth and economic development have led to a decline in population growth, but there are no hard and fast rules and other factors, such as availability of family planning, social expectations and government intervention can play an important role (https://www.coursehero.com/file/110360971/Factors-That-Influence-the-Size-of-Human-Populationpdf/).

What Is Population Growth?

- Population is defined as a cluster of individuals or same kind of species or group of societies living in an exact habitation or environment at the same period.
- Population is a specific group of individuals or a pool of individuals.
- A population may change or escalate and decline due to fluctuation in birth rate, death rate, emigration and immigration.
- Population growth simply means the increase in size of the population.
- Population growth is the alteration/increase in a population above time.
- Population growth can be calculated as the alteration in a number of individuals of any species in a population using "per unit time" for measurement.
- Population growth is measured equally in absolute and relative terms.

Population Growth Rate

Population growth rate (*r*) is how fast a population changes in size over time. A positive growth rate means a population is increasing. A negative growth rate means it is decreasing. The two main factors affecting population growth are the birth rate (*b*) and death rate (*d*). Population growth may also be affected by people coming into the population from somewhere else (**immigration**, *i*) or leaving the population for another area (**emigration**, *e*). The formula for population growth takes all these factors into account (https://www.scribd.com/document/333138325/8th-grade-LIFE-SCIENCE-book-pdf).

$r = (b + i) - (d + e)$

- r = population growth rate
- b = birth rate
- i = immigration rate

- d = death rate
- e = emigration rate

Factors influencing population growth

Population distribution is the spatial pattern of the dispersal of populations, formation of agglomerations, linear spreads of population, etc. In most countries, there are wide regional variations in the geographic distribution of the population. Population densities are different in various parts of the world. The 2015 Revision of World Population Prospects is the twenty-fourth round of the United Nations' estimates and projections of population. They are prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations(United Nations 2015).

The world's population reached 7.3 billion in mid-2015, which means that the world has added approximately one billion people in the span of the twelve years. The global population is highly dispersed over the seven continents. Most of the world's population (about 60 per cent) lives in Asia (4.4 billion), 16 per cent in Africa (1.2 billion), 10 per cent in Europe (738 million), 9 per cent in Latin America and the Caribbean (634 million), and the remaining 5 per cent in Northern America (358 million) and Oceania (39 million). China (1.4 billion) and India (1.3 billion) are the world's most populous countries and home to19 and 18 per cent respectively of the world's population. India's population is expected to continue growing for several decades. It is projected to reach 1.5 billion in 2030 and 1.7 billion in 2050, while that of China is likely to remain constant and then decrease slightly. Therefore, it is projected that India's population will surpass China in the future (http://www.tezu.ernet.in/denvsc/IDC/2016/world_population_note_2015.pdf).

The ten most populous countries in the world are distributed in all continents: one in Africa (Nigeria), five in Asia (Bangladesh, China, India, Indonesia, and Pakistan), two in Latin America (Brazil and Mexico), one in North America (United States of America), and one in Europe (the Russian Federation). Nigeria's population, currently the seventh largest in the world, is growing most rapidly. With the present rate of growth, the population of Nigeria is projected to surpass that of the United States by about 2050 at which point it will become the third most populous country in the world. By 2050, six of the ten largest countries in the world are expected to have populations more than 300 million: China, India, Indonesia, Nigeria, Pakistan, and United States of America. It is estimated that 50.4 per cent of the world's population is male and 49.6 per cent, female. The median age of the global population, that is, the age at which half the population is older and half younger, is 29.6 years. About one-quarter (26 per cent) of the world's population is below 15 years of age, 62 per cent are aged 15-59 years, and 12 per cent are 60 years or over (https://vbook.pub/documents/post-independence-india-2-5wgl60l1n8o7).

Populations are not evenly distributed over the earth's landmass. Physical environments vary from place to place. Hence, it is necessary for demographers to understand how and where populations are distributed. Present spatial distribution as well as projections for the future are

integral to a demographer's work. With an understanding of certain patterns, and of the factors that have significant impact on population density and the total population, it is possible to make projections of the growth (or possible decline) in the global population, and its spatial distribution. It will then become possible for leaders and policymakers to frame appropriate policies and strategies to protect the environment, plan for sustainable development, and prepare for changes that accompany changes in population characteristics ((http://ndl.ethernet.edu.et/bitstream/123456789/79237/1/Geography%20of%20Population%20and%20Settlement.pptx).

The major factors influence the population growth are (https://www.economicshelp.org/blog/469/development/factors-effect-population-size-and-growth/):

- **Economic development**. Countries who are in the early stages of economic development tend to have higher rates of population growth. In agriculturally based societies, children are seen as potential income earners. From an early age, they can help with household tasks and collecting the harvest. Also, in societies without state pensions, parents often want more children to act as an insurance for their old age. It is expected children will look after parents in old age. Because child mortality rates are often higher, therefore there is a need to have more children to ensure the parents have sufficient children to look after them in old age.
- **Education**. In developed countries, education is usually compulsory until the age of 16. As education becomes compulsory, children are no longer economic assets – but economic costs. In the US, it is estimated a child can cost approx $230,000 by the time they leave college. Therefore, the cost of bringing up children provides an incentive to reduce family size.
- **Quality of children**. Gary Becker produced a paper in 1973 with H.Gregg Lewis which stated that parents choose the number of children based on a marginal cost and marginal benefit analysis. In developed countries with high rates of return from education, parents have an incentive to have a lower number of children and spend more on their education – to give their children not just standard education but a relatively better education than others. To be able to give children the best start in life, it necessitates smaller families. Becker noted rising real GDP per capita was generally consistent with smaller families.
- **Welfare payments/State pensions**. A generous state pension scheme means couples don't need to have children to provide an effective retirement support when they are old. Family sizes in developing countries are higher because children are viewed as 'insurance' to look after them in old age. In modern societies, this is not necessary and birth rates fall as a result.
- **Social and cultural factors**. India and China (before one family policy) had strong social attachments to having large families. In the developed world, smaller families are the norm.
- **Availability of family planning**. Increased availability of contraception can enable women to limit family size closer to the desired level. In the developing world, the

availability of contraception is more limited, and this can lead to unplanned pregnancies and more rapid population growth. In Africa in 2015, it was estimated that only 33% of women had access to contraception. Increasing rates would play a role in limiting population growth. (link)

- **Female labour market participation**. In developing economies, female education and social mobility are often lower. In societies where women gain a better education, there is a greater desire to put work over starting a family. In the developed world, women have often chosen to get married later and delay having children (or not at all) because they prefer to work and concentrate on their career.
- **Death rates** – Level of medical provision. Often death rates are reduced before a slowdown in birth rates, causing a boom in the population size at a certain point in a country's economic development. In the nineteenth and early twentieth century, there was a rapid improvement in medical treatments which helped to deal with many fatal diseases. Death rates fell and life expectancy increased.
- **Immigration levels.** Some countries biggest drivers of population growth come from net migration. In the UK from 2000 to 2013, around 50% of net population growth came from net international migration. Countries like Japan with very strict immigration laws have seen a stagnation in the population.
- **Historical factors/war**. In the post-war period, western countries saw a 'boom' in population, as couples reunited at the end of the Second World War began having families. The 'baby-boomer' period indicates population growth can be influenced by historical events and a combination of factors which caused a delay in having children until the war ended.

Main Factors Driving Population Growth

When demographers attempt to forecast changes in the size of a population, they typically focus on four main factors: fertility rates, mortality rates (life expectancy), the initial age profile of the population (whether it is relatively old or relatively young to begin with) and migration. In the case of religious groups, a fifth factor is switching – how many people choose to enter and leave each group, including how many become unaffiliated with any religion.

This chapter presents an overview of each of these five main drivers of population change. It highlights important trends, discusses key assumptions about the future and acknowledges weak spots in the demographic data currently available on some countries and religious groups.

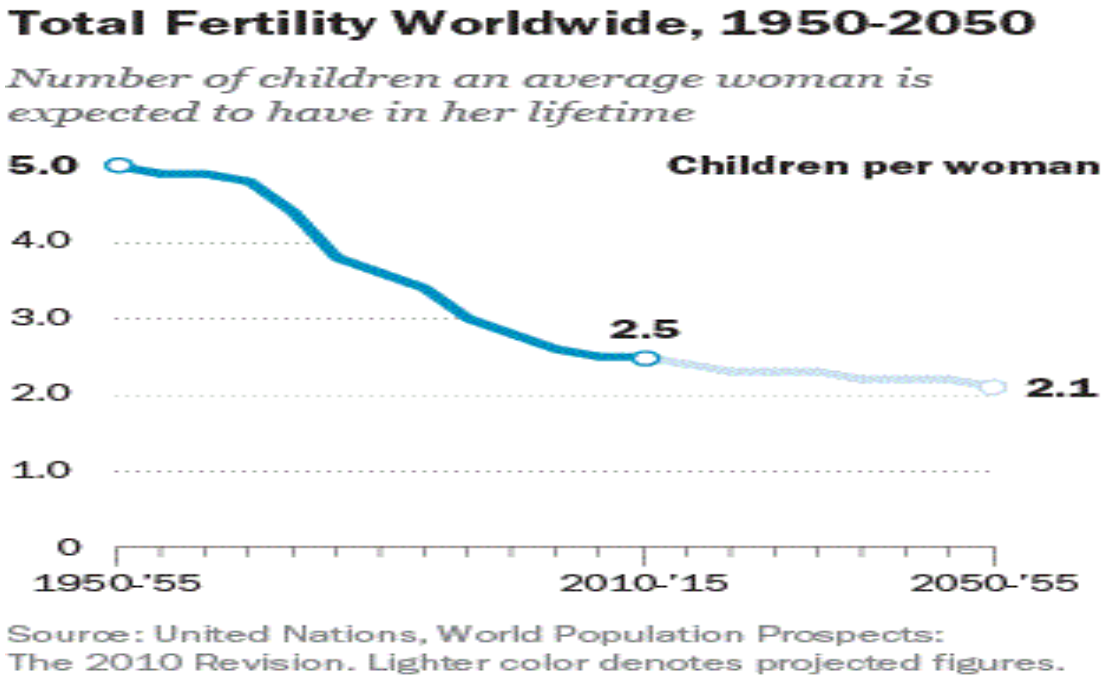
In some cases, this chapter also shows how different the projections would be if particular factors, such as migration, were not taken into account. These hypothetical scenarios are intended to give readers a sense of how much impact various factors have on the projections (https://www.pewresearch.org/religion/2015/04/02/main-factors-driving-population-growth/).

Fertility

Over the last half century, the global fertility rate has fallen sharply.[x] In the 1950 to 1955 period, the average woman was expected to have about five children over the course of her lifetime. By 2010-2015, the global average was about 2.5 children per woman. According to the United Nations Population Division, worldwide fertility rates are expected to continue to

drop in the decades to come, gradually moving toward 2.1 children per woman, which is traditionally viewed as the "replacement level" needed to maintain a stable population in countries with low mortality rates among the young.

As a result of declining fertility rates, global population growth is slowing. Over the four decades from 1970 to 2010, the number of people on Earth grew nearly 90%. From 2010 to 2050, the world's population is expected to rise 35%, from roughly 7 billion to more than 9 billion.Among the world's major religious groups, Muslims have the highest Total Fertility Rate as of 2010-2015, a global average of 3.1 children per woman. This is one of the main reasons why the Muslim population is expected to grow not only in absolute numbers but also in relative terms – as a percentage of all the people in the world – in the decades to come.Christians (2.7 children per woman) are the only other major religious group whose Total Fertility Rate, on a worldwide basis, exceeds the average for all women (2.5), during the present five-year period (2010-2015).



Globally, fertility among Hindus (2.4 children per woman) and Jews (2.3) is above the replacement level (2.1 children). Fertility rates among all the other groups – followers of folk religions (1.8), other religions as a whole (1.7), the religiously unaffiliated (1.7) and Buddhists (1.6) – are below the replacement level, meaning the groups are not bearing enough children to maintain their current populations, all else remaining equal.

One of the assumptions behind the U.N.'s global population forecasts, as well as the Pew Research projections, is that over time fertility rates generally converge toward the replacement level.[17] If they start above the replacement level, they tend to decline. If they start below the replacement level, they tend to rise – although they may change slowly and may not actually

reach the replacement level in the coming decades (https://www.pewresearch.org/religion/2015/04/02/main-factors-driving-population-growth/).

Source: The Future of World Religions: Population Growth Projections, 2010-2050

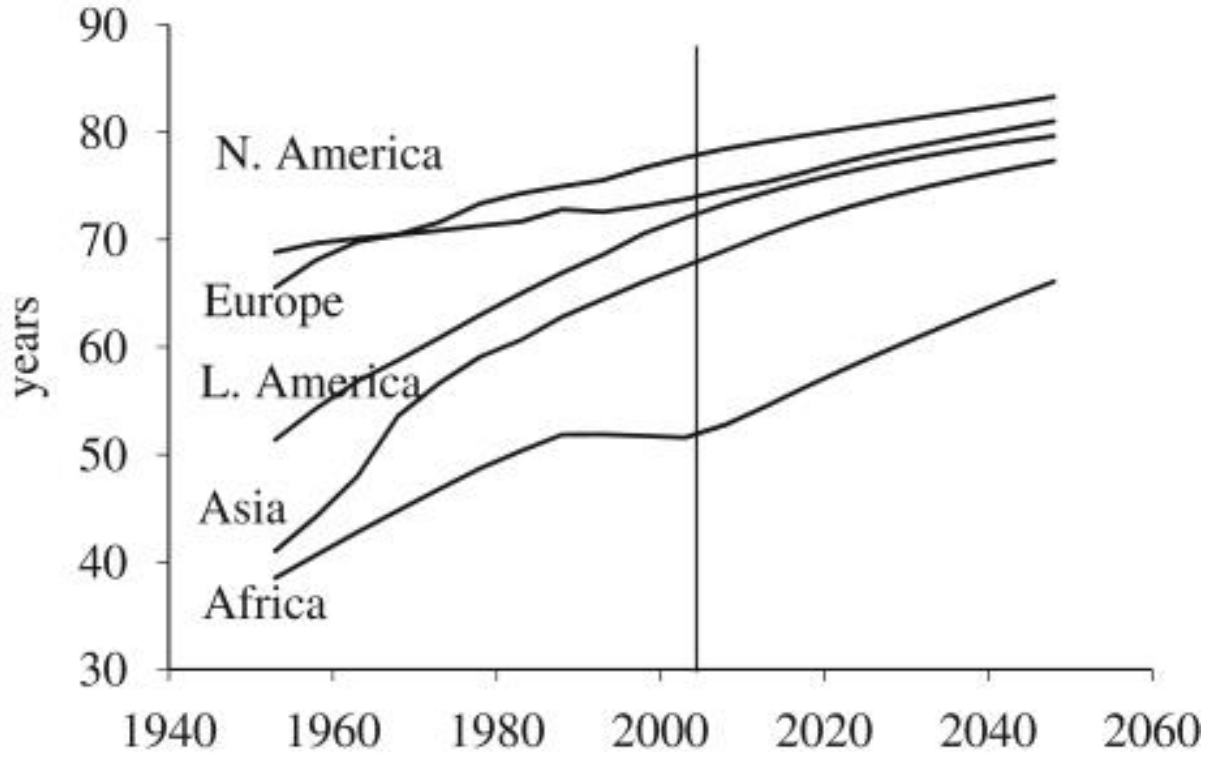
Thus, the religious groups with fertility rates above replacement level in 2010 – Muslims, Christians, Hindus and Jews – are expected to experience a decline in their fertility rates by 2050. Fertility rates for Muslims and Hindus are projected to decline most sharply – more than 20% – from 3.1 to 2.3 children per Muslim woman and from 2.4 to 1.8 children per Hindu woman. Among Christians, the fertility rate is projected to decline from 2.7 children to 2.3. The worldwide fertility rate among Jews also is expected to drop, albeit only slightly, from 2.3 in 2010 to 2.1 in 2050.At the same time, fertility rates among the four religious groups that are

below 2.1 children per woman as of 2010 – followers of folk religions, other religions, Buddhists and the unaffiliated – are expected to rise somewhat over the next four decades, moving closer to the replacement level (https://www.pewresearch.org/religion/2015/04/02/main-factors-driving-population-growth/).

Mortality and life expectancy

Mortality levels have also changed rapidly over the past several decades. The South experienced exceptional improvements in LE from an average of 41 years in 1950–1955 to 64 years in 2000–2005. By the early 2000, Latin America reached mortality levels similar to those prevailing in the North in the 1970s, and Asia was just a few years behind. Africa experienced the highest mortality and improvements in LE stalled in the 1990s due to the AIDS epidemic. As a result, Africa's LE, at 52 years in 2000–2005, was still substantially below that of Asia (68) and Latin America (72). As expected, Europe and Northern America already achieved relatively low levels of mortality by 1950, but they have nevertheless seen significant further improvements since then. Europe's LE (74) is now lower than North America's (78) because of a rise in mortality in Eastern Europe after the break-up of the Soviet Union (Bongaarts, 2009).

Fig: - Mortality pattern of continent wise



Source: - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2781829/

Projections of future LEs by the UN assume continued improvements over time in all regions. The North is expected to reach 82 years in 2050 despite the increasing difficulty in achieving increments as countries reach ever higher levels of LE. Asia and Latin America are expected to continue to close the gap with the North, and Africa will continue to lag, in part because the continent remains affected by the AIDS epidemic.It should be noted that the assumptions made by the UN about future trends in fertility and mortality are not based on a firm theoretical basis. Instead, the UN relies on empirical regularities in past trends in countries that have completed their transitions, mostly in the North, where fertility declined to approximately the replacement level, and increases in LE became smaller over time. This is a plausible approach that unfortunately leaves room for potential inaccuracies in projection results (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2781829/).

Migration

Migration is another type of movement that changes population size. **Migration** is the regular movement of individuals or populations each year during certain seasons. The purpose of migration usually is to find food, mates, or other resources. For example, many northern hemisphere birds migrate thousands of miles south each fall. They go to areas where the weather is warmer and more resources are available. Then they return north in the spring to nest. Some animals, such as elk, migrate vertically. They go up the sides of mountains in spring as snow melts. They go back down the mountain sides in fall as snow returns (https://k12.libretexts.org/Bookshelves/Science_and_Technology/Biology/06%3A_Ecology/6.10%3A_Population_Growth).

The population of any given area can only change through three processes: birth, death and migration. Health departments at the state and local levels keep fairly complete records of births and deaths, but information on gross migration flow—in or out—is practically non-existent. The net effect of migration on population size can be reasonably approximated, however, from census counts and vital statistics. Using data provided by the Indiana State Department of Health, along with 1990 and 2000 census counts, the Indiana Business Research Center estimates that net migration, the difference between inflows and outflows, accounted for 216,000 new state residents in the 1990s—40 percent of Indiana's total population increase for the decade (https://www.meritnation.com/ask-answer/question/what-is-migration-and-its-impact/democracy-and-diversity/9467919).

Assessing the Impact of Migration on Population

To analyse the impact of migration on the population and labour force at regional level in the ESPON area in the period 2005-2050, the DEMIFER team calculated three reference scenarios. The first one is a simulation of what would happen if the demographic regimes of mid-decade (2005) continued unchanged until 2050. In the other two scenarios all or some migration streams are blocked: in the scenario, population of the regions changes due to births and deaths only, while in the scenario it changes also due to internal and international intra-ESPON space migration, but no extra-European migration. A comparison of the results of the three

simulations yields estimates of the impact of migration on population change. The simulations were prepared with the MULTIPOLES population dynamics model (https://www.espon.eu/export/sites/default/Documents/Projects/AppliedResearch/DEMIFER/demifer_PB_migr_impact.pdf).

TYPES OF MIGRATION

The history of humanity and development of human society is underpinned by migration. Migration of people across administrative/political jurisdictions within a country, or across countries, has been a crucial factor in changes in societies. For a better understanding of migration, it is necessary to classify migration according to its types. There are two major types of migration: a) internal migration, which takes place within a country; and b) international migration that takes place across international boundaries (Bhende and Kanitkar, 2006). The processes, causes and consequences of internal migration are very different from those in international migration. The former is a response to the socioeconomic spatial situations within a country, while the latter is related to international socioeconomic and political conditions, especially the immigration and emigration laws and policies of these countries. The relatively permanent movement of people across territorial boundaries is referred to as in-migration and out-migration, or immigration and emigration when the boundaries crossed are international. The place of in-migration or immigration is called the receiver population, and the place of out-migration or emigration is called the sender population (https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000453PO/P001844/M029724/ET/1525153905Module-2PS_MU_2.pdf). There are two basic types of migration studied by demographers:

Internal Migration

Internal migration is the migration of people within the country. The characteristics and patterns of a country's internal migration are vital indicators of the pace and process of its development. For instance, the United States, is quite literally a nation on the move, and it always has been (Weeks, 2008), on the other hand population of many developing countries is less mobile. However, the mobility of people within national boundaries is very difficult to measure. For this reason, it is necessary to have a clear understanding of the definition of internal migration. People constantly move from one place to another; and these movements are diverse in nature. The distances covered vary from a few kilometers to several kilometers. Moreover, the duration of stay involved in the new location may vary from a few hours to several years. Many movements are casual, such as commuting to and from the place of work, shopping, visiting, and travelling for business or for pleasure etc. Such movements do not involve a sustained or a permanent change of residence and must, therefore, be distinguished from migration, which involves a change of place of usual residence-a taking up of life in a new or different place (https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000453PO/P001844/M029724/ET/1525153905Module-2PS_MU_2.pdf).

An operational definition of internal migration is that it is a change of residence from one civil division to another, or across the administrative boundary of a civil division. Thus, it may be said that a migrant is a mover who changes her (or his) residence from the political area of her usual residence. It is obvious that the civil division, as a migration-defining criterion, lacks uniformity, for divisions vary widely in size, shape and length of the border. This criterion is, therefore, not suitable when comparisons of migration in different countries are made. However, the United Nations has recommended that the areal unit should be as small as possible. Internal migration therefore is classified based on various criteria which are described in the following sections (https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000453PO/P001844/M029724/ET/1525153905Module-2PS_MU_2.pdf).

Based on direction of movement

Within internal migration, there is a four-way classification according to the direction of movements within and between rural and urban areas, which are (https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000453PO/P001844/M029724/ET/1525153905Module-2PS_MU_2.pdf):

a) Rural to Rural migration

b) Rural to Urban migration

c) Urban to Rural migration

d) Urban to Urban migration

Of these streams, it is rural to urban migration which is the most significant, because it contributes to the transfer of labour force from the traditional agricultural sector to the urbanized industrial sector, and is directly linked to urbanization. Rural-to urban migration is a response to diverse economic opportunities across space. Income differentials between rural and urban areas is one of the main reasons for this type of migration, since in developing economies like India, agriculture alone cannot sustain rural livelihoods. Deshingkar (2006) argues that in India, the rate of job creation and real wage increases in agriculture have slowed down. Moreover, urban areas attract the surplus labour of the countryside, which is characterized by underemployment or unemployment. Factors that pull the high-income groups in rural areas are availability of a better social infrastructure (education, health, etc.), better amenities and the quest for independence from social, cultural religious and familial shackles. Likewise, urban to urban migration is also related to the concentration of population in large towns and cities which may be the result of step migration from rural areas to any small towns and then small towns to large cities. However, in many developing countries like India, rural to rural migration is also significant, especially among women who move primarily due to marriage, or familial reasons. Each migration stream has distinct premises, causes and consequences.

Based on spatial dimensions

Internal migration stream based on spatial dimensions may be classified into following categories:

a) Intra-district migration, i.e., migration within the district.

b) Inter-district migration, i.e., migration from one district to another within the state.

c) Inter-state migration, i.e., migration from one state to another.

It is important to note that migration within the district is called short-distance migration, migration within the state across the district is called medium-distance migration, and migration across state boundaries is called long-distance migration.

Based on the motive/reasons for migration

Internal migration takes place due to various motivations and reasons. These fall in the following main categories:

a) Marriage migration

b) Labour migration or migration of people for work, employment, etc.

c) Migration due to natural calamities

Marriage migration is by far the largest form of migration in India; and it is close to universal for women in rural areas. In the last decade (2001-2011), around 217.8 million women in India moved to live with their husbands' families on marriage. Most of this has been rural to rural migration, with the women migrating short distances. Labour migration is the migration of people motivated by need of work or employment. Several economic theories have been proposed to explain labour migration. For example, the neoclassical economic theory has tried to frame motivation for migration in terms of the wage differentials between the origin and destination, as well as the employment conditions and migration costs. The theory also argues that it is the individuals alone who take the decision to migrate (https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000453PO/P001844/M029724/ET/1525153905Module-2PS_MU_2.pdf).

Based on duration of migration

Here, migration is classified into two kinds:

a) Permanent migration

b) Temporary migration

The migrant's intention to permanently change his/her residence distinguishes permanent labour migration from temporary migration. In permanent labour migration, the usual place of residence of the migrant's changes and the chances of returning home are weak. In temporary migration, however, migrants continue to remain a usual member of the household and tend to move circularly between the places of origin and destination. In China, instead of the usual

place of residence and duration of stay, a household registration system (Hukou) defines whether a person is temporary or permanent labour migrant. Temporary labour migrants are those individuals whose place of residence differs from their place of registration. Permanent migrants, on the other hand, are migrants who have changed their registration to the place of residence
(https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000453PO/P001844/M029724/ET/1525153905Module-2PS_MU_2.pdf).

International Migration

International migration occurs when movement of persons involve crossing the national borders. Movement of youth from India to USA, European Countries as well as Gulf countries in search of jobs can be categorised under this type of migration. The term immigration and emigration refer respectively to movement into or out of a particular territory, and are used only in connection with international migration. From the perspective of a migrant, immigration is the act of visiting a State whose nationality has not been acquired; also the migrant does not have the intention of settling there. Tourists and students going to other countries for a relatively short time are covered under this category. Emigration is leaving one's country or region to settle in another (https://www.egyankosh.ac.in/bitstream/123456789/6094/4/Unit-1.pdf).

International migrants change residence across national boundaries. An international migrant is a person who moves to a different country. Every year, millions of people cross international borders for a variety of reasons. Some do so for business, while some go on vacations. Still other people leave their homeland with no intentions of moving back. No study of migration is complete without a study of international migration, which has had an important bearing on the population growth of several countries, such as the United States, Canada, Australia, and New Zealand, Israel, Singapore, Hong Kong, South Africa, and many Latin American countries. International migrations can be classified into the following types (https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000453PO/P001844/M029724/ET/1525153905Module-2PS_MU_2.pdf):

Forced migration: According to IOM (2017), Forced migration is "…migratory movement in which an element of coercion exists, including threats to life and livelihood, whether arising from natural or man-made causes (e.g. movements of refugees and internally displaced persons as well as people displaced by natural or environmental disasters, chemical or nuclear disasters, famine, or development projects)".

Circular migration: This is the fluid movement of people between countries, including temporary or long-term movement, which may be beneficial to all involved, if occurring voluntarily, and is linked to the labour needs of countries of origin and destination.

Irregular/undocumented migration: Movement that takes place outside the regulatory norms of the sending, transit and receiving countries. There is no clear or universally accepted definition of irregular migration. From the perspective of the destination countries, it is entry, stay or work in a country without the necessary authorization or documents required under

immigration regulations. From the perspective of the sending country, the migration is irregular if, for example, a person crosses an international boundary without a valid passport or travel document, or does not fulfil the administrative requirements for leaving the country. However, the term "illegal migration" is usually applied only to cases of smuggling of migrants and people trafficking.

Consequences of Migration

Migration is a response to the uneven distribution of opportunities over space. People tend to move from place of low opportunity and low safety to the place of higher opportunity and better safety. This, in turn, creates both benefits and problems for the areas, people migrate from and migrate to. Consequences can be observed in economic, social, cultural, political and demographic terms (http://www.lokayan.com/2021/03/ncert-book-geography.html).

Economic Consequences

A major benefit for the source region is the remittance sent by migrants. Remittances from the international migrants are one of the major sources of foreign exchange. In 2002, India received US$ 11 billion as remittances from international migrants. Punjab, Kerala and Tamil Nadu receive very significant amount from their international migrants. The amount of remittances sent by the internal migrants is very meagre as compared to international migrants, but it plays an important role in the growth of economy of the source area. Remittances are mainly used for food, repayment of debts, treatment, marriages, children's education, agricultural inputs, construction of houses, etc. For thousands of the poor villages of Bihar, Uttar Pradesh, Odisha, Andhra Pradesh, Himachal Pradesh, etc. remittance works as life blood for their economy. Migration from rural areas of Eastern Uttar Pradesh, Bihar, Madhya Pradesh and Odisha to the rural areas of Punjab, Haryana, Western Uttar Pradesh accounted for the success of their green revolution strategy for agricultural development. Besides this, unregulated migration to the metropolitan cities of India has caused overcrowding. Development of slums in industrially developed states such as Maharashtra, Gujarat, Karnataka, Tamil Nadu and Delhi is a negative consequence of unregulated migration within the country (http://www.lokayan.com/2021/03/ncert-book-geography.html).

Demographic Consequences

Migration leads to the redistribution of the population within a country. Rural urban migration is one of the important factors contributing to the population growth of cities. Age and skill selective out migration from the rural area have adverse effect on the rural demographic structure. However, high out migration from Uttarakhand, Rajasthan, Madhya Pradesh and Eastern Maharashtra have brought serious imbalances in age and sex composition in these states. Similar imbalances are also brought in the recipients states. What is the cause of imbalance in sex ratio in the place of origin and destination of the migrants?

Social Consequences

Migrants act as agents of social change. The new ideas related to new technologies, family planning, girl's education, etc. get diffused from urban to rural areas through them. Migration

leads to intermixing of people from diverse cultures. It has positive contribution such as evolution of composite culture and breaking through the narrow considerations and widens up the mental horizon of the people at large. But it also has serious negative consequences such as anonimity, which creates social vacuum and sense of dejection among individuals. Continued feeling of dejection may motivate people to fall in the trap of anti-social activities like crime and drug abuse (http://www.lokayan.com/2021/03/ncert-book-geography.html).

Environmental Consequences

Overcrowding of people due to rural-urban migration has put pressure on the existing social and physical infrastructure in the urban areas. This ultimately leads to unplanned growth of urban settlement and formation of slums shanty colonies. Apart from this, due to over-exploitation of natural resources, cities are facing the acute problem of depletion of ground water, air pollution, and disposal of sewage and management of solid wastes (http://www.lokayan.com/2021/03/ncert-book-geography.html).

Others

Migration (even excluding the marriage migration) affects the status of women directly or indirectly. In the rural areas, male selective out migration leaving their wives behind puts extra physical as well mental pressure on the women. Migration of ‘women’ either for education or employment enhances their autonomy and role in the economy. If remittances are the major benefits of migration from the point of view of the source region, the loss of human resources particularly highly skilled people is the most serious cost. The market for advanced skills has become truly a global market and the most dynamic industrial economies are admitting and recruiting significant proportions of the highly trained professionals from poor regions. Consequently, the existing underdevelopment in the source region gets reinforced (http://www.lokayan.com/2021/03/ncert-book-geography.html).

UNIT: - 6
RURAL AND URBAN SETTLEMENTS AND ITS CLASSIFICATION

INTRODUCTION

Human Settlement means cluster of dwellings of any type or size where human beings live. For this purpose, people may erect houses and other structures and command some area or territory as their economic support-base. Thus, the process of settlement inherently involves grouping of people and apportioning of territory as their resource base. Though we use this term very frequently, but when it comes for defining, it is very difficult to give a clear cut definition. In simpler term we can define settlement as any form of human habitation which ranges from a single dowelling to large city. The word settlement has another connotation as well as this is a process of opening up and settling of a previously uninhabited area by the people. In geography this process is also known as occupancy. Therefore, we can say settlement is a process of grouping of people and acquiring of some territory to build houses as well as for their economic support. Settlements can broadly be divided into two types – rural and urban. Before discussing about meaning and types of rural and urban settlement in India, we should know some basic differences between rural and urban areas in general (https://www.scribd.com/document/231393485/News-Prepation).

1. The major difference between rural and urban areas is the function. Rural areas have predominantly primary activities, whereas urban areas have domination of secondary and tertiary activities.
2. Generally the rural areas have low density of population than urban.

TYPES OF RURAL SETTLEMENTS

Before discussing types and patterns of rural settlements in India, let us have some idea about the words: – type and pattern. Type refers to a category of things having some common features whereas pattern refers to a regular form or order in which a series of things occur. When we say settlement pattern, the term is strictly applied to the spatial arrangement or distribution of settlements within a given area. It differs from settlement form. Settlement form relates more to the spatial characteristics of individual settlement. However, sometimes forms and patterns are used interchangeably. But here we will discuss about the patterns only. As far as type of rural settlements is concerned, it implies the degree of dispersion of the dwellings (Seto et. al., 2014).

Types of Rural Settlements

Geographers have suggested various schemes of classification. If we group settlements found all over the country, these can broadly be grouped under four categories:

A. Compact/clustered/nucleated settlement

B. Semi-compact/Semi-clustered/fragmented settlement

C. Hemleted settlement

D. Dispersed settlement.

Let us discuss these types one by one along with some of the major patterns associated with each type.

(A) Compact Settlements: - As the name suggests, these settlements have closely built up area. Therefore in such settlements all the dwellings are concentrated in one central sites and these inhabited area is distinct and separated from the farms and pastures. Maximum settlements of our country come under this category. They are spread over almost every part of the country. These settlements are distributed over the entire northern Indo-Ganga plain (from Punjab in the north-west to West Bengal in the east), Orissa coast, basins of Mahanadi in Chhattisgarh, coastal areas of Andhra Pradesh, cauvery delta of Tamil Nadu, Maidaus of Karnataka, lower Assam and Tripura, in the valleys of Siwaliks etc. Sometimes people live in compact settlement for security or defence purpose. The greatest example of this type is in Bundelkhand region of Madhya Pradesh and Uttar Pradesh. In Rajasthan also people live in compact settlement because of the scarce availability of cultivable land and water body. Therefore, they want to make maximum use of available natural resources (Seto et. al., 2014).

Such settlements generally range from a cluster of about thirty to hundreds of dwelling of different forms, size and functions. On an average, their size various from 500 to 2,500 persons in sparsely populated parts of Rajasthan to more than 10,000 persons in Ganga plain. Very often these settlements have a definite pattern due to closely built area and intervening street patterns. As many as 11 patterns are identified. We will discuss only Five major patterns. These patterns are: (i) Linear pattern (ii) Rectangular pattern (iii) Circular pattern (iv) Square pattern (v) Radial pattern.

- **Linear Pattern:** It is commonly found along main roads, railways, streams, etc. It may have a single row of houses arranged along the main artery. For example rural settlements found along the sea coast, river valley, mountain ranges etc.
- **Rectangular Pattern:** This is a very common type which develops around the rectangular shape of agricultural fields as it is common to find a system of land measurement based on square units. Village paths and cart tracks also confirm to the rectangular field patterns and run through the village in north-south and east-west directions. Accessibility to farms and fields and connectivity to other settlements lead to rectangular shape of settlements. The settlements of coastal Maharashtra and Andhra Pradesh and either side of Aravali hills, etc. may be cited for examples.
- **Square Pattern:** This is basically a variant of rectangular type. Such a pattern is associated with villages lying at the crossing of cart tracks or roads and also related to features restricting the extension of the village outside a square space. These features may include an old boundary wall, thick orchards, a road or a pond.
- **Circular Pattern:** In the upper Doab and Trans – Yamuna districts, Malwa region, Punjab and Gujarat, large villages are characterized by a very high degree of

compactness. The outer walls of dwellings adjoin each other and present a continuous front so that when viewed from outside, the villages look like a walled and fortified enclosure pierced by a few openings. The round form was a natural outcome of maximum aggregation for the purpose of defence during the past.

- **Radial Pattern:** In this type, a number of streets converge on one centre which may be a source of water (pond, well), a temple or mosque, a centre of commercial activity or simply an open space. Thus, the streets seem to be radiating from a common centre. Examples are settlements near Gurushikar, Mount Abu in Rajasthan, Vindhyachal in Uttar Pradesh, etc.

(B) Semi- Compact Settlement:-As the name suggests, the dwellings or houses are not well-knitted. Such settlements are characterized by a small but compact nuclears around which hamlets are dispersed. It covers more area than the compact settlements. These settlements are found both in plains and plateaus depending upon the environmental conditions prevailing in that area. Such settlements are situated along streams in Manipur Mandla and Balaghat districts of Madhya Pradesh, and Rajgarh district of Chhattisgarh. Different tribal groups inhabit such settlements in the Chhota Nagpur region. In Nagaland, such settlements may be in the form of blushing villages. Like, compact settlements, semi-compact settlements may also have different patterns. Some of the patterns are (i) checker board pattern (ii) Elongated pattern (iii) Fan shaped pattern (https://www.scribd.com/document/231393485/News-Prepation).

- **Checker Board Pattern:** This is a type of settlement found generally at the junction of two roads. The village streets meet each other at an angle or are parllel to each other. This is because of the tendency to align the dwellings along cardinal axes. This pattern is common in the northern plains.
- **Elongated Pattern:** Such settlement occurs as a result of elongation of the rectangular pattern due to influence of site features. For instance, in the Ganga plains, in areas liable to inundation, the rectangular pattern becomes unusually elongated along the high ground. Even otherwise the advantage offered by riverside location forces such a pattern.
- **Fan Shaped Pattern:** This is seen where some focal points or line is situated at one end of the village. A focal object may be a tank a riverside, a road, an orchard, a well or even a place of worship. Such patterns are common in the delta region where the dwellings simply follow the fan shaped profile of the delta as in the case of Mahanadi, Godavari, Krishna, Cauvery, etc. Such patterns are also common in the Himalyan foothills.

(C) Helmeted Settlements: These type of settlements, are fragmented into several small units. The main settlement does not have much influence on the other units. Very often the original site is not easily distinguishable and these hamlets are often spread over the area with intervening fields. This segregation is often influenced by social and ethnic factors. The hamlets are locally named as faliya, para, dhana, dhani, nanglay etc. These settlements are generally found in West Bengal, eastern Uttar Pradesh, Madhya Pradesh and coastal plains. Geographically it covers lower Ganga plain, lower valleys of the Himalayas and central plateau or upland region of the country (Seto et. Al., 2014).

(D) Dispersed Settlements: This is also known as isolated settlements. Here the settlement is characterized by units of small size which may consist of a single house to a small group of houses. It varies from two to seven huts. Therefore, in this type, hamlets are scattered over a vast area and does not have any specific pattern. Such types of settlements are found in tribal areas of central part of India covering Chhota Nagpur plateau, Madhya Pradesh, Rajasthan, etc. Such patterns are also common in the hills of north Bengal, Jammu & Kashmir, Tamil Nadu and Kerala.

Factors Influencing the Type of Rural Settlements

There are three factors that influence the type of settlements in India (https://www.seu.edu.bd/seujse/downloads/vol_14_no_1_Jun_2020/SEUJSE-Vol14No1-06.pdf). These factors are (i) Physical (ii) Ethnic or cultural and (iii) Historical or defence. Let us discuss these factors one by one.

Physical Factors: These include relief, altitude, soil capability, climate, drainage, ground water level, etc. These factors influence the type and spacing of dwelling or instance, in dry regions of Rajasthan, water is a crucial factor and, therefore, houses are situated along a pond or well which guides the compactness of the settlement.

Ethnic and Cultural Factors: These include aspects like caste, community, ethnicity and religion. In India it is commonly found that the main land owning caste resides at the centre of the village and the other service providing castes on the periphery. This leads to social segregation and fragmentation of a settlement into several units.

Historical or Defence Factors: In the past, mostly border areas of north-western plains were conquered or attacked frequently by outsiders. For a long time, apart from attack from outsiders, there had been continuous fight between princely states and kingdom within the country therefore; security concerns favoured the evolution of nucleated settlements.

TYPES OF URBAN SETTLEMENTS

Urban settlement is a large nucleated settlement in which the majority of the employed inhabitants are engaged in non-agricultural activities (secondary, tertiary and quaternary economic activities). In other words, urban are related to cities and towns. The census of India defines urban settlements as “All places which have municipality, corporation, cantonment board or notified town area committee and have a minimum population of 5000 persons, at least 75 per cent of male workers are engaged in non-agricultural pursuits and a density of population of at least 400 persons per square kilometers are urban The study of urban places has been central theme to several social sciences, including geography because of their importance in the distribution of population and in the organization of production, distribution and exchange (Roy & Bandyopadhyay, 2017). The classification of urban settlements based on function and size have been briefly discussed in the following paragraphs –

Bases for classification of Urban Settlement

The definition of urban areas varies from one country to another. Some of the most common bases of classification of urban areas in the world are following (https://www.pen2print.org/2017/01/classification-of-urban-settlements.html?m=0) –

Population Size: In India, settlement having a population more than 5000 with population density of 400 persons per square kilometer and share of non-agricultural workers are taken into consideration. In Japan it is 30000 persons whereas in Sweden it is 250 persons. The cut off figure depends upon the density of population in the country (https://pdfcoffee.com/urban-amp-rural-settlements-pdf-free.html).

Fig:ClassificationofUrbanSettlements				
Class	**Population Size**	**No. Of Cities**	**Total Urban Pop. (in thousand)**	**% of total Urban Population**
I	100000 & more	468	227899	60.45
II	50000-99999	474	41328	10.96
III	20000-49999	1373	58174	15.43
IV	10000-19999	1683	31866	8.25
V	5000-9999	1749	15883	4.21
VI	Lessthan 5000	424	1956	0.51

Source: Census of India – 2011 and India, 2017, Ministry of Information and Broadcasting, Government of India

Occupational Structure: Besides size of population, occupational structure is also taken as the criteria to define urban settlement. In India, if more than 75 per cent of workforce is engaged in non-agricultural activities then the settlement is called as urban. Other countries have their own criteria for to define urban places (e.g. For Italy it is 50 per cent workforce).

Administrative Setup: In India, a settlement is called as urban if it has a municipality, cantonment board or a notified area. In Brazil, any administrative centre is termed as urban.

Functional Classification of Urban Settlement

The earlier functions of towns were related to administration, trade, industry, defence and religious. Today, towns performs various functions such as recreational, residential, transporting, mining, manufacturing and most recently activities related to information technology. Some towns are well known for their functions (e.g. London as a port city, Sheffield as an industrial city, Chandigarh as an administrative city, Mecca as a religious city etc.). Large city of the world have a greater diversity of functions. Geographers have classified towns and city on the basis of their site, situation, size, rank and location. A more useful classification of towns and cities is on the basis of functions they perform. This categorization is known as functional classification of towns. So, the functional classification of towns categories towns and cities according to their economic functions (http://exploringgeography.wikispaces.com/file/view/CHAPTER-10+Human+settlements.pdf). The functional classification of towns are discussed in the following paragraphs –

(1) Administrative Tows: - The main function of administrative towns and cities is to administer the country, provinces or a specific territory. It includes not only the capital cities of countries, but all the centres of provinces, districts and other administrative division of the country (https://www.shareyouressays.com/knowledge/9-things-you-must-know-about-the-functional-classification-of-towns/111237). The administrative cities contain government offices, public buildings, royal palaces, presidents, prime minister, minister, bureaucrats and other offices. These are usually the headquarters of sate-run organizations e.g. banks, post offices, railways, defence, trade, industries etc. The major examples of administrative towns are New Delhi, London, Washington D.C. Cairo, Tokyo etc. In India, all the states headquarter are administrative towns (https://www.coursehero.com/file/135936549/Functions-of-a-settlementpdf/).

(2) Defence Towns: - Defence has been an important function of towns in the past as well as the present. The main purpose of defence town is to provide necessary security and protect the integrity and sovereignty of the country. They include fort towns, garrison towns, air bases and cantonments. In many garrison and defensive towns, there is a clear division of land use between the civil and military authorities, so that the military installations are often at a little distance from the town or are grouped together in one part of the town. This is necessary to maintain security, though often many town people are employed by the military. The few examples of defensive towns in India as well as in the worlds are Vishakhapatnam, Nova Scotia, Portsmouth, Peshawar etc (https://lagosstate.gov.ng/wp-content/uploads/2022/02/Y2020-Household-Survey-Report.pdf).

(3) Cultural Towns: - Towns famous for religious and educational functions are called cultural towns. Places of pilgrimage, such as Mecca, Jerusalem, Varanasi, Badrinath etc. are religious towns whereas Oxford, Cambridge, Aligarh are the most suitable example of educational towns (https://www.coursehero.com/file/135936549/Functions-of-a-settlementpdf/).

(4) Collection Towns: - The mining towns, fishing ports and lumbering centres fall under the category of collection centres/towns. There are numerous metallic, non-metallics, precious stones and energy resources which are obtained from mines. The towns which serve these mines may be small settlements serving a particular mine such as Zawar near Udaipur (Rajasthan), Bjiladela (Madhya Pradesh) and Digboi (Assam).They may be large in size such as Raniganj, Hazaribagh (Jharkhand), Ipoh in the tin rich Kinta valley of Malaysia, or Kuwait and Abadan in the oil producing regions of Kuwait and Tehran, respectively. Such towns may have some industries related to the mineral mines, such as smelters and refineries. The shops in such towns sell mining equipment and special clothes needed for miners (https://rasfreenotes.in/prelims-notes/indian-geography/functional-classification-of-urban-settlements-problems-of-human-settlement-in-india/).

(5) Production Towns: - Urban places, town and cities in which some kind of manufacturing industry is the major function is known as a production towns. The size and appearance of the town are affected by the type of industry located there. For example, Jamshedpur, Rourkela, Bhilai, Durgapur, Dhanbad and Bhadravati in India, Pittsburgh in USA, Magnitogorsk in Russia and Birmingham in UK are dominated by large steel plants. Such iron and steel

producing towns are generally located near the coal fields. For the manufacturing towns, as collecting centres, transportation is very important for the transport of raw materials and the finished goods. These days such towns are generally set up on lines of communication. In manufacturing towns, there is a segregation of houses and establishments; the officer"s quarters may be grouped at one place and that of the labourers at the other (https://rasfreenotes.in/prelims-notes/indian-geography/functional-classification-of-urban-settlements-problems-of-human-settlement-in-india/).

(6) Residential Towns: - In some towns, the chief function is simply to house a concentration of population. In such areas, most of the land is devoted to houses, parks and hospitals. These towns are very- well-connected with the major cities, which enables the commuters to get to work each day. Example – all suburbs of major cities of the world (https://rasfreenotes.in/prelims-notes/indian-geography/functional-classification-of-urban-settlements-problems-of-human-settlement-in-india/).

(7) Recreational / Resorts Towns: - The urban places which cater to the recreation needs of people are known as resorts or recreation towns. These urban places may be based on health-giving water (hot springs), seaside recreation, mountain climbing, cultural attractions, historical monuments, sports facilities, national parks and attractive scenery. Resorts and recreational towns have many hotels to accommodate visitors, and also provide sporting facilities such as golf courses, swimming pools, trekking and skiing. Moreover, they have numerous entertainment facilities, such as theatres, cinemas, and night clubs and children parks. There are numerous examples of recreational or resort towns i.e. Ooty, Manali, Bern, Athens, Florence, Venice, Jaipur, Agra, Pattaya, Ho Chi Minh, Vienna, Denpasar, Barcelona, Las Vegas etc.

(8) Transfer and Distribution Towns: - The main functions performed at transfer centres are the trade, commerce and services. Towns which are concerned with the transfer and distribution of goods, however, have trade as their major function. They include several types of towns. For example, market towns, sea ports and financial towns. Market towns are characterized by markets, a wide range of shops, stores, warehouses, godowns, cold storages and wholesale markets. Market towns also have banks, insurance companies and other financial organizations. Kanpur, Ahmedabad, Vadodara, Indore, Bhopal, Patna, Lucknow, Ludhiana and Hapur in India, Norwich in England, Alexandria in Egypt, and Kumasi in Ghana are some of the examples of such towns (https://rasfreenotes.in/prelims-notes/indian-geography/functional-classification-of-urban-settlements-problems-of-human-settlement-in-india/).

(9) Tourist towns: -Nainital, Mussoorie, Shimla, Pachmarhi, Jodhpur, Jaisalmer, Udagamandalam (Ooty), Mount Abu are some of the tourist destinations. The cities are not static in their function. The functions change due to their dynamic nature. Even specialised cities, as they grow into metropolises become multifunctional wherein industry, business, administration, transport, etc., become important. The functions get so intertwined that the city cannot be categorised in a particular functional class (https://www.scribd.com/document/231393485/News-Prepation).

Major Problems of Urban Settlement

Urban Sprawl, Overcrowding, Slums and Squatter Settlements, Chronic Problems & Seweage problem

UNIT: - 7
MAJOR ECONOMIC ACTIVITIES- PRIMARY, SECONDARY AND TERTIARY

INTRODUCTION

The ascendancy of service output for the 20th century and its growing share in total activity is as important an economic development as the industrial revolution and the growing share of manufacturing were for the preceding two centuries. The transition from preponderantly agricultural to industrial economies involved much economic, social and cultural stress within and among nations; it would be naive for our age to expect a smooth transition to the service economies in this and the next century. Many economic problems of our times are apparently related to the sectoral structural shifts in modern economies and therefore this topic deserves intensified study. In particular we should understand better the input-output relationships of the key sectors; the economic inefficiencies that may be related to sectoral structural adjustment problems; and the challenges to economic thinking posed by this major transformation of the world economy (https://www.coursehero.com/file/33360078/359pdf/).

People engaged in different sectors for their livelihood, the sectors in which maximum number of people working are primary, secondary and tertiary sectors. Primary sector includes those activities which lead to the production of goods by utilization of natural resources, secondary sector includes those activities which results in transformation of natural products into other forms by manufacturing. Tertiary sector includes those activities that help in the development of the primary and secondary sectors by supplying the production process. Tertiary sector is a technical name of service sector of the economy, which encompasses a wide range of business including businesses, financial institution, school, hotels and restaurants (https://www.coursehero.com/file/33360078/359pdf/).

Classification of economic activities

In terms of the national economy, a basic classification of economic sectors, broken into four basic sectors is used (https://www.slideshare.net/MijanurRahman80/introduction-to-economic-geography):

1. Primary Sector (Raw Materials)

2. Secondary Sector (Manufacturing and Industry)

3. Tertiary Sector (Service Sector)

4. Quaternary Sector (Knowledge Sector)

5. Quinary Sector (Decision Making Sector)

A. Primary Sector:

Simply speaking primary sector refers to that sector of the economy which uses natural resource to produce goods. Natural factors play crucial role in the production process.

Agriculture and allied activities like mining, fishery, forestry, dairy and poultry are included in this sector. Primary sector dominates in underdeveloped countries.

Features of Primary Economic Activity

i. Primary economic activity involves taking natural resources from the land or the sea.

ii. Primary economic sectors are-

i. Farming
ii. Fishing
iii. Forestry
iv. Mining
v. Quarrying

iii. In developing countries, most people (75% average) work in primary sectors.

iv. In developed countries, very few people (10% average) work in primary sectors.

v. Natural sources can be 2 types

a. Renewable resources (resources that can be used over and over again. With careful management, they will not run out)

b. Non-renewable resources (can only be used once. Each time such resources are used less of that resource is left for the future. Nonrenewable resources will eventually run out)

vi. People who are involved in primary economic activity is called red collar worker. vii. Frequency of primary economic activity indicates the initial stage of economic development of a country.

viii. It has a great role in earning foreign remittance.

Role and Importance of Primary Sector

In the primary sector agriculture is the predominance occupation and has the largest share in national income. So let us concentrate on the role and importance of agriculture in the Indian economy in terms of its share in the national income, providing employment food and raw materials. Let us take them one by one (Lipsey & Chrystal, 2011).

1. Share in National income: - At the time of independence agriculture was contributing more than 50 percent to national income. In recent years its share has come down. In 2009-10 agriculture contributed around 15 percent to national income.

2. Providing employment to largest section of population: - Agriculture is the mainstay of Indian economy. It is the occupation of the largest section of India's population. At the time of independence about 70 percent of our population depended on agriculture and allied activities to earn their livelihood. With development of manufacturing and service sector dependency on

agriculture has slightly reduced. About 50 percent of India's population was working in agriculture in the year 2009-10.

3. Providing Food to Millions: - Food is the most basic requirement of life. Without agriculture food production and supply would be non-existent. India's food requirement is not only very high but also increasing every year because of increase in its population. The total food grain production of India in 2008-9 was around 234 million tonnes. This includes wheat, rice and pulses.

4. Providing raw materials to industries: - Industries such as sugar, jute, cotton textiles, vanaspati etc. get their raw materials from agriculture. Do you know how paper is made? It requires a special type of grass, bamboo etc. Without agriculture paper production is not possible. Look at the food processing industry which is supplying so many different varieties of packed food items such as pickles, fruit jam, juice, biscuits, bread, semi –prepared food etc. Food processing industry is operating because of agriculture only (http://docplayer.net/45915177-Sectoral-aspects-of-indian-economy.html).

B. Secondary Sector

Secondary sector is also called as manufacturing sector or industrial sector. The primary sector cannot satisfy all human requirements. We need certain industrial goods to make our lives comfortable. The sector which transforms one physical good into another is called secondary sector. The manufacturing, electricity, gas, water supply etc. are included in this sector (https://www.slideshare.net/MijanurRahman80/introduction-to-economic-geography).

Features of Secondary Economic Activity:

i. The secondary sector involves the transformation of raw materials into goods.

ii. Secondary activity is mainly associated with manufacturing and industry.

iii. Example of secondary sectors are- textile, leather industry, ceramic industry, cash crop industry etc.

iv. In developing countries, very few people (5% average) work in secondary sectors.

v. In developed countries, moderate number people (25% average) work in secondary sectors.

vi. It includes the processing of raw materials.

vii. Secondary activity ultimately leads to industrialization.

viii. Frequency of secondary activity indicates the median period of economic development in a state.

ix. When an economy moves into the second sector, new farm techniques are used, and industrialization changed how goods can be transformed, distributed and sold.

x. It has a great role in earning foreign remittance.

Role and Importance of Secondary Sector

In the secondary sector manufacturing industries form the major part. These industries are categorized into small scale industry and large industry. What is a small scale industry? An industry which can be established by spending a minimum of Rs. 25 lakh on plants and machinery is called a small scale industry. These industries mostly use labour-intensive technology. i.e. production process of these industries use more labour force. Large scale industry, on the other hand needs huge amount of investment in the form of plant and machinery. It is also physically spread over many acres of land and employs large number of people. It also uses capital intensive technology in the form of big machines. Take for example an iron and steel plant. The Tata Iron and steel plant is the oldest in the country. It is situated in Jamshedpur over an area of about 37.31 km. square of land. The importance of Industrial sector, both small and large, has been increasing after independence. Let us discuss them one by one (https://singhaniauniversity.co.in/bse/images/syllabus/d1a73d3f69463d5b221d9f9bbf3274f1.pdf).

(1) Share in national income: - The contribution of industrial sector has been increasing slowly over time after independence. In 2009-10 the share of this sector was 28 percent in India's domestic product. At the time of independence it was only 14 percent. The increase is due to increase in number of manufacturing units and increase in industrial production.

(2) Employment generation: - Industrial sector has also largely contributed to providing employment opportunities to India's population. Nearly 3 crores 30 lakhs people are engaged in both small and large scale industries combined. Out of this small industries provide nearly 3 crore 12 lakh jobs.

(3) Creation of Infrastructure: - Today it has become easier to travel to distant places because of existence of roads, highways, railways, airways. Think of the big Dam projects such as Hirakud and Bhakra-Nangal which provide electricity and irrigation. Look at the big buildings which accommodate offices, shopping centers, factories, institutions etc. and provide residences. Also see the Radio and Telephone towers which facilitate communication. These are all part of infrastructure. You can imagine, how impossible will it be to live without these facilities today? Infrastructure building is possible because of contribution of large scale industries which make the machinery and equipments needed build infrastructure.

(4) Provision of consumer goods: - The clothes you wear, the pen, the tooth brush, soap, shoes, cycle, scooter, car etc. you use are produced by manufacturing industries. Today the market is flooded with many goods of your choice. This is possible because of industrialization.

C. Tertiary Sector

The service sector of the economy is called tertiary sector. Services of various kinds like education, health, banking, insurance, trade and transport are included in this sector. In advanced countries, the contribution of tertiary sector to national income is the highest (https://www.slideshare.net/MijanurRahman80/introduction-to-economic-geography).

Features of Tertiary Economic Activity

i. The tertiary sector involves the supplying of services to consumers and businesses.

ii. This sector provides services to the general population and businesses, including retail, sales, transportation and restaurants.

iii. The types of workers in this sector include restaurant bartenders, accountants, pilots etc.

iv. Frequency of tertiary activity indicates the matured period of economic development in a state.

v. In developing countries, few people (10% average) work in tertiary sectors.

vi. In developed countries, most people (65% average) work in tertiary sectors.

vii. The tertiary sector indicates a competition in international business sector.

Role and Importance of Service Sector

Service sector of India has been expanding and growing very fast. Look around and you will see that number of trains carrying people as well as goods have increased significantly. You also find so many buses, cars and trucks moving on the roads from one place to another. This means that the transport services have grown over time. More number of people are having telephones including mobile phones. More number of schools have been built in the country to provide education. The number of study centres under open schooling has increased so that more students can be benefitted. You can also find hospitals; health centresetc. are providing health services to people. Banks have also opened their branches so that people can open their account, withdraw money they want and take loans to purchase house, car, scooter etc. There are hotels and restaurants in almost all public places to provide food to people. These are examples of different types of services. It is difficult to think life in the economy without services. Hence it is important to know the role and importance of service sector which we will discuss below under the following heads (https://singhaniauniversity.co.in/bse/images/syllabus/d1a73d3f69463d5b221d9f9bbf3274f1.pdf).

(i) Contribution of service sector to National income.
(ii) Contribution of service sector in providing employment
(iii) Attracting funds from foreign countries.
(iv) Contribution of service sector in Exports.

(i) Contribution to National Income: - Among all the three sectors i.e. agriculture, industry and service, it is the service sector that has contributed maximum to the national income of India. If India's income is 100, then service sector contributed 55.20 in the year 2009-10 which is more than half of the total.

(ii) Contribution to Employment: - Now a days more and more people are getting employment in service sector. Out of total employment level in the country, this sector has

absorbed 29.4 percent of them in 2009-10. In times to come this figure is going to increase further. The main reason is that the number of educated people in India is increasing every year. They belong to various fields such as matriculates, graduates in arts, commerce, science, engineering, medicine and other professional and vocational streams. Service sector needs these people. In terms of wages and salaries, service sector, pays more than that of agricultural sector. Compared to agriculture, service sector provides more job opportunities. There is existence of large varieties of services which are provided round the year. But there are some seasonal activities in agriculture. So as people become more educated they move to service sector. So employment in service sector is increasing.

(iii) Attracting Funds from Foreign Countries: -Looking at the growth of service sector of India people from foreign countries are showing more interest to invest money in this sector to earn profit. Banking, insurance, trade, transport, hotel services combined have attracted more than 1lac 18 thousand crores rupees from foreign countries in the form of direct investment. Recently computer service has grown many fold in India. This has attracted more than forty seven thousand crores of rupees from foreign countries. If investments are made then more job opportunities are created. This is advantageous for the nation.

(iv) Contribution of Service Sector to Exports: -Exporting means selling goods and services to citizens in foreign countries to earn foreign exchange in the form of dollar, euro, yen, pound etc. In recent years India's service sector has contributed a lot in earning foreign exchange for the country through exports. Our business services which include – IT, consultancy, legal services, etc. have become world standard.

D. Quaternary Sector

The quaternary sector of the economy is a way to describe a knowledge-based part of the economy, which typically includes services such as information technology, information-generation and -sharing, media, and research and development, as well as knowledge-based services like consultation, education, financial planning, blogging, and designing.

Features of Quaternary Economic Activity

i. It is a knowledge based sectors.

ii. Computing knowledge, ICT expertise, scientific research etc. are included in this sector.

iii. The developing countries have almost 1 or less than 1 percentile of this sector.

iv. The developed countries have a notable percentage of quaternary sectors.

v. It indicates a permanent stability and richness of economy of a country.

vi. Decision making and planning activities are enhanced in this sector.

vii. The development of this sector leads to quinary economic activity which is based on decision making actions.

E. Quinary

Sector Some consider there to be a branch of the quaternary sector called the quinary sector, which includes the highest levels of decision making in a society or economy. This sector would include the top executives or officials in such fields as government, science, universities, nonprofit, healthcare, culture, and the media (https://www.slideshare.net/MijanurRahman80/introduction-to-economic-geography).

Linkages among the Three Sectors of the Economy

All the three sectors are interlinked. In fact they complement and supplement each other. We give you the following story to understand it.

Hari Singh is a farmer who cultivates wheat on his agricultural land in the village Rampur. Last year he had a good harvest due to good rain fall. So he could sell 10 quintals of wheat in the local mandi and keep another 10 quintals for his household consumption. This year there is no proper rainfall. The area is also having no irrigation facility. Then how to provide water to the wheat crop? Hari Singh decided to lift ground water. But for this he needs a diesel pump set. Who will provide a diesel pump set? It is produced by a manufacturing unit called Ravi manufacturers which is situated 200km away in an industrial area called Karim Nagar. Now going to such distant place is a difficult task. Ganga Singh, a friend of Hari Singh told that there is no need to worry. He took Hari Singh to the nearest township market called Shiv Mandi. In the market complex there is a shop called Pappu Hardware Store run by Ganga's brother-in-law named Pappu who sells pump sets. When Hari Singh asked for the pump set Pappu told him to wait for two hours because the truck carrying 50 Ravi pump sets and some spare parts for tractors from Karim Nagar would reach his shop by that time. Pappu also talked to Ravi Khetrapal, who is the owner of Ravi pumps, over his mobile phone to confirm this. In the meantime Ganga and Hari took tea and snacks in the tea stall, went to enquire about admission into primary schooling for Hari's little daughter and brought medicines from the health center for Ganga's son who was having fever at home. After two hours when they came back to Pappu's shop they saw labourers unloading the pump sets. Pappu told them that he had ordered 50 pumps from the factory in Karim Nagar. The truck would deliver the spare parts to another shop in the same market place which sells auto and tractor parts (https://singhaniauniversity.co.in/bse/images/syllabus/d1a73d3f69463d5b221d9f9bbf3274f1.pdf).

Hari saw that Pappu gave a cheque of Rs.100, 000 to the truck driver who received it on behalf of Ravi Khetrapal. "Since the amount is big, it is not safe to give cash. Cheque is a better option. Mr. Khetrapal can deposit the cheque in his bank account to get the money" Pappu said. He further said that this payment was made to settle some earlier dues. The payment for pumps would be made after he sells the pumps to the customers in the similar way. Hari Singh paid Rs. 7000 to Pappu and bought one pump set. "Due to bad monsoon this year pump sets are in great demand and will be sold quickly" said Pappu confidently. "What about the truck now?" asked Hari while returning back to village with Ganga Singh. "The truck will now carry wheat

and vegetables from the mandi which would be sold to households in the Karim Nagar industrial area and township" replied Ganga.

From the story above you can easily establish the link between the agriculture, industry and service sectors. Like Hari Singh there are many farmers in the agricultural sector who need diesel pumps to irrigate their land. Besides pumps there are many other inputs such as fertilizer, pesticides, plough, tractor etc. are required for cultivation. These things are supplied by industry in the same way as the pump in the story. In return people working in industries and services get food supplied by the agricultural sector in the same way as Hari Singh had sold his surplus wheat in the mandi. What is role of service sector then? Its role is to facilitate and ensure these transactions between agriculture and industry. In the story the truck carrying pumps and spare parts from Karim Nagar to Shiv Mandi and food items on its journey back is a part of transport service. Use of mobile phone to keep track of the order aspart of communication services. Cheque deposit in the bank is part of financial service. Pappu's shop provides business service of delivering the good. Note that all these activities are duly backed and supported by money flow. Here in the story Hari Singh sold wheat and got money. He used the money to buy a pump. Pappu got money from Hari and paid it back to supplier of pumps after keeping his profit. After receiving the money the pump supplier will pay the truck driver his due and give wages to people in the factory. These people will use the money to buy food in the local market transported by the truck from mandi (https://www.slideshare.net/MijanurRahman80/introduction-to-economic-geography).

TYPES OF AGRICULTURE

INTRODUCTION

Agriculture is the most comprehensive word used to denote the many ways in which crop plants and domestic animals sustain the global human population by providing food and other products. The English word agriculture derives from the Latin ager (field) and colo (cultivate) signifying, when combined, the Latin agricultura: field or land tillage. But the word has come to subsume a very wide spectrum of activities that are integral to agriculture and have their own descriptive terms, such as cultivation, domestication, horticulture, arboriculture, and vegeculture, as well as forms of livestock management such as mixed crop-livestock farming, pastoralism, and transhumance. Also agriculture is frequently qualified by words such as incipient, proto, shifting, extensive, and intensive, the precise meaning of which is not selfevident. Many different attributes are used too to define particular forms of agriculture, such as soil type, frequency of cultivation, and principal crops or animals. The term agriculture is occasionally restricted to crop cultivation excluding the raising of domestic animals, although it usually implies both activities. The Oxford English Dictionary (1971) defines agriculture very broadly as "The science and art of cultivating the soil, including the allied pursuits of gathering in the crops and rearing live stock (sic); tillage, husbandry, farming (in the widest sense)." In this entry, we too use the term in its broadest, inclusive sense (Harris & Fuller, 2014).

In the published literature on early agriculture, there is a tendency for the word agriculture and many of its subsidiary terms to be used vaguely without precise definition, and sometimes their connotations overlap, for example, proto/incipient and shifting/extensive. There is need to clarify much agricultural terminology to avoid confusion, particularly because the multidisciplinary nature of research on the subject leads to many concepts being used that derive from disparate disciplines; principally archaeology, anthropology, biogeography, genetics, linguistics, and taxonomy. In this entry, we cannot review comprehensively all the typological terms currently used in discussions of the origins and early development of agriculture. Instead we focus on the two most fundamental processes that led to agriculture, cultivation and domestication (of plants and animals), and then comment on some of the terms used to denote particular categories of agricultural production. In conclusion, we return to agriculture itself as a process of landscape-scale food production (http://www.lokayan.com/2021/03/ncert-book-geography.html).

Primary activities include all those connected with extraction and production of natural resources. Agriculture, fishing and gathering are good examples. Secondary activities are concerned with the processing of these resources. Manufacturing of steel, baking of bread and weaving of cloth are examples of this activity. Tertiary activities provide support to the primary and secondary sectors through services. Transport, trade, banking, insurance and advertising are examples of tertiary activities. Agriculture is a primary activity. It includes growing crops, fruits, vegetables, flowers and rearing of livestock. In the world, 50 per cent of persons are engaged in agricultural activity. Two-thirds of India's population is still dependent on agriculture. Favourable topography of soil and climate are vital for agricultural activity. The

land on which the crops are grown is known as arable land (Fig. 4.1). In the map you can see that agricultural activity is concentrated in those regions of the world where suitable factors for the growing of crops exist (Harris & Fuller, 2014).

Definition of Agriculture

The term Agriculture is derived from two Latin words ager or agri meaning soil and cultura or Cultus meaning cultivation. Agriculture is an applied science which encompasses all aspects of crop production including horticulture, livestock rearing, fisheries, forestry, etc.

Agriculture is defined as an art, science and business of producing crops and livestock for economic purposes. As an art:- It embraces knowledge of the way to perform the operations of the farm in a skilfulmanner, but does not necessarily include an understanding of the principles underlying the farm practices. As a science: Utilizes all technologies developed on scientific principles such as crop breeding, production techniques, crop protection, economics etc. to maximize the yield and profit. For example, new crops and varieties developed by hybridization, Transgenic crop varieties resistant to pests and diseases, hybrids in each crop, high fertilizer responsive varieties, water management, herbicides to control weeds, use of bio-control agents to combat pest and diseases etc. As the business: As long as agriculture is the way of life of the rural population production isultimately bound to consumption. But agriculture as a business aims at maximum net return through the management of land labour, water and capital, employing the knowledge of various sciences for production of food, feed, fibre and fuel. In recent years, agriculture is commercialized to run as a business through mechanization.

Agriculture is defined in the Agriculture act (1947), as including 'horticulture, fruit growing, seed growing, dairy farming and livestock breeding and keeping, the use of land as grazing land, meadow land, osier land, market gardens and nursery grounds, and the use of land for woodlands where that use ancillary to the farming of land for Agricultural purposes" (http://www.hrsacademy.in/wp-content/uploads/2017/02/Principles-of-Agronomy-and-Agricultural-Meteorology.pdf).

Branches of Agriculture

1. Agronomy 2. Horticulture 3. Animal husbandry 4. Forestry 5. Fishery science 6. Agricultural Engineering and 7. Home science.

1. Agronomy word drive from two Greek word "Agros" means field and "Nomos" means to manage. It is defined as an agricultural science deals with principles and practices of crop production and field management.

2. Horticulture word drive from two Latin word "Hortus" means garden and "Cultura/ Cultus" means cultivation. Horticulture is a branch of agriculture in which deal fruit crops, vegetable crops, ornamental plants, commercial flower, medicinal crops, aromatic crops, spices crops, plantation crops, individual tree, shrub, climber and post-harvest management and processing.

3. Animal husbandry word drive from “Animal” and “Husband” words. Animal means livestock and husband means one who takes care. Animal husbandry is the branch of agriculture concerned with animals that are raised for meat, fibre, milk, eggs, or other products. It includes day-to-day care, selective breeding, and the raising of livestock.

4. Forestry: - Forestry word drive from French “Forest” word means wooded country. Forestry is defined as the theory and practice of all that constitutes the creation, conservation and scientific management of forests and the utilization of their resources (Anon, 1966). It includes all thinking and all actions pertaining to creation and management of forests, including harvesting, marketing and utilization of all forest products and services. It includes not only management of existing forests but also the creation of new forests.

5. Fishery science: - Aquatic and fisheries science is the study of aquatic ecosystems to increase scientific understanding and to apply basic ecological principles to their management, thereby sustaining them for multiple uses.

6. Agricultural Engineering:- It is the branch of engineering involved with the design of farm machinery, with soil management, land development, and mechanization and automation of livestock farming, and with the efficient planting, harvesting, storage, and processing of farm commodities.

7. Home Science:- Home Science can be defined as the multidisciplinary field of study that deals with health, diet, caring child, textile and garment designing, managing resources and other subjects concerned with a home.

8. Apiculture:-Apiculture word drive from two Latin words. - It is a branch of agriculture in which deal study of bee keeping and honey production.

9. Sericulture:- Sericulture word drive from two Latin words. It is a branch of agriculture in which deal study of Silkworm (Bombyxmori) domestication and silk production.

10. Lac Culture:- The English word lac synonyms Lakh in Hindi which itself is derivative of Sanskrit word Laksh meaning a lakh or hundred thousand. It would appear that Vedic people knew that the lac is obtained from numerous insects and must also know the biological and commercial aspects of lac industry. It is also worth to mention that a lakshgriha would need a lot of lac which could only come from a flourishing lac industry in that period. It is a branch of agriculture in which deal study of Lac insect (Lacciferlacca) domestication and lac production (Svetlov et. al 2019).

Types of Agriculture

Imagine a family farm on a small plot of land and a huge commercial farm that spans acres and acres of land. What do you think makes these two types of farms different? Although both of these farms are designed to produce food, they vary in the methods of production, the amount of food they produce and who consumes the food produced.

Although for most of human history our species has survived by hunting and gathering food, around 10,000 years ago, our ancestors started producing their own food. Agriculture is the term used to describe the act of growing crops and raising livestock for human consumption and use. Since the development of agriculture, many different types of production have been implemented. Currently, agriculture is divided into two different types, including industrialized agriculture and subsistence agriculture (http://www.uzoma.waphall.com/agriculture/types-of-agriculture).

Whittlesey's World Agricultural Systems

Agriculture is the most fundamental form of human activity. It constitutes both the cultivation of crops and domestication of animals. Thus the land on which agriculture is practiced is the most fundamental of the world's resources as it fulfills man's basic needs of food, clothing and shelter. The evolution process of man indicates that initially human beings were food gatherers and over the time they started cultivating. In the process, animals were tamed, first as a source of meat and milk and later as draught animals. Men were now able to live in permanent settlements and had time to develop various arts and skills. With more scientific and technological developments mechanization of farms took place and resulted in surplus production. As a result different agricultural systems or regions developed in different parts of the world.

Agricultural system or region is an area or region with similar agricultural functional attributes; it may be a single farm or a group of interrelated farms having similarities of agricultural characteristics. To classify world into different agricultural regions is not an easy task as the pattern of agricultural activities practiced around the world is very complex. If one tries to classify according to climatic types than there is the possibility of duplication of farming activities. If classification is based on the types of crops cultivated or animals domesticated than one tends to ignore the methods used in different agricultural regions. One such attempt was made by DerwentWhittlesey in 1936. He defined agricultural region as an uninterrupted area having some kind of homogeneity with a specifically defined outer limit (1936). He wrote an article on major agricultural regions of the Earth which was published in the Annals of Association of American Geographers (vol.26: 199-240) in 1936 itself.

Whittlesey World Agricultural Systems/Region: Whittlesey in his monumental paper delineated the agricultural systems of the earth on the basis of the five characteristics of agriculture. These are — (a) crop and livestock combination (b) the intensity of land use (c) processing and marketing of farm produce (d) the level of mechanism, and (e) types and relations of the building and other structures associated with agriculture (Whittlesey, 1936).

He identified thirteen types of agricultural occupance of land over the Earth and also marked their distribution on the map. These are — 1. Nomadic herding 2. Livestock ranching 3. Shifting cultivation 4. Rudimentary tillage 5. Intensive subsistence tillage (with paddy dominance) 6. Intensive subsistence tillage (without paddy dominance) 7. Commercial plantation 8. Mediterranean agriculture 9. Commercial grain farming 10. Commercial livestock and crop farming 11. Subsistence crop and livestock farming. 12. Commercial dairy farming 13. Specialized horticulture.

1. Nomadic Herding: This is a type of extensive farming where animals graze on natural pasture land. This type of activity requires constant seasonal migration of the nomads with their cattle. Nomadic herding is confined to sparsely populated parts of the world where the natural vegetation is mainly grass. This activity can be called the aboriginal form of livestock ranching. It is found in areas which are very dry to produce crops, but not completely wasted desert. Availability of water and presence of natural grassland decides the location of this activity and in most case the first element that is availability of water; dominates. Ways are very similar across the world, but intensities, care in reproduction and consequently vary widely. Where animals or their products are sold, the methods in this farming are of progressive nature and where the products provide only subsistence, the methods are traditional in nature (https://www.tandfonline.com/doi/abs/10.1080/00045603609357154).

Location: No reliable data exists for demarcating the Nomadic Herding regions. A general view is that it is spread over large areas in Saharan Africa (Sudan, Libya, Algeria, Mauritania, Mali, Niger, Chad,), the south-western central parts of Asia, some parts of Scandinavian countries (Norway, Sweden, Finland) and northern Canada.

Characteristics

(a) Nomadic herding ism ecological or rear ecological systems of agriculture It is derived mainly to produce food for the family to fulfill the daily needs of clothing shelter recreation.

(b) It is a declining type of agriculture.

(c) The main characteristic is the migration of nomads with their livestock in search of forage for the animals.

(d) The Bedouin of Saudi Arabia, the tauregs of the Sahara also practice nomadic herding in the desert and semi desert areas of North Africa and South West Asia.

(e) Therefore, the chief components of nomadic herding are (https://www.tandfonline.com/doi/abs/10.1080/00045603609357154)

- Seasonal pattern of movement.
- Various types of animals are grazed and
- Transhumance

2. Livestock Ranching

The extensive temperate grasslands - once known either for their nomadic herdsmen or by hunters - are now permanent grounds of ranches, where large numbers of cattle, sheep, goats, horses are reared. Everywhere livestock has been established by the ancestors of the European sedentary people in the drier parts of the country. There traditional way of beliefs, habits, behavior has been carried along to the humid areas with them. There are several temporary exceptions where they have modified themselves with accordance to the harsh and insensitive environment of their adopted land. Example can be cited of South Africa's boar, the pioneerswere forced to convert into nomadic herders but with developments in the

transportation they became more comfortable with their original culture (https://old.amu.ac.in/emp/studym/100018929.pdf).

The livestock ranching is a semi-sedentary and extensive type of activity where the cowboy or the rancher is a business operator. He usually works on a large scale and takes good care of the cattle. Usually animal and the product on which it specializes vary from region to region. Cattle, sheep and goats are the most common draught animals (https://www.studocu.com/in/document/jamia-millia-islamia/paper-ix-economic-and-resource-geography/whittlesey-classification/8398076).

Location: Livestock ranching regions are located in North America, Australia, the Republic of South Africa, Brazil, Argentina, Peru and New Zealand (https://www.uou.ac.in/sites/default/files/slm/GE-302.pdf).

Characteristics

The important characteristics of livestock ranching are - (a) specializes in animal husbandry (rearing) to the exclusion of crop raising in both arid and semi-arid region. (b) The ranchers have fixed place of residence and operate as individuals rather than in associations. (c) Ranching differs from nomadic herding as (http://bhattercollege.ac.in/E_Learning/Geography/Agriculture_Geography_6th_Sem_02_05_2020.pdf)

- The vegetation cover is continuous.
- There is little or no migration.
- Ranches are scientifically managed.
- The animal's are raised for sale.
- Commercial grazing supports the development of town.

3. Shifting Cultivation

Shifting cultivation essentially is a land rotation system which is mainly concentrated in the humid low latitudes (rain forests and its fringe areas). The harsh climatic conditions in this region, forces the primitive people to move their farmed plots every few years, usually from one to three years. Although it differs from region to region as it depends on local conditions. As it is practiced by different people it has many different names, e.g. milpa in Central America, conuco in Venezuela, roca in Brazil, masole in Zaire, ladang in Malaysia, humah in Indonesia, caingin in the Philippines, taungya in Myanmar, tamrai in Thailand, poda in India and chena in Sri Lanka (https://www.tandfonline.com/doi/abs/10.1080/00045603609357154).

Location: Shifting cultivation is primarily located in the tropical rainforests and tropical lowland hills in Central America, Africa, and Southeast Asia. In Africa it is also found on the outer margins of the rain forests as tsetse – an enemy of animal husbandry- is found in abundant there.

Characteristics

(a) Sites for shifting cultivation are usually selected in the virgin forest by the elderly members of the community.

(b) The forests are cleared by fire and the ashes are used as manure. Trees that are not cut are left to rot naturally. This method is prominently called “Slash and Burn agriculture”.

(c) The fields are usually small in size ranging from 0.5 to 1 hectare. They are widely spread in the forest and are separated from one another either by a dense bush or by a stretch of forest covers.

(d) Primitive tools like hoe, sickle and sticks are used for cultivation.

(e) Starchy foods like tapioca, yams, maize, millet, beans, upland rice and bananas are the common crops raised.

(f) Short period of crop cultivation is alternated with long duration of fallowing. Therefore, in this type field rotation is practiced rather than crop rotation.

(g) This type of cultivation is mainly practiced by aboriginal tribes of the tropical rain forest region.

4. Rudimentary Sedentary Tillage

This is a more advanced type of subsistence agriculture that is found in the tropical lowlands. In this type of a system fallow fields are frequently reused and the communities engaged in this type of crop cultivation usually stay in one place permanently. The common methods practiced are crop rotation, intensive tillage, use of crude implements and greater use of manpower (https://reliablebooks.in/content/Reliable%20OTBA%20Economics%20XI%20SA%20II%202014.pdf).

Location: This type of agricultural activity occurs in Southeast Asia (Indonesia, Malaysia, and the Philippines), Sri Lanka, West Africa, South and Central America and Central America.

Characteristics

(a) Crop rotation occurs most rather than field rotation.

(b) Potatoes, Sweet potatoes, Maize, Sorghum, Banana etc are grown.

(c) This type of agriculture is often combined with the cultivation of cash crops like cacao, oilpalm, cocopalm, rubber, peanut and cotton.

5. Intensive Subsistence Tillage (with paddy dominance)

Intensive subsistence tillage is confined to the Asian monsoon region, South and East Asia and adjacent islands which is wet in nature. There is another pair of agricultural form, which is very different from all the rest, but the crop is different from each other with the presence or absence of rice in the association. Where the season is very long to mature rice, the excessive intensive farming system supports the dense rural population found in large areas anywhere on Earth.

Although three types of crops are associated with three types of fields, the key to this land occupation is irrigable delta, floodplains, coastal plains and roofs imposed on rice. Two crops are collected in a year where the climate is hot or where the water is less or there is interference in cold weather. Rice produces more grain per acre than any other crop (https://reliablebooks.in/content/Reliable%20OTBA%20Economics%20XI%20SA%20II%202014.pdf).

Location: Intensive subsistence tillage dominated by paddy is practiced mostly in the tropical Asia. It is carried on mainly in China, Japan, India, Bangladesh, Myanmar, Thailand, Srilanka, Malaysia, Philippines etc.

Characteristics

(a) Farming is in intensive nature and double cropping is practiced. In which more than one crop is grown on the same land during a plantation season.

(b) Paddy is the only crop that can be raised in this type of farming. While other food or cash crop such as sugar, tobacco, oil seeds, or fiber crop like jute are raised normally in the dry season.

(c) Asian farmer are now producing even greater yields per acre because of the recent introduction of improved varieties of hybrid rice.

(d) Hand labour is predominant.

(e) Animal husbandry is little developed as the entire focus is on the cultivation of rice.

(f) Animal and plant manures are used liberally.

6. Intensive Subsistence Tillage (without paddy dominance)

In areas where the neighboring country is called rice country, the crop is deprived of the lack of moisture or lack of weather, and during the year a good deal is out of service. These hurdles revise the agricultural machinery in a subtle but profound manner. For the main rice, many bowls of cereal are replaced; none of these are productive of cereals. The climatic condition makes paddy cultivation impracticable leading to inland farms where the drainage basins in the form of delta, floodplains and coastal regions are absent or short. Irrigation is practiced wherever possible even if on a small scale (https://www.tandfonline.com/doi/abs/10.1080/00045603609357154).

Location: It includes interior India, North-East China, North Korea, Northern Japan and parts of continental South – East Asia.

Characteristics

(a) The land is intensively used and worked primarily by human power.

(b) Farming in these regions suffers from frequent crop failures and famines.

(c) Wheat, Soya bean, Barley, Kaoliang is grown.

(d) Irrigation is often employed as there is lack of moisture.

7. Commercial Plantation

The specialized commercial cultivation of cash crops like tea, rubber, coffee, oil palm, cocoa, cotton, sugarcane, pineapples and bananas on estates or a plantation is a unique type of tropical agriculture. This type of agriculture was initialized by the Europeans in their colonies. The term plantation agriculture was originally applied specifically to the British settlements in America than to any Intra estate in North America, west India, southeast Asia which was cultivated mainly by Negro or other colored labor (https://www.studocu.com/in/document/jamia-millia-islamia/paper-ix-economic-and-resource-geography/whittlesey-classification/8398076).

Location: Commercial plantation is found in different parts of the world though it is concentrated in the tropical regions of Asia and Africa and in the tropical and sub-tropical regions of America.

Characteristics

(a) In plantation farming a land holding is developed for the specialized production of one tropical or subtropical crop mainly for commercial purpose.

(b) Climatic hazards' like strong winds, prevalence of diseases, deterioration of soil often handicap or may even prevent the development and establishment of the plantation.

(c) The plantation estates are generally large and are found mainly in the thinly populated areas. The size of farm varies from 40 hectares in Malaya India, to 60000 hectares in Liberia.

(d) The labour is generally disciplined but unskilled and in huge numbers.

(e) The characteristics features of commercial plantation are - (a) Estate farming. (b) Foreign ownership and local labor. (c) Scientifically managed farming in the estates (d) Heavy capital outlay (https://old.amu.ac.in/emp/studym/100018929.pdf).

8. Mediterranean Agriculture

Within the Mediterranean climatic region where there is winter rain and summer drought a distinctive type of agriculture has evolved. This is said to be the most satisfactory type of agriculture as it represents the stable ancient relationship that existed between man and land. Here both subsistence and cash crops are grown although the emphasis on different crops varies with the amount of rainfall received. The methods used also differ from region to region for example in Italy little land labour is used while in California most of the work is done by hand. The business here is intensive. Horticulture is well developed giving high returns. The Mediterranean Lands are often termed as the "Orchard Lands of the World" (https://old.amu.ac.in/emp/studym/100018929.pdf).

Location: Mediterranean Agriculture is confined to the coastal parts of the Mediterranean Sea in Europe, Asia Minor and the North African coastal strip. Outside the Mediterranean coastal areas, this typology is concentrated in California (USA), Central Chile, the southeast regions of Cape Province (South Africa) and South-West parts of Western Australia (https://www.proquest.com/docview/2157983667).

Characteristics

(a) The Mediterranean agriculture is governed by factors like length of summer drought, availability of water for irrigation and power supply, local soil conditions, financial aspects and fluctuations in the local, regional and global markets.

(b) These conditions lead to four sub0-types of agriculture in this region – a. Orchard farming – citrus fruits, olives, figs b. Viticulture – Grapes for wine making c. Cereal and Vegetable cultivation – wheat (hard winter type), barley, rice in river plains, green and leafy vegetables, lentils, beans, onions, tomatoes, carrots and sugarbeet d. Limited animal husbandry – goats, sheep, dairy farmingnad fishing (https://old.amu.ac.in/emp/studym/100018929.pdf).

9. Commercial Grain Farming

Commercial grain farming is another market oriented type of agriculture in which farmers specialize in growing wheat. This is recent development (a result of Industrial Revolution) which has occurred in the temperate grasslands of the mid-latitudes. The area used for large scale grain cultivation was previously used either for animal husbandry or for livestock ranching. Some regions were also occupied by the nomadic herders. In such a type of agriculture the balance between crop and stock is standardized. The methods are neither intensive nor traditional rather they are progressive in nature as machinery is used to a large extent (https://old.amu.ac.in/emp/studym/100018929.pdf).

Location: Great wheat belts stretch through the Canadian and American Prairies, Argentinean Pampas, Eurasian Steppes, South African Velds and Australian Downs.

Characteristics

(i) The main characteristics of this systems are-- (a) Big farms in size (b) Comprehensive use of heavy machines (c) Wheat Monoculture (d) Low use of irrigation and fertilizer (d) Low yield per acre but high yield per man (e) Long distance of farm from the market.

(ii) Widespread use of machinery enables commercial grain farmer to operate on this large scale; commercial grain farming is more mechanized than any other form of agriculture.

(iii) Wheat is the main crop; Maize, Barley, oat are another important crops. (iv) The wheat production regions are divided into two belts - (a) Winter wheat belt and (b) Spring wheat belt.

10. Commercial Livestock and Crop Farming

This form of agriculture is often called "mixed cultivation" or ‘mixed farming’. It is one of the three lineages of medieval agriculture in Central Europe, all of which are different

organizations having both crops and animals but in different ratios. It is one of the most developed forms of agriculture mainly found in the most developed parts of the world. Here, the ratio of crop and stock is dependent on factors like location of the farm, fertility of the soil, animal carrying capacity of land, demand of the market, price of crops and animals and government policies (https://lotusarise.com/world-agriculture-typology-of-agricultural-regions-upsc/).

Location: It is found throughout Europe from high land in the West through central Europe to Russia. It is also found in North America at 98o W Meridian, in the Pampas of Argentina, Southeast Australia, Australia, South Africa and New Zealand.

Characteristics

(a) The main characterized of the mixed farming is that in the farms both livestock and the crops are integrated and their ratios standardized.

(b) Mixed farms one characterized by high expenditure on machinery farm building extensive use of machinery arm buildings fertilizers also by the skill experts of farmers who need to know about all aspects of farming to grow market their range of product successfully.

(c) Mixed farming is mainly associated with the densily populated regions, where urbanized industrialized societies are residing.

(d) More than one crop is grown; cereals dominate the land use and the leading grain varies with varying climatic and soil conditions.

(e) Within this system three well established agricultural sub systems can be recognized. These are – a. Mixed Farming – crops are grown and livestock are raised b. Dairy Farming – High intensive type of livestock farming c. Market gardening and horticulture – cultivation of fruits, vegetables and flowers (https://lotusarise.com/world-agriculture-typology-of-agricultural-regions-upsc/).

11. Subsistence Crop and Livestock Farming

The second of the three type of agricultural land acquisition that has its origins in Northern Europe is very similar to the first one. The main difference is that in this type of system the farmer produces for his own consumption and sells either in small proportions or nothing at all. This is due to lack of finance or money, and also because of his unaffordable condition of buying expensive machinery. He can neither sow the best seed nor can buy good breeding stock. Their return is comparably low, and they cannot sell their rare surplus in competition with the high-grade and reliable production of commercial areas. In the absence of a competitive market incentive, the method is raw. In this way, the vicious circle round and round roll continues (https://lotusarise.com/world-agriculture-typology-of-agricultural-regions-upsc/).

Location: Parts of Northern Europe, Magreb countries, Central Asia and Mountain region of Mexico.

Characteristics

(a) Produced crops and raised livestock mainly used for own subsistence.

(b) The traditional way of farming.

(c) Seeds are poor of quality and animals are poorly domesticated.

(d) Capital input is normally unknown.

(e) Wheat, Maize, Rye, Barley etc are the main crops.

(f) Sheep and Goats are the most important animal.

12. Commercial Dairy Farming

The Commercial dairying is the third form that develops from the medieval system of Northern Europe. In this farming generally rearing of the cattle associated with their different products such as milk, milk products (butter, cheese, condensed milk, dried milk etc) is known for dairy farming. Commercial dairying develops only where the products can be consumed in the immediate urban market. So far, the largest consumers of these farming products are the population of the northern European cities.

Location: It is mainly practiced in Europe, Northern USA, Canada, Australia, New Zealand, Denmark, Netherlands, Belgium, Finland, France, and Switzerland.

Characteristics

(a) Dairying is capital intensive and returns are high.

(b) The cattle size in diaries varies from country to country from farm to farm depending on the size of holding. In the United Kingdom, for example, the ratio of cattle pasture is one cow after one acre. The average size of dairy cattle in northwest Europe is only five cows per farm.

(c) Nearly 80% of the total milk production of the world is produced in Europe, Russia, Anglo America, Australia, New Zealand.

(d) This type of farming requires more labour than crop farms as it is associated with animals.

13. Specialized Horticulture

Specialized cultivation of vegetables, fruits, flowers is called horticulture. The production of fruits and vegetables in kitchen gardens and home orchards is the characteristic of specialized horticulture. This is mainly found in the wetland areas of mid-latitude Mediterranean region. This is again found near large metropolises as the products start perishing if not consumed quickly. Although the production is dependent on demand, the returns are high.

Location: Horticulture is well developed in the densely populated industrial districts of northwest Europe, Britain, Denmark, Germany, Netherlands, France, Italy, Argentina and parts

of North America (https://lotusarise.com/world-agriculture-typology-of-agricultural-regions-upsc/).

Characteristics

(a) In horticultural the farms are small; such farms are located where communication links to the consumption centers are appreciably good.

(b) The market gardens are scientifically managed to achieve optimum yields and handsome returns. (c) Vegetables and bush fruits like apples, cherries and pears are main crops.

By agriculture, many of the necessities of life especially food, drink, fibers are produced. In this modern period, most of the people are depends on agriculture for this food livelihood. But at this stage, many portions of the world suffer from food deficiency. So, a modern cultivation method should be applied for achieving sufficiency in food (https://www.tandfonline.com/doi/abs/10.1080/00045603609357154).

UNIT: - 9
INDIAN INDUSTRIES: IRON AND STEEL AND TOURISM

INTRODUCTION

The processing of natural resources into more useful items is called manufacturing. These manufactured goods are finished products derived from the raw materials. These raw materials

used in manufacturing industry may be either in their natural form such as cotton, wool, iron ore etc. or may be in the semi processed form like cotton yarn, pig iron etc. which can further be used for making more useful goods. Thus the finished product of one industry may serve as the raw material for another industry. Economic development cannot be achieved by a country without developing its industries. There is a direct relationship between the level of industrial development and the economic prosperity of a country. Developed countries like the USA, Japan, Russia owe due to their prosperity to highly developed industries. Industrially less developed countries export their natural resources and import finished goods at higher prices and continue to remain economically backward (http://nos.org/media/documents/316courseE/ch24.pdf).

In India manufacturing industries contributed about 30 per cent of the gross domestic product. These industries provide employment to about 28 million people. Thus industries are a major source of national income and employment (http://nos.org/media/documents/316courseE/ch24.pdf).

BRIEF HISTORY OF MODERN INDUSTRIES

The modern industrial development in India started with the establishment of the first cotton textile mill at Mumbai in 1854, predominantly with Indian capital and entrepreneurship. Jute industry made a beginning in 1855 with the establishment of a jute mill in the Hooghly Valley near Kolkata with foreign capital and entrepreneurship. Coal mining was first started at Raniganj in 1772. Railways were introduced in 1854. Tata Iron and Steel Plant was set up at Jamshedpur in 1907. Several other medium and small size industries like cement, glass, soaps, chemicals, jute, sugar and paper followed. The industrial production in preindependence period was neither adequate nor diversified. At the time of independence, the economy was under-developed with agriculture contributing to more than 60 per cent of the GDP and most of the country's export earnings.

After 60 years of independence, India has now shown the signs of becoming a leading economic power. Industrial development in India can be divided into two phases. The Government successively increased its control over different economic sectors during the first phase (1947-1980). In the second phase (1980-97) it took measures to liberalise the economy between 1980 and 1992. These measures were somewhat adhoc. After 1992, the whole process of liberalization became more focused and radically different in nature.

After independence, systematic industrial planning under different five year plans helped in establishing a large number of heavy and medium industries. The main thrust of the industrial policy was to remove regional imbalances and to introduce diversification of industries. Indigenous capabilities were developed to achieve self-sufficiency. It is due to these efforts that India has been able to develop in the field of industry. Today, we export a large number of industrial goods to various countries (https://www.coursehero.com/file/146891330/sophomore-geography-11pdf/).

Performance of the Industrial Sector

The Indian industry has developed a highly diversified structure, considerable entrepreneurship and a vast capital market. As the economy develops and competition intensifies, major changes in the industry structure are inevitable. Over the years, adjustments have been made in the policy to accelerate the pace of industrial growth by providing greater freedom in investment decisions keeping in view the objectives of efficiency and competitiveness, technological upgradation, maximisation of capacityutilisation and increased exports. Notwithstanding the dislocation caused by structural changes and adjustment in industrial reforms carried out in the Eighth Plan, the rate of industrial growth during the Plan was 7.3 per cent. The Ninth Five Year Plan was formulated based on careful stock-taking of the strengths and weaknesses of the past development strategy. The pace of reforms continued in the Ninth Plan.

The performance of industry during 1997-98 and 1998-99 – first two years of the Ninth Plan – fell short of the average annual growth rate target of 8.2 per cent. As measured by the Index of Industrial Production, IIP, the industrial growth revived slightly to 6.6 per cent in 1997-98 from 5.6 percent in 1996-97. This revival, however, faltered in 1998-99 when growth rate fell to a meagre 4 per cent. The mining sector (including crude oil) witnessed the greatest deceleration in growth from 5.9 per cent in 1997-98 to –1.7 per cent in 1998-99. Manufacturing sector growth also fell from 6.7 percent to 4.3 per cent during the same period. Although real growth in industrial production was below the target, a positive feature was that the competitive pressures that were built up as a result of opening up of the economy and slackening of demand kept the prices low and thus kept a check on the inflation. In view of the shortfall in growth rate during first two years of the Plan, the industrial sector would need to achieve a growth rate of around 10 per cent in the remaining period of the Plan if it is to achieve the targets set for it in the Plan (http://planningcommission.nic.in/plans/mta/mta-9702/mta-ch5.pdf).

Reasons for Industrial Slowdown

The slow-down in industrial growth can be attributed to slackening in aggregate demand on account of inadequate investment in infrastructure sector like power, port and transport and slow-down in general investment mainly due to subdued capital market conditions and partly due to corporate restructuring in some industries. There has been a decline in the entry of new units in the industrial sector which, in turn, reflects both the slow-down in economic activity and the risk aversion of investors to the Public Offers. The external factors include decline in export growth due to economic crisis in the SouthEast Asian countries and a slowdown of growth in international trade (http://planningcommission.nic.in/plans/mta/mta-9702/mta-ch5.pdf).

Performance of Industry Sector During 1999-2000

The performance of the industry sector during 1999-2000 indicates that the industry is on the path of recovery with overall growth in the general index being 8.3 per cent. What is most heartening, the Machinery and Equipment (other than transport equipment) sector has recorded a growth of as much as 17.4 per cent as against 1.7 per cent during the corresponding period in the previous year, which is a clear indication of a significant improvement in the investment climate.

The world economy is coming out of its depressed phase, which has been predicted based on positive signals from the western countries and more particularly with the economy of Japan recording a positive growth of around 1.9 per cent during April-June 1999 over a year ago and South East Asian crisis having blown over. Then, there are the measures announced in the Budget of 1999-2000, comfortable performance of the agriculture sector and the exports pick-up because of recovery of the world economy. All these have led to expectations that the industrial growth would be significantly higher in 1999-2000 compared to 1998-99 and may be even higher in last two years of the Plan so as to achieve the 8.2 per cent target (http://planningcommission.nic.in/plans/mta/mta-9702/mta-ch5.pdf).

Factors Influencing the Location of Industries

Many important geographical factors involved in the location of individual industries are of relative significance, e.g., availability of raw materials, power resources, water, labour, markets and the transport facilities. But besides such purely geographical factors influencing industrial location, there are factors of historical, human, political and economic nature which are now tending to surpass the force of geographical advantages. Consequently, the factors influencing the location of industry can be divided into two broad categories i.e (https://old.amu.ac.in/emp/studym/99998503.pdf).

(A) Geographical factors, and

(B) Non-geographical factors

(A) Geographical Factors: Following are the important geographical factors influencing the location of industries.

1. Raw Materials: The significance of raw materials in manufacturing industry is so fundamental that it needs no emphasising. Indeed, the location of industrial enterprises is sometimes determined simply by location of the raw materials. Modem industry is so complex that a wide range of raw materials is necessary for its growth. Further we should bear in mind that finished product of one industry may well be the raw material of another. For example, pig iron, produced by smelting industry, serves as the raw material for steel making industry. Industries which use heavy and bulky raw materials in their primary stage in large quantities are usually located near the supply of the raw materials. It is true in the case of raw materials which lose weight in the process of manufacture or which cannot bear high transport cost or cannot be transported over long distances because of their perishable nature. This has been recognized since 1909 when Alfred Weber published his theory of location of industry. The jute mills in West Bengal, sugar mills in Uttar Pradesh, cotton textile mills in Maharashtra and Gujarat are concentrated close to the sources of raw materials for this very reason. Industries like iron and steel, which use very large quantities of coal and iron ore, losing lot of weight in the process of manufacture, are generally located near the sources of coal and iron ore.

Some of the industries, like watch and electronics industries use very wide range of light raw materials and the attractive influence of each separate material diminishes.

The result is that such industries are often located with no reference to raw materials and are sometimes referred to as 'footloose industries' because a wide range of locations is possible within an area of sufficient population density (https://old.amu.ac.in/emp/studym/99998503.pdf).

2. Power: Regular supply of power is a pre-requisite for the localisation of industries. Coal, mineral oil and hydro-electricity are the three important conventional sources of power. Most of the industries tend to concentrate at the source of power. The iron and steel industry which mainly depends on large quantities of coking coal as source of power are frequently tied to coal fields. Others like the electro-metallurgical and electro-chemical industries, which are great users of cheap hydro-electric power, are generally found in the areas of hydro-power production, for instance, aluminium industry. As petroleum can be easily piped and electricity can be transmitted over long distances by wires, it is possible to disperse the industry over a larger area. Industries moved to southern states only when hydro-power could be developed in these coal-deficient areas. Thus, more than all other factors affecting the location of large and heavy industries, quite often they are established at a point which has the best economic advantage in obtaining power and raw materials.

Tata Iron and Steel Plant at Jamshedpur, the new aluminium producing units at Korba (Chhattisgarh) and Renukoot (Uttar Pradesh), the copper smelting plant at Khetri (Rajasthan) and the fertilizer factory at Nangal (Punjab) are near the sources of power and raw material deposits, although other factors have also played their role (https://old.amu.ac.in/emp/studym/99998503.pdf).

3. Labour: No one can deny that the prior existence of a labour force is attractive to industry unless there are strong reasons to the contrary. Labour supply is important in two respects (a) workers in large numbers are often required; (b) people with skill or technical expertise are needed. Estall and Buchanan showed in 1961 that labour costs can vary between 62 per cent in clothing and related industries to 29 per cent in the chemical industry; in the fabricated metal products industries they work out at 43 per cent. n our country, modem industry still requires a large number of workers in spite of increasing mechanisation. There is no problem in securing unskilled labour by locating such industries in large urban centres. Although, the location of any industrial unit is determined after a careful balancing of all relevant factors, yet the light consumer goods and agro-based industries generally require a plentiful of labour supply.

4. Transport: Transport by land or water is necessary for the assembly of raw materials and for the marketing of the finished products. The development of railways in India, connecting the port towns with hinterland determined the location of many industries around Kolkata, Mumbai and Chennai. As industrial development also furthers the improvement of transport facilities, it is difficult to estimate how much a particular industry owes to original transport facilities available in a particular area.

5. Market: The entire process of manufacturing is useless until the finished goods reach the market. Nearness to market is essential for quick disposal of manufactured goods. It helps in reducing the transport cost and enables the consumer to get things at cheaper rates. It is becoming more and more true that industries are seeking locations as near as possible to their markets; it has been remarked that market attractions are now so great

that a market location is being increasingly regarded as the normal one, and that a location elsewhere needs very strong justification. Ready market is most essential for perishable and heavy commodities. Sometimes, there is a considerable material increase in weight, bulk or fragility during the process of manufacture and in such cases industry tends to be market oriented.

6. Water: Water is another important requirement for industries. Many industries are established near rivers, canals and lakes, because of this reason. Iron and steel industry, textile industries and chemical industries require large quantities of water, for their proper functioning. Also it requires 36,400 litres of water to produce one kwh of thermal electricity. Further, it is worth noting that water used in industries gets polluted and is therefore not available for any other purpose.

7. Site: Site requirements for industrial development are of considerable significance. Sites, generally, should be flat and well served by adequate transport facilities. Large areas are required to build factories. Now, there is a tendency to set up industries in rural areas because the cost of land has shot up in urban centres.

8. Climate: Climate plays an important role in the establishment of industries at a place. Harsh climate is not much suitable for the establishment of industries. There can be no industrial development in extremely hot, humid, dry or cold climate. The extreme type of climate of north-west India hinders the development of industries. In contrast to this, the moderate climate of west coastal area is quite congenial to the development of industries. Because of this reason, about 24 per cent of India's modem industries and 30 per cent of India's industrial labour is concentrated in Maharashtra-Gujarat region alone. Cotton textile industry requires humid climate because thread breaks in dry climate. Consequently, majority of cotton textile mills are concentrated in Maharashtra and Gujarat. Artificial humidifiers are used in dry areas these days, but it increases the cost of production (https://old.amu.ac.in/emp/studym/99998503.pdf).

(B) Non-Geographical Factors: Now-a-days alternative raw materials are also being used because of modern scientific and technological developments. Availability of electric power supply over wider areas and the increasing mobility of labour have reduced the influence of geographical factors on the location of industries. The non-geographical factors are those including economic, political, historical and social factors. These factors influence our modern industries to a great extent. Following are some of the important non- geographical factors influencing the location of industries (https://old.amu.ac.in/emp/studym/99998503.pdf).

1. Capital: Modem industries are capital-intensive and require huge investments. Capitalists are available in urban centres. Big cities like Mumbai, Kolkata, Delhi, and Chennai are big industrial centres, because the big capitalists live in these cities.

2. Government Policies: Government activity in planning the future distribution of industries, for reducing regional disparities, elimination of pollution of air and water and for avoiding their heavy clustering in big cities, has become no less an important locational factor. There is an increasing trend to set up all types of industries in an area, where they derive common advantage of water and power and supply to each other the products they turn out. The latest example in our country is the establishment of a large

number of industrial estates all over India even in the small-scale industrial sector. It is of relevance to examine the influence of India's Five Year plans on industrial location in the country. The emergence of suitable industries in south India around new nuclei of public sector plants and their dispersal to backward potential areas has taken place due to Government policies. The state policy of industrial location has a greater hand in the establishment of a number of fertilizer factories, iron and steel plants, engineering works and machine tool factories including railway, shipping, aircraft and defence installations and oil refineries in various parts in the new planning era in free India. We may conclude by noting that the traditional explanation of a location of industry at a geographically favourable point is no longer true. Location of oil refinery at Mathura, coach factory at Kapurthala and fertiliser plant at Jagdishpur are some of the results of government policies.

3. Industrial Inertia: Industries tend to develop at the place of their original establishment, though the original cause may have disappeared. This phenomenon is referred to as inertia, sometimes as geographical inertia and sometimes industrial inertia. The lock industry at Aligarh is such an example.

4. Efficient Organisation: Efficient and enterprising organisation and management is essential for running modem industry successfully. Bad management sometimes squanders away the capital and puts the industry in financial trouble leading to industrial ruin. Bad management does not handle the labour force efficiently and tactfully, resulting in labour unrest. It is detrimental to the interest of the industry. Strikes and lock-outs lead to the closure of industries. Hence, there is an imperative need of effective management and organisation to run the industries.

5. Banking Facilities: Establishment of industries involves daily exchange of crores of rupees which is possible through banking facilities only. So the areas with better banking facilities are better suited to the establishment of industries.

6. Insurance: There is a constant fear of damage to machine and man in industries for which insurance facilities are badly needed (https://old.amu.ac.in/emp/studym/99998503.pdf).

INDIAN IRON AND STEEL INDUSTRIES

Indian steel production has grown strongly in recent decades and India is now the world's fourthlargest steel producer. Nevertheless, India's consumption of steel relative to the size of its economy is very low by international standards. As the economy develops further, steel consumption is likely to increase. Indeed, Indian steelmakers have plans to expand capacity substantially in order to meet the anticipated increase in demand. While India has relatively large reserves of iron ore, its steelmakers import most of the coking coal they require. As Australia is a major supplier of coking coal to India, these exports from Australia are likely to expand further.

Steel production in India has expanded rapidly in recent decades and, as a result, India has become the world's fourth-largest producer of crude steel (having been the 10th largest in 1995; Graph 1). Relative to the size of its economy, India's steel consumption, however, remains low; with large additions to steelmaking capacity planned to meet expected growth in steel

demand, the nation's steel industry is expected to expand as India develops further. While India has large reserves of relatively high-quality iron ore, its reserves of coking coal are limited and mostly unsuitable for steelmaking; accordingly, Indian steelmakers import much of the coal required for producing steel. Australia is a major source of India's coking coal imports, and given its proximity to India, these exports are likely to grow as Indian steel production expands. This article discusses the Indian steel industry, focusing on its structure, the production technologies used and the sources of its steelmaking commodities.

Steel production in India has expanded rapidly in recent decades and, as a result, India has become the world's fourth-largest producer of crude steel (having been the 10th largest in 1995; Graph 1). Relative to the size of its economy, India's steel consumption, however, remains low; with large additions to steelmaking capacity planned to meet expected growth in steel demand, the nation's steel industry is expected to expand as India develops further. While India has large reserves of relatively high-quality iron ore, its reserves of coking coal are limited and mostly unsuitable for steelmaking; accordingly, Indian steelmakers import much of the coal required for producing steel. Australia is a major source of India's coking coal imports, and given its proximity to India, these exports are likely to grow as Indian steel production expands. This article discusses the Indian steel industry, focusing on its structure, the production technologies used and the sources of its steelmaking commodities (https://old.amu.ac.in/emp/studym/99998503.pdf).

Factors Affecting the Location of Iron and Steel Industries in India

Raw materials: Most of the large integrated steel plants are located close to the source of raw materials, as they use large quantities of heavy and weight losing raw materials. Eg: Concentration of iron and steel industry in Chota Nagpur region is due to the presence of iron ore in this region. TISCO at Jamshedpur gets coal from Jharia coalfields, and iron ore, limestone, dolomite and manganese from Odisha and Chhattisgarh.

Markets: Since the products in iron & steel industries are heavy & bulky, transportation cost is high. Therefore nearness to market is important, especially for mini steel plants access to nearby markets is most important in order to minimize transportation cost. TISCO in Jamshedpur is nearer to Kolkata which provided a large market. Visakhapatnam steel plant located near the coast has excellent import-export facility.

Labour: Availability of cheap labour is also important. Most of the plants in Chota Nagpur region find abundant supply of cheap labour in the region.

Availability of water for cooling: Eg: Bokaro steel plant on the bank of river Damodar, Visheshwarya steel plant in Bhadravati, Karnataka is near river Bhadra.

Nearness to Industrial Town: Mini steel plants, that use scrap metals as input, require recycling of waste metals and hence, are located mostly near industrial towns eg, steel plants in Maharashtra.

Government Policies: Governments incentivise industries set up in backward regions. It provides subsidies, tax rebates and capital to influence the location of industries. Bhilai Steel Plant in Chhattisgarh was set up to remove the backwardness of the region.

Power: Availability of power is another determinant for the industry location. TISCO and Bokaro steel plant get hydroelectricity from Damodar Valley Corporation (DVC). Bhilai Plant gets energy from Korba Thermal Station.

Transport: Connectivity to raw material locations, markets and ports is another factor. TISCO is well connected with railway to Kolkata, Mumbai Chennai. Durgapur Plant has Navigable Canal from Durgapur to Hugli and Kolkata Port.

Before 1800 A.D. iron and steel industry was located where raw materials, power supply and running water were easily available. Later the ideal location for the industry was near coal fields and close to canals and railways. After 1950, iron and steel industry began to be located on large areas of flat land near sea ports. This is because by this time steel works had become very large and iron ore had to be imported from overseas.

In India, iron and steel industry has developed taking advantage of raw materials, cheap labour, transport and market. All the important steel producing centres such as Bhilai, Durgapur, Burnpur, Jamshedpur, Rourkela, Bokaro are situated in a region that spreads over four states — West Bengal, Jharkhand, Odisha and Chhattisgarh. Bhadravati and Vijay Nagar in Karnataka, Visakhapatnam in Andhra Pradesh, Salem in Tamil Nadu are other important steel centres utilising local resources.

To conclude iron and steel Industry is the backbone of manufacturing sector in India. With change in technology, demand patterns, international trade dynamics and energy sources the location of the iron and steel industry keeps shifting. However, due to industrial inertia the existing locations always remain relevant (https://old.amu.ac.in/emp/studym/100007275.pdf).

Trend and Development of Iron and Steel Industry in India

India has a long heritage of steel making. Although steel production process started in India thousand years ago, the modem steel production technology started functioning only at the beginning of the 19th century. In fact the growth of steel industry in India has been spectacular only after independence. The first successful attempt was made in 1875 in setting up an iron and steel works at Barakar by Bengal Iron and Steel Company. This was taken over by Bengal Iron Company in 1889. This was the first attempt to produce pig iron in India through modern methods. But the iron and steel industry in India had a real beginning in the year 1907 after the establishment of Tata Iron and Steel Company (TISCO) at Sakchi in Bihar. It was the dream of late Jamshedji Tata, the father of Indian steel industry, whose career was a true example of industrial romance.

Setting up of Indian Iron and Steel Company Ltd. in the year 1918 at Burnpur in West Bengal was another landmark in the history of iron and steel industry in India. The Steel Corporation of Bengal Ltd. was set up in 1937 in association with Indian Iron and Steel Company for manufacturing steel. In 1923 the State Government of Mysore set up an iron works at

Bhadrabati known as Mysore Iron and Steel Works, thereafter named as Visvesvaraya Iron and Steel Ltd. So before independence iron and steel industry in India consisted of four units viz. the Tata Iron and Steel Company, the Indian Iron and Steel Company, the Steel Corporation of Bengal and the Mysore Iron and Steel Works. Out of these four units, only one unit namely Mysore Iron and Steel Works was a state-owned unit, the remaining three were in the private sector.

After independence special attention was given for the development of iron and steel industry in India and a series of plans and proposals were made for the setting up of new steel plants. Major Iron and Steel plants of India have been discussed below (https://old.amu.ac.in/emp/studym/100007275.pdf):

Major Iron and Steel Plants in India

(1) Tata Iron and Steel Company (TISCO): This is the oldest iron and steel centre of India. It is a private sector enterprise. It was established in 1907 by Jamshedji Tata at Sakchi in Singhbhum district of Jharkhand. Later on, it was renamed as Jamshedpur after Jamshedji. The production commenced in 1911. This plant is ideally located in terms of raw material assemblage and proximity to the market. Coal is obtained from Jharia, 180 kms north. Iron are is supplied from Noamundi, only 120 kms away. Dolomite is obtained from Gangpur, situated just 160 kms west of Jamshedpur. An embankment was erected on the river Kharkai to supply large amount of water to the plant. The principal market is Calcutta, situated just 239 kms from the plant.

(2) Indian Iron and Steel Company (IISCO): Three plants at Kulti, Hirapur and Bumpur in West Bengal were set up in 1864, 1908 and 1937 respectively. In 1972, these plants have been merged together and are known as Indian Iron and Steel Company (IISCO). It was brought under government control and management in July 1972. The three plants are linked by Kolkata-Asansol railway line. Hirapur plant produces pig iron which is sent to Kulti for making steel. The rolling mills are located at Bumpur. IISCO also enjoys advantages of easily available raw material, cheap labour, market, water, and road and rail connectivity with other parts of the country.

(3) The Visweswaraya Iron and Steel Ltd: It was established as Mysore Iron and Steel Company (MISCO) in 1923 by the erstwhile state of Mysore. It is located at Bhadravati on the banks of river Bhadravati in Shimoga district of Karnataka. This plant was brought under state control in 1962 and was renamed as Visveswaraya Iron and Steel Ltd. after the name of great engineer Dr. Visweswaraya. In order to increase the production of iron and steel, the Government of India established The Hindustan Steel Limited in public sector. Consequently, three plants under the public sector, i.e. Bhilai, Rourkela and Durgapur came into operation during the Second Five Year Plan. Capacity of each plant was fixed at 10 lakh tonnes of steel which was expanded during the Third Five Year Plan and a proposal of setting up a steel plant at Bokaro was also made. These plants enjoy very favourable factors for their development.

(4) Bhilai: Bhilai iron and steel centre was set up in Durg district of Chhattisgarh in 1957 with the technical and financial support of the then Soviet Union. It started production in 1959. Its

initial capacity was 10 lakh tonnes which has been raised to 52 lakh tonnes. Coal comes from Korba mine, 225 kms from the plant. Apart from Korba, coal is also ob-tained from Jharia and Kargali fields. Highgrade manganese is being supplied from Balaghat, 190 km away. Fluxing materials, specially limestone, is obtained from Akaltara, 170 km from the plant. Tendula canal and water reservoir provides water.

(5) Rourkela: Plant of Hindustan Steel Limited at Rourkela is situated in the Sundargarh district of Orissa It was set up with the help of the then West German firm, Krupps and Demang, during t e Second Five Year Plan (West Germany and East Germany have united to form one country now). The plant is located at the confluence of Sankh&Koel Rivers. It was inaugurated in 1956.

(6) Durgapur: This plant of The Hindustan Steel Ltd. is located at Durgapur in Burdwan district of West Bengal. It was set up in 1959 with the help of the United Kingdom. Situated in the Burdwan district of West Bengal, this plant enjoys the close proximity of the necessary trio —coal, iron ore and market.

(7) Bokaro: A new public sector company, the Bokaro Steel Ltd. was formed in 1964 to erect a steel plant with the collaboration of the erstwhile Soviet Union at Bokaro near the confluence of the Bokaro and Damodar rivers in Hazaribagh district of Jharkhand. It is the second plant set up with the Soviet help. It started production in 1972. This plant gets iron ore from the Kiriburu mine situated within a 100 km. radius. Coal is obtained from Bokaro and Jharia coal mines, situated nearby.

(8) The Salem Steel Plant: The plant has been set up at Salem in the Salem district of Tamil Nadu. The plant has the advantage of rich iron ore and limestone, which is readily available in the adjoining areas. It also enjoys the facilities of cheap power, charcoal and vast market. The iron ore available here has low sulphur and phosphorus content and is suitable for producing special grade iron and steel. The plant started commercial production in 1982. Today the Salem Steel Plant is a major producer of world class stainless steel and is in a position to export stainless steel to some of the advanced countries such as the USA, Mexico, Australia and some countries of South-East Asia.

(9) Vijayanagar Steel Plant: This plant has been set up at Tomagal near Hospet in Bellary district of Karnataka. This plant has very favourable proximity factors to easily get iron, coal, good quality limestone and dolomite and water and power requirements. Power is harnessed from hydel power grid of Karnataka State Electricity Board.

(10) Vishakhapatnam Steel Plant (VSP): This integrated steel plant has a unique location on the sea port. In fact, it is the first shore based steel plant in the country. Although the foundation stone of the plant was laid in 1972, the construction work could not start in the real sense till February 1982 when RashtriyaIspat Nigam Limited was incorporated as a public sector company to implement the construction of the plant. Currently holding 67th rank among 80 largest steel makers on the globe, as certified by the Brusselsbased International Iron and Steel Institute, VSP is smooth-sailing towards reaching its goal of turning into a ‘world class company in steel industry’; as a result of the effective turnaround strategy adopted by its

management for the last couple of years. The raw material recycling method was adopted to minimize raw material requirement.

Problems of Iron and Steel Industry

- Poor demand, price slump, competition from cheaper imports and delays in project execution are major problems in Indian steel industry.
- Inadequate supply of power and coal, Inefficiency of public sector units and under-utilisation of capacity are other challenging issues.
- Indian banks are grappling with bad loans (NPA) and at the same time the industry which has a long gestation period, needed huge investment.
- Raw material and infrastructure bottlenecks issues are also there.
- Obsolete technology in PSUs led to inferior quality products.
- Under-utilization of labour due to frequent strikes, lockout, inefficient management (slow land acquisition, environment clearances etc.) factors facilitate dumping in the market decreasing the global prices hitting the domestic producers and their exports.
- Global glut and a surge in cheap imports from China, Russia, Korea and Japan have dented the domestic industry's fortunes.

Suggestions

- The iron and steel industry needed a comprehensive planning for modernisation, up gradation of technologies, replacement of obsolete equipment and removal of technological imbalances.
- Presently, the government is trying to support the industry through the RBI's strategic debt restructuring scheme. But it needs long-term finance, such as, pension funds, savings etc. which can withstand cyclical volatility of profits unlike funding from banks or capital markets.
- Anti dumping duties on cheap import to protect domestic producers.
- More focus on infrastructure and automobile industry to increase domestic demand and job creation to counter-balance global slowdown.
- Servicing of bad loans by government to provide capital and reviewing the credibility before dispatching the loans.
- Increased foreign investment.
- More emphasis on Green Climate Fund to procure environment friendly technology.
- Decrease iron ore exports to ensure raw material supply (https://www.drishtiias.com/to-the-points/paper3/iron-and-steel-industry-in-india).

Way Forward

- The Indian steel industry has entered into a new development stage, post deregulation, riding high on the resurgent economy and rising demand for steel.
- Huge scope for growth is offered by India's comparatively low per capita steel consumption and the expected rise in consumption due to increased infrastructure construction and the thriving automobile and railways sectors.

- The New Industrial Policy Regime provides opportunities for growth of Iron and Steel in private sector.
- The Government has also announced a policy for providing preference to domestically manufactured Iron & Steel products in Government procurement.
- Ministry of Steel is playing the role of a facilitator, providing broad directions and assistance to new and existing steel plants, in the liberalized scenario.

FIG: INDIAN IRON AND STEEL INDUSTRIES

Source: - https://old.amu.ac.in/emp/studym/100007275.pdf

INDIAN TOURISM INDUSTRIES

Tourism is a most desirable human activity; which is capable of changing the socio-cultural, economic and environmental face of the World. Tourism is one of the largest and fast growing industries in the world; it has the potential to influence the living pattern of communities. It is one of the most important channels of cultural exchange which breaks down the barriers between people of different parts of the world. It is the collection of activities, services and industries that deliver a travel experience including transportation, accommodation, eating and drinking, establishments of retail shops, entertainment, business and other hospitality services provided for individuals or groups of travelling away from home (Dayananda, 2016).

Tourism has emerged as one of world's largest industries and a fastest growing sector of the world economy; tourism receipts account for a little over 8% of world export of goods and more than 34% of world export of services. In India, however, the sector has failed to receive due importance on the country's development agenda. Employing only 2.4% of the Indian workforce, the vast potential of tourism as an instrument of employment generation and poverty alleviation has tended to remain largely unutilized. Of the 625 million world tourist arrivals in 1998, India received a meagre 2.36 million or 0.38% of the total world tourist arrivals and only 0.62% of world tourist receipts. Compared to other countries in the region India's performance in the sector has been rather poor. Major causes cited for the low performance are lack of professionalism, unhygienic conditions, poor infrastructure, lack of easily accessible information, lack of safety, poor visitor experience, restrictive air transport policy, inadequate facilitation services, multiplicity of taxes and the low priority accorded to tourism. However, despite its tiny share of world tourist arrivals, tourism in India has emerged the second largest foreign exchange earner for the country even though the mainstay of the Tourism industry in India continues to be domestic tourism (http://planningcommission.nic.in/plans/mta/mta-9702/mta-ch23.pdf).

Tourism has emerged as a key sector of the world economy and has become a major workforce in global trade. It has been making a revolutionary and significant impact on the world economic scenario. Tourism has been identified as the major export industry in the world. The multifaceted nature of this industry makes it a catalyst to economic development and helps balanced regional development. It is a low capital, labour intensive industry with economic multiplier and offers opportunity to earn foreign exchange at low social cost. Tourism industry acts as a powerful agent of both economic and social changes. It stimulates employment and investment, alters structure of an economy, significant contribution toward foreign exchange earnings and maintaining favourable balance of payment. The money spent by the tourist in a country is turned over several times in the process; the total income earned from tourism is a number of times more than actual spending. The multiplier effect of tourism receipts is completely recognized as spreading to secondary and tertiary sectors of an economy. Tourism consist economic, social, cultural, educational and political significance. Marketing and promotion are of vital importance in tourism sector due to the competitiveness of tourism industry both within and between tourism generating nation. Tourism sector creates direct, indirect and induced employment. It produces a vast spectrum of employment from highly

qualified and trained mangers of star hotels to room boys, sales girls and artisans. With its faster growth new horizons of employment open up for youth of the developing countries.

Tourism in India has a strong relevance to economic development, cultural growth and national integration. India is a vast country of great beauty and diversity and her tourist potential is equally vast. With her rich cultural heritage as superbly manifest in many of the architectural wonders palaces, temples, mosques, forts, caves and prehistoric wall paintings, her widely varied topography ranging from the monotonous plains to the loftiest mountains of the world, her large climatic variations ranging from some of the wettest and the driest as well as from the hottest and the coldest parts of the world, beautiful long beaches on the sea coast, vast stretches of sands, gregarious tropical forests and above all, the great variety of the life-style, India offers an unending choice for the tourist (Dayananda, 2016).

The Indian tourism and hospitality industry has emerged as one of the key drivers of growth among the services sector in India. The third-largest sub-segment of the services sector comprising trade, repair services, hotels and restaurants contributed nearly US$ 187.9 billion or 12.5 per cent to the Gross Domestic Product (GDP) in 2014-15, while growing the fastest at 11.7 per cent Compound Annual Growth Rate (CAGR) over the period 2011-12 to 2014-15.Tourism is also a potentially large employment generator besides being a significant source of foreign exchange for the country. The industry is expected to generate 13.45 million jobs across subsegments such as Restaurants (10.49 million jobs), Hotels (2.3 million jobs) and Travel Agents/Tour Operators (0.66 million). The Ministry of Tourism plans to help the industry meet the increasing demand of skilled and trained manpower by providing hospitality education to students as well as certifying and upgrading skills of existing service providers. India has moved up 13 positions to 52nd rank from 65th in Tourism & Travel competitive index (Dayananda, 2016).

Swot Analysis of Indian Tourism

To review the performance, to find the loopholes as well as provide solutions to them for Tourism Industry, particularly in India, scope is there of conducting a SWOT Analysis. A SWOT analysis (alternatively SWOT matrix) basically signifies a structured planning method used to evaluate the Strengths, Weaknesses, Opportunities and Threats involved in a project or in a business venture. A SWOT analysis can be carried out for a product, place, industry or person. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favourable and unfavourable to achieve that objective.

SWOT Analysis is an important technique of environmental analysis too. By SWOT, we can observe the impact of each environmental sector like economic, political and social on the organization. As a summarized depiction of the environmental factors and their impact on future conditions, the profile is a convenient means by which attention of top management can be drawn to the most critical factors and their potential impact on the strategy of the firm as a whole, and key aspects of its operations. The logic behind this technique is that an effective strategy maximizes a business' strengths and opportunities on the one hand and minimizes its weaknesses on the

other(https://www.icsi.edu/media/webmodules/publications/CS%20as%20Corporate%20Saviour%20-%20Tourism%20Industry.pdf).

Opportunities

An opportunity is a major favourable situation in the Industry/ Organization's environment. Opportunities an Industry could represent an improved buyer and supplier relationships, identification of a previously overlooked market segment, enjoying the benefit of technological changes, changes in regulatory framework and in competitive circumstances, etc. As far as Tourism Industry in India is concerned the opportunities are more hands-on role from the Government of India in terms of framing policies; allowing entry of added multinational companies into the country, giving home country a worldwide perception; these besides as well as development of domestic tourism is one of the factors of the growth of the tourism industry. A pioneer initiative by Ministry of Tourism, Government of India has be taken that would help tap into the full prospective of tourism; a countrywide promotion that aims at sensitizing key stakeholders towards tourists, through a process of training and orientation; the Commonwealth Games 2010 in New Delhi was the largest ever event in India's sporting history. International players of different sports from across the world visited to take part in CWG 2010 (https://www.icsi.edu/media/webmodules/publications/CS%20as%20Corporate%20Saviour%20-%20Tourism%20Industry.pdf).

Threats

Unfavourable situation in the Industry environment is a major threat to the individual organizations. Major elements that could represent threats to the industry may be entrance of a new competitor, slow market growth, increased bargaining power of key buyers or suppliers, technological changes and changing regulations, etc. The threats relates to Tourism Industry consist of aggressive strategies adopted by other countries like China, Australia, Singapore in promoting their tourism its impact on Indian tourism; Tourist often ignored, Cheated and rudely dealt with spoils the image of country. These incidents considerably reduce the foreign tourist arrivals in India; Crime rates growing in the country ranging from insignificant thefts to serious murder cases; diseases in recent years such as Dengue, Chikungunya and Swine Flu are causing the tourists to stay away from visiting various parts of the country; Food problems plague the tourists; lack of basic infrastructure and accommodations for tourists in rural areas of the country; Women particularly western women get harassed by the local men making the place unsafe for them and aged tourists (https://www.icsi.edu/media/webmodules/publications/CS%20as%20Corporate%20Saviour%20-%20Tourism%20Industry.pdf).

Strengths

Strength is a comparative advantage or edges over our competitors. The skill, available resources, goodwill, market leadership and buyer/seller relationships are the examples of strengths of an industry. India's geological location is a culmination of forests, deserts, and mountains and beaches. A variety of culture, i.e., a mix of diverse civilizations and their traditions; a wealth of archeological sites; Indian tourism is known for its heritage and

monuments; India has a corporation to administer support issues related to tourism; country of prosperous heritage and traditions having an enormous and varied history; Places of prehistoric civilization and settlements dating back to numerous centuries present in India; unity in Diversity, i.e., multicultural people staying collectively in the same country. One of the best growing economies of the world; growing literacy rate among the local people and improving infrastructure leading to increase in tourist visits. India has been maintaining good and pleasant association with different countries which helps the people of those countries to get the visas easily to visit India (https://www.icsi.edu/media/webmodules/publications/CS%20as%20Corporate%20Saviour%20-%20Tourism%20Industry.pdf).

Weaknesses

A weakness is a limitation or deficiency in resources, skills and capabilities that impede effective information. Facilities, financial resources, management capabilities, marketing skills and brand image and lack sufficient infrastructure could be the causes of weakness. An intolerant attitude among certain sections of the people also affects tourism. In Indian Tourism Industry the areas of weaknesses are improper. There is no appropriate marketing of India's tourism in foreign lands. Loss of local culture as well as the loss of traditional environmental awareness is one of the negative impacts of uncontrolled tourism; Costly travel, elevated fuel prices resulting in the increase of fares of flight and trains, the major means of transport for the tourists, lapses in security and safety, incidents of flaunt and harassment of tourists in some places, gap between requirement and supply of manpower.

These are reasons impede the follow of foreign tourists as well as that of the domestic. Insufficient standard hotels in the country leading to the crisis of accommodation for the visiting tourists there is lack of proper care infrastructure; poor health, lack of hygiene and proper sanitation among common people especially in the rural parts of the country; Incidents of local people harassing and torturing the visiting tourists especially the foreign tourists in diverse parts of the country; and regular progress of different parts of the country all these limitations keep the foreigners at bay Tourism and Travel organization in the present day is mode of life of all individuals. Tourism is considered as one of the principal industries in India, as it receives approximately 465.6 million domestic and worldwide tourists each year.

India has the prospective to be the No.1 tourist destination in the world provided: our strengths are maintained as it is and in fact, we have to increase our standards. Our weaknesses should be minimized if it is not possible to wipe them away completely we should make fine use of our opportunities. And last but not the least. The government has to strive for these but it is not impossible to get rid of our weaknesses. Madhya Pradesh bagged the Best Tourism State Award in 2012. A wish to break from routine or to look forward to an enhanced life, travel has forever remained a constant joy ever since intelligent lifestyle came into being.

India has a dazzling future in the area of tourism and has a kaleidoscope of tourist attractions and marvellous handicraft lifestyle product to offer to visitors. Realizing this Government of India is giving intense attention to build up facilities to attract tourists from world over. The

venture in the present scenario requires capable and confident manpower which has entire knowledge of the complicated technicalities involved in the soft working of this industry (https://www.icsi.edu/media/webmodules/publications/CS%20as%20Corporate%20Saviour%20-%20Tourism%20Industry.pdf).

Types of Tourism

Medical Tourism: Medical tourism refers to the practice, when you are travelling from your home country (typically a greater developed country) to a lesser developed nation, of projecting medical care at a lower price. This is a fast-growing industry in India because of India's lower prices for key health care treatments (prices are typically up to 30 percent lower in India as compared to the of United States and the United Kingdom). India's medical tourism industry is estimated to increase to around US$20 billion over the next few years, and India has promoted it by way of providing tourists with personal healthcare services. It is projected that the total marketplace for medical tourism will reach US$2 billion by 2015, and this sector is expected to grow at an estimated rate of 30 percent annually until 2015. An estimated 150,000 foreign tourists travel to India for low-priced healthcare procedures each year.

Rural Tourism: Rural India has much to present to humanity as an ancient civilization rich in arts, crafts and culture. Thousands of overseas tourists visit rural areas in Rajasthan, Gujarat and south India every year. Exports of local handicraft have boomed as a result, with exports from Rajasthan reaching nearly US$1 million in 2009. India's handicrafts exports jumped 17.5 percent year-on-year between 2011 and 2012 to US$2.7 billion. In addition, the union tourism ministry and the United Nations Development Programme (UNDP) have launched tourism projects for the development of rural tourism in India. The UNDP plans to donate US$2.5 million to the project in addition to assist with capacity building, and increasing participation from NGOs, local communities and artisans.

Adventure Tourism: This sector of tourism has seen increased attention because of India's vastly different geography and climate. Either on land, in water or in the air, you can enjoy whatever form of adventure you may desire. India's hilly regions present many opportunities for mountaineering, rock-climbing, trekking, skiing, skating, and mountain-biking and safaris, and the rivers that flow from these mountains are ideal for river rafting, canoeing and kayaking. As a bonus, the ocean is not far from there and is easily accessible, providing many chances for adventure in the form of diving and snorkelling.

MICE Tourism: Meeting, Incentive, Conferencing and Exhibition (MICE) tourism in India offers the businessperson the latest and fastest growing type of international business tourism. This sector caters to a variety of trade meetings, international conferences and conventions, events and exhibitions, and has gradually captured the interests of major hotel brands. Worldwide MICE tourism accumulates over US$280 billion annually, and, of this, the Asia-Pacific region alone earns US$60 billion. India earns about US$4.8 billion yearly through MICE tourism. To capitalize, the Ministry of Tourism has initiated expansion in this sector by investing a total of INR 2 billion to encourage tourism in major cities in India

(https://www.icsi.edu/media/webmodules/publications/CS%20as%20Corporate%20Saviour%20-%20Tourism%20Industry.pdf).

Positive Impacts of Tourism

Creating Income and Employment: Tourism in India has emerged as an instrument of income and employment generation, poverty alleviation and sustainable human development. It contributes 6.23% to the national GDP and 8.78% of the total employment in India. Almost 20 million people are now working in the India's tourism industry.

Source of Foreign Exchange Earnings: Tourism is an important source of foreign exchange earnings in India. This has favourable impact on the balance of payment of the country. The tourism industry in India generated about US$100 billion in 2008 and that is expected to increase to US$275.5 billion by 2018 at a 9.4% annual growth rate.

Preservation of National Heritage and Environment: Tourism helps preserve several places which are of historical importance by declaring them as heritage sites. For instance, the TajMahal, the Quota Minar, Ajanta and Ellora temples, etc, would have been decayed and destroyed had it not been for the efforts taken by Tourism Department to preserve them. Likewise, tourism also helps in conserving the natural habitats of many endangered species.

Developing Infrastructure: Tourism tends to encourage the development of multiple-use infrastructure that benefits the host community, including various means of transports, health care facilities, and sports centres, in addition to the hotels and high-end restaurants that cater to foreign visitors. The development of infrastructure has in turn induced the development of other directly productive activities.

Promoting Peace and Stability: Honey and Gilpin (2009) suggests that the tourism industry can also help promote peace and stability in developing country like India by providing jobs, generating income, diversifying the economy, protecting the environment, and promoting cross-cultural awareness. However, key challenges like adoption of regulatory frameworks, mechanisms to reduce crime and corruption, etc, must be addressed if peace-enhancing benefits from this industry are to be realized (http://www.trcollege.edu.in/articles/74-development-and-impact-of-tourism-industry-in-india).

Negative Impacts of Tourism

Undesirable Social and Cultural Change: Tourism sometimes led to the destruction of the social fabric of a community. The more tourists coming into a place, the more the perceived risk of that place losing its identity. A good example is Goa. From the late 60's to the early 80's when the Hippy culture was at its height, Goa was a haven for such hippies. Here they came in thousands and changed the whole culture of the state leading to a rise in the use of drugs, prostitution and human trafficking. This had a ripple effect on the country.

Increase Tension and Hostility: Tourism can increase tension, hostility, and suspicion between the tourists and the local communities when there is no respect and understanding for each other's culture and way of life. This may further lead to violence and other crimes

committed against the tourists. The recent crime committed against Russian tourist in Goa is a case in point.

Creating a Sense of Antipathy: The tourism brought little benefit to the local community. In most all-inclusive package tours more than 80% of travellers' fees go to the airlines, hotels and other international companies, not to local businessmen and workers. Moreover, large hotel chain restaurants often import food to satisfy foreign visitors and rarely employ local staff for senior management positions, preventing local farmers and workers from reaping the benefit of their presence. This has often created a sense of antipathy towards the tourists and the government.

Adverse Effects on Environment and Ecology: One of the most important adverse effects of tourism on the environment is increased pressure on the carrying capacity of the ecosystem in each tourist locality. Increased transport and construction activities led to large scale deforestation and destabilisation of natural landforms, while increased tourist flow led to increase in solid waste dumping as well as depletion of water and fuel resources. Flow of tourists to ecologically sensitive areas resulted in destruction of rare and endangered species due to trampling, killing, disturbance of breeding habitats. Noise pollution from vehicles and public address systems, water pollution, vehicular emissions, untreated sewage, etc. also have direct effects on bio-diversity, ambient environment and general profile of tourist spots (http://www.trcollege.edu.in/articles/74-development-and-impact-of-tourism-industry-in-india).

Problems of Indian Tourism

The Indian government's "Incredible India" tourism campaign and the information technology growth in India have been attracting millions of foreign tourists and business tourists to India. Medical tourism has also recently mushroomed in India. Tourism industry is a big foreign exchange earner in India, yet the industry still is hampered by several problems like (https://www.studymode.com/v1/turnitin_essay/1616364)–

1. Poor transportation

2. Lack of basic hygienic amenities at halting points

3. Non-standardization of rates and fares

4. Lack of sound marketing and promotion strategies

5. Poor maintenance of heritages.

6. Issues regarding security and harassment.

7. Lack of passionate and trained professionals.

8. Inadequate capacity.

9. Costly travel – soaring fuel surcharges, poor flight management etc.

10. Lack of supportive infrastructure – bad roads, improper health and hygiene, communication gaps, etc.

11. Gap between demand and supply of manpower.

12. Lapses in security and safety – incidents of tout and harassment of tourists in some places.

13. Uneven progress – slow growth of village tourism, lack of information about tourist profile etc.

14. Non Implementation of Legislative Law .

15. Excessive formalities for an issue of special permit to view restricted areas sites.

16. Untrained Guides.

17. Tourism development projects are usually developed by Indian Government without any discussion with community leaders and they are dumped to follow the ineffective projects blindly.

18. Poor Administration & management.

19. Absence of alternate site nearby and fair and festival creates a bottleneck problem in crowd management. Like In Kumbh fair no effective remides are applied by Indian Government to curtail overcrowd by creating other destinations in nearby localities.

20. Involvement of too many agents and tourism operators also makes the cost of tourism package too high in India.

21. Lack of entrepreneurship opportunities also restrict youth to follow a career in Tourism such as opening a hotel resort or retail outlet or handicraft business to serve Tourism Industry in India (http://www.ijtrd.com/papers/IJTRD7776.pdf).

New Issues and Challenges

India represents one of the most potential tourism markets in the world. It has expanded rapidly over the past few years and underpinned by the government support, rising income level and various international sports events, the Indian tourism industry will continue to grow at the fastest pace in the coming years. However, the industry may have to cope up with several challenges which will limit its growth. Post globalization and under GATS many changes and challenges are confronted by the tourism industry in India. A few are may be mentioned here (https://www.studymode.com/v1/turnitin_essay/1616364):

(1) Liberalization and Tourism: GATS came into existence as a result of the Uruguay Round of negotiations and entered into force on 1 January 1995, with the establishment of the WTO. India also signed all the WTO agreements under the single undertaking rule and GATS is a part of this whole package. More and more services like transport, banking and insurance, tourism etc became "tradable services". Under GATS, tourism and travel related services –

hotels and restaurants (including catering), travel agencies and tour operators' services, tourist guide services etc are covered for open market access and liberal FDI.

(2) Social and Political Concerns: Globalization has raised socio-cultural issues in tourism too. From going global we have arrived to the need for "thinking globally and acting locally". The nexus of globalism and tourism is so sensitive that it is a real challenge to development of environmentalism. Can hi-tech tourism go hand in hand with heritage tourism? How balanced are virtual tourism and rural tourism? How to make India a safe and healthy place to tour and travel? New parameters at the micro, macro and meso levels have to be identified for developing tourism keeping in view the incidents of communalism, deforestation, pollution etc. Isn‟t it ironical that in this era of globalization – when we are using hi-tech to squeeze space and conquer time – that we have to pause and ponder over communal problems? In Kashmir sadly it looks like terrorism industry vs. tourism industry. Now it is seen in the southern states too. These are a few aspects of the new paradigm of "geo-politics of tourism" today. No doubt, technological improvements are likely to lead to increased destination alternatives to physical tourism (e.g. cyber tourism). Our tourism industry must prepare itself to meet these and other emerging challenges.

(3) Infrastructural Bottlenecks: A sector that is expected to increase forex by rupees 5000-10000 crore by 2010, cannot go on and on with the mediocre infrastructural facilities. For example, the Indira Gandhi International Airport which today ranks amongst the worst in the world according to the WTCC Report needs to be converted into a modern state-ofthe-art airport. Lack of integration between domestic and international tourism, lack of coordination between modes of transport and communication is eating up people‟s time and money, unproductively. Success of tourism depends to a large extent on better access to infrastructure, consumer-centric approach, terrorism, natural disasters, climate change, global warming.

(4) Alternatives: A major breakthrough is taking place in international tourism. That is alternative tourism, a new option for India too. This includes health tourism, village tourism (in the vintage of global village!), sports and games tourism etc. Kerala has done innovative thinking in "monsoon tourism". This is really a rich and attractive avenue that not only helps in reducing seasonality of tourism but also ensure optimum use of tourist facilities and services.

Future of India Tourism Industry

1. India is expected to see an influx of 10 Million international tourists by 2010, up from just 5 Million in 2007.

2. Indian outbound tourist departure is expected to reach 20.5 Million by 2015.

3. In 2008, top four (4) states captures more than 75% of total market share of Indian domestic tourist visits.

4. Domestic tourist visits is expected to increase with a CAGR of 12.29% for the period spanning 2008-2015.

5. Indian tourism Foreign Exchange Earnings is expected to grow with a CAGR of 7.9% for the period spanning 2010- 2015.

6. In Indian union budget 2010 Indian government has given more than INR 1,000 Crore to Ministry of Tourism India

7. In 2009 FDI investment in Indian hotel and tourism sector was more than US$ 550 Million.

8. The number of cruise tourist arrivals in India is expected to jump by 233.33% by 2010 from the number of cruise tourist arrivals in 2007.

9. The number of medical tourist arrivals in India is expected to increase by a CAGR of 24.6% from 2009 to 2013.

10. India has been promoting its healthcare tourism by providing the visitors with private healthcare facilities. India medical tourism market is expected to be more than US$ 2 Billion by 2013.Key Findings. SUGGESTIONS For everything we need a policy – a sound policy. Let me now put forward a few policies (https://www.studymode.com/v1/turnitin_essay/1616364).

Suggestions to Develop Sustainable Tourism in India

1. India should make the most of its topography, natural resources and labor to develop not only traditional products but also nontraditional products of tourism.

2. Rural tourism should be a byproduct of Indian tourism. At the Same time eco-tourism for sustainable livelihoods must be encouraged.

3. Enhancing security, stepping up investment and boosting (world class) infrastructural activities should be on the top of the agenda. Service quality – in hotels, Airports, railway stations, etc – needs to be upgraded.

4. Proper market segmentation should be done on the basis of criteria like demographic, socioeconomic and geographic variables. Yet a holistic approach should be the objective to project an Incredible and Inclusive India. Commercialization should not result in dehumanizing tourism.

5. Education, research and training are crucial cogs in the wheel of tourism. HRD should be given priority. Adequate importance should be given to inductive research on historical importance and contemporary relevance. Tour operators, guides must develop a good rapport with tourists. From touring to learn we should move to learning to tour.

Tourism is today emerging as a leading sector in the world and is now considered by some as the number one industry. Demographic, socio-structural and socio-cultural developments have always led to changes in tourist demands, and service providers in tourism are faced with a substantial need to adjust. These constant challenges have expanded and intensified considerably in the first few years of the new millennium. War and tourism, extreme weather, the ongoing internationalization of tourism and the ageing of society (increasingly prominent

in public awareness) have emphatically demonstrated the latent vulnerability of tourism as a boom industry.

The survival of the tourism industry depends decisively on recognizing the relevant trends and allowing for them in good time. Development of tourism is a very complex process of interaction among many players, who have shared the responsibility concerning the environmental, social and economic sustainability of this lucrative sector. Consumer trends in tourism, which are gradually changing, require an appropriate response in terms of both policy formulation and investment and the survival of the tourism industry depends decisively on recognizing the relevant trends and allowing for them in good time. However the Indian tourism industry has been hit by pollution. The effluent emitted by the Mathura Refinery has led to the decolonization of the TajMahal in Agra. The condition of many of our monuments is deteriorating due to the negligence of the concerned authorities.

On the other hand, beaches have become the dumping grounds of garbage and waste left by tourists. This nuisance should be properly monitored. Kashmir is the paradise for domestic and international tourists. The terrorism in this valley not only affects the life of the common people but also the tourism, which is very important for the economy of the state. Necessary steps should be taken by the state government as well as central government to prevent this menace (http://www.ijtrd.com/papers/IJTRD7776.pdf).

UNIT: - 10
CRISIS, CONSERVATION AND MANAGEMENT OF RESOURCE; SUSTAINABLE DEVELOPMENT

INTRODUCTION

Natural resources such as land, water, timber, minerals, metals and oil are vitally important sources of livelihoods, income and influence for countries and communities around the globe. When natural resources are poorly managed or inequitably shared, however, or when business operations are implemented without due consideration for context and communities, they can contribute to tensions that can escalate into violent conflict, or feed into and exacerbate pre-existing conflict dynamics. Moreover, population growth and environmental degradation are intensifying competition over already scarce resources, such as land and water, and climate change threatens to increase such competition even further. It comes as no surprise, then, that many experts and governments expect natural resources to become key drivers in a growing number of disputes, with potentially significant consequences for international, regional, and national peace and security.

In light of these risks, renewed attention needs to be paid to mechanisms for mitigating and resolving natural resource disputes. One particularly useful tool is mediation, which can be defined as a non-adversarial and collaborative process through which an impartial third party helps parties in a dispute reach a resolution through interest-based negotiations. Indeed, mediation processes – which are voluntary and consensus-based – tend to lead to resolutions and outcomes that are longer lasting and more sustainable than adversarial processes or otherwise imposed outcomes. In conflicts involving natural resources, sustainable outcomes are even more desirable because the shared benefits of these resources often cross tribal, societal, communal, and national boundaries. Collaboration over their ownership, management, and use is therefore critical to peace and stability.

Importantly, natural resource conflicts are often more amenable to mediation than disputes where ideology or ethnicity are the main driving factors. Indeed, finding consensus and building alliances over natural resources is often easier because natural resources shape economic incentives that transcend other divides. Mediation over natural resources can effectively help parties identify ways to maximize and share benefits, and ultimately unlock entrenched or zero-sum positions, allowing parties to develop cooperative and constructive relationships that can be carried over to other areas. As such, natural resources can help provide entry-points to other divisive issues (https://moam.info/natural-resources-and-conflict-unep-document-repository-home_5a9dfb571723dde75c22d34b.html).

Definition of Resource

Everything available in our environment which can be used to satisfy our needs, provided, it is technologically accessible, economically feasible and culturally acceptable can be termed as 'Resource'.

The process of transformation of things available in our environment involves an inter-dependent relationship between nature, technology and institutions. Human beings interact with nature through technology and create institutions to accelerate their economic development. Do you think that resources are free gifts of nature as is assumed by many? They are not. Resources are a function of human activities. Human beings themselves are essential components of resources. They transform material available in our environment into resources and use them. These resources can be classified in the following ways– (a) On the basis of origin – biotic and abiotic (b) On the basis of exhaustibility – renewable and non-renewable (c) On the basis of ownership – individual, community, national and international (d) On the basis of status of development – potential, developed stock and reserves (https://www.scribd.com/document/231393485/News-Prepation).

A resource is a source or supply from which a benefit is produced and that has some utility. Resources can broadly be classified upon their availability, a natural resource is anything obtained from the environment to satisfy human needs and wants they are classified into renewable and non-renewable resources. They can also be classified as actual and potential on the basis of the level of development and use, on the basis of origin they can be classified as biotic and abiotic, and on the basis of their distribution, as ubiquitous and localized an item becomes a resource with time and developing technology (http://www.ndvsu.org/images/StudyMaterials/VPH/topic-3-Natural-resources-types-uses-and-abuses.pdf).

Introduction to Natural Resources

Any material which can be transformed in a way that it becomes more valuable and useful can be termed as resource. In other words, it is possible to obtain valuable items from any resources. Resource, therefore, are the means to attain given ends. The aspect of satisfaction is so important that we consider a thing or substance a resource, as so long it meets our needs. Life on this planet depends upon a large number of things and services provided by the nature, which are known as Natural Resources. Thus water, air, soil, minerals, coal, forests, crops and wild life are all examples of natural resources.

Classification of natural resources: Depending upon availability of natural resources can be divided into two categories such as

(1) Renewable

(2) Non-renewable resources

1.Renewable resources: Renewable resources are in a way inexhaustible resources. They have the ability to replenish themselves by means such as recycling, reproduction and replacement.Examples of renewable resources are sunlight, animals and plants,soil,water,etc.

2**. Non-Renewable Resources:** Non-renewable resources are the resources that cannot be replenished once used or perished. Examples of non-renewable resources are minerals, fossil fuels, etc. Resources can also be classified as biotic or abiotic.

a)Biotic resources: These are living resources (e.g. forest, agriculture, fish and wild life) that are able to reproduce or replace them and to increase.

b)Abiotic resources: These are non-living resources (e.g. petrol, land, minerals etc.) that are not able to replace themselves or do so at such a slow rate that they are not useful to consider them in terms of the human life times.

Problems associated with natural resources

1. The unequal consumption of natural resources: A major part of natural resources today are consumed in the technologically advanced or 'developed' world, usually termed 'the west'. The 'developing nations' of 'the east', including India and China, also over use many resources because of their greater human population. However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases.

2. Planning land use: Land is a major resource, needed for not only for food production and animal husbandry, but also for industry and growing human settlements. These forms of intensive land use are frequently extended at the cost of 'wild lands', our remaining forests, grasslands, wetlands and deserts. This demands for a pragmatic policy that analyses the land allocation for different uses.

3. The need for sustainable lifestyles: Human standard of living and the health of the ecosystem are indicators of sustainable use of resources in any country or region. Ironically, both are not in concurrence with each other. Increasing the level of one, usually leads to degradation of other. Development policies should be formulated to strike a balance between the two (http://ecoursesonline.iasri.res.in/mod/page/view.php?id=4527).

CRISIS OF RESOURCE

Globally, natural resources are becoming more strained each year as more people lay claim for the consumption and demand a higher standard of living. As countries search for more resources to exploit, an enormous toll is being taken on the planetary resources. Water resources are available in the form of rivers, lakes and aquifers which get replenished by rain. Because of overexploitation the water availability has almost polluted 80% of the aquifers and dams and check dams though originally created for irrigation has made the rivers run dry and rain water runs off to sea because of over exploitation through sand mining in river beds for construction purposes.

Globally, natural resources are becoming more strained each year as more people lay claim for the consumption and demand a higher standard of living. As countries search for more resources to exploit, an enormous toll is being taken on the planetary resources. Water

resources are available in the form of rivers, lakes and aquifers which get replenished by rain. Because of overexploitation the water availability has almost polluted 80% of the aquifers and dams and check dams though originally created for irrigation has made the rivers run dry and rain water runs off to sea because of over exploitation through sand mining in river beds for construction purposes.

Fossil fuels are also exploited and contribute to pollution; burning fossil fuels warms the planet and acidifies the oceans by releasing carbon and other greenhouse gas emissions into the environment. In spite of contributions to air pollution and oil spills on sea water etc. the exploitation of fossil fuel will continue, till alternate sources are identified. In Indonesia and Malaysia-the top two palm oil producing countries-palm oil cultivation is largely unregulated and is depleting tropical forests, which are important carbon sinks and habitats for endangered species. Due to deforestation the forest fires have become more frequent and more damaging.

Trees provide many essential roles-creating and regulating ecosystems, providing food, filtering water, absorbing carbon, protecting people from droughts and extreme weather, mitigating floods, and many more. Yet trees are destroyed around the world. In the last century, more than half of the world's rainforests have been cut down. Roughly 48 football fields worth of trees are lost each minute. And it's estimated that up to 15% of global greenhouse gas emissions comes from chopping down or otherwise destroying trees. Deforestation is driven by industries ranging from agriculture and livestock to real estate development and palm oil production. There are other destructions like top soil degradation by usage of artificial manmade chemical fertilizers. The latest development is the destruction due to deep sea water exploration for minerals and metals (Subramanian, 2018).

Natural resources refer to the things that exist freely in nature for human use and do not necessarily require the action of mankind for their generation or production. The key aspect of natural resources is that they determine the survival of humans and other life forms on earth. These resources include land, rocks, forests (vegetation), water (ocean, lakes, streams, seas, and rivers), fossil fuel, animals (fish, wild life, and domesticated animals), minerals, sunlight and air. Some examples of natural resources are: air which provides wind energy, Coal which act as an input for electricity, forests which provide paper, wood and various medicines, Water which is used for drinking and production of hydroelectric energy, sunlight that is used for drying clothes, photosynthesis and solar energy. They are known as Natural Resources because they provide for the basis of life on earth. It is from the natural resources that humans obtain and produce the components and materials found within our environments. Every artificial product is made from the natural resources. The materials may be used as they occur naturally or may be transformed in other forms. However, most natural resources are prone to depletion and degradation which has brought about worldwide concerns for their sustainable usage and management (https://eartheclipse.com/environment/types-and-threats-to-natural-resources.html).

The world is heading for an "ecological credit crunch" far worse than the current financial or economic crises because humans are over-using the natural resources of the planet, an international study warns. The Living Planet report calculates that humans are using 30% more

resources than the Earth can replenish each year, which is leading to deforestation, degraded soils, polluted air and water, and dramatic declines in numbers of fish and other species. The problem is also getting worse as populations and consumption keep growing faster than technology can find new ways of expanding what can be produced from the natural world (Subramanian, 2018).

Threats to Natural Resources

As the human population keeps on growing, there is a lot of pressure on the utilization of almost all natural resources. This often causes over-exploitation of the natural resources. To worsen matters, exhaustible natural resources such as arable land, coral reefs, fresh water, fossil fuels, and a variety of vegetation in forests drop sharply due to overexploitation to cater to the ever increasing needs of population. This creates competitive demands on the vital life-sustaining resources and contributes to an incredible decline in the quality of life. Over population, depletes the available natural resources like food, timer, fish, clothes, leather, natural water, gas and so on.

Intensive agriculture, road building and construction activities have made a toll of forest reserves. Run off of agricultural wastage, fertilizers and pesticides corrupt and decay fresh water environments and sources of fresh water. Over population has led to climate change generation of greenhouse gases, and several atmospheric threats to biodiversity and ultimately favourable surviving condition for human life. Majority of natural resources have been destroyed due to toxic emission, pesticides, and the pollution of the natural air has affected human and animal lives. Aquatic life has been threatened by pollutants in the form of factory discharges without treatment. Land use patterns like industrial construction, road and rail building, have affected natural parks and air spaces. 20th century life styles of humans have taken toll of several natural resources and made several resources scarce and unaffordable. Six of the world's resources that are being overexploited in ways which are dangerous to both the planet and humanity.

Sand: is used to form beaches and places for recreation. It's used to make windowpanes, cell phone screens, and sunglasses. Concrete and asphalt both come from sand. And the industrial uses of sand-to fill holes, make moulds, and create traction-are seemingly endless. It's the second-most exploited resource after water, and the world is running out of it. Facing a shortage of sand, many countries-from the US to the United Arab Emirates are dredging ocean bottoms for sand, nearly destroying aquatic ecosystems in the process. As The New Yorker reports, "Seafloor dredging creates the undersea equivalent of choking sandstorms, killing organisms, destroying coral reefs and other habitats, and altering patterns of water circulation."

Water: Lakes, aquifers, and underground sources of water are generally replenished through rain and the gradual filtering of water through natural ecosystems. All around the world, however, water sources are being overexploited and polluted, forcing people to dig and search for new sources of water, import water from elsewhere, or buy bottled water. More than half of the world's major aquifers are receding. In China, more than 80% of the country's rural water wells are polluted. Mexico City is literally sinking because it's located on top of aquifers

that are being sucked dry to feed demand. Throughout the Middle East, severe droughts in recent years have created extreme water stress. Globally, one in 10 people do not have access to clean water and it's expected that more than half of the world's population will be living in areas of with highly stressed water sources.

Fossil fuels: Since the start of 2015, the world has harvested more than 99 billion barrels of oil, nearly 25 billion tons of coal, and more than 10.6 trillion cubic meters of natural gas, according to an interactive graphic by The Guardian. Fossil fuels supply the vast majority of the world‟s energy demands and will continue to do so for the foreseeable future. Burning fossil fuels also leads to air pollution, which kills an estimated 6.5 million people each year. Extracting oil can cause devastating spills in marine environments; extracting coal can destroy forests and other landscapes; and extracting natural gas can pollute waterways and cause earthquakes.

Palm oil: Because it's so cheap and versatile, palm oil is the most common vegetable oil in the world, used in everyday products like bread, chocolate, soap, lipstick, and margarine. But it's also causing enormous ecological harm in the countries where it's harvested. Indonesia's forests are more carbon-rich than the Amazon rainforest, yet palm oil companies are rapidly eliminating them, according to the Union of Concerned Scientists. This includes draining and burning peat lands, which can hold up to 28 times as much carbon as forests.

Trees: In 2012, the US lost 804,000 hectares of forest, or 3,250 square miles, primarily through palm oil and other industries. This is threatening already endangered species such as orang-utans and elephants. Forest fires, meanwhile, are becoming more severe in the country because of decapitated forests that in the past provided natural buffers through their thick and water-rich roots. In five months of 2015, forest fires in the country emitted more greenhouse gases than either Japan or Germany do in an entire year.

Soil: It can take more than a millennium to produce 1 centimetre of soil, yet humanity has degraded roughly a third of all the world's soil, according to the UN, and half of all topsoil has been lost in the past 150 years. The primary drivers of this loss include industrial pollution, erosion, bad agricultural practices, real estate development, saltwater contamination, and others. For example, farming a single crop (monoculture farming) on a piece of land with the help of pesticides-the primary mode of farming in the world-has caused widespread soil degradation throughout the world. Since 95% of the food that humans eat comes from soil, the continued degradation of soil poses an existential risk.

Global Citizen Campaigns on the Global Goals, call for the sustainable use of natural resources. Buildings, infrastructure, mobile phones, batteries, and electric cars contain valuable metals such as copper, zinc, silver, and gold. With the seemingly insatiable demand for products enabled by these materials, new sources are needed, particularly as land-based reserves become scarce or are located in places that are too difficult, dangerous, or costly to access. Hydrothermal vent structures at the Mariner site in the South Pacific are deep-sea locations where minerals are often found. The presence of iron in sulphide structures tints these chimneys red. These metals exist, however, in mineral.

However, with a lack of accurate scientific information and so many economic, technological, and environmental uncertainties, is it even possible to create effective environmental regulations? To this end, the researchers suggest that when exploration and testing contracts are granted, those executing the contracts not only survey potential resources and try new technologies but also use the opportunity to study ecosystem responses and provide valuable data to researchers. They also call for a trans-disciplinary approach, drawing on the expertise of researchers from across different fields in the physical and social sciences to inform such international agreements (Subramanian, 2018).

CONSERVATION OF RESOURCES

Resource conservation and recovery offers significant opportunities for local governments to reduce GHG emissions while saving money. Local governments are typically responsible for managing the waste generated within their municipalities. The cost of managing municipal solid waste depends in large part on its volume, which has increased by 184 percent in the United States over the past half-century—from 88 million tons in 1960 to 250 million tons in 2010 (U.S. EPA, 2011e). Additionally, the extraction, production, use, and disposal of goods and materials are responsible for an estimated 42 percent of U.S. GHG emissions (U.S. EPA, 2009a). Every stage of a product's life-cycle (illustrated in Figure 1 at right) contributes to climate change due to the emission of GHGs during the use of natural resources, the consumption of fossil fuels for energy, and the decomposition of organic waste.

Local governments can reduce these emissions by implementing resource conservation and recovery practices, which involve avoiding, delaying, or decreasing the raw materials required to produce new products. As described in Section 3, Resource Conservation and Recovery Practices and Technologies, the greatest emission reductions and cost savings come from avoiding waste in the first place through source reduction and reuse. For materials that reach the endof-life disposal stage, recycling and composting are the most environmentally preferable options, while waste treatment with energy recovery and landfilling are the least environmentally preferable options (https://www.epa.gov/statelocalenergy).

Consumption of natural resources is increasing with growing population. With the increasing industrialisation and urbanisation, we need to conserve natural resources for their destruction will also upset the ecological balance. Conservation is the proper management of a natural resource to prevent its exploitation, destruction or degradation. Conservation is the sum total of activities, which can derive benefits from natural resources but at the same time prevent excessive use leading to destruction or degradation (http://docplayer.net/39771001-Conservation-and-use-of-natural-resources.html).

Conservation of Natural Resources and Traditions of India

The need for conservation of natural resources was felt by our predecessors and in India, there was a tradition of respecting and preserving nature and natural resources. Natural resources were conserved in the form of sacred groves/forests, sacred pools and lakes, sacred species etc. e.g. the river Ganges. In our country the conservation of natural forests is known from the time of Lord Ashoka. Sacred forests are forest patches of different dimensions dedicated by the

tribal to their deities and ancestral spirits. Cutting down trees, hunting and other human interferences were strictly prohibited in these forests. This practice is widespread particularly in peninsular, central and eastern India and has resulted in the protection of a large number of plants and animals. Similarly, several water bodies, e.g., Khecheopalrilake in Sikkim was declared sacred by people, thus, protecting aquatic flora and fauna. Worshipping certain plants like banyan, peepal, tulsi etc. has not only preserved them but also encouraged their plantation. History recalls numerous instances where people have laid down their lives for protecting trees.

Recent Chipko movement in India is one of the best examples. This movement was started by women in Gopeshwar village in Garhwal in the Himalayas. They stopped the felling of trees by hugging them when the lumbermen arrived to cut them. This saved about 12000 square kilometres of sensitive water catchment area. Similar movements also occurred in some other parts of the country (https://gurukpo.com/wp-content/uploads/B.-Sc.-III-Ecology-and-Environmental-Biology.pdf).

Benefits of Resource Conservation and Recovery

Resource conservation and recovery strategies can produce significant environmental, economic, and quality of life benefits by helping local governments to do the following (https://www.epa.gov/statelocalenergy):

1. Reduce GHG emissions and other pollutants: Preventing the generation of future waste, along with recycling and composting existing waste, reduces GHG emissions. These strategies decrease the consumption of fossil fuels used to manufacture, transport, and dispose of goods, and in turn, reduce the emission of GHGs, such as carbon dioxide (CO2), methane, and nitrous oxide, as well as criteria air pollutants such as sulphur dioxide (SO2) and nitrogen oxides (NOX). Resource conservation and recovery strategies also help reduce the amount of waste that is ultimately landfilled or combusted, which lowers methane emissions from landfills and other air pollution from MSW incinerators.

The complex nature of the economy and product life-cycles means that some of the emissions benefits of resource conservation and recovery may accrue outside of the municipalities implementing these practices. These “displaced benefits” arise for two basic reasons. First, since many municipalities send their waste to landfills located outside their boundaries, the emissions benefits from avoided disposal in landfills will also occur outside their jurisdictions. Second, increasing their recycling rate will reduce the upstream manufacturing energy and GHG emissions required to make new materials from virgin inputs.

2. Reduce dependence on virgin materials: By reusing and recycling materials local governments can reduce the need for manufacturers to extract virgin natural resources. Reducing reliance on virgin resources can also provide other benefits. For example, avoiding the need to cut down trees for paper and other products can increase carbon sequestration, which is the uptake and long-term storage of atmospheric carbon.

3. Support economic growth through job creation and market development: Local governments that invest in resource conservation and recovery can stimulate the local economy, encourage development of recycling and composting markets and businesses, and create jobs. According to the Tellus Institute, increasing the national average recycling rate in the United States (currently about 34 percent) to 75 percent by 2030 could create more than 2.3 million jobs, approximately 2.7 times the number of jobs in this sector in 2008 (Tellus Institute, 2011). Local governments can encourage economic development in their communities by establishing or expanding reuse centres and recycling collection, and by hosting recycling or composting processing facilities.

4. Reduce waste collection and landfilling costs: When local governments encourage residents to divert waste from landfills, they save money by spending less on collecting waste, transporting it to landfills, and paying a fee to landfill each ton. In 2008, the average U.S. tipping fee (a fee for landfilling waste) was approximately $44 per ton, and Americans generated an average of 1.28 tons of waste per person (van Haaren et al., 2010). Assuming these national average values, annual tipping fees alone for the waste generated by a town of 50,000 residents would cost more than $2.8 million. If that town were to initiate a recycling program with a diversion rate of 50 percent, it would avoid $1.4 million in tipping fees.

5. Demonstrate leadership: Local governments can demonstrate environmental, fiscal, and societal leadership by adopting resource conservation and recovery policies in their own operations. Policies that mandate specific waste reduction goals, promote recycling and composting, or set minimum recycled content requirements for product purchasing can reduce waste collection and disposal and encourage the growth of local recycling and composting businesses. These policies can reduce environmental and health impacts, save money, stimulate economic development, and encourage residents and the private sector to adopt resource conservation and recovery practices.

6. Improve public health: Resource conservation and recovery reduces air and water pollution, providing significant human health benefits. By reducing waste, resource conservation and recovery also reduces the amount of landfill capacity needed, allowing local governments to close existing landfills earlier and convert them into beneficial public spaces.

Methods of Conservation of Resources

(1) It is necessary to create awareness about the preservation and conservation of resources among people. They should be made aware of the harmful result of large scale destruction of natural resources.

(2) Afforestation, preventing the felling of immature and young trees and creating awareness amongst the local people about planting and nurturing trees may help in conserving forests.

(3) Terrace farming in hilly regions, contour ploughing, controlling the shifting cultivation, overgrazing and plugging the Gullies. Some of are the import methods of soil conservation.

(4) Construction of dams to impound rain water, use of sprinklers, drip or trickle irrigation technique, recycling of water for industrial and domestic purposes will help in conservation of the invaluable water resource.

(5) Minerals are non-renewable resources so they need to be conserved through efficient utilisation, development of better technology of extraction and purification, recycling of minerals and use of substitutes.

(6) Non-conventional sources of energy e.g. solar, wind or water will have to be developed in order to save conventional sources of energy (http://nos.org/media/documents/316courseE/ch19.pdf).

Policy on Conservation of Resources

With growing consciousness of environment conservation, the efficient use of resources has become important for a developing country like India. We have to increase our R & D (Research and Development) efforts to explore for new resources, devise technologies to minimize waste and conserve non-renewable resources. Government of India has formulated several policies and programmes to implement for conservation of our biotic & abiotic resources (https://www.msuniv.ac.in/Download/Pdf/84cb78a7213448a).

1. A ministry of forests and environment was created at the Union level in 1980 to give high priority to issues relating forest and environment in the country. By now, all the state government have also created independent ministry of forest and environment.

2. National Forest policy of 1950 was revised in 1988 to make an effective tool as per current needs to protection, conservation and development of forest in the country. Under this policy social forestry scheme was launched to increase green coverage, produce and supply of fuelwood etc.

3. National land use and conservation Boards were established in 1983, and restructured in 1985 for land resource conservation and preparation of perspective plan for optimum utilization of land resources.

4. National water policy was adopted in 1987 which accord the highest priority to drinking water, followed by irrigational hydel power generation, navigational, industrial and other uses of water.

5. A National Mineral Policy framed in 1990 has allowed both domestic and foreign enterprise to invest in mineral extraction and export. It also allowed the authority to permit investment in mineral extraction directly under the Union Ministry of Mines.

6. In new agriculture policy of encouragement is given to use eco-friendly and sustainable agricultural technology, i.e. bio-technology.

About 23 percent of total area of India is covered by forests. About 75,000 species of animals are found in India. Wide climatic variations and a long crop growing season has put an advantage before India to grow variety of crops. India has nearly three-fifths or about 57

percent of the world's buffalo population and 15 percent of the cattle population. Further, the large continental shelf provides large scope for the development of fisheries in India. Vast size of India in itself is the most important resource.

Large water resources are found in form of surface water, ground water, rains and oceans. Mineral wealth of India is equally rich. Conservation of resources stands for judicious and planned use of natural resources. It is necessary to create awareness among people about the preservation and conservation of resources. Various methods like afforestation, terrace farming in hilly regions, use of advanced irrigation techniques, efficient utilization of minerals and use of alternative sources of energy should be used to conserve natural resources.

MANAGEMENT OF RESOURCES

It is important to note that none of the resources are unlimited. All resources are finite. We need to utilise resources effectively to achieve our goals faster and efficiently. Resources, therefore, should not be misused and wasted. Thus, to achieve our goals, effective management of resources is extremely essential.

Managing resources is about getting the most from the resources which are available to us. For example, everybody has 24 hours in a day. While some plan their schedule everyday and utilise every hour to achieve their goals, others waste their time and are not able to do anything productive the entire day. Management of resources involves implementing resource management procedures which include planning, organising, implementing, controlling and evaluation (https://ncert.nic.in/textbook/pdf/kehe101.pdf).

Why Do We Need to Manage Our Resources?

Not just roads and buildings, but all the things we use or consume – food, clothes, books, toys, furniture, tools and vehicles – are obtained from resources on this earth. The only thing we get from outside is energy which we receive from the Sun. Even this energy is processed by living organisms and various physical and chemical processes on the earth before we make use of it. Why do we need to use our resources carefully? Because these are not unlimited and with the human population increasing at a tremendous rate due to improvement in health-care, the demand for all resources is increasing at an exponential rate.

The management of natural resources requires a long-term perspective so that these will last for the generations to come and will not merely be exploited to the hilt for short term gains. This management should also ensure equitable distribution of resources so that all, and not just a handful of rich and powerful people, benefit from the development of these resources. Another factor to be considered while we exploit these natural resources is the damage we cause to the environment while these resources are either extracted or used. For example, mining cause's pollution because of the large amount of slag which is discarded for every tonne of metal extracted. Hence, sustainable natural resource management demands that we plan for the safe disposal of these wastes too (https://www.scribd.com/document/423227756/Environment-NCERT-Summary).

But we need not feel powerless or overwhelmed by the scale of the problems because there are many things we can do to make a difference. You must have come across the three R's to save the environment: Reduce, Recycle and Reuse. What do they refer to? (https://www.philoid.com/epub/ncert/10/154/jesc116).

Reduce: This means that you use less. You save electricity by switching off unnecessary lights and fans. You save water by repairing leaky taps. You do not waste food. Can you think of other things that you can reduce the usage of?

Recycle: This means that you collect plastic, paper, glass and metal items and recycle these materials to make required things instead of synthesising or extracting fresh plastic, paper, glass or metal. In order to recycle, we first need to segregate our wastes so that the material that can be recycled is not dumped along with other wastes. Does your village/town/city have a mechanism in place for recycling these materials?

Reuse: This is actually even better than recycling because the process of recycling uses some energy. In the 'reuse' strategy, you simply use things again and again. Instead of throwing away used envelopes, you can reverse it and use it again. The plastic bottles in which you buy various food-items like jam or pickle can be used for storing things in the kitchen. What other items can we reuse?

But even while making everyday choices, we can make environment friendly decisions. For doing this, we need to know more about how our choices affect the environment, these effects may be immediate or longterm or long-ranging. The concept of sustainable development encourages forms of growth that meet current basic human needs, while preserving the resources for the needs of future generations. Economic development is linked to environmental conservation. Thus sustainable development implies a change in all aspects of life. It depends upon the willingness of the people to change their perceptions of the socio-economic and environmental conditions around them, and the readiness of each individual to alter their present use of natural resources.

The Management Process

As stated above, the management process involves five aspects – planning, organising, implementing, controlling and evaluation (https://ncert.nic.in/textbook/pdf/kehe101.pdf).

(a) Planning: It is the first step in any management process. It helps us to visualise the path to reach our goals. In other words, to plan is to produce a scheme for action to achieve specified goals by using the available resources. Planning involves selecting the course of action. To plan effectively to achieve a goal, you must ask the following four basic questions. The answers to these questions will help you to develop a plan.

1. What is our present situation? This involves assessing the present situation, analysing what one has at present and what one would like to have in future.

2. Where do we want to reach? This involves setting specific goals or targets which we desire to achieve keeping in mind the present and future needs.

3. Gap. This is the difference between our present situation and the desired situation. We need to cover this gap in order to achieve our goal.

4. How can we reach our desired goals? Answering this question will help you to decide how to cover this gap. This involves making a plan to achieve goals.

Steps in planning: The basic steps in planning are–

1. Identifying the problem.\

2. Identifying different alternatives.

3. Choosing between alternatives.

4. Acting to carry out the plan/Putting the plan into action.

5. Accepting the consequences.

For example, there is only one month left for your annual examination and you have not completed your revision (present situation); your aim is to score good marks (goal). To achieve this goal you need to study five subjects in the specified time period (gap). You would think of a way of achieving this goal (prepare a plan of action), which will include the number of hours you will devote to each subject, prioritising subjects, curtailing other activities and so on.

(b) Organising: It is collecting and arranging appropriate resources in order to implement plans in an effective and efficient manner. If we take the above example, you would organise and arrange all the resources which you may require to study and secure good marks. Some resources could include books, notes, space to study, light, stationery, energy and time.

(c) Implementing: This stage involves carrying out the prepared plan. In the above example, you would put the plan into action by starting to study from the available resources (e.g., books, stationary, notes, etc.).

(d) Controlling: It refers to the task of ensuring that your activities are producing the desired results. In other words, the plan you have put into action is getting the desired results. Controlling helps monitor the outcome of activities and makes sure that the plans are being implemented correctly. It is important as it provides feedback and helps to check errors. Feedback helps you to revise your plan of action so you can achieve your goal. Therefore, while you are putting your study plan into action, yet you are unable to complete your allotted chapter because you watch television, this gives you the feedback that you need to minimise your distractions. You will not watch T.V., play or chat with friends during the study hours, as it can affect the outcome of your formulated plan (i.e., study as per the decided number of study hours).

(e) Evaluation: In the final stage, the outcomes that you have arrived at after putting your plan into action are evaluated. The end result of the task is compared with the desired result. All the limitations and the strengths of the task are noted so that they can be used in future to achieve one's goals effectively. With reference to the example of studying, evaluation is what you do

when you get back the checked answer sheets of the examination. You evaluate your marked answer sheets as per the preparation you had done for the examination and the results you had wanted to achieve. If the scores for any subject fall short of your expectations, you try to identify the reasons for the same. At the same time, you also try to find out your strengths which helped you to secure good marks in other subjects. Then you use these strengths to overcome your limitations to secure better marks in your next examination.

SUSTAINABLE DEVELOPMENT

The term development is generally used to denote growth or progress. However the term, particularly in last two centuries, has become synonym to economic growth in terms of gross domestic product or the per capita income of the nation. This definition has created a rat race amongst the nations to attain and retain development goals. These goals are often contradictory to the idea of preservation or sustenance of environment. In order to re-build the harmonious relationship between man and nature, world organizations like UN, has begun the campaign to have a sustainable development.

The Concept of Sustainable Development

The most frequently used definition of Sustainable development is from the Brundtland Report "Sustainable development is the development that meets the needs of the present (people) without compromising the ability of future generation to meet their own needs". In other words it is improving the quality of life of the present generation without excessive use or abuse of natural resources, so that they can be preserved for the next generation.

The term was first coined in 1972 at the United Nations Conference on Human Environment at Stockholm. The most important piece of writing on Sustainable development is in the publication by the World Commission on Environment and Development (WCED) in 1987 titled „Our Common Future". In 1992 at the Earth summit at Rio-de-Janerio, 170 countries signed many important documents on sustainable development pledging preservation of environment.

Sustainable development is often referred as the marriage of economy and ecology. i.e. to attain economic development without compromising the ecological balance. It can be attained by rigorous policy change, taking action and altering practices. There are three aims of sustainable development:-

a) Economic- to attain balanced growth

b) Ecological- to preserve the eco system

c) Social-guarantying equal access to resources to all human communities.

The objective laid down in the Brundtland report is as follows: -

- Dividing growth
- Changing the quality of growth
- Meeting essential needs of all in terms of job, food, energy, water and sanitation.

- Ensuring a sustainable population
- Conserving and enhancing the resource base.
- Reorienting technology, building technology that's less exploitative
- Managing environment and economics in decision making.

Need for sustainable development

There are several challenges that need attention in the arena of economic development and environmental depletion. Hence the idea of Sustainable development is essential to address the following issues.

- To curb or prevent the environmental degradation
- To ensure a safe human life
- To check the exploitative technology and find alternative sources
- To check the over exploitation and wastage of natural resources
- To regenerate renewable energy resources.

The concept of Sustainable development is based on following principles

- Integration of environment and economic decision
- Stewardship or humans as the caretaker of the environment
- Shared responsibility, accountability and decision making
- Prevention and mitigation
- Conservation
- Waste minimization
- Enhancement of productivity, capability, quality of nature and human life \
- Rehabilitation and reclamation (https://www.scribd.com/document/429287349/FC-pdf).

Three Pillars of Sustainability

The purpose of Sustainable Development is to "Meet the needs of the present without compromising the ability of future generations to meet their own needs". In order to perceive Sustainability, someone has to take into account three main areas of influence, the so called "Three Pillars of Sustainability" and the corresponding aspects which are the Social, Economic and Environmental aspect.

This three aspects are interconnected and if they are combined and applied in real world situations they can create a steady base for a sustainable world from which everybody can benefit. "Natural resources are preserved, the environment is protected, the economy is not harmed and the quality of life for our people is improved or maintained" (https://www.ihu.edu.gr/icsd/docs/introduction-to-sustainable-development.pdf).

Environmental Sustainability: - In order to achieve environmental sustainability, natural environment should retain its total functionality and utility for a long period of time. It is preferable that actions taken should encourage a balance in our natural environment while

simultaneously promote positive growth rates. Any actions that disrupt the balance of the environment should be avoided but if they occur they should be limited to a lesser extent. Environmental impacts of any action or decision should be taken into account. There is a variety of issues related with environmental sustainability from pollution to the management of natural resources. The main purpose of Environmental Sustainability is to minimize the impact of human activities to the environment and furthermore encourage the restoration and preservation of our natural habitat.

Economic Sustainability: - Economic sustainability is the ability of an economy to support a defined level of economic production indefinitely. Economic value can be created out of every project or decision. Economic sustainability refers to decisions that are made in the most prudent way possible with respect to the other aspects of sustainability. True sustainability is not promoted when only the economic aspects are considered. On the large scale the usual approach used to be "business as usual" which meant than profit was the only concern and aim of firms. However, when good business practices are incorporated with the social and environmental aspects of sustainability, the result is significantly more positive. Economic sustainability consists of many things. From "smart growth" to subsidies or tax breaks for green development. It is important though to reinforce and promote it with education programs, research and informing the public. Also, much emphasis should be placed on other areas such as reducing unnecessary spending (https://www.ihu.edu.gr/icsd/docs/introduction-to-sustainable-development.pdf).

Social Sustainability: - Social Sustainability relies on decisions and projects that promote the general improvement of society. Generally, the social aspect of sustainability supports the concept of intergenerational justice, which means that future generations are entitled with the same or greater quality of life as current generations. This concept also encloses many other socially related issues such as environmental law, human and labor rights, health equity, community development via public involvement and participation, social capital, support justice and responsibility, cultural competence, community resilience, and human adaptation. The social dimension of sustainability is equally important as the other two pillars. If it is not taken into serious consideration it can lead to the collapse of the whole process of sustainability as well as the society itself.

Nobel LaureatAmartya Sen gives the following dimensions for social sustainability:

• Equity - the community provides equitable opportunities and outcomes for all its members, particularly the poorest and most vulnerable members of the community

• Diversity - the community promotes and encourages diversity

• Interconnected/Social cohesions - the community provides processes, systems and structures that promote connectedness within and outside the community at the formal, informal and institutional level

• Quality of life - the community ensures that basic needs are met and fosters a good quality of life for all members at the individual, group and community level (e.g. health, housing, education, employment, safety)

• Democracy and governance - the community provides democratic processes and open and accountable governance structures.

• Maturity - the individual accept the responsibility of consistent growth and improvement through broader social attributes (e.g. communication styles, behavioural patterns, indirect education and philosophical explorations) (https://www.ihu.edu.gr/icsd/docs/introduction-to-sustainable-development.pdf).

Sustainable Development Goals

Accelerating climate actions and progress towards a just transition is essential to reducing climate risks and addressing sustainable development priorities, including water, food and human security (robust evidence, high agreement). Accelerating action in the context of sustainable development involves not only expediting the pace of change (speed) but also addressing the underlying drivers of vulnerability and high emissions (quality and depth of change) and enabling diverse communities, sectors, stakeholders, regions and cultures (scale and breadth of change) to participate in just, equitable and inclusive processes that improve the health and well-being of people and the planet (https://www.ihu.edu.gr/icsd/docs/introduction-to-sustainable-development.pdf).

Goal 1: No poverty

Goal 2: Zero hunger (No hunger)

Goal 3: Good health and well-being

Goal 4: Quality education

Goal 5: Gender equality

Goal 6: Clean water and sanitation

Goal 7: Affordable and clean energy

Goal 8: Decent work and economic growth

Goal 9: Industry, Innovation and Infrastructure

Goal 10: Reduced inequality

Goal 11: Sustainable cities and communities

Goal 12: Responsible consumption and production

Goal 13: Climate action

Goal 14: Life below water

Goal 15: Life on land

Goal 16: Peace, justice and strong institutions

Goal 17: Partnership for the goals

Measures taken for implementing SDGs in India

NITI Aayog, the Government of India's premier think tank, has been entrusted with the taskof coordinating the SDGs. States have also been advised to undertake a similar mapping of theirschemes, including centrally sponsored schemes.In addition, the Ministry of Statistics and Programme Implementation (MoSPI) is engagedin the process of developing national indicators for the SDGs. Many of the Government's flagship programmes such as Swachh Bharat, Make in India,Skill India, and Digital India are at the core of the SDGs. State and local governments play a pivotalrole in many of these programmes (http://www.oiirj.org/oiirj/mar2020-special-issue/07.pdf).

India is a country with the second largest population in the world. The steps taken by Indiafor the achievement of SDGs matter a lot to the world. If India succeeds in attaining the SDGs itwould mean a larger section of the world has achieved it. Therefore it is imperative for India todevelop effective methods for implementing, monitoring and measuring the progress of SDGs. Thebiggest challenge for India seems to be the development of suitable indicators (http://www.oiirj.org/oiirj/mar2020-special-issue/07.pdf).

Reference

Bongaarts, J. (2009). Human population growth and the demographic transition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1532), 2985-2990.

Dayananda, K. C. (2016). Tourism and its impact on Indian economy. *IOSR J Hum Soc Sci (IOSR-JHSS)*, *21*, 24-28.

Harris, D. R., & Fuller, D. Q. (2014). Agriculture: definition and overview. *Encyclopedia of global archaeology*, 104-113.

Lipsey, R., & Chrystal, A. (2011). *Economics*. Oxford University Press.

Rogers, P. P., Jalal, K. F., & Boyd, J. A. (2012). *An introduction to sustainable development*. Routledge.

Roy, S., & Bandyopadhyay, T. (2017). Municipal solid waste.

Sustainable Development Goals (SDGs)-Challenges for India. Available from: https://www.researchgate.net/publication/324200471_Sustainable_Development_Goals_SDGs-Challenges_for_India [accessed Aug 11 2022].

Sustainable Development Goals (SDGs)-Challenges for India. Available from: https://www.researchgate.net/publication/324200471_Sustainable_Development_Goals_SDGs-Challenges_for_India [accessed Aug 11 2022].

Seto, K. C., Dhakal, S., Bigio, A., Blanco, H., Delgado, G. C., Dewar, D., ... & Ramaswami, A. (2014). Human settlements, infrastructure and spatial planning.

Subramanian, K. R. (2018). The crisis of consumption of natural resources. *International Journal of Recent Innovations in Academic Research*, *2*(4), 8-19.

Svetlov, N. M., Siptits, S. O., Romanenko, I. A., & Evdokimova, N. E. (2019). The effect of climate change on the location of branches of agriculture in Russia. *Studies on Russian economic development*, *30*(4), 406-418.

Wormald, B. (2015). The Future of World Religions: Population Growth Projections, 2010-2050. *Pew Research Center's Religion & Public Life Project*.

UNIT-11: CONCEPT AND TYPES OF SCALE AND MAP; LAND SURVEY INSTRUMENTS AND THEIR USES

What is map?

Although there are many kinds of maps, one description can be adopted that defines all maps: "A **map** is a graphic representation of the milieu" (Robinson and Petchenik 1976, 16). In this context, *milieu* is used broadly to include all aspects of the cultural and physical environment. It is important to note that this definition includes *mental abstractions* that are not physically present on the geographical landscape. It is possible, for example, to map people's attitudes, although these do not occupy physical space. In this context, maps also have been described as "models of reality"—although one's reality may be different than another's. One of the most basic map distinctions in modern cartography is that maps are either tangible (also called "real") or virtual in nature. Printed maps, such as maps in books, hardcopy atlas maps, the large maps at the front of many classrooms, or the map that you just printed, all have a physical reality and are tangible maps. A **virtual map** is a map that is viewable but is without a physical or tangible reality, such as a map that is displayed on a computer monitor display or as a projected graphic in a lecturer's Power Point presentation. Virtual maps originally had several definitions, depending on the map's permanence and how the map information was stored, and could even include original map data (after Moellering 1984). However, in a practical, contemporary sense, the virtual map has come to mean most impermanent, nonprint maps that appear on a display. The term includes static map images, such as scanned historical maps in an online map collection, as well as interactive maps, such as those maps that can be zoomed in or out from, or can be clicked on and queried, such as those maps found in the *National Atlas of the United States* (2007) or *Encarta* (Microsoft 2007). The term also includes elaborate animated maps and visual terrain fl ythroughs, such as the weather maps on television. Virtual maps are perhaps most commonly found on the Internet but are also found on other sources, such as CD and DVD-ROMs and television broadcasts. Most static maps can be printed, of course, but until they are actually in hardcopy form, they are considered virtual maps. There are also such things as **mental maps,** generally described as mental images that have spatial attributes. Mental maps are developed in our minds over time by the accumulation of many sensory inputs, including tangible or virtual maps. Figure 1.2, for example, is an interesting composite mental map. The defi nition used throughout this book, however, assumes that the map is a tangible or virtual *object* that can be viewed by many people.

What Is Cartography?

The newcomer will probably be confused by the array of terms, names, and descriptions associated with mapmaking. It is unlikely that all those involved will ever reach complete agreement on terminology. For present purposes, we will adopt the following definitions. First, **mapmaking,** or mapping, refers to all of the processes of producing a map, whether the person is collecting data, performing the design of the map, or preparing the map for distribution in hardcopy or for the Web. Mapping, then, is the process of "designing, compiling, and producing maps" (Monmonier 1977, 9). The mapmaker may also be called a *cartographer* (Robinson and Petchenik 1976). A second problem is the proper definition of **cartography.** As the discipline has matured and become broader in scope, many professional cartographers have

come to make a distinction between mapmaking and cartography. In general, cartography is viewed as broader than mapmaking, for it requires the study of the philosophical and theoretical bases of the rules for mapmaking. It is often thought to be the study of the artistic and scientific foundations of mapmaking. The International Cartographic Association defines cartography as follows: *The art, science, and technology of making maps, together with their study as scientific documents and works of art. In this context may be regarded as including all types of maps, plans, charts, and sections, three-dimensional models and globes representing the Earth or any celestial body at any scale* (Meyen 1973, 1). This definition is broad enough in scope to be acceptable to most practitioners. It certainly will serve us adequately in this introduction.

Geographic Cartography Geographic cartography, although certainly a part of all cartography, should be defi ned a bit further. *Geographic cartography* is distinct from other branches of cartography in that it alone is the tool and product of the geographer. The geographic cartographer understands the spatial perspective of the physical environment and has the skills to abstract and symbolize this environment. The cartographer specializing in this branch of cartography is skillful in map projection selection and the mapping and understanding of areal relationships, and has a thorough knowledge of the importance of scale to the fi nal presentation of spatial data (Robinson 1954). Furthermore, geographic cartography, involving an intimacy with the abstraction of geographical reality and its symbolization to the fi nal map product, is capable of "unraveling" or revising the process, that is, geographic cartographers are very adept at map reading (Muehrcke 1981). Geographers have for many years embraced the study of maps and often suggested that maps are at the heart of their discipline. For example, the famous Berkeley geographer Carl O. Sauer writes: *Show me a geographer who does not need them [maps] constantly and want them about him, and I shall have my doubts as to whether he has made the right choice in life. The map speaks across the barriers of language* (Sauer 1956, 289). British geographer Peter Haggett writes, while exploring new ways of mapping accessibility in the Pacifi c Basin: *Although the new map is unfamiliar, it shows the locational forces at work in the Pacifi c in a dramatic way. In the physical world the earth's crust is reshaped by the massive slow forces of plate tectonics. So also technological changes of great speed are grinding and tearing the world map into new shapes. Capturing those spatial shifts [on maps] is at the heart of modern geography* (Hagget 1990, 54). And American geographer John Borchert comments on the importance of maps to geography: *In short, maps and other graphics comprise one of three major modes of communication, together with words and numbers. Because of the distinctive subject matter of geography, the language of maps is the distinctive language of geography. Hence sophistication in map reading and composition, and ability to translate between the languages of maps, words, and numbers are fundamental to the study and practice of geography* (Borchert 1987, 388). Hodler (1994) points out that with the current availability of point and click map production, it may be too easy to ignore fundamental cartographic and geographic principles and knowledge that have been at the traditional core of our discipline. The technological advances that we are experiencing provide the potential for new and better map designs, but without proper cartographic education not only will map quality ultimately suffer but the geographic understanding that is obtained in practicing geographic cartography may be lost as well.

Atlas Mapping

One prominent opportunity for thematic mapping is found in atlas production, as evidenced by the proliferation of state and national atlases. *The Atlas of Georgia* (Hodler and Schretter 1986) and the *Atlas of Pennsylvania* (Cuff *et al.* 1990), for example, contain hundreds of maps, most of them thematic, and are considered classic examples of high quality printed atlases. Electronic atlases, which are distributed online or on CD-ROMs, can contain not only static maps but may also have interactive or animated maps, as well as other multimedia features such as video and sound. The CD-ROM version of the *Atlas of Oregon* (Loy *et al.* 2001) is an excellent example of an electronic atlas that contains numerous interactive and animated thematic maps. The *National Atlas of the United States* (2007) is a prominent online atlas that allows its user to access maps (some of them animated) and data. The atlas also allows its users to decide what features to combine, as well as some of the maps' display options. Those map users making cartographic decisions notwithstanding, the thematic cartographer will continue to need sound design principles, regardless of the medium.

Kinds of Maps

A review of the variety of maps leads to a better understanding of where quantitative thematic mapping fi ts into the larger realm of maps and mapping. At one time, thematic mapping was estimated to be only 10 percent of the fi eld (Bickmore 1975, 330). In general, most maps may be classifi ed as either general purpose or thematic types. The two categories of maps can overlap at times, making some maps appear as if they can fall into either category. Air photos and other remotely sensed imagery, which are often available on websites featuring maps (such as the popular *Google Earth*), are not generally considered maps as such but are often used in the mapmaking process. However, it is possible to develop the classifi cation further to include a greater variety, and one such scheme is depicted here (see Figure 1.3). These map types are discussed in the sections that follow.

General Purpose Maps

Another name commonly applied to the **general purpose map** is *reference map* (Robinson 1975). Such maps customarily display objects (both natural and man-made) from the geographical environment. The emphasis is on location, and the purpose is to show a variety of features of the world or a portion of it (Robinson and Petchenik 1976). Examples of century. Geographers, explorers, and cartographers were preoccupied with "fi lling in" the world map. Because knowledge about the world was still accumulating, emphasis was placed on this form. It was not until later, when scientists began to seize the opportunity to express the spatial attributes of social and scientifi c data that thematic maps began to appear. Such subjects as climate, vegetation, geology, population, and trade, to mention a few, were mapped.

Thematic Maps

The other major class of map is the thematic map, also called a *special-purpose, single-topic,* or *statistical* map. The International Cartographic Association defi nes the thematic map this way: "A map designed to demonstrate particular features or concepts. In conventional use this

term excludes topographic maps" (Meynen 1973, 291). The purpose of all thematic maps is to illustrate the "structural characteristics of some particular geographical distribution" (Robinson 1975, 11). This involves the mapping of physical and cultural phenomena or abstract ideas about them. Structural features include distance and directional relationships, patterns of location, or spatial attributes of magnitude change. A thematic map, as its name implies, presents a *graphic theme* about a subject. In GIS terminology, it is a graphic display of *attribute data*, such as population density, average income, or daily temperature range. These attributes are also called variables. It must be remembered that a single theme is chosen for such a map; this is what distinguishes it from a reference map (see Figure 1.5). Thematic maps may be subdivided into two groups, **qualitative** and **quantitative.** The principal purpose of a qualitative thematic map is to show the spatial distribution or location of single theme of *nominal data*. These types of thematic maps do not show any quantities at all but rather purely qualitative information, and are usually rather generalized in its record. Maps of ecoregions, geology, soil types, and land use/land cover maps are all common types of qualitative maps. With qualitative maps, the reader cannot determine quantity, except as shown by relative areal extent. Quantitative thematic maps, on the other hand, display the spatial aspects of numerical data. In most instances a single variable, such as corn, people, or income, is chosen, and the map focuses on the variation of the feature from place to place. These maps may illustrate numerical data on the ordinal (less than/greater than) scale or the interval/ratio (how much different) scale. These measurement scales will be treated in depth in a later chapter. Quantitative mapping, as already pointed out, functions to show *how much* or *to what degree* something is present in the mapped area. The principal operation in quantitative thematic mapping is in the transformation of tabular data (an aspatial format) into the spatial format of the map (Jenks 1976). The qualities that the map format provides (distance, direction, shape, and location) are not easily obtainable from the aspatial tabular listing. In fact, this is the quantitative map's primary reason for existing. If the transformation does not add any spatial understanding, the map should not be considered an alternative form for the reader; the table will suffi ce. Furthermore, if the reader requires exact amounts, a quantitative thematic map is not the answer. The results of the transformations in mapping are *generalized* pictures of the original data. "A statistical map is a symbolized generalization of the information contained in a table" (Jenks 1976, 12). Yet the map is the only graphic means we have of showing the spatial attributes of quantitative geographic phenomena. The special process of abstracting, generalizing, and mapping data (even at the expense of losing detail) is therefore justifi ed when the spatial dimension is to be communicated. *Common Quantitative Thematic Map Forms.* Quantitative thematic maps often take one of several common forms. The **choropleth map** is a common map type for mapping data collected in **enumeration units.** Each unit, such as a county, state, country, province, is shaded according to a variable or attribute, such as population density (see Figure 1.8). **Dot maps** attempt to show variations in spatial density. These maps have a relatively simple rationale: that one dot represents so many units of some commodity, such as wheat (see Figure 1.9). **Proportional symbol maps** have symbols (usually circles) that are scaled to values at points. The point may be an actual point feature such as a city, or the point may also be derived from an area unit, such as the center of a state (see Figure 1.7). **Isarithmic maps** attempt to map 3-D continuous volumes, such as elevation, temperature, or precipitation. *Isarithms* (also *isolines*) connect points or places of equal value (see Figure

1.10). In the **Value-by Area Cartogram,** the enumeration units' area values are replaced by the variable being represented, often creating a very striking appearance (. **Flow maps** show linear movement between places. The lines' thickness and/or colour indicate the magnitude of the fl ow or movement. Each quantitative thematic technique can be used for a variety of topics, although different dimensions of spatial data that we will explore in Chapter 4 will have a dramatic impact in the selection of the form or forms that are appropriate. Each technique also has its own governing body of theory and design principles. Part II of this text, "Techniques of Quantitative Thematic Mapping," examines each of the six thematic map forms in detail. *Components of the Thematic Map.* Every thematic map is composed of three important components: a geographic or base map, a thematic overlay, and a set of ancillary map elements, such as titles, legends, compilation credits, neatlines, and other elements. The user of a thematic map must integrate this information, visually and intellectually, during map reading. The purpose of the geographic base map is to provide locational information to which the thematic overlay can be related. The base map must be well-designed *and include only the amount of information thought necessary to convey the map's message.* Also central to the base map is employment of a correct map projection. Simplicity and clarity are important design features of the thematic overlay, as is choosing correct symbols or thematic map type to match the data that is being mapped. The symbolization should also be visually prominent on the map. Note that in many GIS mapping applications, the base map and thematic data that are used to generate the symbols are tied together in a single data layer. Major issues with base maps and thematic data and symbolization are discussed at length in the following chapters in this section. The ancillary map elements in a map layout must accurately and succinctly describe the map to the map reader, and should be placed to visually balance the map. In most cases, the most important of these are the title and the legend. A title usually includes a what, where, and when component, such as Iowa Corn Production, 2008. A legend is important to help the reader correctly interpret symbols, data ranges, and so forth. Legends can also add information about the data, such as the level at which the data have been collected and/or aggregated. Compilation credits, also called a source statement, are also an extremely important map element, although they occupy a small space in the layout, and are placed in an unobtrusive portion of the map (such as smaller text in the lower left or right corner of the layout). The source statement simply acknowledges the source(s) for any data used in the map. The credits may also include a brief statement about the map authorship. The neatline is usually a thin, unobtrusive line that surrounds the mapped area. All other map objects are balanced within the neatline. An expression of map scale, such as a scale bar or representative fraction is useful if the cartographer wishes to impart a sense of distance, especially if the mapped area is not intuitive to the map reader. A few other common map elements include inset maps, ancillary explanatory text, and a north arrow or other indication of direction. Selection of these or other map elements (for example, pictures or graphs in larger format poster) will depend on the map's purpose and scale, and the medium used by the cartographer.

Map Scale

When cartographers decide on graphic representation of the environment or a portion of it, an early choice to be made is that of **map scale.** Scale is the amount of reduction that takes place

in going from real-world dimensions to the new mapped area on the map plane. Technically, map scale is defined as a ratio of map distance to earth distance, with each distance expressed in the same units of measurement and customarily reduced so that unity appears in the numerator (for example, 1:25,000). Scale selection has important consequences for the map's appearance and its potential as a communication device. Scale operates along a continuum from large scale to small scale. Large-scale maps show small portions of the Earth's surface; *detailed information* may therefore be shown. Small-scale maps show large areas, so only *limited detail* or generalized situations can be carried on the map. It is important to note that the definition of scale as discussed here and in other textbooks is specific to cartography and maps. The cartographer's approach to scale is somewhat different from that used by people in defining the scope of what they do or events that occur. For example, the newscaster may report that the disaster was contained to a small scale (meaning held to a limited area) or that the cure for polio was implemented on a large scale (meaning great breadth). Since a cartographer's view is the "opposite" of these popular connotations of scale, it may be helpful to remember the often-used pneumonic for many cartographers: large scale, large in detail, but small in area—small scale, small in detail, but large in area. Which final scale is selected for a given map design problem will depend on the map's purpose and physical size. The amount of geographical detail necessary to satisfy the purpose of the map will also act as a constraint in scale selection. Generally, the scale used will be a compromise between these two controlling factors. Another important consequence of scale selection is its impact on *symbolization.* In changing from large scale to small scale, map objects must increasingly be represented with symbols that are no longer true to scale and thus are more *generalized.* At large scales, the outline and area of a city may be shown in proportion to its actual size—that is, may occupy areas on the map proportional to the city's area. At smaller scales, whole cities may be represented by a single dot having no size relation to the city's real size. Scale, symbolization, and map projection are thus interdependent, and the selection of each will have considerable effect on the final map. *The selection of scale is perhaps the most important decision a cartographer makes about any map.* In general, there is an inverse relationship between reference maps and thematic maps regarding scale. In other words, most thematic maps are made at small scales and reference maps tend to be made at larger scales. As thematic cartographers generally work at small map scales, they must be especially attentive to the operations of **cartographic generalization.** This is especially true for geographic cartographers. In cartography, scale is represented by a ratio of map distance to Earth distance. It is generally expressed as a representative fraction (RF), and will always contain unity in the numerator. The denominator is referred to the RFD, or representative fraction denominator. The RF scale can be expressed as a traditional fraction (such as 1/25,000), but is most commonly written as a ratio using a colon, such as 1:25,000. RF scales are to be read, "One unit on the map *represents* so many of the *same* units on the Earth." The number in the fraction may be in any units, but both numerator and denominator will be in the *same* units. The cartographer should never say, "One unit on the map *equals* so many of the same units on the Earth." This is incorrect and logically inconsistent. There are three customary ways of expressing scale on a map: the representative fraction, a graphic or bar scale, and a verbal scale. The RF is perhaps the most important expression of scale for three reasons: 1. It is unit independent: the other methods are designed for expression of scale in specific units. It is

mathematically the most precise expression of map to real Earth distances. 2. Most GIS and mapping software allow you to specify a scale or scale range in which map data is to be displayed, which is expressed as an RF. This expression of scale is what cartographers use when interacting with the spatial data via GIS and mapping software. 3. Most distributed maps and map data have suggested scale ranges that are appropriate for display. Sometimes the scale at which the data was originally created is also provided. Provided scales or scale ranges are always in the RF form. On many maps, a *graphic* (linear) bar scale is included. This bar is usually divided into equally spaced segments and labeled with familiar linear units, such as miles, kilometers, meters, or feet, depending on the scale of the map. This scale is read the same as an RF scale. This form of scale is very useful for the following reasons. 1. It has a fairly high communicative value when compared to the representative fraction. The average map reader probably does not understand what 1:100,000 means, but a graphic scale in miles or kilometers makes distances clear. 2. If the map is enlarged or reduced, the bar scale changes in correct proportion to the amount of reduction. For example, a virtual map will change its size from monitor to monitor, and also if displayed on a projector (for example, in a Power Point presentation). If a paper map is enlarged or reduced on a photocopier, the bar scale again changes. In each case, the bar scale will change with the map, but an RF will become incorrect. Another common expression of scale is the *verbal* scale. This is a simple expression on the face of the map stating the linear relationship. For example, "one inch represents five miles" is an example of a verbal scale. This scale form is easily converted to an RF scale between map and Earth distances (for more on converting between scales and working scale problems, see "Appendix A"), but lacks the visual appeal of the graphic scale, and also is incorrect if the map is enlarged or reduced. This scale also locks you into *specific* units and numbers. For these reasons, some cartographers feel that the verbal scale is somewhat inflexible and therefore of less utility when compared with the RF and graphic scale expressions. Nonetheless, all three scale forms are common. Their inclusion in a thematic map, as with other design decisions, should rest on the purpose of the map, along with consideration of the audience who will view the map. If communication of distances is important to the map, then we recommend the use of the *graphic* (linear) bar scale. Cartographers use the terms small, medium (or intermediate), and large scales quite often and somewhat casually. Actually, there are many suggested ranges published from numerous sources as to what exactly defines small, medium, and large scales. For our purposes, we will use the guidelines of: • Large Scale—1:30,000 or larger • Intermediate Scale—1:30,000 to 1:300,000 • Small Scale—1:300,000 or smaller Although these are relative terms, most texts provide ranges that are somewhat similar. But note that with continental, hemisphere, and world maps, which will all be small scale, one is better off saying "larger or smaller" scales relative to an existing map. For example, a world map in a typical printed atlas may be displayed at 1:100,000,000, but a map of the continental United States might be at a larger scale of 1:15,000,000. Likewise, local maps of varying scales may all fall in the category of large scale—1:1,000 scale mapping is a much larger scale than 1:24,000, but both are still considered large scale maps (Dent, Torguson, & Holder, 2009).

LAND SURVEY INSTRUMENTS AND THEIR USES

Theodolite

A **theodolite** is a precision optical instrument for measuring angles between designated visible points in the horizontal and vertical planes. The traditional use has been for land surveying, but it is also used extensively for building and infrastructure construction, and some specialized applications such as meteorology and rocket launching.

It consists of a moveable telescope mounted so it can rotate around horizontal and vertical axes and provide angular readouts. These indicate the orientation of the telescope, and are used to relate the first point sighted through the telescope to subsequent sightings of other points from the same theodolite position. These angles can be measured with accuracies down to microradians or seconds of arc. From these readings a plan can be drawn, or objects can be positioned in accordance with an existing plan. The modern theodolite has evolved into what is known as a total station where angles and distances are measured electronically, and are read directly to computer memory.

In a *transit theodolite*, the telescope is short enough to rotate about the trunnion axis, turning the telescope through the vertical plane through the zenith; for non-transit instruments vertical rotation is restricted to a limited arc.

The optical level is sometimes mistaken for a theodolite, but it does not measure vertical angles, and is used only for leveling on a horizontal plane (though often combined with medium accuracy horizontal range and direction measurements).

Level

A **level** is an optical instrument used to establish or verify points in the same horizontal plane in a process known as levelling, and is used in conjunction with a levelling staff to establish the relative height levels of objects or marks. It is widely used in surveying and construction to measure height differences and to transfer, measure, and set heights of known objects or marks.

It is also known as a Surveyor's level, Builder's level, Dumpy level or the historic "Y" level. It operates on the principle of establishing a visual level relationship between two or more points, for which an inbuilt telescope and a highly accurate bubble level are used to achieve the necessary accuracy. Traditionally the instrument was completely adjusted manually to ensure a level line of sight, but modern automatic versions self-compensate for slight errors in the coarse levelling of the instrument, and are thereby quicker to use.

The optical level should not be confused with a theodolite, which can also measure angles in the vertical plane.

Prismatic compass

A **prismatic compass** is a navigation and surveying instrument which is extensively used to find out the bearing of the traversing and included angles between them, waypoints (an endpoint of the lcourse) and direction. Compass surveying is a type of surveying in which the directions of surveying lines are determined with a magnetic compass, and the length of the surveying lines are measured with a tape or chain or laser range finder.[2] The compass is generally used to run a traverse line. The compass calculates bearings of lines with respect to magnetic needle. The included angles can then be calculated using suitable formulas in case of

clockwise and anti-clockwise traverse respectively. For each survey line in the traverse, surveyors take two bearings that is fore bearing and back bearing which should exactly differ by 180° if local attraction is negligible. The name *Prismatic compass* is given to it because it essentially consists of a prism which is used for taking observations more accurately.

Total station (**TS**)

A **total station** (**TS**) or **total station theodolite** (**TST**) is an electronic/optical instrument used for surveying and building construction. It is an electronic transit theodolite integrated with electronic distance measurement (EDM) to measure both vertical and horizontal angles and the slope distance from the instrument to a particular point, and an on-board computer to collect data and perform triangulation calculations.

Global Positioning System (**GPS**)

The **Global Positioning System** (**GPS**), originally **Navstar GPS**, is a satellite-based radio navigation system owned by the United States government and operated by the United States Space Force. It is one of the global navigation satellite systems (GNSS) that provides geolocation and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. It does not require the user to transmit any data, and operates independently of any telephonic or Internet reception, though these technologies can enhance the usefulness of the GPS positioning information. It provides critical positioning capabilities to military, civil, and commercial users around the world. Although the United States government created, controls and maintains the GPS system, it is freely accessible to anyone with a GPS receiver.

The GPS project was started by the U.S. Department of Defense in 1973. The first prototype spacecraft was launched in 1978 and the full constellation of 24 satellites became operational in 1993. Originally limited to use by the United States military, civilian use was allowed from the 1980s following an executive order from President Ronald Reagan after the Korean Air Lines Flight 007 incident. Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS and implement the next generation of GPS Block IIIA satellites and Next Generation Operational Control System (OCX). Announcements from Vice President Al Gore and the Clinton Administration in 1998 initiated these changes, which were authorized by the U.S. Congress in 2000.

From the early 1990s, GPS positional accuracy was degraded by the United States government by a program called Selective Availability; that could selectively deny access to the system, or degrade the service at any time as happened to the Indian military in 1999 during the Kargil War, however, this was discontinued on May 1, 2000, in accordance with a law signed by President Bill Clinton. As a result, several countries have developed or are in the process of setting up other global or regional satellite navigation systems.

The Russian Global Navigation Satellite System (GLONASS) was developed contemporaneously with GPS, but suffered from incomplete coverage of the globe until the mid-2000s. GLONASS reception in addition to GPS can be combined in a receiver thereby

allowing for additional satellites available to enable faster position fixes and improved accuracy, to within two meters (6.6 ft).

China's BeiDou Navigation Satellite System began global services in 2018, and finished its full deployment in 2020. There are also the European Union Galileo navigation satellite system, and India's NavIC. Japan's Quasi-Zenith Satellite System (QZSS) is a GPS satellite-based augmentation system to enhance GPS's accuracy in Asia-Oceania, with satellite navigation independent of GPS scheduled for 2023.

When selective availability was lifted in 2000, GPS had about a five-meter (16 ft) accuracy. GPS receivers that use the L5 band have much higher accuracy, pinpointing to within 30 centimeters (11.8 in), while high-end users (typically engineering and land surveying applications) are able to have accuracy on several of the bandwidth signals to within two centimeters, and even sub-millimeter accuracy for long-term measurements.Consumer devices, like smartphones, can be as accurate as to within 4.9 m (or better with assistive services like Wi-Fi positioning also enabled).As of May 2021, 16 GPS satellites are broadcasting L5 signals, and the signals are considered pre-operational, scheduled to reach 24 satellites by approximately 2027.

Differential Global Positioning System

A **Differential Global Positioning System** (**DGPS**) is an enhancement to a global navigation satellite system (GNSS) which provides improved location accuracy, in the range of operations of each system, from the 15-metre (49 ft) nominal GPS accuracy to about 1–3 centimetres (0.39–1.18 in) in case of the best implementations.

Each DGPS uses a network of fixed ground-based reference stations to broadcast the difference between the positions indicated by the GPS satellite system and known fixed positions. These stations broadcast the difference between the measured satellite pseudoranges and actual (internally computed) pseudoranges, and receiver stations may correct their pseudoranges by the same amount. The digital correction signal is typically broadcast locally over ground-based transmitters of shorter range.

The United States Coast Guard (USCG) and the Canadian Coast Guard (CCG) each run DGPSes in the United States and Canada on longwave radio frequencies between 285 kHz and 325 kHz near major waterways and harbors. The USCG's DGPS was named NDGPS (Nationwide DGPS) and was jointly administered by the Coast Guard and the U.S. Department of Defense's Army Corps of Engineers (USACE). It consisted of broadcast sites located throughout the inland and coastal portions of the United States including Alaska, Hawaii and Puerto Rico. Other countries have their own DGPS.

A similar system which transmits corrections from orbiting satellites instead of ground-based transmitters is called a Wide-Area DGPS (WADGPS) Satellite Based Augmentation System (Wikipedia).

References:

Dent, B. D., Torguson, J. S., & Holder, T. W. (2009). *Cartography- Thematic Map Design.* Boston: McGraw Hill.

UNIT-12: CONCEPT AND CLASSIFICATION OF HAZARDS; NATURAL HAZARDS IN WEST BENGAL: FLOOD AND LANDSLIDE

A **hazard** is an agent which has the potential to cause harm to a vulnerable target. The terms "hazard" and "risk" are often used interchangeably. However, in terms of risk assessment, they are two very distinct terms. A hazard is any agent that can cause harm or damage to humans, property, or the environment. Risk is defined as the probability that exposure to a hazard will lead to a negative consequence, or more simply, a hazard poses no risk if there is no exposure to that hazard.

Hazards can be dormant or potential, with only a theoretical probability of harm. An event that is caused by interaction with a hazard is called an incident. The likely severity of the undesirable consequences of an incident associated with a hazard, combined with the probability of this occurring, constitute the associated risk. If there is no possibility of a hazard contributing towards an incident, there is no risk.

Hazards can be classified as different types in several ways. One of these ways is by specifying the origin of the hazard. One key concept in identifying a hazard is the presence of stored energy that, when released, can cause damage. Stored energy can occur in many forms: chemical, mechanical, thermal, radioactive, electrical, etc. Another class of hazard does not involve release of stored energy, rather it involves the presence of hazardous situations. Examples include confined or limited egress spaces, oxygen-depleted atmospheres, awkward positions, repetitive motions, low-hanging or protruding objects, etc. Hazards may also be classified as natural, anthropogenic, or technological. They may also be classified as health or safety hazards, by the populations that may be affected, and the severity of the associated risk. In most cases a hazard may affect a range of targets, and have little or no effect on others.

Identification of hazards assumes that the potential targets are defined, and is the first step in performing a risk assessment.

Definition

Zaplatynskyi V. (2013) defines "Hazard" - a subjective concept that refers to the possibility of the circumstances under which the matter, field, information, energy, or both of them may influence the complex system, it would lead to consequences that are, or valued stakeholders (at the level of thinking, feeling or instinct) at a certain stage of development of the perceiver as negative.

Kates (1978) defines environmental hazard as "the threat potential posed to man or nature by events originating in, or transmitted by, the natural or built environment". This definition includes a broader range of hazards ranging from long term environmental deterioration such as acidification of soils and build-up of atmospheric carbon dioxide to communal and involuntary social hazards such as crime and terrorism to voluntary and personal hazards such as drug abuse and mountain climbing. Environmental hazards usually have defined or common characteristics including their tendency to be rapid onset events meaning they occur with a

short warning time, they have a clear source of origin which is easily identified, impact will be swift and losses suffered quickly during or shortly after on-set of the event, risk of exposure is usually involuntary due to location or proximity of people to the hazard and the "disaster occurs with an intensity and scale that justifies an emergency response" .

Hazards may be grouped according to their characteristics. These factors are related to geophysical events which are not process specific:

1. Areal extent of damage zone
2. Intensity of impact at a point
3. Duration of impact at a point
4. Rate of onset of the event
5. Predictability of the event

Natural hazards may be defined as "extreme events that originate in the biosphere, hydrosphere, lithosphere or atmosphere" or "a potential threat to humans and their welfare" which include earthquake, landslide, hurricane and tsunamis. Technological and manmade hazards include explosions, release of toxic materials, episodes of severe contamination, structural collapses, and transportation, construction and manufacturing accidents etc. A distinction can also be made between rapid onset natural hazards, technological hazards and social hazards which are described as being of sudden occurrence and relatively short duration, and the consequences of longer term environmental degradation such as desertification and drought, .

In defining hazard Keith Smith argues that what may be defined as hazard is only a hazard if there is the presence of humans to make it a hazard and that it is otherwise merely an event of interest. In this sense the environmental conditions we may consider hostile or hazardous can be seen as neutral in that it is our perception, human location and actions which identify resources and hazards within the range of natural events. In this regard human sensitivity to environmental hazards is a combination of both physical exposure (natural and/or technological events at a location related to their statistical variability) and human vulnerability (in regard to social and economic tolerance of the same location).

Smith states that natural hazards are best seen in an ecological framework in order to distinguish between natural events as natural hazards. He says "natural hazards, therefore, result from the conflict of geophysical processes with people and they lie at the interface what has been called the natural events system and the human interface system." He says that "this interpretation of natural hazards gives humans a central role. Firstly through location, because it is only when people and their possessions get in the way of natural processes that hazard exists."

A natural hazard can be considered as a geophysical event which when it occurs in extremes and a human factor is involved that may present a risk. In this context we can see that there may be an acceptable variation of magnitude which can vary from the estimated normal or

average range with upper and lower limits or thresholds. In these extremes the natural occurrence may become an event that presents risk to the environment or people. Smith says "most social and economic activities are geared to some expectation of the 'average' conditions. As long as the variation of the environmental element remains fairly close to this expected performance, insignificant damage occurs and the element will be perceived as beneficial. However when the variability exceeds some threshold beyond the normal band of tolerance, the same variable starts to impose a stress on society and become a hazard." Thus above average wind speeds resulting in a tropical depression or hurricane according to intensity measures on the Saffir–Simpson scale will provide an extreme natural event which may be considered a hazard.

Classification

Hazards can be classified as different types in several ways. One of these ways is by specifying the origin of the hazard. One key concept in identifying a hazard is the presence of stored energy that, when released, can cause damage. Stored energy can occur in many forms: chemical, mechanical, thermal, radioactive, electrical, etc. Another class of hazard does not involve release of stored energy, rather it involves the presence of hazardous situations. Examples include confined or limited egress spaces, oxygen-depleted atmospheres, awkward positions, repetitive motions, low-hanging or protruding objects, etc.

Hazards may also be classified as natural, anthropogenic, or technological. They may also be classified as healthor safety hazards and by the populations that may be affected, and the severity of the associated risk.

In most cases a hazard may affect a range of targets, and have little or no effect on others. Identification of hazards assumes that the potential targets are defined.

BASED ON ENERGY SOURCE

Biological hazard

Biological hazards, also known as biohazards, originate in biological processes of living organisms, and refer to agents that pose a threat to the health of living organisms, the security of property, or the health of the environment.

The term and its associated symbol may be used as a warning, so that those potentially exposed to the substances will know to take precautions. The biohazard symbol was developed in 1966 by Charles Baldwin, an environmental-health engineer working for the Dow Chemical Company on the containment products.and is used in the labeling of biological materials that carry a significant health risk, such as viral samples and used hypodermic needles.

Biological hazards include viruses, parasites, bacteria, food, fungi, and foreign toxins.

Many specific biological hazards have been identified. For example, the hazards of naturally-occurring bacteria such as *Escherichia coli* and *Salmonella*, are well known as disease-causing pathogens and a variety of measures have been taken to limit human exposure to

these microorganisms through food safety, good personal hygiene and education. However, the potential for new biological hazards exists through the discovery of new microorganisms and through the development of new genetically modified (GM) organisms. Use of new GM organisms is regulated by various governmental agencies. The US Environmental Protection Agency (EPA) controls GM plants that produce or resist pesticides (i.e. Bt corn and Roundup ready crops). The US Food and Drug Administration (FDA) regulates GM plants that will be used as food or for medicinal purposes.

Biological hazards can include medical waste or samples of a microorganism, virus or toxin (from a biological source) that can affect health.

Many biological hazards are associated with food, including certain viruses, parasites, fungi, bacteria, and plant and seafood toxins. Pathogenic *Campylobacter* and *Salmonella* are common foodborne biological hazards. The hazards from these bacteria can be avoided through risk mitigation steps such as proper handling, storing, and cooking of food. Disease in humans can come from biological hazards in the form of infection by bacteria, antigens, viruses, or parasites.

Chemical hazard

A chemical can be considered a hazard if by virtue of its intrinsic properties it can cause harm or danger to humans, property, or the environment.

Health hazards associated with chemicals are dependent on the dose or amount of the chemical. For example, iodine in the form of potassium iodate is used to produce iodised salt. When applied at a rate of 20 mg of potassium iodate per 1000 mg of table salt, the chemical is beneficial in preventing goiter, while iodine intakes of 1200–9500 mg in one dose have been known to cause death. Some chemicals have a cumulative biological effect, while others are metabolically eliminated over time. Other chemical hazards may depend on concentration or total quantity for their effects.

A variety of chemical hazards (e.g. DDT, atrazine, etc.) have been identified. However, every year companies produce more new chemicals to fill new needs or to take the place of older, less effective chemicals. Laws, such as the Federal Food, Drug, and Cosmetic Act and the Toxic Substances Control Act in the US, require protection of human health and the environment for any new chemical introduced. In the US, the EPA regulates new chemicals that may have environmental impacts (i.e. pesticides or chemicals released during a manufacturing process), while the FDA regulates new chemicals used in foods or as drugs. The potential hazards of these chemicals can be identified by performing a variety of tests prior to the authorization of usage. The number of tests required and the extent to which the chemicals are tested varies, depending on the desired usage of the chemical. Chemicals designed as new drugs must undergo more rigorous tests that those used as pesticides.

Some harmful chemicals occur naturally in certain geological formations, such as radon gas or arsenic. Other chemicals include products with commercial uses, such as agricultural and industrial chemicals, as well as products developed for home use. Pesticides, which are

normally used to control unwanted insects and plants, may cause a variety of negative effects on non-target organisms. DDT can build up, or bioaccumulate, in birds, resulting in thinner-than-normal egg shells which can break in the nest. The organochlorine pesticide dieldrin has been linked to Parkinson's disease. Corrosive chemicals like sulfuric acid, which is found in car batteries and research laboratories, can cause severe skin burns. Many other chemicals used in industrial and laboratory settings can cause respiratory, digestive, or nervous system problems if they are inhaled, ingested, or absorbed through the skin. The negative effects of other chemicals, such as alcohol and nicotine, have been well documented.

Ergonomic hazard

Ergonomic hazards are physical conditions that may pose risk of injury to the musculoskeletal system, such as the muscles or ligaments of the lower back, tendons or nerves of the hands/wrists, or bones surrounding the knees. Ergonomic hazards include things such as awkward or extreme postures, whole-body or hand/arm vibration, poorly designed tools, equipment, or workstations, repetitive motion, and poor lighting. Ergonomic hazards occur in both occupational and non-occupational settings such as in workshops, building sites, offices, home, school, or public spaces and facilities.

Mechanical hazard

A mechanical hazard is any hazard involving a machine or industrial process. Motor vehicles, aircraft, and air bags pose mechanical hazards. Compressed gases or liquids can also be considered a mechanical hazard.

Hazard identification of new machines and/or industrial processes occurs at various stages in the design of the new machine or process. These hazard identification studies focus mainly on deviations from the intended use or design and the harm that may occur as a result of these deviations. These studies are regulated by various agencies such as the Occupational Safety and Health Administration and the National Highway Traffic Safety Administration.

Physical hazard

A physical hazard is a naturally occurring process that has the potential to create loss or damage. Physical hazards include earthquakes, floods, fires, and tornadoes. Physical hazards often have both human and natural elements. Flood problems can be affected by the natural elements of climate fluctuations and storm frequency, and by land drainage and building in a flood plain, human elements. Another physical hazard, X-rays, naturally occur from solar radiation, but have also been utilized by humans for medical purposes; however, overexposure can lead to cancer, skin burns, and tissue damage.

Psychosocial hazard

Psychological or psychosocial hazards are hazards that affect the psychological well-being of people, including their ability to participate in a work environment among other people. Psychosocial hazards are related to the way work is designed, organized and managed, as well as the economic and social contexts of work and are associated with psychiatric, psychological

and/or physical injury or illness. Linked to psychosocial risks are issues such as occupational stress and workplace violence which are recognized internationally as major challenges to occupational health and safety.Based on origin

Natural hazards

Natural hazards such as earthquakes, floods, volcanoes and tsunami have threatened people, society, the natural environment, and the built environment, particularly more vulnerable people, throughout history, and in some cases, on a day-to-day basis. According to the Red Cross, each year 130,000 people are killed, 90,000 are injured and 140 million are affected by unique events known as natural disasters.

Recent policy-oriented work into hazard management began with the work of Gilbert White, the first person to study engineering schemes as a means of mitigating flooding in the US. From 1935 to 1967 White and his colleagues led the research into flood defences, and further collaboration on investigation was undertaken at the University of Chicago.

In December 1989, after several years of preparation, the United Nations General Assembly adopted resolution 44/236 proclaiming the 1990s as the International Decade for Natural Disaster Reduction. The objective of that decade was stated in the annex of Resolution 44/236 as follows:

"…to reduce through concerted international action, especially in developing countries, the loss of life, property damage, and social and economic disruption caused by natural disasters, such as earthquakes, wind-storms, tsunamis, floods, landslides, volcanic eruptions, wildfire, grasshopper and locust infestations, drought and desertification and other calamities of natural origin."

Methods to reduce risk from natural hazards include construction of high-risk facilities away from areas with high risk, engineering redundancy, emergency reserve funds, purchasing relevant insurance, and the development of operational recovery plans.

Anthropogenic hazards

Hazards due to human behaviour and activity.

The social, natural and built environment are not only at risk from geophysical hazards, but also from technological hazards including industrial explosions, release of chemical hazards and major accident hazards(MAHs).

Technological hazards

Hazards due to technology, and therefore a sub-class of anthropogenic hazards.

Sociological hazards

Hazards due to sociological causes, also a sub-class of anthropogenic hazards

Sociological hazards include crime, terrorist threats and war.

Environmental hazards

Any single or combination of toxic chemical, biological, or physical agents in the environment, resulting from human activities or natural processes, that may impact the health of exposed subjects, including pollutants such as heavy metals, pesticides, biological contaminants, toxic waste, industrial and home chemicals.

BASED ON EFFECTS

Health hazards

Hazards affecting the health of exposed persons, usually having an acute or chronic illness as the consequence. Fatality would not normally be an immediate consequence. Health hazards may cause measurable changes in the body which are generally indicated by the development of signs and symptoms in the exposed persons, or non-measurable, subjective symptoms.

Safety hazards

Hazards affecting the safety of individuals, usually having an injury or immediate fatality as the consequence of an incident.

Economic hazards

Hazards affecting property, wealth and the economy.

Environmental hazards

Hazards affecting the environment, particularly the natural environment and ecosystems.

DISASTER

Disaster can be defined as a serious disruption, occurring over a relatively short time, of the functioning of a community or a society involving widespread human, material, economic, societal or environmental loss and impacts, which exceeds the ability of the affected community or society to cope using its own resources. Disaster can manifest in various forms, threatening those people or environments specifically vulnerable. Such impacts include loss of property, death, injury, trauma or post-traumatic stress disorder.

Disaster can take various forms, including hurricane, volcano, tsunami, earthquake, drought, famine, plague, disease, rail crash, car crash, tornado, deforestation, flooding, toxic release, and spills (oil, chemicals). These can affect people and the environment on the local regional level, national level or international level (Wisner et al., unknown) where the international community becomes involved with aid donation, governments give money to support affected countries' economies with disaster response and post-disaster reconstruction.

A disaster hazard is an extreme geophysical event that is capable of causing a disaster. 'Extreme' in this case means a substantial variation in either the positive or the negative direction from the normal trend; flood disasters can result from exceptionally high precipitation and river discharge, and drought is caused by exceptionally low values. The fundamental

determinants of hazard and the risk of such hazards occurring is timing, location, magnitude and frequency. For example, magnitudes of earthquakes are measured on the Richter scale from 1 to 10, whereby each increment of 1 indicates a tenfold increase in severity. The magnitude-frequency rule states that over a significant period of time many small events and a few large ones will occur. Hurricanes and typhoons on the other hand occur between 5 degrees and 25 degrees north and south of the equator, tending to be seasonal phenomena which are thus largely recurrent in time and predictable in location due to the specific climate variables necessary for their formation.

Major disaster, as it is usually assessed on quantitative criteria of death and damage was defined by Sheehan and Hewitt (1969) having to conform to the following criteria:

- At least 100 people dead,
- at least 100 people injured, or
- at least $1 million damage.

This definition includes indirect losses of life caused after initial onset of the disaster such as secondary effects of, e.g., cholera or dysentery. This definition is still commonly used but has the limitations of number of deaths, injuries and damage (in $). UNDRO (1984) defined a disaster in a more qualitative fashion as:

an event, concentrated in time and space, in which a community undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented.

As with other definitions of disaster, this definition not only encompasses social aspect of disaster impact and stresses potentially caused but also focuses on losses, implying the need for an emergency response as an aspect of disaster. It does not however set out quantitative thresholds or scales for damage, death or injury respectively.

Status of hazard

- **Dormant**—The situation environment is currently affected. For instance, a hillside may be unstable, with the potential for a landslide, but there is nothing below or on the hillside that could be affected.
- **Armed**—People, property, or environment is in potential harm's way.
- **Active**—A harmful incident involving the hazard has actually occurred. Often this is referred to not as an "active hazard" but as an accident, emergency, incident, or disaster.

RISK

The terms "hazard" and "risk" are often used interchangeably. However, in terms of risk assessment, these are two very distinct terms. A hazard is an agent that can cause harm or

damage to humans, property, or the environment. Risk is the probability that exposure to a hazard will lead to a negative consequence, or more simply, a hazard poses no risk if there is no exposure to that hazard.

Risk can be defined as the likelihood or probability of a given hazard of a given level causing a particular level of loss of damage. The elements of risk are populations, communities, the built environment, the natural environment, economic activities and services which are under threat of disaster in a given area. The total risk according to UNDRO 1982 is the "sum of predictable deaths, injuries, destruction, damage, disruption, and costs of repair and mitigation caused by a disaster of a particular level in a given area or areas.

David Alexander distinguishes between risk and vulnerability saying that "vulnerability refers to the potential for casualty, destruction, damage, disruption or other form of loss in a particular element: risk combines this with the probable level of loss to be expected from a predictable magnitude of hazard (which can be considered as the manifestation of the agent that produces the loss)." As hazards have varying degrees of severity, the more intense or severe the hazard, the greater vulnerability there will be as potential for damage and destruction is increased with respect to severity of hazard. Ben Wisner argues that risk or disaster is "a compound function of the natural hazard and the number of people, characterised by their varying degrees of vulnerability to that specific hazard, who occupy the space and time of exposure to the hazard event." (Wisner, et al., 1994).

Another definition of risk is "the probable frequency and probable magnitude of future losses". This definition also focuses on the probability of future loss whereby degree of vulnerability to hazard represents the level of risk on a particular population or environment. The threats posed by a hazard are:

Hazards to people – death, injury, disease and stress

Hazards to goods – property damage and economic loss

Hazards to environment –loss of flora and fauna, pollution and loss of amenity

Marking of hazards

Hazard symbols or warning symbols are easily recognisable symbolsdesigned to warn about hazardous materials, locations, or objects, The use of hazard symbols is often regulated by law and directed by standards organisations. Hazard symbols may appear with different colors, backgrounds, borders and supplemental information in order to specify the type of hazard and the level of threat (for example, toxicity classes). Warning symbols are used in many places in lieu of or addition to written warnings as they are quickly recognized (faster than reading a written warning) and more universally understood, as the same symbol can be recognized as having the same meaning to speakers of different languages (Paul, 2011).

Natural hazards in West Bengal: Flood and Landslide

A flood is an overflow of an expanse of water that submerges land. The EU Floods directive defines a flood as a temporary covering by water of land not normally covered by water. In the

sense of "flowing water", the word may also be applied to the inflow of the tide. Flooding may result from the volume of water within a body of water, such as a river or lake, which overflows or breaks levees, with the result that some of the water escapes its usual boundaries. While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, it is not a significant flood unless the water covers land used by man like a village, city or other inhabited area, roads, expanses of farmland, etc.
River and coastal flooding are the most frequently occurring natural disaster and are increasing in occurrence more rapidly than any other disaster. Urbanization and deforestation reduce the capability of the earth to hold excess water. As asphalt- and concrete-covered surfaces expand and open spaces disappear at the edges of metropolitan areas, it takes less rain to flood communities as water running over the pavement collects quickly and easily disrupts storm drain systems. Those areas which are most at risk for floods include low-lying areas, coastal regions, and communities on rivers downstream from dams. Flood waters are extremely dangerous; a mere six inches of swiftly moving water can knock people off their feet. In some places flooding is caused by excessive monsoons, while in others flooding is caused downstream from dams when reservoirs, which normally help to prevent downstream areas of rivers from flooding, are opened due to unusually high levels of rain to prevent the reservoir from overflowing the dam. Dam breaks are also a cause of catastrophic flooding. West Bengal has 37,660 sq. km flood prone area spread over 111 blocks where the total geographical area of the state is 88,752 sq. km. An analysis of the statistics of flood that occurred during last 41 years (from 1960 - 2000) shows that only on 5 occasions the state has not faced any severe flood. The total devastated area crossed 20,000 sq. km in 4 different years and the flood of medium magnitude i.e. between 2,000 to 10,000 sq. km. occurred on 10 occasions.

The Flood Problem

The flood problems of the state are of different nature at different regions. The rivers Teesta, Torsa, Jaldhaka, Raidak-I, Raidak-II etc. flowing through the districts of Jalpaiguri and Cooch Behar originate in the neighbouring country of Bhutan and the state of Sikkim and flows down to Bangladesh, another neighbouring country to meet the Bramhaputra at different locations. The rivers of the districts of Uttar Dinajpur and Dakshin Dinajpur originating at Bangladesh passes through these districts and then joins the Ganga-Padma at downstream of Farakka in Bangladesh. Both the places of origin and also the outfall of most of these rivers are in Bangladesh. The district of Malda through which the river Ganga flows receives its flood water from about 11 (eleven) States and is battered by the run-off flow generated from these vast areas. Ultimately the river flows down the Farakka Barrage to Bangladesh. Another portion of the Malda district receives floodwaters of the Mahananda, which again originates in the hills of the neighbouring country of Nepal and has some catchment area in the neighbouring state of Bihar and then passes through the district to join the Ganga-Padma at downstream of Farakka Barrage in Bangladesh. Major contributing factors to flood in North Bengal regions are the run-off because of heavy local rainfall, discharge of upper basin areas and also outfall condition in the neighbouring countries. The Mahananda and most of the rivers of Uttar and Dakshin Dinajpur districts get stagnated when the Ganga upstream and downstream of Farakka Barrage rules high thereby not allowing drainage of flood discharge during that period.

Analysis of Area Flooded against Years of Occurrence

Flood affected area (in sq. km)	Years during which the flood occurred	Total No. of years
Below 500	1985, 89, 92, 94 & 97	5
Between 500 - 2000	1962, 63, 64, 65, 66, 72, 75 & 96	8
2000 - 5000	1960, 61, 67, 69, 70, 74, 76, 80, 81 & 82	10
5000 - 10000	1973, 77, 93, 95 & 98	5
10000 - 15000	1968, 79, 83, 90 & 99	5
15000 – 20000	1971, 86, 87 & 88	4
Above 20000	1978, 84, 91 & 2000	4

Types of Flood

It is a temporary inundation of large regions as a result of an increase in reservoir, or of rivers flooding their banks because of heavy rains, high winds, cyclones storm surge along coast, tsunami, melting snow or dam bursts.

Flash Floods: It is defined as floods which occurs within six hours of the beginning of heavy rainfall, and are usually associated with cloud bursts, storms and cyclones requiring rapid localized warning and immediate response if damage is to be mitigated. In case of flash floods, warning for timely evacuation may not always be possible.

River Floods: Such floods are caused by precipitation over large catchment's areas. These floods normally build up slowly or seasonally and may continue for days or weeks as compared to flash floods.

Coastal Floods: Some floods are associated with the cyclonic activities like Hurricanes, tropical cyclone etc. Catastrophic flooding is often aggravated by wind-induced strom surges along the coast.

River System in West Bengal

The Ganga-Padma river artery divides the state in two parts, north and south. Being a part of Ganga-Bhrammhaputra-Meghna basin, North Bengal is extremely flood prone. The rivers Teesta, Torsa, Jaldhaka, Raidak-I, Raidak-II and their numerous tributaries belonging to the Brammhaputra basin and flowing through a part of Darjeeling, Jalpaiguri and Coochbehar originate in the Himalayas of Sikkim and Bhutan and flows south-east to Bangladesh. A part of Darjeeling and the districts of Uttar Dinajpur, Dakshin Dinajpur and Malda are drained through the rivers of Mahananda, Dauk, Tangon, Nagar, Atreyee, Punarbhaba and their tributaries. These are part of Ganga basin. Except the Mahananda, all other rivers originate in the plain of West Bengal and Bangladesh and join the Ganga-Padma at downstream of Farakka in Bangladesh. The

Mahananda emerges from the Nepal Himalayas. Malda through which the river Ganga Flows receives its flood water from about eleven states and batters by the run-off flow generated from these vast areas. In central and southern part of this state, there are certain distinctive features of drainage condition which gives rise to flood situation. Basin-wise there are a number of rivers on the right bank of the Bhagirathi-Hoogly. These are Pagla-Bansloi, the Dwarka-Bramhani, the Mayurakshi-Babla-Uttarasan, the Bakreswar-Kuye and also the Ajoy. They emerge from the Jharkhand Plateau an flow southeast to meet Bhagirathi-Hoogly. These rivers drain an area of 17,684 km. spread over the State Jharkhand and Birbhum, western part of Murshidabad and Burdwan. Originating from Ganga-Padma, the Bhairab-Jalangi-Sealmari system of rivers drain the eastern part of Murshidabad and meet the Bhagirathi at Swarupnagar in Nadia. Nadia is drained partly by Jalangi and partly by the Churni which is a part of Mathabhanga-Churni-Ichamati system, taking off from Ganga-Padma flowing southwest, to meet Bhagirathi on the east bank at Ranaghat. The other part viz. the Ichamati flows east through Bangladesh enters the district of Uttar 24 Paraganas, flows in the south direction to fall into the tidal creek of the Raimangal. Part of Howrah and Uttar and Dakshin 24 Paraganas are drained mainly by the Hoogly and its tidal creeks and other internal drainage canals. Burdwan, Howrah and Hoogly districts are mainly drained by Damodar and Bhagirathi-Hoogly Rivers. In the Damodar-Barakar basin system, the rivers originate at Chotanagpur plateau and flow down the plains of West Bengal to meet Bhagirathi. The Ajoy forms the border between Birbhum and Burdwan. Purulia and Bankura are drained by the rivers of Kangsabati, Kumari, Shilabati, Keleghai, Dwarakeswar and their tributaries. The Keleghai also drains Paschim Medinipur and a part of Purba Medinipur. These rivers originate from the western highland of the state and flow in southeast direction to form the tidal rivers of the Rupnarayan and the Haldi to meet the Hoogly on the west bank. The Rupnarayan forms the boundary between Hoogly and Purba Medinipur. A part of Purba Medinipur is drained by the river Subarnarekha originating from the Jharkhand Plateau and flowing in southwest direction to meet the Bay of Bengal in Orissa.

Causes of Flood

I. Excessive rainfall in river catchments or concentration of runoff from the tributaries and river carrying flows in excess of their capacities.
II. Backing of water in tributaries at their confluence with the main river.
III. Synchronization of flood peaks of the main rivers and tributaries.
IV. Landslides causing obstruction to flow and change in the river course.
V. Poor natural drainage.
VI. Cyclone and very intense rainfall.
VII. Intense rainfall when river is flowing full.

The floods of West Bengal have special characteristics. Heavy rainfall at origin or catchment's areas of main flooding rivers of this state cause flood, but these areas are mainly lying outside this state. The West Bengal is flooded by water from adjoining states or countries.

Major contributing factors to flood in Northern regions are the run-off because of heavy local rainfall, discharge of upper basin areas and also out fall condition in the neighbouring countries. The Mahananda and most of the rivers of Uttar and Dakshin Dinajpur districts get stagnated when the Ganga upstream and downstream of Farakka Barrage rules high there by not allowing draining of flood discharge during that period. Flooding Malda is caused by the rivers Fulhar-

Mahananda-and Ganga. The Ganga, forming the southern boundary of the district, brings flood water from eleven states and Nepal. The Fulhar meets the Ganga upstream of Farakka.

The rivers of rivers of Bhagirathi-Hoogly basin generate flood because of high rainfall and limited carrying capacity of the river Bhagirathi from Jangipur in Murshidabad to Kalna in Bardwan. In this reach the Bhagirathi has discharge carrying capacity of maximum 1.3 lac. Cusec. But all these rivers if receive rainfall simultaneously in their catchment areas can generate run-off volume of any amount between 4-6 lac. Cusec. In this vast tract of land there is only the Massanjore dam to interfere with the natural flow of flood water.

The basic reason of flood in this zone is the shape of the catchment area, its steep slope from a high level plateau area sloping sharply down to aflat terrain near the outfall and also adverse outfall condition because of its limited intake capacity. This feature is again adversely affected by the tidal condition as is generally noticed in the month of September, when the Hoogly is in high tide condition. Delay in drainage causes more accumulation resulting in spread of flood in the upstream of the river system in the west and beyond Berhampur. Generally part of Murshidabad and Nadia suffer from flood because of three reasons –

I. High intensity rainfall in the basin area of Bhairabi-Jalangi-Sealmari itself,
II. Inflow of flood water from Ganga-Padma at its high spate and
III. Drainage congestion at its outfall because of the high stage of Bhagirathi.

Traditionally, Damodar basin was known to be a curse. The basin of river Damodar has a very special shape and this influences its flood pattern. The river has about 70% of its basin just upstream of Durgapur town. This upper catchments of Jharkhand plateau, above Durgapur, generates heavy run-off during high rainfall and is carried to Durgapur in a short time. From here, this discharge travels through the river, bifurcating at Beguahana. One branch, the lower Damodar with very small capacity, reaches the Hoogly on the west bank. The major discharge passes through the Mundeswari to meet the Rupnarayan. Any major discharge along the downstream of Durgapur Barrage may cause flood depending upon the outfall condition of the Mundeswari at Harinkhola. In Kangsabati river system, the Kangsabati Dam has a limited flood storage capacity which is very nominal. Any major spillway discharge from Kangsabati Dam may cause flood at lower areas downstream of Medinipur town depending on tide and downstream rainfall.

Occurrence of Flood

Flood	**North Bengal**	**South Bengal**
Districts Affected by Flood	Cooch Behar, Jalpaiguri, Uttar Dinajpur, Dakshin Dinajpur, Malda;	Nadia, Howrah, Murshidabad, North 24 Parganas, South 24 Parganas, Hooghly, Burdwan, Birbhum, Paschim Medinipur, Purba Medinipur
Relatively scare Districts affected by Flood	Darjeeling	Puruliya & Bankura

Flood Among natural hazards, occurrence of flood ranks first in West Bengal which has become annual festival in the State. Almost all the districts are affected by flood from July to October. But flood is relatively scarce in Darjeeling in North Bengal and Bankura & Purulia in South Bengal. The detail is depicted in the following matrix. According to the Irrigation Department, 37.6 lakhs Ha of West Bengal (42.4% of the total geographical area and 69% of its net cropped area) has been identified as flood prone area; of this 29.8 lakh Ha (i.e., 58% of the flood prone area) is Protected Area. Strong monsoon, rivers and floods are an integral part of Bengal's characteristic ecology that shaped its civilization and culture and at the same time, cause of flood hazard and disasters for the society as a whole.

Flood Among natural hazards, occurrence of flood ranks first in West Bengal which has become annual festival in the State. Almost all the districts are affected by flood from July to October. But flood is relatively scarce in Darjeeling in North Bengal and Bankura & Purulia in South Bengal. The detail is depicted in the following matrix. According to the Irrigation Department, 37.6 lakhs Ha of West Bengal (42.4% of the total geographical area and 69% of its net cropped area) has been identified as flood prone area; of this 29.8 lakh Ha (i.e., 58% of the flood prone area) is Protected Area. Strong monsoon, rivers and floods are an integral part of Bengal's characteristic ecology that shaped its civilization and culture and at the same time, cause of flood hazard and disasters for the society as a whole.

Followings are the records of large floods in West Bengal

Period	**Description**
1978	Major Flood
1986	Flooding due to heavy rains in some areas of Kolkata, Hooghly, Howrah, Parganas and Midnapore
1988	Monsoonal rains caused flooding in areas of Balurghat and Dinajpur lying under the purview of the Ganges and Churani rivers
1991	Flash floods caused damage 35,000 houses
1995	Flooding triggered by heavy rains caused erosion, severe agricultural damage and outbreak of diseases
1998	Monsoon rains caused flooding of the Ganges River
1999	Tropical cyclones caused destruction of an estimated number of 1500 villages. Floods due to brief torrential rains affected areas of Kolkata, Burdwan and Birbhum

Period	Description
2000	Besides flash floods triggered by incessant torrential rains, disaster is also accredited to the opening of sluice gates of dams. The fatalities counted to the tune of 1262, besides affecting millions of people.
2002	Flooding in Jalpaiguri, Cooch Behar and Jalpaiguri in north Bengal due to monsoonal rains. Flash floods swamped ten villages, causing four deaths and 11,000 displacements
2003	Monsoonal rains caused floods affecting the regions of Darjeeling, Jalpaiguri, Malda and Murshidabad
2004	Heavy monsoonal rains affected several districts
2005	Heavy rains caused floods in many areas. About 3000 coastal villages were inundated and 60,000 huts and many roads washed away.
2005	Heavy rains caused floods in many areas. About 3000 coastal villages were inundated and 60,000 huts and many roads washed away. Heavy monsoon rains triggered flash floods and landslides
2006	The regions of Birbhum, Burdwan and Murshidabad were affected mainly from continuous monsoonal downpour Monsoonal rains and tropical cyclone-driven storms in the Bay of Bengal hit India and Bangladesh. West Bengal recorded 50 deaths, 300 were injured and 30,000 mud houses destroyed. Heavy rains left large parts of Kolkata city under water; subsequently 2000 people were evacuated from the city.
2007	Heavy rain from tropical depression in the Bay of Bengal caused flooding leading to 51 deaths, and affecting 3.2 million people.
2013	Heavy rainfall & water release from various dams by DVC led to widespread flooding in the districts of Paschim & Purba Medinipur, Howrah, Hooghly, Bardhaman and Bankura Causing 17 deaths, 8790 villages affected, and affecting 2.1 miillion people

Elements at Risk

Anything in the flood plains will get inundated. building built of earth, weak foundations, and soluble materials will collapse endangering humans and their property. Basements of buildings are under risk. Utilities such as sewerage, water supply, communication lines, and power are put at risk. Food stock in the godowns, agricultural fields, livestock, vehicles, machinery and equipments mounted on the ground, fishing boats are also put at risk (West Bengal Disaster Management and Civil Defence Department).

References:

Paul, K. B. (2011). *Environmental Hazards and Disasters: Contexts, Perspectives and Management.* New delhi: John Wiley & Sons, Ltd.

West Bengal Disaster Management and Civil Defence Department

1.7. Self Assessment Test

i. Highlight the characteristics of the inner core and outer core.
ii. Distinguish between aggradation and degradation.
iii. Highlight the role of Tibetan plateau on Indian monsoon.
iv. Discuss different horizons of soil profile.
v. Distinguish between emigration and immigration.
vi. Define urban settlement.
vii. Give an account of different economic activities with examples.
viii. What is subsistence agriculture?
ix. Highlight the salient features of iron and steel industries of India.
x. Define sustainable development.
xi. Highlight the basic characteristics of maps.
xii. Distinguish between hazard and disaster.

1.8. Study Tips

- Gabler, R. E., Petersen, J. F., Trapasso, L. M., & Sack, D. (2009). *Physical Geography.* Brooks/Cole CENGAGE Learning.

- Barry, R. G., & Chorley, R. J. (2003). *Atmosphere, Weather and Climate.* London: Routledge.

- Husain, M. (2020). *Geography of India.* New Delhi: McGraw Hill.

- Plaster, E. J. (2014). *Soil Science and Management.* New York: Cenage Learning.

- Dent, B. D., Torguson, J. S., & Holder, T. W. (2009). *Cartography- Thematic Map Design.* Boston: McGraw Hill.

- Paul, K. B. (2011). *Environmental Hazards and Disasters: Contexts, Perspectives and Management.* New delhi: John Wiley & Sons, Ltd.

- West Bengal Disaster Management and Civil Defence Department
- Bongaarts, J. (2009). Human population growth and the demographic transition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1532), 2985-2990.
- Dayananda, K. C. (2016). Tourism and its impact on Indian economy. *IOSR J Hum Soc Sci (IOSR-JHSS)*, *21*, 24-28.
- Harris, D. R., & Fuller, D. Q. (2014). Agriculture: definition and overview. *Encyclopedia of global archaeology*, 104-113.
- Lipsey, R., & Chrystal, A. (2011). *Economics*. Oxford University Press.
- Rogers, P. P., Jalal, K. F., & Boyd, J. A. (2012). *An introduction to sustainable development*. Routledge.
- Roy, S., & Bandyopadhyay, T. (2017). Municipal solid waste.
- *Sustainable Development Goals (SDGs)-Challenges for India*. Available from: https://www.researchgate.net/publication/324200471_Sustainable_Development_Goa

ls_SDGs-Challenges_for_India [accessed Aug 11 2022].

- *Sustainable Development Goals (SDGs)-Challenges for India*. Available from: https://www.researchgate.net/publication/324200471_Sustainable_Development_Goals_SDGs-Challenges_for_India [accessed Aug 11 2022].
- Seto, K. C., Dhakal, S., Bigio, A., Blanco, H., Delgado, G. C., Dewar, D., ... & Ramaswami, A. (2014). Human settlements, infrastructure and spatial planning.
- Subramanian, K. R. (2018). The crisis of consumption of natural resources. *International Journal of Recent Innovations in Academic Research*, *2*(4), 8-19.
- Svetlov, N. M., Siptits, S. O., Romanenko, I. A., & Evdokimova, N. E. (2019). The effect of climate change on the location of branches of agriculture in Russia. *Studies on Russian economic development*, *30*(4), 406-418.
- Wormald, B. (2015). The Future of World Religions: Population Growth Projections, 2010-2050. *Pew Research Center's Religion & Public Life Project*.

Disclaimer: This self-learning material is compiled from different books, journals and web-sources.