Cartography

Definition, Types and Elements

The International Cartographic Association defines cartography as the discipline dealing with the conception, production, dissemination and study of maps. Cartography is also about representation – the map. This means that cartography is the whole process of mapping. Viewed in the broadest sense, this process includes everything from the gathering, evaluation and processing of source data, through the intellectual and graphical design of the map, to the drawing and reproduction of the final document.

Types of Maps Based on Scale:

On the basis of scale, maps may be classified into large-scale and small-scale. Large scale maps are drawn to show small areas at a relatively large-scale. For example, the topographical maps drawn at a scale of 1: 250,000, 1:50,000 or 1:25,000 and the village maps, the zonal plans of the cities and house plans prepared on a scale of 1:4,000, 1:2,000 and 1:500 are large scale maps. On the other hand, small-scale maps are drawn to show large areas. For example, atlas maps, wall maps, etc.

(i) **Large-scale Maps**:

Large-scale maps are further divided into the following types: (a) Cadastral maps (b) Topographical maps (a) Cadastral Maps : The term 'cadastral' is derived from the French word 'cadastre' meaning 'register of territorial property'. These maps are drawn to show the ownership of landed property by demarcating field boundaries of agricultural land and the plan of individual houses in urban areas. The cadastral maps are prepared by the government agencies to realise revenue and taxes, along with keeping a record of ownership. These maps are drawn on a very large scale, such as the cadastral maps of villages at 1 : 4,000 scale and the city plans at a scale of 1 : 2,000 and larger.(b) Topographical Maps : These maps are also prepared on a fairly large scale. The topographical maps are based on precise surveys and are prepared in the form of series of maps made by the national mapping agencies of almost all countries of the world. For example, the Survey of India undertakes the topographical mapping of the entire country at 1 : 250,000, 1 : 50,000 and 1 : 25,000 scale (Fig. 1.3). These maps follow uniform colours and symbols to show topographic details such as relief,

drainage, agricultural land, forest, settlements, means of communication, location of schools, post offices and other services and facilities.

(ii) **Small-scale Maps**:

Small-scale maps are further divided into the following types : (a) Wall Maps (b) Atlas Maps (a) Wall Maps : These maps are generally drawn on large size paper or on plastic base for use in classrooms or lecture halls. The scale of wall maps is generally smaller than the scale of topographical maps but larger than atlas maps. (b) Atlas Maps : Atlas maps are very small-scale maps. These maps represent fairly large areas and present highly generalised picture of the physical or cultural features. Even so, an atlas map serves as a graphic encyclopaedia of the geographical information about the world, continents, countries or regions. When consulted properly, these maps provide a wealth of generalised information regarding location, relief, drainage, climate, vegetation, distribution of cities and towns, population, location of industries, transport-network system, tourism and heritage sites, etc.

Types of Maps Based on Function:

The maps may also be classified on the basis of their functions. For example, a political map serves the function of providing administrative divisions of a continent or a country and a soil map shows the distribution of different types of soils. Broadly, maps based on their functions may be classified into physical maps and cultural maps. (i) **Physical Maps**: Physical maps show natural features such as relief, geology, soils, drainage, elements of weather, climate and vegetation, etc. (a) **Relief Maps**: Relief maps show general topography of an area like mountains and valleys, plains, plateaus and drainage. (b) **Geological Maps**: These maps are drawn to show geological structures, rock types, etc. (c) **Climatic Maps** : These maps depict climatic regions of an area. Besides, maps are also drawn to show the distribution of temperature. rainfall, cloudiness, relative humidity, direction and velocity of winds and other elements of weather .(d) **Soil Maps** : Maps are also drawn to show the distribution of different types of soil(s) and their properties .

(iii) **Cultural Maps**: Cultural maps show man-made features. These include a variety of maps showing population distribution and growth, sex and age, social and religious composition, literacy, levels of educational attainment, occupational structure, location of settlements, facilities and services, transportation lines and production, distribution and flow of different

commodities. (a) **Political Maps** : These maps show the administrative divisions of an area such as country, state or district. These maps facilitate the administrative machinery in planning and management of the concerned administrative unit. (b) **Population Maps**: The population maps are drawn to show the distribution, density and growth of population, age and sex composition, distribution of religious, linguistic and social groups, occupational structure of the population, etc. Population maps serve the most significant role in the planning and development of an area. (c) **Economic Maps**: Economic maps depict production and distribution of different types of crops and minerals, location of industries and markets, routes for trade and flow of commodities

Elements of Cartography:

In view of the variety of maps, we may find it difficult to summarise what they all have in common. Cartography, being an art and science of map-making, does include a series of processes that are common to all the maps. These processes that may also be referred to as elements of maps are: Scale,Map Projection " Map Generalisation, Map Design, Map Construction and Production

Scale: We know that all maps are reductions. The first decision that a map-maker has to take is about the scale of the map. The choice of scale is of utmost importance. The scale of a map sets limits of information contents and the degree of reality with which it can be delineated on the map..

Projection: We also know that maps are a simplified representation of the three-dimensional surface of the earth on a plane sheet of paper. The transformation of all-side-curved-geoidal surface into a plane surface is another important aspect of the cartographic process. We should know that such a radical transformation introduces some unavoidable changes in directions, distances, areas and shapes from the way they appear on a geoids. A system of transformation of the spherical surface to the plane surface is called a map projection. Hence, the choice, utilisation and construction of projections is of prime importance in map-making. Generalisation: Every map is drawn with a definite objective. For example, a general purpose map is drawn to show information of a general nature such as relief, drainage, vegetation, settlements, means of transportation, etc. Similarly, a special purpose map exhibits information pertaining to one or more selected themes like population density, soil types or location of industries. It is, therefore, necessary to carefully plan the map contents

while the purpose of the map must be kept in the forefront. As maps are drawn at a reduced scale to serve a definite purpose, the third task of a cartographer is to generalise the map contents. In doing so, a cartographer must select the information (data) relevant to the selected theme and simplify it as per the needs.

Map Design: The fourth important task of a cartographer is the map design. It involves the planning of graphic characteristics of maps including the selection of appropriate symbols, their size and form, style of lettering, specifying the width of lines, selection of colours and shades, arrangement of various elements of map design within a map and design for map legend. The map design is, therefore, a complex aspect of mapmaking and requires thorough understanding of the principles that govern the effectiveness of graphic communication.

Map Construction and Production: The drawing of maps and their reproduction is the fifth major task in the cartographic process. In earlier times, much of the map construction and reproduction work used to be carried out manually. Maps were drawn with pen and ink and printed mechanically. However, the map construction and reproduction has been revolutionalised with the addition of computer assisted mapping and photo-printing techniques in the recent past.

HISTORY OF MAP MAKING

The history of map making is as old as the history of mankind itself. The oldest map was found in Mesopotamia drawn on a clay tablet that belongs to 2,500 B.C. Greek and the Arab geographers laid the foundation of modern cartography. The measurement of the circumference of the Earth and the use of the system of geographical coordinates in map-making are some of the significant contributions of the Greeks and the Arabs. The art and science of mapmaking was revitalised in early modern period, with extensive efforts made to minimise the effects of the transformation of the geoid onto a plane surface. The maps were drawn on different projections to obtain true directions, correct distances and to measure area accurately. The aerial photography supplemented the ground method of survey and the uses of aerial photographs stimulated map-making in the nineteenth and twentieth centuries. The foundation of map-making in India was laid during the Vedic period when the expressions of astronomical truths and cosmological revelations were made. The expressions were crystallised into ‘sidhantas' or laws in classical treaties of Arya Bhatta, Varahamihira and Bhaskara, and others.

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MAPPING TECHNIQUES

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There are four ways of representing knowledge;

_By a written language called **Literacy**

_By a spoken language called **Articulacy**

_By way of symbolising numbers, sets , magnitudes etc called numeracy

_And the fourth way of communication is called **Graphicacy.**

In cartography, our dealing is more with Graphicacy and the use of graphics to capture the spatial structure of the environment is the subject matter of Cartography. Graphic methods extend from drawing and painting to construction of maps, charts, plans, diagrams etc.

By Graphicacy, we mean that if we want to communicate in someone's mind a spatial relationship, we try to evoke a similar image in the person's mind which we have in our own mind and the best way to provide visual representation of this image is the **Map** and the **Cartography** is the art of making and studying of maps in all their aspects. Therefore, Cartography is an important branch of Geography because it is an extremely efficient way of manipulating, analysing

and expressing ideas, forms, relationships etc that occur in space. **Map is the central intellectual object which reflects the character skill of all cartographers in its making.**

Cartography is concerned with reducing the spatial characteristics of a large area or a smaller portion of it and putting it on map format and lets us see therefore the broader spatial relations that exist over large areas. It is a carefully designed instrument for recording, calculating, displaying, analysing and understanding the interactions of objects in space. Its most fundamental function is to bring things into view.

Four processes are involved in cartography;

1. Collecting and selecting data for mapping.
2. Manipulating and generalising the data, designing and constructing the map.
3. Reading or viewing the map.
4. Responding to or interpreting the information.

In order to master these processes a cartographer must be familiar with all mapping techniques including those associated with other mapping sciences like **Geodesy, Surveying, Photogrammetry, Remote Sensing** and other **G.I.S** techniques. A skilled cartographer must also know a great deal about human thought and communication (Cognitive science) and the discipline associated with environmental features being mapped.

Cartographers must be sensitive to the mapping needs of diverse fields. The mapping effectiveness is best achieved by treating the making and using of maps equally. The task of map designer is to enhance the map user's ability to retrieve the information. The great power of mapping process lies in its ability to provide fresh and insightful perspective on man-environmental relationship.

In short a cartographer must be well versed in diverse fields of knowledge in order to make his drawing meaningful, observable and attractive because he has to depict the maximum of information on the minimum of space and therefore should also be well versed in conventional signs (cartographic symbols).

DIFFERENT CARTOGRAPHIC TECHNIQUES

In depicting information on maps, different cartographic techniques are used in different maps. The application of any one method for all the types of maps is not possible. Following are some of the methods used in the preparation of various types of maps;

1. *Isopleth method*
2. *Choropleth method (shading method)*
3. *Choroschematic method (symbol method)*
4. *Chorochromatic method (colour or tint method)*
5. *Dot method*
6. *Diagramatic method*

ISOPLETH METHOD:

Quantities are represented on some maps by lines each of which is of constant value. Thus a line which joins places of equal value in respect of some distribution is generally called as ISOPLEATH. It is a combination of Greek words ISOS-(means same) and Plethron-(means measure). Thus a line on a map joining points having same amount of rainfall is an isopleth and is called as *ISOHYET.* Similarly an isopleth connecting places of equal temperature is called an **Isotherm, Isobars** for equal pressure, **Isobath** for equal depth, **Isohaline** for equal salinity etc.

Isopleths are drawn at a selected and constant interval and the value of each isopleths is written at the end of the line. Isopleths never intersect or join each other. Selection of interval of Isopleths is carefully done. Number of Isopleths should neither nor too small. Isopleths are drawn one by one taking care that an Isopleth runs through the stations representing the quantities of same value or is interpolated proportionately between them. The spaces between the

consecutive Isopleths are shaded to show the varying values. The shade becomes darker as the value increases. It may be noted that the shades here do not stand for density per unit area and should not be thus confused with Choropleths. The Isopleths when drawn close together indicate a sharp change in the values and when drawn wider apart, they show a gentle change.

CHOROPLETH METHOD:

Choropleth method or technique is employed to represent the variations in the distribution of average value per unit area within the geographical or administrative divisions by applying various cartographic shades. It is a technique of depicting the variations with the help of different shades or designs which indicate very low, low, medium, high and very high values of distribution of data. It is used to show various demographic features like density of population, age-structure, sex-ratio, literacy levels etc. Various aspects of agriculture like landuse categories, proportion of area under different crops, cropping intensity etc. The variation in density from one administrative division to other is represented by various cartographic shades. Low densities are shown by light shades and high densities by darker shades. The contrast between various shades should be clearly discernible but not abrupt.

CHOROSCHEMATIC METHOD:

In this technique, areal distribution of geographical phenomenon like soil, landuse, vegetation etc are depicted by various cartographic symbols like dots, circles, triangles, initial letters of the elements etc to represent on the map. This method mostly stresses on the location rather than the characteristics of the phenomenon. Neither the shape nor the colour of the symbol used represents the dimension of the object. The main advantage of this method is that many elements may be shown together on a single map.

CHOROCHROMATIC METHOD:

In this method different, features of earth like mountains, plateaus, plains, water bodies, natural vegetation etc are shown on a map by a combination of various colours or by different shades of one colour (layer tints). For example, in a vegetation map, forests may be shown by green, grasslands by yellow and desert vegetation by yellow colour.

APPLICATION OF QUANTITATIVE TECHNIQUES/STATISTICAL TECHNIQUES IN GEOGRAPHY

Statistical techniques and procedures are applied in all fields of academic research; wherever data are collected and summarized or wherever any numerical information is analyzed or research is conducted, statistics are needed for sound analysis and interpretation of results.

Geographers use statistics in numerous ways;

- To describe and summarize spatial data.
- To make generalizations concerning complex spatial patterns.
- To estimate the probability of outcomes for an event at a given location.
- To use samples of geographic data to infer characteristics for a larger set of geographic data (population).
- To determine if the magnitude or frequency of some phenomenon differs from one location to another.
- To learn whether an actual spatial pattern matches some expected pattern.

MEASURES OF CENTRAL TENDENCY

Central tendency (or, more commonly, a *measure of central tendency*) is a central or typical value for a probability distribution. It may also be called a *center or location* of the distribution. Colloquially, measures of central tendency are often called *averages*. The most common measures of central tendency are the arithmetic mean, the median and the mode. A central tendency can be calculated for either a finite set of values or for a theoretical distribution, such as the normal distribution. Occasionally authors use central tendency to denote "the tendency of quantitative data to cluster around some central value." The three main measures of central tendency are:

- **Arithmetic mean (or simply, mean)** – It is calculated as sum of all measurements divided by the number of observations in the data set. It is denoted by symbol '$\bar{x}$'. The mean is calculated for a dataset below as an example;

  Q; Calculate mean of 2,3,5,6,7,9,3,5,10,14,22

  Ans; Since, Mean = $\frac{Sum\ of\ observations}{No.of\ Observations}$

  Mean= $\frac{88}{11}$

  Mean= **8**

- **Median** – the middle value that separates the higher half from the lower half of the data set. The median and the mode are the only measures of central tendency that can be used for ordinal data, in which values are ranked relative to each other but are not measured absolutely. The median is simply the middle observations of the ranked dataset. As an example the median of dataset given below is calculated;

  Q: Calculate median of 2,3,2,4,5,11,7,8,9,11,19,23,25

  Ans; Since for determining the median, the data has to be arranged either in ascending order or descending order; therefore the data could be arranged as;

  2,2,3,4,5,7,8,9,11,11,19,23,25 ***OR*** 25,23,19,11,11,9,8,7,5,4,3, 2,2

  The middle observation in both the cases is **'8'**, therefore median of given dataset is **'8'.**

- **Mode –** It is defined as the most frequent value or observation in the data set. This is the only central tendency measure that can be used with nominal data, which have purely qualitative category assignments. As an example, the mode of below given dataset is calculated;

  Mode of 2,3,5,4,5,6,4,5,9,10,5 is **'5'** because it is most common observation.

MEASURES OF DISPERSION

Dispersion (also called *variability, scatter, or spread*) denotes how stretched or squeezed a distribution (theoretical or that underlying a statistical sample) is. Common

examples of measures of statistical dispersion are the variance, standard deviation and interquartile range. Dispersion is contrasted with location or central tendency, and together they are the most used properties of distributions. A measure of statistical dispersion is a non-negative real number that is zero if all the data are the same and increases as the data become more diverse. Most measures of dispersion have the same units as the quantity being measured. In other words, if the measurements are in metres or seconds, so is the measure of dispersion. Such measures of dispersion include:

- Standard deviation
- Mean deviation
- Quartile deviation
- Range

Standard deviation (SD, also represented by the Greek letter sigma '**σ**' or the Latin letter s) is a measure that is used to quantify the amount of variation or dispersion of a set of data values. A low standard deviation indicates that the data points tend to be close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values. The mathematical formula for calculating standard deviation is;

$$s_N = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2},$$

Where *'xi'* is the individual observations; '$\overline{x}$' is the mean and 'N' is the no. of observations

Mean deviation- The mean deviation (also called the mean absolute deviation) is the mean of the absolute deviations of a set of data about the data's mean. For a sample size N, the mean deviation is defined by

$$\mathrm{MD} \equiv \frac{1}{N}\sum_{i=1}^{N}|x_i - \overline{x}|,$$

where $\overline{x}$ is the mean of the distribution.

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❖ Geomorphic field Survey: Meaning, Significance and procedure

Man and nature is the basic theme of geography. Man's existence on the earth's crust is depends upon the terrain it provides and boundaries it offers. According to **Vidal de La Blache** a famous geographer, "Nature provides the stage and it is for man to act on it".

Geography is often considered as the study of the feature of earth's surface including their spatial distribution and interrelation and the interaction of man with them. The natural or physical geographic elements consist of physical feature like landforms, climate, water bodies' flora and fauna.

Geography is considered to be a scientific discipline. But it is different from Zoology or Botany. In these science subjects practical's are mostly conducted and performed in an indoor lab. Geographers are also engaged in the practical but the real lab of a geographer is the world outside.

The geomorphic field studies have obtained vital importance in geography. Such field studies are not important only to get the first hand information and the data about socio – economic aspects of human life, but these are of even greater importance to develop full understanding about physical features like V–shaped valley, Delta formation by river, U – shaped valley by glacier, Sand dunes by the action of wind etc. existing in the natural field.

➢ Significance of Geomorphic field Survey

These field surveys are concerned with the study of location, altitude and space relations of various places. Besides it also studies rock types, their litho – logical and mineral characteristics, various structural features like folds, faults, dips, strikes, thrust etc., various landforms such as mountains, plateaus, plains, valleys, gorges, block mountains

etc., various geomorphic processes which are constantly engaged in changing the morphological characteristics of the earth's surface the area under investigation.

There are of course, various techniques of field work and surveying which help in collection of data regarding the geomorphology of the area under study. The information obtained thus is presented in the form of maps – topographical maps, geological maps and many other types of maps. All these maps produce detailed information of the area concerned. Number of instruments is used during the field surveys.

Information about altitude of various places can be obtained with the help of a variety of instruments like Clinometers, Dumpy level, Theodolite. These instruments are called leveling instruments.

Procedure: Before going in the field for any Geomorphic field Survey following criteria should be taken into the consideration:

a) Plan for visiting area to survey

b) Purpose for surveying

c) Acquainted knowledge

d) Well trained / equipments

e) Execution of plan & skills

f) Proper observation

g) Politeness

h) Compilation and presentation.

- **Field survey and its importance in Socio-economic Survey:**

Field survey refers to collection of information by an individual or group of individuals through direct observation in the field. Through a field survey, information about the physical and socio-economic survey such as relief features, drainage patterns, types of soil and natural vegetation etc (physical features), as well as population structure, sex ratio, literacy, means of transport and communication, urban and rural settlements, etc (socio-economic)is collected which gives a clear view of the pertaining information. The distribution and growth of any phenomena can be best understood by collecting data from the concerned field mainly by field survey.

Field survey constitutes an extremely important aspect of geographical studies. From the very beginning, the geographers have studied the natural and cultural environment of different parts of the earth through field work only. The study of geography can be done only by personally visiting the concerned area because that gives first-hand information. An area can be remembered better by visiting it rather than by reading about it in the books.

According to a popular saying, “I read, I forget; I see, I remember; I do, I understand.” While emphasizing the importance of field work James Fairgrieve says, “ Geography comes through the soles of one’s shoes.” This means that true knowledge of geography lies in the field rather than in the library. Another importance of field survey can be best seen from the remarks of Ratzel (German geographer), I travelled, I sketched, I described.

The importance of field survey in the field of socio-economic aspects of human population is huge and irreplaceable. As we are aware that there are vast differences in

social, cultural and economic characteristics between different regions of a country as well different strata of society within a region in other words regional disparities everywhere which directly influenced by the productivity of land , occupation of people , services and facilities available to them as well as the capacity of the people to utilize the resources all these facts need to be gauged out in order to have coherent knowledge of prevailing heterogenetic nature of socio-economic conditions of the concerned area. All these aspects can best gauged through filed observation rather through learning from any secondary sources in order to collect information of all the facts which might not be available or its authenticity might be in doubt borrowed from any secondary sources. As the published data are often not adequate so it is better to collect information through direct observation in the field and validate its authenticity as much as possible. By examining socio-economic conditions of any area it is important to visit the particular area to gauge out the selective indicators by various means such as through personal investigation, questionnaire/ schedule and other primary ways to have a better knowledge of the concerned phenomena and helped to draw rationalized results.

Procedure: Before going in the field for any socio-economic survey following criteria should be taken into the consideration:

i) Plan for visiting area to survey

j) Purpose for surveying

k) Acquainted knowledge

l) Well trained / equipments

m) Execution of plan & skills

n) Proper observation

o) Politeness

p) Compilation and presentation.