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FERAL

An Introduction to Maps

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Anupama Pai

Foundation for Ecological Research, Advocacy and Learning

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Chapter 1:

A brief history of maps

Who we are has always mattered to us. We identify ourselves in many ways; the place we live in, the place our ancestors belonged to, the rivers, the climate of the place etc. We also use additional information of the types of animals or plants of a place, the industries located there...... One could go on endlessly to list the different ways in which we can provide information about who we are and where we come from. It is this need to describe a place and where it is that led to the invention and development of maps. The science of maps is called cartography.

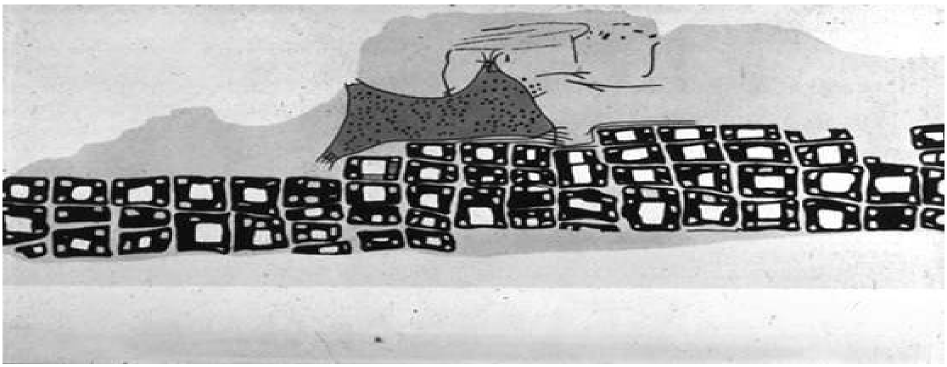
The earliest of maps were drawings which were used by several civilizations. First, each culture had its own type of maps, for eg. settlements on the coast vs inland. Second, as different writing material was discovered, map production also changed accordingly.

A snapshot of map making

- Primitive wall paintings of Turkey 6200 BC
- The "Babylon clay tablet" of 2300 BC discovered in present day Iraq, showing the Earth as a flat disc
- Ptolemy's world map, 150 AD, first known attempt to show the Earth's round surface on a flat surface
- Al-Idrisi's world map, 1154 AD
- The copper and wooden engravings found as early as 1400 AD
- Printing of maps using wooden blocks 15th century.
- Printing of maps using copper blocks 16th century.
- Rosselli's World map, 1508. The first map to show the entire globe.
- World map van Keulen, 1720. The ultimate map for navigation of the world

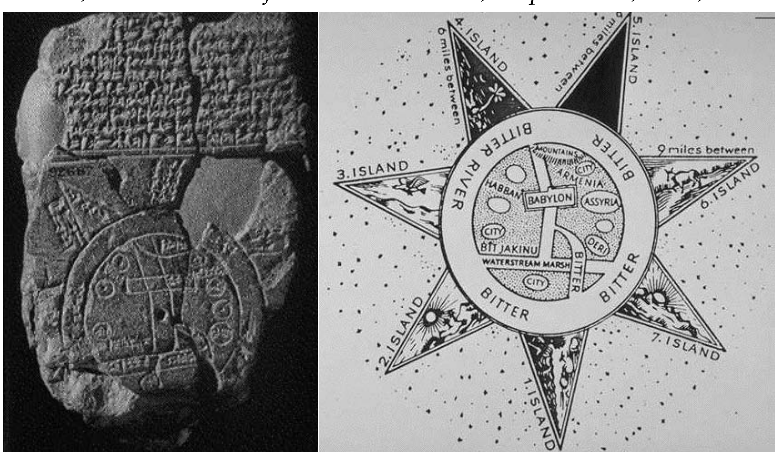
In olden days maps needed to be drawn or carved out. This meant that only a skilled artist was able to prepare maps. Thus maps were not for use by everybody, they were expensive and available only to the rich. But as different technologies were developed producing maps became much easier. The type of people and number of people who wanted to use maps also increased. People no longer lived in small isolated settlements, they started travelling to new places and getting in contact with with each other.

Found in 1963 by James Mellaart In Ankara, Turkey. Wall painting approx. Nine feet long Radiocarbon date of 6,200 + 97 B.C



Interpretation: Depicts a town plan of Çatalhöyük, Anatolia. A settlement of about eighty households, with a volcano in the background

The Babylonian interpretation of the world as a flat disc. Excavated in 1930, at the city of Ga-Sur at Nuzi , near the towns of Harran and Kirkuk, Iraq. Dated 2,300-2,500 B.C.



Maps also tell us what people know about the world. The earliest recorded maps (such as the Babylonian clay tablets) show the earth as a flat circular disk. Around 200 BC, the Greeks proved that the Earth was round. Therefore, its development has followed the advance of scientific discoveries, theories developed and new lands explored. **Ptolemy** (150 AD) introduced scientific cartography. He is known as the "Father of Geography" and developed the first detailed world map. In the middle ages, the Arab world took the lead in map development. **Al-Idrisi** (1154 AD), a much traveled cartographer, developed a still famous world map. He worked under the patronage of King Roger II Guiscard of Sicily at Palermo. This was a meeting place of merchants, sailors, explorers, pilgrims and scholars. Al-Idrisi's maps evolved through collecting and compiling information from all published sources and from these numerous travellers.

Travel over water has been practiced even before land maps were used extensively. In the beginning sailors moved only close to the coast using directions and a list of different landmarks. This was known as the periplus. The Greeks and Pheonicians were the first to sail far away from land. They used the sun and the north star as their main guides for direction and estimating the time they travelled. This led to the development of **nautical charts**. A nautical chart is a precise representation of the sea and land of a given place. Imagine being out at sea and having no one to ask for directions! In fact, the word navigate comes from the Latin navis : ship and agere : to move or direct.

Influence of inventions on Mapping

The Printing Press : Until the invention of the printing press (1450), a very skilled artist was required to draw out maps. The job was slow and difficult. Thus not everyone could get a map. The ability to print brought down the cost of map making substantially. Finally, maps could be used by ordinary people.

Ship Design : Adventurers and explorers have been key to adding detail in maps. Initial maps were only of one land mass. As people began traveling across the seas they brought back information of new lands. Better ships meant explorers could go out farther into the new world.

Magnetic Compass : Knowing where to go is is of course, important. Early travellers used the sun and stars to keep track of their movements. Several instruments were developed in the age of European sea explorations for accurate location measurements. The magnetic compass (1187) made navigation of the seas and exploring new areas easier. This meant a better picture of what the world looked like.

Interest in Maps

Explorations : increased with new places being discovered and the need to show where they were and describe them. The European explorers like Marco Polo and Columbus discovered new worlds for map makers to draw.

Trade Routes : As travel became easier and more common, merchants went from one region to another with their goods and traded. They used maps to show the routes they followed, good halting sites, watering holes etc.

War & Empire Building : Mapping efforts were also encouraged by rulers who wanted to know the extent of their lands. They also used maps for planning battles and attack routes. In fact, it is the military applications that have been a major influence in the development of maps and recently in GIS and satellite technologies.

Biology : Interest in the patterns of distribution of plants and animals around the world has led to the development of bio-geography as a field. This started from even before Darwin and Wallace, who were the main persons who looked at land forms and locations and related this to the species found.

However, for a long time maps were a mixture of correct details and imaginations of what the world was like. Advances in astronomy changed the way people looked at the stars, planets and earth. Map views and the science of developing them grew in leaps and bounds from the time of Ptolemy to the 19th century. Various developments in the mathematics and physics, inventions of survey instruments and new information from explorers, led to the development of the present days maps. The 20th century has added a whole new dimension to the world of maps. Aerial photographs (photographs taken from the sky), computers, satellites and space research, have changed the world of cartography to an all encompassing one of Geographic Information System[1] .

1. "The character and technology of map making may have changed over the centuries,...but the potential of maps has not. Maps embody a perspective of that which is known and a perception of that which may be worth knowing." John Noble Wilford from The Mapmakers.

Chapter 2:

What is a Map

Thus far we have spoken of maps as pictures of the world as known to people through the ages. What would be a definition for a map? That is, if I asked you 'What is a map?', what will be your answer?

Sounds like a simple question, doesn't it. However, there are several definitions of a map. The Chambers/Oxford dictionary definition is

A map is a representation in outline of the surface features of the earth or a part of it, usually on a plane surface.

Just like how we have detailed maps of the earth, maps of the moon and some of the planets have been made.

In general, maps are graphic representations (or in simple words, a picture) of a set of features whose relationships are shown by size and position. They provide information about a particular place and the objects present within that place. The important thing to remember is that a map is not a true picture, it is only showing those details that the map maker is focussing on.

Map language

Just as each region has its own culture or language, maps have their own language. Imagine telling a friend the route that she needs to take to reach your house. A map would give the same information in its own language.

Without understanding this language, the information shown on a map is of no use to us. It is like trying to read a book written in a language that you do not know. You could also say that a map is like a good sentence : a subject, a body, a tense; which together with proper spelling convey a meaning. The alphabets of map language are the symbols, colours and various types of lines used. Just as grammar is important in speaking or writing well, the same applies to a map. This determines how well information is shown or how easily it is understood by a reader. The basic parts of a map are

Title : Tells you what the map is all about (see types of maps), which area is being shown, when it was made, by whom.

Legend : This explains what the different symbols, lines and colours represent. For eg. different types of lines for tar roads, mud roads and paths, the use of blue for water and green for forests.

Scale : It tells us how the map is related to the area on ground, i.e. how are the distances shown between places on the map related to the actual distance of these places from one another.

Orientation : A map talks of where, so we need to know the four directions, North South East West, on the map. By convention, North is shown on the top and this provides an orientation to the image. (Imagine looking at a building from different sides or from the top; do you see the same view?)

Projection : A map is always drawn on a flat surface such as a paper, wooden block, on the ground. But the earth is a round object. What do you think happens when you cut open a round object (such as a ball) and try to flatten it? It is difficult to do so, there are many wrinkles. The process of smoothening out these wrinkles is known as projection. There are several projections that can be used and this will be discussed later (Chapter 3 :Projections)

Geometry and Survey tools in Mapping

The development of geometry (relationship of distances and directions of objects) and the invention of different tools for measuring distance and direction has been the key to improvements in mapping skills. The initial simple tools were the level, sight and measuring chain. Later, the sextant, magnetic compass, telescope, marine chronometer used with the mathematics of distance relations increased the accuracy of maps produced.

- Eratosthenes (200 BC) calculated the circumference of the earth using angle and distance measures from shadows quite accurately, he was off by only 500 miles.
- Ptolemy developed the geometry for projecting a spherical area on a flat surface and also the system of location by the co-ordinate system
- Survey accuracy was greatly improved by the use of the triangulation methoed in the late 1600s. It is the determination of a new location by measuring a distance between two known points and measuring angles from each end of this line to the new point.
- Measuring distances in the north and south direction was possible from solar observations. However, accurate measurement in the east west direction was possible only after the invention of the marine chronometer in 1765.

Variations of a language

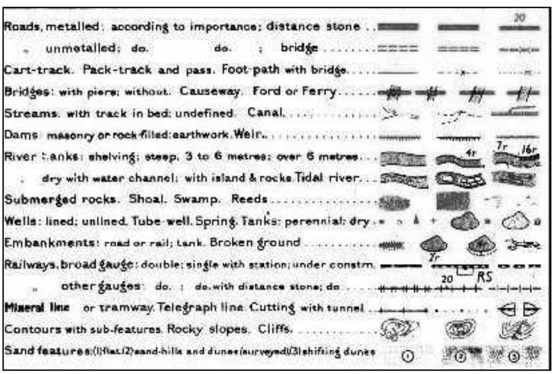
Each language has letters which make up the words. Also the way in which a language is spoken changes from one place to another. For example Tamil; Chennai Tamil is different from that spoken in Madurai or Tirunelveli or Kanyakumari. With reference to maps, this can be said of the way symbols or pictures are used. The sizes, shapes and colours of symbols are the alphabets of a map that show different features. The selection of symbols differs to some extent from place to place and also the type of map. Thus the features shown and how they are shown are dependent on what the author of the map is trying to tell you. You could say, that the author of a map is like a censor board for films[2] . There are several types of symbols that are used depending on who is going to use the map and what we want the reader to see.

Types of Maps

Maps are of several types and are classified in different ways. A map can be 'original', i.e. created at a point in time showing details of that time, for example the maps by Ptolemy or Al-Idrisi or it could be a map that you make of Pondicherry as it is today. A map could be 'historical', which means created at a later time but showing features of the past. Thus, if you made a map today of Pondicherry as it was 10 years ago, it would be a historical map.

They can also be classified based on the information it shows. This could be of a small area (a detailed map) or a large area (not much detail). We give below one such classification

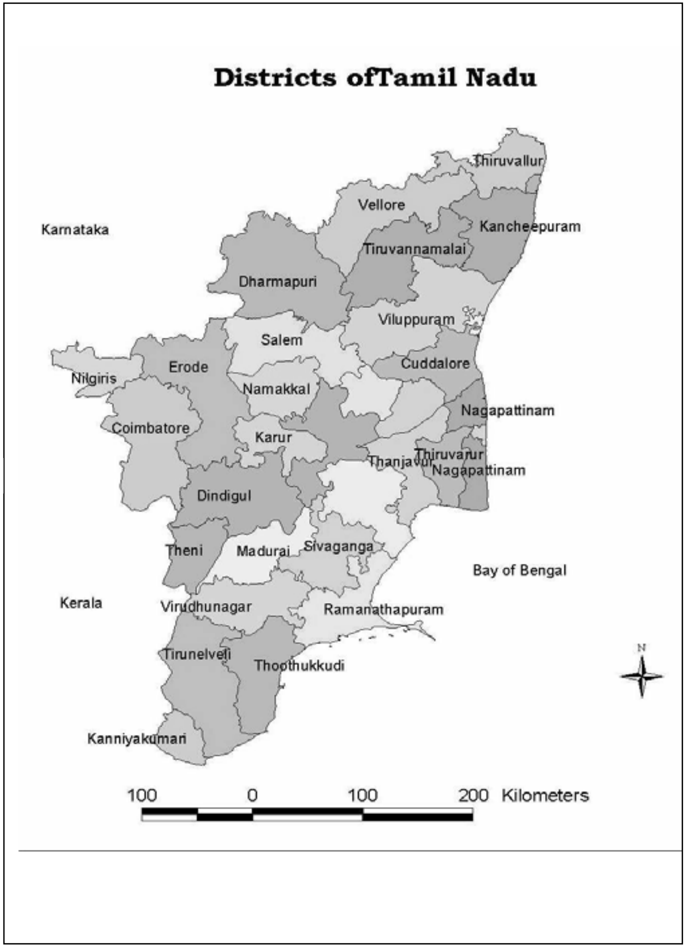
Location maps : cities, rivers, zoos, schools, hospitals



Network maps : road, rail, water lines,
Topographical : landscape features such as rivers, mountains, forests
Political : countries, districts
Cadastral : map of a single village
Thematic : population, crops grown, soil type, maps shown during elections

Maps are not only for work, but also for play; many video games are based on maps : look for a treasure, fight a battle, build a city.....

2. The chapters of a book : The Power of Maps by Wood, Denis, New York: Gilford Press, 1992, explain this well. They are: "Maps Are Embedded in a History They Help Construct," "Every Map shows this…But Not That," and "The Interest the Map Serves is Masked."


Districts ofTamil Nadu
Karnataka
Kerala
Bay of Bengal
Thiruvallur
Vellore
Kancheepuram
Tiruvannamalai
Dharmapuri
Viluppuram
Salem
Cuddalore
Erode
Nilgiris
Namakkal
Nagapattinam
Coimbatore
Karur
Thanjavur
Thiruvarur
Nagapattinam
Dindigul
Theni
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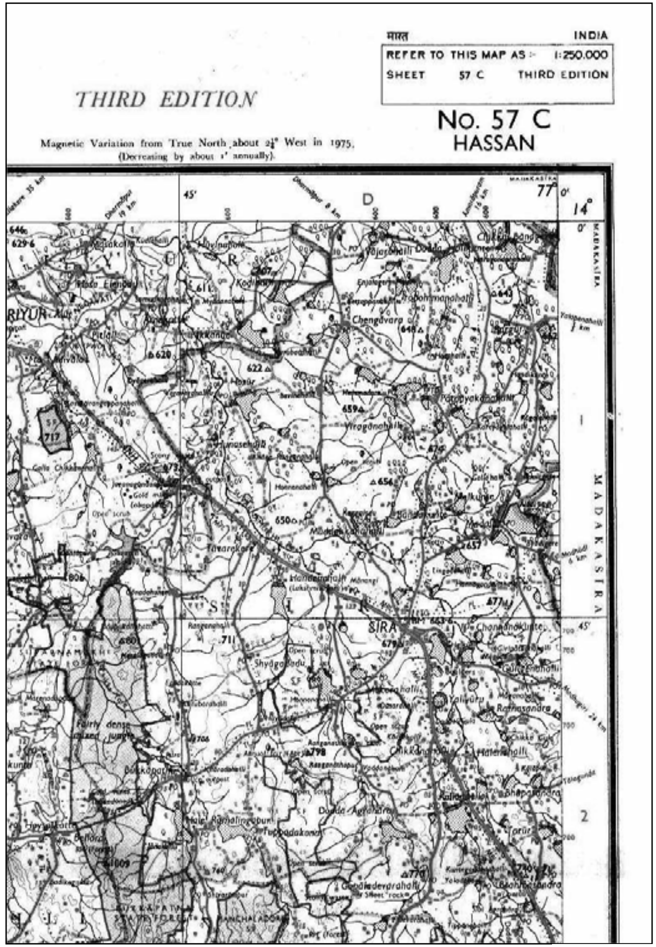

भारत INDIA
REFER TO THIS MAP AS :- 1:250.000
SHEET 57 C THIRD EDITION
THIRD EDITION
No. 57 C
HASSAN
Magnetic Variation from True North about 2¼° West in 1975.
(Decreasing by about 1' annually).
MADAKASIRA
SIRA

Chapter 3:

Reading a map

We now discuss why understanding a map is important. Does the ability to read a map properly make any difference to us? Yes, reading a map is like reading a story book. Some of this may be fiction and some reality. But it is important to know the difference. Also, by reading maps, we can understand more about a place than just its name or where it is located on the face of the earth. Studying maps can also give us a sense of why history is the way it is.

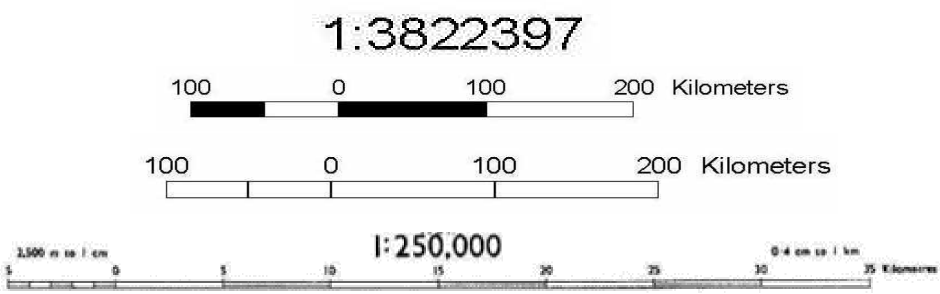
- the growth and decline of kingdoms and nations, the wars that were fought
- development of an area or how a place changed from a sleepy town to a noisy city
- and why this change- why did one place become a famous business center and not another
- explorations and discovery of different cultures, the natural wonders of the place.

Understanding symbols

We have already seen that a good map should have a title, a date of when it was prepared, a scale and a legend. In early times, each map maker used his own set of symbols and lettering. Blank areas for which information was not available was filled in with designs or drawings of the animals or birds of that area, the map maker was really an artist. As map science developed, some general rules were formed of how a map could be drawn. Further, a common set of symbols, lines and colours began to be used. Thus a topographical map made in India and one made in the UK or USA of a place would be quite similar.

Scale

A map as we said before is a representation of a place on the ground. So, how do you determine this relationship , i.e. if you wanted to go from place A to place B marked on a map, how would you know the real distance that you would have to travel. This relationship is shown on a scale. The scale of a map is written as units or a ratio (1:1000, 1:50,000) or shown as a ruler with markings. The first method tells us that 1 unit on paper is equal to 1000 or 50,000 units on the ground. This could be cm, km, feet; any unit of measurement which is specified on the map. The ruler also gives a similar ratio and is marked into sections giving the distances.

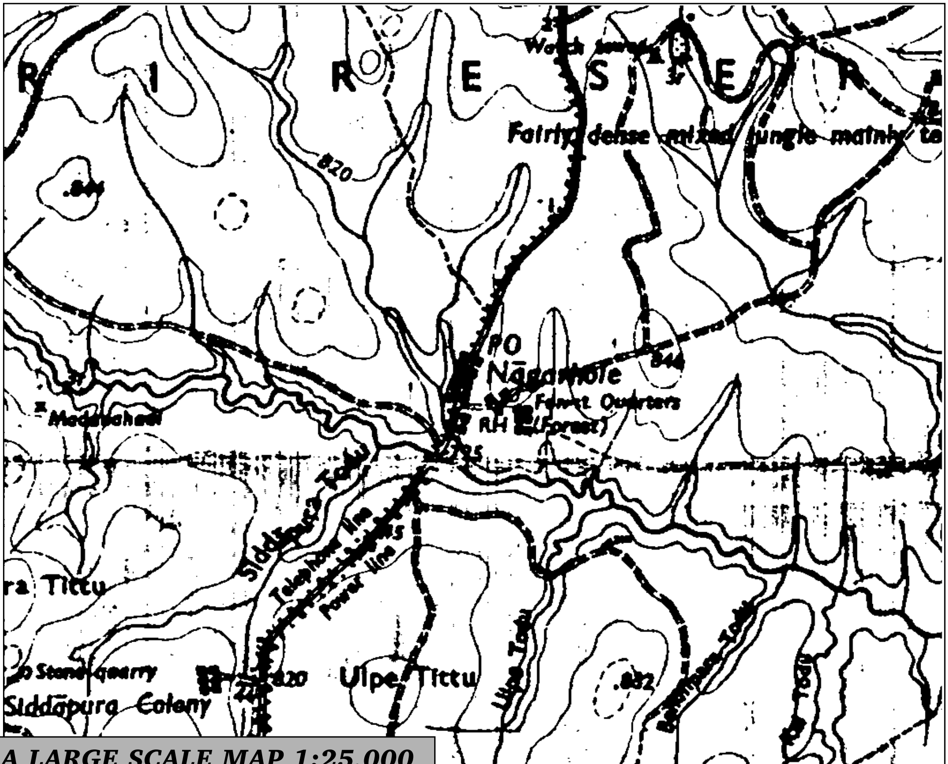


Now, this brings us to an interesting point, what do map makers mean by a large scale map or a small scale map? Your first answer may be that the large scale must be a big map and the small scale a small one. But, does this mean the size of paper on which it is drawn or does it mean how much area shown or does it mean the amount of detail? To a map maker large scale actually means a small area shown in great detail or high resolution i.e. more information per space on the ground. Small scale means a much larger area which does not give fine details but covers more space on the ground. For eg. A map of Pondicherry town is a large scale map when compared to a map of Pondicherry Union Territory. The town map will have details of several streets and major buildings; the U.T. map would show Pondicherry with just a few main streets.

Another issue with large or small scale is the accuracy of the details shown. In a large scale map, accuracy is much higher than in a small scale. To understand this take a state map and an India map. Look at the main roads or rivers shown. Compare these features in the two maps. How many twists and turns are shown from start to finish?

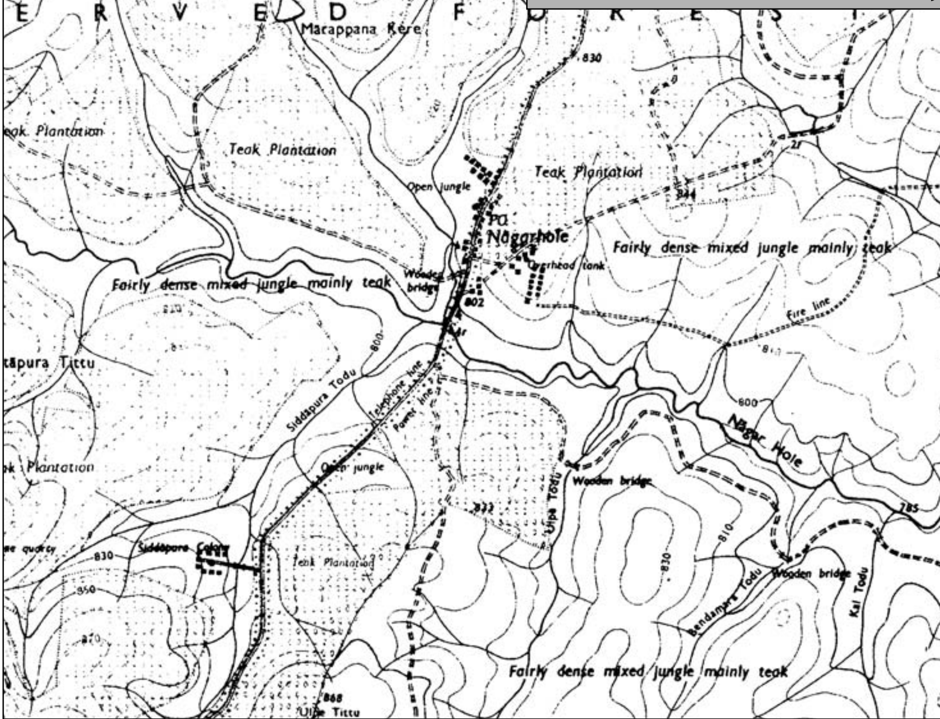
Questions to reflect upon

1. What would happen to the scale of a map if you did an enlarged photocopy of the map?
2. If one map has a scale of "1 cm = 1 km" and another has "1 cm = 10 km", which map covers more area?
3. What about altitude contours (lines joining places with same heights), what would the number of lines and how close they are drawn tell about the heights in an area.
4. If you wanted to explore an area what features would you look for in a map?



A LARGE SCALE MAP 1:25,000

A SMALL SCALE MAP 1: 50,000



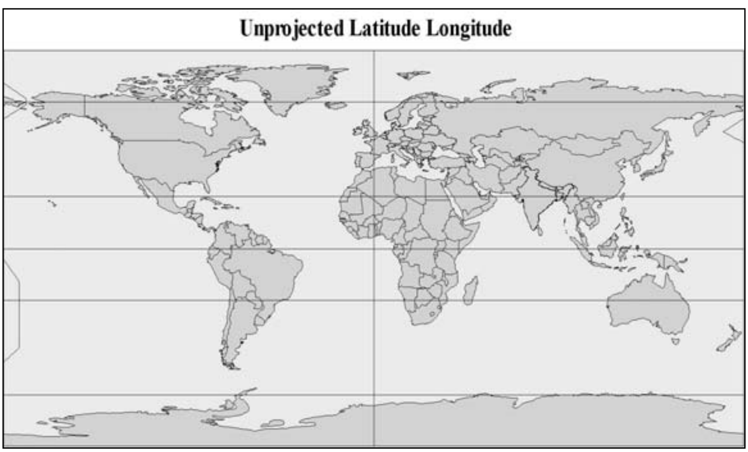
Projections

The process of transferring information from the round surface of the earth to a flat surface is known as projection. Think of cutting open a ball and trying to put it flat on the ground. The only way you can do this is to stretch or pull the opened piece in different directions. When you do this any picture that is there on the ball undergoes some change in its shape. A projection tries to show the areas, shapes, distances and directions of the different continents as correctly as possible even when the sphere is put on a flat surface. There are many different ways of doing this, each with its own advantages and disadvantages. Some examples are given below

Conformal : the lines of latitude and longitude intersect at right angles and the scale of the map at any point is the same in all directions.
Equal area : the proportional size of areas is the same as on earth, but the shapes are somewhat distorted.
Orthographic : the shapes of areas are shown as seen from space

Thus many projections concentrate on showing one quality correctly, some show a few, but no single projection can show all aspects accurately. A commonly used projection is the Mercator projection designed by Flemish cartographer, Gerardus Mercator, in 1569. The key feature is that compass directions were straight lines in all directions from all points on the map. He made longitude lines parallel and increased the distance between latitude lines away from the equator. Thus the regions closer to the poles look much bigger than they actually are. For example, Greenland looks larger than South America, although South America is actually eight times larger. This projection also makes the distances appear larger than they are.

Unprojected maps include those that are formed by considering longitude and latitude as a simple rectangular coordinate system. Scale, distance, area, and shape are all distorted with the distortion increasing toward the poles.



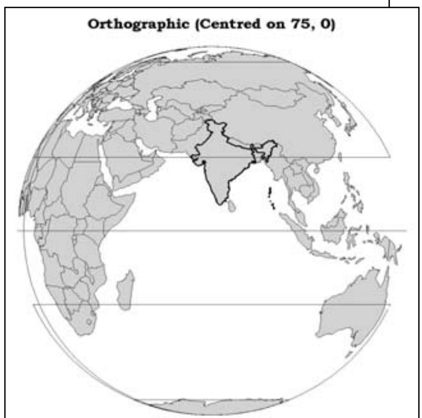
The Universal Transverse Mercator (UTM) projection is used to define horizontal positions by dividing the surface of the Earth into sixty zones, each spanning six degrees of longitude. Each zone has its own central meridian. This projection is a specialized application of the Transverse Mercator projection. The limits of each zone are 84° N, 80° S

Uses and applications

(a) United States topographic quadrangles, 1:100,000.

(b) Large-scale topographic mapping of the Soviet Union.

(c) Medium-scale maps of regions throughout the world

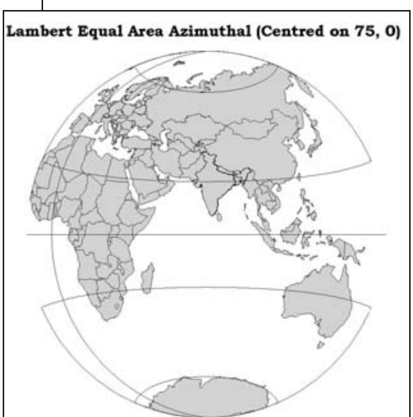


The Orthographic projection views the globe from an infinite distance. This perspective gives the illusion of a three-dimensional globe. Distortion in size and area makes the view more realistic to our eye than that seen in almost any other projection.

Uses and applications

(a) Uses of this projection are aesthetic more than technical.

(b)Most popular projection to make atlases.



This projection preserves the area of individual polygons while simultaneously maintaining a true sense of direction from the center. The general pattern of distortion is radial. This projection is best suited for individual land masses that are symmetrically proportioned, either round or square.

Uses and applications

(a)Population density (area).

(b)Political boundaries (area).

(c)Oceanic mapping for energy, minerals, geology and tectonics (Direction).

(d)This projection can handle large areas, thus it is used for displaying such geographical areas as entire continents and polar regions.

Chapter 4:

Mapping to Geographical Information Systems (GIS)

What is a GIS

We have looked at maps, how they store information and the types of information. Now let us see how the analysis of this information is done with the different technological developments that have happened in the last few decades. Today we do not talk of only maps, we also say Geographical Information Systems. The meaning is there in the words themselves. It a system of tools and technologies that are used to show information of different kinds which come from the same area. Thus information such as population of a place, the diseases that affect the people, the water sources, waste dumps and the hospital network can all be looked at together on a GIS. The information is of different types and collected in different ways; the common point is the place or their location.

Simply said, a GIS is the 'what' and 'who' being linked to 'where' helping us understand better the 'why' and 'how'.

GIS Development

The development and use of GIS, around the 1960s, was encouraged by several things. Cameras in space became possible with the launching of the Sputnik satellite. Computers became easier to make and use. New software was being developed constantly. In fact, the earliest GIS was known as computer cartography.

Some early milestones

- 1963 : First GIS center (Canada Geographic Information System) set up in Canada by Roger Tomlinson to develop a system for land use planning and management. Several types of information ranging from agriculture to wildlife was used to develop a simple classification of 1 (best) to 7 (poorest).

- 1964 : Howard Fischer set up the Harvard Lab for Computer Graphics and

Spatial Analysis in the USA as a research center for development of software

- 1969 : Environment Science Research Institute (ESRI) founded by Jack and Laura Dangermond as a private consulting agency for GIS and RS work.

- 1969 : Indian Space Research Organisation (ISRO) established.

- 1970 : French Institute of Pondicherry starts the cartographic programme for the Western Ghats.

- 1970 : National Oceanic and Atmospheric Administration (NOAA) an environmental scientific agency formed of several research institutions in America.

- 1973 : Maryland Automatic Geographic Information (MAGI), one of the first statewide GIS projects begins in the USA.

Initial interest in GIS was from land management institutions and the military. As the use of GIS became more common, several research and application centers were setup, both government and private, to deal with the demands.

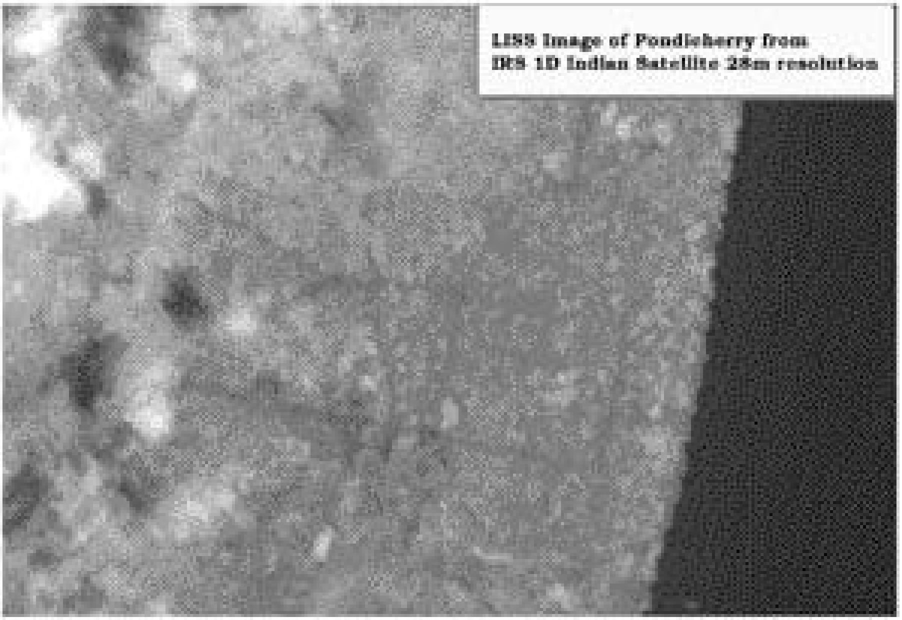
The Remote Sensing (RS) Advantage

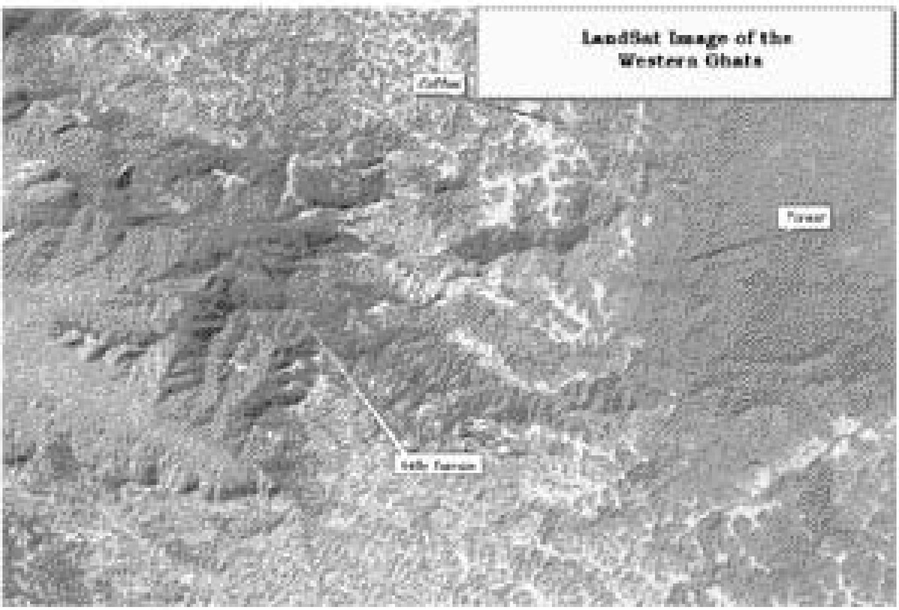
All mapping was first based on what people were able to see directly. When satellites were launched into the sky, gathering information through indirect observations became possible. Cameras on space vehicles began to take pictures of the earth from the sky. In 1968, the Apollo space program returned with the first pictures of Earth from space. This made scientist more eager to develop satellites to continuously send us information about the earth and its images from space.

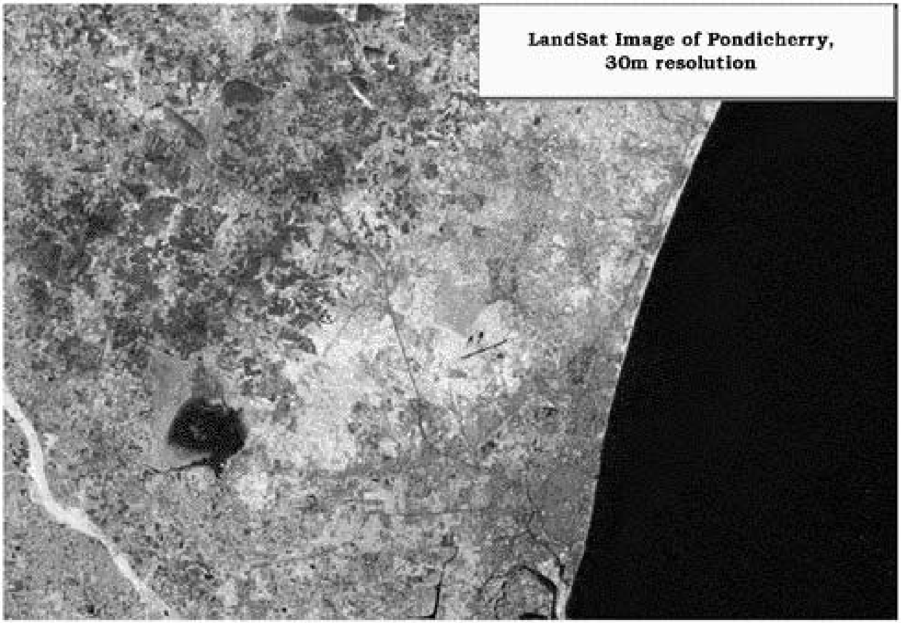
Just us we need to know the scale of a map, it is essential to know the resolution (amount of detail) of a satellite image. The satellite pictures or any picture stored on a computer is made up of several small squares (known as pixels) of different colors. The size of the pixel in relation to the real world determines the resolution of the image. Images were first available at 1 pixel = 35m, and as cameras were improved the resolution became better. Today we can get images which have 1 pixel = 1 m on the ground.

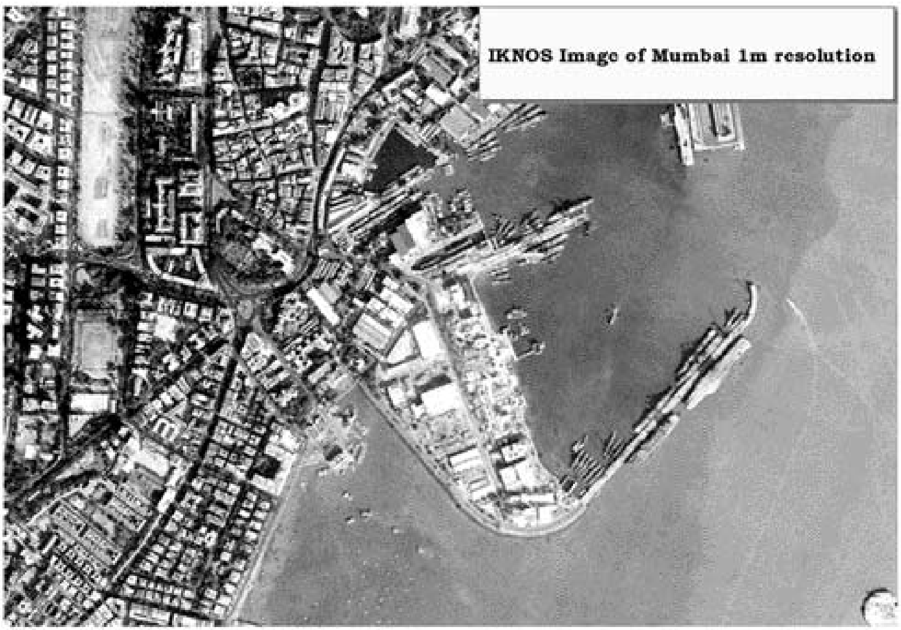
Yes, you can see people and read the number plates of vehicles from these!

Do you think where a satellite is placed and how it moves would make a difference to the pictures it sends back? Hint: think of the earths movement.


LISS Image of Pondicherry from
IRS 1D Indian Satellite 28m resolution


LandSat Image of the
Western Ghats


LandSat Image of Pondicherry,
30m resolution


IKNOS Image of Mumbai 1m resolution

Chapter 5:

The building blocks of a GIS

The system of storing and analysing information is done on computers as it involves maps, large amounts of information and the special mathematics to analyse the relationships and patterns in this information. Just like a car has to have standard parts: an engine, wheels, gears, etc which could be of different makes, so also a GIS has four main parts which are of several makes. These are explained below.

Data

The backbone of a GIS is the various information that can be attached to a location. Location, itself, can be either at a small or large scale, eg. country, state, city or village. For example, a residential plot would have data such as size, owner, number of people staying in the house, telephone number, type of house, presence of a well, etc.

Maps

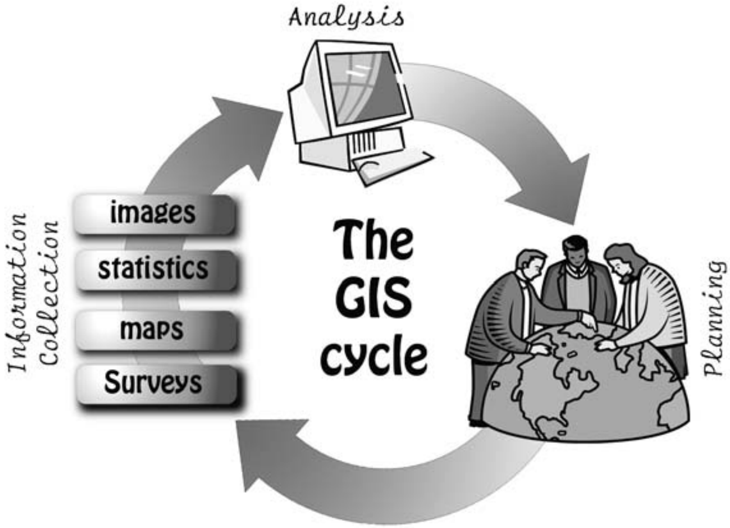
The fact that we are looking at spatial patterns makes maps another important part of GIS. These maps can be from different sources, you could use those that are already made or draw one for the specific region you are interested in.

Software

Different software packages are needed for copying (scanning), creating (digitising) and editing maps. You need packages that can store large amounts of data which can be searched for specific information easily. Finally, you need programs which can link the map and the data and then looking for relationships and patterns.

Hardware

A computer is a basic requirement for any GIS as a large amount of information has to be dealt with. The type of computer makes a difference to the amount of information that can be analysed, the quality of images that are displayed and the speed at which work is done. There are also several other equipment which do specialized work, eg. a scanner to copy paper maps onto computer.



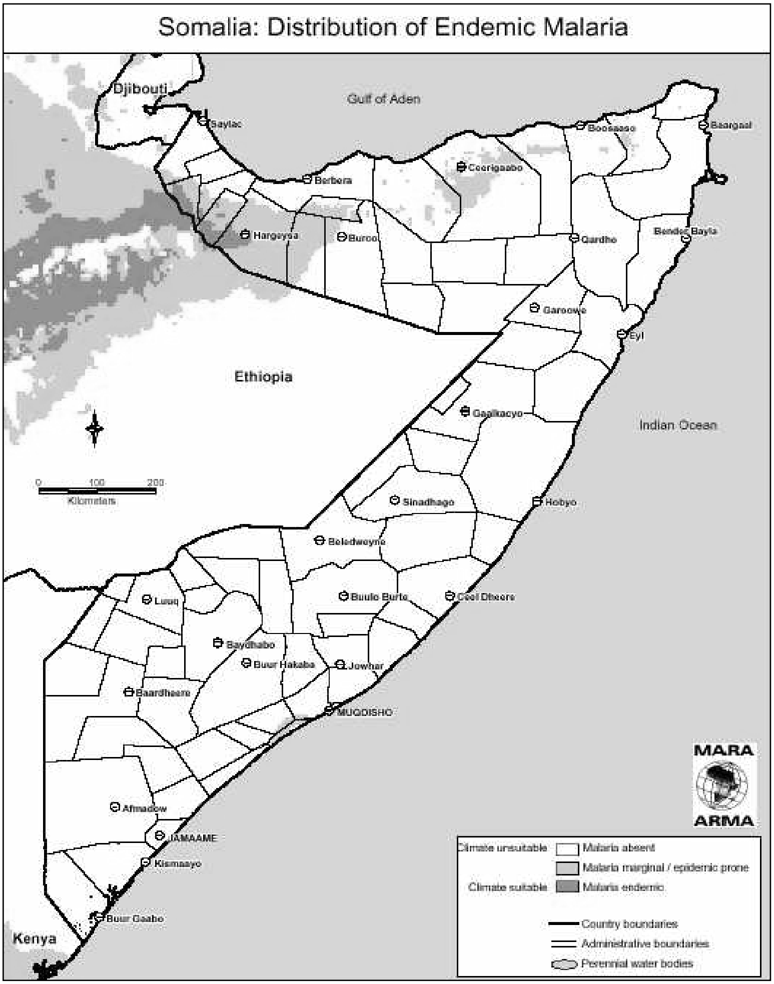
Applications of GIS and RS

The power of GIS has been increased a lot with the use of remote sensing technology. The combined use of maps and these pictures help us study many things which would otherwise be difficult or take a lot of time. The use of GIS and RS has been made in diverse fields such as marketing, medical sciences, military needs, agricultural planning, forestry studies, city development etc. The following maps show several examples of how GIS can be used. Today GIS applications are used in diverse fields such as biology, social sciences, marketing, health, agriculture......the list is endless.

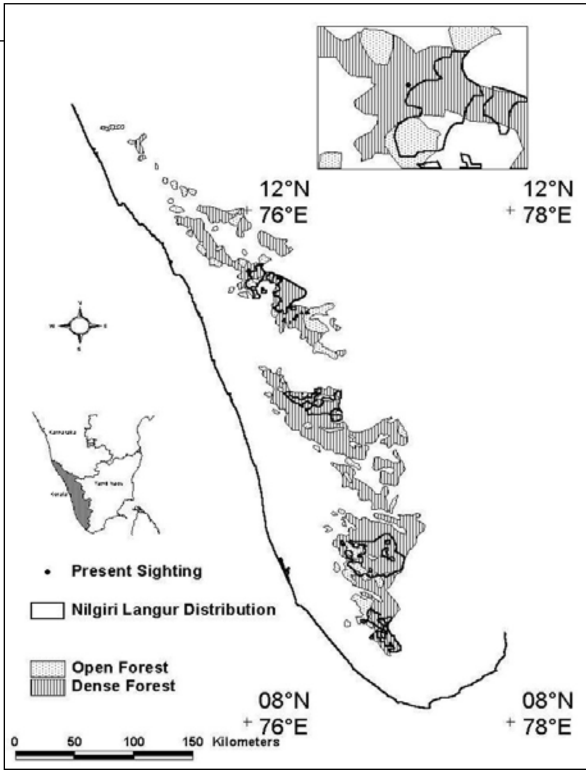
Some Applications

Agriculture, Forestry	Land Use	Geology	Water Resources	Oceans	Environment
Difference between - Crop types, Forest types Measurement of crop area Soil conditions	Land use types Rural - urban maps Transportation networks Water bodies	Volcanic areas Mapping geological types	Water networks Snowlines and movement of glaciers Sediments in waterways	Detecting marine organisms Coastline changes Mapping ice areas in oceans	Effects of natural disasters - cyclones, floods Water pollution Surface mining effects

Health : GIS can be used to study how diseases may spread, plan hospital locations or identify special health problem areas. This is done by relating places with many cases of a disease with the infrastructure available (water supply, drainage etc.), the local water and soil quality, occupation of people, common animals found etc. For example the presence of malaria is studied with the help of GIS.

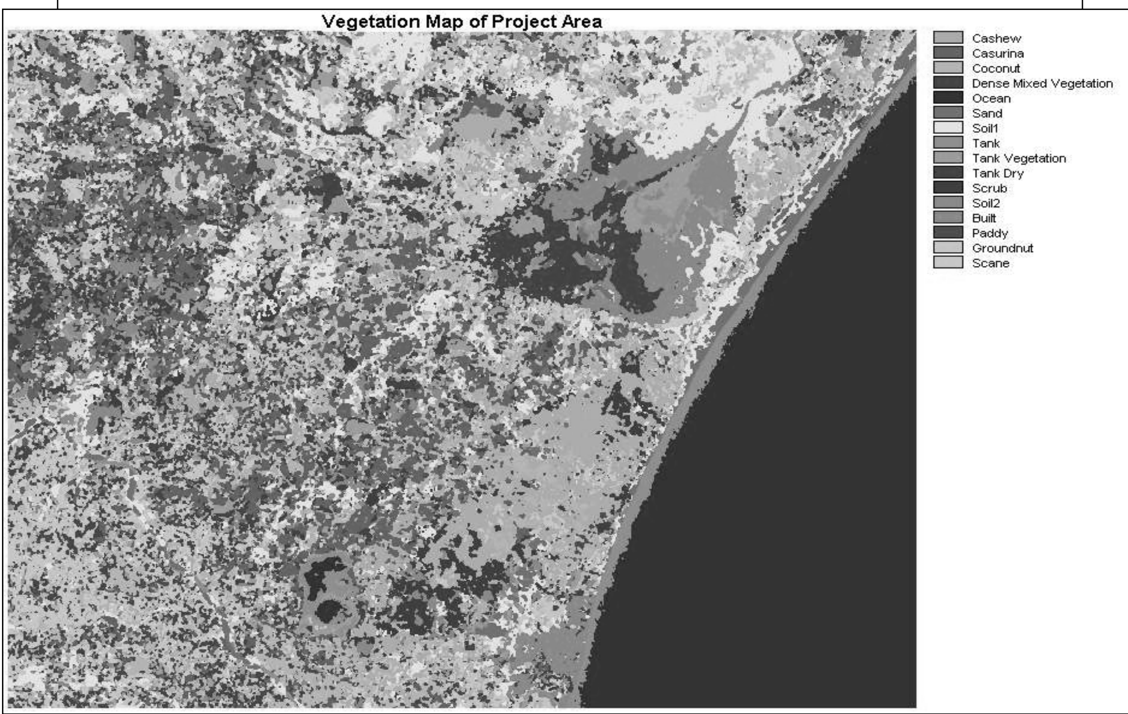


▲ *The MARA/ARMA initiative is an effort of several individuals and organistions to map the presence of malaria and the risk of the local population in getting the disease. This work has helped in identfying high priority areas, methods of control, timing and effectiveness of malaria control measures.*
http://www.mara.org.za/



▲ *Studying distribution patterns of animals over large areas using GIS tools*

▼ *Developing land use and cover maps using satellite imageries*



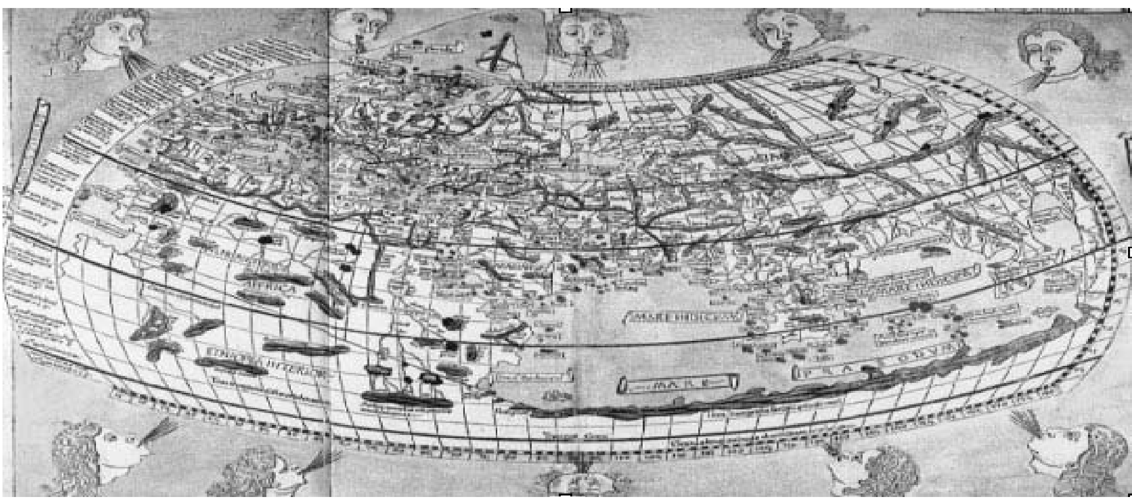
1 Fact File

Ptolemy - Father of Geography

Claudius Ptolemy (Klaudios Ptolemaios, 90-168 A.D), was a Greek who lived in Alexandria (Egypt). His contributions have been in the field of astronomy, mathematics and geography.

Ptolemy improved upon the system developed by Aristotle to explain the position and movement of the Earth and other objects in the sky. These were the sun, moon, five planets and the stars. His system consisted of the Earth almost at the center and the other objects moving in various paths around it. His calculations and predictions were accurate enough for observations with the naked eye. **Almagest**, his thirteen volume book, gives details of the mathematics developed and theories of astronomy. This system was followed until the Polish scholar, Copernicus, proposed a heliocentric (Sun as the centre of the universe) view in 1543.

The first known attempt of showing a sphere on a flat surface was by Ptolemy. His work gives details of drawing maps in three different projections, co-ordinates of about eight thousand places and the concepts of latitude and longitude. This was compiled in the book, **Geographia**, and was the major source of information until the time of Columbus(1493). In Ptolemy's map, Asia extended much too far east, which is believed to have influenced Columbus's decision to sail west for the Indies.

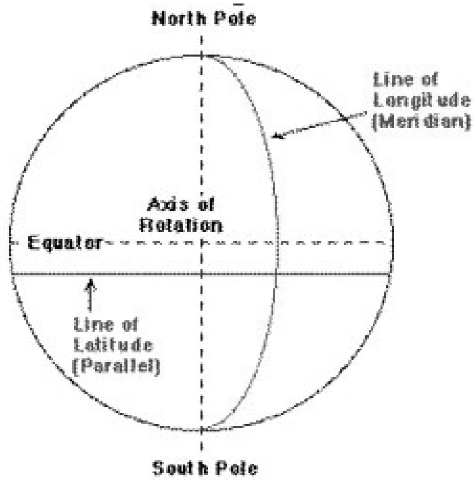


2 Fact File

Latitude and Longitude

Where is Pondicherry? The answer could be the south-east coast of India, south of Chennai etc. For an exact position or reference we use imaginary lines known as latitude and longitude. These were developed to provide an exact reference to the different places on the surface of the Earth and is known as a co-ordinate system. It is like drawing a large graph sheet on the Earth to give a x,y location for each place.

The Earth is a slightly flattened sphere (like an orange). Imagine parallel lines going around it from the middle to the top and bottom in circles. These horizontal lines are the lines of latitude and they give the location on a vertical plane. That is the position of a place on the sphere in the top to bottom direction. The largest line going round the middle (equidistant from the North and South poles) is the Equator and this is numbered zero degrees. The numbering increases as we move towards the poles which are 90 degrees. As we move in two directions, the lines are named accordingly as so many degrees N or S.



How far do we travel when we go up the lines of latitude? Each degree is divide into 60 minutes of latitude and each minute into 60 seconds. In navigation, one minute of latitude = one nautical mile (0.714km = 1 nautical mile). The distance from the equator to the north pole would be __________.

The lines that go round the Earth vertically and each time passing through the poles, are the lines of Longitude or meridians. These give location on the horizontal place, that is the position in the east - west direction on the Earth. The starting point or 0 degrees is the prime meridian which runs through Greenwich, England, where the British Royal Observatory is located. The meridians are numbered 0 to 180 East and 0 to 180 West around the earth. Meridians are considered Great Circles, i.e. if you sliced through the earth along any one of them you would cut through the centre and get two equal halves. Are any of the lines of Latitude great circles?

3

Fact File

Remote Sensing

We are aware of the different things that happen around us through our sensory organs. We "see" things because of reflections of light from objects, "hear" due to disturbances caused in the air by sound waves. Thus we collect various signals around us, interpret them and understand the world around us. A simple definition of remote sensing would be "the collection and measurement of information about an object by a recording device not in physical contact with the object. This information is collected using different types of radiation."

Remote sensing thus involves the collection of information through sensors from a distance - typically from above. We normally see the world from a horizontal view. This limits the area that can be covered in one look and also the kind of information that we are able to gather. This changes as we start looking from above. Imagine looking at a street while standing on the road. The same road from the top of a house or a 10 or 30 storied apartment. The view and details are quite diferent. The view possible from a satellite thus can cover several hundreds of square km.

Advances in remote sensing

- The photographic camera, you could say, was the first remote sensing system. It captures a "picture" of objects outside itself by concentrating (through a lens) light on to a recording medium or film.
- The idea of the "aerial photograph" or pictures from the sky began in the 1840s as balloonists took pictures of the ground using the newly invented photo-camera.
- In 1908, L.P.Bonvillian, a passenger on Wilbur Wright's aircraft, took the first photographs from a plane during a demonstration flight over France.
- Until the 1960s, cameras mounted on aeroplanes remained the primary source of information from the sky.
- The German V-2 rockets that were captured after World War II were the first rockets to carry cameras to space.
- With the advent of Sputnik in 1957, the possibility of putting film cameras on spacecraft was realized. The first cosmonauts and astronauts carried cameras, just like tourists, as they went into space.
- Apollo 8 space program returns in 1968 with the first pictures of Earth from space.
- Initial cameras were like TV cameras which provided only low quality pictures.
- First satellites gathered information on cloud cover, air temperature, wind patterns etc.

4

Fact File

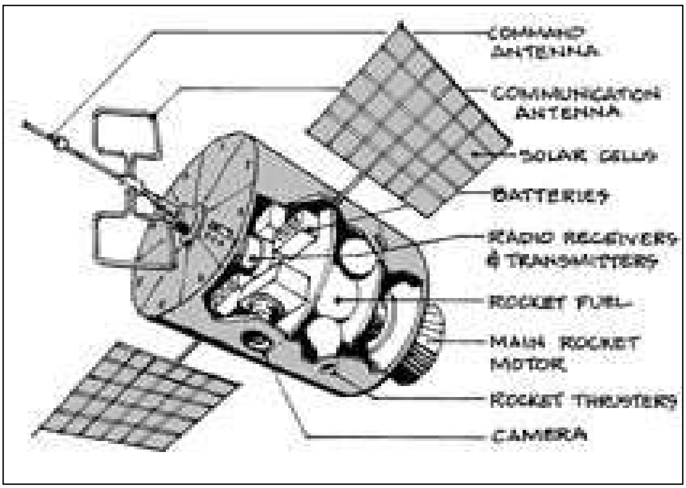
Some Satellites in the Sky

Remote sensing as a proper system for collecting information about the Earth on a regular schedule, began in the 1970s when instruments were flown on Skylab and later, the Space Shuttle. Landsat was the first satellite launched specifically to monitor land and ocean surfaces. Satellites are grouped based on the information they collect. A few of the satellites in the sky are listed below.

Group 1 - *Primarily Land Observers:* Landsat (1-6) (USA)(1973); Seasat (1978); SPOT (France) (1-3) (1986); IRS(1A-1D) (India) (1986); Radarsat (Canada) (1995); IKONOS (1999)

Group 2 - *Primarily Meteorological Observers:* TIROS (1-9)(France) (1960); the Russian Kosmos (1968) and Meteor series (1969); NOAA (1-5) (1976); GMS series (Japan) 9 (1977); Bhaskara (India) (1979); INSAT (India) (1983)

Group 3 - *Major Use in Oceanography:* Seasat (1978); Nimbus 7 (1978) Topex-Poseidon (1991); SeaWiFS (1997)



Components of a Satellite that collect and Interpret Information

5

Fact File

Satellite Orbits

How do satellites stay up in the sky? Does the distance of the satellite from the Earth's surface make any difference? How does this relate with the fact that the Earth is also moving? The path followed by a satellite is known as the orbit. There are different orbits into which satellites are launched and this depends on the type of work they do.

The most common of the orbits is the **geostationary** , where the satellite is always in the same position with respect to the rotating Earth. It is at a distance of about 35,790 km. At this location, the time taken by the satellite to complete one orbit is the same as the time the Earth takes to complete one rotation (23 hrs, 56 mins, 4.09 secs). The satellite thus looks like it is stationary or synchronous with respect to the movement of the Earth. The view from these satellite covers a large area of the Earth's surface. However, given that it is in the equatorial plane, the regions near the poles look distorted.

Polar orbits are perpendicular to the equator and thus give a more global picture of the Earth. They are typically at a distance of 700 to 800 km. They are mainly used to gather information about areas which are difficult to reach (i.e. the poles). The movement of the satellite is synchronised with that of the sun. That is to say that the satellite and the sun cross each latitude at the same time throughout all seasons. This helps in collecting information regularly for long term comparisons. The satellites themselves also rotate at about one degree a day so that they keep time with the rotation of the Earth.

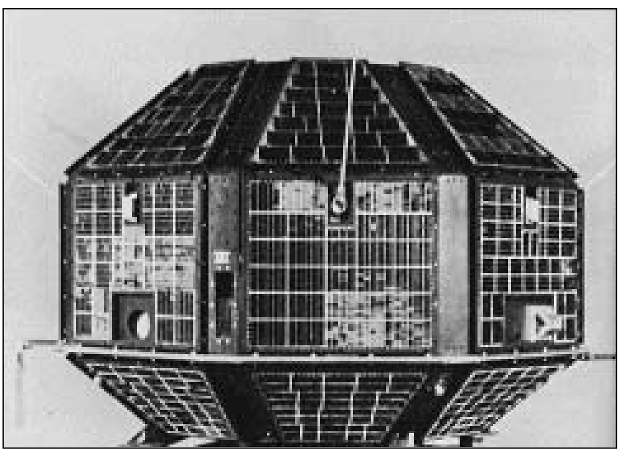
Inclined orbits are in between the above two. The inclination (angle to the earths surface) is determined by the region that they are meant to study. For. eg. if only the tropic areas are of interest, the satellite would be at a low inclination. Such satellites are launched at a distance of a few hundred kilometers. Thus they orbit around the Earth every few hours. They also end up viewing the same place at different times as they do not move in a sun-synchronous manner.

6 Fact File

Vikram Sarabhai : pioneer in Indian space research

Vikram Ambalal Sarabhai (1919 to 1971) has contributed to the development of the Indian nation in many ways. He also realised the need for professional management training in the country and established the Indian Institute of Management (IIM) in 1962 at Ahmedabad.

- Born 1919
- Research scholar under Sir C V Raman at the Indian Institute of Science, Bangalore.
- PhD from Cambridge University, 1945
- Established the Physical Research laboratory at Ahmedabad in 1947.
- Established the Indian Institute of Management at Ahmedabad in 1962.
- Chairman of Indian National committee for Space Research, 1962.
- Setup the first rocket launching station in the country near Thiruvananthapuram.
- The Satellite Instructional Television Experiment initiated in 1975 to take education to our villages, a result of his efforts.



◂ The Aryabhata satellite

7 Fact File

Indian Space Program - A few milestones

1965 -Space Science & Technology Centre (SSTC) was established in Thumba.

1969 - Indian Space Research Organisation (ISRO) was created in the Department of Atomic Energy.

1972 - The Space Commission and the Department of Space (DOS) established in June. ISRO became a part of DOS. Several other research institutes are also establised.

1975 - Aryabhata, the first Indian space satellite, was launched for India on April 19. The National Remote Sensing Agency (NRSA) is set up at Hyderabad for receiving and distributing data from satellites.

1980- India successfully launched its own Rohini-1 satellite on July 18 on a Satellite Launch Vehicle (SLV) rocket from the Sriharikota Island launch site.

1982 - The Natural Resource Data Management System (NRDMS) started by Department of Science and Technology (DST) for research, development and application of GIS technology. INSAT-1 multipurpose satellite is launched.

1984 - The first Indian cosmonaut, Squadron Leader Rakesh Sharma, became the 138th man in space when he spent eight days aboard the USSR's space station Salyut 7.

1988 - First remote sensing satellite IRS-1A launched under the umbrella of National Natural Resources Management System (NNRMS).

1992 - The Indian-built INSAT-2 geostationary communications and meteorological satellite put into space.

2001 - The first launch of a large Geosynchronous Satellite Launch Vehicle (GSLV) rocket was successful on April 18.

8

Fact File

Survey of India

- Land survey was pioneered by Raja Todarmal, in Akbar's empire (1567). He set in place the process of collecting revenue based on statistics of different types of land.

- Early mapping efforts (17th century) in India were mainly of the territories controlled by the Mughal Empire

- Southward expansion under Aurangzeb led to merging of mapping in the north and the southern peninsula (early 18th century)

- James Rennell, "Father of Indian Geography", who was Surveyor General of Bengal, began mapping all of India in 1765, based on information collected by British army.

- The East India Company established the Survey of India (SOI) in 1767 to develop maps of the territories it acquired.

- Rennell's Map of India published in 1788 becomes the starting point of map making by the Indian government.

- The Great Trigonometrical Survey of India (GTS) starts in 1802 with the measurement of a baseline near Madras by Colonel W.Lambton.

- Project to compile an Atlas of India at a scale of four mile to an inch (1:253,440) initiated in 1820. The GTS becomes a part of this effort.

- Settlement level surveys (Cadastral) are started in 1871 based on the GTS on a scale of 16 inches to a mile.

- In 1930 the British Survey of India maps on a scale of 1:63,630 are published.

- In 1950, the SOI is organised into 5 Directorates mainly to look at the needs of the defense forces.

- The Survey of India today has 18 Directorates and is responsible for all survey requirements of the Government of India.

Glossary of Cartographic and GIS terms

Attribute
A specific set of information stored along with geographic features, usually in tabular format e.g., the attributes of a well might include depth, type of motor, water level.

Azimuth
The horizontal direction measured clockwise in degrees of rotation.

Coordinate
A set of numbers that designate location in a given reference system, such as x,y in a planar coordinate system or an x,y,z in a three-dimensional coordinate system. Coordinates represent locations on the Earth's surface relative to other locations

Georeference
To establish the relationship between coordinates on a map and the real-world coordinates.

GIS
Geographic information system. An organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.

Global Positioning System
A system of satellites and receiving devices used to identify co-ordinates of points on the Earth.

Hardware
The physical components of a computer system-the computer, plotters, printers, terminals, digitizers, and so on.

Image
A graphic representation or description of a scene, typically produced by an optical or electronic device. Common examples include remotely sensed data (e.g., satellite data), scanned data, and photographs.

Latitude-Longitude
A spherical reference system used to identify locations on the Earth's surface. Latitude and longitude are angles measured from the Earth's center to locations on the Earth's surface. Latitude measures angles in a north-south direction. Longitude measures angles in the east-west direction.

Legend
The area on a map that lists and explains the colors, symbols, line patterns, shadings and characters used on a map. The legend often includes the scale, origin, orientation, and other map information.

Map
An abstract representation of the physical features of a portion of the Earth's surface graphically displayed on a flat surface. Maps display signs, symbols, and spatial relationships among the features. They typically emphasize, generalize, and omit certain features from the display to meet specific needs. E.g., railway features might be included in a transportation map but omitted from a highway map.
Map projection
A mathematical model that transforms the locations of features on the Earth's surface to locations on a two-dimensional surface. Because the Earth is three-dimensional, some method must be used to depict a map in two dimensions. Some projections preserve shape; others preserve accuracy of area, distance, or direction.
Map scale
A statement of a measure on the map and the equivalent measure on the Earth's surface, often expressed as a fraction of distance, such as 1:24,000 (one unit of distance on the map represents 24,000 of the same units of distance on the Earth). Map scale can also be expressed as a statement of equivalence using different units; for example, 1 inch = 1 mile or 1 inch = 2,000 feet.
Pixel
The smallest unit of information in an image or raster map. Referred to as a cell in an image.
Raster
Images or pictures where data is composed of rows and columns for storing the image information. Groups of cells with the same value represent features.
Remote Sensing
Acquiring information about an object without contacting it physically. Methods include aerial photography, radar, and satellite imaging.
Resolution
Resolution is the accuracy at which a given map scale can depict the location and shape of geographic features. The larger the map scale, the higher the possible resolution. As map scale decreases, resolution diminishes and feature boundaries must be smoothed, simplified, or not shown at all. For example, small areas may have to be represented as points.
Scanning
The process of capturing data into raster format using a device called a scanner. Some scanners also use software to convert raster data to vector data.
Spatial Data
Information about the location, the shape of the location and its relationships among other geographic features, usually stored as coordinates and elevation.
Vector
An element which has a length and direction. Co-ordinates between different points are used to determine their shape and length.

Websites of Interest

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