CHAPTER – 5

Global positioning System (GPS)

Learning Objectives

5.1 Overview of GPS
5.2 Understanding functions of GPS
5.3 Knowing the various segments of GPS
5.4 Understanding the various factors affecting the GPS Data
5.5 Understanding the applications of GPS

5.1 Overview Global Positioning System (GPS)

GPS stands for Global Positioning System and it allows users to determine their location on land, sea and in the air using Satellite and Receiver. There are currently 24 satellites in orbit operated by the US Department of Defense (DoD) that provide worldwide coverage 24 hours a day, 7 days a week in all weathers.

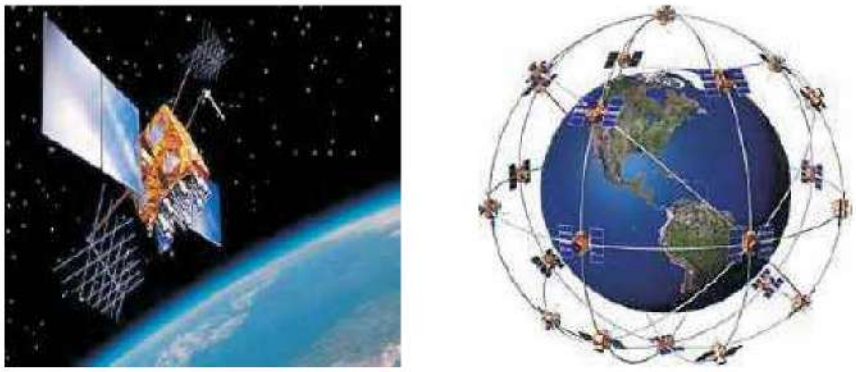


Fig. 77

GPS Satellites

Nmt. Edu.

The GPS technology has tremendous amount of applications in GIS data collection, surveying, and mapping in utilities.

The technology can benefit GPS user community in terms of obtaining accurate data upto 100 meters for navigatoion, mapping up to meter level and down to millimeter level for geodetic positioning.

5.2 Functions of GPS

GPS satellite sends time and position information to the receiver. Receiver picks up this information using the signals from at least four satellites. Information user can get latitude, longitude, and elevation information.

Fig. 78

Functioning of GPS Network

pevisonalgps.wordpress.com.

The Global Positioning System consists of 24 earth-orbiting satellites so that it can guarantee that there are at least 4 of them above the horizon for any point on earth at any time. Each satellite contains an atomic clock. The satellites send radio signals to GPS receivers so that the receivers can find out how far away each satellite is sometimes with millimeters precision at a given time.

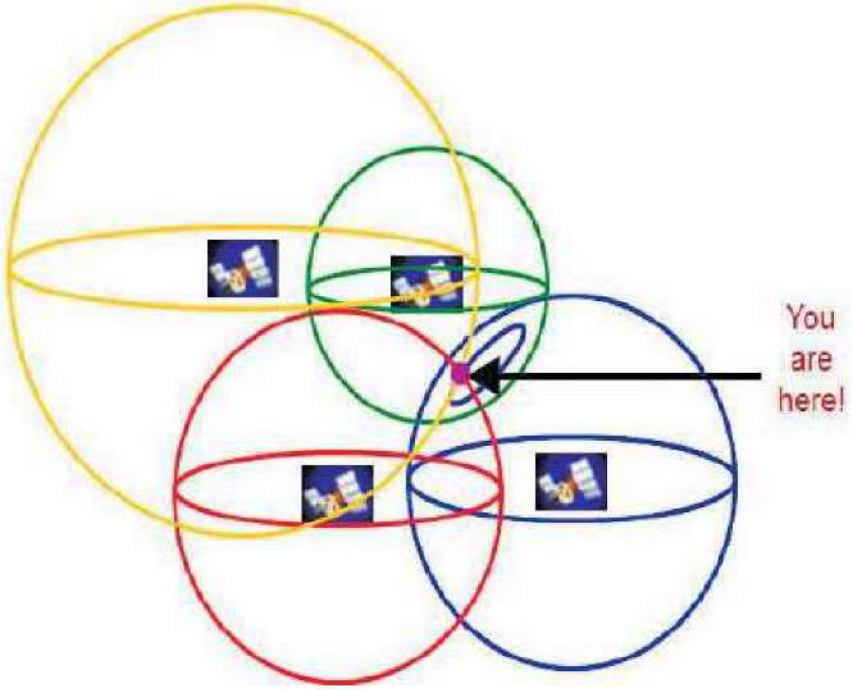


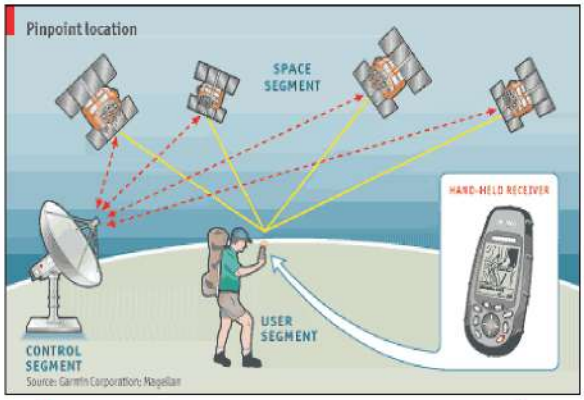
Fig. 79

Trilateration is a basic geometric principle that allows us to find the location of an unknown point by knowing the location of other points. The GPS receiver has the ability to find the receiver's distance from 4 (or more) GPS satellites. Once it determines its distance from the four satellites, the receiver can calculate its exact location and altitude on Earth. If the receiver can only find three satellites, then it can use an imaginary sphere to represent the earth and can give you location information but no altitude information.

5.3 Segments of GPS

The GPS is divided into three major components:

1. The Space Segment
2. The Control Segments
3. The User Segment



Segments of GPS

Fig. 80

(a) The Space Segment

Global Positioning System consists of 24 earth-orbiting satellites. The satellites are arrayed in 6 orbital planes. They orbit at altitude of about 12000 miles. Each satellite contains four precise atomic clocks and has a microprocessor on board for limited self-monitoring and data

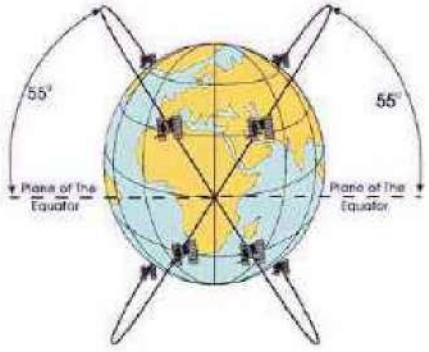


Fig. 81

processing. The satellites are equipped with thrusters, which can be used to maintain or modify their orbits.

Fig. 82

(b) The Control Segment

The Control Segment consists of five Monitoring stations (Colorado Springs, Ascension Island, Diego Garcia, Hawaii, and Kwajalein Island). Three of the stations (Ascension, Diego Garcia, and Kwajalein) serve as uplink installations capable of transmitting data to the satellites including new ephemerides (satellite positions as a function of time), clock corrections, and other broadcast message data, while Colorado Springs serve as the master control station.

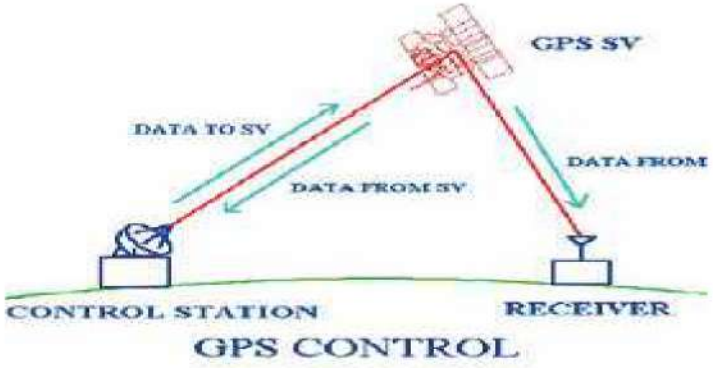


Fig. 83

The Control Segment is the sole responsibility of the DoD who undertakes construction, launching, maintenance, and virtually constant performance monitoring of all GPS satellites.

(c) The User Segment

The GPS receiver is the user segment in GPS system. Entire spectrum of applications equipment and computational techniques that is available to the users.

Fig. 84

5.4 Factors Affecting GPS Data

(a) Accuracy of GPS

The accuracy of GPS depends on several factors such as the receiver and the surroundings in which it is being used in. Factors which affect the accuracy of the GPS readings are explained below

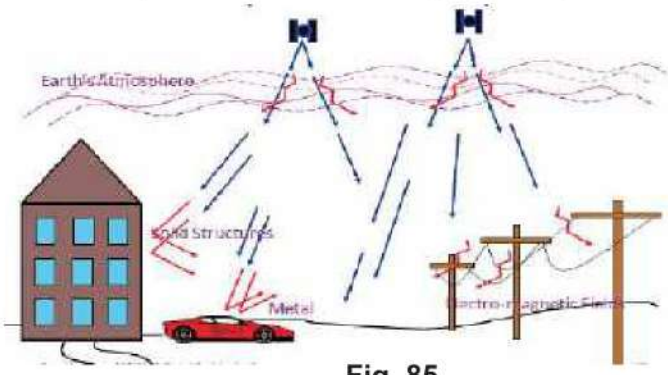


Fig. 85

(b) Atmospheric Conditions

The ionosphere and troposphere both refract the GPS signals. This causes the speed of the GPS signal in the ionosphere and troposphere to be different from the speed of the GPS signal in space. Therefore, the distance calculated from "Signal Speed x Time" will be different for the portion of the GPS signal path that passes through the ionosphere and troposphere and for the portion that passes through space.

(c) Orbital position Error/Clock Drift/Measurement Noise

GPS signals contain information about orbital position (ephemeris) errors, and about the rate of clock drift for the broadcasting satellite. Distortion of the signal by measurement noise can further increase positional error. The disparity in orbital position data can introduce 1-5 meters of positional error, clock drift disparity can introduce 0-1.5 meters of positional error and measurement noise can introduce 0-10

(d) Selective Availability

Orbital position error should not be confused with Selective Availability (SA), which is the intentional alteration of the time and Orbital position signal by the Department of Defense. SA can introduce 0-70 meters of positional error. Fortunately, positional errors caused by SA can be removed by differential correction.

(e) Multipath

A GPS signal bouncing off a reflective surface prior to reaching the GPS receiver antenna is referred to as multipath. Because it is difficult to completely correct multipath error, even in high precision GPS units, multipath error is a serious concern to the GPS user.

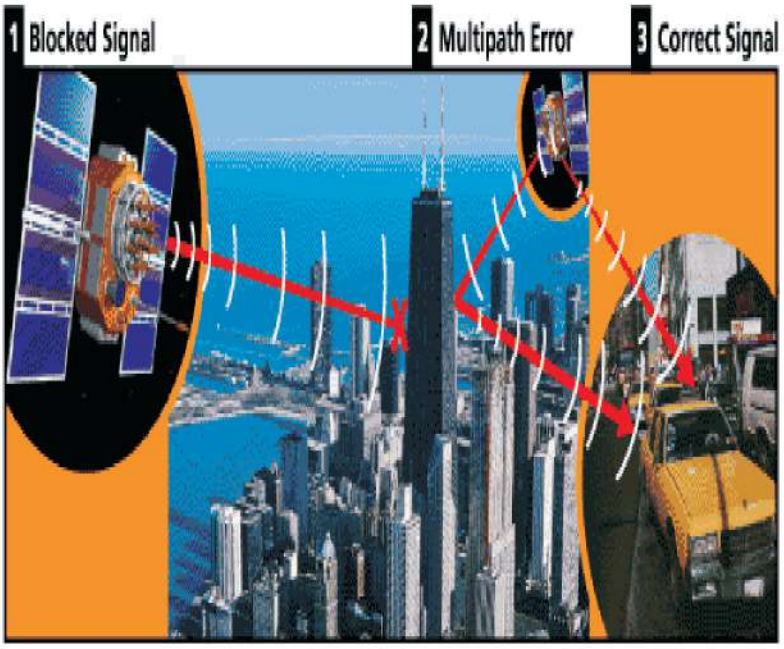


Fig. 86

Multipath error in
GPS Sinnal
www.aysva.com.my.

5.5 GPS Applications

One of the most significant and unique features of the Global Positioning Systems is the fact that the positioning signal is available to users in any position worldwide at any time. With a fully operational GPS system, it can be generated to a large community which is likely to grow continuously as there are multiple applications, ranging from surveying, mapping and navigation to GIS data capture.

Fig. 87

Let us wrap up what we covered in this chapter:

1. GPS stands for Global Positioning System
2. It allows users to determine their location on land, sea and in the air around the earth.
3. There are currently 24 satellites in orbit operated by the US Department of Defense
4. GPS is divided into 3 Segments
5. The Space Segment consists of the Constellation of 24 earth orbiting satellites.
6. Master control station is in Colorado Springs. Control segment is the sole responsibility of DOD
7. GPS receivers are called User Segment.
8. Atmospheric condition, Orbital position error, selective availability, multipath are some of the factors which affect the GPS readings
9. GPS are used in surveying, navigation, to track the vehicles etc

Review

Very Short Answer Questions

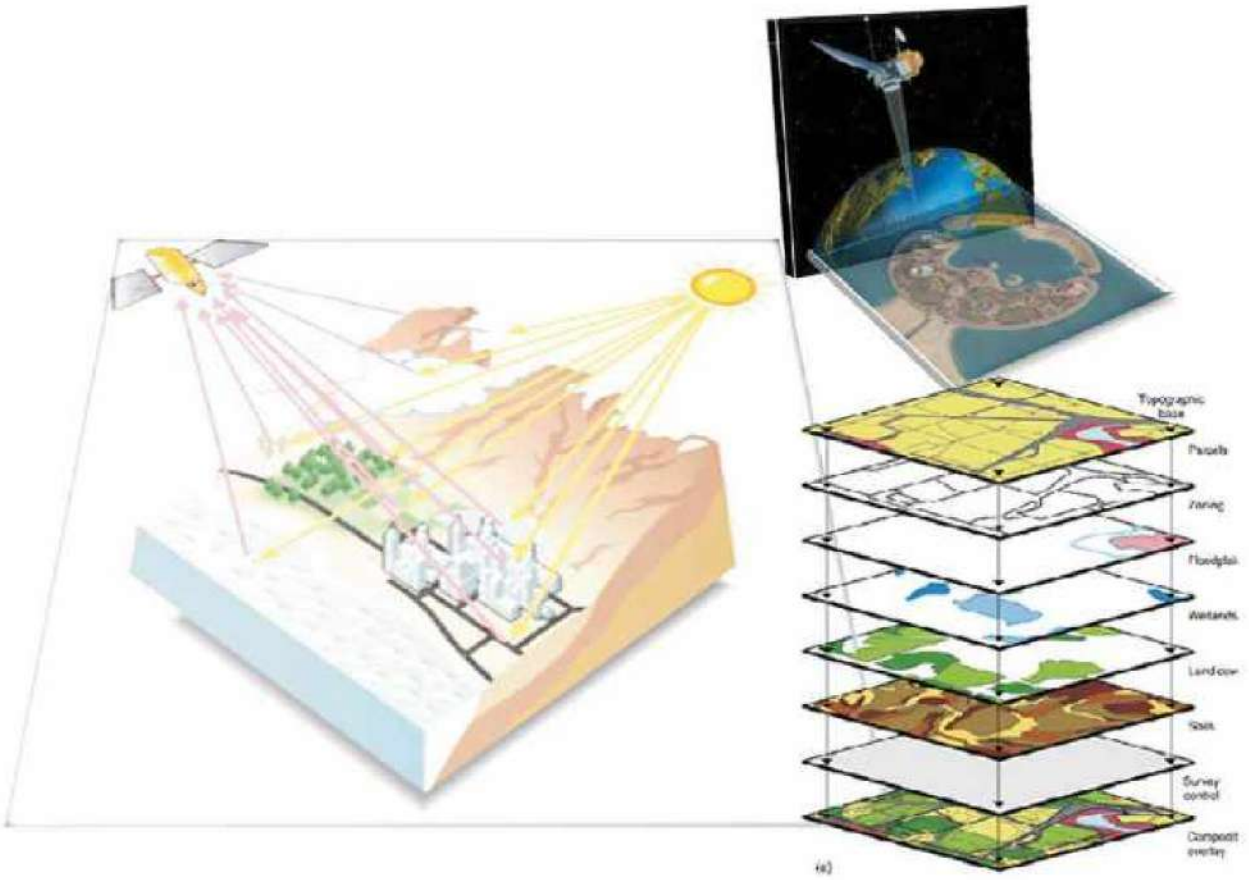
1. How many satellites are there in GPS System?
2. What information can we get from GPS?
3. Where is the Master Control Station?
4. Who is sole responsible for Control Segment?
5. Which component is the user Segment of GPS?

Short Answer Question

1. What is GPS?
2. Explain the function of GPS? Briefly explain the Control Segment of GPS
3. Briefly explain the Space Segment

Long Answer Questions

1. Name some of the applications of GPS?
2. Explain the factors affecting the readings of GPS?



Geospatial Technology

Class-XI

Practicals

Exercise - 1

Aim:

1. To map school building and surrounding environment.

Procedure:

2. Take a blank sheet and draw the map borders.
3. Show school building and other building with proper shape.
4. Show associated features of school building with respective location.

   Example - Parking Area, Playground, Access Road, Class Rooms, Principal's Room, Tree Lines etc.

Exercise - 2

Aim:

1. To display various types of maps.
2. To read the maps and indentify map features.
3. To learn usage of maps.

Required Data sets:

1. Geo Physical Map
2. Geological Map
3. Political Map
4. Meteorological Map
5. Air Road Route Map
6. Literacy Map

Software Used:

Rolta Geomatica Software

Procedure:

1. Open the Rolta Geomatica Software
2. Add the map to display window
3. Indentify the map features

Results needs to be provided for all datasets

Table-1

S. No.	Question	Answer
1	Name of the map	
2	Scale of the map	
3	Features identified in the map	
4	Usage of the maps	

Question:

1. What is a map?
2. What do you mean by map scale?
3. Name different types of maps.
4. Describe the uses of maps.

Solution: 1

Map name: Geo Physical Map of India

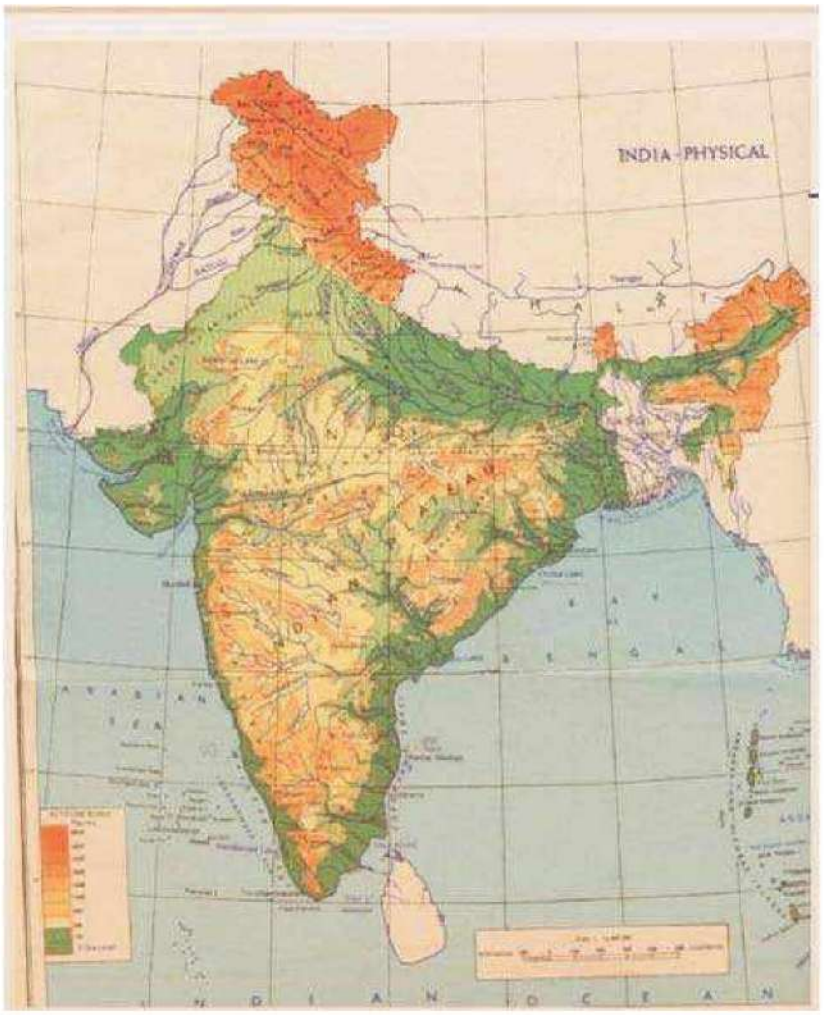


Fig. 1

Solution: 2

Map name: Political map of India

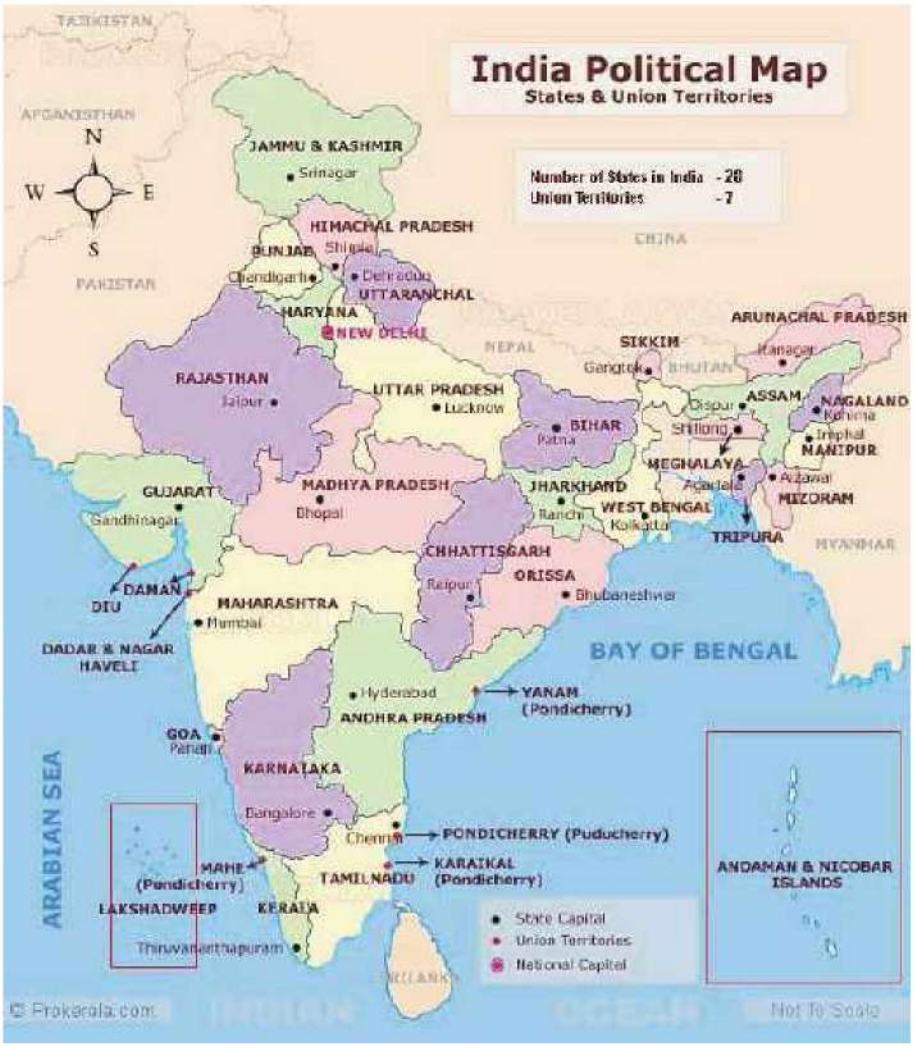


Fig. 2

Solution: 3

Map name: Meteorological map of India

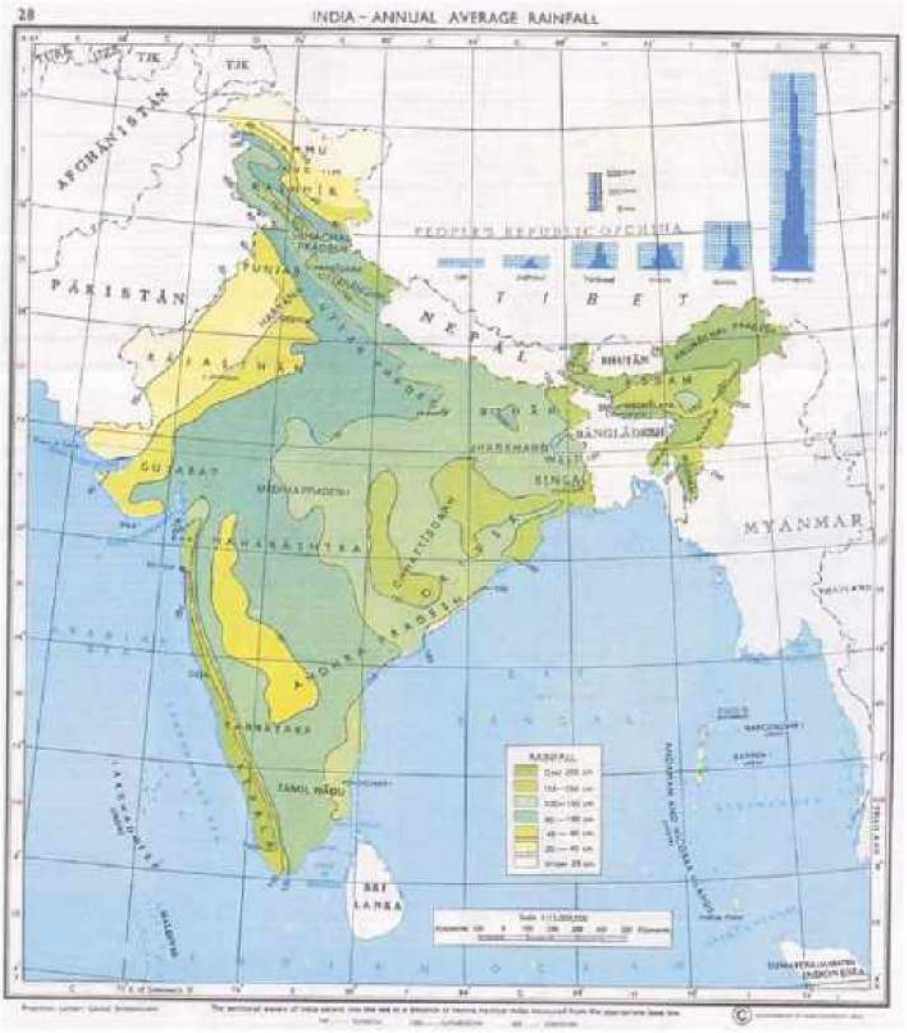


Fig. 3

Solution: 4

Map name: Soil map of India

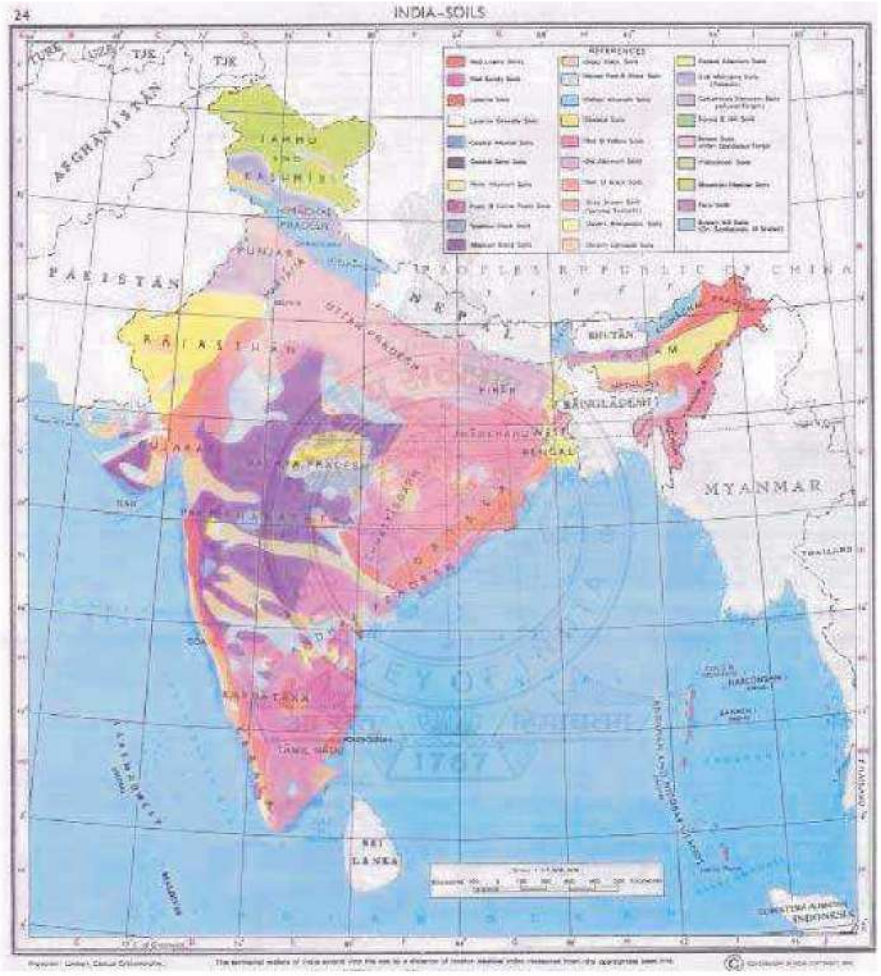


Fig. 4

Exercise - 3

Aim:

1. To display two different scales of Toposheets (1:50,000 and 1:250,000) of the Mt. Abu area
2. To read Toposheet index and identify the adjacent toposheets.
3. To understand the small and large scale map concepts.
4. To compare the area coverage by two different scaled toposheets.
5. To identify the features like Roads, Water Body, River, Contour Lines, Railway Lines, Forest Areas, Settlements etc.
6. To identify the map elements.
7. To know the coordinates of the Toposheets.
8. To find the location of any point.

Required Data sets:

In the example we have used sample toposheet of Mt. Abu area. It is suggested that regional maps be used depending on the availability.

- ∀ Toposheets of 1:50,000
- ∀ Toposheets of 1:250,000

Software Used:

Rolta Geomatica Software

Example for Toposheet:

Fig. 5

Procedure:

1. Open the Rolta Geomatica software
2. Open Toposheet (1:50,000 scale) of same area
3. Read the Index and scale of the map
4. Read the Toposheet Coordinates
5. Identify features
6. Open Toposheet of 1:250,000 scale at same map window.
7. Compare the amount of area coverage and details in both maps.

Results need to be provided for both toposheets:

Table-2

Index Number of Toposheet of	
Scale of the Toposheet	
Coordinates of the Toposheet Top Left Corner Top Right Corner Bottom Right Corner Bottom Left Corner	
Name the adjacent toposheet No. of following: Top, Right, left and bottom	

Question:

1. What features do you find in Toposheet? Name them.
2. How can you make use of toposheet?
3. What is a difference between large and small scale map? Discuss with example.
4. Longitude varies along with _____axis
5. Explain how can you calculate location information at any point on the Toposheet?
6. What map element do you use to get the information about adjacent toposheet?

Solution: 1

Toposheet Scale 1:50,000

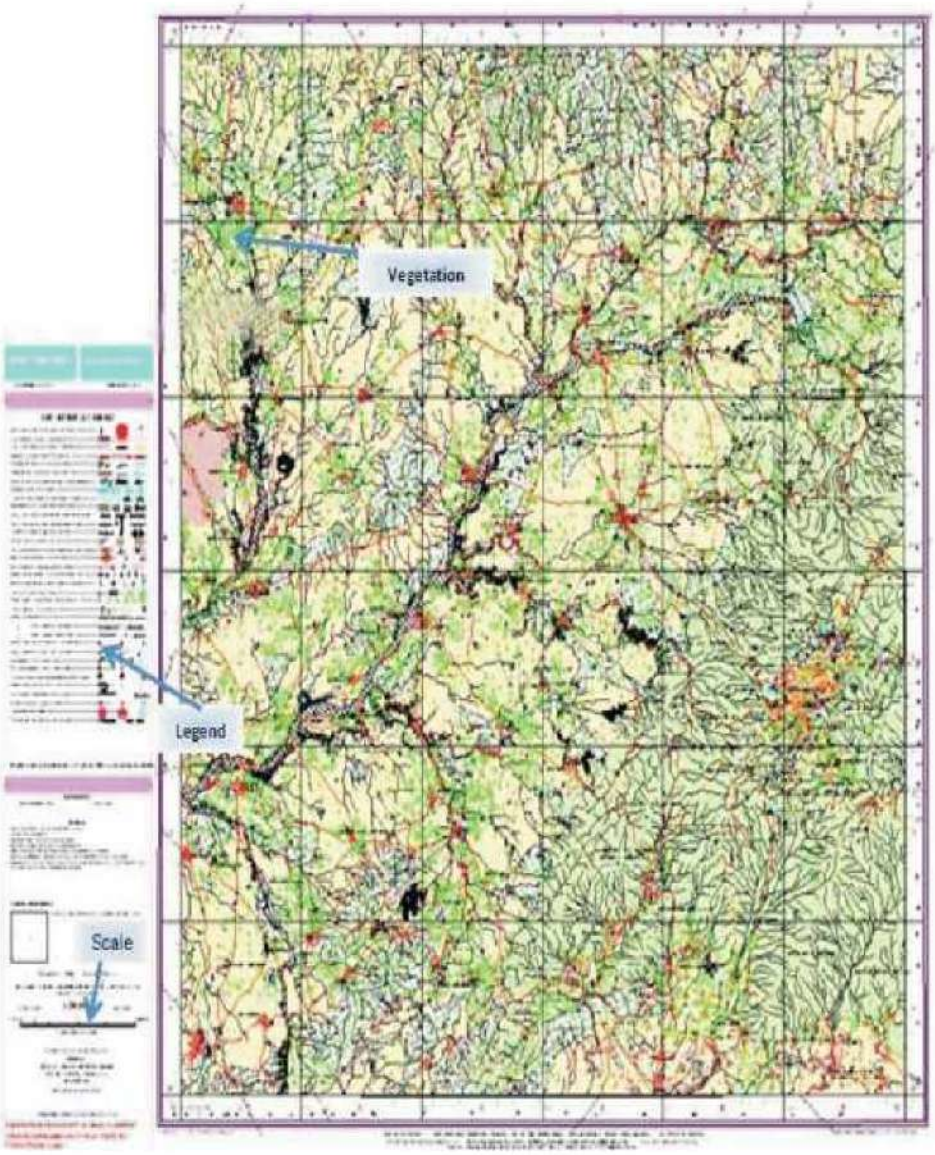


Fig. 6

Exercise - 4

Aim:

1. To display the satellite Imagery and Toposheet of same area
2. To identify the features such as Roads, Railway line, Shadows, Buildings, Water body, River, Forest area, Open space, Play grounds, Airports etc. from Toposheet as well as Satellite image

Required Data sets:

We have provided Sample toposheets and Images but depending on the availability, it is suggested to use regional Indian satellite images and Toposheets. For comparison and better understanding, satellite Images with different resolution & toposheet of same area with different scale can be used.

Software Used:

Rolta Geomatica Software.

Procedure:

1. Open Rolta Geomatica software
2. Add satellite image to display window
3. Identify the image features
4. Add Toposheet to display window
5. Identify the features in toposheet
6. Compare the features from both the data sets and discuss

Result

Table-3

Name of the satellite image	
Identify resolution of image	
Identify same objects in image as well as in Toposheet	

Question:

1. What is the altitude of remote sensing satellite?
2. What is spatial resolution?
3. What is the spatial resolution of Quick Bird and IKONOS pan Image?
4. What do you mean by Pixels?
5. What technique would you use to identify the features in an Image and toposheet?
6. Name the features you indentified in the satellite Image as well as in Toposheet. Compare the objects identified and explain in brief.
7. Compare the objects identified in different resolution. Did you find any change in objects please discuss?

Solution: 1

IKONOS Data Set

Fig. 7

Solution: 2

Landsat Data Set

Fig. 8

Exercise - 5

Aim:

To understand the GIS environment

Software Used:

Rolta Geomatica Software

Procedure:

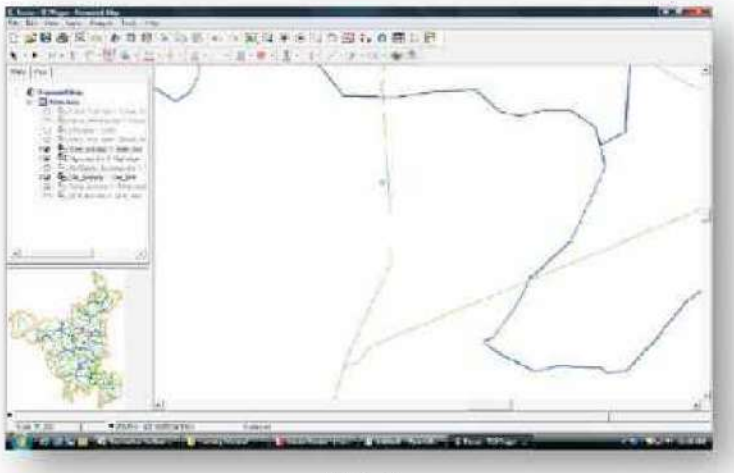
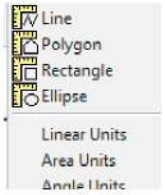


Fig. 9

1. Open any vector layer for where distance is to be measured
2. Click on the drop down arrow on the Distance tool
3. Linear Distance from one point to another rectangular, Polygon and ellipsoidal area can be measured.



4. Select Line from the tool and set the distance units as Meter
5. Now click on the map. Distance along with azimuth from one point to another will be displayed.
6. Coordinates of the map will also be displayed on the bottom
7. If you have 2 vector layers you can overlay them and check the result.

Result:

1. By using GIS you can measure distance, area.

Solution: 1

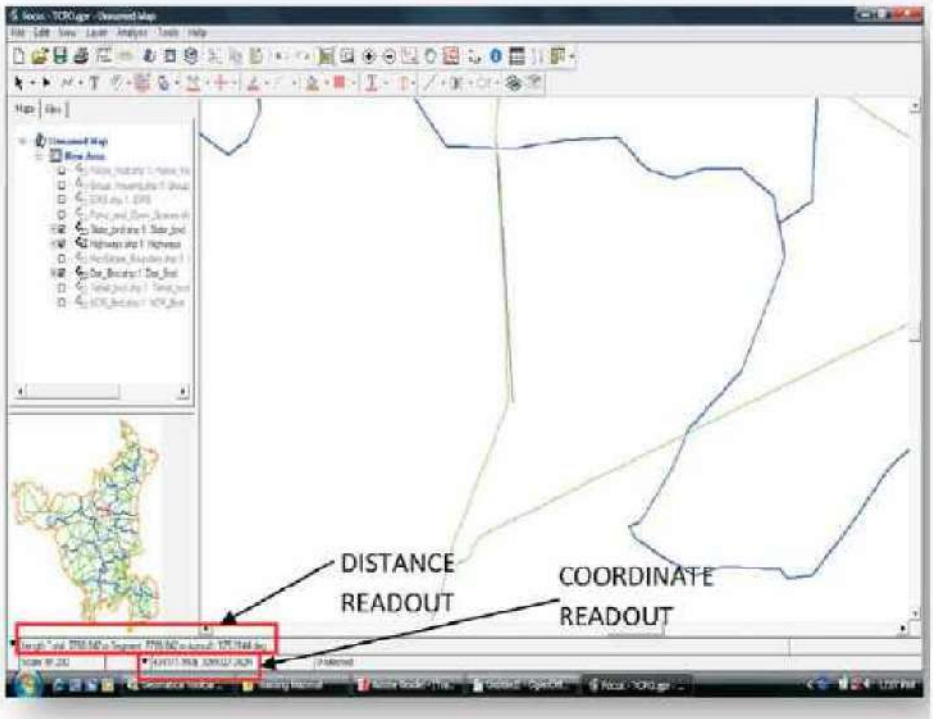


Fig. 10

Exercise - 6

Aim:

To understand the GPS data collection

Device Required:

1. GPS Receiver, if GPS is not available user can use any GPS activated mobile.

Procedure:

1. Select an Open Area
2. Activate the GPS
3. Collect The GPS coordinates
4. Find the Coordinates of your school building with GPS receiver
5. View the GPS textual data in GIS format

Result:

By using GPS you can locate your location in the earth. Take the points of school building and inserted that in the Google Earth and check.