NATIONAL HYDROLOGY PROJECT

NHP

Online Training on "GPS & Total Station"

09th - 11th August, 2021

At

National Institute for Geo-informatics Science & Technology
Hyderabad, Survey of India
(DEPARTMENT OF SCIENCE & TECHNOLOGY, GOVT OF INDIA)

National Geo-Spatial Data Centre
Hathibarkala Estate
Dehradun – 248 001
(Uttrakhand)

PREFACE

National Hydrology Project Known as NHP-III is a World Bank assisted project and coordinated by Ministry of Jal Shakti. The aim of the project is to improve the planning, development and management of water resources as-well-as flood forecasting and reservoir observations in real-time.

Under NHP-III, SOI is providing updated digital topographical Geo-database and DEM of 3-5m accuracy of around 8,00,000 Sq. Km. area as–well-as DEM of 0.5m accuracy of approximately 58472 Sq. Km. area.

During various discussions at NPMU and with other State Implementing Agencies (IAs), it was felt that there is a need to create awareness among officers and staff of IAs, specifically regarding Datum, Projection System, Geographical Positioning System(GPS), GPS Data Processing and Total Station. Hence, a online training programme of 3 days was envisaged and conducted from 09th – 11th August, 2021 in which 66 participants participated from various IAs.

The response of online training on "GPS & Total Station" has been very encouraging and there is a demand for more training on the subject.

We expressed extreme gratitude to Surveyor General of India for his continuous support to NHP in general and conduct of training in particular. We are also thankful to Additional Surveyor General, NIGST for his support to conduct the training. Sincere thanks due to Shri G. Varuna Kumar, DSG, NIGST, Shri K.V. Ramana Murty, Suptdg. Surveyor, Shri P Nityanandam, OS, Shri Maheshwar Singh, OS, Shri K Gopal, Svy Asstt, Smt Faheeda Ehsan, D/Man, Shri Sumit Bhadra, Syr and Shri Raj Kumar Gupta, Syr for taking lectures and other staff of NIGST, Hyderabad for conducting online training. Thanks are also due to Shri Mahipal Singh, SS, Shri Ajay Kumar, OS and other officers & staff of NGDC for organizing the training as-a-whole.

At last but not the least we are extremely thankful to NPMU for their continuous guidance and state IAs for deputing various officers to participate in the training.

(S. V. Singh)
Project Director
National Hydrology Project-III

CONTENTS

Training Schedule Online Training on GPS & Total Station			
Date	**Time**	**Topic**	**Lecture Taken By**
		09th – 11th August, 2021	
09 August 2021	0900 – 1300 Hrs	Introduction to GPS & Total Station	Sh. K.V. Ramana Murty SS, NIGST, Hyderabad
	1330 – 1730 Hrs	GPS Data Processing	- do -
10 August 2021	0900 – 1100 Hrs	Introduction to Datum, Projection System & Map Reading Concepts	- do -
	1115 – 1300 Hrs	Map Reading Assigning Different Projections	Sh. K Gopal, Svy Asstt Smt. Fahmeeda Ehsan, D/Man
	1330 – 1500 Hrs	GPS Observations (Demo)	Sh. Sumit Bhadra, Syr. Sh. Raj Kumar Gupta, Syr.
	1515-1730 Hrs.	Advances in GNSS Technology – CORS	Sh. G. Varuna Kumar Dy. Surveyor General
11 August 2021	0900 – 1100 Hrs	Introduction to GIS Concepts & Applications	Sh. Maheswar Singh OS
	1115 – 1300 Hrs	Introduction to ArcGIS Interfaces & Applications (Demo)	Sh. K Gopal, Svy Asstt Smt. Fahmeeda Ehsan, D/Man
	1300 – 1730 Hrs	Total Station Survey, Concepts, Working Principles, Sources of Error	Sh. P. Nityanandam, OS

Total List of participants for the (GPS & Total Station)

Sr. No.	Agency	Name	EmailID	MobileNo	Department Name	Designation
1	Andhra Pradesh GW	Pattikonda Ravi Teja	vravitejap994@gmail.com	9014316570	Ground Water and Water Audit Department, Government of Andhra Pradesh	Scientist E
2	Andhra Pradesh SW	Muddada Srinivasa rao	msraocivil@gmail.com	9492250071	Water Resources Department, Government of Andhra Pradesh	Assistant Executive Engineer
3	Andhra Pradesh SW	J.Venkatachalam	venc3j@gmail.com	9494918811	Water Resources Department, Government of Andhra Pradesh	Assistant Executive Engineer
4	Andhra Pradesh SW	ANNAMNAIDU BENDI	gsd2sklm@gmail.com	9491811755	Water Resources Department, Government of Andhra Pradesh	Assistant Executive Engineer
5	Andhra Pradesh SW	GARAPATI VENKATA RAGHU	raghu.gv99@gmail.com	9848899556	Water Resources Department, Government of Andhra Pradesh	Assistant Executive Engineer
6	Andhra Pradesh SW	K Anil kumar reddy	anilreddy.me@gmail.com	9701644789	Water Resources Department, Government of Andhra Pradesh	Assistant Executive Engineer
7	Andhra Pradesh SW	Saikiran saravakota	saikiran19812005@gmail.com	8919362554	Water Resources Department, Government of Andhra Pradesh	Assistant Executive Engineer
8	Andhra Pradesh SW	DUNDI.VIJAYA LATHA DEVI	vijaya.devi77@gmail.com	9398191841	Water Resources Department, Government of Andhra Pradesh	Assistant Executive Engineer
9	Andhra Pradesh SW	Surya Kumari Thavitiki	thavitiki@gmail.com	9642060099	Water Resources Department, Government of Andhra Pradesh	Assistant Executive Engineer
10	Andhra Pradesh SW	M.V.S.K.Prasad	mvsk9prasad@gmail.com	9949799439	Water Resources Department, Government of Andhra Pradesh	Deputy Engineer
11	Andhra Pradesh SW	LEENA KILUGU	leenakstr@gmail.com	6302681230	Water Resources Department, Government of Andhra Pradesh	Deputy Engineer
12	Andhra Pradesh SW	Akki Ravi Kumar	raviakki@rediffmail.com	9676028365	Water Resources Department, Government of Andhra Pradesh	Deputy Engineer
13	Andhra Pradesh SW	RAMOJI RAO JOGI	ramojirao.jogi@gmail.com	9492312380	Water Resources Department, Government of Andhra Pradesh	Hydrogeologist Jr.
14	Assam	TRISHNA MONI SHARMA PHUKAN	trishnas.phukan@gmail.com	8638070797	Water Resources Department, Government of Assam	Junior Engineer
15	Assam	Abu zafor	zaforcee@gmail.com	197108343	Water Resources Department, Government of Assam	Senior Hydrogeologist
16	CGWB	GAJANAN RAMTEKE	gajanan-cgwb@gov.in	9550823171	Central Ground Water Board (CGWB)	Scientist B
17	CGWB	MOHAMMAD DANIS KHAN	mdkdaniya@gmail.com	8982358346	Central Ground Water Board (CGWB)	Hydrogeologist
18	Delhi	JYOTI KUSHAWAHA	jyoti.vaishnavi@gmail.com	8800569927	Irrigation and Flood Control Department, Government of NCT Delhi	Hydrogeologist
19	Delhi	Shrikant Maury	info@geoexterra.com	8400662626	Irrigation and Flood Control Department, Government of NCT Delhi	Managing Director
20	Delhi	Sreerama Naik SR	shree.rathod72@gmail.com	9876149018	Irrigation and Flood Control Department, Government of NCT Delhi	Senior Research Officer
21	DOWR	Peeyush Gupta	peeyush.gupta@nmcg.nic.in	9958455518	Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation	Geo-Informatics Specialist
22	Gujarat	Suryaprakash Bhanubhai Suryavansi	suryaprakash000001@gmail.com	8141398925	Water Resources Department , Government of Gujarat	Senior Research Officer
23	Gujarat	Mohammadaamilali	aamusaiyed@gmail.com	9510202395	Water Resources Department , Government of Gujarat	Consultant
24	Haryana	TAJINDER KUMAR	tajinderk55@gmail.com	9004740398	Irrigation & Water Resources Department, Government of Haryana	GIS Specialist
25	Haryana	Pankaj Shekhwal	pankajshekhwal@gmail.com	7417544453	Irrigation & Water Resources Department, Government of Haryana	Hydrogeologist

26	Jharkhand	SHAMS QUAMAR	quamarrh2@gmail.com	7631389777	Water Resources Department, Government of Jharkhand	Hydrogeologist Jr.
27	Jharkhand	AMBRISH KUMAR	cauchyriemann2014@gmail.com	9661536148	Water Resources Department, Government of Jharkhand	Junior Engineer
28	Karnataka SW	Dr. ANILKUMAR DANDEKAR	aniluasb@gmail.com	9620225175	Water Resources Department, Government of Karnataka	Senior Scientist
29	Madhya Pradesh	Mahesh Paliwal	maheshpaliwal@rediffmail.com	9424050155	Water Resources Department, Government of Madhya	Deputy Director
30	Madhya Pradesh	Anand Kumar	anandgis.93@gmail.com	8889706698	Water Resources Department, Government of Madhya Pradesh	GIS Specialist
31	Maharashtra SW	YOGESH JAGANNATH GHOGARE	yghogare89@gmail.com	9921597050	Water Resources Department, Government of Maharashtra	Junior Engineer
32	Maharashtra SW	JITENDRA HATWAR	ENQUIRY.AEES@GMAIL.COM	9665930804	Water Resources Department, Government of Maharashtra	Consultant
33	Maharashtra SW	Balasaheb K Avhad	avhadbalasaheb@gmail.com	9405314893	Water Resources Department, Government of Maharashtra	Deputy Engineer
34	Maharashtra SW	Balasaheb K Avhad	avhadbalasaheb@gmail.com	9823233173	Water Resources Department, Government of Maharashtra	Deputy Engineer
35	Manipur	Wotrami Marchang	aoustor@gmail.com	9402275308	Irrigation and Flood Control Department, Government of Manipur	Executive Engineer
36	Manipur	Ningombam Prikash Meetei	pksangom@gmail.com	9485263726	Irrigation and Flood Control Department, Government of Manipur	Hydrogeologist
37	Mizoram	Remsangpuia	remsangpuiahmar@gmail.com	9436190913	Irrigation & Water Resources Department, Government of Mizoram	Junior Engineer
38	NIH	Jagadish Prasad Patra	patra.nih@gmail.com	9870784572	National Institute of Hydrology (NIH)	Scientist D
39	NIH	Ravi kumar	ravikr.geost@gmail.com	8709398923	National Institute of Hydrology (NIH)	Research Officer
40	NIH	Pankaj	mailofpmani@yahoo.com	9471006278	National Institute of Hydrology (NIH)	Scientist F
41	NIH	Dhiraj Kumar	dhirajkumar.nihr@gmail.com	6398782187	National Institute of Hydrology (NIH)	Senior Research Officer
42	Odisha	CHANDAN SARAF	cndnsrf@gmail.com	9439396426	Ground Water Development , Government of Odisha	Assistant Executive Engineer
43	Odisha	MANAS KUMAR MAJHI	mkmdowr2016@gmail.com	9439011298	Ground Water Development , Government of Odisha	Assistant Executive Engineer
44	Odisha	S SIGNUM	signumdowr@gmail.com	7846922816	Ground Water Development , Government of Odisha	Assistant Executive Engineer
45	Odisha	Abhijit behera	Abhijitbehera91@gmail.com	8847845575	Ground Water Development , Government of Odisha	Research Assistant
46	Odisha	RAKESH BARAL	rakeshbaral209@gmail.com	9853047555	Ground Water Development , Government of Odisha	GIS Specialist
47	Punjab	Gagandeep Singh	gaganjahlan93@gmail.com	8872742149	Department of Irrigation , Government of Punjab	Sub Divisional Officer
48	Rajasthan	VINAY KUMAR GAUTAM	vinaykumargautam24@gmail.com	8349784582	Water Resources Department, Government of Rajasthan	Research Assistant
49	Rajasthan	Prem Chand Meena	eewrjhalawar2@gmail.com	9414069625	Water Resources Department, Government of Rajasthan	Executive Engineer
50	Tamil Nadu	G. R. Radhakrishna	meeradha1@gmail.com	9597249929	Water Resources Department, Government of TamilNadu	Assistant Executive Engineer
51	Tamil Nadu	VENKATESH	venkatvenkateshwaran@gmail.com	9080639519	Water Resources Department, Government of TamilNadu	Geologist
52	Tamil Nadu	K.Shanthakumari	shanthameenakshikumari@gmail.com	8754024773	Water Resources Department, Government of TamilNadu	Assistant Engineer
53	Tamil Nadu	Surendar M	sureyardersun@gmail.com	9445496349	Water Resources Department, Government of TamilNadu	GIS Specialist

54	Tamil Nadu	Nagaraj S	nagaraj116011@gmail.com	9944133599	Water Resources Department, Government of TamilNadu	Hydrogeologist
55	Tamil Nadu	SANTHOSH RAJ	sanrani.raj@gmail.com	8122785879	Water Resources Department, Government of TamilNadu	Hydrogeologist Jr.
56	Telangana SW	Prathyusha	prathyusha.h@gmail.com	8712101720	Irrigation & CAD Department, Government of Telangana	Assistant Engineer
57	Uttar Pradesh GW	PRAVEEN KUMAR SINGH	pksingh1583@gmail.com	9532140854	Ground Water Department, Uttar Pradesh	Assistant Engineer
58	Uttar Pradesh SW	Sonu Kumar	skgeodu@gmail.com	8743881727	Irrigation and Water Resources Department, Government of Uttar Pradesh	PS
59	Uttarakhand	Nitin Kumar	nitin.kec09@gmail.com	9675919414	Irrigation Department, Government of Uttarakhand	Research Assistant
60	Uttarakhand	Atul Kumar	atulram1990@gmail.com	9675566994	Irrigation Department, Government of Uttarakhand	GIS Specialist
61	Uttarakhand	Manoj Kumar Patley	mpatley7@gmail.com	9791398372	Irrigation Department, Government of Uttarakhand	GIS Assistant
62	West Bengal GW	Md Imran Islam Rabbi	imran140105@gmail.com	1871574568	Department of Water Resources Investigation & Development, Govt. of West Bengal	Member(RM)
63	West Bengal GW	Souvik Banik	souvikbanik257@gmail.com	8617425875	Department of Water Resources Investigation & Development, Govt. of West Bengal	Junior Engineer
64	West Bengal GW	Biswajit Paul	paulbiswajit.geo@gmail.com	8436796565	Department of Water Resources Investigation & Development, Govt. of West Bengal	Research Assistant
65	West Bengal SW	VINAY SANJAY SULE	vinaysule@kolkataporttrust.gov.in	8329335698	Irrigation and Waterways Department, Government of West Bengal	Executive Engineer
66	West Bengal SW	SANTANA DEBNATH	sd58991@gmail.com	9830548257	Irrigation and Waterways Department, Government of West Bengal	GIS Assistant

Presentations

PRESENTATION ON

INTRODUCTION TO GPS & TOTAL STATION

By Shri K V Ramana Murty,
Superintending Surveyor

WELCOME

to

Presentation on
Modern Survey Techniques using GNSS/GPS

by
K. V. Ramana Murty, Superintending Surveyor

National Institute for Geo-informatics Science & Technology

SURVEY OF INDIA, HYDERABAD

Introduction to Various GNSS (Global Navigational Satellite systems) in the World (focusing on GPS in detail)

GPS, GLONASS & GALILEO - Configuration

Constellation	GPS	GLONASS	GALILEO
Total Satellites	24+3	24 (4 Opr)	27+3
Orbital Period	12 hrs	11hrs 15min	14Hrs 22min
Orbital planes	6	3	3
Orbital height (km)	20200	19100	23616
Sat In each plane	4	8	10
Inclination	55 deg	64.8 deg	56 deg
Plane Separation	60 deg	120 deg	120 deg
Frequency	1575.42MHz 1227.6MHz	1246 - 1257 MHz 1602 - 1616 MHz	1164 - 1300 MHz 1559 - 1591 MHz
Modulation	CDMA	FDMA	CDMA

GPS - GLOBAL POSITIONING SYSTEM

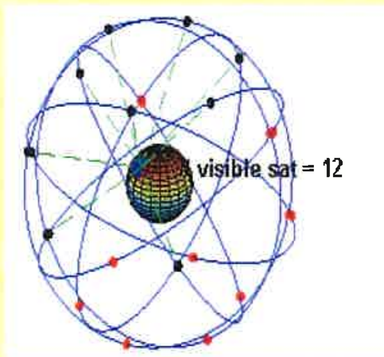
GPS is the only system today which is able to show you your exact position on the Earth any time, anywhere and in any weather conditions, that's why it is very popular and is widely used all over the world.

The NAVSTAR GPS (*NAVigation System with Time And Ranging Global Positioning System) is a satellite-based radio navigation system providing precise three dimensional* position, navigation, and time information to suitably equipped users. The system is continuously available on a world-wide basis, and is independent of meteorological Conditions.

GPS (Advantages)

- Availability of data any where on the Earth surface / sea all the time.
- Day & Night observations can be done
- Intervisibility between stations is not required
- All weather operation
- Co-ordinates are accurate and are obtained in a very fast manner.
- Co-ordinates obtained are in Internationally accepted datum i.e. WGS84 datum.

GPS constellation



GPS (Global Positioning Systems)

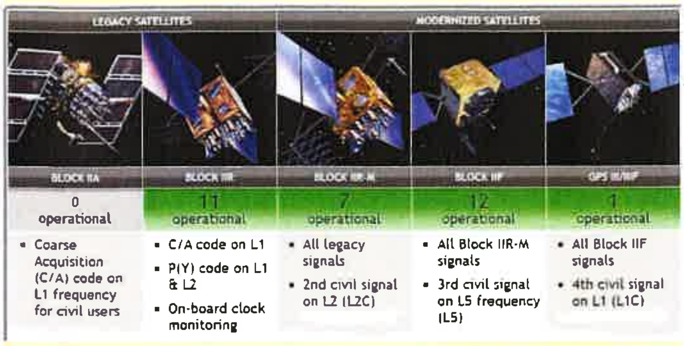
- 24 Satellites + 7 Active spare satellites
- 6 orbital planes
- 4 satellites minimum per orbit
- At a distance of 20200 km above Earth
- 55° Orbital inclination
- Minimum 4 satellites can be tracked anywhere on Earth at any point of time.
- Day and night observations can be done

Various Segments of GPS

- Space Segment
- Control Segment
- User/Receiver Segment

Space Segment

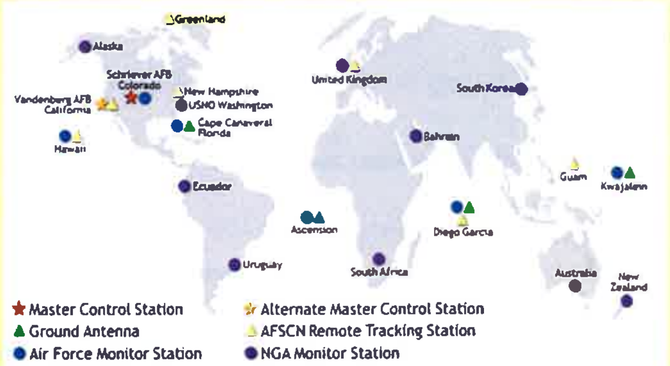
The constellation of GPS satellites, it receives DATA from Control Segment and retransmit the DATA to User Segment.



As of February 20, 2020, there were a total of 31 **operational satellites** in the GPS constellation, not including the decommissioned, on-orbit spares.

Control Segment

Monitoring and operation of the Satellite system, estimate satellite orbits, clock errors, generate the navigation message .uploaded to satellites through the Ground Antennas,



User Segment

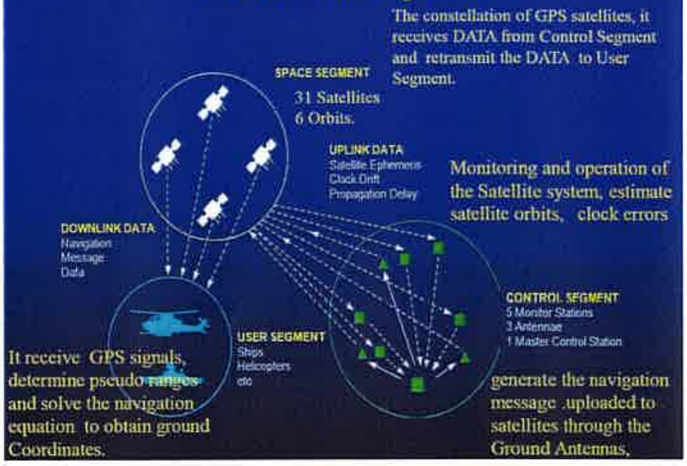
User segment consists of GPS receiver equipment, which receives the signals from the GPS satellites and uses the transmitted information to calculate the user's 3-D position and time.

The surveying and mapping community was one of the first to take advantage of GPS because it dramatically increased productivity and resulted in more accurate and reliable data. Today, GPS is a vital part of surveying and mapping activities around the world.

GPS provides surveying and mapping data of the highest accuracy. GPS-based data collection is much faster than conventional surveying and mapping techniques, reducing the amount of equipment and labor required.

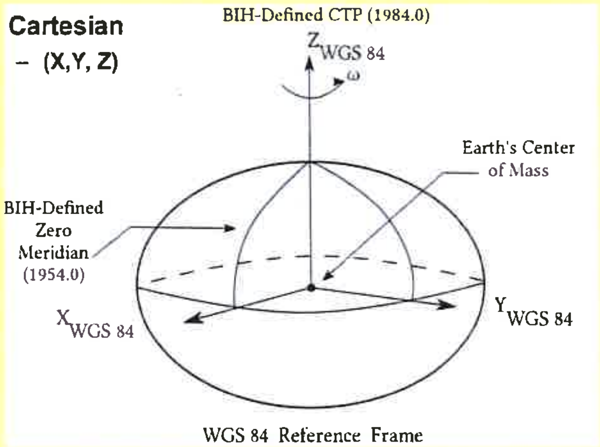
Examples
- Agriculture
- Aviation
- Environment
- Marine
- Public Safety & Disaster Relief
- Rail
- Recreation
- Roads & Highways
- Space
- Surveying & Mapping
- Timing

The Navstar System



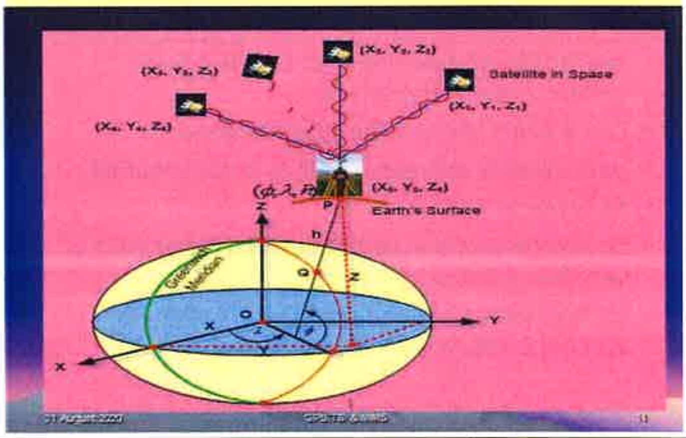
DATUM: WGS'84

Cartesian
- **(X,Y, Z)**



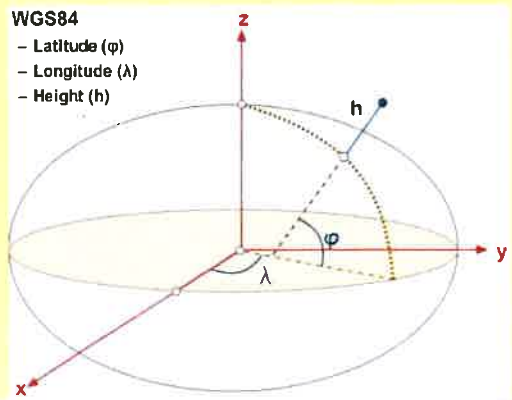
WGS 84 Reference Frame

GPS/GNSS co-ordinates in WGS84 system (World Geodetic System,1984)



GPS Coordinates (WGS84)

WGS84
- **Latitude (φ)**
- **Longitude (λ)**
- **Height (h)**



Points to be kept in mind while procuring any GPS Instrument

- Purpose of the Survey
- Accuracy desired
- Budget provision
- Method of Survey to be adopted
- Instrument capabilities such as Single frequency / Dual frequency receiver etc.
- Company's Previous Record for maintenance etc.

GPS Accuracies & Considerations

Grades of Accuracy

(Type-III)Recreational / Mapping grade
5-15 meter (1-5 meter with differential correction)

(Type-II)Sub-meter Mapping grade
10 cm – 1 meter

(Type-I)Survey grade
≤1 cm

Types of GPS instruments

Price of unit largely dependent upon grade

Cheapest
$100-$1000+

Recreational / Navigational
Ex. Hiking, boating, automobiles
(Type –III GPS receivers)

Mid-level
$5,000-$14,000

Mapping
Ex. GIS data Collection, Agriculture
(Type-II GPS Receivers)

Most Expensive
$20,000 - $45,000

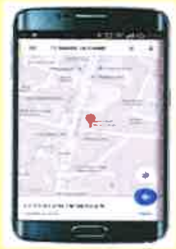
Surveying
Ex. Surveying, Cadastral, Mine Surveying
(Type-I GPS receivers)

GPS Receiver

It is a device that is capable of receiving information from GPS SATELLITES and then to calculate the device's geographical position, using suitable software, then the device display the geographical position.

1. Navigational Receivers :- Positional accuracy in meters, absolute positioning is obtained. Ex:-Hand held GPS, Mobile devices.

GARMIN 12 CHANNEL



MOBILE DEVICE

GPS Receiver

Geodetic Receivers:- Positional accuracy is in Cms, Relative positioning is obtained. Ex:- Single frequency, Dual frequency. GNSS Receivers.

Trimble S F

Trimble D F

Leica D F

Trimble R8S

Trimble R8S

Trimble Alloy CORS Receiver

Some GPS Receivers

Antenna

Antenna detects the Electromagnetic waves arriving from the satellite, converts the wave energy into digital form.

Types of Antenna

1. Monopole or Dipole
2. Helix
3. Spiral helix
4. Micro strip
5. Choke ring
6. Zypher Geodetic

Antenna

Monopole antennas – These are used in the very high frequency (VHF) broadcast applications, television and FM **radio broadcasting**, as well as ship and aircraft communications

Helical antenna or **helix antenna** -These are used for compact antennas for portable and mobile two-way radios, and for UHF television broadcasting antennas.

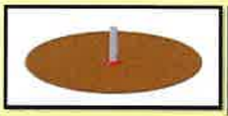
Microstrip antennae are also **used** in the fields of RFID (radio frequency identification), mobile communication and healthcare.

A **choke ring antenna** is a type of omnidirectional **antenna** (An **antenna** that radiates and receives energy equally well in all horizontal directions) that is **used** for GNSS applications. ... These **antennas** are known for their ability to reject multipath signals.

Choke ring antennas have specially designed filters, inserted in each groove, which reduces multipath **signals** in both the L1 and L2 bands within the same **antenna** configuration

The Trimble **Zephyr Geodetic** 2 **Antenna** is designed to receive all existing and proposed public GNSS signals, including GPS, GLONASS, Galileo and Compass. In addition, these **antennas** are **used** in the highest-accuracy IGS reference frame networks where only the best possible long-term performance is accepted.

GPS Antennas



Monopole

Dipole

Helix

Spiral helix

Micro strip

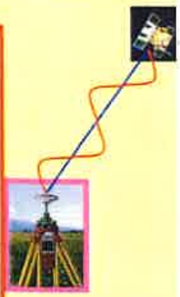
Choke ring

Zypher Geodetic

Trimble GNSS-Ti v2 Choke Ring

GPS Antennas:

GPS OBSERVATION PRINCIPLE:



Signal Transmitted time from satellite – T_t

Signal receiving time by receiver - T_1

Synchronization error in satellite and receiver clock - T_o

Satellite position (X_1, Y_1, Z_1) - Known

Receiver Position (X_o, Y_o, Z_o) – Unknown

Speed of signals – c (velocity of light)

Signal Travel Time = $(T_1 - T_t) + T_o$

Range $R = c\{(T_1 - T_t) + T_o\} = \sqrt{(X_1-X_0)^2+(Y_1-Y_0)^2+(Z_1-Z_0)^2}$

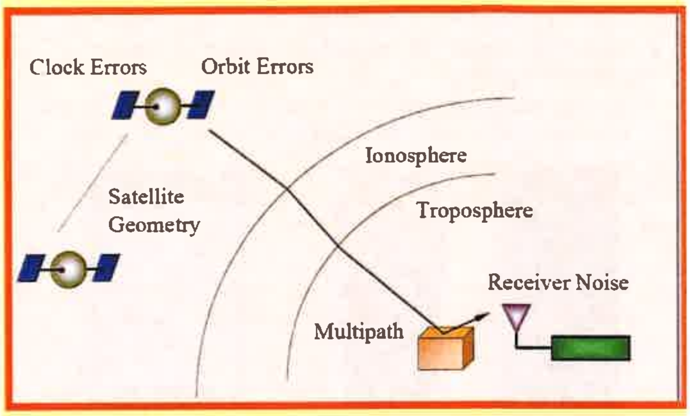
Or $c(T_1 - T_t) = \sqrt{(X_1-X_0)^2+(Y_1-Y_0)^2+(Z_1-Z_0)^2} - c\,T_o$

Minimum four satellites are required to compute four unknown values -(X_o, Y_o, Z_o) and T_o

Factors Influencing GPS Accuracy :

- **Ionospheric and atmospheric delays**
- **Satellite and Receiver Clock Errors**
- **Multipath**
- **Dilution of Precision**
- **Selective Availability (S/A)**
- **Anti Spoofing (A-S)**

Factors Influencing GPS Accuracy : (Contd.)



- Field observation procedure
- Data downloading and processing
- Results after processing
- Computations
- Possible applications
- Benefits and application of GPS for GIS

Field Observation Procedure & Techniques

- Absolute Positioning or
  Single point Positioning technique

* Relative positioning techniques

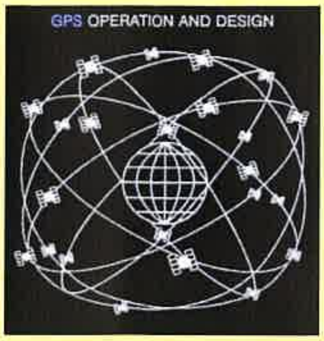
Relative positioning techniques

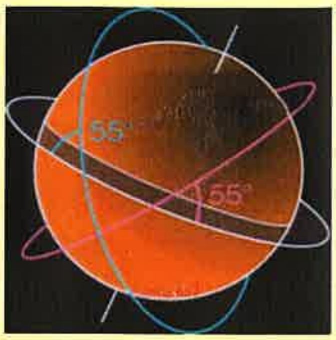
- Static positioning technique
- Fast static or Rapid static
- Stop-and-go technique
- Differential GPS technique
- RTKM (Real time Kinematic technique)

POSSIBLE APPLICATIONS OF GPS:

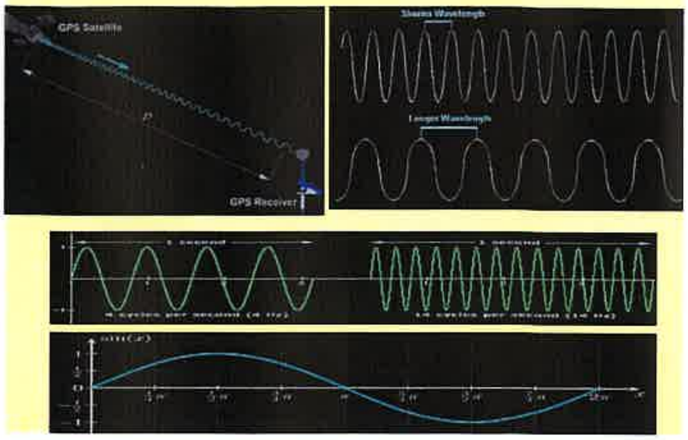
- Navigation – aircraft, spacecraft, ship, vehicle
- Control surveys
- Cadastral surveying
- Geodynamics
- Monitoring and Engineering Problems
- Precise Navigation
- Photogrammetry and Remote Sensing
- Marine and Glacial Geology and many more

No. of Orbits Orbital Inclination





Frequency & Wave length



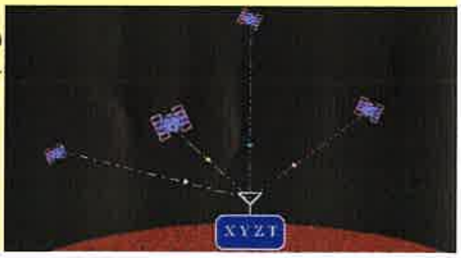
How many satellites are required in GPS to find position?

With two satellites one can determine X or Y & T (time).

With three satellite X, Y or Z & T (time).

With four satellites X, Y, Z and T (time).

So, minimum four (4) satellites are required.



Then why four satellites?

In general, geometrical point of view three ranges are sufficient to know our position.

A fourth range is necessary because GPS uses one way ranging technique & receiver clock is not synchronized with satellite clock.

This clock synchronization error is the reason for the term "Pseudorange".

To determine the "Pseudoranges" , the fourth Observation is necessary.

So , four satellites are required

Determination of Position

Antenna position is determined by calculating the distances to at least 4 satellites.

This enables, solving four unknown variables:
X, Y, Z and T (time).

Method of Trilateration is used to find range first and Resection is used to find the position.

Determination of Range

- 1. Code Measurement:

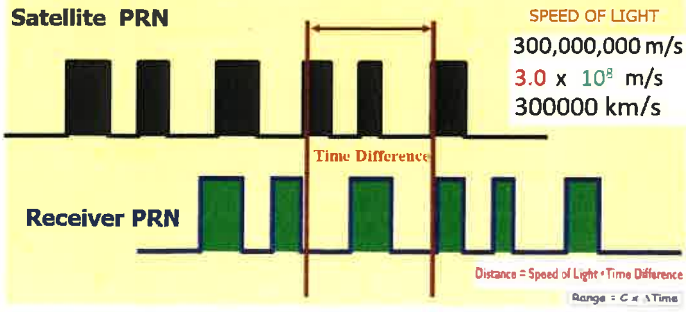
  GPS measurements based on the pseudo random code (C/A or P)
  (1-5 meter accuracy)

- 2. Phase Measurement or Observations:

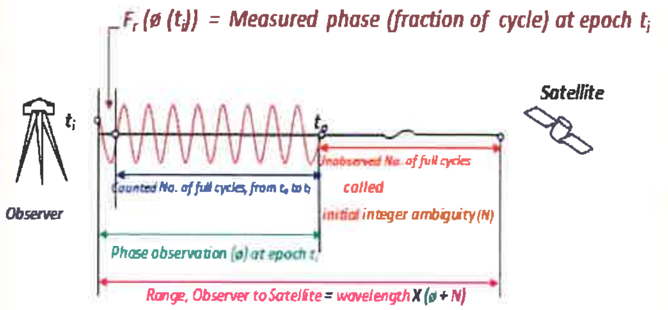
  GPS measurements based on the L1 or L2 carrier signal.
  (sub-metre accuracy)

RANGE by Code Measurement

Is CODE – CORRELATION TECHNIQUE, Where by Incoming CODE from the SATELLITE is correlated with REPLICA of the corresponding CODE generated inside RECEIVER.



Range by Phase (Carrier) Measurement



Range = Wavelength x (ø + N)

Range between a SATELLITE and RECEIVER exprssed in units of Cycles of the Carrier Phase

GPS OBSERVATION PRINCIPLE

Satellite position (X_i, Y_i, Z_i) - Known

Receiver Position (X_0, Y_0, Z_0) – Unknown

Then Geometric range(ρ)= $\sqrt{(X_i - X_0)^2 + (Y_i - Y_0)^2 + (Z_i - Z_0)^2}$

Signal Transmitted time from satellite – T_t

Signal receiving time by receiver – T_r

Synchronization error in satellite and receiver clock – T_0

Range $R = c\{(T_r - T_t) - T_0\}$

So, $c(T_r - T_t) = \sqrt{(X_i - X_0)^2 + (Y_i - Y_0)^2 + (Z_i - Z_0)^2} + c\,T_0$

Where (X_0, Y_0, Z_0) = Coordinates of Antenna in ECEF coordinate system

(X_i, Y_i, Z_i) = Coordinates of satellites in ECEF coordinate system

GPS SIGNALS

GPS signals provide a means for determining positions in real-time.

This is achieved by modulating the carriers with *pseudorandom noise (PRN) codes.*

Two different codes are in use, the P-code and the C/A-code.

P means - precision or protected

C/A means - Coarse acquisition.

GPS SIGNAL "P-Code"

The P-code is the principle code for navigation and available on both carrier frequencies L1 and L2.

The *P-code has a frequency of 10.23 MHz,*

Its wavelength is 30 m ((Duration of 0.1 micro second)

GPS SIGNAL "C/A-Code"

The C/A-code is currently only transmitted on the L1 carrier.

The C/A-code *has a frequency of 1.023 MHz*

Its wavelength is 293 m (Duration of one micro second)

GPS SIGNAL - Navigation Message

The third type of signal transmitted from a GPS satellite is the broadcast/navigation message.

The message is sent at a rather slow rate of 50 bits per second (bps), and repeats every 30 seconds.

NAVIGATION MESSAGE

- GPS Signals are also modulated with the navigation message.
- It contains information such as Satellites orbital data,
- Satellite almanac data, Satellite clock correction parameters
- Satellite health and constellation status
- Ionospheric model parameters for single frequency users
- offset between GPS and UTC (Universal Time Coordinated) time system.
- The content of the navigation message is continuously updated by GPS control segment and broadcast to the user by GPS satellites.

GPS SIGNAL – L1

The **L1 signal** is the oldest & most established **GPS signal**.

L1 carrier signal frequency =154 × 10.23 MHz = 1575.42 MHz

L1 wavelength 19.05 cm

Its frequency is relatively slow & not very effective at traveling through obstacles.

The cheapest GPS units are capable of receiving it.

GPS SIGNAL – L2

The L2 frequency was implemented after the L1.

It has Precision Code (P-code).

L2 carrier signal frequency = 120 × 10.23 MHz = 1227.60 MHz

L2 wavelength 24.45 cm

It is faster than the L1. It travels through obstacles such as cloud cover, trees, and buildings.

L2 has been brought to estimate Ionospheric delay to GPS.

It must be used along with L1 frequencies for better results.

GPS SIGNAL – L2C

L2C is the second civilian GPS signal, broadcast on the L2 fequency.

L2C contains two distinct PRN code sequences to provide ranging information; the *civil-moderate* code (CM), and the *civil-long* length code (CL).

CM is modulated with the CNAV Navigation Message

CL does not contain any modulated data and is called a *data less sequence*.

When combined with L1 C/A in a dual-frequency receiver, L2C enables ionospheric correction.

L2C broadcasts at a higher effective power, it makes easier to receive under trees and even indoors.

GPS SIGNAL – L1, L2, L2C, L5, L1C

There are three new signals designed for civilian use: L2C, L5, & L1C.

L5 is the third civilian GPS signal.

L5 carrier signal 115 × 10.23 MHz, i.e., L1 - frequency 1176.45 MHz

L5 wavelength 25.50 cm

Similary L1C & L2C are new signals used for civilian purpose

SOURCES OF ERROR IN GPS/GNSS

1. Satellite geometry(DOP)
2. Ephemeris(Orbital) error
3. Multipath error
4. Satellite clock error
5. Atmospheric effects
   - Ionospheric propagation delay
   - Tropospheric propagation delay
6. Receiver error & Personal error

DOP

DOP means **Dilution of Precision**, it indicates the quality of the satellite geometry in the sky at a particular epoch, at a particular place whether good or bad.

It is a unit less number.

Lesser DOP value indicates that satellites are well distributed hence better the precision &accuracy in co-ordinates

Types of DOP's

GDOP – Geometric DOP (ϕ, λ, h, t)

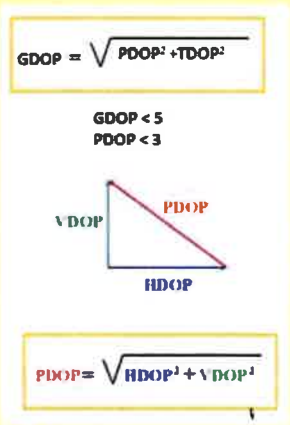
PDOP – Positional DOP (ϕ, λ, h)

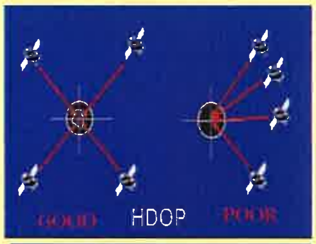
HDOP – Horizontal DOP (ϕ, λ)

TDOP – Time DOP(t)

DOP

The higher the DOP value, the poorer the precision in measurement



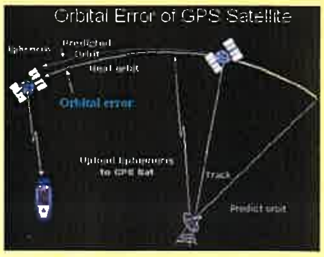


Ephemeris(Orbital) error

Although the satellites are positioned in very precise orbits, slight shift of the orbits are possible due to gravitational forces and radiation pressure.

Sun and moon have a weak influence on the orbits. The orbit data are controlled and corrected regularly and are sent to the receivers through ephemeris data. However, error of not more than 2m is possible due to this.

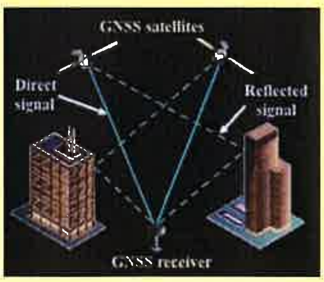
Eliminates by Double differencing.



Multipath error

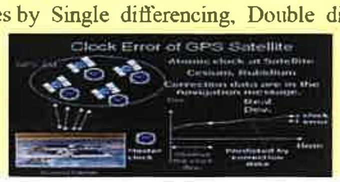
The multipath effect is caused by reflection of satellite signals on objects. Reflected signals reaches to the antenna, in addition to the direct signal

Eliminates by Cut off angle, Recee, Reflecting surfaces, Carefully designed antenna. i.e Micro strip and choke ring antenna.



Satellite clock error

1. Differences between satellite clock (atomic cock) and receiver clock (quartz clock)
2. Difference between atomic clock of MCS of GPS system and satellite's atomic clock causes error
3. Despite synchronization of receivers clock with the satellite time during the position determination, the remaining inaccuracy of the time still leads to error of about 2m in position determination.
4. Eliminates by observation to one more satellite.
5. Eliminates by Single differencing, Double differencing.

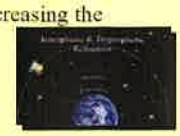


Atmospheric effects

While radio signals travel with the velocity of light in the outer space; their propagation in inosphere and troposphere is slower. Slowing down is 1∝ 1/f² while passing the ionosphere.

Electromagnetic waves with lower frequencies (f) are slowed down more than those of higher frequencies.

In troposphere also due to different concentration of water vapour, electromagnetic waves are refracted, thereby increasing the runtime.



Eliminates by Double differencing.

Receivers using signals of both L1 and L2 frequencies are able to eliminate the errors due to inospheric delay .

Receiver error

Error in position is caused because of receiver's internal hardware error, thermal error, Firmware error

Eliminates by Proper handling & timely serving.

Personal & Intentional error

AS(anti spoofing): P code encrypted

SA(Selective availability): Selective availability is an artificial random falsification of the time in the L1 signal transmitted by the satellite.

In this way an inaccuracy of the position of 50-100 m for several hours can be induced.

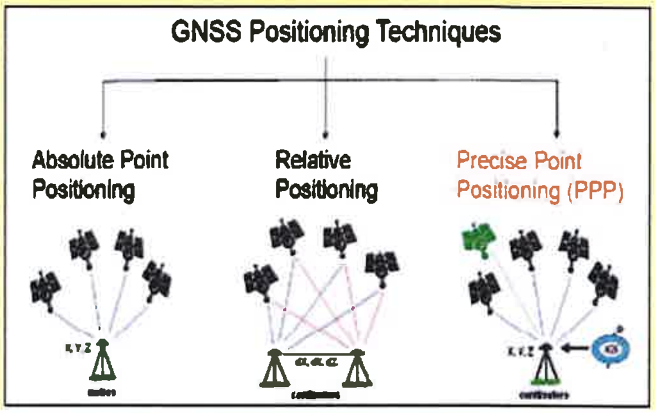
However since May 2, 2000 this SA is turned off.

Source of GPS errors and their Magnitudes

Source	Amount of error	Differential GPS
Satellite clock	±2m	0.0m
Orbital error	±2.5m	0.0m
Inospheric effects	±5m	±0.5m
Troposphere effects	±0.5 m	±0.2 m
Multipath	±1 m	±1 m
Receiver Noise	±1 m	±1 m

Errors are cumulative and increased by increase in PDOP Value

GNSS/GPS surveying Techniques

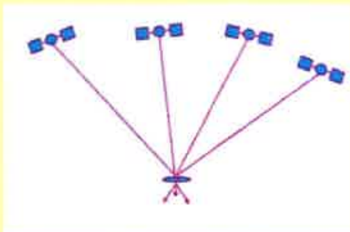


Various Field Positioning Techniques that are followed in GPS observations in General

51

Absolute positioning (SPP)

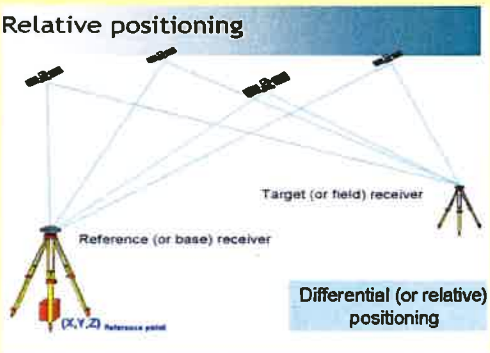
(**Single point positioning**, 1 – 5 mts)
No Post Processing



It is achieved by intersecting the measurements from four or more satellites at a single receiver on the earth's surface instantaneously using an inexpensive hand-held GPS receiver and by collecting C/A code measurements .

Relative Point positioning

It is based on Post Processing code and carrier phase measurements



Relative Point positioning

It is based on Post Processing code and carrier phase measurements

a. Static Gps Surveying Technique

b. Rapid Static Gps Surveying Technique

c. Kinematic Gps Surveying Technique

Stop & Go | **DGPS** | **RTK GPS** | **CORS / VRS**

Relative Point positioning

a. Static Gps Surveying Technique: Instrument kept in Static position during observation.

- **Long base line** GPS technique with a distance > 300 km
  - ✓ More observation time Ranging from 24Hrs to 72 Hrs
  - ✓ It is based on post processing Code & Carrier Phase measurement.
  - ✓ Scientific Software's like BERNES & GAMIT are used.
  - ✓ Input file RINEX format only.(Observation Interval 30")
  - ✓ We need to download 12 more different format files.
  - ✓ .sp3 updates after 12-18 days of observation.
  - ✓ .erp, .clk , .ion , .ERP, .VEL ,.CRD ,.FIX ,.CRX, P1P2, P1C1
  - ✓ It is mainly used in Geodetic works (Main frame) & Plate tectonic movement study. EX: SOI GCP Phase I library.

Relative Point positioning

a. Static Gps Surveying Technique: Instrument kept in Static position during observation.

b. Medium base line GPS technique with a distance 50km to 300 km

- ✓ Observation time Ranging from 03hrs to 12 hrs
- ✓ It is based on post processing Code & Carrier Phase measurement.
- ✓ Instrument vendor Software's like TBC, Leica are used.
- ✓ Input file Native format or RINEX format only
- ✓ Broadcast ephemerides are used for processing baselines .
  If require we can import and process with precise ephemerides.
- ✓ For Network adjustment minimum three to four CP are required, two at starting and two at the end or one, vice versa.
  EX: SOI GCP Phase II library.

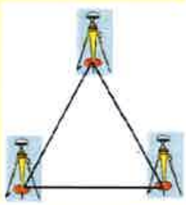
Relative Point positioning

b. Rapid Static Gps Surveying Technique:

Earlier in post processing software's base lines are processed in Radial method also, but now all base lines are processed in closed figure.

a. Short base line GPS technique with a distance <50km

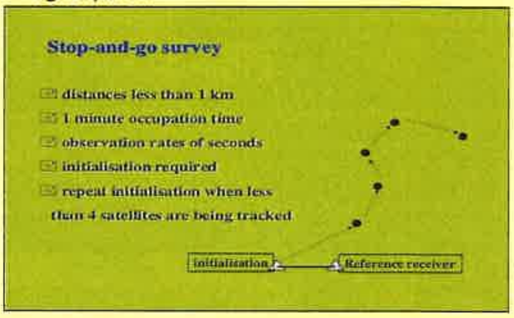
- ✓ Observation time <03hrs
- ✓ It is based on post processing Carrier Phase measurements.
- ✓ Instrument vendor Software's like TBC, Leica are used.
- ✓ Input file Native format or RINEX format.
- ✓ Broadcast ephemerides are used for processing baselines .
- ✓ Here we can use single frequency receiver.



Relative Point positioning

Kinematic GPS Surveying Technique
(GPS Receiver collects the data while moving)

Stop & Go : It tracks satellites continuously, but records when we are static, Initial ambiguity to be resolved, post–processing required.



Relative Point positioning

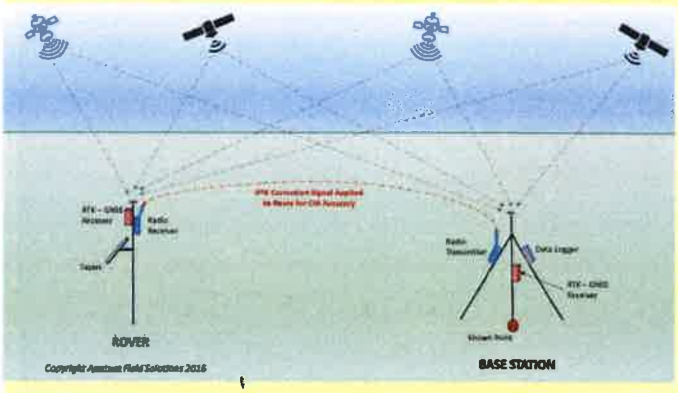
Depending on Accuracy requirement **Three Modes** of real Time Operation can be performed. DGPS, RTK, Network RTK.

Differential GPS: (No Post processing is required)

1. One Base Station (Known Coordinate)
2. One Rover station (Coordinate to be find out.)
3. Tracks satellite and determine correction through Wireless Data Link.
4. It sends correction through Standard format i.e., RTCM (Radio Technical Commission for Maritime Services)
5. DGPS Decodes the RTCM Message and determine the position.

Relative Point positioning

Differential GPS



Relative Point positioning

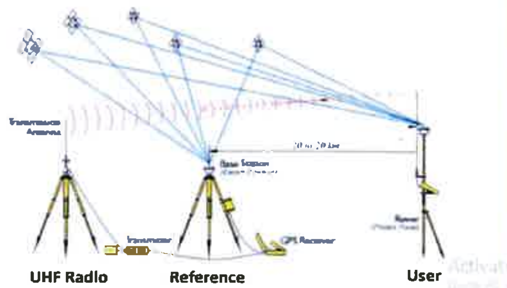
Real time Kinematic GPS (No Post processing is required)

(For large scale surveying, plotting by using Carrier phase)

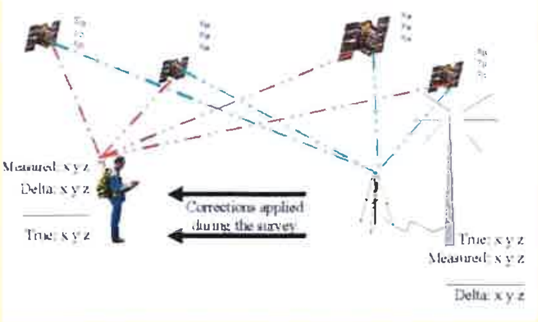
1. One Base Station (Known Coordinate)
2. One Rover station (Coordinate to be find out.)
3. Tracks satellite and determine correction through Wireless Data Link. VHF or UHF (Very High Frequency or Ultra High Frequency)
4. It sends carrier phase measurements to Rover, Rover microprocessor resolves the ambiguity in shortest time possible (OTF – AR Algorithm) resulting Carrier range data is used to resolve Cm level accuracy
5. Its Base line length is 5 to 10 Km.

Real-Time Kinematic (RTK)

- Positional accuracy +/- 2cm (horiz)
- Single base solution
- Range < 10-20 km (accuracy decreases with distance)
- Data transfer via UHF radio

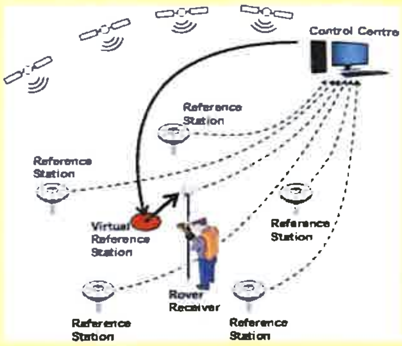


Real-Time Differential GPS

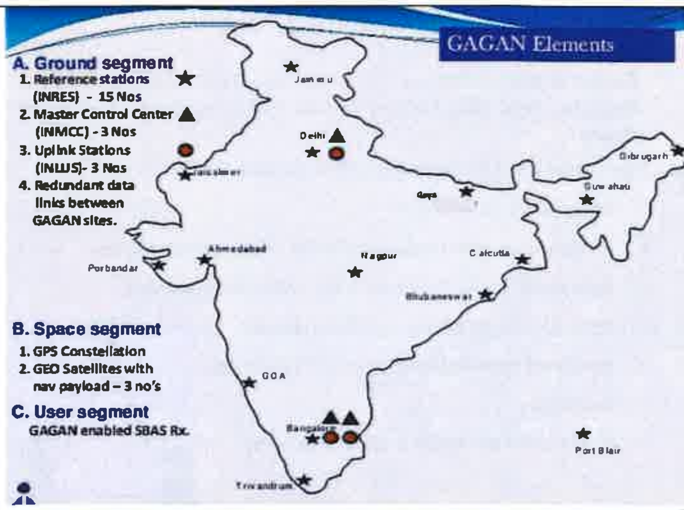


Network RTK—
CORS (Continuously Operated Reference Station)

A VRS (Virtual Reference Service) uses data from several (permanent) CORS to compute corrections that are generally more accurate than corrections from a single Reference station. These corrections are then broadcast over the Internet.



International GNSS Services (IGS)



IRNSS

- IRNSS stands for Indian Regional Navigation Satellite System (IRNSS)
- It Hindi name is **NAVIC** (means "sailor" or "navigator")
- IRNSS is an independent regional navigation system.
- 7 satellite constellation and ground segment. **3 in Geo-Stationary orbit, 4 Satellites in GEO Synchronous orbit**
- Most of the constellation is seen by user all the time.
- Ionosphere correction messages are available to users.
- Coverage area is about **1500 km beyond Indian territory**.

7 Satellites Covering INDIA for IRNSS / NAVIC

IRNSS

IRNSS is an independent regional navigation satellite system being developed by India. It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is its primary service area. An Extended Service Area lies between primary service area and area enclosed by the rectangle from Latitude 30 deg South to 50 deg North, Longitude 30 deg East to 130 deg East.
IRNSS will provide two types of services, namely, Standard Positioning Service (SPS) which is provided to all the users and Restricted Service (RS), which is an encrypted service provided only to the authorised users. The IRNSS System is expected to provide a position accuracy of better than 20 m in the primary service area.

7 Satellites Covering INDIA for IRNSS / NAVIC

- Any questions please .... ?

Thank you....

PRESENTATION ON

INTRODUCTION TO DATUM & PROJECTION SYSTEM AND MAP READING CONCEPTS

By Shri K V Ramana Murty,
Superintending Surveyor

WELCOME

Presentation on

Modern Techniques of Surveying, Concepts of Map, Datums, Co-ordinate systems & Map projections

by

K. V. Ramana Murty , Superintending Surveyor

National Institute for Geo-informatics Science & Technology

SURVEY OF INDIA, HYDERABAD

SURVEY OF INDIA

- National Surveying, Mapping & Geo-spatial data agency of Govt. of India.
- Established in 1767
- Adviser to the Govt.of India on all Surveying & mapping tasks for entire India.

SURVEY OF INDIA
DUTIES & RESPONSIBILITIES

- All Geodetic Control (Horizontal and Vertical) and Geodetic and geophysical surveys
- All Topographical control, Surveys and Mapping within India
- Mapping and Production of Geographical maps and Aeronautical charts
- Surveys for National Developmental Projects like National Hydrology Project (NHP), National Mission for Clean Ganga (NMCG), Hydro-electric projects across the country etc...
- Large-Scale Mapping for Cities, Guide Maps & Cadastral Surveys
- Survey and Mapping of special purpose maps
- SVAMITVA project for various States Large scale mapping
- Participation in Indian Scientic Expeditions to icy continent Antarctica

SURVEY OF INDIA
DUTIES & RESPONSIBILITIES (contd..)

- Demarcation of the External Boundaries of the Republic of India, their depiction on maps published in the country and advice on the demarcation of inter-state boundaries
- Training of officers and staff of Survey of India, other Central & State Govt. departments and trainees from foreign countries.
- Research & Development in Digital mapping and creation of Digital Topographic Data Base on 1:250,000, 1:50,000 & 1:25,000 scale, Printing, Geodesy, Photogrammetry, Topographical Surveys and Indigenisation.
- Prediction of tides at 44 ports including 14 foreign ports and publication of Tide Table one year in advance to support navigational activities.
- Scrutiny and Certification of external boundaries & coastline on maps published by the other agencies including private publishers

Topics to be discussed

- **Map and Types of Maps**
- **Concept of Datums / Reference surfaces**
- **Horizontal Datum – WGS84 Ellipsoid**
- **Vertical Datum - Geoid / MSL**
- **Concepts of Map Projections**
- **Various Co-ordinate Systems**
- **Various methods of Surveying techniques**
- **Various methods of Provision of Control Points and Detail Surveys for map making.**
- **Modern Survey Methods & Equipments**

What is a Map ?

- Map is a graphical representation of the Earth surface on a 2-dimensional plane surface i.e. paper.
- Every map will have a scale. Scales are mainly classified into 3 types.

a) Engineer's scale e.g. 1cm= 40 m

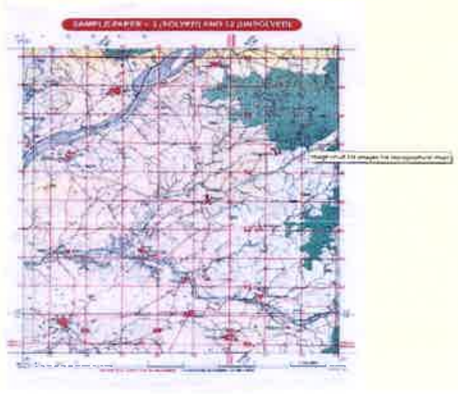
b) Graphical Scale

c) Representative fraction 1: 4,000 etc..

Types of Maps

- Topographical maps
- Cadastral maps
- Physical maps
- Political maps
- Thematic maps
- World maps / Atlas
- Geographical maps

Topographical map



Cadastral map

Physical map

Geographical maps
(Political map of India)

Thematic maps
(Rainfall map of India)

World Atlas

Concept of Datums / Ref.systems

- A datum may be defined as a set of numerical or geometrical quantities which serve as a base or reference for other quantities. In geodesy we consider two types of datum;

Horizontal Datum

- Everest spheroid (Earlier used in India)
- WGS-84 (Currently used in India)

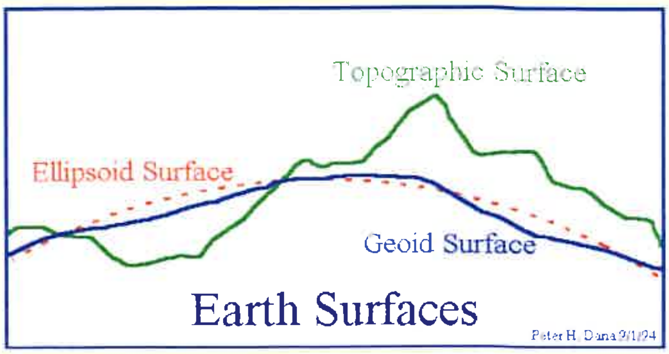
Vertical Datum

- Mean sea level / Geoid

Shape of the Earth

We think of the earth as a sphere

It is actually an Ellipsoid, slightly larger in radius at the equator than at the poles



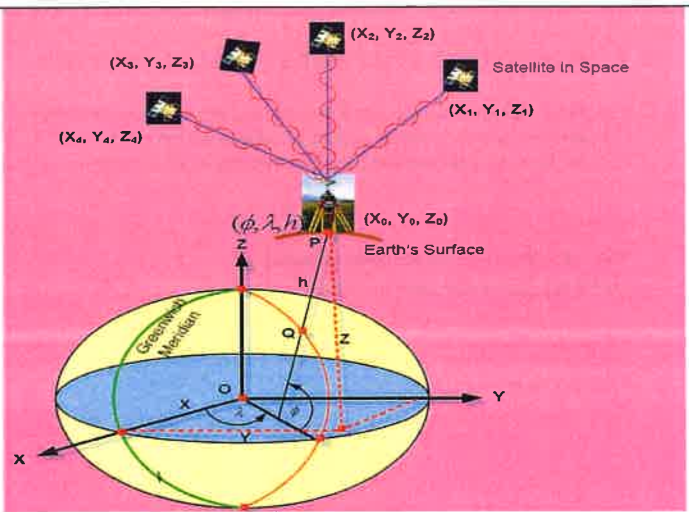
Relationships between the earth's surface, the geoid and a reference ellipsoid

Horizontal datum / Reference Ellipsoid

- Earth being irregular surface is not suitable for mathematical calculation of Horizontal Control.
- A mathematical surface has been conceived by geodesists which closely fit the surface of earth
- That mathematical surface is Ellipsoid, whose center is a close approximation of center of mass of earth & minor axes is parallel to axis of rotation of earth.
- This ellipsoid has been assigned some geometrical as well as physical parameters.

WGS-84 (World Geodetic System-1984) Datum

- Popularly known as World Geodetic System-1984.
- Established initially for U.S. Department of Defence
- WGS-84 is defined and maintained by NIMA (US National Imagery and Mapping Agency).
- It is used as datum for Global Positioning System called as GPS.
- It is a combination of GRS-80 datum with ECEF (Earth Centred Earth Fixed Reference Frame)
- Based on the theory of Geocentric Equipotential Ellipsoid.
- Internationally accepted.



WGS-84 Datum (Contd..)

1. **Origin** :- Earth's Centre of mass is assumed to be the geometric center of WGS-84 Ellipsoid.
2. **X-axis** :-Intersection of the WGS-84 reference meridian plane with the conventional terrestrial pole (CTP)'s equator, the reference meridian being parallel to the zero meridian defined by Bureau of International de Heure (BIH) on the basis of the co-ordinates adopted for BIH stations.
3. **Z-axis** :-It is parallel to the direction of CTP (for polar motion) as defined by BIH.
4. **Y-axis** :-It is chosen in such a way that it forms a complete right handed Earth centred Earth Fixed orthogonal co-ordinate system measured in the plane of the CTP's equator 90° East of X-axis.

(Contd….)

WGS-84 Datum Parameters

$a = 6378137m$

$b = 6356752 \cdot 3142m$

$f^{-1} = 298.257223563$

$GM = 3986005 \times 10^{8}\ m^{3} s^{-2}$

$\tau_{2,0} = -484.16685 \times 10^{-6}$

(Normalised second degree zonal gravitational coefficient)

$\omega = 7292115 \times 10^{-11}\ rad\ s^{-2}$

VERTICAL DATUM

Geoid / MSL

Vertical Datum

Geoid / Mean sea Level:

In India, the vertical datum i.e. the datum for height measurement was taken as MSL which was established with tidal observation at nearly 09 ports along Indian Coast continuously for about 19 years. The tidal observations were started in india some time in the year 1865 and Indian MSL was defined in 2005 after a complete metonic (Lunar) cycle.

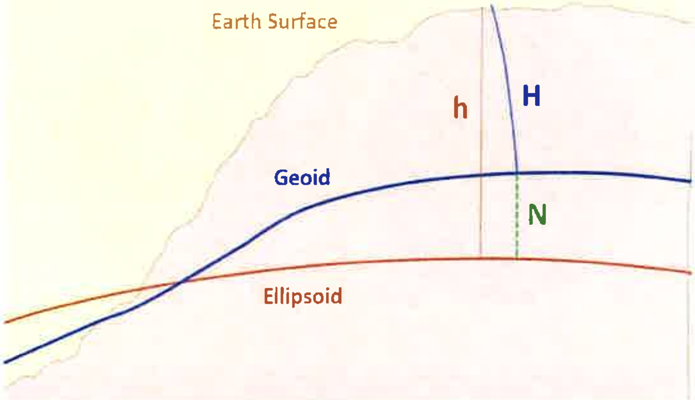
INDIAN MEAN SEA LEVEL

Geoidal/Ellipsoidal ht.

- Geoid:It is equipontial surface of earth's attraction & rotation.It is nearly ellipsoidal but a complex surface.The geoid is almost the same as MSL.It may be defined as surface coinciding MSL in the oceans and lying under the land at the level to which th sea would reach if admitted by friction less channels. Difference between Geoid & MSL is maximum $\pm$ 1mts.
- Ellipsoidal ht:Ht of a point above an ellipsoidal surface measured along ellipsoidal normal. Also known as GPS height.Vary from MSL by -70 to 110 mts.

H = MSL Height
h = Ellipsoidal Height
N = Geoidal Undulation

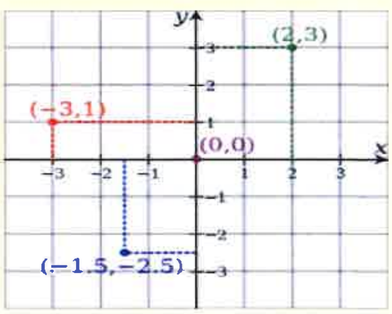
h = H + N



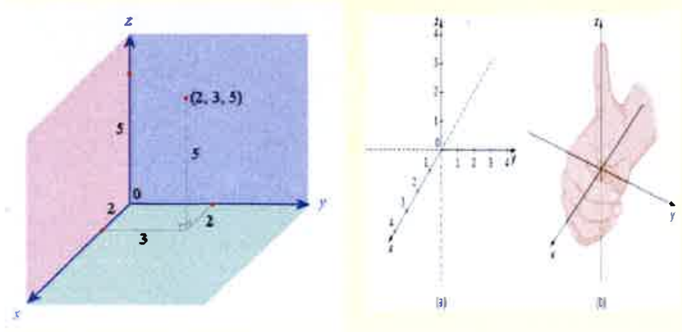
TYPES OF COORDINATE SYSTEMS

- Plane Coordinate System (x,y) / 2-D
- Cartesian Coordinate System (X,Y,Z) / 3-D
- Geographical Coordinate System (ϕ,λ)
- Geodetic Coordinate System (ϕ,λ,h)
- Geo-centric Coordinate System

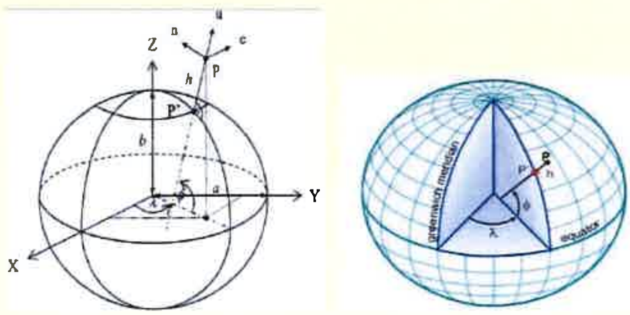
Plane/cartesian Coordinate System in 2-D (x,y)



Cartesian Co-ordinate System (x,y,z) in 3-D



Geodetic Co-ordinate System (ϕ,λ,h)

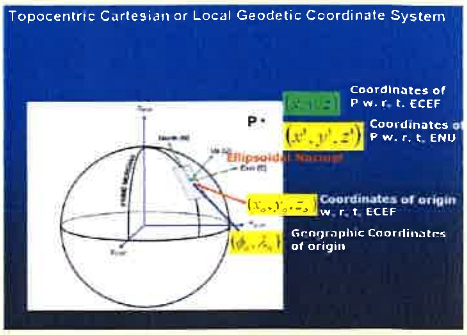


Relation between Geodetic co-ordinates & Geo-centric Cartesian co-ordinates

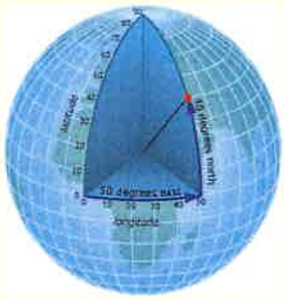
The following relationship exists between Geocentric Cartesian Coordinate (X,Y,Z) and geodetic coordinate (ϕ, λ, h)

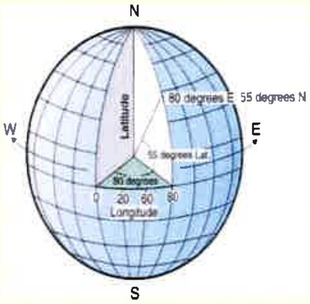
$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} (N+h)\cos\phi\cos\lambda \\ (N+h)\cos\phi\sin\lambda \\ \left(N\frac{b^2}{a^2}+h\right)\sin\phi \end{bmatrix}$$

Topocentric cartesian / Local Geodetic Coordinate System

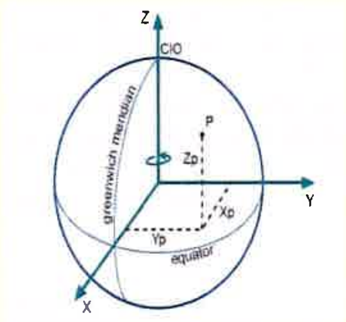


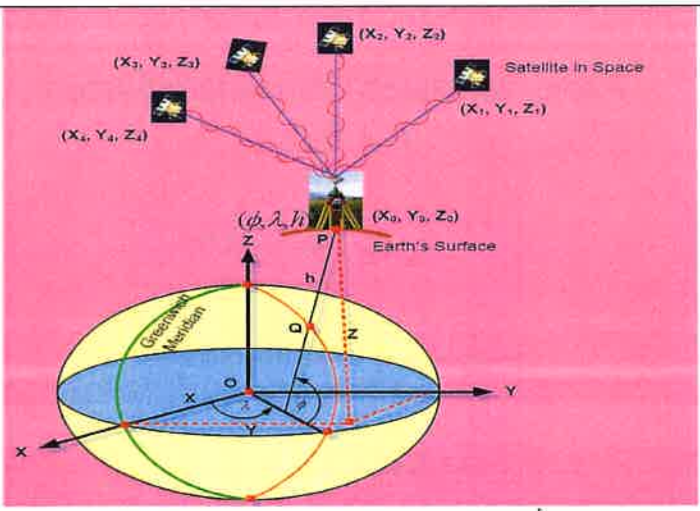
Geographic Co-ordinate system (ϕ,λ)





Geo-centric co-ordinate System



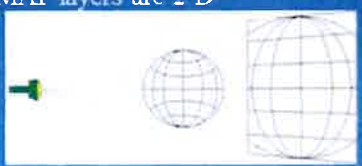


Introduction to Map Projections

Map Projection

- This is the method by which we transform the earth's spheroid (real world) to a flat surface (abstraction), either on paper or digitally
- Because we can't take our globe everywhere with us!
- Remember: most MAP layers are 2-D

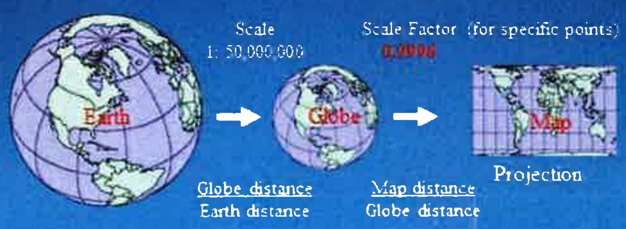
Think about projecting a see-through globe onto a wall



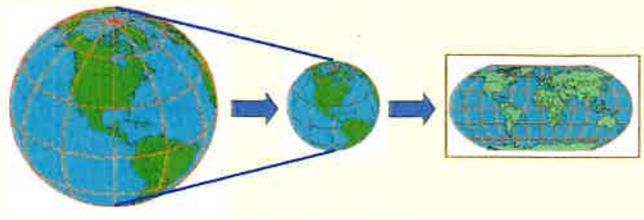
Laying the earth flat

- How?

  Projections – Transformation of curved earth to a flat map; systematic rendering of the lat. & lon. graticule to rectangular coordinate system.



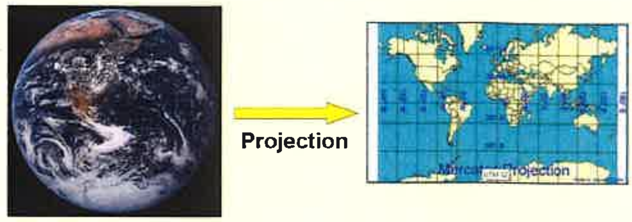
Earth Globe Map



Why We Need Projection

EARTH : 3D

MAP : 2D



Lat, Long, Ht

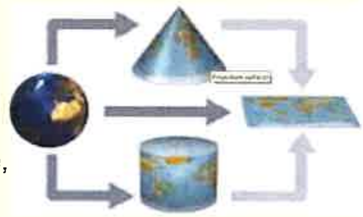
or

X, Y, Z

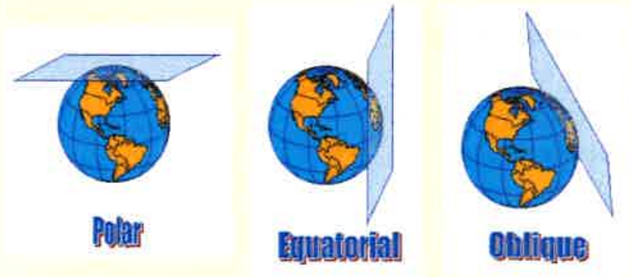
X , Y

Classification

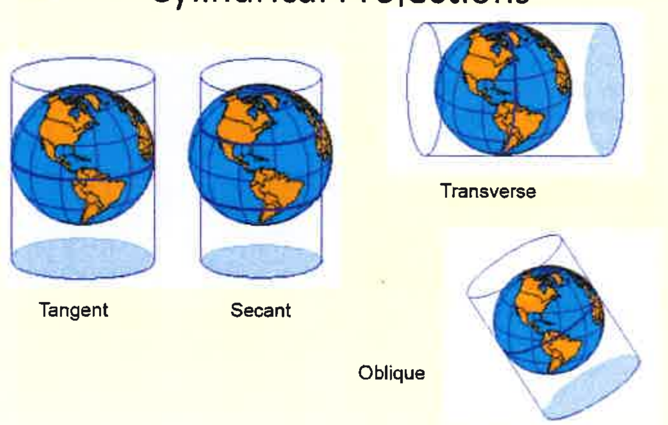
- **A) Based on Extrinsic property**
- Nature:
  - Plane, Cone, Cylinder
- Coincidence:
  - Tangent, Secant, Polysuperficial
- Position:
  - Normal, Transverse, Oblique



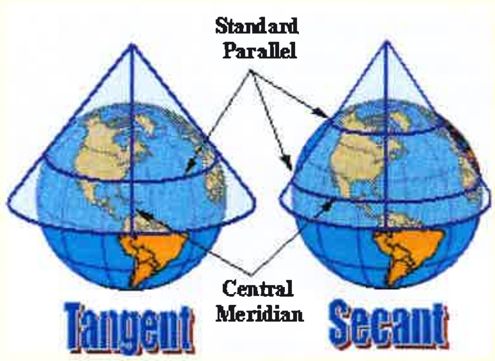
Azimuthal Projections



Cylindrical Projections

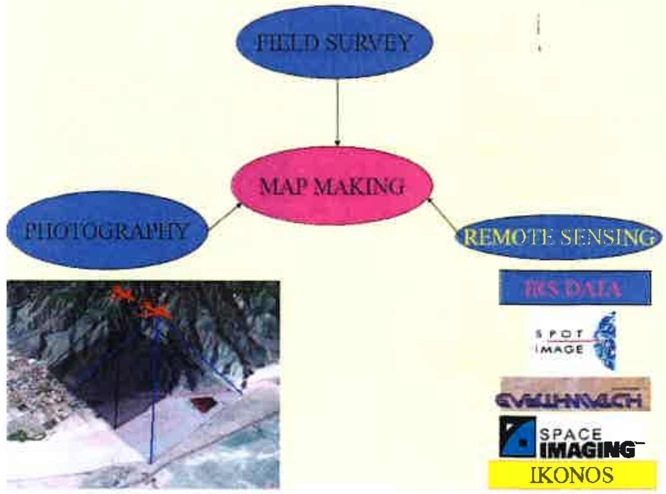


Conic Projections



SURVEYING METHODS

- Conventional Ground Survey methods like Chain surveying, Compass surveying, Triangulation, Traverse & Plane Tabling surveys etc..
- Photogrammetric surveys using Aerial Cameras & Drones etc..
- Remote Sensing techniques using satellites.



DATA CAPTURING

- CONTROL PROVISION
- DETAIL SURVEYS

SURVEYING METHODS

- For Provision of Control Points (Co-ordinates)

Conventional techniques :
- Triangulation
- Theodolite Traverse
- Ordinary Levelling, etc..

Modern techniques :
- GPS (Global Positioning Technique)
- EDM (Electronic Distance Measurement) technique
- Total station surveys
- Photogrammetric Aerial cameras/Drones fitted with GPS
- High Precision Levelling etc..

SURVEYING METHODS

- For Detail Surveys & Mapping

Conventional techniques :
- Chain Surveying
- Plane Table Surveying

Modern techniques :
- Total station surveys
- Survey with Photogrammetric Aerial cameras/Drones
- Survey by Remote Sensing technique using Satellites

SURVEYING INSTRUMENTS

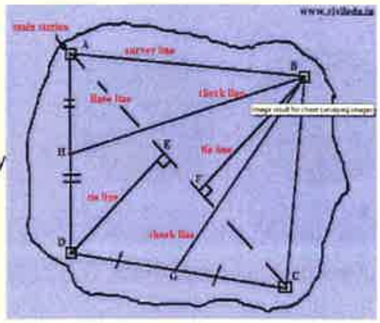
- CHAINS
- COMPASSES
- PLANE TABLE
- LEVELLING INSTRUMENTS
- THEODOLITES
- TOTAL STATIONS
- GPS & MOBILE MAPPING INSTRUMENTS

THE "CHAIN" SURVEY

chain surveying is the branch of surveying in which only linear measurement are made in field

CHAIN SURVEYING

- It is used for surveying & mapping by taking field measurements on the ground by a chain and then plotting them on a sheet of paper(called as chain survey map)
- Used mainly for cadastral/revenue mapping in India



Compass Surveying

- It is used to take angular measurements in the field.
- Conventional method

PLANE TABLING SURVEY

- Used for taking measurements & surveying directly in the field and mapping on the ground itself

Plane Tabling accessories

- Plane Table and stand

- Sight rule

- Compass

- Clinometer

- Spirit Level

Survey of India Team doing Large scale mapping in Antarctica using Plane Tabling survey

Mapping at Larsemann Hills using Plane Table and GPS

Mapping at Larsemann Hills using GPS

LEVELLING INSTRUMENT

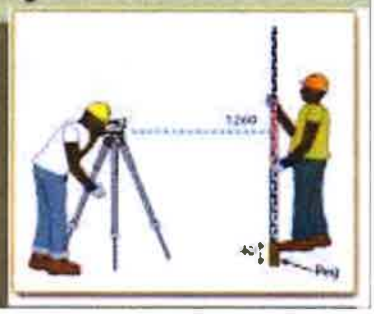
- It gives the difference of elevations / heights between any two places
- Very useful for Surveying & Engineering applications like Topographical, Road, Railway and Canal surveys etc..

- Dumpy Level

- Auto Level

Instruments for levelling

- The following instruments are essentially required for levelling
- Level
- Levelling Staff



AUTO LEVEL

- **Now most commonly used levelling instruments are - Auto level.**
  - **Auto level, as name sounds it has a auto level compensator and corrects automatically if instrument goes out of level within it's range.**

Modern Digital Levels

- Widely used now a days
- Used for Levelling work
- Stores data in digital mode
- Automatic computations & adjustments are done in field itself.

Theodolite (conventional)

- It is used for measuring Horizontal and vertical angles.
- Used for Traverse & Triangulation surveys.

Theodolite (Modern)


Modern Surveying instruments (Total Stations)

- It is used for many tasks such as Horizontal & Vertical angular measurements, Distance & height measurements
- Computes co-ordinates automatically using a processor and gives data in digital format

Modern Surveying instruments (Total Stations.. Contd..)



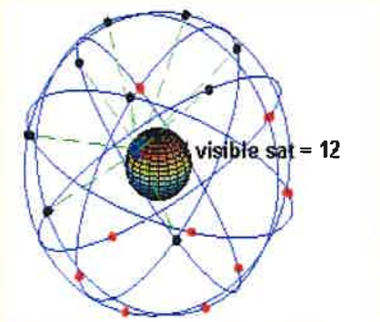
Modern Surveying instruments (Robotic Total Stations with sensors)




Modern Surveying Instruments GPS (GLOBAL POSITIONING SYSTEM)

- It is used to get co-ordinates (Latitude & Longitude) of any place on the Earth in real time
- Gives Accurate data
- Based on Satellite system
- Day & night observation can be done
- All weather operation
- Very useful for Navigation, Surveying & Mapping and other Engineering Applications.

GPS constellation



GPS (How it works ?)


GPS instruments




GPS observations at Maitri
(2nd Indian station at icy continent Antarctica) by
Survey of India team

GPS observations at Bharati
(3rd Indian station in Antarctica) by
Survey of India team

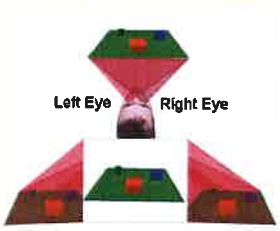
Aerial Photogrammetry

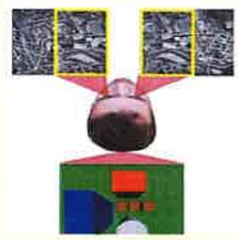
- Used for mapping the ground taking photographs from Aeroplanes/Drones etc..
- A large area can be surveyed in less time.

By having an overlap in successive photos

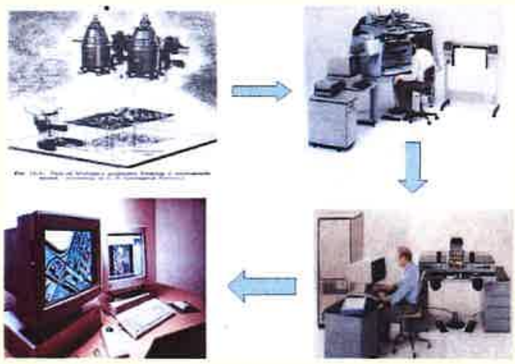
Aerial Photogrammetry

Aerial Photogrammetry





Photogrammetry procedures



Uses of Drones in Survey of India

- For large scale mapping of selected areas in the entire country
- For National Hydrology Project (NHP)
- For National Mission for Cleaning Ganga (NMCG project)
- For Cadastral mapping of different states like Karnataka, Haryana, Maharashtra etc..etc..

Drones used for Aerial Photogrammetry Surveying

Drone photography India:

The uses of Drone services in India include – Aerial Photography for mapping and many more applications like aerial UAV industrial inspections, aerial survey for GIS, agriculture and mining, drone photography for the real estate& video shooting for media & production houses.

With massive rise in the popularity of UAV's or drones that are extensively used for precision of aerial photography but you can have unlimited fun while flying and strapping a camera to this object can bring some of the most stunning aerial images that you have ever come across.

About Drone photography India

- Drone photography gives the freedom and view like what birds experience.
- It gives 3-dimensional freedom to move on land, water or through the air and capture beautiful images.
- It is more energy efficient than real planes or real bigger sized helicopters.

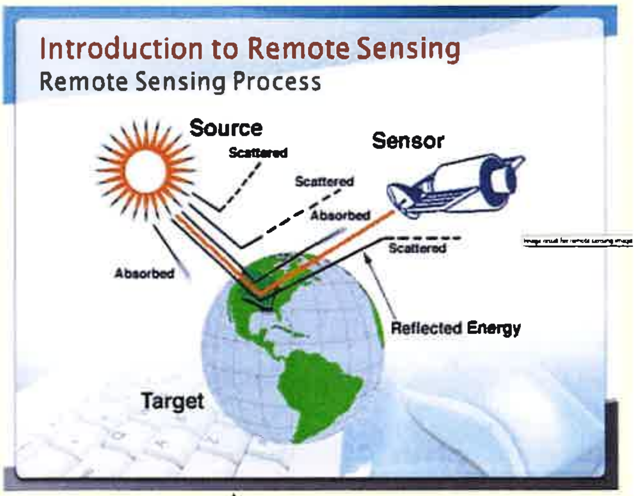
Mumbai Drone photography

Safety of flying:

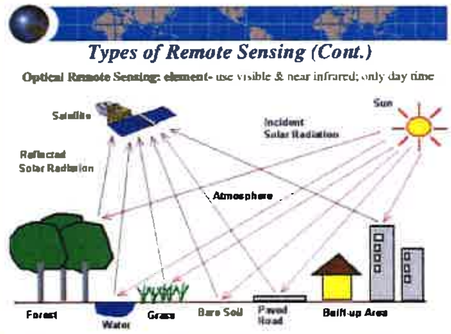
Drone is widely used today for aerial filming but the pilots need to undergo proper training and must have license to fly this object. However, it is one of the safest options available for aerial films. There are inbuilt safety mechanisms that offer complete safety to the pilots and the work of filming can also be completed with ease. For Large Scale mapping in India, Aerial Photography by using Drone is by far the most useful object which can be used.

Remote Sensing

- Images of ground are taken from Satellites
- Very useful for mapping large areas and surveying can be done frequently
- It is used for mapping.
- It is also used for disaster management at the time of cyclones, floods, landslides and other types of natural calamities.

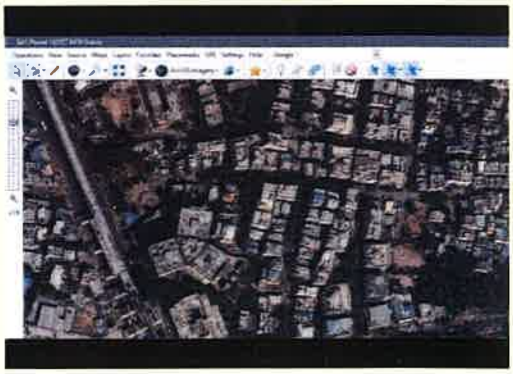


Remote sensing (examples)



Remote sensing satellites

Remote sensing imagery



LIDAR

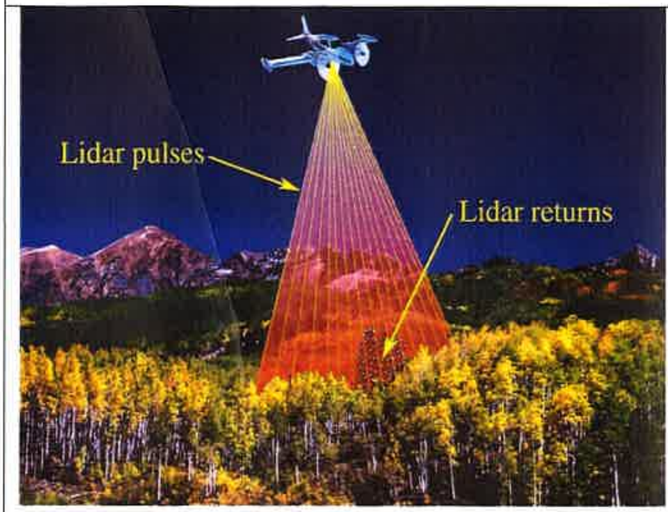
(Light Detection and Ranging) Technology

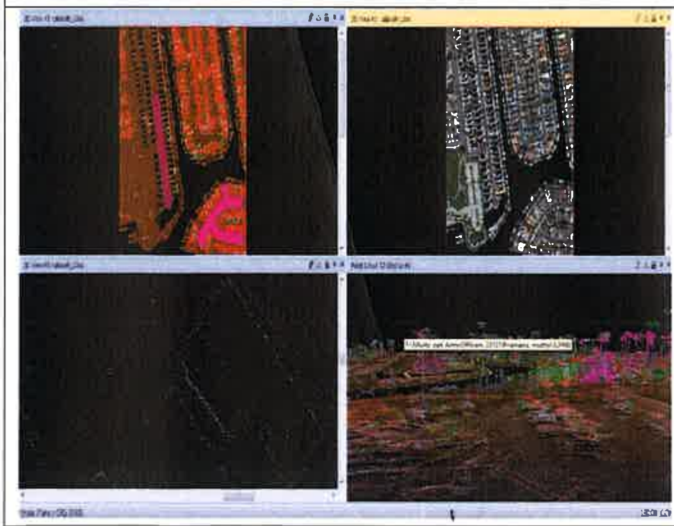
- **Lidar** (called **LIDAR**, **LiDAR**, and **LADAR**) is a surveying method that measures distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor. Differences in laser return times and wavelengths can then be used to make digital 3-D representations of the target.
- The name *lidar*, now used as an acronym of *light detection and ranging* was originally a portmanteau of *light* and *radar*. Lidar sometimes is called **3D laser scanning**, a special combination of a 3D scanning and laser scanning. It has terrestrial, airborne, and mobile applications.

LIDAR

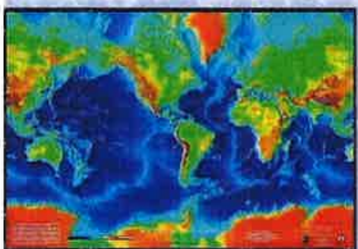
(Light Detection and Ranging) Technology

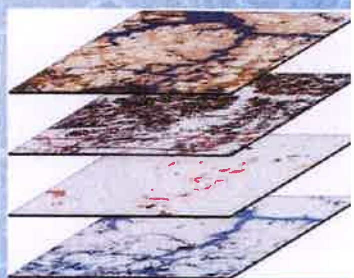
- Lidar is commonly used to make high-resolution maps, with applications in geodesy, geomatics, archaeology, geography, geology, geomorphology, seismology, forestry, atmospheric physics, laser guidance, airborne laser swath mapping (ALSM), and laser altimetry. The technology is also used in control and navigation for some autonomous cars.





Geographic Information Systems (GIS)

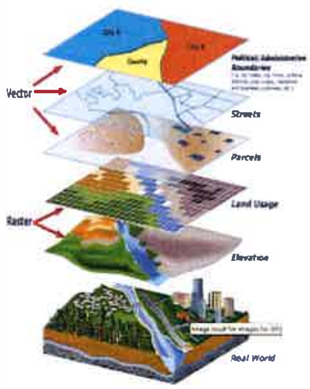




A system that uses digital map information to create a databank to produce specialized maps.

GIS (Geographical Information System)

- It contains Spatial data (x,y,z co-ordinates) and Attribute data (Descriptive Information) regarding any unit of land e.g. an individual's plot etc..
- It has both Raster & Vector data.
- Data can be seggregated into different layers as per user's requirement in GIS environment very easily.



- Any questions please .... ?

Thank you....

PRESENTATION ON

MAP PROJECTIONS

By Shri K V Ramana Murty,
Superintending Surveyor

Welcome to the Presentation on Map Projections

by
K.V.Ramana Murty
Superintending Surveyor
National Institute for Geo-informatics Science & Technology
SURVEY OF INDIA

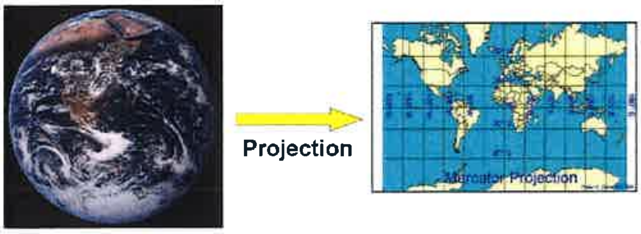
Map Projections :

The basic problem of map projection is representation of 3 dimensional curved surface into a 2-dimensional plane. Applicationally, it is often the problem of representing the earth on a flat map.

The representation of a curved surface as a plane involve 'stretching', 'shrinking' resulting in distortions or 'tearing' resulting in interruptions. Different techniques of representations are applied to achieve best results which possess certain properties favourable for specific purpose. The technique of representations is called map projection.

Why We Need Projection

EARTH : 3D — MAP : 2D



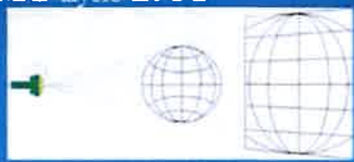
Lat, Long, Ht
or
X, Y, Z

X , Y

Map Projection

- This is the method by which we transform the earth's spheroid (real world) to a flat surface (abstraction), either on paper or digitally
- Because we can't take our globe everywhere with us!
- Remember: most MAP layers are 2-D

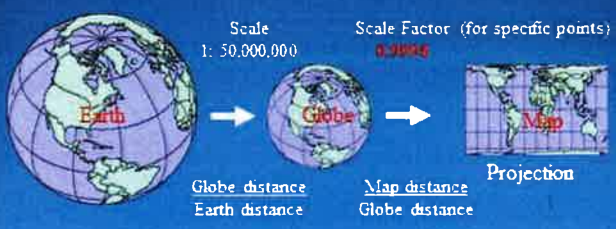
Think about projecting a see-through globe onto a wall



Laying the earth flat

- How?

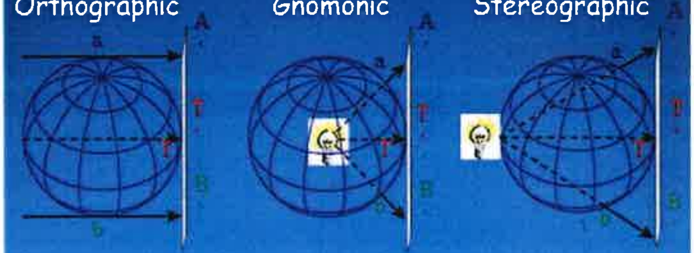
Projections – Transformation of curved earth to a flat map; systematic rendering of the lat. & lon. graticule to rectangular coordinate system.



Laying the earth flat

- How?

Projection types:



Basics of Map Projections

- A map projection is a mathematical model for conversion of locations from a three-dimensional earth surface to a two-dimensional map representation
- Necessarily distorts some aspect of the earth's surface, such as area, shape, distance, or direction
- Some projections minimize distortions in some of these properties at the expense of maximizing errors in others
- Some projection are attempts to only moderately distort all of these properties
- Every projection has its own set of advantages and disadvantages. There is no "best" projection
- The mapmaker must select the one best suited to the needs, reducing distortion of the most important features
- Mapmakers and mathematicians have devised almost limitless ways to project the image of the globe onto a flat surface (paper)

Purpose and Methods of projection :-

Three principal cartographic criteria that are applied for evaluation of map projection are as under :-

a) Equidistance - Correct representation of distances.
b) Conformality - Correct representation of shapes.
c) Equivalency - Correct representation of areas.

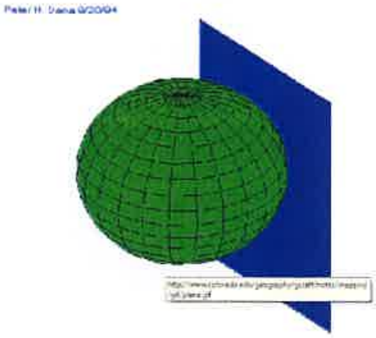
These three criteria are basic and mutually exclusive.

There are three kinds of projection surfaces

- Plane
- Cone
- Cylinder

} these being developable into a plane.

The transformation from datum to projection surface may be
- Geometrical
- Semi-geometrical
- Mathematical



Planar Projection Surface

Cylindrical Projection Surface

Conical Projection Surface

Map Projections are thus classified as under :

-	Class	Varieties		
Projection Surface (extrinsic property)	I. Nature II. Coincidence III. Position	**Plane Tangent Normal**	**Conical Secant Transverse**	**Cylindrical Polysuperficial Oblique**
Projection itself (intrinsic property)	IV. Properties V. Generation	**Equi-distance Geometric**	**Equivalent Semi-Geometric**	**Conformal Conventional or Mathematical**

<u>Choice of Projections:-</u>

There can be number of projections. It is purpose specific. However when one purpose is well served, other qualities need to be preserved as far as possible. A map can be of equal area type but then the conformality is certainly lost. When the area covered on map is rather small, all properties can be preserved within a small allowance, by almost all the projections. But when the portion of the globe that comes as a map is much, choice of projections becomes important. Again the choice of the projections will be influenced by location on the globe. If it is the whole globe, or only a hemisphere or a continent or two – the projection can vary.

Rhumb lines and great circles on globe are important for navigation and Mercator or Gnomonic projections are good respectively. In azimuthal maps, straight lines through center of projection are great circles on globe.

Some examples of Projections used for different types of maps

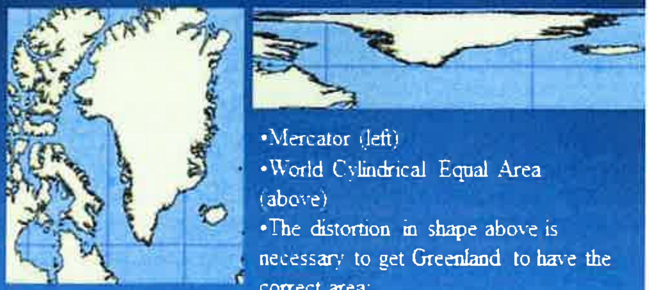
- Topographical maps - Polyconic Projection,LCC, Stereographic Azimuthal, Transverse Mercator, UTM etc..
- Geographical maps (large extent in N-S direction) - Lambert Conformal Conic (LCC) Projections
- Cadastral Maps (small extent in E-W direction) - Cassini projection, LCC
- Air & Sea Navigation maps - i) Mercator Projection (Equatorial regions) ii) Gnomonic projection (Polar regions)
- World Maps in one piece - Lambert's Azimuthal Equal area, Mercator Projection, Gall's Stereographic Cylindrical
- Continents and Atlases - Simple Conic, Bonne's Equal area, Lambert Azimuthal Equal area, LCC

Map Projection-distortion

- The problem with map projection is that it distorts one or several of these properties of a surface
- Shape
- Area
- Distance
- Direction
- Some projections specialize in preserving one or several of these features, but none preserve all

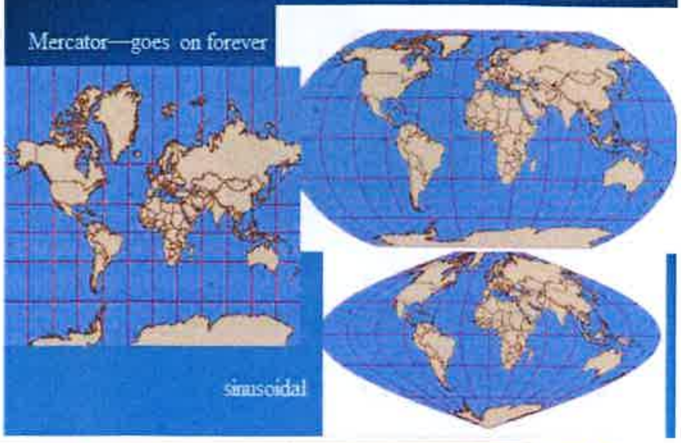
Distance distortion

Shape distortion



- •Mercator (left)
- •World Cylindrical Equal Area (above)
- •The distortion in shape above is necessary to get Greenland to have the correct area;
- •The Mercator map looks good but Greenland is many times too big

Some Examples of distortion



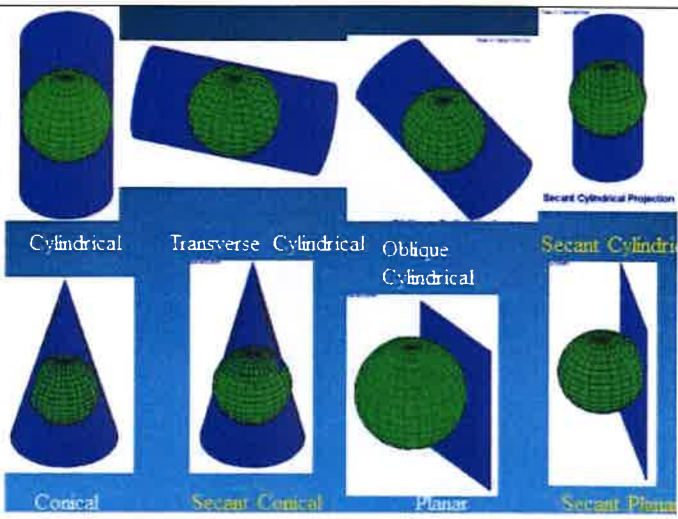
Classes of Map projections

Physical models:

- Cylindrical projections (cylinder)
  - Tangent case
  - Secant case
- Conic Projections (cone)
  - Tangent case
  - Secant case
- Azimuthal or planar projections (plane)
  - Tangent case
  - Secant case

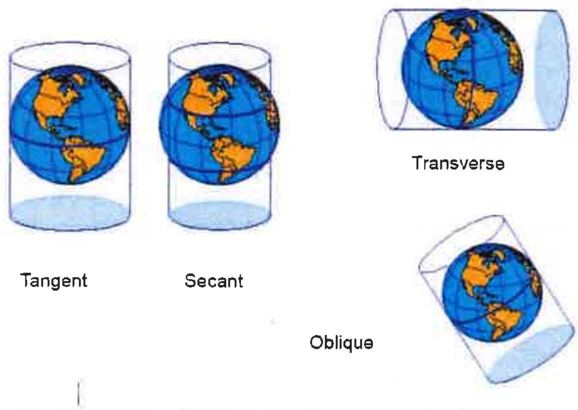
Distortion properties:

- Conformal (preserves local angles and shape)
- Equal area or equivalent (area)
- Equidistant (scale along a center line)
- Azmuthal (directions)



Planar/Azimuthal Projections

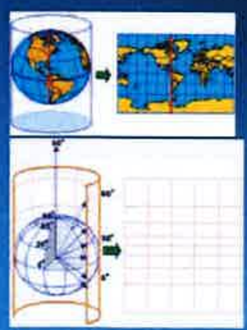
Cylindrical Projections

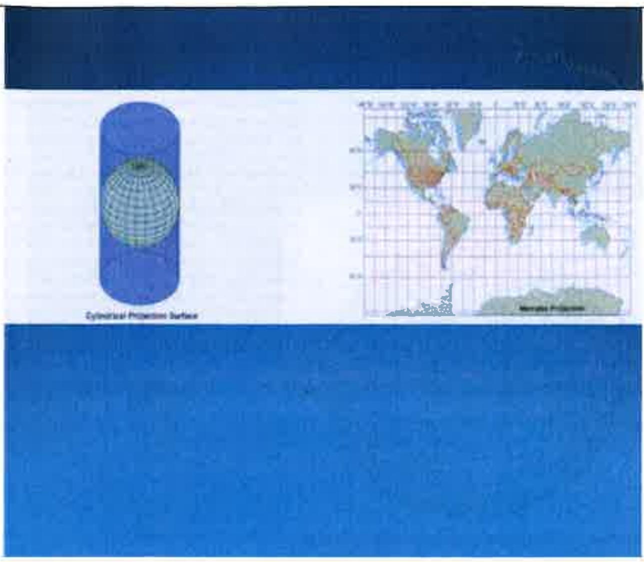


Conic Projections

General Map Projection: Cylindrical

•Created by wrapping a cylinder around a globe and, in theory, projecting light out of that globe; the meridians in cylindrical projections are equally spaced, while the spacing between parallel lines of latitude increases toward the poles; meridians never converge so poles can't be shown





Cylindrical Map Projections

- Cylindrical map projections are made by projecting from the globe onto the surface of an enclosing cylinder, and then unwrapping the cylinder to make a flat surface
  - Mercator
  - Transverse Mercator
  - Cassini-Soldner

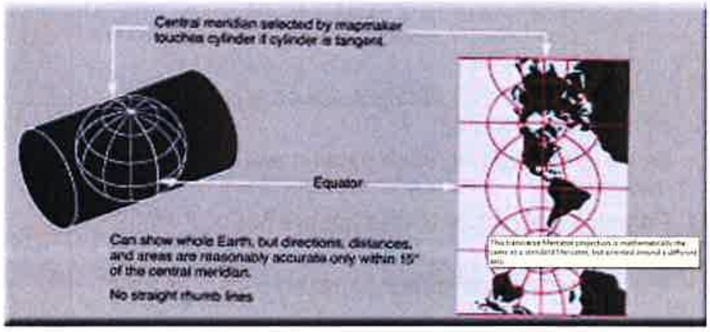
Mercator Projection

- Cylindrical, Conformal
- Meridians are equally spaced straight lines
- Parallels are unequally spaced straight lines
- Scale is true along the equator
- Great distortion of area in polar region
- Used for navigation

REGULAR CYLINDRICAL PROJECTION: THE MERCATOR

Transverse Mercator Projection

- Cylindrical (Transverse)
- Conformal
- Central meridian and equator are straight lines
- Other meridians and parallels are complex curves
- For areas with larger north-south extent than east-west extent



TRANSVERSE CYLINDRICAL PROJECTION: THE TRANSVERSE MERCATOR

Conic Projections

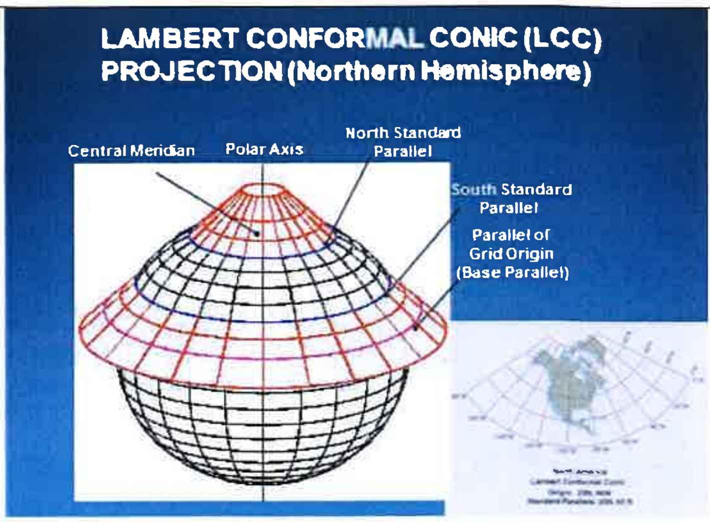
- For a conic projection, the projection surface is cone shaped
- Locations are projected onto the surface of the cone which is then unwrapped and laid flat

General Projection Types: Conic

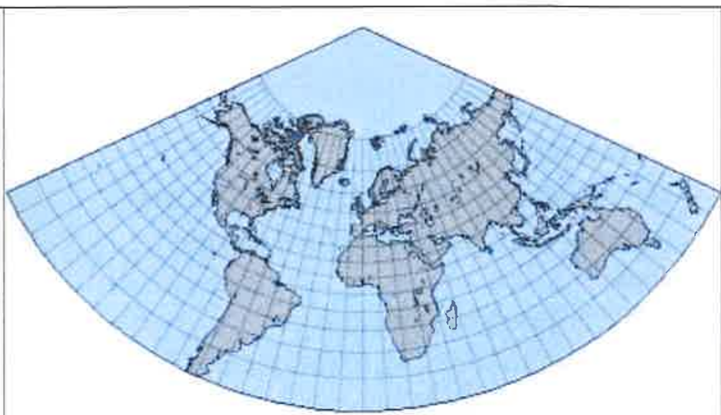
- Projects a globe onto a cone
- In simplest case, globe touches cone along a single latitude line, or tangent, called *standard parallel*
- Other latitude lines are projected onto cone
- To flatten the cone, it must be cut along aline of longitude (image)
- The opposite line of longitude is called the *central meridian*

Lambert Conformal Conic (LCC) Projection

- Conical, Conformal
- Parallels are concentric arcs
- Meridians are straight lines cutting parallels at right angles.
- Scale is true along two standard parallels, normally, or along just one.
- It projects a great circle as a straight line – much better than Mercator
- Used for maps of countries and regions with predominant east west expanse



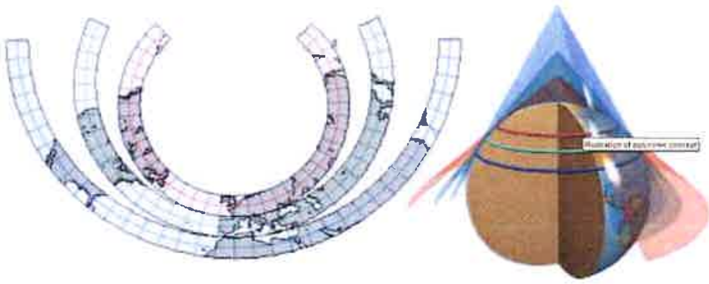
LCC PROJECTION



LCC PROJECTION

Polyconic Projection

- In this projection all parallels are projected without any distortion
- Scale is exact along each parallel and central meridian.
- Parallels are arcs of circles but are not concentric.
- It is neither conformal nor equal area.



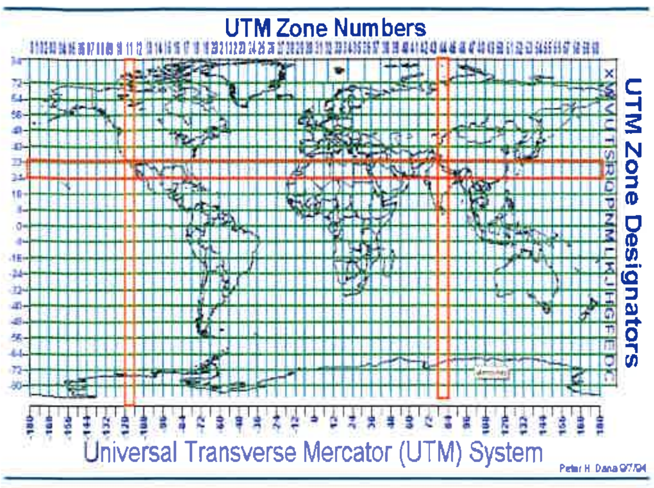
Three partial equidistant conic maps, each based on a different standard parallel, therefore wrapped on a different tangent cone (shown on the right with a quarter removed plus tangency parallels). When the number of cones increases to infinity, each strip infinitesimally narrow, the result is a continuous polyconic projection

Polyconic Projection (contd..)

- Central meridian and equator are straight lines; all other meridians are curves.
- Central Meridian cuts all parallels at 90 degrees
- Free of distortion only along the central meridian.
- It has rolling fit with adjacent sheets in EW direction.
- Used in India for all topographical mapping on 1:250,000 and larger scales.

Universal Transverse Mercator

- Particular case of Transverse Mercator Projection.
- The earth between latitudes 84° N and 80° S, is divided into 60 zones each 6° wide;
- Origin – the junction of equator & Central meridian
- Assumed (false) northing (y): 0 metres for northern hemisphere; 10,000,000 metres for southern hemisphere
- Assumed (false) easting (x): 500,000 metres;
- scale factor at the central meridian: 0.9996


UTM Zone Numbers
UTM Zone Designators
Universal Transverse Mercator (UTM) System
Peter H. Dana 9/7/94

Thank You

PRESENTATION ON

INTRODUCTION TO BASIC CONCEPTS OF GIS

By Shri Maheshwar Singh,
Officer Surveyor

Introduction & Basic Concept of Geographic Information System

MAHESHWAR SINGH, Officer Surveyor
Faculty of Carto, DM & GIS
National Institute for Geo-informatics Science & Technology, NIGST, Hyderabad
August11, 2021

CONTENTS OF THIS LECTURE

- Basic concept of GIS
- Basic elements of GIS
- Types of GIS data
- Examples of GIS applications

BASIC CONCEPT OF GIS

- **What does GIS stand for?**

Geographic Information System
- **is a system designed for capturing, storing, analyzing, and displaying spatial data**
- **is the use of hardware, software, people, procedures, and data**

Geographic Information Science
- **is the science concerned with the systematic and automatic processing of spatial data and information with the help of computers**
- **is the theory behind how to solve spatial problems with computers**

BASIC CONCEPT OF GIS

- **Literal Definition**

Geographic **relates to the surface of the earth.**

Information **is a knowledge derived from study or experience.**

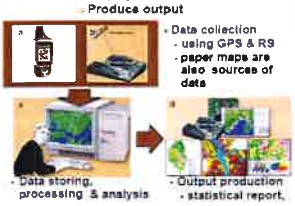
System **is a group of interacting, interrelated, or interdependent elements forming a complex whole.**

- **Component Definition**

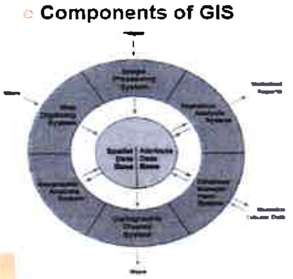
GIS is an organized collection of computer hardware, software, geographic data, procedures, and personnel designed to handle all phases of geographic data capture, storage, analysis, query, display, and output.

BASIC CONCEPT OF GIS

- **Functions of GIS**
  - *Data collection*
    - Capture data
  - *Data storing, processing & analysis*
    - Store data
    - Query data
    - Analyze data
  - *Output production*
    - Display data
    - Produce output



- **Components of GIS**



BASIC ELEMENTS OF GIS

- People
- Data
- Software
- Hardware
- Procedures/Methods

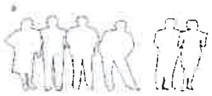
BASIC ELEMENTS OF GIS

- **1. People**

are the most important part of a GIS

define and develop the procedures used by a GIS

can overcome shortcoming of the other 4 elements (data, software, hardware, procedure)



- Ground truth data collection
- Data storing, processing and analysis

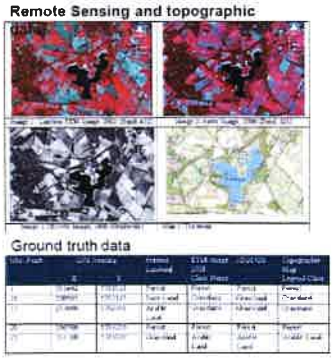
BASIC ELEMENTS OF GIS

- **2. Data**

Data is the information used within a GIS

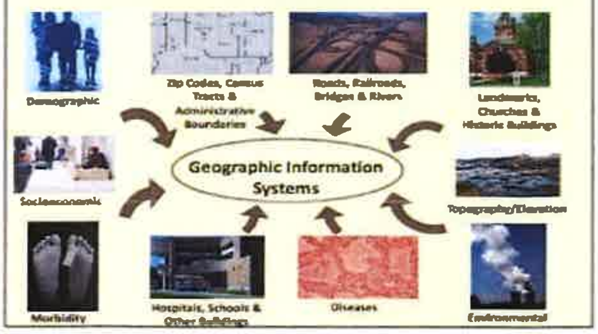
Since a GIS often incorporates data from multiple sources, its accuracy defines the quality of the GIS.

Remote Sensing and topographic



Basic elements of GIS

- 2. Data – more examples



Basic elements of GIS

- **3. GIS software**

  The functionality of the software used to manage the type of problems that the GIS may be used to solve.

  The software used *must* match the *needs* and *skills* of the end user.

- **Popular GIS Software**

  Vector-based GIS
  ArcGIS (ESRI)
  ArcView
  MapInfo

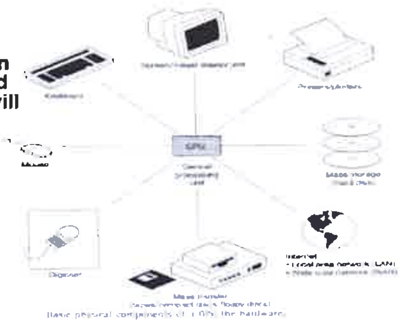
  Raster-based GIS
  Erdas Imagine (Leica)
  ENVI (RSI)
  ILWIS (ITC)
  IDRISI

Basic elements of GIS

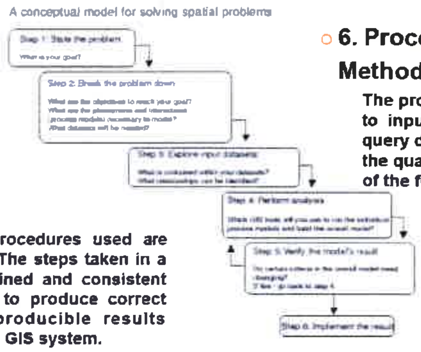
- **4. Hardware**

  The type of hardware determines, to an extent, the speed at which a GIS will operate.

  Additionally, it may influence the type of software used.



Basic elements of GIS



- **6. Procedures/ Methods**

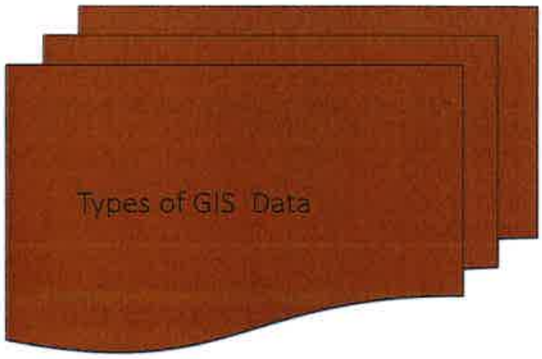
  The procedures used to input, analyze, and query data determine the quality and validity of the final product.

The procedures used are simple. The steps taken in a well defined and consistent method to produce correct and reproducible results from the GIS system.

History Of GIS

Roger Tomlinson ("The father of GIS").

In 1960, Roger Tomlinson was working at Spartan Air Services, an aerial survey company based in Ottawa, Ontario. The company was focused on producing large-scale photogrammetric and geophysical maps, mostly for the Government of Canada. In the early 1960s, Tomlinson and the company were asked to produce a map for site-location analysis in an east African nation. Tomlinson immediately recognized that the new automated computer technologies might be applicable and even necessary to complete such a detail-oriented task more effectively and efficiently than humans. Eventually, Spartan met with IBM offices in Ottawa to begin developing a relationship to bridge the previous gap between geographic data and computer services. Tomlinson brought his geographic knowledge to the table as IBM brought computer programming and data management.



Types of GIS Data

There are three types of data are used in GIS platform as:-

a. Spatial Data

b. Non-Spatial data.

c. Metadata

- Spatial data contains co-ordinates that is latitudinal and longitudinal position of feature. The Spatial data are presented with the help of point, line and polygon/area feature.
- Non-Spatial data(attribute data) represents a set of information that is systematically organized and compute against each spatial data.

e.g. if the spatial data contains a polygon represent a state or country and in attribute data it has information about its administrative divisions, total areas, population and so on respectively.

- **Metadata: creation date of the GIS data, GIS data author, contact information, source agency, map projection and coordinate system, scale, error, explanation of symbology and attributes, data dictionary, data restrictions, and licensing.**

Spatial Data

The spatial data are divided into two types:-

a. Raster data

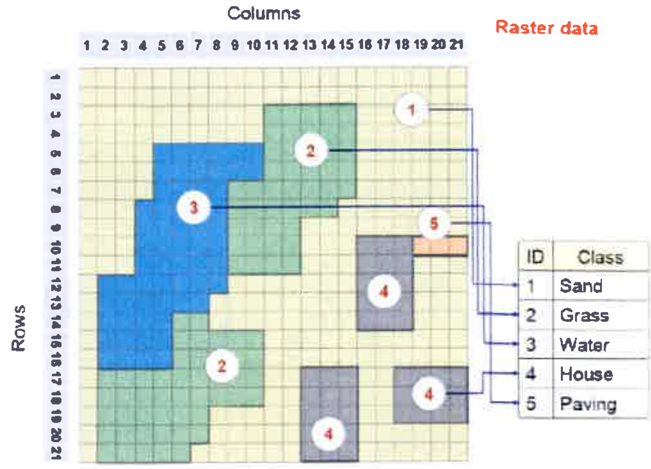
b. Vector data.

- Raster data comes in the form of individual pixels. Each pixel has its spatial location in referenced to real earth. Attribute is represented as a single value of each pixel or cell often called as DN value.
- Vector data.

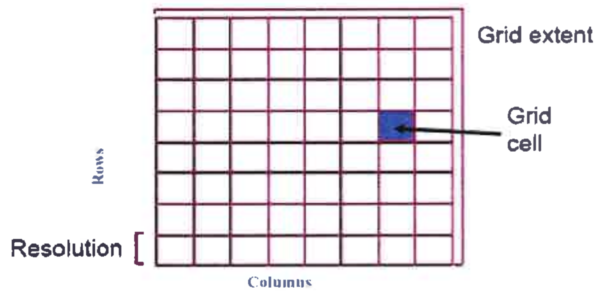
Vector data feature records spatial information as X & Y co-ordinates. The point features are recorded as single X & Y part of co-ordinates. The line feature as well as polygon feature are recorded as a series of X & Y co-ordinates. The vector attributes are recorded against feature ID numbers assigned by system itself.

Raster Data Structure

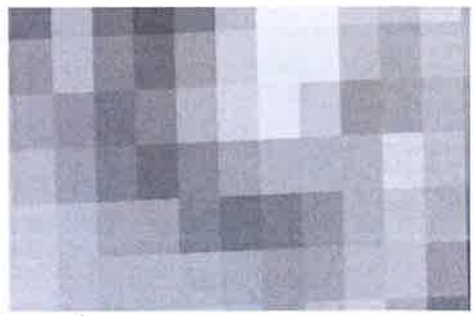
- Raster data comes in the form of individual pixels. It is represented as matrix grid of pixel. Each pixel preserves locational information. This type of spatial data is usually bulky and required large storage capacity.
- Example of raster data as: Satellite imagery, Digital Elevation Model, Aerial photography, Scanned maps etc.
- All pixels in a raster data must be the same size, determining the resolution. The pixel can be of any size, but they should be small enough to perform max detail analysis. A pixel or cell can represent a square kilometer, a square meter or even a square centimeter.
- The x & y value of a pixel usually represents the pixel size, i.e. the spatial resolution of the pixel.



A Field Data Model Uses a Raster or Grid Data Structure.



Raster Data Structure



Vector Data Structure

- ❑ A vector system usually stores data as coordinates.
- ❑ For example, each uniform area is surrounded by a set of straight line segments called vectors.
- ❑ In a vector based system every point is recorded by a pair of x and Y coordinates.
- ❑ Straight line segments called vectors are displayed to indicate line based data (roads, rivers,)
- ❑ Most spatial features can be displayed as: - Points- Line- Polygons

Vector Data Structure

- In general vector data structure produce smaller file size than raster data structure. Besides the size issues, vector data is easier to handle than raster data. Its structure is simple & it is more flexible to be adjusted for different scale, for example a projection system in mapping application. This makes vector data structure the apparent choice for most mapping in GIS. There are mainly three ways of vector data representation having three different data structure as:

<u>Point feature</u>.

- It has 0 dimension(can represent neither length or width)
- Represented by single X,Y co-ordinate pair.
- It has area size zero.
- Mostly used for denotes a single particular feature.

Vector Data Structure

<u>Line feature</u>.

- It has one dimension(can represent the length)
- Represented by connecting two or more pair of X, Y co-ordinates.
- It has its length value.
- Commonly used to demarcate roads, rivers, stream & so on.

<u>Polygon feature</u>

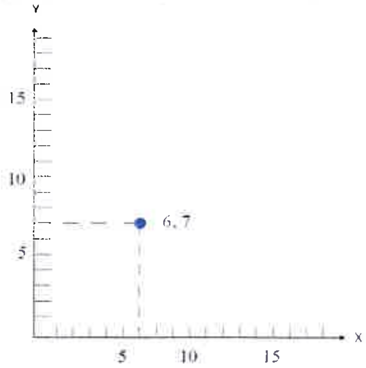
- It is two dimensional(can represent the length as well as width)
- Represented by connecting four or more pair of X,Y co-ordinates.
- The starting point should be the ending point.
- Preserve an area.
- Commonly used to demarcate feature having closed boundary.

Vector Data Structure

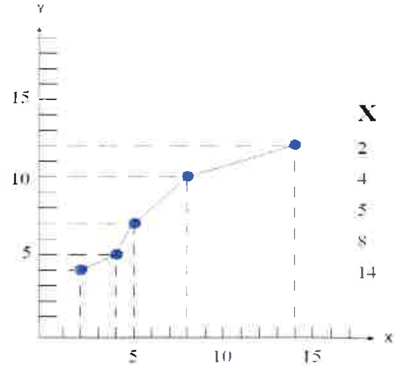
- Vector data structure maintains the geometrical & mathematical relationship between the associated feature.
- Topology among geometrical objects or items are much easier to be represented using vector data structure.
- Since a commonly shared edge can be easily defined according to its left and right side polygon.

Vector Data

DIGITAL REPRESENTATION OF A POINT

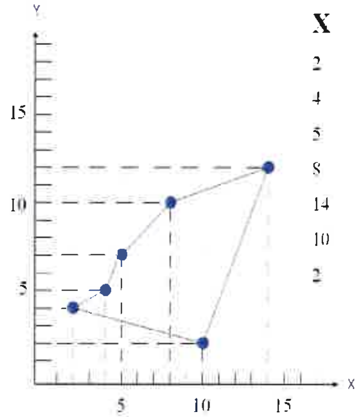


DIGITAL REPRESENTATION OF A LINE



X	Y
2	4
4	5
5	7
8	10
14	12

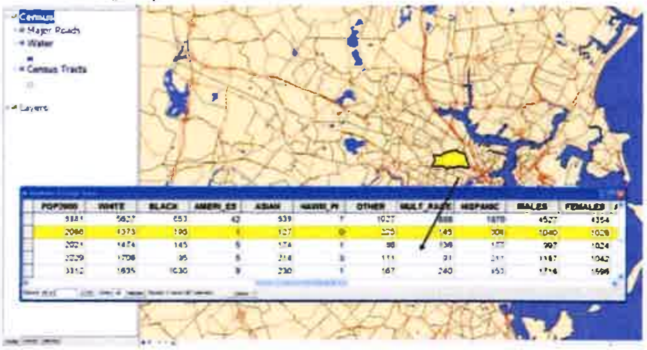
DIGITAL REPRESENTATION OF AN AREA



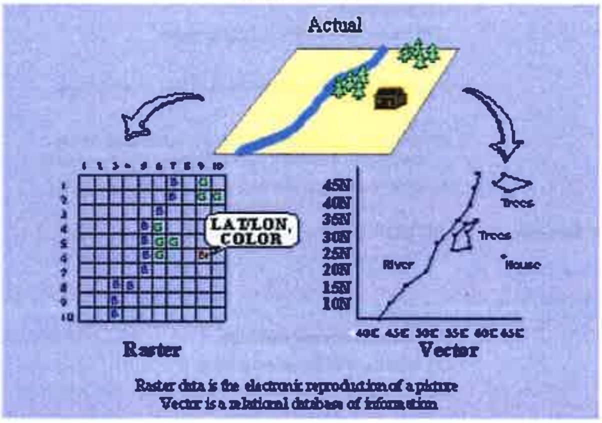
X	Y
2	4
4	5
5	7
8	10
14	12
10	2
2	4

Vector data

In vector data layers, the feature layer is linked to an attribute table. Every individual feature corresponds to one record (row) in the attribute table.



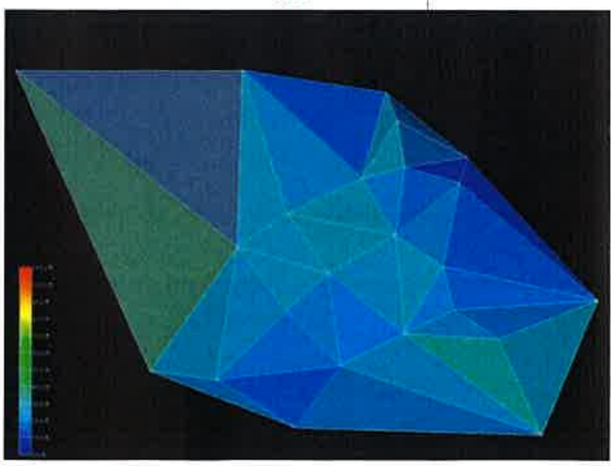
Vector Data



TIN(Triangulated Irregular Network)

- It is a vector data structure that represents the earth surface as contiguous non overlapping triangles.
- Within each triangle the surface is read by a plane.
- The triangles formed by a set of points that called as a mass points.
- It is a three dimensional way to represent the homogeneous earth surface,
- In a triangulated irregular network model, the world is represented as a network of linked triangles drawn between irregularly spaced points with X,Y & Z values.
- Tin are an efficient way to store & analyze surface.

TIN



Advantages & Disadvantages of Raster & Vector Data Structure

Advantages of Raster Data Structure

- Simple data structure.
- Overlay & combination of maps and remote sensed images easy.
- Some spatial analysis methods simple to perform.
- Simulation easy, because cells have the same size and shape.

- Disadvantages of Raster Data Structures
- Crude raster maps are considerably less beautiful than line maps.
- Network linkage are difficult to establish.
- Projection transformations are time consuming unless special algorithms or hardware used

Advantages of Vector Data Structure

- Good representation of phenomenonology .
- Compact
- Topology can be completely described.
- Accurate graphics.
- Retrieval, updating & generalization of graphics & attribute possible.

Disadvantages of Vector Data Structures

- Complex data structure.
- Combination of several vector polygon maps through overlay create difficulties.
- Simulation is difficult because each unit has a different topological form.
- Display & plotting can be expensive, particularly for high quality color.
- The technology is expensive, particularly for the more sophisticated software & hardware.

File Format Raster & Vector

Raster:- Some of the important raster file formats are:-

Image	Image file	World File
Tiff	Image.tiff	Image.tfw
Bitmap	Image.bmp	Image.bpw
BIL	Image.bil	Image.blw
JPEG	Image.jpg	Image.jpw

Note:- " geotiff " is a single file format that preserve both image & world information in a single file. However " tiff " & " geotiff " most commonly used in raster file format.

File Format Vector

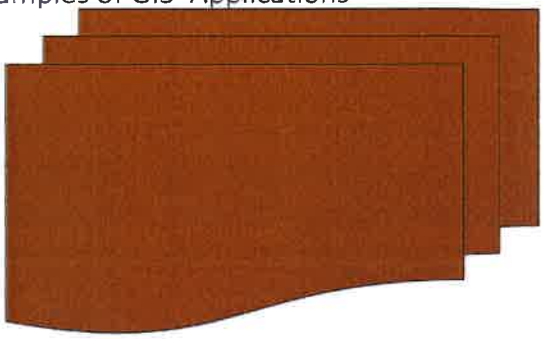
Vector:- In vector data structure there are two types of file formats:-

a. Shapefile
b. Geodatabase

- Geodatabase also divided into two types:-
  File geodatabase & Personal geodatabase.

Note:- The geodatabase has the more storage capacity than the Shapefile. It also can create Topology that removes the geometrical error between the associate features in the map. In large scale mapping geodatabase is more preferable than the shapefile so that it can store more attributes.

Examples of GIS Applications



Applications of GIS

Fields	Activity
1. Agriculture	(i) Crop acreage and production estimation . (ii) Monitoring and management from macro level to national level . (iii) Change detection of vegetated areas.
2. Archeology	(i) Site description and scenario evaluation .
3. Forestry	(i) Monitoring vegetation health . (ii) Analysis of deforestation and associated environmental hazards . (iii) Management , planning and optimizing extraction and replanting. (iv) Monitoring forest fire .
4. Epidemiology & health	(i) Location of disease in relation to environment factors.
5. Commerce & business	(i) Market share analysis . (ii) Insurance . (iii) Site location and target groups .
6. Tourism	(i) Location and analysis of facilities & attraction
7. Utilities	(i) Location, management and planning of water, drains,gas, electricity telephones, cable services. (ii) Site elevation and costing : cut &fill, computing volumes of material.
8. Emergency Services	(i) Optimizing fire, police & ambulance routing (ii) Improved understanding of crime & its location.
9. Defense agencies	(i) Target site identification (ii) Tactical support planning (iii) Mobile command modeling (iv) Intelligence data integration
10. Environmental Management	(i) Monitoring and management of Land degradation, waste land Mapping (ii) Land evaluation & rural planning (iii) Land Slides (iv) Desertification (v) Water quality and quantity (vi) Ground water potential mapping (vii) Mineral mapping potential (viii) Pollution monitoring (ix) Natural hazard assessment (x) Resource Management (xi) Environmental impact Assessment (xii) Monitoring Ocean Productivity

THIS LIST IS ENDLESS...............

QUERY ANALYSIS

QUERIES :-

- Queries are the most basic of analysis operations in which the GIS is used to answer simple and well defined to complex questions posed by the user

EXAMPLES:-

(i) Name the Feature
(ii) Getting information about a feature
(iii) Finding a feature
(iv) Selecting the features by building query expressions
(v) Finding the highest and lowest value of an attribute

Spatial Analysis:

- Spatial analysis is the crux of Geographical Information Systems.
- Spatial analysis can reveal things that might otherwise be invisible.
- It involves analyzing, querying, manipulating, modeling and making new information available in the form of maps, reports, charts, etc.

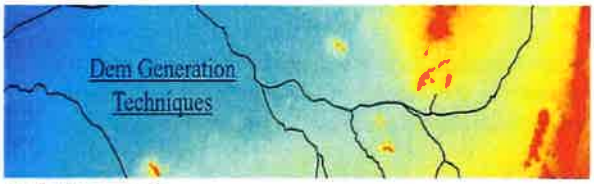
VECTOR DATA ANALYSIS

Attribute Query
Location Query
Buffering

3D Analysis
Digital Elevation Model

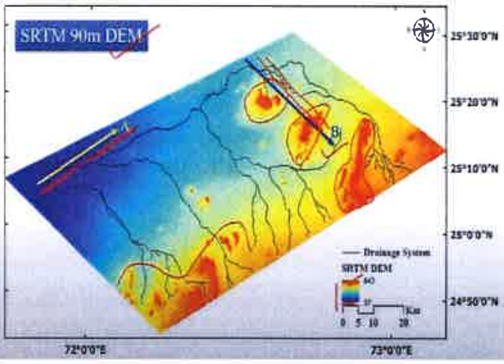
- Digital elevation model represents height information (Z-value) along with latitude and longitude of the topography.
- Automatic extraction of topographic and hydrological information is one of the major uses of DEMs.
- In addition, its products such as Slope, Aspect and basin information, etc. are enormously used in may applications.
- **Most commonly used DEMs are: SRTM, ASTER, IKONOS, GTOPO30 and CARTOSAT.**

Digital Elevation Model

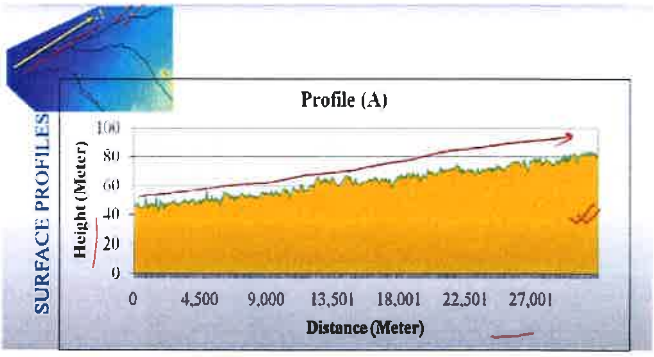


- Satellite stereo pair
- Photogrammetry
- Radar interferometry
- Laser altimetry
- Contour lines

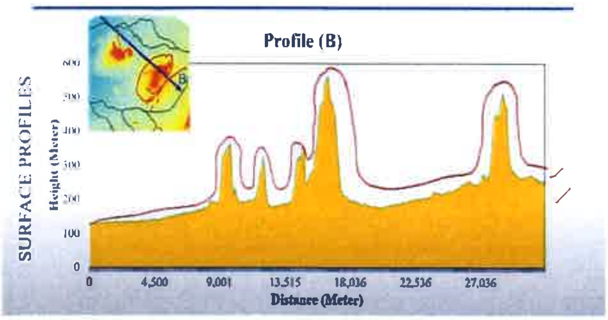
Digital Elevation Model



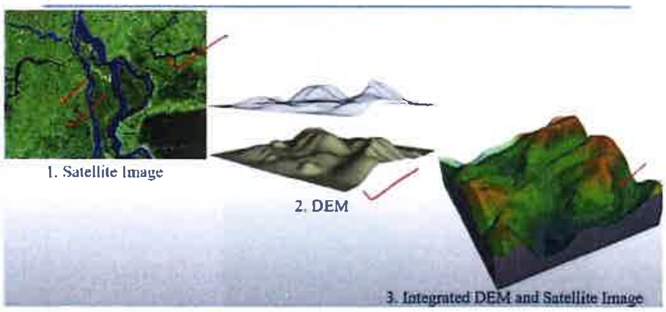
Digital Elevation Model



Digital Elevation Model



Digital Elevation Model



Surface Analysis

- •Slope
- •Aspect
- •HillShade
- •Curvature
- •Viewshed
- •Watersheds
- •Surface Area and Volume Calculation

Surface Analysis

1. Slope: The DEM can easily be transformed into a slope map with the Slope tool. This map describes the slope for each raster cell in degrees based on the elevation at each point.

2. Aspect: Another derivative is the aspect map. This map displays the aspect of each raster cell grouped into compass directions (north, northwest, etc.).

3. Hillshade: This tool creates a map with a shade-effect based on the input parameters that are entered in the tool. The resulting map is easier to interpret than the original DEM, because some topographic features are better visible (on small scale especially).

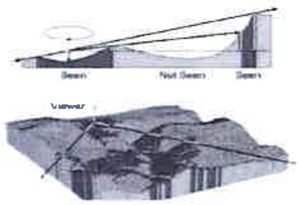
4. Curvature: The curvature map (fig. 2.4) is calculated by using the curvature tool. This basically calculates the relative change in slope, could be seen as a second order DEM derivative.

5. Contour: Topographic contour lines can be plotted with the contour tool (fig. 2.6). Based on the user defined parameters the new map will display (elevation based) contour lines.

6. Viewshed & Observer Points: These tools are used to calculate a (set of) positions relative to a user defined (point) feature (fig. 2.7). This is useful to determine the visibility of a location.

Viewshed Analysis

A viewshed is an area that is visible from a specific location. Viewshed analyses are a common function of most geographic information system (GIS) software. The analysis uses the elevation value of each cell of the digital elevation model (DEM) to determine visibility to or from a particular cell.



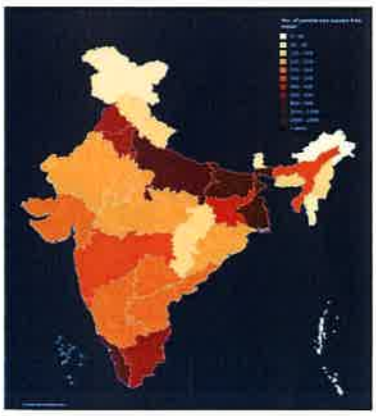
NETWORK ANALYSIS

Network Data Analysis

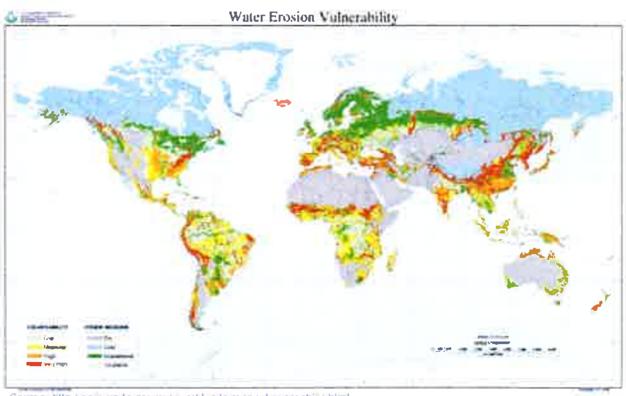
Network analysis is used to find the shortest path between source and destination points. If a barrier exist on any segment between source and destination then the next alternate route is selected. Generally network analysis is applied to road network, pipe lines etc. The attribute table of roads may have fields like speed, impedance. Impedance is the obstacle / resistance / hurdles to the flow of traffic.

EXAMPLES OF GIS APPLICATIONS

- Mapping population density



EXAMPLES OF GIS APPLICATIONS



EXAMPLES OF GIS APPLICATIONS

- Landslide Risk Mapping

Open Source GIS

quantum GIS - qgis.org

uDIG - uDIG.refractions.net

GRASS - grass.itc.it

Thank you for your attention

PRESENTATION ON

MAP MAKING THROUGH AGES

By Shri K V Ramana Murty,
Superintending Surveyor

Map Making Through Ages

by
K.V.Ramana Murty,
Superintending Surveyor

National Institute for Geo-informatics Science & Technology

Survey of India

Topics to be covered

- Feature on Map
- Map Making:Through Ages

Body of the Map

Features available inside body are:

•Point features

•Line features

•Area features

•Descriptive remarks

Body of the Map

•Point features

- Temple
- Chathri
- Idgha
- Mosque
- Church
- Hut
- Over head tank
- Tube well
- Well
- Hand pump

Body of the Map

•Point features

- Tree ordinary
- Coconut tree
- Plantain tree
- Palmyra tree
- Surveyed tree

Body of the Map

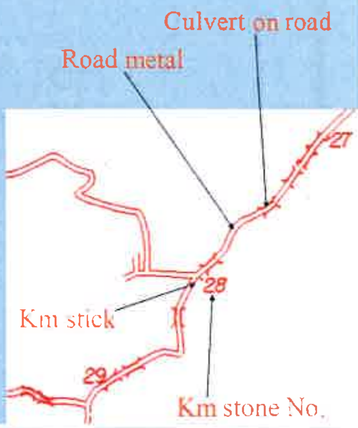
•Line features

Road metal is divided into 3 categories

•First importance

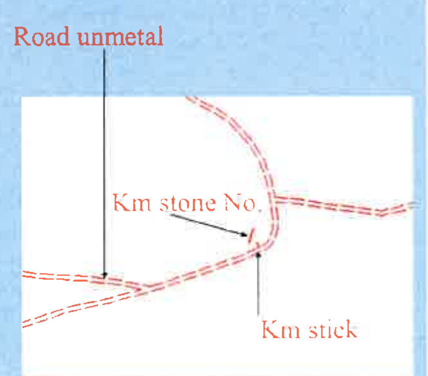
•Second importance

•Third importance



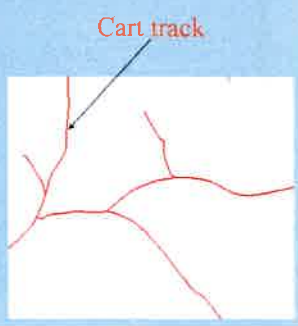
Body of the Map

•Line features



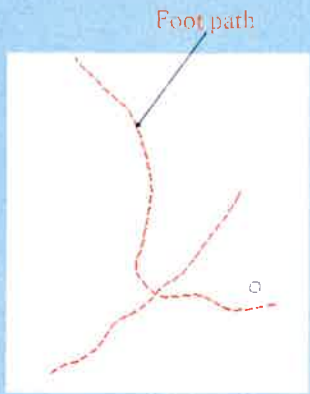
Body of the Map

•Line features



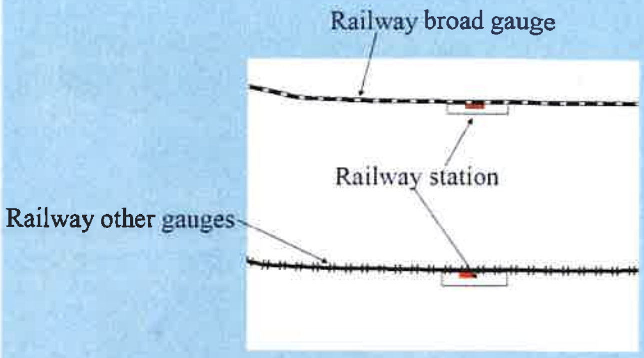
Body of the Map

- Line features



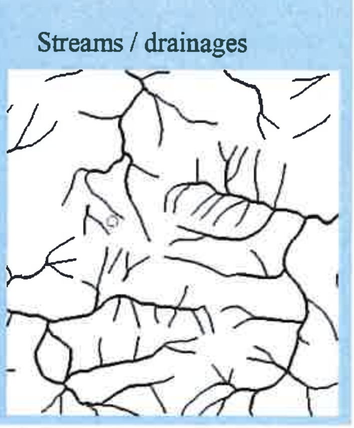
Body of the Map

- Line features



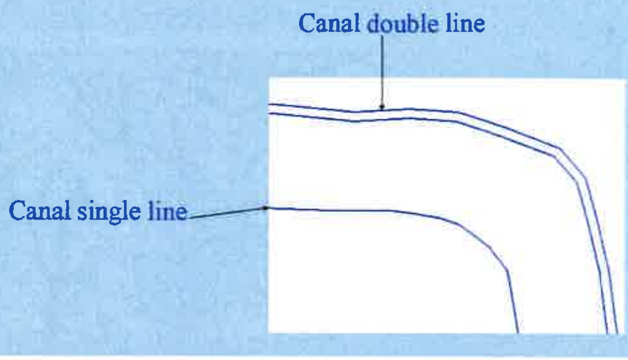
Body of the Map

- Line features



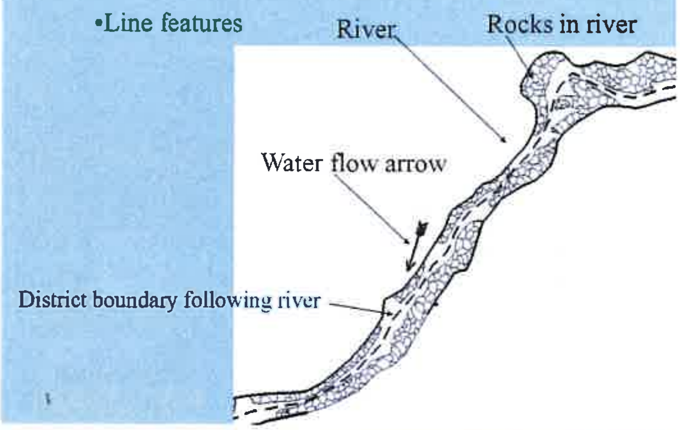
Body of the Map

- Line features



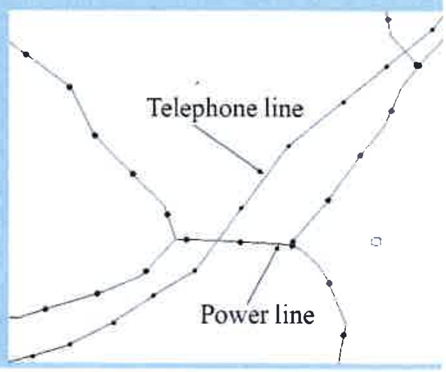
Body of the Map

- Line features



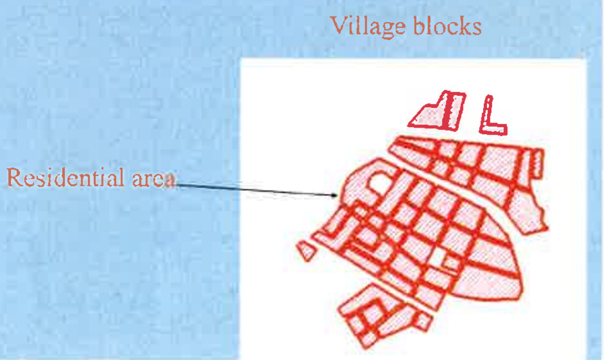
Body of the Map

- Line features



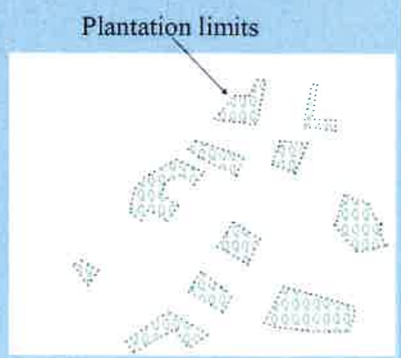
Body of the Map

- Area features



Body of the Map

- Area features



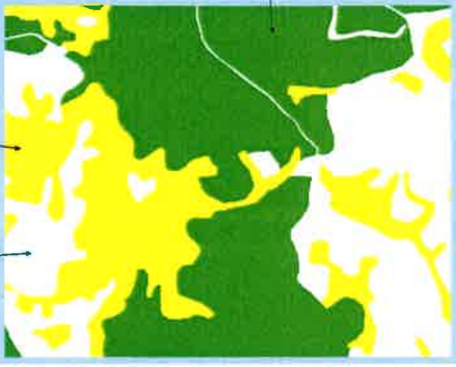
Body of the Map

- Area features

Wooded area

Cultivated area

Open scrub



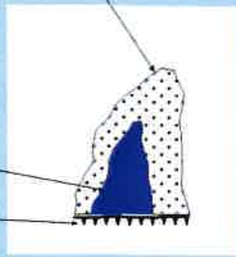
Body of the Map

- Area features

Tank limit

Tank water limit

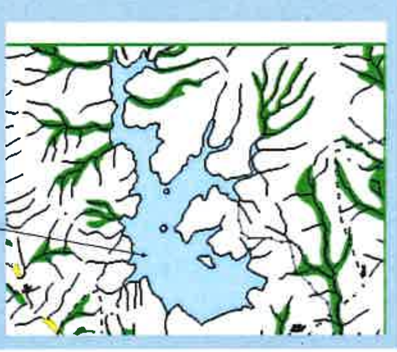
Tank bund



Body of the Map

- Area features

Reservoir



Body of the Map

- Descriptive remarks

The following descriptive remarks are used in topo maps

- BM Bench-mark
- PO Post office
- TO Telegraph office
- PTO Post & Telegraph office
- PS Police station

- DB Bungalows Dak or travelers
- IB Inspection bungalow
- RH Rest house
- CH Circuit house
- CG Camping ground
- RF Reserved forest

FIELD SURVEY

MAP MAKING

PHOTOGRAPHY

REMOTE SENSING

IRS DATA

SPOT IMAGE

SPACE IMAGING

IKONOS

NEW TECHNOLOGY

- MAP MAKING STAGES

DATA ACQUISITION

DATA TRANSFORMATION

MAP PUBLISHING

DATA ACQUISITION

Conventional Plane Tabling

Hand Held Global Positioning System with Palmtops

GPS Obs. at 7500 ft.

Conventional Thedolite

Dual Frequency GPS

Total Station

Conventional N-3 Level

Modern Digital level

DATA ACQUISITION

Conventional Analogue Photogrammetry systems

INSTRUMENTS: A10,A8,B8
INPUT: Pair of Diapositives
OUTPUT:MAP WITH CONTOUR

Digital Photogrammetry

INSTRUMENTS: PC & Software
INPUT:Scan Data of Dpositives/Soft Data from DigitalCamera
OUTPUT:Soft Copy

DATA TRANSFORMATION

Conventional Fair Mapping / Scribing

Digital Cartography

MAP PUBLISHING

Digital Map Publishing System

Thank you

ABSTRACT OF THE TRAINING

The online training on " GPS & Total Station" was organized at NIGST, Survey of India, Hyderabad from 09th-11th August 2021. The aim of the training was to familiarize the officers from various Implementing Agencies under NHP about the technical aspects and use of height, map projection, Global Positioning System, Geographical Information System and Total Station. It includes the general introduction about horizontal and vertical control, ellipsoidal, map reading assigning different projections, GIS concepts & applications, use of GPS and total stations and introduction to modern survey techniques.

ONLINE LECTURE ORGANIZED

SNO	TOPIC	LECTURE BY	DATE
1	Introduction to GPS & Total Station	Sh. K.V. Ramana Murty SS, NIGST, Hyderabad	09.08.2021
2	GPS Data Processing	Sh. K.V. Ramana Murty SS, NIGST, Hyderabad	09.08.2021
3	Introduction to Datum, Projection System & Map Reading Concepts	Sh. K.V. Ramana Murty SS, NIGST, Hyderabad	10.08.2021
4	Map Reading Assigning Different Projections	Sh. K Gopal, Svy Asstt Smt. Fahmeeda Ehsan, D/Man	10.08.2021
5	GPS Observations (Demo)	Sh. Sumit Bhadra, Syr. Sh. Raj Kumar Gupta, Syr.	10.08.2021
6	Advances in GNSS Technology – CORS	Sh. G. Varuna Kumar Dy. Surveyor General	10.08.2021
7	Introduction to GIS Concepts & Applications	Sh. Maheswar Singh OS	11.08.2021
8	Introduction to ArcGIS Interfaces & Applications (Demo)	Sh. K Gopal, Svy Asstt Smt. Fahmeeda Ehsan, D/Man	11.08.2021
9	Total Station Survey, Concepts, Working Principles, Sources of Error	Sh. P. Nityanandam, OS	11.08.2021