Photogrammetry

is a Science | among the earliest techniques of Remote Sensing.

The word is a combination of three distinct Greek words.

Photo - light

Gram - drawing

metry - measurement

Photogrammetry means ⇒ it is the technological ability of determining the measurement of any object by means of photography.

⇒ It can be defined as the Science & Technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring and interpreting photographic images and patterns.

⇒ It is a 3-dimensional co-ordinate measuring technique that uses photographs as the fundamental medium for metrology (measurement).

⇒ The out of photogrammetry is typically a map, drawing, measurement or a 3D model of some realworld object/scene.

Branches of Photogrammetry

- **Metric**
  - ⇒ Deals with precise measurements & computations on photographs eg. size, shape & position of photographic features.
  - Photos are taken using metric camera & is mostly used in engineering fields like surveying.
- **Interpretive**
  - ⇒ It involves recognizing objects from photographic images.
  - ⇒ Uses images created from satellite images/photographs.
  - ⇒ forms basis for remote sensing.

Metric

=) To determine distances, elevations, areas, volumes etc. to compile topographical maps from photographic measurements.

=) Mostly uses aerial photos, sometimes terrestrial photos.

Purpose of photogrammetry

=) Measuring values

=) Extracting geometrical information and producing maps.

=) Extracting qualitative information

=) Cheaper than terrestrial methods

=) High speed of map generation.

=) Ideal technology when measuring objects such as

  => Vast regions to be mapped

  => Irregular shapes

  => Objects that are too

    - Hot or cold
    - Soft
    - Delicate
    - Inaccessible
    - Toxic
    - Radioactive to touch

History of Photogrammetry

Invented in 1850 by 'Colonel Aime Laussedat'

=> The development of photogrammetry has passed through diff. phases =>

Plane Table	(Photography => 1850)
Analog	(1900, Aeroplane)
Analytical	(1950, computer)
Digital	(2000, CCD camera)

↳ Charge coupled digital

1850 (19th centiw) => People did perspective drawings & terrestrial photo.

=> At the end of 19th century, used balloons to take photos from air & produce airphoto maps.

~~Plane table~~

Perspective drawings

⇓

Balloon photography

⇓

Plane table

⇓

Analog

⇓

Analytical

⇓

Digital.

SEVERITY (S)	EXAMPLE	RATING
Catastrophic	Numerous fatalities, irrecoverable property damage and productivity	5
Fatal	Approximately one single fatality major property damage if hazard is realized	4
Serious	Non-fatal injury, permanent disability	3
Minor	Disabling but not permanent injury	2
Negligible	Minor abrasions, bruises, cuts, first aid type injury	1

Table B

TABLE 5

2.1.1 RISK ASSESMENT:

Risk can be presented in variety of ways to communicate the results of analysis to make decision on risk control. For risk analysis that uses likelihood and severity in qualitative method, presenting result in a risk matrix is a very effective way of communicating the distribution of the risk throughout a plant and area in a workplace.

Risk can be calculated using the following formula:

L x S = Relative Risk

L = Likelihood

S = Severity

An example of risk matrix (Table C) is shown below:

	Severity (S)				
Likelihood (L)	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Table C

High

Medium

Low

TABLE 6

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Aerial Photography

It is defined as the Science of taking photograph from a point in the air for the purpose of making some type of study on earth surface.

⇒ It is one of the most common and economical forms of remote sensing

⇒ It was the first method of Remote sensing and still used today.

Many diff. types of aerial cameras are available:

⇒ Aerial mapping camera (single lens)

⇒ Reconnaissance camera

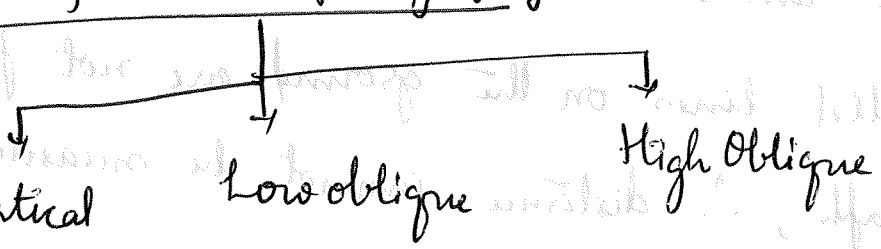
⇒ Strip camera

⇒ ~~Panchromatic~~ camera Panoramic

⇒ Multilens camera

⇒ Digital Camera

Types of aerial photography



① Vertical aerial photography :

This photograph is taken with the camera as straight down as possible.

⇒ The lens axis perpendicular to the surface of the earth.

⇒ It covers a relatively a small area

⇒ The shape of the ground area covered would be almost a square / rectangle.

⇒ ~~The objects have~~ It gives an unfamiliar view of the ground.

② Low oblique :-

⇒ This is a photograph taken with the camera inclined about 30° from the vertical.

⇒ It is used to study an area before an attack, to substitute ~~before~~ for a reconnaissance, to substitute for a map, or to supplement a map.

⇒ It covers a relatively a small area.

⇒ Photo is square / rectangle but the ground area covered is a trapezoid

⇒ The objects have a familiar view.

⇒ No scale is applicable to the entire photograph and distance cannot be measured.

⇒ Parallel lines on the ground are not parallel on this photograph, ∴ distance cannot be measured.

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③ High Oblique :

⇒ This is a photograph taken with the camera inclined about 60° from the vertical.

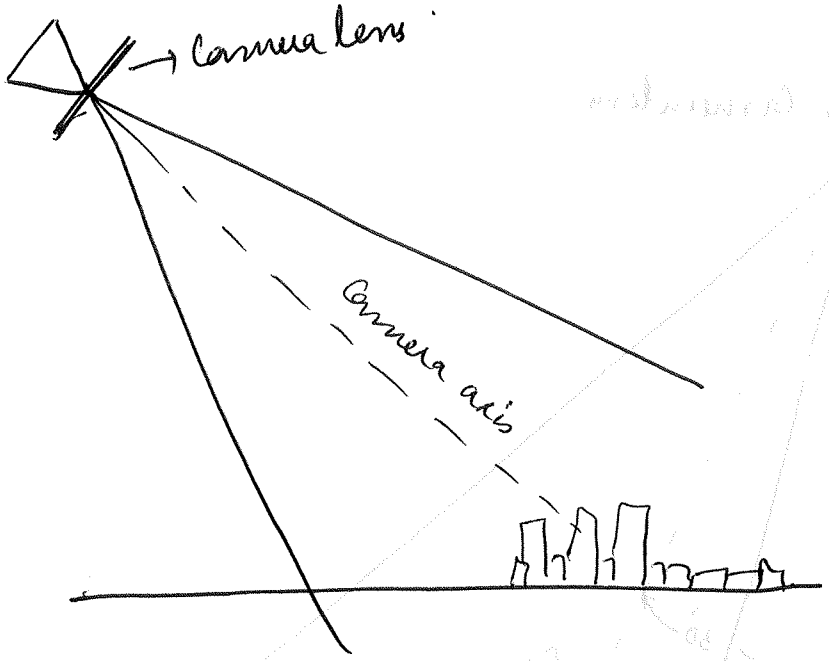
⇒ It is used primarily in the making of aeronautical charts.

⇒ It covers a very large area (not all usable).

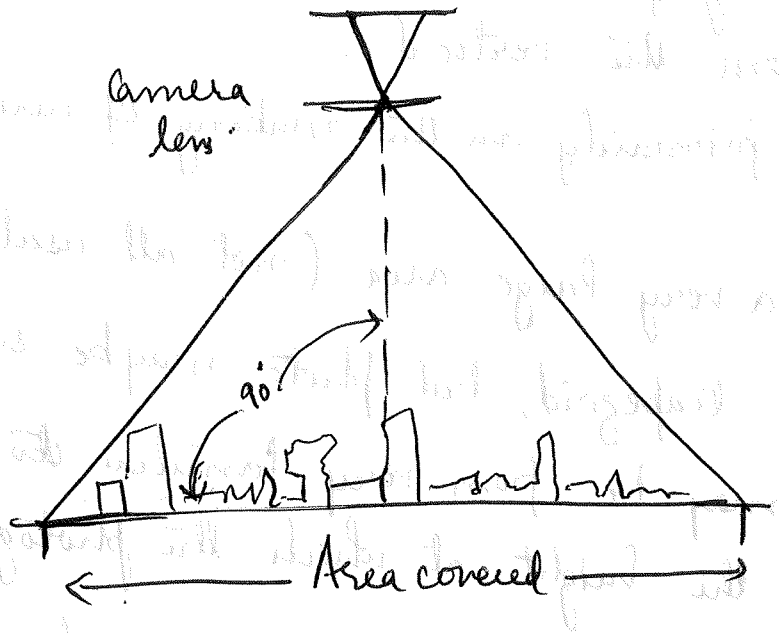
⇒ Ground area trapezoid, but photo may be square/rectangle

⇒ The view may be from very familiar to unfamiliar depending on the height at which the photograph is taken

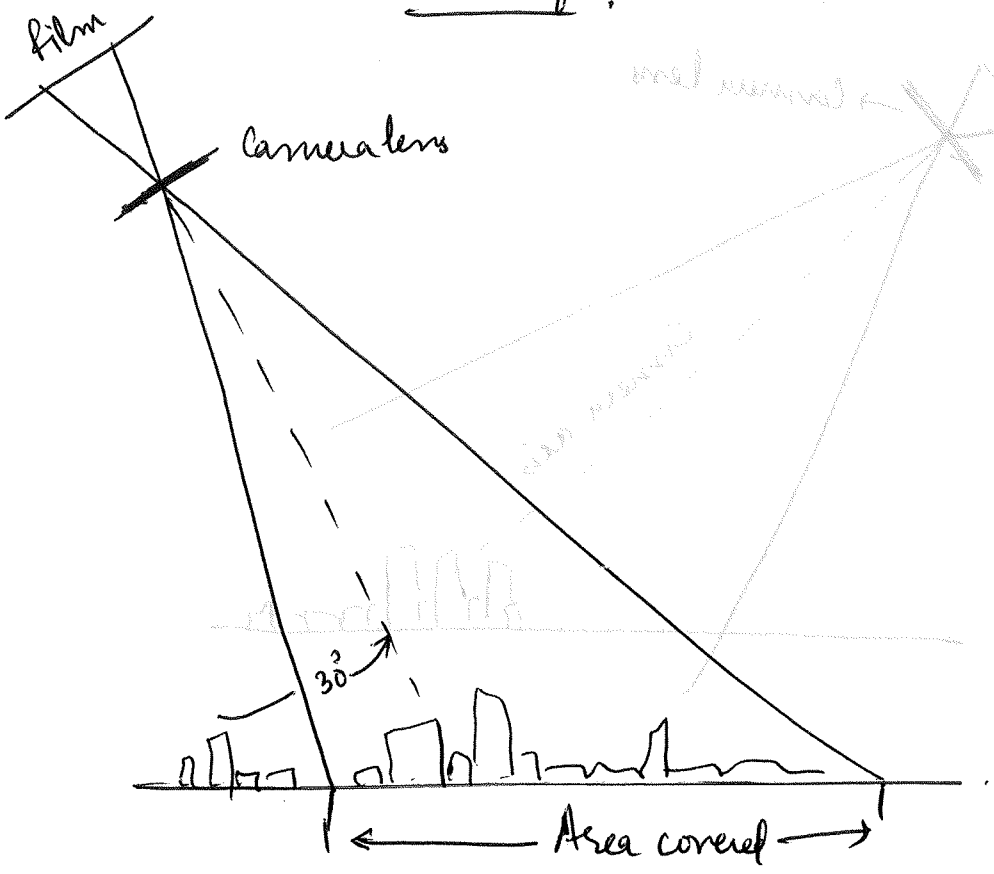
⇒ Distances / directions are not measured.



Vertical

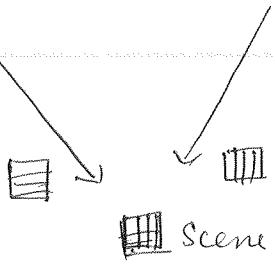


Low oblique



Stereoscopy

Also called as solid vision.

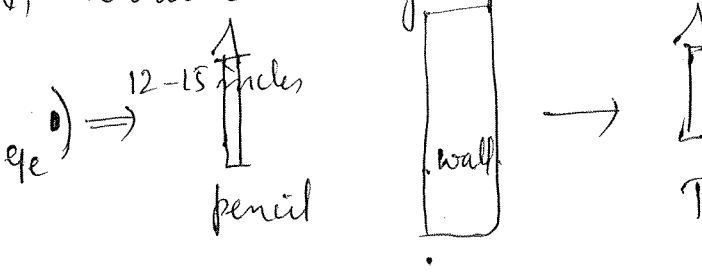


Observing two photos of the same scene simultaneously captured from two locations, image of the seen will appear in 3-dimensions. This is called stereoscopic viewing. ⇒ Three dimensions

& ⇒ Normal two-eyed vision is required for measuring depth by stereoscopy.

⇒ Two important phenomenon are involved in stereoscopic vision.

i) Double image phenomenon.



when a pencil is put 12-15 inches infront of your eyes and your gaze is fixed on a spot on the wall, there will be two images of pencil.

⇒ When the gaze is concentrated on the pencil, then two images of the spot on wall will be formed. The right image is formed by the left eye and the left image is formed by the right eye.

⇒ While the eyes are gazing at the wall, pencil is moved towards and away from the eye, the double images disappear.

⇒ It is a technique for enhancing the illusion of depth in an image by stereoscopes for binocular vision.

2 D images are combined in the brain to give the perception of 3D depth.

(or)

Stereoscopy creates the illusion of three dimensional depth from given two dimensional images.

⇒ Any stereoscopic image is called a stereogram.

⇒ Stereoscopy is used in photogrammetry

⇒ Stereopair photographs provided a way for 3-dimen. visualisations of aerial photographs.

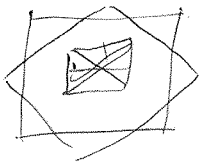
⇒ 3D aerial views are mainly based on digital stereo imaging techno.

Stereoscopic imaging is a technique used to enable a 3-D effect adding an illusion of depth to a flat image.

Mosaic

Mosaic is a combination of two or more images.

Maps.	Mosaic
1. It is a single photograph	⇒ Two or more photographs combined is known as mosaic.
2. In maps symbols of objects are used.	⇒ In mosaics objects are easily recognized and the true picture of objects helps in mosaics.
3. Time taking process for prepn of maps	⇒ Cost & time saves in mosaics preparing
4. Expert is required	⇒ This can be used by a non technical person.

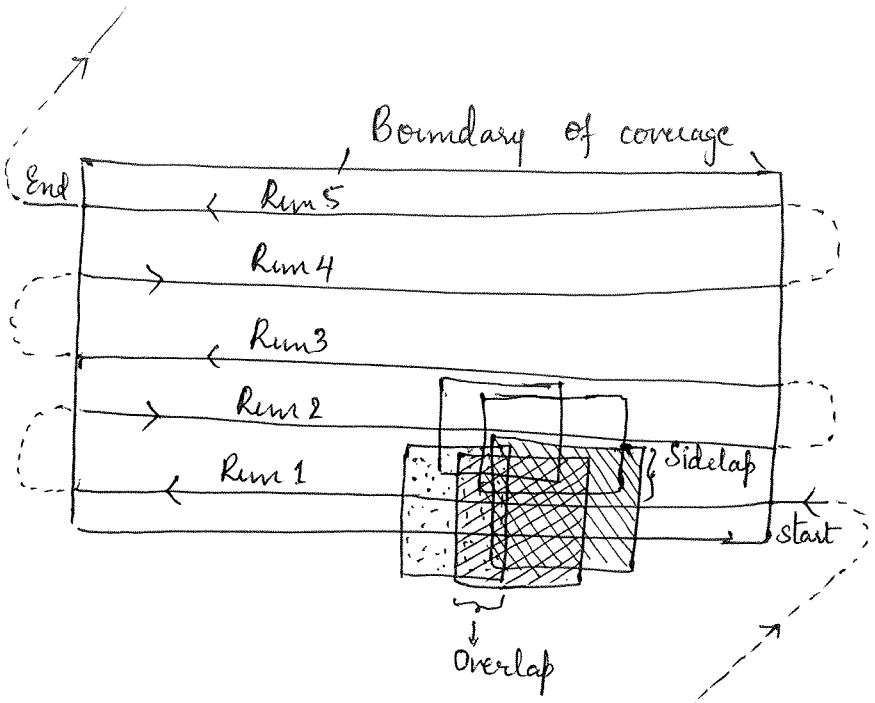


Drift : When aircraft is swayed away from its preplanned flight line, then it is known as drift.

Ground control :- To determine the exact position of aerial camera for the identification of objects on ground.

Crab :- Opposite line of photographs are not parallel to flight line is known as crab of photograph.

Ground coverage by aerial photography



Drift : Two successive flight lines should be parallel in ideal case

⇒ At high altitudes because of strong wind currents called sidewind influence the aeroplane in maintaining predetermined direction and straightness of run.

⇒ This deviation from the original intended flight path is called as drift.

Crab : During sidewinds if pilot tries to maintain original path, he has to turn the nose of the aeroplane slightly against the wind, which will make the aeroplane to rotate on its vertical axis.

⇒ In this case, original path is maintained but the area covered by photograph is much different than that planned in the original.

⇒ The aerial photograph is rotated in the direction opposite to wind direction here. This defect is called as crab.

The above two defects causes red^{n} in the coverage of terrain.

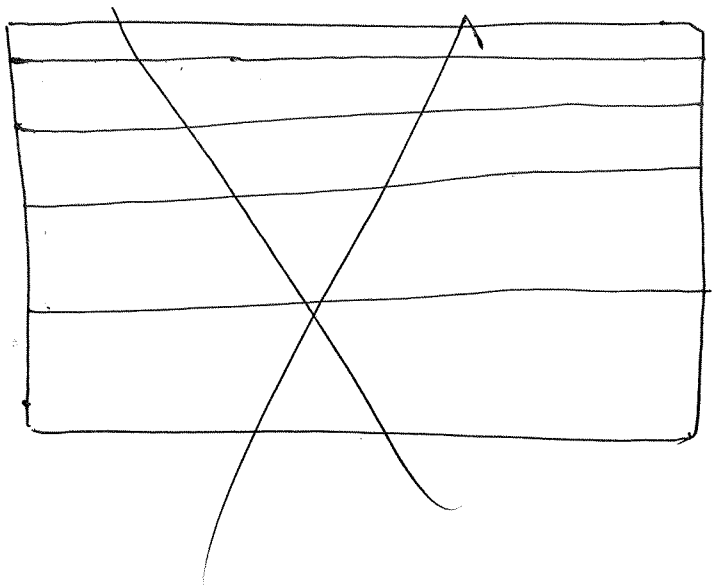
⇒ Photographs are taken in runs in the direction of flight- in such a way there will be minimum 60% overlap between adj. photos and 30% sidelap between adjacent runs.

⇒ The quality of photograph depends on

i. flight and weather conditions
ii. Camera lens
iii. film & filters
iv. Developing & printing process.

⇒ As far as possible, photograph should be vertical and free from elements of tilt.

⇒ free from defects like drift & crab.



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Principle of Stereoscope :

Two separate photos viewed in stereoscope, the image of left photograph viewed by left eye and the image of right photograph viewed by right eye is fused together in brain to provide 3-D view. This is called stereoscopic fusion.

Parallax :

In normal binocular vision, the movement of a point viewed first with one eye and then with the other is known as Parallax.

⇒ It is the displacement of two images in successive photographs.

Parallax means for height determination.

$$\text{Height of object} = \frac{H \cdot dp}{p + dp}$$

H → height of aircraft above the ground

dp = differential parallax.

p → Abso. parallax at the base of object being measured

The advantage of stereoscopy is the ability to extract 3-D information.

Eg. Classification between tall trees & low trees, terrestrial features such as height of terraces, slope gradient, detailed geomorphology in flood plains etc.

IV - B. Tech class mail
civilb mrec@gmail.com

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Basic Concepts of Remote Sensing

Remote Sensing is an art and Science of obtaining infor° about an object or feature without physically coming in contact with that object or feature.

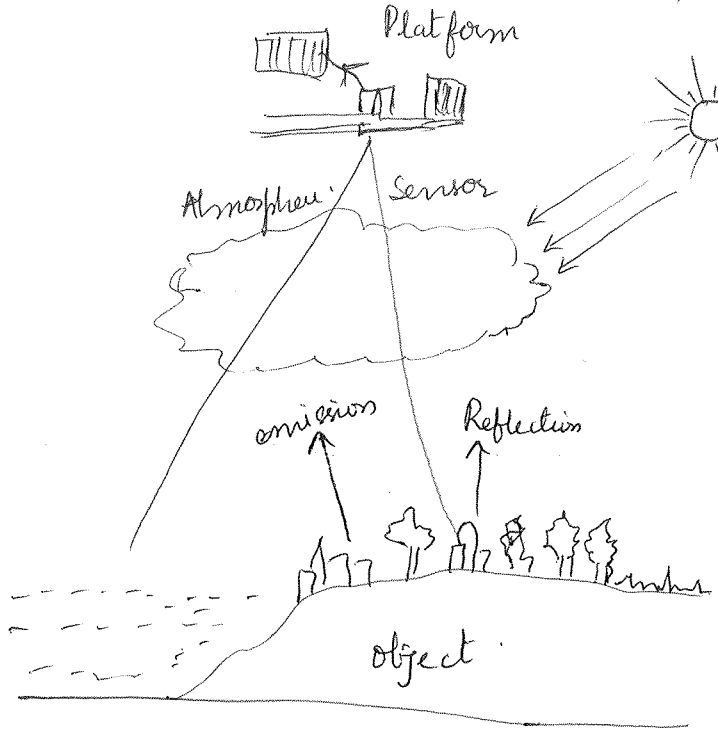
⇒ The data collected can be of many forms: variations in acoustic wave distributions (eg: sonar), variations in force distri^{n} (eg. gravity meter), variations in electromagnetic energy distri^{n} (eg. eye) etc.

⇒ These remotely collected data through various sensors may be analyzed to obtain inform^{n} about the objects or features under investig^{n}.

Remote Sensing through electromagnetic energy sensors

⇒ The electromagnetic radiation can either be reflected/emitted from the Earth's surface.

⇒ RS is detecting & measuring EM energy emanating/reflected from distant objects made of various materials, basing on which classification (type of substance) can be done.



Schematic represent^{n} of RS technique.

⇒ RS provides a means of observing large areas at finer spatial & temporal frequencies.

⇒ Extensive applications in CE including watershed studies, hydrological states & fluxes situation, hydro. modeling, DM services such as flood & drought warning & monitoring, damage assessment, urban planning, env. monitoring e

Electromagnetic energy : It is the energy propagated in the form of an advancing interaction between electric & magnetic fields.

⇒ It travels with the velocity of light.

⇒ Visible light, UV rays, Infrared rays, Δ, radiowaves, X-rays are all diff. forms of EM energy [E]

↓

Can be expressed as $E = hcf$ or hc/λ

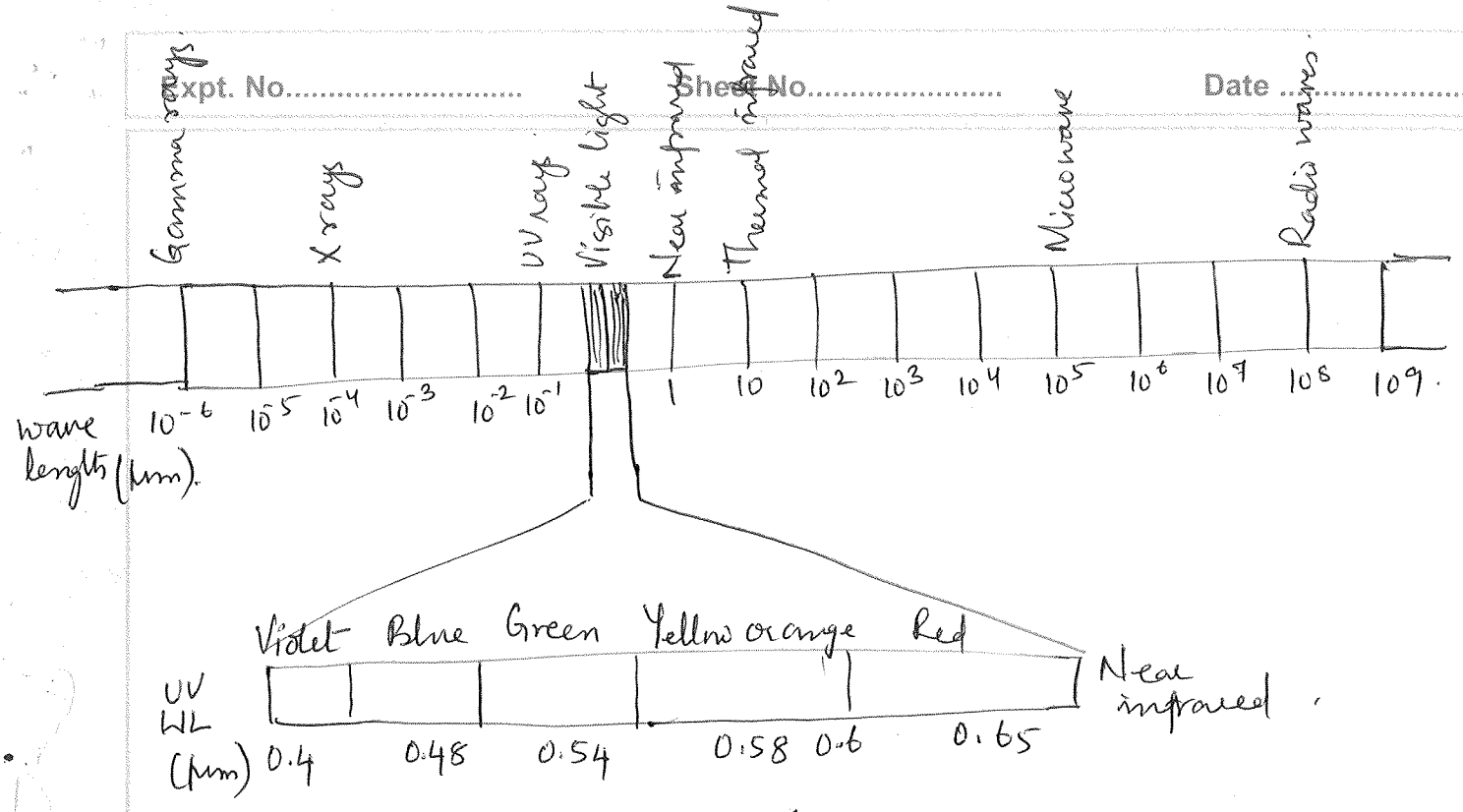
h = Planck's const (6.626×10^{-34} Joules-sec]

c = is a const that expresses the speed of light (3×10^{8} m/s)

f = frequency expressed as in Hertz &

λ = wavelength expressed in micrometers ($1\mu m = 10^{-6} m$)

⇒ Shorter wavelengths have higher energy content and longer lower energy content



EM radⁿ spectrum

⇒ In RS terminology, EM energy is generally expressed in terms of wavelength λ

⇒ Different objects reflect or emit diff. amnts. of energy in diff. bands of the EM spectrum.

⇒ Detection & discrimination of objects or surface features is done through the uniqueness of the reflected or emitted EM radⁿ from the object.

⇒ A device to detect this reflected or emitted EM radⁿ from an object is called a 'sensor'. (eg. Cameras | scanners.

⇐ A vehicle used to carry the sensor is called a platform (eg. aircrafts & satellites

Components / elements of Remote Sensing :

i) Uniform energy source

ii) A Non-interfering atmosphere

iii) Energy interactions with the atmosphere.

iv) Super sensor ⇒ which is highly sensitive to all wave-lengths. ↳ simple, reliable, accurate, economical

v) Real time ~~tissue~~ data handling system.

vi) Analysis of data ⇒ Multiple data Users.

↓↓

knowledge in their respective disciplines.

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Energy Sources & Interactions

⇒ The first requirement for remote sensing is to have an energy source to illuminate the target.

⇒ Sun ⇒ Natural source of energy
⇓
in the form of electromagnetic radiation (EMR)

Depending on the predominant source of energy, RS can be classified as :

i) Passive RS
ii) Active RS

Passive RS :- Depends on a natural source for energy.
↳ Sun is the commonly used source of energy.

⇒ The satellite sensor records it'ly the rad^{n} that is reflected from the target.

⇒ RS in the visible part of the electromagnetic spectrum is an eg. of passive (reflected) RS.

⇒ A portion of sun's rad^{n} is not reflected back to the sensor but is absorbed by the target raising the temp: of target. This absorbed rad^{n} is later emitted by the material at a diff. wavelength.

⇒ Passive RS can also be carried in the absence of Sun

⇒ RS in the thermal infrared portion of EM spectrum is an example of passive (emitted) RS.

Active RS

⇒ This uses artificial source of energy, satellite itself can send a pulse of energy which can interact with the target.

⇒ In this, we can control the source of the energy [like wavelength, power, duration etc.].

⇒ RS in the microwave region of EM spectrum (Radar RS) is an example of active RS.

⇒ Active RS can be carried during day/night and in all weather conditions.

Based on wavelength regions, RS can be classified as:

i) Visible & reflective infrared RS.

ii) Thermal infrared or emitted RS

iii) Microwave RS.

Energy interactions in the atmosphere.

⇒ In RS, all radiations have to through the atmosphere to reach the sensor.

⇒ As the radiation passes through the atmos, the gases and the particles in the atmosphere interact with them causing changes in the magnitude, wavelength, velocity and direction.

Composition of atmosphere:

In addn to these, water vapour, methane, dust particles, pollen from vegn, smoke etc.

Compo.	%
N_2	78.08
O_2	20.9
Argon	0.93
CO_2	0.03
O_3	0.00000004

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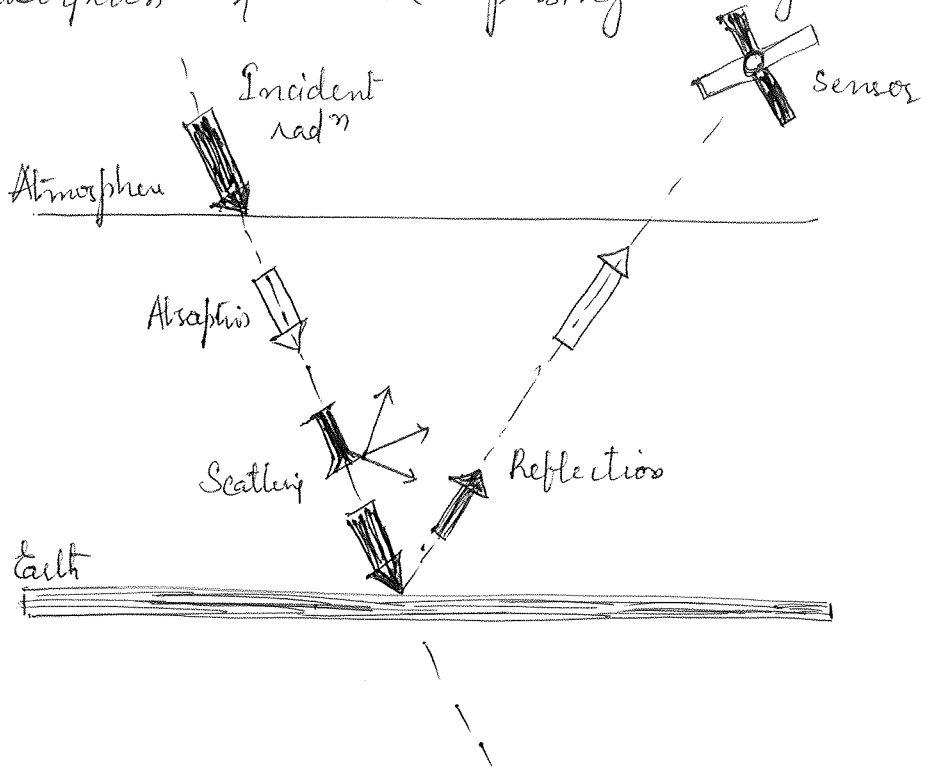
⇒ Gases and the particles present in the atmos. cause scattering and absorption of EMR passing through it.



Interactions in the atmosphere

These effects are caused principally through the mechanism of absorption, atmospheric scattering and reflection.

Absorption :- Radiant energy is absorbed and converted into other forms of energy.

O_3, CO_2 & H_2O vapour are the three main atmosp. constituents that absorb rad^n.

- absorb UV rad^n.
- CO_2 will absorb far infrared
- microwave rad^n

This cumulative effect of the absorption by various constituents can cause the atmosphere to close down completely in certain regions of spectrum which is not desired for RS as no energy is available to be sensed.

Scattering : It is an unpredictable diffusion of EMR by atmospheric particles. This occurs when the particles interact with EMR and cause the EMR to be redirected from its original path.

⇒ Amount of scattering depends on several factors ⇒
- ⇒ wavelength of the rad^n.
- ⇒ Diameter of particles / gases
- ⇒ distance the rad^n travels through the atmosp.

Two types of Scattering

Selective
⇓
Only particular wavelengths will be scattered [like blue green etc.].

Nonselective scattering
⇓
All wavelengths of light are scattered equally.
⇒ Takes place in the lowest portion of the atmosphere where there are particles > than 10 times the λ of the incident EMR.
⇒ Thus water droplets, ice crystals that make up clouds scatter all λs of visible light equally well, causing the cloud to appear white.

Rayleigh Scattering
⇓
also known as molecular scattering.
⇓ This occurs when the air/gas molecules (eg. O_2 & N_2) in the atmos is many times smaller than the λ of the incident EMR.
⇒ Rayleigh scattering occurs in the upper 4.5 km of the atmos where UV rad^n of EMR is present.
⇒ The shorter violet and blue wavelengths are more efficiently scattered than longer green & red λs.

Mie Scattering

⇒ Smaller particles present in the atmos. scatter the shorter λs more compared to longer λs.

⇒ Molecules of N_2 & O_2 cause this type of scattering of the visible light of EMR.

⇒ Within the visible range of EMR, smaller λ blue light is scattered more compared to green or red.

⇒ A blue sky is thus a manifestn of rayleigh scattering

$$I \propto \frac{1}{\lambda^4}$$

↓

Scattering (Rayleigh).

2) Mie scattering :-

⇒ Occurs when the λs of the energy is almost equal to the diameter of the atmos. particles.

⇒ In this type, longer λs also get scattered.

⇒ This type of scattering is caused by aerosol particles, such as dust, smoke etc.

⇒ Gas molecules are too small to cause Mie scattering

3) Reflection

↓

It is a process where by radiations bounces off an object. It exhibits fundamental characters that are important in RS.

Energy interactions with surface features

When EM energy is incident on any given earth surface feature three fundamental energy interactions with the feature are possible.

⇒ Energy incident on the element are reflected, absorbed &/or transmitted.

⇒ The interrelationship between these three energy interactions can be expressed as

$$E_I(\lambda) = E_R(\lambda) + E_A(\lambda) + E_T(\lambda)$$

where

E_I = incident energy

E_R = reflected energy

E_A = absorbed energy

E_T = transmitted energy.

⇒ The proportions of energy reflected, absorbed and transmitted will vary for diff. earth features, depending on their material type and condition.

⇒ These differences permit us to distinguish diff. features on an image.

⇒ Not only this each earth feature can also be distinguished based on their wavelength band.

⇒ In RS, the radiation reflected from targets can be of two types

Specular reflection & Diffuse reflection.

⇒ for a smooth surface, mirror like or specular reflection occurs where all of the energy is directed away from the surface in a single direction.

⇒ Diffuse reflection occurs when the surface is rough and the energy is reflected almost uniformly in all the directions.

⇒ Diffuse reflections contain spectral information on the color of the reflecting surface where as specular reflections do not.

⇒ Hence in R.S., more often diffuse reflectance properties of terrain features are measured.

⇒ This is measured as a function of wavelength and is called spectral reflectance, $\rho(\lambda)$.

⇒ The spectral reflectance of a material to diff. wavelengths of EMR can be represented graphically as a spectral reflectance curve.

There are three ways in which the total incident energy will interact with earth's surface materials. They are

Absorption(A):- When the rad^n is absorbed into the target

Transmission (T): when rad^n passes through a target

Reflection(R): occurs when rad^n bounces off the target and is redirected.

Depends on (how much energy is A/T/R) etc

① λ of the energy

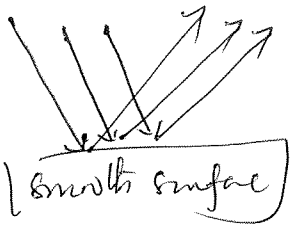
② Material

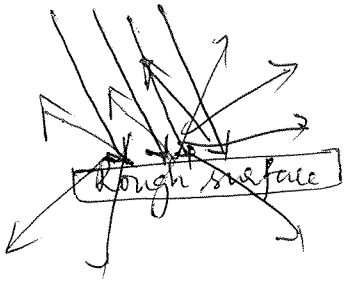
③ Condition.

In RS, more interested in measuring the rad^n that is reflected from targets.

Specular reflection:- When the surface is smooth, we get mirror like or smooth reflection where all the EI (incident energy) is reflected in one direction. This gives rise to images.

Diffuse reflection:- When the surface is rough, the energy is reflected uniformly in almost all directions. This will not give rise to images.





Eg. water:

longer wavelengths and near IR rad^n is absorbed more by water than shorter wave lengths. Thus water looks blue due to stronger reflectance in shorter wavelengths.

Chlorophyll in algae absorbs more of the blue wavelengths and reflects the green making the water appear more green.

Sensors

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A sensor is a device that detects and responds to some type of input from the physical environment.

1) Active sensors : It emits radiation in the direction of the target to be investigated. The sensor then detects and measures the radiation that is reflected or backscattered from the target. The majority of active sensors operate in the microwave portion of EM spectrum, which makes them able to penetrate the atmosphere under most conditions.

Laser altimeter :- measures the height of the platform (aircraft/spacecraft) above the surface. The height of the platform with respect to the mean Earth's surface is used to determine the topography of the underlying surface.

Lidar : Light detection and ranging sensor that uses laser (light amplification by stimulated emission of radiation) It is a surveying method that measures distance to a target. to transmit light, and a receiver with sensitive detector to measure the backscattered/reflected light.

Radar :- Radio detection and ranging sensor that provides its own source of electromagnetic energy. Uses radiowaves to determine the range, angle or velocity of objects.

Ranging instrument : It's a device that measures the distance between the instrument and a target object.

Scatterometer : It is a high frequency microwave radar designed specifically to measure backscattered rad^n. Derive maps of surface wind speed and direction.

Sounder : It is an instrument that measures vertical distribution of precipitation and other atmos. chara. like temp., humidity & cloud composition :-

Passive Sensors : Detect natural energy (radⁿ) that is emitted / reflected by the object / scene : Reflected sunlight is the most common source of radⁿ measured by passive sensors. They operated in the visible, IR, Thermal IR ~~and~~ portions EM spectrum

Accelerometer :- measures acceleration (change in velocity / time)

Hyperspectral radiometer : Advanced multispectral sensors that detects hundreds of very narrow spectral bands through out the Vis IR portions of EMR.

Imaging radiometer : It has a scanning capability to provide a two-dimensional array of pixels from which an image may be produced.

Radiometer : Quantitatively measures the intensity of EMR in some bands within the spectrum

Sounder :- Instrument that measures vertical distⁿ of atmos. parameters

Spectrometer :- device designed to detect, measure, and analyze the spectral content of incident EM radⁿ.

Spectroradiometer :- This measures the intensity of radⁿ in multiple bs.

Satellites.

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Satellites: A satellite is a planet or machine that orbits a planet or star.

For eg. Earth is a satellite becoz its orbits the sun, moon is a satellite because it orbits earth.

⇒ Satellite refers to a machine that is launched into space and moves around Earth or another body in space.

⇒ Earth & moon are natural satellites.

⇒ Thousands of man-made satellites orbit earth.

⇒ Some take pictures that help meteorologists predict weather and track hurricanes.

⇒ Some take pictures of other planets, the sun, black hole dark matter or other galaxies. This helps in better understanding of the solar system and universe.

⇒ Some satellites are used for communications such as TV signals and phone calls around the world.

⇒ Some satellites make up the GPS system, if u have a GPS receiver these satellites can help figure out your exact location.

Significance of satellites:-

⇒ Satellites have birds-eye view that allows them to see large areas of earth at one time.

⇒ Satellites can collect more data, more quickly than instruments on the ground.

⇒ Satellites can see into space better than telescope at earth's surface since they fly above the clouds, dust and molecules in the atmos. that can block the view from ground level.

⇒ Satellites come in many shapes and sizes. They have two parts in common - an antenna and a power source.

⇒ The antenna sends and receives inform^n, while the power source can be a solar panel or battery.

⇒ Solar panels make power by converting sunlight into electricity

⇒ Most satellites are launched into space on rockets.

⇒ Two most common satellites are :- i) Geostationary satellite
ii) Polar satellite.

Geostationary satellite :- Travels from west to east over the equator. It moves in the same direction and at the same rate earth is spinning.

Polar orbiting satellite :- Travels ~~from~~ in a north-south direction from pole to pole. As earth spins underneath, these satellites can scan the entire globe, one strip at a time.

'Sputnik' 1 was the first satellite in space. The Soviet Union launched in 1957.

Explorer 1 was America's first man-made satellite.

⇒ A satellite follows an elliptical orbit around the earth.

⇒ The time taken to complete one revol^n of the orbit is called the orbital period.

⇒ The satellite traces out a path on the earth surface, called its ground track, as it moves across the sky.

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Resolution: It is the mini. distance between two objects that can be distinguished in the image.

=) In RS, resolution represents resolving power which includes not only the capabability of identifying the presence of two objects, but also their properties.

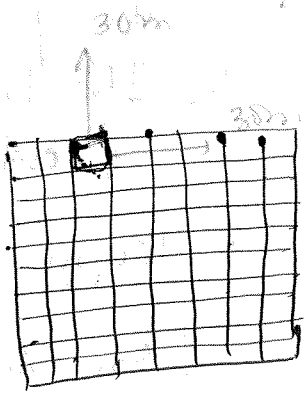
=) In other words, resolution is the amount of details that can be observed on an image.

=) Four types of resolutions: Pixel

i. Spatial => Usually reported as length of one side of a single pixel.
ii. Spectral
iii. Temporal
iv. Radiometric

Eg: Landsat 8 has 30 m spatial resol?

Spatial resolution:



=) A digital image consists of an array of pixels.

=) Each pixel contains information about a small area on the land surface, which is considered as a single object.

=) Spatial resolution is a measure of the area or size of the smallest dimension on the earth's surface over which an independent measurement can be made by the sensor.

=) It is expressed by the size of the pixel on the ground in metres.

⇒ This area on the ground is called ground resolution (or) ground resolution cell. It is also referred or spatial resolution of the remote sensing system.

Based on spatial resolution, satellite systems can be classified as:

Low resolution systems

Medium " "

High " "

Very high " "

i) Remote Sensing systems with spatial resol^{n} of more than 1Km are generally considered as low resol^{n} systems.
e.g. MODIS & AVHRR are low resol^{n} sensors used in Satellite R.S.

ii) When the spatial resol^{n} is 100m - 1km, Moderate resol^{n} system.
e.g. IRS Wifs, band 6 ie, thermal infrared band of the Landsat TM. (resol^{n} of 250m - 500m)

iii) 5 - 100m e.g. Lansat ETM, IRS LISS III, SPOT 5

iv) < 5m spatial resol^{n} e.g. GeoEye, IKONOS, Quickbird (2.4 - 2.8 m)

Spectral resolution

⇓

Represents the spectral band width of the filter and the sensitiveness of the detector.

⇒ It may be defined as the ability of a sensor to define fine wavelength intervals (or)
the ability of a sensor to resolve the energy received in a spectral bandwidth to characterize diff. constituents of earth surface.

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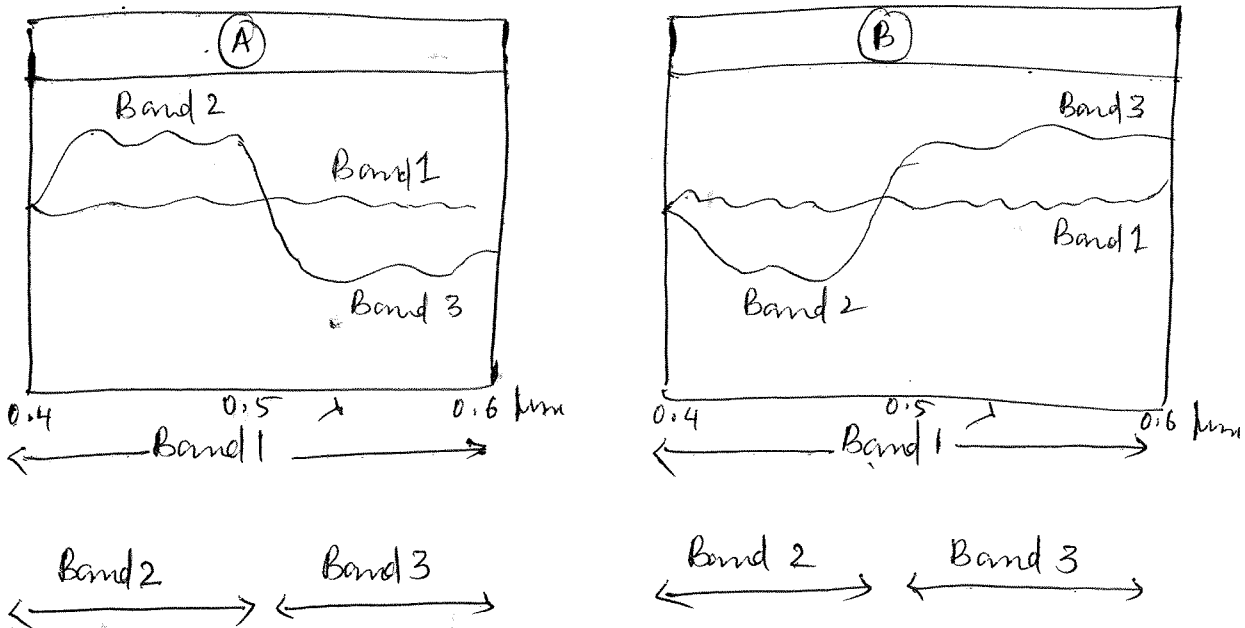
⇒ The finer the special resolution, the narrower the wavelength range for a particular channel or band.

⇒ In RS, diff. features are identified from the image by comparing their responses over different distinct special bands.

⇒ Broad classf^{n} classes such as Veg^{n} & water can be easily separated using broad wavelength ranges like visible and near infrared.

⇒ For more specific classes like veg^{n} type, rock classf^{n} etc much finer wavelength ranges and hence finer spatial resol^{n} are required.

Two diff. surface (A) & (B).



(5) Radiometric resol^{n} of a sensor is a measure of how many grey ~~colors~~ levels are measured between pure black (no reflectance) to pure white

=) Radiometric resol^{n} represents the sensitivity of the sensor to the ~~magnetic~~ magnitude of EM energy.

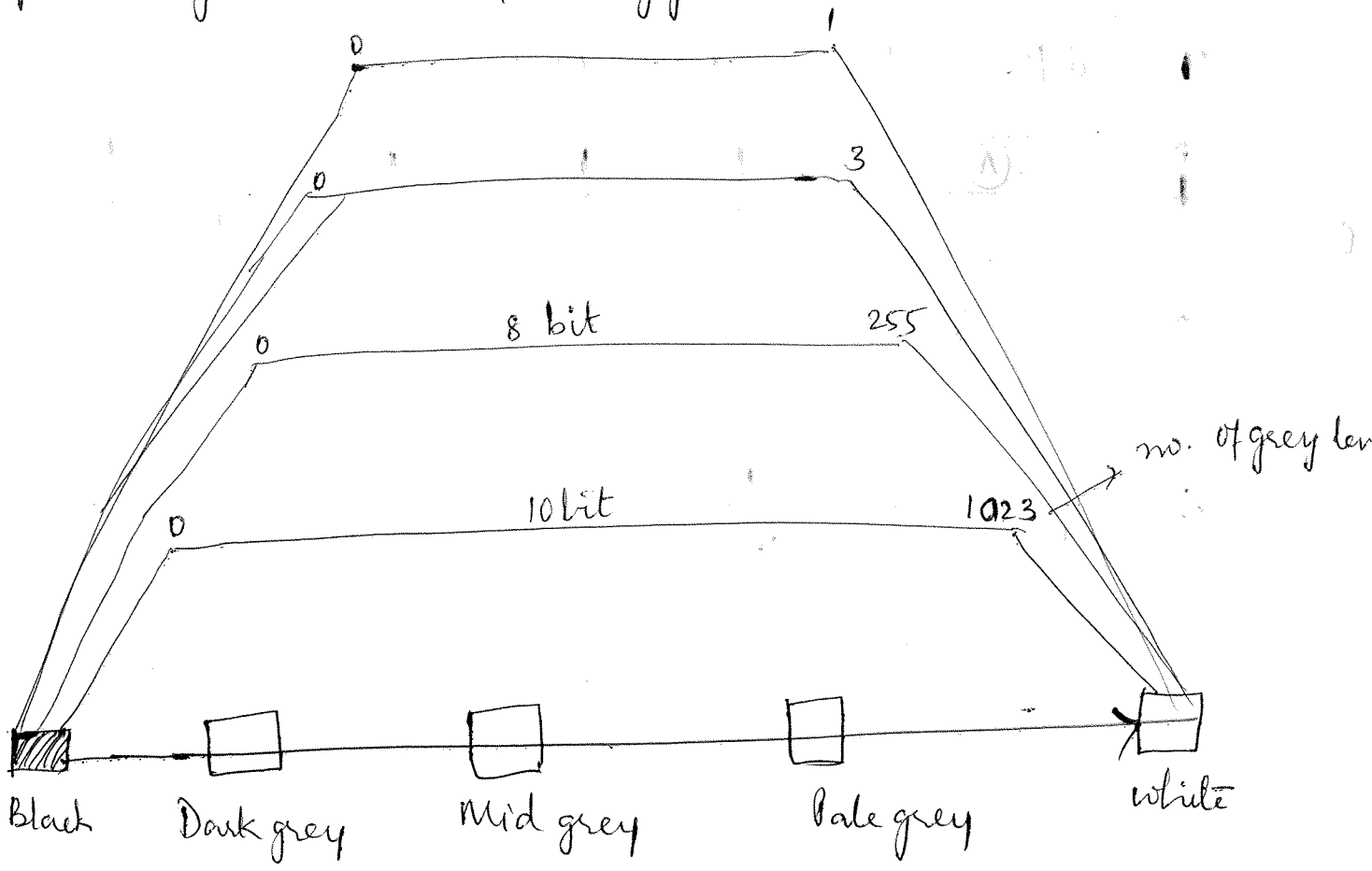
=) The finer the radiometric resolution of a sensor, the more sensitive it is in detecting small differences in reflected ~~or~~ emitted energy.

(or)

in other words, the system can measure more no. of grey ~~colors~~ levels.

=) Radi. resol^{n} is measured in bits.

=) The brightness levels depends on the no. of bits used in representing the recorded energy.



Temporal resol^n : Describes the no. of times an object is sampled or how often data are obtained for the same object.

or

imaging the same area at the same viewing angle a second time is equal to the repeat cycle of a saleltite.

Repeat cycles are diff. for diff. objects :

for polar orbiting satellite eg. IRS-1C and Resourcesat-2 -et is 24 days, for Landsat => 18 days.

Temporal resol^n of a sensor depends on a variety of factors

i) Satellite / sensor capabilities

ii) Swath overlap iii) Latitude

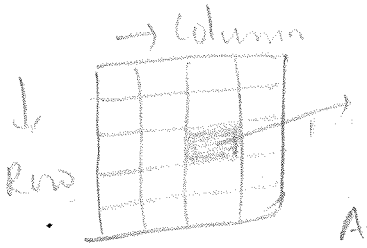
=> Images of the same area of the earth's surface at diff. periods of time show the variation in spectral chara. of diff. features or areas over time.

=> Such multitemporal data is essential for following studies.

i. Landuse / Land cover classf^n

ii. Monitoring a dynamic event like Cyclone, Flood, Volcanoes

A digital image comprises of a 2-D array of individual picture elements called pixels arranged in columns and rows



represents an area on the earth's surface.

A pixel has an intensity value and a location address in the 2-D image.

Visual interpretation techniques:

=) Act of examining images to identify objects and judge their significance.

=) It is a process of extracting information from the images.

=) Image is a pictorial representation of an object / scene.

=) Image can be analog / digital. => satellite images are digital.

↓

Aerial photographs are analog.

=) A digital image is made up of square / rectang. areas called pixels.

=) Methods of image interpretation

- Visual
  - =) On a hard copy / photograph.
  - =) On a digital image.
- Digital image processing

=) Types of interpretation
- Qualitative
- Quantitative.

Eight elements of image interpretn

1. Shape (depends on the object outline)
2. Size (relative to one another)
3. Tone (brightness)
4. Site (location helps recognition)
5. Texture (smooth / coarse).
6. Shadow (helps to determine height).
7. Association (features that are normally found near object)
8. Pattern.

Factors governing interpretability

- Training / experience
- Nature of object
- Quality of photographs
- Equipment and method of interpretn
- Interpretn guides, Keys & manuals
- Prior knowledge of the area

Interpretation of terrain features on a map.

Terrain :- is a stretch of land with many physica features.

⇒ It is imp. to identify terrain features on a map to navigate with, using the best and least resistant route possible.

Eg. Closer the contour lines on a map indicates steep (slope) terrain on the ground which helps to avoid travelling in a direction that would require a lot of effort to move across.

Different types of terrain features :

Major terrain
- Ridge line
- Hill
- Saddle
- Valley
- Ridge
- Depression

Minor terrain
- Draw
- Spur
- Cliff

Cut
Fill

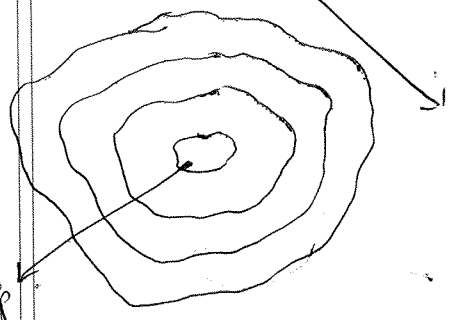
Terrain features are interpreted using contour lines, ridgelining or streaming.

Contours is defined as an imaginary line of constant elevation on the ground surface

- Ridge line : All terrain features are derived from a complex landmass known as a mountain or ridge line.
  - It is a line of high ground usually with changes in elevation along its top.

- ~~Major terrain~~

i) Hill : is an area of high ground. from hilltop, the ground slopes in all directions. Denoted on map by forming concentric circles.

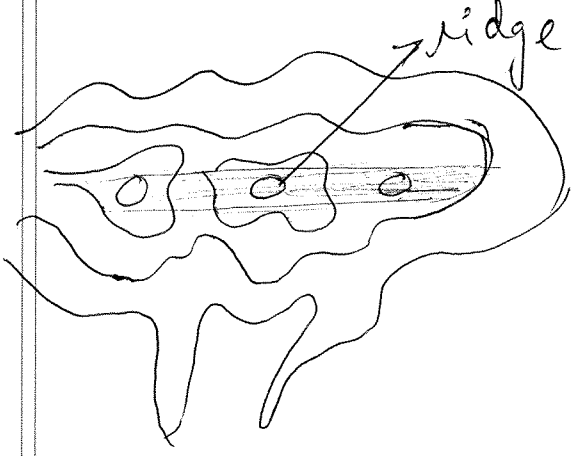


ii) Saddle : It is a dip or low point between two area of higher ground. There is a high ground in two opposite directions and lower ground in the other two directions.

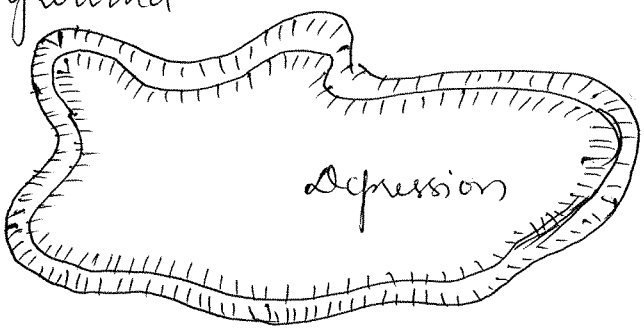
iii) Valley : It is a stretched out groove in the land, usually formed by stream or rivers. A valley begin

with there is high ground on three sides, and usually has a course of running water flowing from higher ground to lower ground.

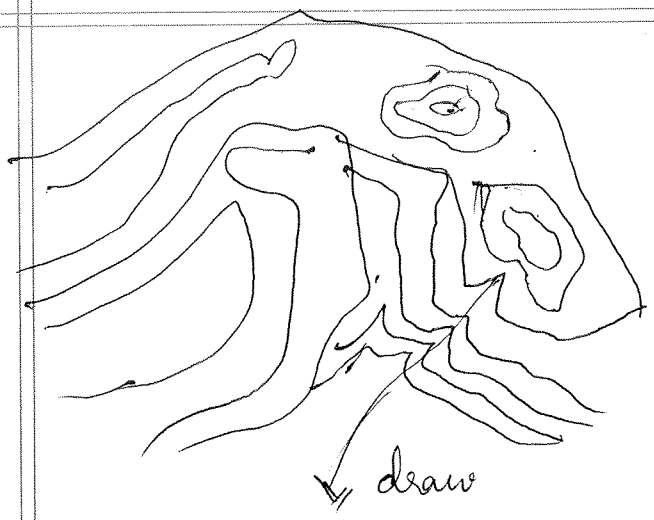
iv. Ridge ; It is a geographical feature consisting of a chain of mountains or hills that form a continuous elevated crest for some distance.



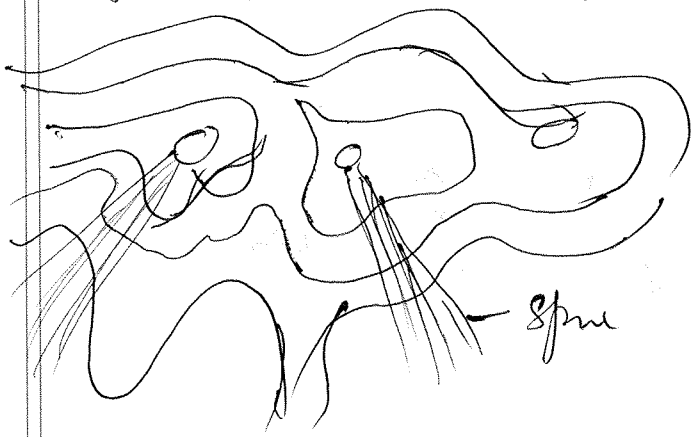
v. Depression ; is a low point or hole in the ground, surrounded on all sides by higher ground.



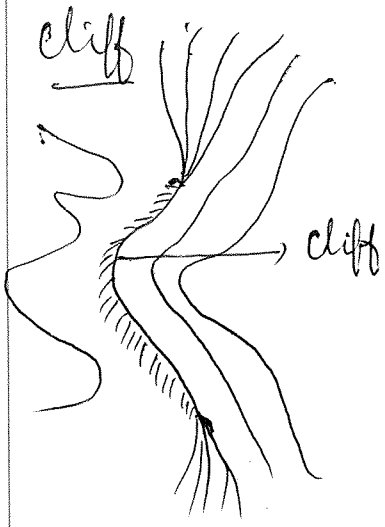
vi. Draw ; Draw is similar to a valley, except that it normally is a less developed stream course. These are caused by flash floods and can be found on flat terrain or along the sides of ridges.



Spur => usually short, continuously sloping line of higher ground jutting out from the side of a ridge.



Cliff



Contour lines being close together, touching or by a ticked contour line

Alfisols => Clay soils rich in Aluminium & Iron (Al & f). Found in Humid & semi-arid regions.

Vertisol => Soil which has high content of expansive clay minerals called montmorillonite. They form deep cracks in drier seasons or yrs.

Vertisol => Soil with high content of expansive clay minerals that forms deep cracks in drier seasons.

Module - III

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Introd^{n} to GIS.

Geographic Information System : GIS tech. links geographic information with descriptive information.

=) A GIS map can present many layers of diff. information. Each layer represents a particular trait of the map.

=) These ~~tay~~ traits can be layered on top of one another creating a unique view of the geographic area.

=) Layers can be added and removed to build each map.

Definition :-

GIS is an information system for capturing, storing analyzing, managing and presenting data which are spatially referenced.

Purpose :- To support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities and other administrative records.

Benefits of GIS :

i) Geospatial data better maintained in a standard format
ii) Revision and updating easier.
iii) Value added products can be generated.
iv) Geospatial data can be shared and exchanged freely.
v) Saving in time and money.

GIS Terminology :

(1) Reclassification : Using one set of values to derive a second set more directly useful to the problem at-hand.

(2) Dissolve : Remove boundaries between polygons of the same designation.

(3) Query : Extracts polygons and places them in a new layer by themselves.

(4) Buffers : Polygons created within a certain distance of a feature.

(5) Attributes :- Each feature from a vector file contains information linked to a storage table with feature identification code (FID).

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GIS categories:

Two types: Vector GIS & Raster GIS.

Vector GIS :- It is the traditional mapping approach where the objects are represented as points, lines and areas. The positions of points, lines and areas are precisely specified.

Raster GIS:

GIS divides the geographic space into a regular grid of cells in specific sequence in a row-column structure.

Raster data perform the geometric area of interest and the entire space is broken into grid cells of a fixed or uniform size.

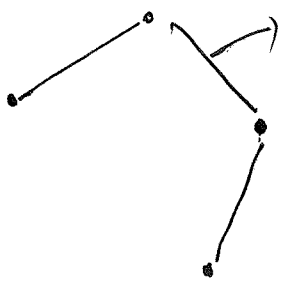
Components of GIS

→ All of these components need to be in balance for the system to be successful. No one part can exist without the other.

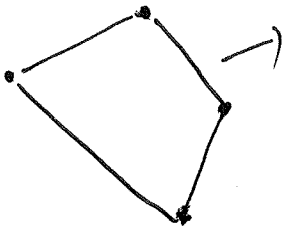
⇒ Raster data is made up of pixels (or cells) and each pixel has an associated value.

⇒ Vector data is comprised of vertices & paths.

⇒ City boundary lines at a global scale are not visible, maps often use points to display cities



→ lines represent features that are linear in nature Eg. maps show rivers, roads & pipelines as vector lines. Busier highways have thickened lines.



Polygons → to show boundaries and they have an area Eg building footprint has a square footage and agricultural fields.

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Fundamental Operations of GIS

- Access methods / Map algebra operations
  - in which processing oper^{ns} are considered as similar to the mathematical oper^{ns}.
- Analytical oper^{ns} (divided into)
  - ⇒ Reclassification
  - ⇒ Overlay
  - ⇒ Distance / connectivity measurement
  - ⇒ Neighbourhood charact^{n} of the data
- Rendering Oper^{ns} — data as some sort of map

⇒ **Reclassification** :- Oper^{ns} transform the attribute inform^{n} associated with a single map coverage.

⇒ **Overlay** :- Oper^{ns} involve the combin^{n} of two or more maps and may result in the delineation of new boundaries

⇒ **Distance & Connectivity** :- measurement include both simple measure of interpoint distance & more complex oper^{y} such as constru^{n} of zones

⇒ **Neighbourhood characteriz^{n}** : involves the values to a location both summary and mean measures of a variable

They generate entirely new information by characterising the positioning of features. Shortest path between two locations

These oper^{ns} summarize the conditions occurring in the general vicinity of a location.

A Theoretical framework for GIS

A model of how different processes take place in a digital GIS environment while producing the digital geographic inform^{n}.

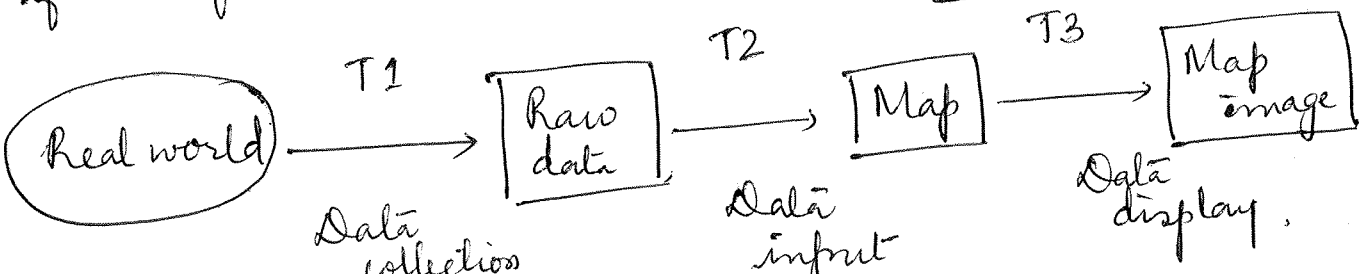
⇒ The GIS approach of transforming data into inform^{n} is based on the cartographic principles.

⇒ Cartography provides the understanding of relationships between the real world and map as a model.

⇒ The relationships help in understanding various transform^{n} the real world data takes to become a map.

Eg. Process of analog map prod^{n} may be modelled as a series of transform^{ns}.

Traditional transf^{n}



[Converting a paper map into a digital map].

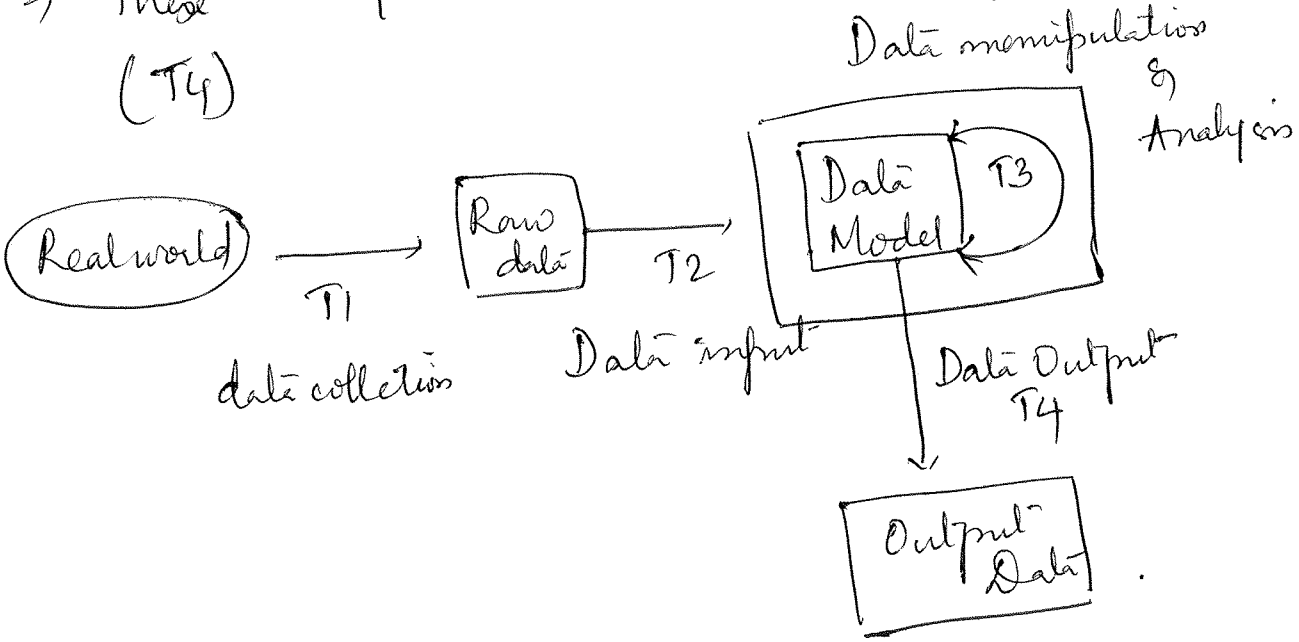
⇒ The significance of these transform^{ns} is that they control the amt. of inform^{n} transmitted from one stage to the next.

⇒ In the first transform^{n} (T1), data are selected from the real world as Eg. surveying measurements or census data.

⇒ These are then input for the GIS in some form (T2) to provide the basis for its digital map repres^{n} of the real word.

=) Within the system many manipulation operations are available to further transform and store the results (T3)

=) These may be communicated as graphic images (T4)



A transformation based view of GIS operation.

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Data input methods :

=) Keyboard entry
=) Coordinate geometry
=) Manual digitizing
=) Scanning.

① Keyboard entry : involves manually entering the data at a computer terminal.
Attribute data are commonly input by keyboard, very rarely the spatial data.
Eg. Roads file will use codes for various road types
Census file =) uses exact nos. like total population age etc.

② Co-ordinate Geometry (COGO) : involves entering survey data using a keyboard. From these data, the coordinates of spatial features are calculated.
This produces a very high level of precision & accuracy, But 6-20 times more expensive than manual digitizing. Surveyors and Engineers use COGO because of its higher accuracy for their applications while planners they go for manual digitizing.

Manual Digitizing :- The most widely used method for entering spatial data from maps.
Map is mounted on a digitizing tablet and then traced each map feature.
It is a tedious job, Operator fatigue (eye strain, back soreness) can serious degrade the quality of data.

Scanning : Provides a faster means of data entry compared to manual digitizing.

- Flat bed scanner: map placed on a flat scanner & detector move across the map in both X & Y direction
- Drum scanner
  ⇓
  map placed on drum which rotates while detector moves horizontally across the map.
  Sensor motion provides movt. in X-direction while drum motion provides movt. in Y direction. The output from the scanner is a digital image.

Data Output :
Output is the procedure by which information from the GIS is presented in a form suitable to the user.
Formats : Hardcopy, Soft-copy and electronic.
⇓ permanent means of display [paper, photographic films]
Output is the format viewed on a computer monitor.
formats consists of computer-compatible files

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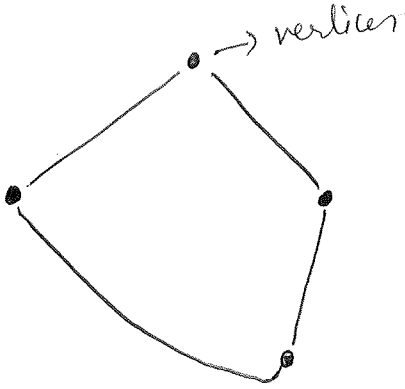
Representation of GIS data:

Types of Spatial data

1. Vector GIS
2. Raster GIS



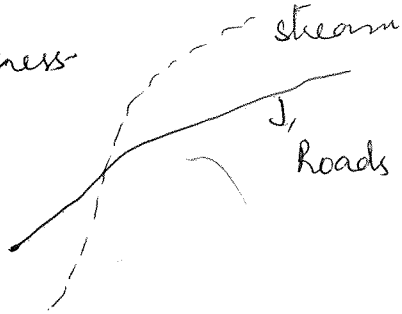
⇒ Polygon

⇒ line (arc)

⇒ Point data

Polygon features are two dimensional and ∴ can be used to measure the area & perimeter of a geographic feature. These features are most commonly distinguished using either a thematic mapping symbology [color] or patterns. Agricultural fields, building footage

Line (or arc) data is used to represent linear features. Eg. rails, streets, rivers. Line features have a starting and ending point and have only one dimension. Symbology most commonly used to distinguish arc features from one another are line types [solid lines verses dashed lines) or line thickness



Point data = is most commonly used to represent non-adjacent features and to represent discrete data points. Points have zero dimensions, ∴ we can measure neither length or area with this data set.
Eg. Schools, bridges, culverts.

Raster data

Also known as grid data represents the fourth type of feature : surfaces.
There are two types of raster data : Continuous & discrete.
Continuous => Eg. temp. & elevⁿ measurements
Discrete => Eg. Population density, land cover/use map.
Raster data is made up of pixels (also referred to as grid cells). They are usually regularly spaced & square.
Raster models are useful for storing data that varies continuously.
Eg. elevation surfaces, temp, lead contamiⁿ

Discrete rasters have distinct themes/categories
Eg. One grid cell represents a land cover class/soil type
→ data usually consists of integers to represent classes
for eg. value 1 might represent urban areas,
" 2 represents forests etc.

Continuous rasters (non discrete) are grid cells with gradual changing data such as elevⁿ, temp..

Advantages of using vector data :

=) Vector data have vertices & paths which means that the graphical output is generally more aesthetically pleasing

=) It gives higher geographic accuracy becoz data doesn't depenedent on grid size.

Disadvantages :

Continuous data is poorly stored and displayed as vectors.

Topology manipulation (esp dales) is complex.

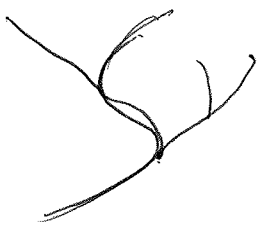
Advantages of Raster

Raster grid format is a data model for satellite data and other remote sensing data.

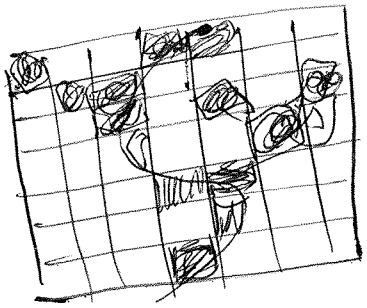
Disadvantages of raster :

Becoz cell size contributes to graphic quality, it can have a pixelated look & feel.

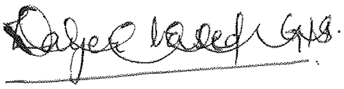
Linear features & paths are difficult to display.



Vector



Raster



Feature based GIS (FBGIS)

Feature

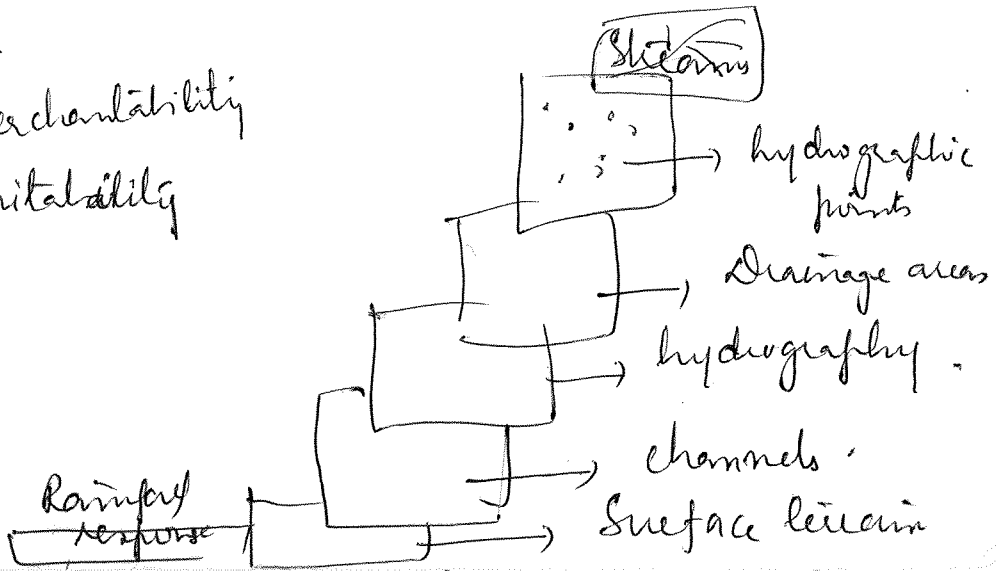
- Geographic entity
  - defines a geo. phenomenon and shares common attributes & relations
  - Eg. Road object
    - common attributes & functions
    - Eg. → It may have name, type, no. of lanes, starting point & terminating point.
- Geometric Object
  - represents the spatial attributes of the feature such as location & shape.
  - Eg. park can be represented as polygon, River as a chain
- Graphic Symbol.
  - is a visual representation of a geo. phenomenon to the users.
  - Eg. a river can be displayed as a red or dot - eg.

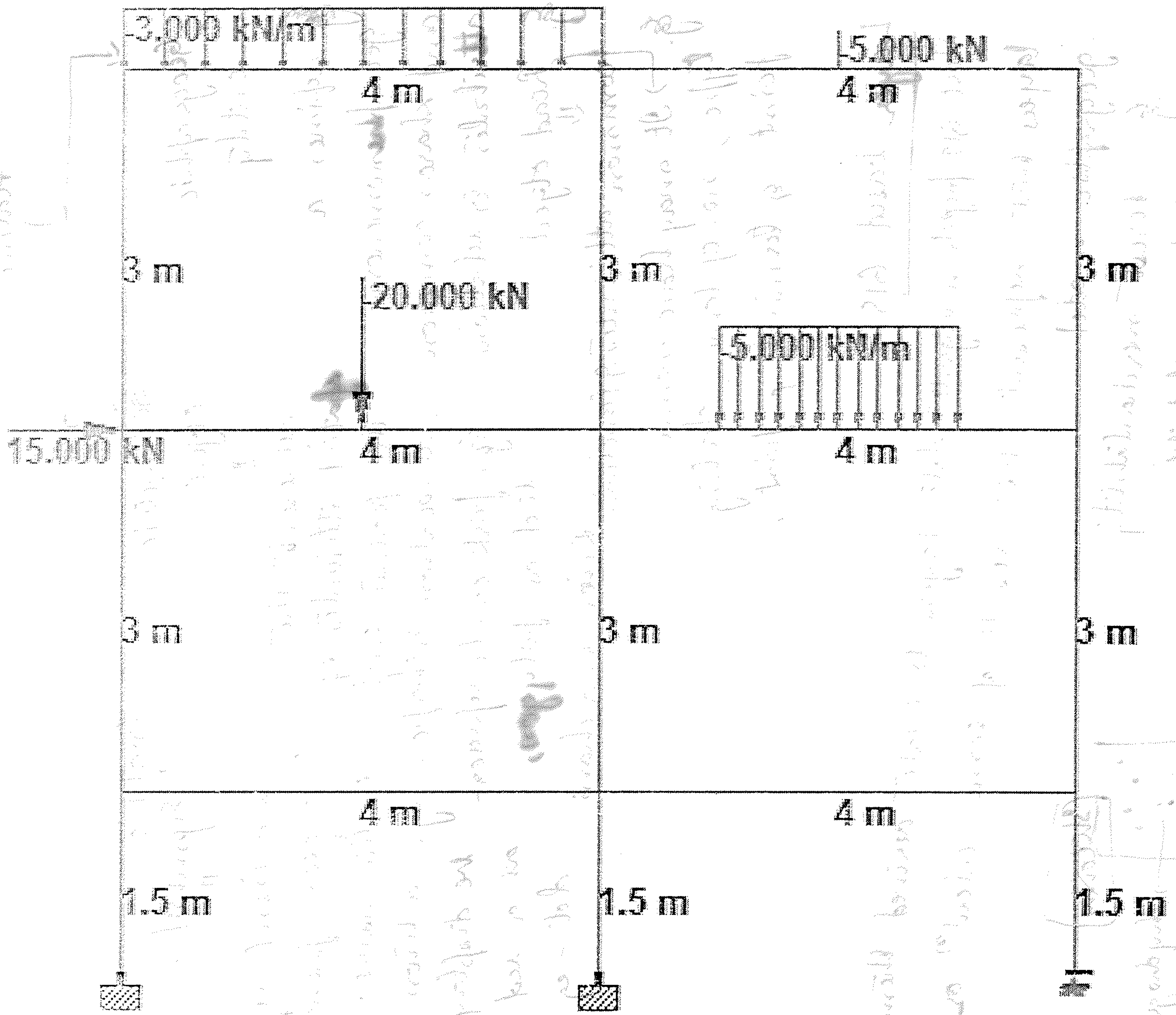
Layer based GIS

Most GIS projects integrate data layers to create derived themes / layers that represent the result of some calculation or geographic model.

Eg. Forest merchantability
landuse suitability

Hydro data model





-3.000 kN/m
-5.000 kN
4 m
4 m
3 m
3 m
3 m
-20.000 kN
-5.000 kN/m
15.000 kN
4 m
4 m
3 m
3 m
3 m
4 m
4 m
1.5 m
1.5 m
1.5 m

(1) Differentiate Raster GIS and Vector GIS?

Ans:

Raster	Vector.
1.) It is a simple data structure.	1) More complex data structure.
2.) Overlay operations are easily and Efficiently implemented	2.) Overlay operations are more difficult to implement
3.) High spatial variability is Efficiently ~~represented~~ represented in a raster format.	3.) The representation of high spatial variability is inefficient.
4.) The raster format is more or less required for Efficient manipulation and Enhancement of digital images	4) Manipulation and Enhancement of digital images cannot be effectively done in the vector domain.
5.) Area and polygon analysis performed.	5.) ~~Area~~ Linear type analysis are Easily performed.
6.) Raster data use a matrix of square area to define where features are located	6.) Vector data use x and y coordinates to define the locations of points, lines and areas.
7.) Topology among graphical objects are much Easier to represent.	7.) Topological relationship are difficult to present.

Raster	Vector
8.) A Representation of the world as a surface divided into a regular grid of cells	8.) A representation of the world using points, lines and polygons.
9.) Raster data structure produce huge ~~file~~ file size.	9.) Vector data structure produces smaller file size.

(2.) Explain in detail about data input and output methods?

Ans: Data input methods:-

There are five types of data Entry systems economy used in a GIS.

→ Keyboard Entry.
→ coordinate geometry
→ manual digitizing
→ Scanning
→ Input of existing digital files.

Keyboard Entry:-

Involves manually entering the data at a terminal attribute data are commonly input by keyboard where as spatial data are rarely input this way.

Keyboard Entry may also be used during manual to Enter the attribute information.

However this is usually more efficiently handled as a separate operation.

(2.) Co-ordinate Geometry (COGO):-

Involves entering survey data using a data using a keyboard from these data the co-ordinates of spatial features are calculated. This produces a very high level precision and accuracy which is a codastral system. COGO packs are commonly 6 times and can be up to 20 times more expensive than manual digitizing.

(3.) Manual digitizing:

The most widely used method for Entering spatial data from maps. The map is mainted on digitizing. Tablet and a hand held device termed a puck or curser is used to trace each map feature. The position of the puck is accurately measured by the device to generate the co-ordinate data.

The most common digitizer used a fine wires mesh grid Embedded in the table. The curser normally has 16 more boltons that are used to operate the data Entry and to Enter attribute data.

(4) Scanning.

Scanning provides a faster means of data entry compared to manual digitizing. In scanning a digital image of map is produced by moving an electronic device across the surface of the map.

There are two types of scanner designs:-

(1) Flat-bed scanner
(2) Drum scanner.

(5) Inputting existing digital files:-

There are many companies and organizations on the market that provides (or) sell digital data files often in a format that can be read directly into a GIS. These digital data sets are priced at a fraction of the cost of digitizing existing maps.

Data output methods:-

(1) Hard copy:
(2) soft copy
(3) electronic copy.

(1) Hard copy outputs are permanent means of display. The formation is printed on paper, mylar, photographic film (or) other similar materials.

2) soft copy is in the format viewed on a computer monitor soft copy outputs are used to allow operator interaction and to preview data before final output. A soft copy output can be changed interactively but the view is restricted by the size of the monitor.

3) The hard copy output takes longer to produce and requires more expensive equipment. However it is a permanent record output in electronic formats consists of computer compatible files.

(3) Write short notes on.

(a) Computational analysis method.

(b) Visual analysis method.

Ans: (b) Visual analysis method

In this method to interpret information and surroundings from visible messages reaching the eye.

The procedures:

→ Understand urban context; time "history" and place 'location"

→ Morphological analysis: plans, sections "axis, distance, height, 2D shape.

→ 3D form analysis, Elevations, "proportion, symmetry

balance, details".

⇒ serial vision study.

→ Urban experience 'urban sense, identity, styles".

(a) Computational analysis method:

The ground movement computation is not limited within the GIS. It also could be performed outside the GIS. In this case, the GIS system would be used only as a spatial-related database of ground moment for storing, displaying and updating the inputted data.

→ The main advantage of this approach, using existing external subsidence, prediction model is to save in programming the model algorithms into the GIS.

→ A disadvantage of this method is the complication caused by the conversion of complex geometrical data to and form external models.

(4) Write short notes on.

(a) Data manuplation

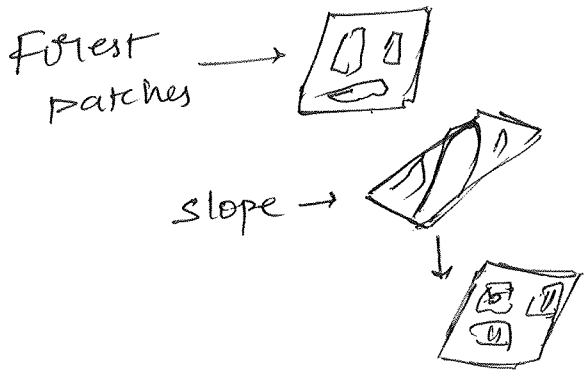
(b) Integrated analysis of spatial and attribute data?.

Ans: (a) Data manipulation:

Data needed for GIS comes from many different sources. They will need to be transformed (or) manipulated in some way to make them compatible with the GIS system.

→ To correct distortions
→ To sharpen ~~digital~~ definition.
→ To ensure colour consistency.
→ To ensure correct latitude and longitude.

(b) Integrated analysis of spatial and attribute data:-



Forest patches "cookies cut" Through slope.

Resulting map shows average slope for each forest patch.

Overlay:-

Overlay is a GIS operations in which layers with a common, registered map base are joined on the basis of their occupation of space. The overlay fuction creates composite maps by combining diverse data. The overlay function can be perform

simple operations such as laying a road maper a map of local methods.

1. Neighborhood Function:

This type of analysis is often used in image processing a new map is created by computing the value assigned to a location as a function of the independent values surrounding that location.

2. Topographic function:

Characteristic with continously changing value over an area such as elevations, aeromagnetic noise, level, income levels and pollution levels.

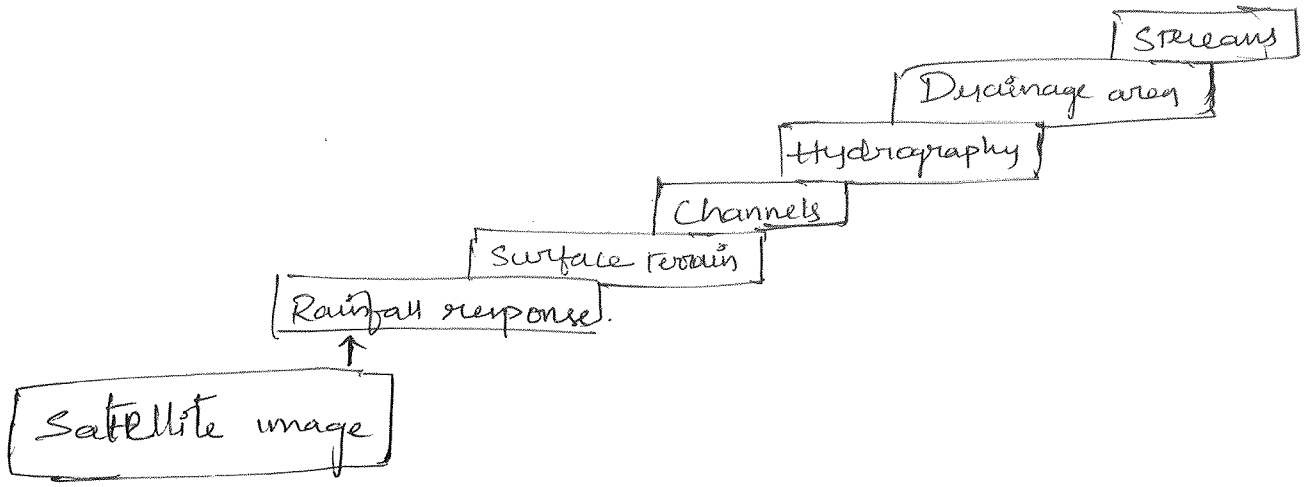
5. Write short notes on

(a) layer based GIs

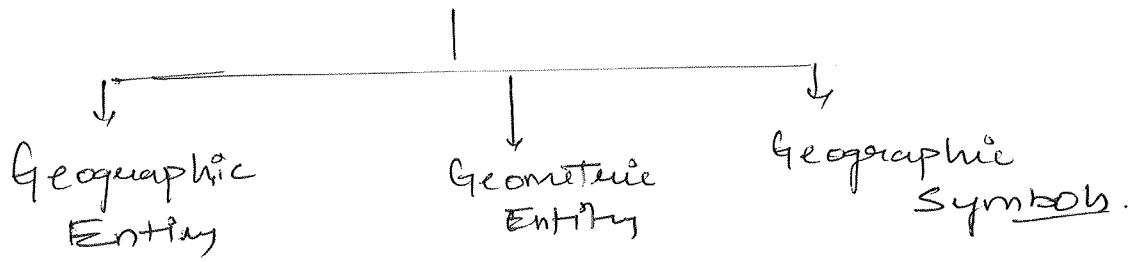
(b) Feature based GIS

Ans. (a) layer based GIS

Layers are the mechanism used to display geographic data sets in ArcMap, ArcGlobe, and ArcScene. Each layer references a data set is portrayed using symbols and text labels, when you add a layer to a map.



(b.) Feature based GIS :



→ Geographic Entity :

An entity (or) geographic feature that occupies a position in space about which data describing the attributes of the entity and its geographic location are recorded.

→ Geometric Entity :

Geometric Entity at the top picture are point entity shown by the small circles. one of this uses can be as "tick marks' which identify target shape positions for the boat, curve Entities a curve Entity as in this programm can

be like a polyline, a Nurb curve, a combination of two.

→ Geographic symbols :

Visuals representation :

Maps often contains symbols or pictures, These symbols images are listed and explained in a key on the map - example of symbols include a cross which represents a church. pt which represent a public house (or) pub, such represent a school..

Layer based GIS :

In this, the spatial data are represented in a set of thematic maps, named layer, which denotes some given themes such as road, building, subway, contour etc.

Generally, the map in layer-based approach is organized as following steps :

i. Analyzing the special property of target map, determining the theme of layers which will be divided.

ii. Creating the layers depending on the themes

iii. Creating the indexing data for every layer.

Advantages :

i. Easy query processing and spatial analysis. (Overlapping problems can be resolved).

ii. Efficient management of data divided transmission. (Avoiding unnecessary displaying of all of the details of map).

Drawbacks :

i. It is difficult to extend the map.

28 He thinks he was appointed chairman of LBI because the company

A knew of his successes with failing companies.
B felt he had a positive image with the public.
C liked his fearless approach to problem-solving.

29 According to Philip Spencer, successful managers are distinguished by their

A concern for detail.
B desire to make money.
C strong leadership.

30 His final advice to people starting in business is to

A make every effort to prevent mistakes.
B find the best sources of information.
C maintain a positive attitude at all times.

You now have 10 minutes to transfer your answers to your Answer Sheet.

Expt. No..... Sheet No..... Date .....

Spatial Analysis :- It is a technique applied to analysis of geographic data

Spatial analysis confronts many fundamental issues =)

⇒ Construction of analytical operations to be used.

=) Use of computers for analysis

=) Limitations (common errors)

Eg. Fragile nature of coastal line length measurement [straight line in computer but in real world, it is a curved line).

=) Presentation of analytic results.

These problems present a challenge in spatial analysis

Common errors in Spatial analysis :

Length :- depends directly on the scale at which they are measured & experienced.

Locational fallacy : Spatial characteriz" may implicitly limit the subject of the study

for eg. Spatial analysis of crime data :

but these studies can only describe the particular kinds of crime which can be described spatially.

- An error in the interpretation of statistical data in an ecological study.

Ecological fallacy:

for eg. A pixel represents the average surface temps within an area. Ecological fallacy would be to assume that all points within the area have same temp.

=) The true power of GIS lies in the ability to perform analysis.

=) Spatial analysis is a process in which you model problems geographically, derive results by computer processing and then explore & examine those results

Advantages of Spatial analysis

=) It is effective for evaluating the geographic suitability of certain locations for specific purposes.

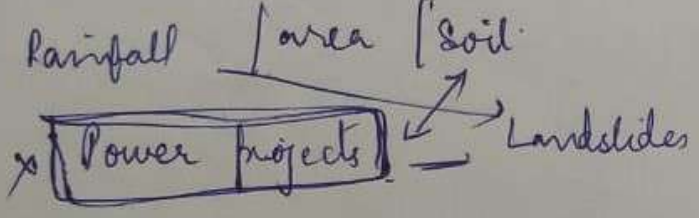
=) For estimating & predicting outcomes.

=) Interpreting and understanding the change.

=) Detecting inf. patterns hidden etc.

Atomic fallacy :-

It arises when the relationships between indi. variables are used to make interpretations on the relationships or associations between the corresponding variables at the group level.



Uncertainity in the measurement of geographic phenomena.

(1) Physical measurement errors

=) Instruments & procedures we to make physical measurements are not perfectly accurate.

Eg. Mt. Everest =) 8,850 m (height) with an accuracy of + or - 5 m.

In addition, earth is not a perfectly stable platform from which to make measurements.

Seismic motions, continental drift etc. can cause physical meas. inexact.

Data capture

↓

Data collection

↓

Data Interpretation

↓

Input into GIS.

⇓

Ground truth verification

[field surveying].

Eg Apartment i, No. of flats, Electricity Dept.

which transformer they are connected. ||,

Map data linkup to attribute data.

Spatial analysis :

⇓ Analysis of Geographical data.

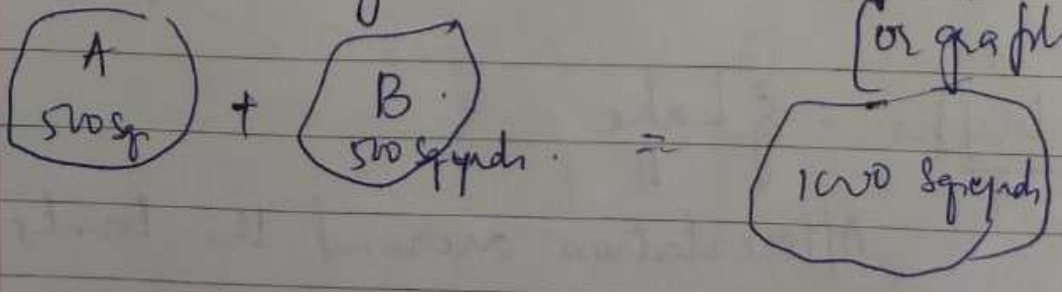
CAM & VAM.

⇓

Using mathematical algorithms [System inbuilt]

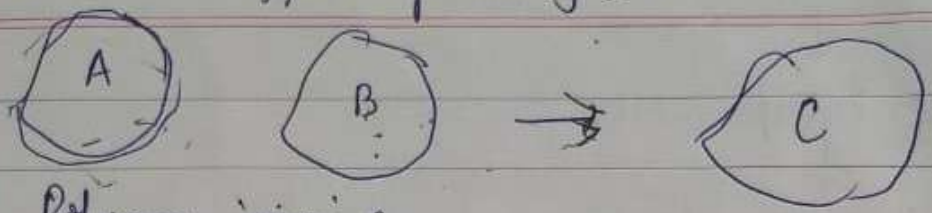
Eg: 500 sq yrs ⇒ ↓

Real estate buildings but the output is displayed visually [or graphical representation]



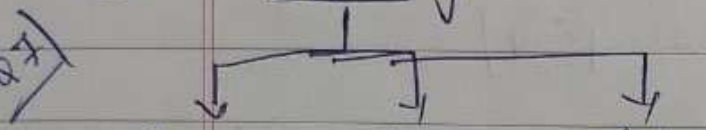
Visual Analysis methods

① Point buffer Spatial join



Polygon joining

② Buffering



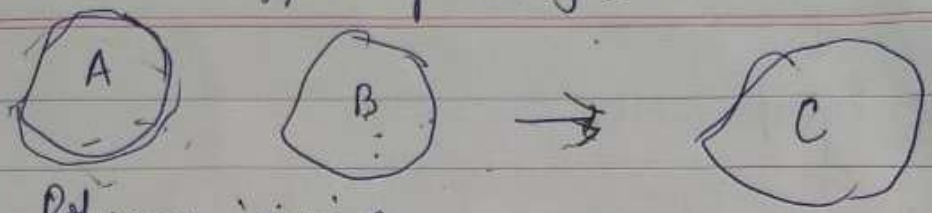
Point → Industry (Pharma)
↓
impact till what area residential area should not be there.
[Municipal org^n will not allow const^n of residential buildings

Line → Roads extension
↓
NH [Govt. decided to convert to SH or NH]
20m ← | | → 20m
Buildings / Govt. bodies land are present, Govt. has to compensate [how much land parcel is lost, land cost]

Polygon buffer:- ① e.g. Lake
↓
Afforestation around the banks of Lake ⇒
Ground water table exists around upto 500 m and hence can grow plants till that distance

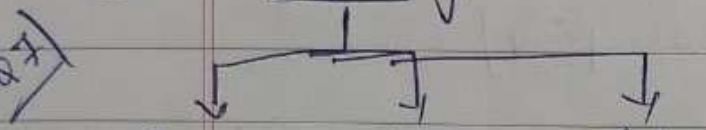
Visual Analysis methods

① Point buffer Spatial join



Polygon joining

② Buffering



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Data storage

The different types of information required for a GIS require storage which allows the information to be updated and queried for analysis by the user.

There are two types of information to be stored

i) Spatial data [Vector data]

ii) Attribute data.

Spatial data :- It is usually stored as themes, layers or coverages.

Eg. Georeferenced spatial data [lat. & long. will be embedded in the file so that it will be displayed in GIS in its proper location in relation to its other features.

Themes can be anything located on a traditional paper map such as roads, rivers, cities, wells, forest ect. and they are all georeferenced.

Attribute data :- It is the information about an object or feature.

Eg. School => its name, location, how many children attend each year etc.

Electricity dept => No. of consumers, linemen, meters etc.

Attribute data is usually stored in a database, latrubase or spread sheet type format.

Database management System [DBMS]

Database => is a collection of logically related data.

=> Many databases exist for many applications, and each one of them is maintained by a collection of programs known as a database management system.

=> A DBMS is a computer program that stores and manages large amounts of data.

=> Constructing the database means storing the data in the database.

Advantages of DBMS

=> Controlling Redundancy : Redundancy means storing the same data multiple times. DBMS checks redundancy and prevents duplication of efforts, saves storage space and preserves the data files from being inconsistent.

=> Restricting unauthorized Access : A DBMS provides a security and authorization system, which the database administrator used to create accounts and to specify account restriction.

=> Providing storage structures for efficient query processing : Data base systems provide capabilities for efficient execution of queries and updates.

=> Providing backup and recovery : The backup and recovery subsystem of the DBMS helps in recovering from hardware or software failures.

It is the process of changing data to make it easier to read or the more organised.

Expt. No..... Sheet No..... Date .....

Data manipulation and analysis

QC & QA checking

CA Operator Digitiz?
↓
QC
↓
QA.

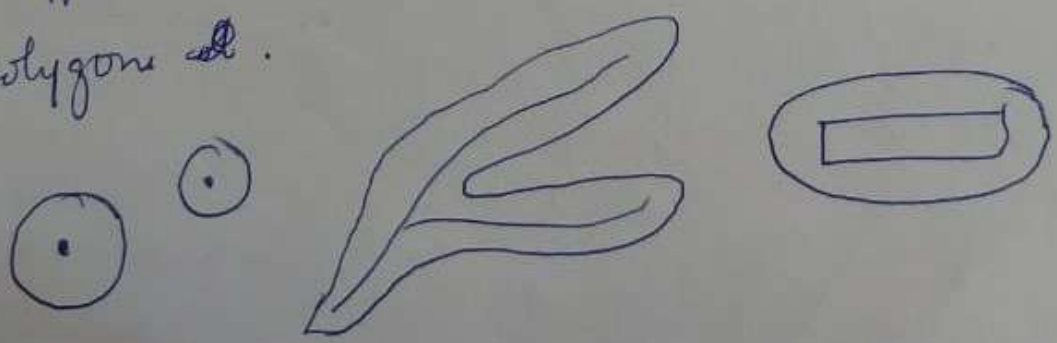
SQC ⇒ Survey

Satellite features
Eg. Transmission tower
⇓
point feature

Buffer zones ⇒ set up to protect the env., protect residential & commercial zones from indust. accidents or natural disaster.

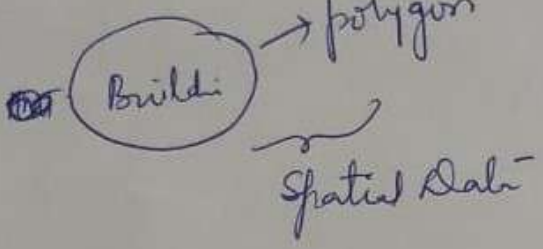
Eg. Greenbelts between residential & commercial areas, noise prot^n zones around airports, pollution prot^n zones along river.

In GIS applic^n, buffer zones are always represented as vector polygons.



Overlaying :- what layer is above what.

Integrated analysis of spatial & attribute data



Field :
Who's house is it
Owner
No. of Tenants
Electricity meter

} Ground Truth verification.

All Info to collect will be given by Client

Central = Hyder
South = Tirupathi
East = Vizag
North = Warem

} C APPDCL.

Unit-5

Land use - Land cover

Land cover : defined as the assemblage of biotic & abiotic components on the Earth's surface. It is one of the most crucial properties of the earth system.

Significance of land cover [LC]

i) Interaction of land cover with atmosphere leads to regulation of hydrological cycle and energy, thus both needed for weather & climate prodⁿ.
Eg. Surface roughness, evapotranspiration & respⁿ.

ii) Land cover plays a major role in the carbon cycle acting as both source and sink of carbon.
Eg. Rates of deforestⁿ, afforestⁿ, regrowth play an imp. role in the release of carbon ⇒ & strength of Greenhouse effect.

iii) It also reflects the availability of food, timber, fuel, fiber, shelter resources for humans thus serving as a critical ecological indicator of other ecosystem services [biodiversity].

⇒ Information on land cover is useful for global applicⁿ including watershed manag. & agri. productivity.

Land cover : is what covers the ~~land~~ surface of the earth.

Land use : describes how the land is used.

↳ Eg. land cover classes include ; water, snow, grassland, deciduous forest & bare soil.

↳ wildlife manag area, agri. land, urban, recreation area etc.

Land cover | use studies

⇓

are multidisciplinary in nature

⇒ Changes in land cover will be examined by environ. monitoring researchers, conserv^n authorities and depts. of Municipal affairs.

How LU|LC change impact water resources :

classific^n :- Barren land
Forests
Agriculture
~~Commercial (Industri)~~.
Water bodies
Glacier (Snow).

⇒ Govt. houses.

⇒ Encroachment

⇒ Water quality

⇒ Loss of ~~water~~ wet lands (Chennai floods)

⇒ Deforest^n.

Impact: - of floods & drought

Floods,
Drought,
Global Warming
Greenhouse effect

Floods :-

Excess / overflow of water

Impacts.

=> loss of property => Spreading of diseases.
=> loss of life
=> Measures -

① Rehabilitation
② Desiltation
③ River banks construction
④ Afforestation
⑤ Construction of levees.

Drought

Scarcity of water / Less rainfall below the average / Late arrival of rains

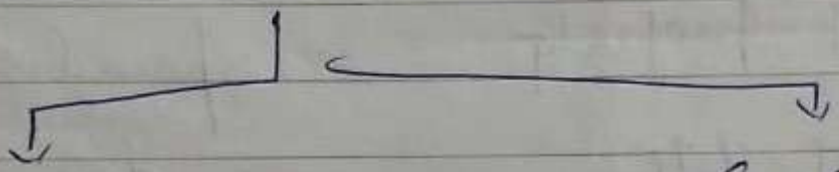
Impacts

① famine
② Shortage of food
Loss of Recreational activities
Agriculture prod^n loss

=) Loss in fisheries prod"
=) Desertification
=) Increase in Poverty levels.
=) Economical growth dwindles.

Water Resources Management and Monitoring

Available water resources



Groundwater

Surface water

Surface water inventory

=) No. of surface water bodies available
=) Quality of lakes / streams / rivers
=) ~~Desi~~ Siltation of water bodies
=) Encroachment of water bodies.

Watershed management – Sustainable development

⇓

Drainage basin : is any area of land where precipitation collects and drains off into a river, bay or other body of water.

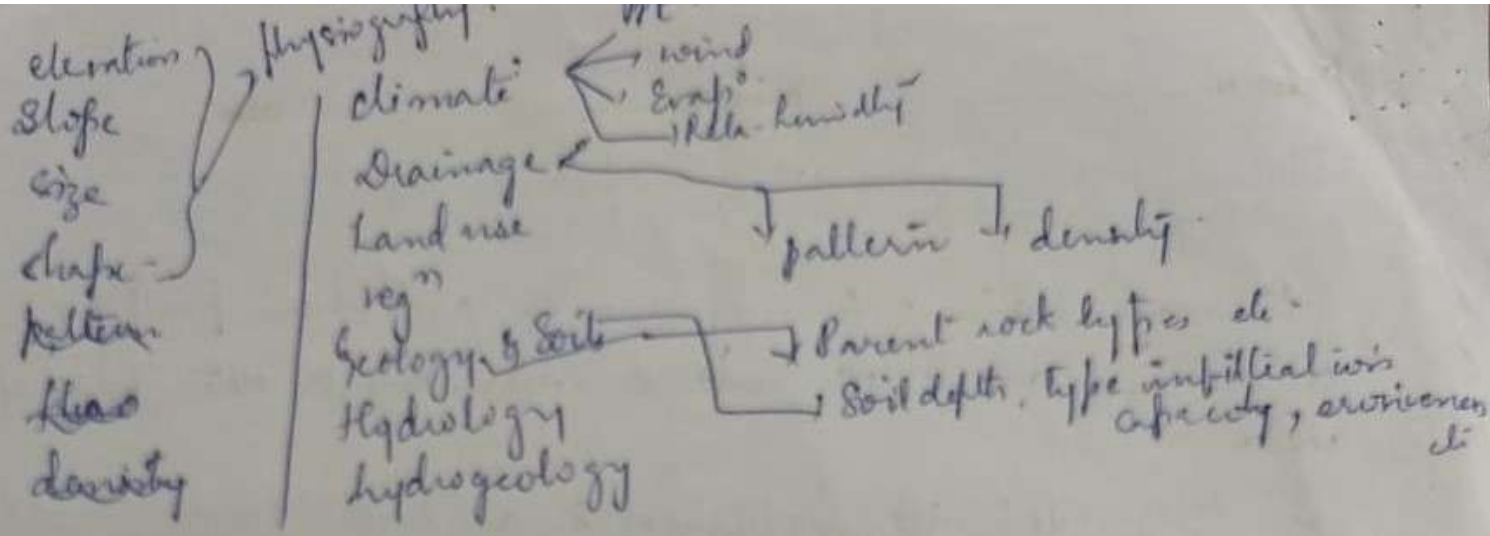
Eg. Mississippi river watershed is an enormous watershed. All the tributaries to the Mississippi that collect rainwater eventually drain into the Mississippi which eventually drains into the Gulf of Mexico.

fluvial geomorphology :- changes in land due to river action.

⇒ Sedimentation
⇒ erosion
⇒ Deposition
⇒ Transportation of materials [Fertility & quality of soil].

ISD

Protection of Coastal area by construction sea wall.
Construction of bunds / levees along river bed line.
Afforestation.



Ground water targeting (tapping).

Identifying ground water sites [new ; bore locations]

Identification of sites for artificial recharge structures

water shed management Approach incorporates

* Soil & water conserv" , land use planning .
=) Mitigate the effects of land use to an acceptable level.
=) restore degraded environments
=) Veg" management, witholled grazing, erosion control
etc., bunding etc. to
i) Stabilize soil & steep slopes
ii) Stabilize | modify water yield & streamflow
iii) Maintain & improve water quality

$$2048 \text{ population} = (\text{population of } 2011) \times (1.008)^{37}$$

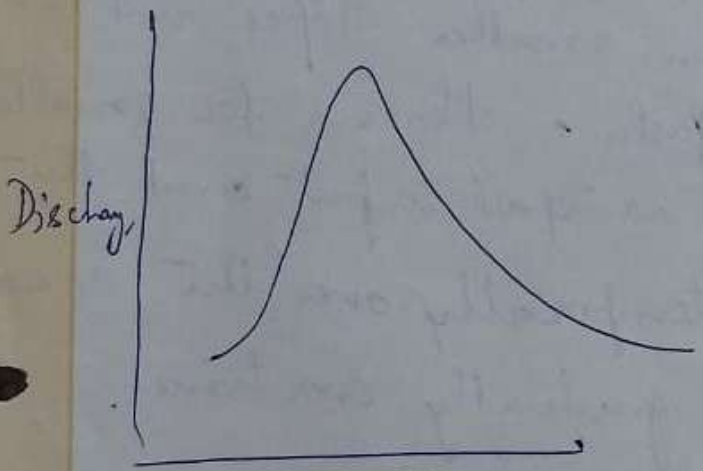
Rainfall runoff relationships:

A runoff model is a mathematical model describing the rainfall - runoff.

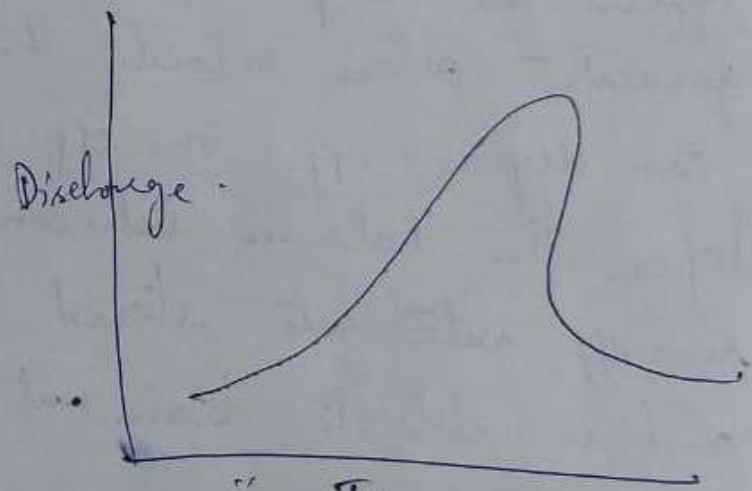
Rainfall, runoff and the characteristics

① Shape of the catchment -

i) Catchment in the form of a pear ⇒ hydrograph is fast rising and has a concentrated high peak.



i)



ii)

ii) Catchment with the same area but shaped with its narrow end towards the outlet has a hydrograph that is slow rising.

(2) Size of the catchment

The vol of runoff expected for a given rainfall input would be proportional to the size of the catchment. The response characteristics of large catchment (large river basin) is different from small catchment (like agricultural plot.)

(3) Slope :-

Slope of the main stream cutting across the catchment and that of the valley sides or general land slope affects the shape of the hydrograph. Larger slopes generate more velocity than smaller slopes and hence can dispose off runoff faster. Hence, for smaller slopes, the balance between rainfall input and the runoff rate gets stored temporally over the area and is able to drain out gradually over time.

Fluvial geomorphology :

It is the study of the form and function of streams and interactions between streams and the landscape around them.

'Fluvial' refers to the processes associated with running waters, 'geo' refers to earth and 'morphology' refers to channel shape.

Reservoir sedimentation

It is a process of erosion, entrainment, transportation deposition and compaction of sediment carried into reservoirs formed and contained by dams.

Waterdepth estimation using GIS

The ocean environment is unique. Sensors | satellites and aircraft are effective at seeing the surface of the ocean but generally cannot look deeply into the water columns where the electromagnetic energy they rely on is dissipated :

Advances in RS have made it possible to collect data on features and processes in the ocean over very broad scales, and GIS tech. has made it

possible to organize and integrate this data, make maps and perform scientific analysis to increase our understanding and help us to make critical decisions.

⇒ Using GIS to synergize diff. types of data (biological, chemical, physical, geological) collected in multiple ways from multiple instruments and platforms has provided the oceanographic community and policy decision makers with more information and insight than could be obtained by considering each type of data separately.

Land use - land cover for water resources

Land cover : refers to the surface cover on the ground, may be vegetation, urban infrastructure, water, bare soil or other.

⇒ Identifying, delineating and mapping land cover is important for global monitoring studies, resource management, and planning activities.

⇒ Identification of land cover establishes the baseline from which monitoring activities (change detection) can be performed and provides the ground cover information for baseline thematic maps.

Land use : refers to the purpose the land serves, for eg. recreation, wildlife habitat, or agriculture.

⇒ Land use applications involve both baseline mapping and subsequent monitoring.

⇒ This information is used to identify the land use changes from year to year.

⇒ This knowledge will helps develop strategies to balance conservation, conflicting uses and developmental pressures like removal or disturbance of productive land, urban encroachment, and depletion of forests.

⇒ The properties measured with remote sensing techniques relate to land cover, from which land use can be inferred particularly with ancillary data.

Impact of land use / land cover on water resources:

⇒ Changes in LC/LU have a great influence on the hydrological processes.

⇒ The future availability of water resources largely depends upon planning and management of land use in the changing environment.

⇒ The continuous human interaction keep on modifying the land use land cover (LU LC) to fulfill the demand especially due to significant increase in population.

⇒ Agriculture, clearing of forests, and the draining of wetlands have caused significant modification to the surface of the earth.

⇒ Tillage of the land and clear cutting of forests change infiltration and runoff characteristics, which affect GW recharge, sediment and water yield and evapotranspiration.

⇒ Irrigation of lands changes the use and distribution of water.

⇒ The removal of SW and GW for irrigation changes the water's natural distribution and impacts the ecosystems that depend upon it.

Land use land cover in water resources.

⇒ Quantity
⇒ Quality

Ground water.

⇒ Quantity ← Climate change
                ← Urbanisation
                ← Increased demand for resources
⇒ GW recharge
⇒ " storage → less infiltration due to concrete based constructions etc.
⇒ GW contamination
⇒ Over exploit^{n} of GW → Excess runoff
⇒ Decreased soil infiltration.
Heavy grazing.

I Collection of Satellite data.

RS data in the form of digital data.

⇒ Coll^{n} of ancillary data.

SOI : toposheets to study LC/LV
for field check & Ground truth verific^{n}.

⇒ Prep^{n} of LC/LV map.

⇒ Various features are identified and distinguished using interpretation key such as tone, texture, size, shape and assoc^{n} to interpret land use pattern.

⇒ ERDAS / EASE PACE software for image processing such as image rectification etc.

⇒ Image classification is done

⇓

Data is given into GIS software

⇓

To prepare LU/LC map.

Surface water resources and inventory

① Annual water surface (water spread) dynamics
② Seasonal changes

} progress of cropping area & water utilization pattern.

location, extent, attributes

④ Availability of water resources (No.
② Encroached.
③ Converted (dried).
④ Quality of water
⑤ Carrying capacity of water.
Delineation of SW bodies.

} water resources planning & management.

Eg
Spectral reflectance characteristics of water bodies.

Qualitative evaluⁿ of water bodies

Drought

Causes :-

- Less rainfall for longer period
- Late arrival of rains.
- Contamination of the usable water.

Impacts.

- Delay growth of crops.
- Livestock may be lost
- Timber prodn ↓
- Loss in fishery prodn.
- Recreation & tourism industry ↓,
- Hydel power ↓
- Loss of species.
- Loss of wetland
- Extinction of species.
- Desertification.

Types

- Meteorological
  - ⇓
  - rainfall is below the average level.
- Agricultural
  - Soil moisture is not sufficient to support the prodn of crops.
- Hydrological
  - Water levels in aquifers, lakes & reservoirs fall below the average levels.

⇒ To rehabilitate the watershed through proper land use and protection / conservation measures inorder to minimize erosion and increase the productivity of the land and the income of the farmers.

⇒ to protect conserve & manage the watershed for the benefit of water resources dev. (domestic water supply, irrigation etc.).

⇒ to develop rural areas in the watershed for the benefit of the people and the economies of the region.

⇒ Geomorphology deals with land forms in a watershed. Survey of the land forms will result in a better understanding of the erosion process.

High stream density ⇒ quick surface runoff and flash floods etc.

This type of information together with rock types & slopes, permits the proper selection of sites for dams & roads.

⇒ Morphometric analysis ⇒ Quantitative analysis of the form characteristics ⇒ stream segments, basin length, basin area, basin parameters, altitude, slope ⇒ which will indicate the nature of dev. of basin.

Bathymetry

It is the measurement of the depth of water in oceans, rivers or lakes.

Echo sounders → [SONAR] are used to make bathymetric measurements. An echosounder sends out a sound pulse from a ship's hull, or bottom, to the ocean floor. The sound wave bounces back to the ship. The time it takes for the pulse to leave and return to the ship determines the topography of the seafloor. The longer it takes, the deeper the water.

Bathymetric surveys are used for many different types of research:

=) Flood inundation.
=) Contour of streams and reservoirs
=) leakage
=) scour and stabilization
=) water quality studies
=) dam removal
=) biological and spill
=) storage and fill in reservoirs and ponds.

⇒ The data used to make bathymetric maps typically comes from an echosounder (SONAR) or from remote sensing LIDAR or LADAR systems. LIDAR/LADAR surveys are usually conducted by airborne systems.

⇒ Bathymetric information on lakes and reservoirs has important value in hydrology. Besides water level, volume or lake area, multi temporal comparison between bathymetries is an indicator for environmental changes like lake or reservoir sedimentation.

⇒ From this information, lake ecosystem functioning, life times of reservoirs or erosion, sedimentation rates of catchments can be derived.

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