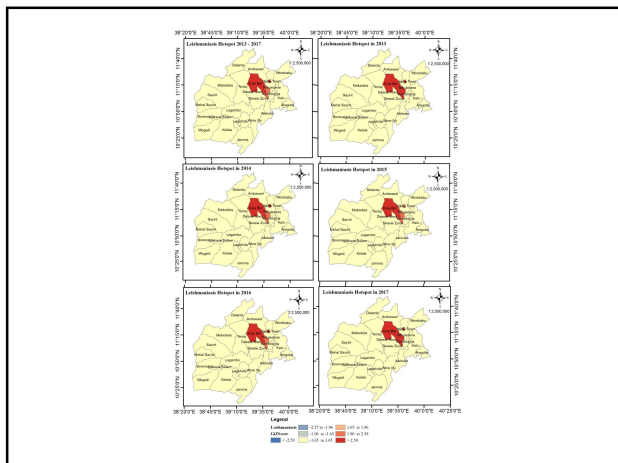
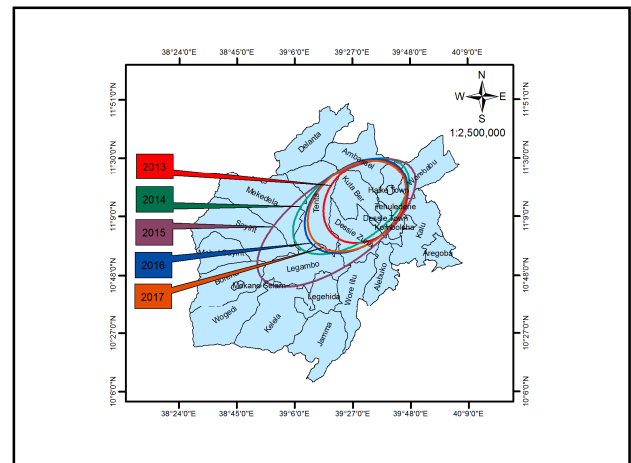
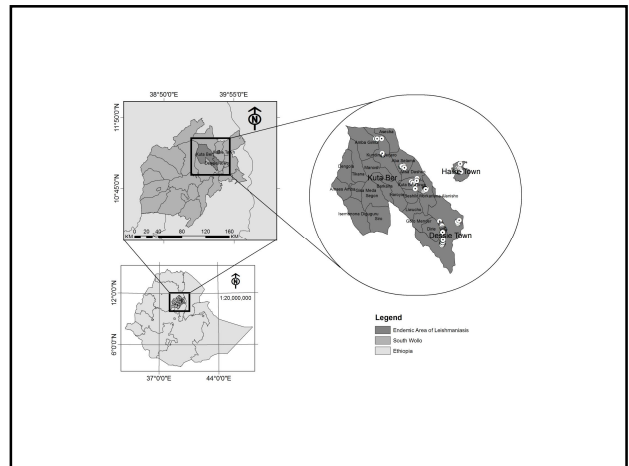
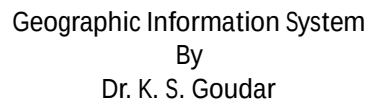




INFORMATION

Information: Is nothing but data attached to the what, where and when. These data can be in the form of tables, attributes (features) or the characteristics (distinctiveness). These forms of data can be used to symbolize and provide further insight of a given experiment, objects and location for inference.



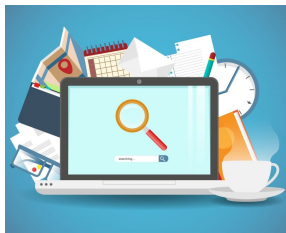
GEOGRAPHIC

Geographic: Is nothing but the data of related to where. Majority of collected data is associated with some location in a particular space.



SYSTEMS

Systems: Is nothing but many components working together to achieve a common goal. With reference to the geography, it is a seamless (without any fault) operation linking the information to the geography which requires hardware, networks, software, data and operational procedures to create map of your desire and need.



MAP

Map a diagrammatic representation of an area of land or sea showing physical features, cities, roads, etc.

Map is applicable for your house, city and forest area.



Definition of GIS

GIS is a computerized system designed for the storage, retrieval and analysis of geographically referenced data. GIS uses advanced analytical tools to explore at a scientific level the spatial relationships, patterns and processes of cultural, biological, demographic, economic, geographic and physical phenomena.



Definition of GIS

As per Environmental Systems Research Institute (ESRI), A geographic information system (GIS) lets us visualize, question, analyze, and interpret data to understand relationships, patterns, and trends.



Definition of GIS

In the strictest sense, a GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information (that is data identified according to their locations). (USGS)



Advantage of GIS

- Better decision made by experts of various disciplines
- Citizen engagement due to better system
- Help to identify communities that is under risk or lacking infrastructure
- Helps in identifying criminology matters



Advantage of GIS

- Better management of natural resources
- Better communication during emergency situation
- Finding different kinds of trends within the community
- Planning the demographic changes



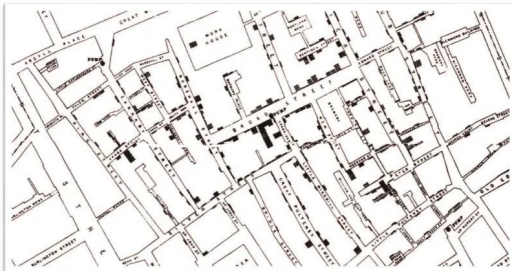
History of GIS

Modern GIS has seen series of development. GIS has evolved with the computer system. Here are the brief events that has happened for the development of the GIS system.



History of GIS

Year 1854 – The term GIS that used scientific method to create maps was used by John Snow in 1854. He used points on London residential map to plot outbreak of Cholera.

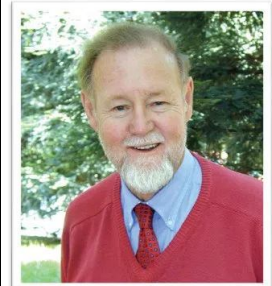


History of GIS

Year 1960 – Modern computerized GIS system began in year 1960.

Year 1962 – Dr. Roger Tomlinson created and developed Canadian Geographic Information System (CGIS) to store, analyze and manipulate data that was collected for the Canada Land Inventory (CLI).

This software had the capacity to overlay, measurement and digitizing (converting scan hardcopy map to digital data). It is never provided in commercial format but Dr. Tomlinson is the father of GIS.



History of GIS

Year 1980 – This period saw rise of commercial GIS software's like M&S Computing, Environmental Systems Research Institute (ESRI) and Computer Aided Resource Information System (CARIS). These all software were similar to CGIS with more functionality and user-friendliness. Among all the above the most popular today is ESRI products like ArcGIS, ArcView which hold almost 80 % of global market.

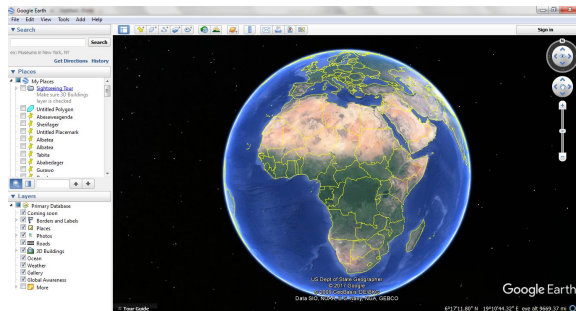


History of GIS



Google maps

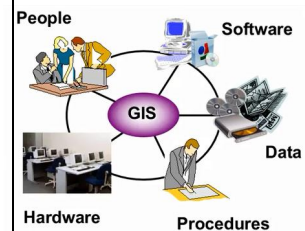
History of GIS



Components of GIS

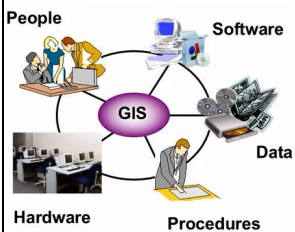
GIS constitutes of five key components:

- Hardware
- Software
- Data
- People
- Method



Components of GIS

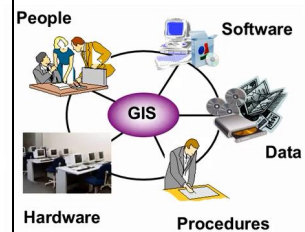
Hardware: Consists of the computer system on which the GIS software will run. The choice of hardware system range from 300MHz personal computers to super computers. The computer forms the backbone of the GIS hardware, which gets it's input through the Scanner or a digitizer board.



Components of GIS

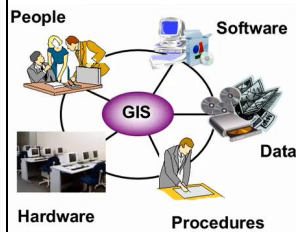
Scanner converts a picture into a digital image for further processing. The output of scanner can be stored in many formats e.g. TIFF and JPG etc.

A digitizer board is flat board used for vectorization of a given map objects. Printers and plotters are the most common output devices for a GIS hardware setup.



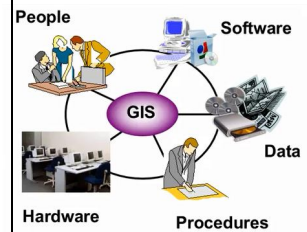
Components of GIS

Software: GIS software provides the functions and tools needed to store, analyze, and display geographic information. GIS software in use are MapInfo, ARC/Info, AutoCAD Map, etc. The software available can be said to be application specific



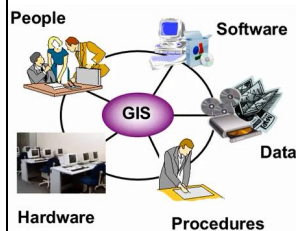
Components of GIS

When the **low cost GIS** work is to be carried out desktop **MapInfo** is the suitable option. It is easy to use and supports many GIS feature. If the user intends to carry out extensive analysis on GIS, ARC/Info is the preferred option. For the people using AutoCAD and willing to step into GIS, AutoCAD Map is a good option.



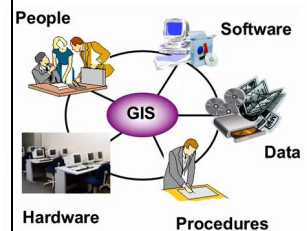
Components of GIS

Data: Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. The digital map forms the basic data input for GIS. Tabular data related to the map objects can also be attached to the digital data.



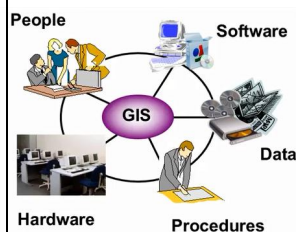
Components of GIS

A GIS will integrate spatial data with other data resources and can even use a Data Base Management System (DBMS), used by most organization to maintain their data, to manage spatial data.



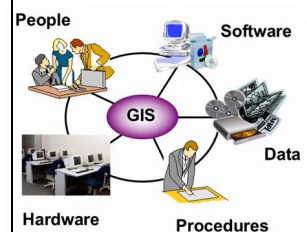
Components of GIS

People: GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work. The people who use GIS can be broadly classified into two classes.



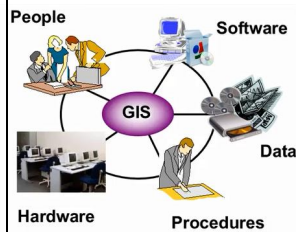
Components of GIS

The CAD/GIS operator, whose work is to vectorise the map objects. The use of this vectorised data to perform query, analysis or any other work is the responsibility of a GIS engineer/user.



Components of GIS

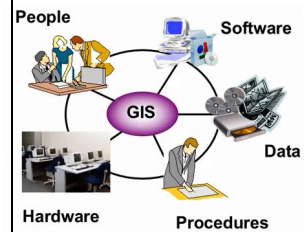
Data providers: data could be acquired through field observation, land survey, GPS, aerial photography, remote sensing technique, socio-economic surveys and so on. In Ethiopia, GIS data can be provided by Ethiopian mapping authority



Components of GIS

Method or Procedures:

There are various techniques used for map creation and further usage for any project. The map creation can either be automated raster to vector creator or it can be manually vectorised using the scanned images. The source of these digital maps can be either map prepared by any survey agency or satellite imagery.



Functions of GIS

- **Projection or co-ordinate system** is a key component of map making. A projection is a mathematical means of transferring information from a model of the earth, which represents a three-dimensional curved surface, to a two dimensional medium – paper or a computer screen



Functions of GIS

- **Geo-referencing** (also known as geo-rectification, geo-locating, geo-coding or registering) is the process of assigning spatial location identity to pieces of information.
- Or "Geo-referencing is the process of establishing a relation between the data displayed in your GIS software and its real world location."



Functions of GIS

- Geo-referencing enables us to know exactly where things are positioned on or in relation to the earth's surface.
- Geo-referencing is commonly achieved by using a coordinate system.



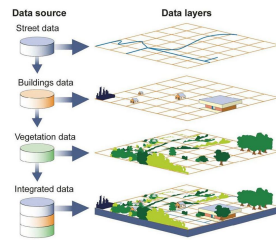
Features of GIS

- GIS is a computer-based tool that combines the visual appeal of conventional maps with database operations and statistical analysis.



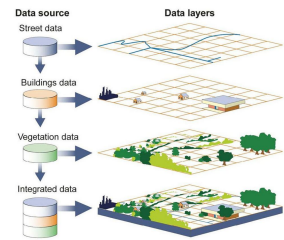
Features of GIS

- It is used for mapping and analyzing things that exist and happen on the surface of the Earth by classifying the information into "layers", making it easy for users to distinguish each element separately.



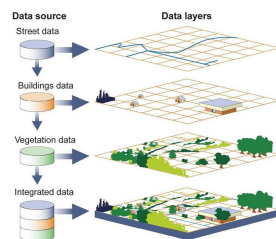
Features of GIS

- The speed and accuracy of a GIS provide an invaluable service to organizations, by explaining events, predicting outcomes and planning future strategies.



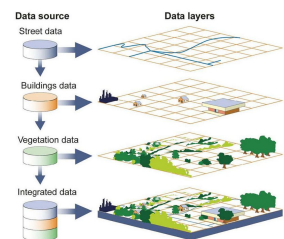
Features of GIS

- It must be realized that GIS is a peculiar technology with the essential features of spatial references and data analysis. Hence, the true power of GIS lies in its ability to integrate information and to help in making decisions.



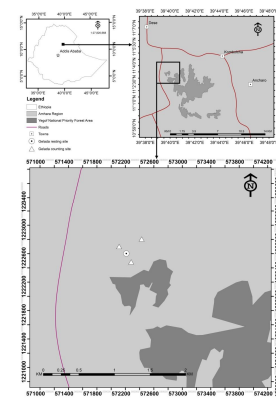
Features of GIS

- A GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.
- GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.



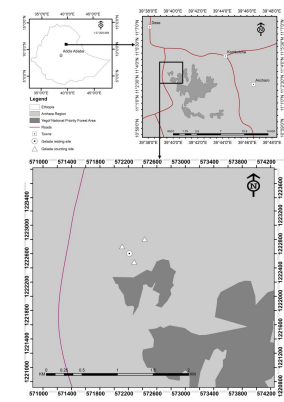
Questions GIS can Answer

- GIS can be used to address concerns relating to location, condition, trends, patterns, modeling, spatial questions, as well as non-spatial questions. Basically, we can identify five broad types of questions that a sophisticated GIS can answer



Questions GIS can Answer

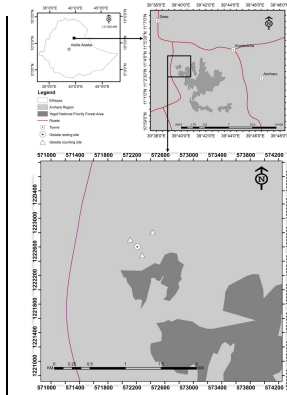
- Location: What is at.....?**
This question seeks to find out what exists at a particular location. A location can be described in many ways, using, for example, a place name, post code, or geographic reference such as longitude/latitude or x/y.



Questions GIS can Answer

- **Condition: Where is it.....?**

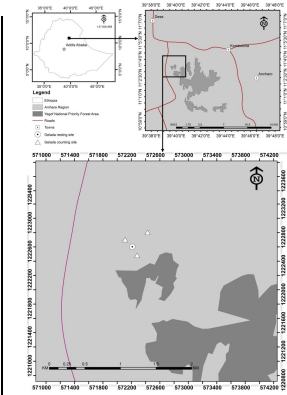
In this question, one may wish to find location(s) where certain conditions are satisfied (e.g. an forested section of at least 2000 square meters in size and with soils suitable for supporting buildings)



Questions GIS can Answer

- **Trends: What has changed since.....?**

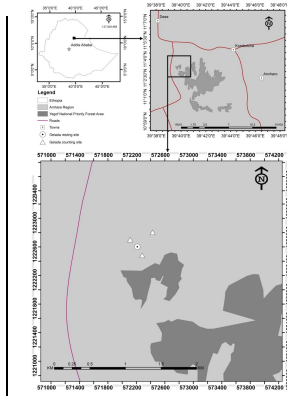
This question involves seeking to know what has changed over a given period of time, as well as the magnitude and spatial pattern of such a change (e.g. change in land use or elevation over time).



Questions GIS can Answer

- **Patterns: What spatial patterns exist.....?**

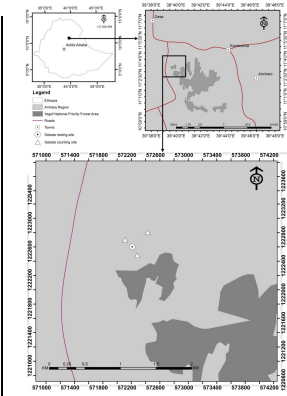
One might ask this question to determine whether, for instance, landslides are mostly occurring near streams.



Questions GIS can Answer

- **Modeling: What if.....?**

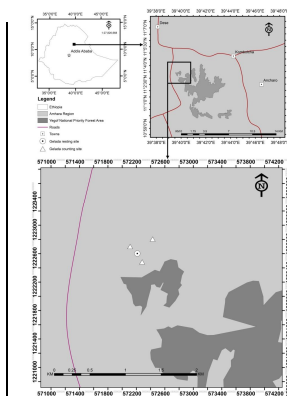
"What if..." questions are posed to determine what happens, for example, if a new road is added to a network or if a toxic substance seeps into the local ground water supply. Answering this type of question requires both geographic and other information (as well as specific models). GIS permits spatial operations.



Questions GIS can Answer

- **Non-spatial Questions**

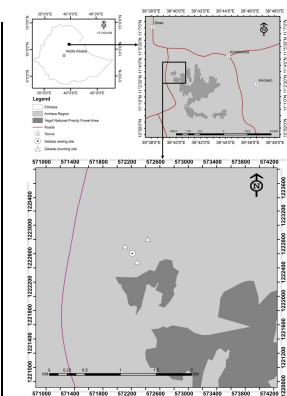
"What's the average number of people working as Estate Surveyors and Agents in each location?" is a non-spatial question - the answer to which does not require the stored value of latitude and longitude; nor does it describe where the places are in relation with each other.



Questions GIS can Answer

- **Spatial Questions**

"How many people work with estate firms in the major urban centers of Lagos metropolis?" OR "Which centre lie within 10 Km of each other?" OR "What is the shortest route passing through all these centers?". These are spatial questions that can only be answered using latitude and longitude data and other information such as the radius of earth. Geographic Information Systems can answer such questions.

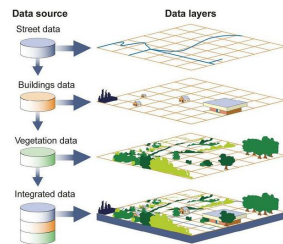




Definition of GIS data

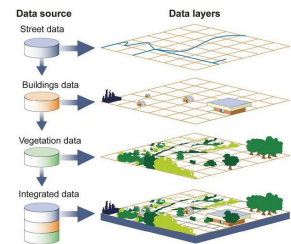
Definition of GIS data

- GIS data also known as Spatial data or geospatial data. it is information about a physical object that can be represented by numerical values in a geographic coordinate system.



Definition of GIS data

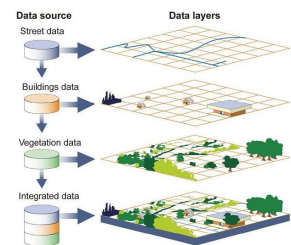
- Generally speaking, spatial data represents the location, size and shape of an object on planet Earth such as a building, lake, mountain or township. Spatial data may also include attributes that provide more information about the entity that is being represented. Geographic Information Systems (GIS) software applications can be used to access, visualize, manipulate and analyze geospatial data.



Database | Structure

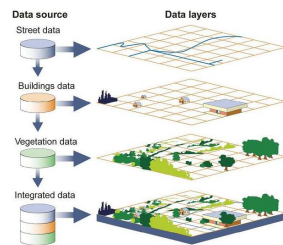
Database Structure

- As we all know, we need some information for GIS analysis. Any information needs to be fed in the form of data and they are organized in form of databases (collection of information about things and their relationship to one another).



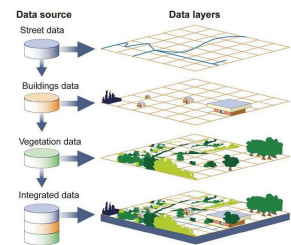
Database Structure

- A database, in turn, is typically organized according to general data structures (a theory of how a database is supposed to look like).
- So, understanding the nature of databases and database management systems is, therefore, crucial to understanding the creation and handling of data in a GIS environment.



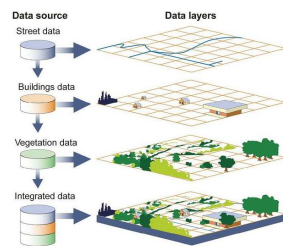
Database Structure

- **Spatial Database:** Spatial databases are the store information related to objects of particular space. A spatial database is a database that is optimized to store and query data that is related to objects in space, including points, lines and polygons.



Database Structure

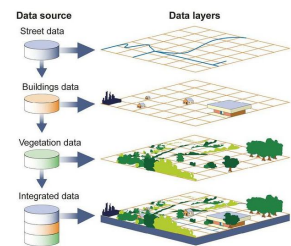
- The spatial database is also called as geometry or features. The content of a spatial database depends on its intended purpose, which in turn dependent on the organization using it.



Database Structure

Characteristics of spatial database

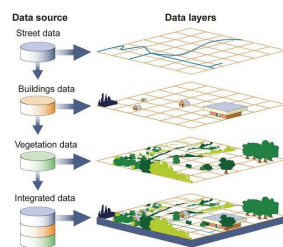
- Data should contain detailed information of the same time period for all its measured variables.
- Data should be accurate in terms of the geographical location or positions of features.
- Data should be exactly compatible with other information that may be overlain with it.
- Data should reveal the nature of phenomena without error
- Data can be easily updated on a regular schedule
- Data has to be accessible to whoever needs it and is authorized to use it



Database Structure

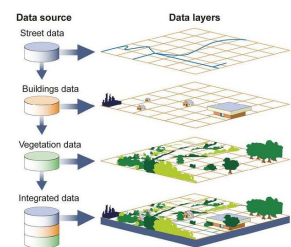
Functions of spatial database

- To perform its functions, spatial databases make use of spatial query types
- Spatial Measurements: Find the distance between points, polygon area, etc.
- Spatial Functions: Modify existing features to create new ones, for example by providing a buffer around them, intersecting features, etc.



Database Structure

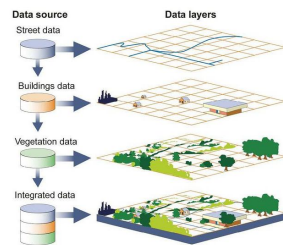
- **Spatial Predicates:** Allows true/false queries such as "is there a residence located within a mile of the area we are planning to build the landfill?"
- **Constructor Functions:** Creates new features.
- **Observer Functions:** specific information about a feature such as the location of the center of a circle.



Database Structure

Spatial Data Model :

- Real world features are represented in GIS using a spatial data model. GIS data represents real objects (such as roads, land use, elevation, trees, waterways, etc.). Real objects can be divided into two abstractions: discrete objects (e.g., a house, a roundabout, or a borehole) and continuous fields (such as rainfall amount, vegetation, or elevations).

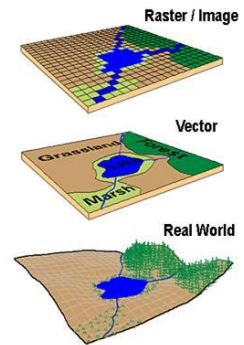


Database Structure

- Traditionally, there are two broad methods or models used to store spatial data in a GIS: *vector structures* and *raster structures* (Images).

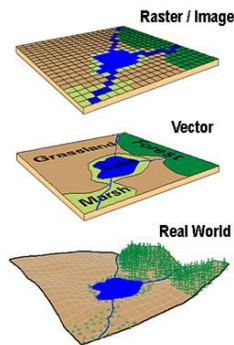
Vector Structure:

- In a GIS, geographical features are often expressed as vectors, by considering those features as geometrical shapes.



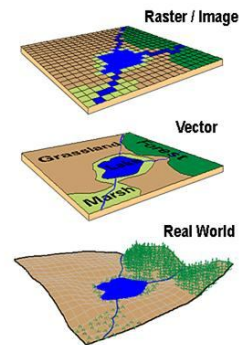
Database Structure

- Vector digital data have been captured as points (Zero-dimensional points are used for geographical features that can best be expressed by a single point reference), lines (a series of point coordinates line one-dimensional lines or polylines are used for linear features such as rivers, roads, railroads, trails, and topographic lines and line features can measure distance.),



Database Structure

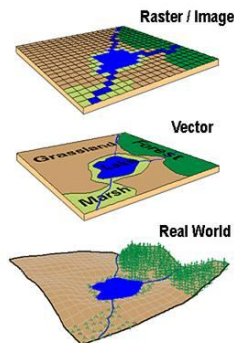
- Areas (shapes bounded by lines or two-dimensional polygons are used for geographical features that cover a particular area of the earth's surface). Polygon features can measure perimeter and area.



Database Structure

Raster Structure:

- A raster data type is, in essence, any type of digital image represented by reducible and enlargeable grids (also known as cells or pixels). Following figure illustrates the representation of point, linear and areal geographical features in a raster format.



Database Structure

- Non-Spatial Database:** Non-spatial data (also called *attribute* or *characteristic* data) is that information which is independent of all geometric considerations. For example, a tree is a geographic feature, but the type, height, and age of the tree are non-spatial data because they are independent of the tree's location.
- In a GIS environment, attribute data are commonly stored in a tabular form. Presently, the Relational Database Management System (RDBMS) is the most widely used commercial data management tool in GIS implementation and application.

Database Structure

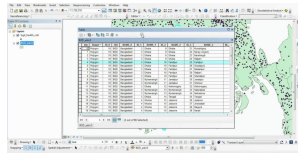
Reason for use of RDBMS in GIS

- *Simplicity* in organisation and data modeling
- *Flexibility* - data can be manipulated in an ad hoc manner by joining tables
- *Efficiency* of storage – proper design of data tables can reduce redundancy
- *Queries* do not need to take into account the internal organization of data.

Data source | and input

Data Source and Input

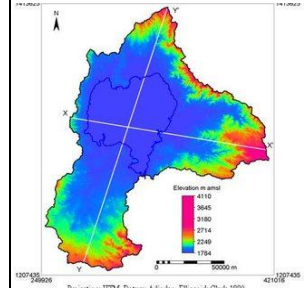
- As previously identified, two types of data are input into a GIS, spatial and attribute. The data input process is the operation of encoding both types of data into the GIS database formats.



Data Source and Input

The most common general sources for spatial data are:

- Hard copy maps;
- Aerial photographs;
- Point data samples from surveys;
- Remotely-sensed imagery;
- Existing digital data files.



Data Source and Input

Existing hard copy maps, e.g. sometimes referred to as *analogue maps*, provide the most popular source for any GIS project.



Data Source and Input

Potential users should be aware that while there are many private sector firms specializing in providing digital data, federal, provincial and state government agencies are an excellent source of data. Because of the large costs associated with data capture and input, government departments are often the only agencies with financial resources and manpower funding to invest in data compilation.



Data Source and Input

The Ethiopian Mapping Agency (EMA) is a branch of the Ethiopian government, a department within the Ministry of Finance and Cooperation that is responsible for cartographic mapping and remote sensing activities in Ethiopia. The EMA has expanded its operation to include a comprehensive map revision program in addition to various phases of digital mapping and information technology.



Assignment

Data input techniques:

There are at least four basic procedures for inputting spatial data into a GIS. These are:

- Manual digitizing;
- Automatic scanning;
- Entry of coordinates using coordinate geometry;
- Conversion of existing digital data.



GIS | Analysis

GIS analysis

There are at different analysis in a GIS. These are:

- Area analysis;
- Buffer analysis;
- Heat map analysis;
- Near analysis;
- Hotspot analysis.



Assignment: Provide the explanation on each one of them

GIS application | and its importance

GIS application and its importance

A GIS is a computer system that is specially designed to carry, reserve, manage, interpret, distribute, and display a variety of spatial and geographical data. These days, these GIS applications have become a necessity in various types of organization.



GIS application and its importance

GIS in Mapping

Mapping is a central function of Geographic Information System, it makes easy for a person to interpret the data into visual interpretation.

There are different people of various professions that use the map to communicate.

The best example of GIS mapping solutions is Google map



GIS application and its importance

Telecom and Network services

GIS application can be a great planning and decision making tool for telecom industries. It helps wireless telecommunication companies to incorporate geographic data into their network design so that they can easily plan, optimize, maintain, and check other activities



GIS application and its importance

Accident Analysis and Hot Spot Analysis

GIS has a great role to play even in minimizing accident hazard on roads. Yes, the current road network helps in optimizing which measures the road safety and check on where it needs to be improved. This all can only be achieved if you have proper traffic systems, thus, this GIS helps in rerouting the design.



GIS application and its importance

Urban Planning

GIS application also helps in analysing the urban population and also checks from where the growth is expanding. Therefore, it finds suitable sites for further urban development. In identifying it checks on several factors such as land accessibility, land's depth, and land should have a good supply of water.



Coordinate | System

Coordinate system

A coordinate system is a reference system used to represent the locations of geographic features, and observations such as GPS locations within a common geographic framework.

Coordinate systems provide a framework for defining real-world locations.



Non-coordinate system

Any place or thing that do not gives the direction is called as non-coordinate system.

Examples are

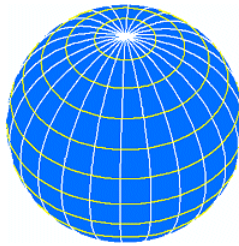
- Postal address
- Postal code
- Telephone codes
- House numbers
- Street address



Geographic coordinate system

A geographic coordinate system is a reference system for identifying locations and measuring features on the curved surface of the earth. It consists of a network of intersecting lines called a graticule.

These coordinates system can gives the direction

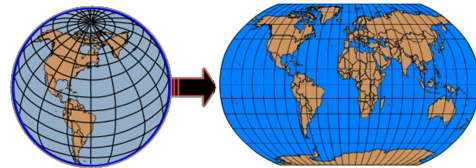


Types of coordinate system

There are two common types of coordinate systems used in GIS:

Angular or spherical coordinate system such as latitude–longitude. These are often referred to as geographic coordinate systems.

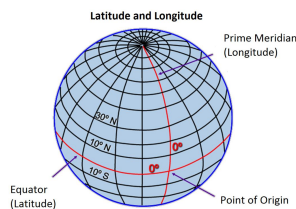
Projected or rectangular coordinate system based on a map projection such as universal transverse Mercator all of which provide various mechanisms to project maps of the earth's spherical surface onto a two dimensional rectangular coordinate system



Angular or Spherical Coordinate System

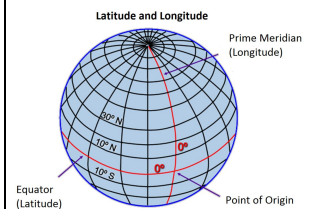
The graticule is made up of vertical lines, called lines of longitude, and horizontal lines, called lines of latitude. Because the earth is spherical, these lines form circles.

In a angular or spherical coordinate system, measurements are expressed in degrees, minutes, and seconds. A degree is 1/360th of a circle. Each degree can be divided into 60 minutes, and each minute can be divided into 60 seconds.



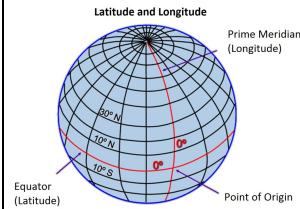
Angular or Spherical Coordinate System

Lines of longitude are called meridians. Measures of longitude begin at the prime meridian (which defines the zero value for longitude) and range from 0° to 180° going east and from 0° to -180° going west. Lines of latitude are called parallels. Measures of latitude begin at the equator and range from 0° to 90° from the equator to the north pole and from 0° to -90° from the equator to the south pole



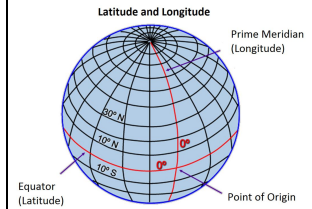
Angular or Spherical Coordinate System

The prime meridian (vertical red line) is the starting point for longitude and has a value of 0. The equator (horizontal red line) is the starting point for latitude and has a value of 0. It runs midway between the north and south poles, dividing the earth into northern and southern hemispheres.



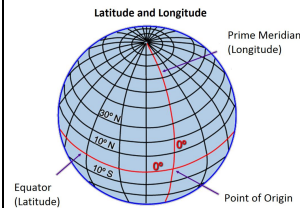
Angular or Spherical Coordinate System

- **Choosing which meridian** will be the prime meridian
- The Spanish have used a meridian passing through Madrid,
- The French a meridian passing through Paris, and during the
- American Revolution considered London or Philadelphia as the starting point.
- Later, the United States adopted Washington, D.C. as the prime meridian.
- Finally, in 1884, an International Meridian Conference was held in Washington, D.C., and the Observatory of Greenwich in Great Britain was adopted as the "official" prime meridian.



Angular or Spherical Coordinate System

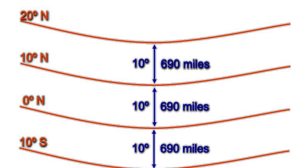
- Angular coordinate system perfectly suited to the ellipsoidal shape of the earth
- Position coordinates are based on an angular distance from known reference points
- The reference point is where the prime meridian and equator intersect
- This coordinate system is used for nautical (Ship navigation) and aeronautical navigation



Characteristics of Latitude

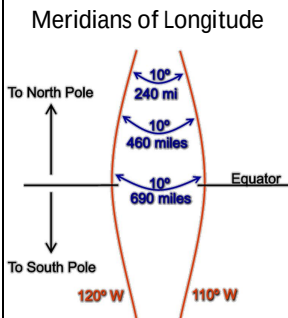
- Latitude is composed of parallels which are equally spaced circles around the earth paralleling to equator
- Parallels are designated by their angle north or south of the equator
- The equator is 0° latitude and north and south poles are at 90° angles from the equator
- The linear distance between parallel (Latitude) lines never changes regardless of their position on the earth

Parallels of Latitude



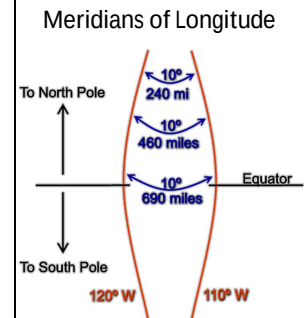
Characteristics of Longitude

- Longitude is comprised of meridians that form one-half or the circle or plane
- Meridians are designed by their angles west or east of the prime meridian
- The prime meridian is designated 0° and extends from the north pole to the south pole through greenwich, England.

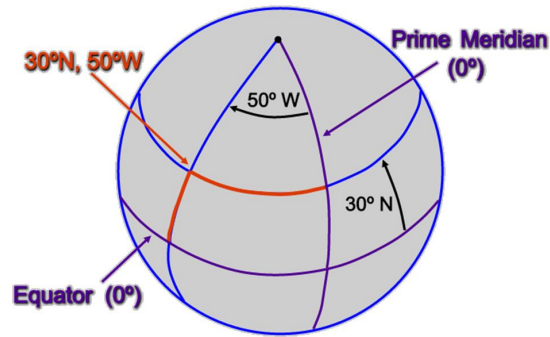


Characteristics of Longitude

- Meridians are angled and do not parallel each other
- The linear distance between one degree of longitude at the equator is approximately 690 statute miles
- The linear distance between one degree of longitude at the arctic circle is only about 26 statute miles



Determining Latitude and Longitude

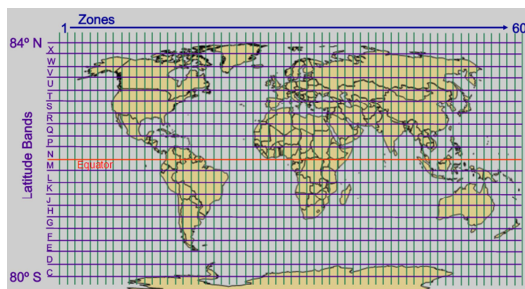


Determining Latitude and Longitude



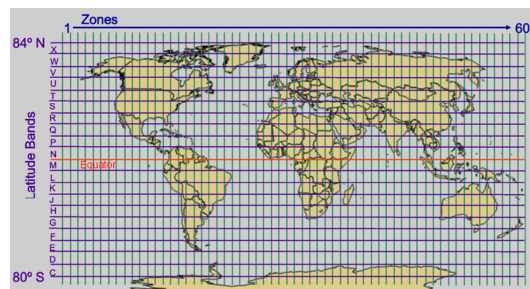
Universal Transverse Mercator

- Is a rectangular (Planar) coordinate system based on the latitude and longitude (Geographic) coordinate system.



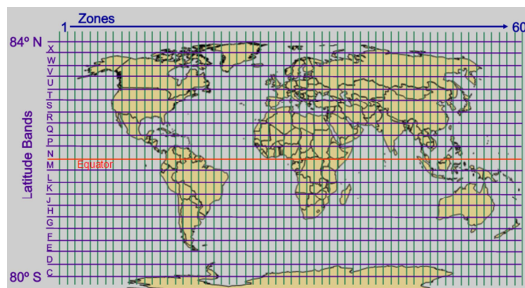
Universal Transverse Mercator

- The earth is divided into 60 UTM zones, starting at the international date line, (each 6° of longitude in width) and 20 latitude bands between 80°S and 84°N latitude (Each latitude band is 8° high)



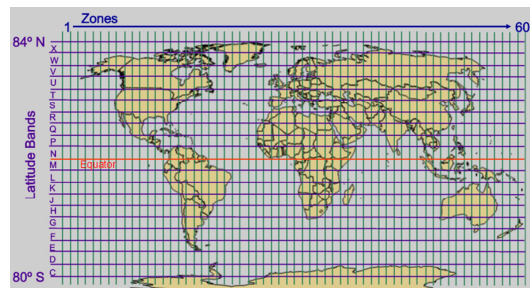
Universal Transverse Mercator

- In latitude band, letter "C" starts at 80°S increasing up until "X", omitting the letters "I" and "O" (because of their similarity to the numerals one and zero). The last latitude band, "X", is extended an extra 4 degrees, so it ends at 84°N latitude, thus covering the northernmost land on Earth.



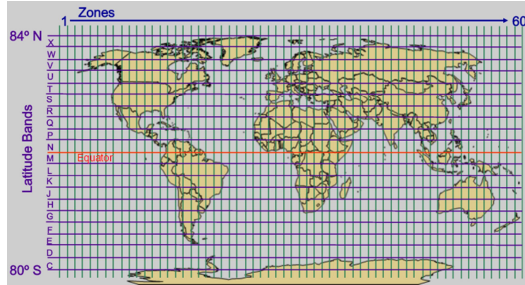
Universal Transverse Mercator

- Latitude bands "A" and "B" do exist, as do bands "Y" and "Z". They cover the western and eastern sides of the Antarctic and Arctic regions respectively. Note: The letter "N" is the first letter in "northern hemisphere", so any letter coming before "N" is in the southern hemisphere, and letter "N" and after is in the northern hemisphere.



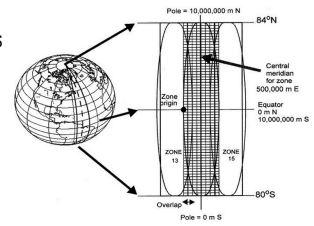
Universal Transverse Mercator

- Sixty zones allows the earth to be projected onto maps with minimal distortion
- Coordinates are expressed in meters
- The combination of a zone and a latitude band defines a grid zone. The zone is always written first, followed by the latitude band.



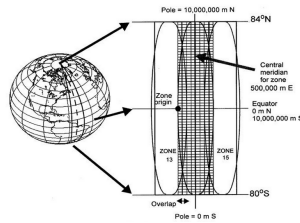
Universal Transverse Mercator

- The easting coordinate of a point is measured from the false origin 500000 meters as it is assigned arbitrarily at central meridian. Within a zone, easting values increase towards east.
- That is 8 meters east of central meridian has an easting of $500000 + 8 = 500008\text{mE}$. The easting of a point 350m towards west of central meridian would be $500000 - 350 = 499650\text{mE}$.



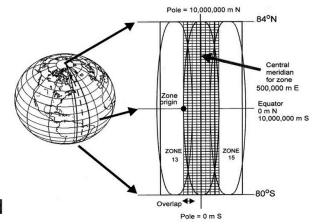
Universal Transverse Mercator

- The east-west distance between two points is obtained by the difference of their easting values. The distance between the above points is $500008 - 499650 = 358\text{m}$.
- Longitude lines are furthest apart at the equator, where latitude is zero.



Universal Transverse Mercator

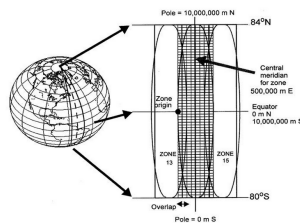
- Therefore the maximum width of a UTM zone occurs on the equator. **In general the easting values can not be larger than 834000m and smaller than 166000m.** As a result, an easting coordinate is always a six digit number. Sometimes in GPS systems and GIS software, the easting values are preceded with a 0 in order to represent them as 7 digit numbers.



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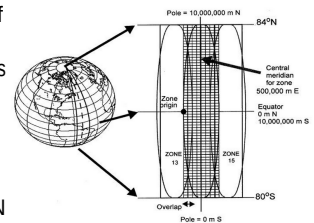
Universal Transverse Mercator

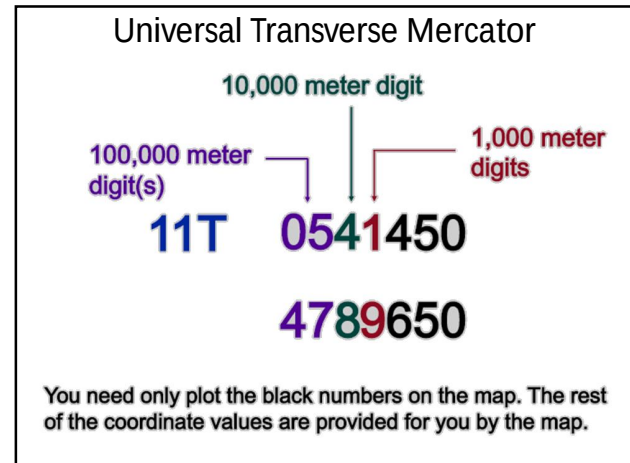
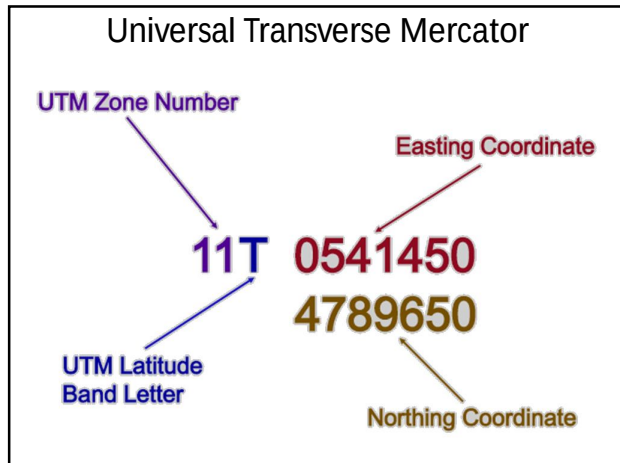
- A northing value in northern hemisphere specifies the number of meters a point is located north of the equator. The northing of a point south of the equator is equal to 10,000,000m minus its distance from the equator. In both northern and southern hemispheres, northing values increase from south to north.



Universal Transverse Mercator

- A point located 34m south of the equator has a northing of 9999966mN, while a point 34m north of the equator has a northing of 0000034mN.
- The north-south distance between two points north of equator with northings of 4867834mN and 4812382mN is $4867834 - 4812382 = 55452\text{m}$.



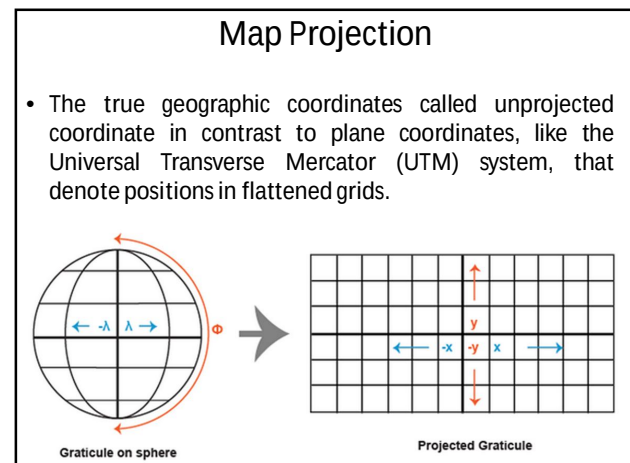
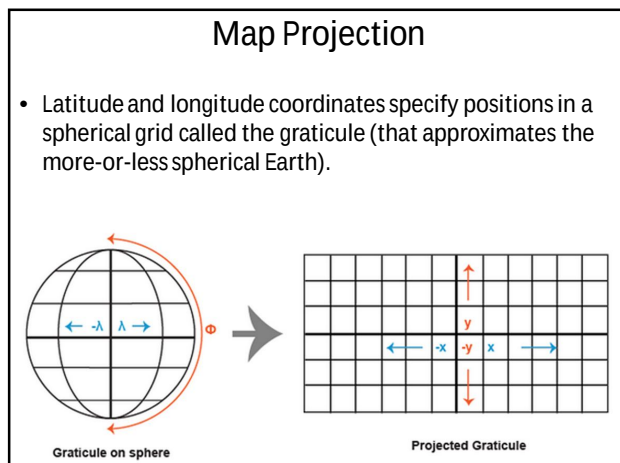


Universal Polar Stereographic coordinate system

- According to this, the Northern Hemisphere's polar region extends from 84 degrees north latitude to the North Pole, which is located at 0 degrees north latitude. This region is split in half, with the Western Hemisphere creating Zone Y and the Eastern Hemisphere creating Zone Z.

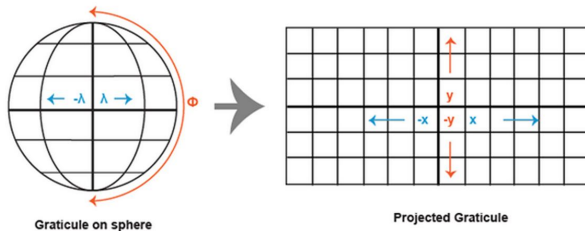
Universal Polar Stereographic coordinate system

- The Southern Hemisphere's polar region extends from 80° south latitude to the South Pole, which is located at 0° south latitude. This region is split in half, with the Western Hemisphere creating Zone A and the Eastern Hemisphere creating Zone B.



Map Projection

- These georeferenced plane coordinates are referred to as projected. The mathematical equations used to project latitude and longitude coordinates to plane coordinates are called map projections.



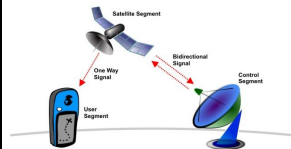
Global Positioning System

- GPS or Global Positioning System is a network of orbiting satellites that send precise details of their position in space back to earth.



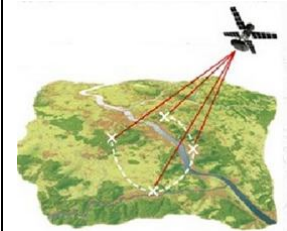
Global Positioning System

- GPS have three segments. They are space, control and user segments.
- A global network tracking system with a master control station is based at the Schriever Air Force Base in Colorado United States of America. This control unit tracks the position of the GPS satellite



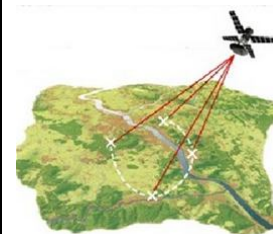
Global Positioning System

- GPS satellites circle the Earth twice a day in a precise orbit. Each satellite transmits a unique signal and orbital parameters that allow GPS devices to decode and compute the precise location of the satellite.



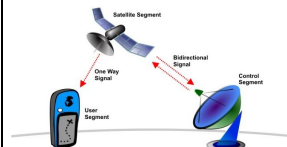
Global Positioning System

- Essentially, the GPS receiver are made to communicate with GPS satellites (Which have a much better view of the earth) to find out exactly where they are on the global scale of things



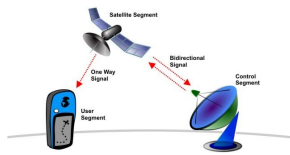
Global Positioning System

- The signals are obtained by user segment from space segment are used to calculate the exact position, speed and time at the particular location.
- GPS receivers use this information and trilateration to calculate a user's exact location.



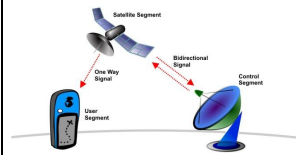
Global Positioning System

- Space segment emits two types of signals. They are
- L1 (1575.42 MHz) for civil use
- L2 (1227.60 MHz) for military use
- Minimum of 9 satellites signals are required for recording the position when we use German GPS user segment.



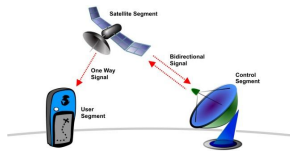
Global Positioning System

- The GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is
- $\text{Velocity} \times \text{Time} = \text{Distance}$
- Radio waves travel at the speed of light, roughly 186,000 miles per second (mps)



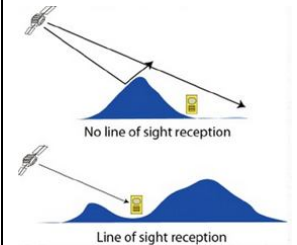
Global Positioning System

- If it takes 0.06 seconds to receive a signal transmitted by a satellite floating directly overhead, use this formula to find your distance from the satellite
- $186,000 \times 0.06 = 11,160$ miles



Global Positioning System

- Line of sight is the ability to draw a straight line between two objects without any other objects getting in the way. GPS transmissions are line of sight transmissions. It means obstructions such as trees, buildings, any natural formations may prevent clear line of sight.



Applications

- Self-navigation for automated machines.
- Aircraft tracking
- Vehicle tracking systems
- Military units: for tracking a target
- Motion measurements of earthquakes and volcanoes





Geographic Information System

By
Dr. K. S. Goudar

Application of GIS | in Wildlife Ecology

Today.....

1. Population viability analysis
2. Home range
3. Human-wildlife conflicts
4. Wildlife conservation
 - a. Population distribution
 - b. Habitat use
 - c. Current regional biodiversity

Population Viability Analysis

Population Viability Analysis

- The use of quantitative methods to predict the likely future status of a population or metapopulation

Or

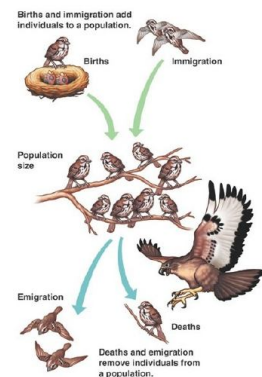
- A quantitative analysis of population dynamics with the goal of assessing extinction risk



Population Viability Analysis

What is population dynamics

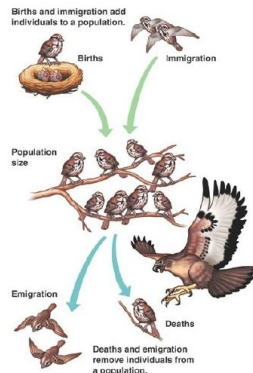
- Population sizes change over time. The population sizes are affected by many things
 1. Demographic uncertainty
 2. Environmental uncertainty
 3. Genetic uncertainty



Population Viability Analysis

Demographic uncertainty

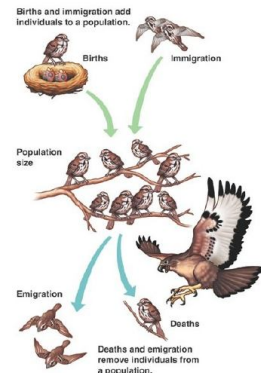
- Random events in survival and reproduction of individuals
- Example are skewed sex ration and unusual deaths
- These are mainly affect the small population



Population Viability Analysis

Environmental uncertainty :

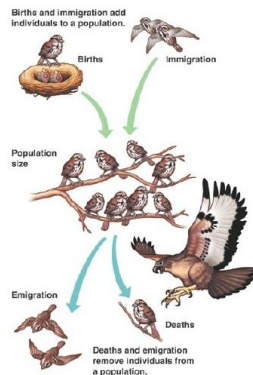
- Changes in weather, food supply, and the populations of competitors, predators and parasites
- Affects populations of all sizes



Population Viability Analysis

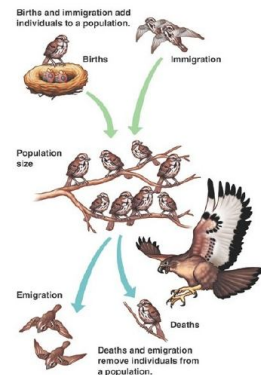
Genetic uncertainty

- a. important for small populations
- Founder effects (is the loss of genetic variation that occurs when a new population is established by a very small number of individuals from a larger population),



Population Viability Analysis

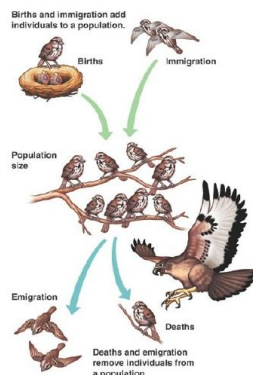
genetic drift (random changes in the frequency of alleles in a gene pool) and inbreeding (breed from closely related people or animals) are the genetic factors



Population Viability Analysis

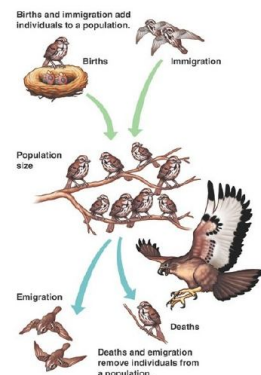
Information needed for population viability analysis:

- The mathematical and statistical modeling used in PVA requires lots of detailed ecological information on the growth and vital rates of the selected species to have any degree of accuracy



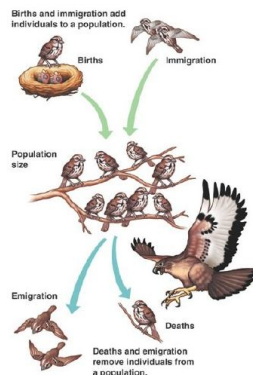
Population Viability Analysis

- For each species, information is required on the morphology, environment, distribution, biotic interactions, behavior, population demography, genetics and physiology



Population Viability Analysis

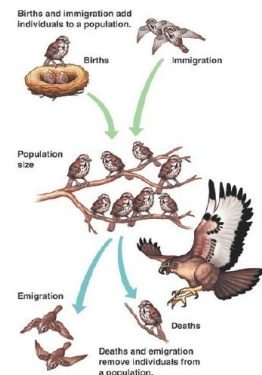
- This information may be compiled from
 - Published literature
 - Unpublished literature
 - Fieldwork
 - The knowledge of experts
 - The knowledge of locals



Population Viability Analysis

Factors affecting effective population size:

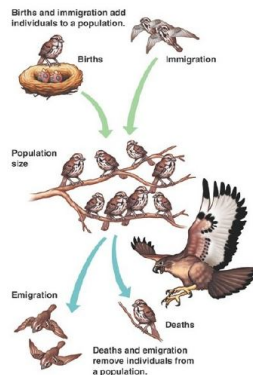
- Unequal sex ratios
- Variation in reproductive output
- Population fluctuations
- Whether or not generations overlap
- Age structure
- Dispersal
- The distribution of individuals
- inbreeding



Population Viability Analysis

Uses of PVA:

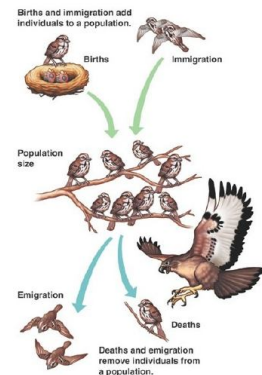
- Estimate the extinction probability for a population
- Determine the minimum viable population
- Determine the minimum reserve size
- Predict future population size
- Shows the importance of recovery efforts



Population Viability Analysis

Uses of PVA:

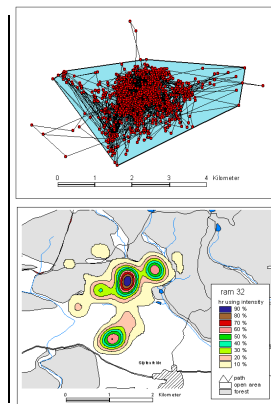
- Identify key stages of the life cycle on which to focus recovery efforts can be taken
- Compare proposed management options and develop action plans for recovery efforts
- Evaluate existing recovery efforts
- Explore and evaluate the potential input of habitat loss or the consequences of assumptions for small populations



Home Range Analysis

Home Range Analysis

- Home range is area transversed by the individuals in its normal activities for food gathering, mating and caring for young ones.
- There are several methods to estimate home ranges of wildlife. They are
 - Polygon method
 - Center of activity method
 - Nonparametric method



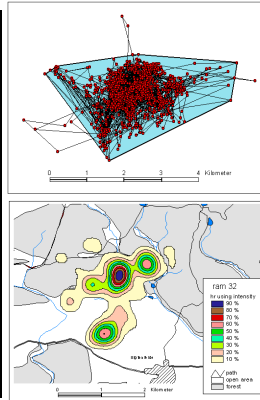
Home Range Analysis

Polygon method:

This estimators are derived from the peripheral points and it provides the extent of the animal range.

Center of activity method:

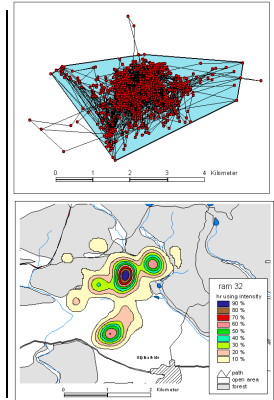
This estimators are derived by assuming a parametric form the utilization distribution function and putting them in the form of activity data



Home Range Analysis

Nonparametric method:

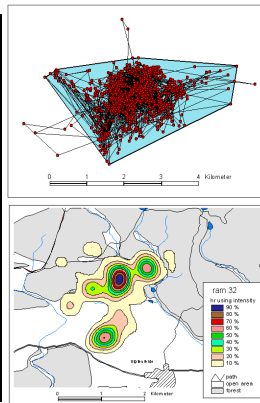
This estimators are derived by approximating the utilization distribution function using robust density estimator on geographic coordinates.



Home Range Analysis

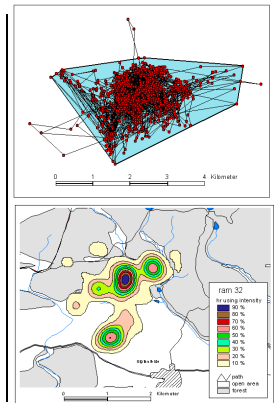
Data evaluation with a GIS:

The location of animals obtained by GPS telemetry Are stored as Cartesian coordinates. For further evaluation the data are converted to Gauss-Krueger coordinates and transferred as dBase files to a geographical information system



Home Range Analysis

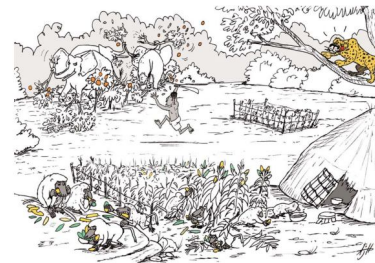
For construction of the GIS various thematic maps of the investigations areas are digitalized and overlaid with the position coordinates of the investigated animals. Then data is analyzed using ArcView software.



Human Wildlife Conflict

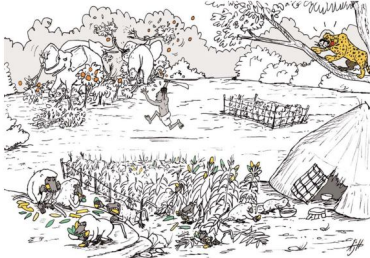
Human Wildlife Conflict

- According to the 2003 International Union for the Conservation of Nature (IUCN), human-wildlife conflict occurs when wildlife requirements encroach on those of human populations, with costs both to residents and wild animals



Human Wildlife Conflict

- Human-wildlife conflict has been in existence for as long as humans and wild animals have shared the same landscapes and resources.



Human Wildlife Conflict

- Human-wildlife conflict does not occur only in Africa. Nowadays human wildlife conflict exists in one form or another all over the world. Conflict between humans and crocodiles, for example, has been reported in 33 countries



Human Wildlife Conflict

- From history point of view, as per the fossil records first hominids fell prey to the animals with which they shared their habitats and shelters. Forensic evidence has recently demonstrated that the "Taung skull", perhaps the most famous hominid fossil, which was discovered in South Africa in 1924, belonged to a child who was killed by an eagle two million years ago

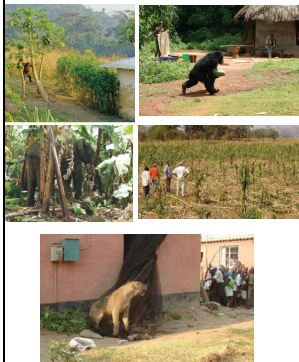


Human Wildlife Conflict

- In fact, the relationships between people and natural resources are extremely important to human societies.
- Since ancient times, human explore or exploit wildlife for subsistence and commercial purposes.
- The most important anthropogenic activities are deforestation and hunting. Deforestation causes fragments and hunting impacts species populations. In fact, it alters the overall function, structure and composition of the ecosystem.

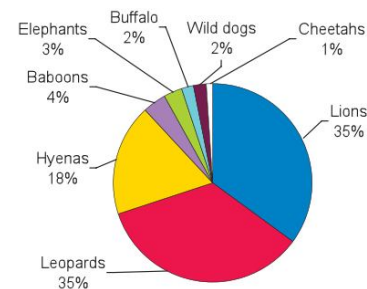
Human Wildlife Conflict

- Damage caused by wild animals are continuous and it can be a various forms which include
 - **Crop damage,**
 - **Livestock predation,**
 - **Property damage and attacks on humans**
- This accounts another way of economic loss of fellow Ethiopians and it is most neglected in this country like other developing countries.



Human Wildlife Conflict

FIGURE 1
Domestic animals killed by wild predators in the African Wildlife Foundation (AWF) Samburu Heartland, Kenya (% of reported deaths)



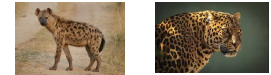
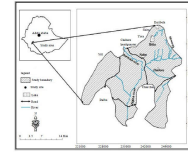
Human Wildlife Conflict

- As per the pastoral people, spotted hyena followed by leopard were responsible for predominant predation of livestock in Bali mountain (Atickem et al., 2010).



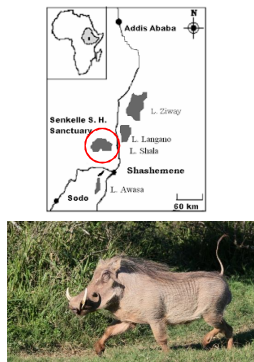
Human Wildlife Conflict

- The most problematic wild animals that damage crop were Vervet monkey and warthog (Datiko and Bekele, 2013a) and hyena and leopard were responsible for livestock predation around Chebera Churachura National park (Datiko and Bekele, 2013b).



Human Wildlife Conflict

- However, warthog was considered as notorious pest in Senkele Swayne's Heartbeest Sanctuary (Kumssa and Bekele, 2013).



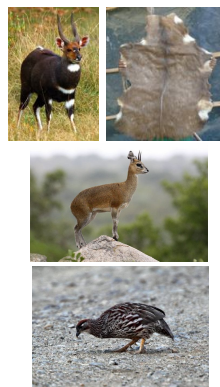
Human Wildlife Conflict

- Hyenas attacks on humans at regular intervals was reported in the town of Kombolcha in the Hararge region of eastern Ethiopia (Baynes-Rock and Marcus, 2013)



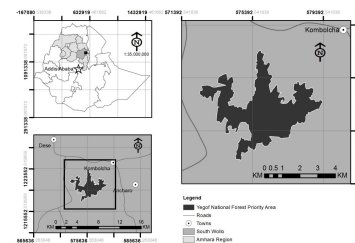
Human Wildlife Conflict

- In another independent study from biology department showed that local community utilizing the wild fauna from Yegof national forest priority area which are suppose to be a natural food for the some of the carnivore
- Menelik's Bushbuck; Amharic: Dukula.
- Klipspringer (Rock jumper)
- Erckel's francolin



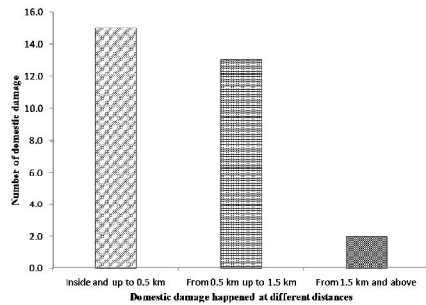
Human Wildlife Conflict

- Considering the facts that the problem of domestic damage are common around different reserve in this country.
- Biology department has made some efforts to identify such events



Human Wildlife Conflict

- Incidence of human wildlife conflict happened in and around Yegof National Priority Area



Wildlife Conservation

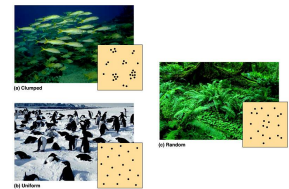
Population Distribution

- Organisms may live in flocks, herds or as solitary individuals or they may cluster around resources such as water holes. Distribution may vary with time changing with the breeding season.
- Ecologist recognize three major pattern of spatial distribution. They are



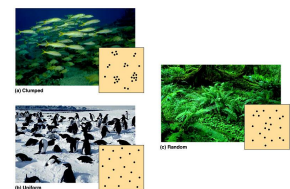
Population Distribution

- Aggregated distribution**
- In this many species form family or social groupings such as sheep herds, baboon troop, flocks of birds or schools of fish.
- Commonest pattern that can be observed in populations.
- Individuals are bunched into groups within the population.



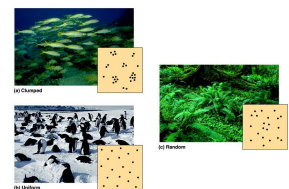
Population Distribution

- This is mainly results from the response to the unevenly distributed resources in their environment.
- Also there are positive interactions between the individuals.
- This supplies many advantages to the population such as protection from predators, reproduce and increase the population size and decrease the energetic cost of moving to do work.



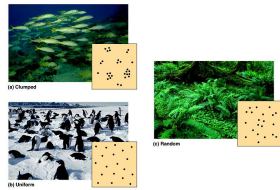
Population Distribution

- Advantages of aggregation distribution**
- Flocks or herds provide may eye on the lookout for localized food such as
- Schooling fish avoid predation by confusing the predator with countless flashing bodies dazzling in all directions.



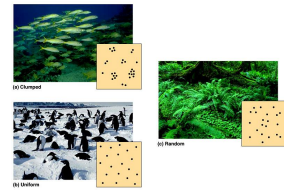
Population Distribution

- **Advantages of aggregation distribution**
- Some species such as elephant herds form temporary aggregations for mating.
- In some, animal populations cluster not for social reasons but because resources such as nutrients, shelter or water are localized.



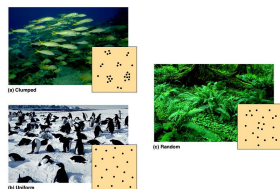
Population Distribution

- **Uniform population distributions**
- Uniform distributed organisms maintain a relatively constant distance between individuals.
- Spacing is often the result of defending scarce resources such as breeding sites, nutrients or water.



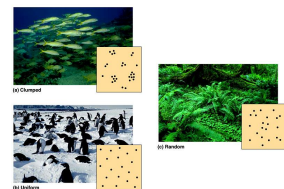
Population Distribution

- This distribution occurs most frequently among animals that defined territories.
- Shorebirds and african penguins re also found often in evenly spaced nests just out of reach of one another



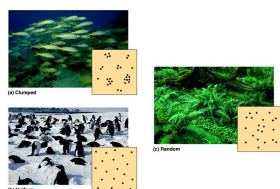
Population Distribution

- Other territorial species such as many birds of prey mate for life and mating pairs continuously occupy well defined very large and relatively uniformly spaced territories.
- Many animals such as cats mark their territories by chemical means to avoid violent face to face confrontations.



Population Distribution

- **Random population distributions**
- It is the least common distributions. In this pattern individuals do not form social groups, the resources they need are more or less equally available throughout the area they inhabit and resources are not scarce enough to required territorial spacing.



Population Distribution

- However, no vertebrate species that maintain random distribution throughout the year because they must breed.
- A behavior that makes social interaction inevitable but other than breeding and coming together to feed.



Population Distribution

- A crime feeding locations during salmon runs bears spend most of their time largely in randomly spaced isolation from one another except with their cubs



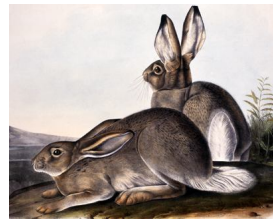
Habitat use

- Habitat – any area offering the resources (food, cover and shelter) and conditions that promote occupancy by a species.
- For example Cotton tails rabbit needs open rangeland to farm land. They utilize hedgerows, gardens and seek cover along fences to protect themselves from risks.



Habitat use

- However, white-tailed jackrabbit depends on the open prairie (Treeless grassy plain)
- It means that the area provides necessary resources and conditions for a species to occupy the respective places.



Habitat use

- **Habitat use:** The way the animal uses the collection of conditions and resources in a habitat. It is measured as relative amount of time spent in different areas within their habitat. Suppose more time they spend in a certain area means more use of resources or conditions at that location.



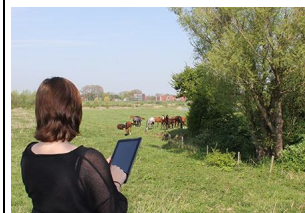
Habitat use

- So how can we study the habitat use:
- Explaining habitat use is a cornerstone of wildlife ecology. There are two approaches
- Experimental (manipulative): in this, alter factors that may be influential (Perturbation may be temporal and/or spatial and it may be lab or field based).



Habitat use

- Observational (mensurative): it is nothing but relative use to natural variations in factors that may influence (temporal and/or spatial) the habitat use
- Note: Most habitat use studies are observational



Habitat use

- **Habitat selection:** It is process both innate and learned by which animals choose which habitat components (conditions and resources) to use.
- To understand the choice of animal's habitat we use indicators which helps us to infer selection of particular conditions and resources.



Habitat use

- One popular indicator is use relative to availability. The resource selection function is one of the techniques used for habitat selection.
- What is resource selection function?
- It is observational approach to understand animal's habitat use typically within the home range which involves three steps



Habitat use

- Step 1: Obtain raw locations either by observation or by telemetry.
- Step 2: Convert locations points to utilization distribution. It is probability density function and this is nothing but quantifying time allocation or concentration of use within home range.
- Step 3: Multiple regressions that relate intensity of use to resources in a specified area typically within an animal's home range



Habitat use

Table 4
Top Far Eastern leopard RSF for the relative probability of selection at the study area scale in the Russian Far East, Southwest Primorsky Krai, 1997–2007. Bold values are significant at $p < 0.01$.

Coefficient	β	SE
Deciduous	-0.85	0.460
Meadows	-0.67	0.272
Shrubs	-0.74	0.222
Korean Pine	0.31	0.121
Agriculture	1.28	0.478
Ungulate Prey	5.27	0.802
Distance to main roads (km)	0.145	0.015
Snow cover (MODIS)	-0.34	0.204
Hillshade	-0.0027	0.0007
Dist (km) to Zapovednik	-0.053	0.007
Elevation (m)	-0.0036	0.0004
Constant, β_0	-4.94	0.010

* The constant (β_0) includes as the reference categories birch, oak, Korean pine, meadow, and agriculture, which were not significantly different from each other.

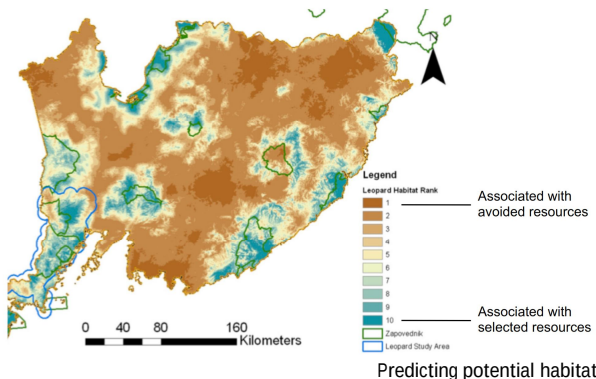


Amur leopard
(*Panthera pardus orientalis*)

avoided

Selected (big surprise!)

Habitat use



“If an egg is broken from outside force....life ends
but
it is broken from inside force life begins.
So
Great things always begin from our inside.

THANK YOU



REMOTE SENSING

By
Dr. K. S. Goudar

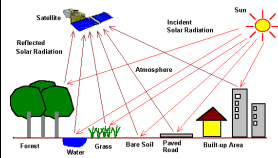
Today.....

1. Definition
2. Electromagnetic radiation
3. Electromagnetic spectrum
4. Interactions with the atmosphere
5. Radiation – target interaction

Definition

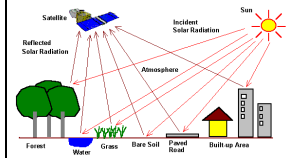
What is Remote Sensing?

If you are reading this sentence, now you are doing Remote Sensing. Infact, any information acquired from the object without touching is Remote Sensing. Following is a scientific definition of Remote Sensing.



Definition

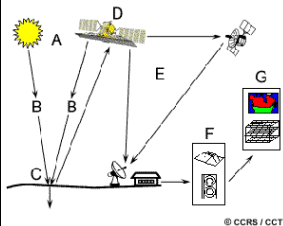
The science of acquiring information about the earth using instruments which are remote to the earth's surface, usually from aircraft or satellites. Instruments may use visiblelight, infrared or radar to obtain data. Remote sensing offers the ability to observe and collect data for large areas relatively quickly, and is an important source of data for GIS.



Definition

This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information.

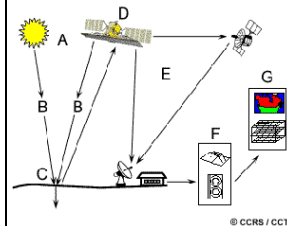
- Seven elements are involved in remote sensing. (Note, that remote sensing also involves the sensing of emitted energy and the use of non-imaging sensors.). They are,



© CCRS / CCT

Definition

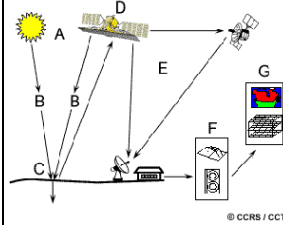
- **Energy Source or Illumination (A)** – the first requirement for remote sensing is to have an energy source which illuminates or provides electromagnetic energy to the target of interest.



© CCRS / CCT

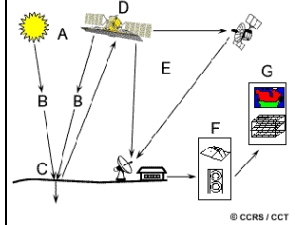
Definition

- **Radiation and the Atmosphere (B)** – as the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.



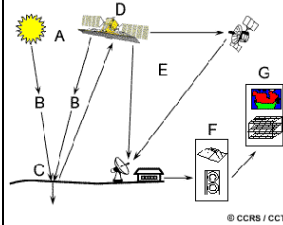
Definition

- **Interaction with the Target (C)** - Once the energy makes its way to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.



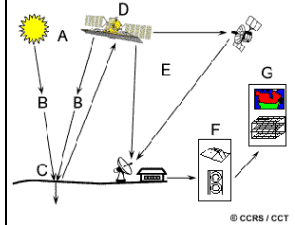
Definition

- **Recording of Energy by the Sensor (D)** - after the energy has been scattered by, or emitted from the target, we require a sensor (remote - not in contact with the target) to collect and record the electromagnetic radiation.



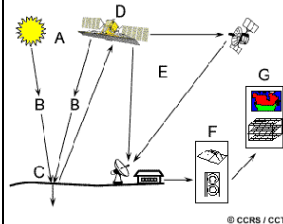
Definition

- **Transmission, Reception, and Processing (E)** - the energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image (hardcopy and/or digital).



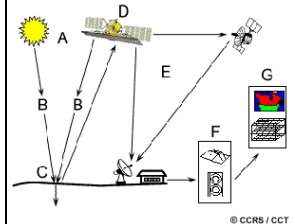
Definition

- **Interpretation and Analysis (F)** - the processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.



Definition

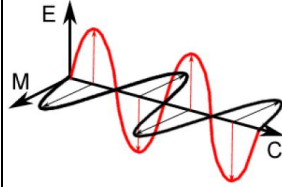
- **Application (G)** - the final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem.



Electromagnetic Radiation

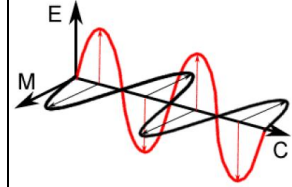
The first requirement for remote sensing is to have an **energy source to illuminate the target** (unless the sensed energy is being emitted by the target). This energy is in the form of electromagnetic radiation.

- The classes of electromagnetic radiation (EMR) are gamma radiation; X-rays; ultraviolet; visible radiation; infrared radiation; microwaves and radio waves.



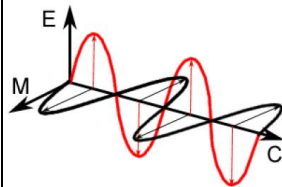
Electromagnetic Radiation

- Electromagnetic radiation consists of an electrical field (E) which varies in magnitude in a direction perpendicular to the direction in which the radiation is traveling, and a magnetic field (M) oriented at right angles to the electrical field. Both these fields travel at the speed of light (c).**



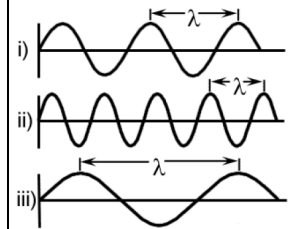
Electromagnetic Radiation

- Two characteristics of electromagnetic radiation are particularly important for understanding remote sensing. These are the
- wavelength**
- frequency.**



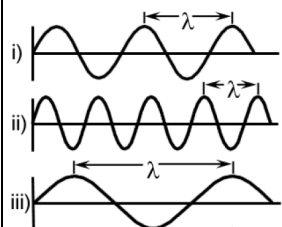
Electromagnetic Radiation

- The wavelength is the length of one wave cycle, which can be measured as the distance between successive wave crests. Wavelength is usually represented by the Greek letter lambda (λ).



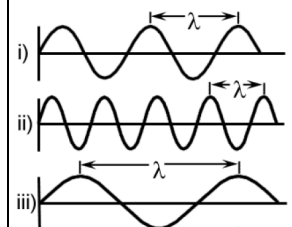
Electromagnetic Radiation

- Wavelength is measured in meters (m) or some factor of meters such as nanometres (nm, 10^{-9} metres), micrometres (μm , 10^{-6} metres), or centimeters (cm, 10^{-2} meters).



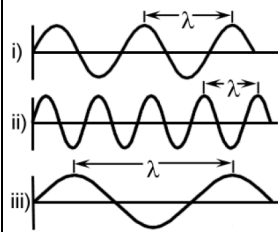
Electromagnetic Radiation

- Frequency refers to the number of cycles of a wave passing a fixed point per unit of time. Frequency is normally measured in **hertz (Hz)**, equivalent to one cycle per second, and various multiples of hertz.



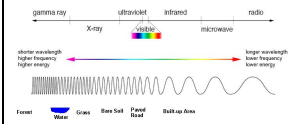
Electromagnetic Radiation

- Therefore, the two are inversely related to each other. The shorter the wavelength, the higher the frequency. The longer the wavelength, the lower the frequency. Understanding the characteristics of electromagnetic radiation in terms of their wavelength and frequency is crucial to understanding the information to be extracted from remote sensing data.



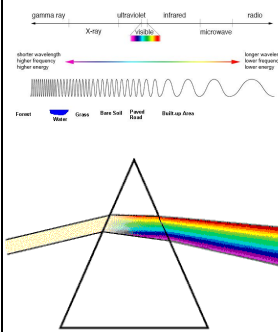
Electromagnetic Spectrum

- The **electromagnetic spectrum** ranges from the shorter wavelengths (including gamma and x-rays) to the longer wavelengths (including microwaves and broadcast radio waves). There are several regions of the electromagnetic spectrum which are useful for remote sensing.



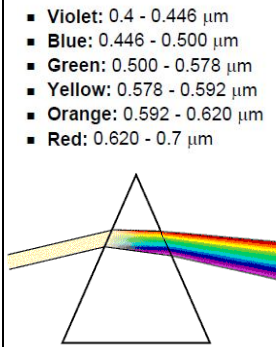
Electromagnetic Spectrum

- The **ultraviolet or UV** portion of the spectrum has the shortest wavelengths which are practical for remote sensing.
- This radiation is just beyond the violet portion of the visible wavelengths, hence its name.
- Some Earth surface materials, primarily rocks and minerals, emit visible light when illuminated by UV radiation.



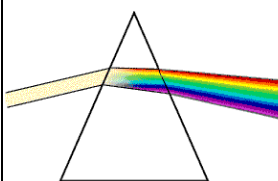
Electromagnetic Spectrum

- The light which our eyes can detect is part of the **visible spectrum**.
- The visible wavelengths cover a range from approximately 0.4 to 0.7 μm . The longest visible wavelength is red and the shortest is violet.
- It is important to note that this is the only portion of the spectrum we can associate with the concept of **colours**.



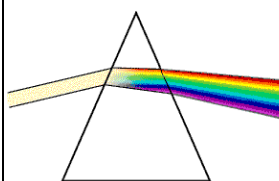
Electromagnetic Spectrum

- Blue, green, and red are the primary colors or wavelengths of the visible spectrum.
- Because these primary color can not be created from any other two colors, but all other colors can be formed by combining blue, green, and red in various proportions.



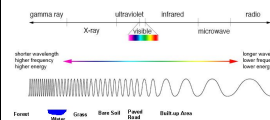
Electromagnetic Spectrum

- Although we see sunlight as a uniform or homogeneous color, it is actually composed of various wavelengths of radiation in primarily the ultraviolet, visible and infrared portions of the spectrum.
- The visible portion of this radiation can be shown in its component colors when sunlight is passed through a **prism, which bends the light in differing amounts according to wavelength**.



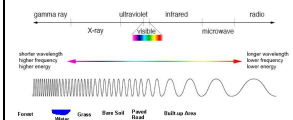
Electromagnetic Spectrum

- infrared (IR) region which covers the wavelength range from approximately $0.7\ \mu\text{m}$ to $100\ \mu\text{m}$ - more than 100 times as wide as the visible portion.
- The infrared region can be divided into two categories based on their radiation properties - the **reflected IR**, and the emitted or **thermal IR**.



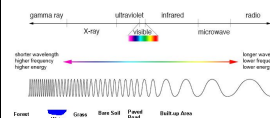
Electromagnetic Spectrum

- Radiation in the reflected IR region is used for remote sensing purposes in ways very similar to radiation in the visible portion.
- The reflected IR covers wavelengths from approximately $0.7\ \mu\text{m}$ to $3.0\ \mu\text{m}$.



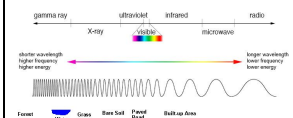
Electromagnetic Spectrum

- The thermal IR region is quite different than the visible and reflected IR portions, as this energy is essentially the radiation that is emitted from the Earth's surface in the form of heat.
- The thermal IR covers wavelengths from approximately $3.0\ \mu\text{m}$ to $100\ \mu\text{m}$.



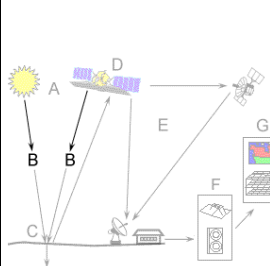
Electromagnetic Spectrum

- The portion of the spectrum of more recent interest to remote sensing is the microwave region from about $1\ \text{mm}$ to $1\ \text{m}$.
- This covers the longest wavelengths used for remote sensing.



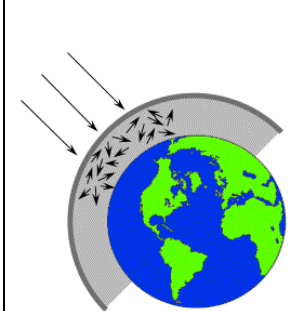
Interactions with the Atmosphere

- All Radiation detected by remote sensors pass through atmosphere. During this two things take place namely **atmospheric scattering** and **absorption**. Both scattering and absorption, in one way or the other, affect the intensity as well as the spectral composition of the available radiation.



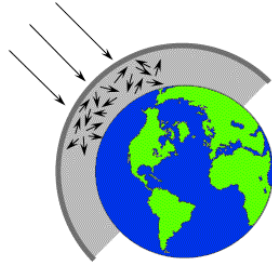
Interactions with the Atmosphere

- Scattering occurs when particles or large gas molecules present in the atmosphere interact with and cause the electromagnetic radiation to be redirected from its original path.



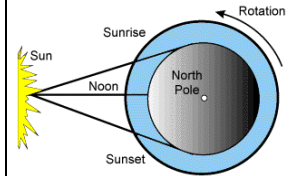
Interactions with the Atmosphere

- How much scattering takes place depends on several factors including the wavelength of the radiation, the abundance of particles or gases, and the distance the radiation travels through the atmosphere. There are three (3) types of scattering which take place.



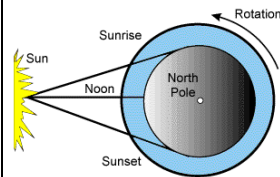
Interactions with the Atmosphere

- Rayleigh scattering** occurs when particles are very small compared to the wavelength of the radiation. These could be particles such as small specks of dust or nitrogen and oxygen molecules.



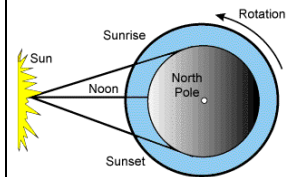
Interactions with the Atmosphere

- Rayleigh scattering causes shorter wavelengths of energy to be scattered much more than longer wavelengths.
- Rayleigh scattering is the dominant scattering mechanism in the upper atmosphere. The fact that the sky appears "blue" during the day is because of this phenomenon.



Interactions with the Atmosphere

- As sunlight passes through the atmosphere, the shorter wavelengths (i.e. blue) of the visible spectrum are scattered more than the other (longer) visible wavelengths.



Interactions with the Atmosphere

- Mie scattering** occurs when the particles are just about the same size as the wavelength of the radiation. Dust, pollen, smoke and water vapour are common causes of Mie scattering which tends to affect longer wavelengths than those affected by Rayleigh scattering.



Interactions with the Atmosphere

- Mie scattering occurs mostly in the lower portions of the atmosphere where larger particles are more abundant, and dominates when cloud conditions are overcast.



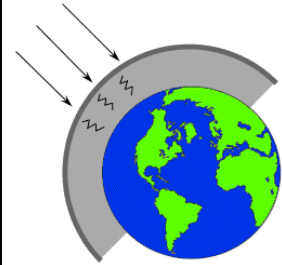
Interactions with the Atmosphere

- The final scattering mechanism of importance is called **nonselective scattering**. This occurs when the particles are much larger than the wavelength of the radiation. Water droplets and large dust particles can cause this type of scattering. In the visible wavelength, equal quantities of blue, green and red light are scattered making fog and clouds appear white.



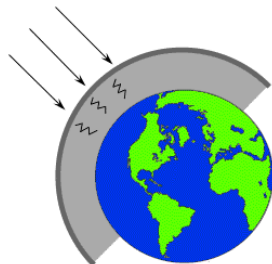
Interactions with the Atmosphere

- Absorption:** In contrast to scattering, this phenomenon causes molecules in the atmosphere to absorb energy at various wavelengths.
 - Ozone,
 - carbon dioxide, and
 - water vapour
- are the three main atmospheric constituents which absorb radiation.



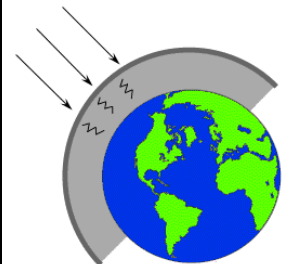
Interactions with the Atmosphere

- Ozone** serves to absorb the harmful (to most living things) ultraviolet radiation from the sun. Without this protective layer in the atmosphere our skin would burn when exposed to sunlight.



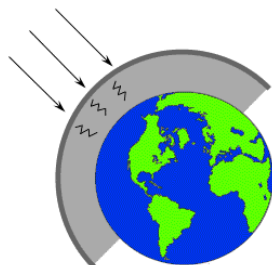
Interactions with the Atmosphere

- You may have heard **carbon dioxide** referred to as a **greenhouse gas**. This is because it tends to absorb radiation strongly in the far infrared portion of the spectrum - that area associated with thermal heating - which serves to trap this heat inside the atmosphere.



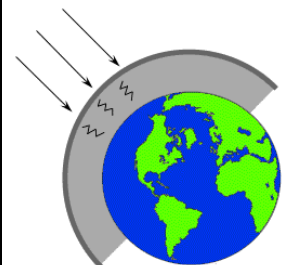
Interactions with the Atmosphere

- Water vapour in the atmosphere absorbs much of the incoming longwave infrared and shortwave microwave radiation (between $22\mu\text{m}$ and 1m). The presence of water vapour in the lower atmosphere varies greatly from location to location and at different times of the year.



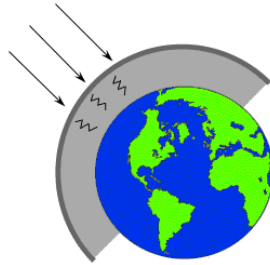
Interactions with the Atmosphere

- For example, the air mass above a desert would have very little water vapour to absorb energy, while the tropics would have high concentrations of water vapour (i.e. high humidity).



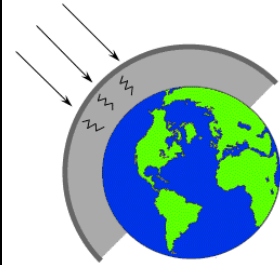
Interactions with the Atmosphere

- Because these gases absorb electromagnetic energy in very specific regions of the spectrum, they direct which part of the spectrum we can look or use for remote sensing purposes. Those areas of the spectrum which are not severely influenced by atmospheric absorption and thus, are useful to remote sensors, are called **atmospheric windows**.



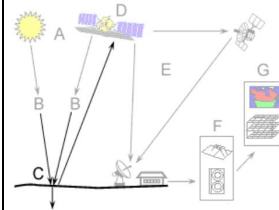
Interactions with the Atmosphere

- In short, we are forced by nature to channel our attention to those spectral regions where the atmosphere will transmit sufficient radiation to our detector.
- The visible region is the most familiar and widely used and has a wavelength range of 0.4 to 0.7 μm .



Radiation - Target Interactions

- Radiation that is not absorbed or scattered in the atmosphere can reach and interact with the Earth's surface.



Radiation - Target Interactions

- There are three (3) forms of interaction when energy strikes, or is incident (I) upon the surface.
- These are: **absorption** (A); **transmission** (T); and **reflection** (R).
- The total incident energy will interact with the surface in one or more of these three ways.



Radiation - Target Interactions

- The proportions of each will depend on the wavelength of the energy and the material and condition of the target.
- Absorption (A) occurs when radiation (energy) is absorbed into the target while transmission (T) occurs when radiation passes through a target. Reflection (R) occurs when radiation "bounces" off the target and is redirected, on of the feature.



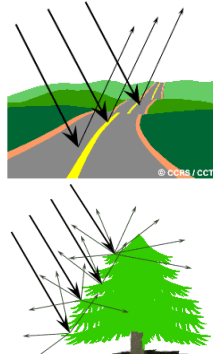
Radiation - Target Interactions

- In remote sensing, we are most interested in measuring the radiation reflected from targets.
- We refer two types of reflection, which represent the two extreme ends of the way in which energy is reflected from a target:
 - Specular reflection**
 - Diffuse reflection.**



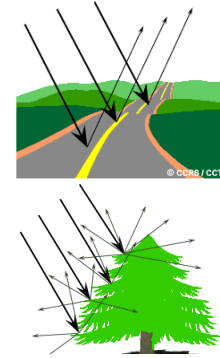
Radiation - Target Interactions

- When a surface is smooth we get **specular or mirror-like reflection** where **all (or almost 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 directions.



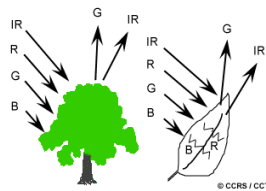
Radiation - Target Interactions

- Passive sensors** can only be used to detect energy when the naturally occurring energy is available. For all reflected energy, this can only take place during the time when the sun is illuminating the Earth.
- Active sensors**, on the other hand, provide their own energy source for illumination. The sensor emits radiation which is directed toward the target to be investigated. The radiation reflected from that target is detected and measured by the sensor.



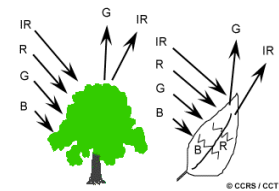
Radiation - Target Interactions

- Examples**
- Leaves:** A chemical compound in leaves called chlorophyll strongly absorbs radiation in the red and blue wavelengths but reflects green wavelengths. Leaves appear "greenest" to us in the summer, when chlorophyll content is at its maximum.
- In autumn, there is less chlorophyll in the leaves, so there is less absorption and proportionately more reflection of the red wavelengths, making the leaves appear red or yellow



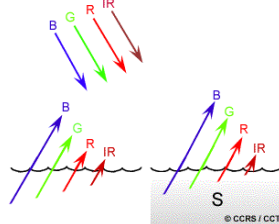
Radiation - Target Interactions

- The internal structure of healthy leaves act as excellent diffuse reflectors of near-infrared wavelengths. If our eyes were sensitive to near-infrared, trees would appear extremely bright to us at these wavelengths.
- In fact, measuring and monitoring the near-IR reflectance is one way that scientists can determine how healthy (or unhealthy) vegetation may be.



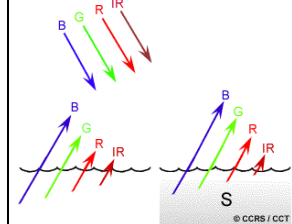
Radiation - Target Interactions

- Water:** Longer wavelength visible and near infrared radiation is absorbed more by water than shorter visible wavelengths. Thus water typically looks blue or blue-green due to stronger reflectance at these shorter wavelengths, and darker if viewed at red or near infrared wavelengths. If there is suspended sediment present in the upper layers of the water body, then this will allow better reflectivity and a brighter appearance of the water.



Radiation - Target Interactions

- By measuring the energy that is reflected (or emitted) by targets on the Earth's surface over a variety of different wavelengths, we can build up a **spectral response for that object**.
- For example, water and vegetation may reflect somewhat similarly in the visible wavelengths but are almost always separable in the infrared.
- So our choice of spectrum is Infrared.

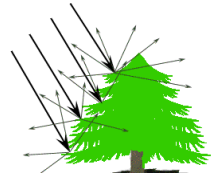
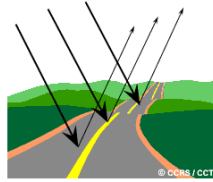


Radiation - Target Interactions

- **Passive vs. Active Sensing:**

The sun provides a very convenient source of energy for remote sensing.

- The sun's energy is either **reflected**, as it is for visible wavelengths, or absorbed and then **reemitted**, as it is for thermal infrared wavelengths.
- Remote sensing systems which measure energy that is naturally available are called **passive sensors**.



THANK YOU

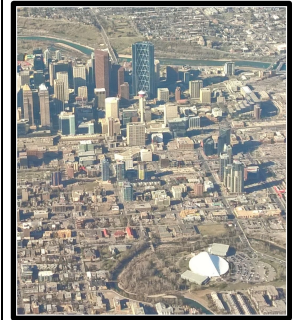


REMOTE SENSING

By
Dr. K. S. Goudar

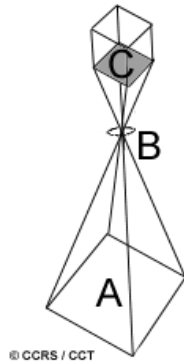
Aerial Photography

- Aerial Photography means photography from the air
- Photography is derived from two Greek words meaning "light" (phos) and "writing" (graphien).
- The aerial photograph is one of the most common versatile and commercial forms of remote sensing device.



Aerial Photography

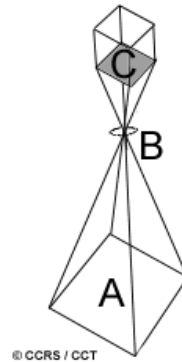
- Cameras and their use for aerial photography are the simplest and oldest of sensors used for remote sensing of the Earth's surface.
- Cameras are framing systems which acquire a near-instantaneous "snapshot" of an area (A), of the surface.



© CCRS / CCT

Aerial Photography

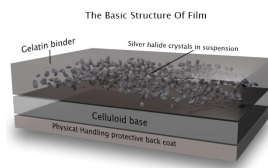
- Camera systems are passive optical sensors that use a lens (B) (or system of lenses collectively referred to as the optics) to form an image at the focal plane (C), the plane at which an image is sharply defined.



© CCRS / CCT

Photographic films and filters

- Photographic film is a strip or sheet of transparent plastic film base coated on one side with a gelatin emulsion containing microscopically small light-sensitive silver halide crystals. The sizes and other characteristics of the crystals determine the sensitivity, contrast, and resolution of the film.



Photographic films and filters

- Photographic films are sensitive to light from 0.3 μm to 0.9 μm in wavelength covering the ultraviolet (UV), visible, and near-infrared (NIR).
- **Panchromatic films are sensitive to the UV and the visible portions of the spectrum.** Panchromatic film produces black and white images and is the most common type of film used for aerial photography.



Photographic films and filters

- UV photography also uses panchromatic film, but a filter is used with the camera to absorb and block the visible energy from reaching the film. As a result, only the UV reflectance from targets is recorded.
- UV photography is not widely used, because of the atmospheric scattering and absorption that occurs in this region of the spectrum.



Photographic films and filters

- For a **normal colour photograph**, the layers are sensitive to blue, green, and red light - the same as our eyes. These photos appear to us the same way that our eyes see the environment, as the colours resemble those which would appear to us as "normal" (i.e. trees appear green, etc.).



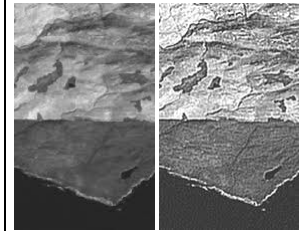
Photographic films and filters

- In a **false colour photograph**, targets with high near-infrared reflectance appear red, those with a high red reflectance appear green, and those with a high green reflectance appear blue, thus giving us a "false" presentation of the targets relative to the colour we normally perceive them to be.



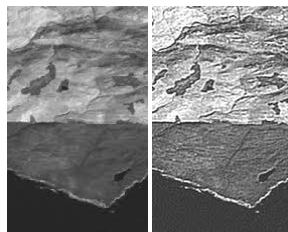
Photographic films and filters

- **Filters:** Encompasses another set of digital processing functions which are used to enhance the appearance of an image.
- Spatial filters are designed to highlight or suppress specific features in an image based on their **spatial frequency**.



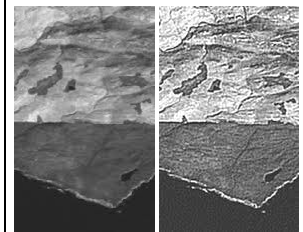
Photographic films and filters

- **Spatial frequency is related to the concept of image texture.** It refers to the frequency of the variations in tone that appear in an image.
- "Rough" textured areas of an image, where the changes in tone are abrupt.
- "Smooth" areas with little variation in tone.



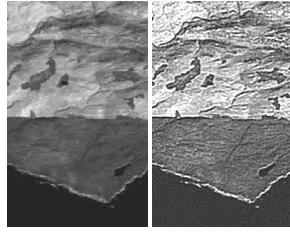
Photographic films and filters

- A low-pass filter is designed to emphasize larger, homogeneous areas of similar tone and reduce the smaller detail in an image.
- Thus, low-pass filters generally serve to smooth the appearance of an image.



Photographic films and filters

- **High-pass filters do the opposite** and serve to sharpen the appearance of fine detail in an image.
- Directional, or edge detection filters are designed to highlight linear features, such as roads or field boundaries.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

- Fiducial marks
- Fiducial axis
- Principal point
- Conjugate principle point
- Nadir point
- Isocentre
- Air base
- Photobase
- Forward overlap
- Lateral overlap
- Tilt
- Focal length
- Flying height or altitude
- Scale of aerial photograph
- Relief displacement

Geometric Characteristics of Aerial Photograph

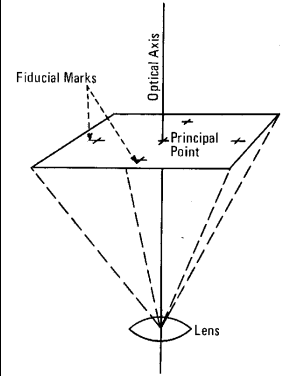
Geometrical elements of the aerial photographs

- Fiducial marks
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- Flying height or altitude
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- Relief displacement

Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

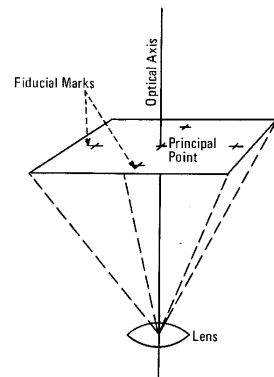
- **Fiducial marks:** Are the marks built into aerial cameras which appear on the sides or in the corners of the photo (or both), and which are used to determine the precise location of the principal point.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

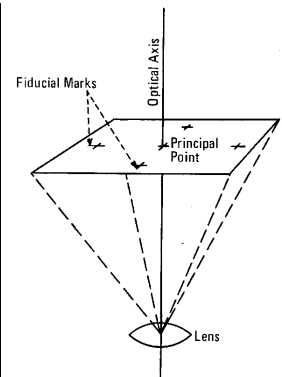
- **Fiducial axes:** The lines joining the opposite fiducial marks on a photograph are called fiducial axes.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

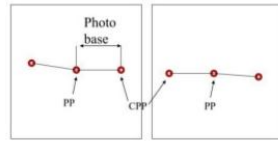
- **Principal point:** The principal point is the point where the perpendicular projected through the center of the lens intersects the photo image.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

- **Conjugate principal point:** It is the principal point of an aerial photograph represented on an adjacent aerial photograph.

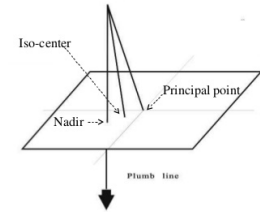


- PP = Principal point = centre of photo
- CPP = Conjugate principal point = adjacent photo's PP

Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

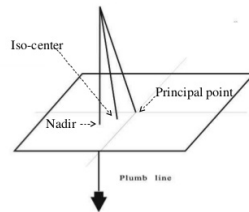
- **Nadir point:** The Nadir is the point vertically beneath the camera center or aircraft.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

- **Isocentre:** The point on an air photo which lies halfway between the Principal Point and the Nadir point.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

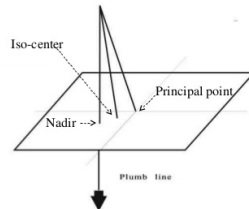
- **Air base (B):** It is a line joining two air stations/exposure stations.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

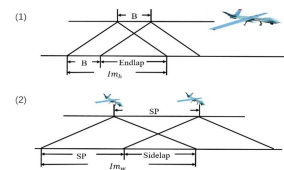
- **Photobase (b):** It is the distance between the principal points of two adjoining vertical photographs.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

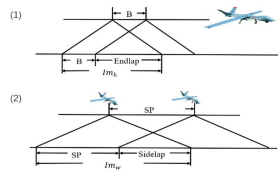
- **Forward overlap/Endlap:** The amount of overlap between successive photos in a flight line to allow for stereo viewing (usually 60 – 70%).



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

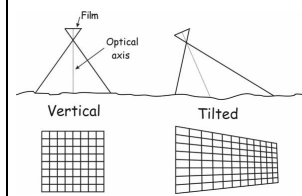
- **Sidelap/Lateral overlap:** The amount of overlap between air photos in adjacent flight lines (usually 20 – 30%).



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

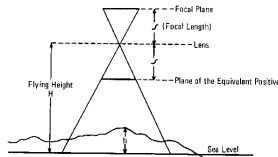
- **Tilt:** It is the angle between the camera axis and the vertical. It is also defined as rotation of the camera away from the vertical, about the x- or y-axis.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

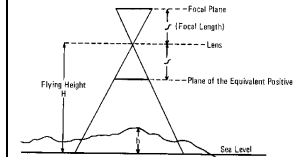
- **Focal length (f):** Distance from the optical centre of the lens to the focal plane.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

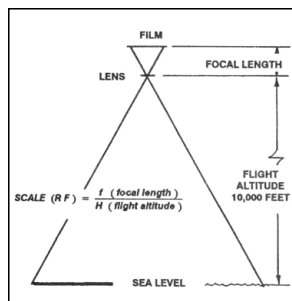
- **Flying height/altitude (H):** It is the vertical distance of aircraft above the datum (usually mean sea level) during flight. It is measured using an instrument called Altimeter mounted in an aircraft.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

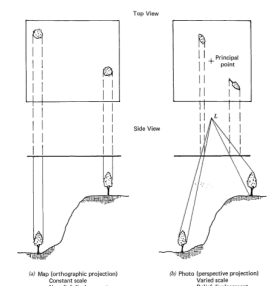
- **Scale of aerial photograph:** Scale of aerial photograph is defined as the ratio of photo distance to the corresponding ground distance.



Geometric Characteristics of Aerial Photograph

Geometrical elements of the aerial photographs

- **Relief displacement:** The relief displacement is the displacement of the objects on an aerial photograph from their true horizontal positions due to central perspective view of the terrain.



Scales of Photographs

Large scale:

- A scale which covers less area but shows more detail is known as large scale. Features on large scale photograph appear large. For example: 1:1,200 is a large scale.

Small scale:

A scale which shows the area in less detail but covers more area is known as small scale. Features on small scale photographs are small.
– example: 1:1,000,000

THANK YOU



VISUAL INTERPRETATION

By
Dr. K. S. Goudar

Visual Interpretation

Human Vision System

- Different spatial objects have different reflecting behaviour in different spectral regions
- The reflectance/emittance are recorded by sensors that are sensitive towards those particular wavelength region
- The human vision system is trained in interpreting the objects in any thematic or specialized area in a space in the visible spectrum only
- To visualize and interpret the information recorded in wavelength other than visible one, the ability of color guns of the computer systems is utilized that project the information recorded in any spectrum through color display channels.

Visual Interpretation

The Need of Interpretation

- Due to different spatial and spectral resolution of the remotely placed sensors, the information recorded by these sensors needs to be interpreted in a skillful manner with a desired accuracy
- The human vision system has an inherent ability to sense, interpret and understand the object's reflectance appearing in the visible spectrum
- Therefore, interpretation of remote sensing images is necessary to understand the object's properties and/or phenomenon

Basic Image Interpretation Elements

- | | |
|-----------|---------------|
| • Tone | • Pattern |
| • Texture | • Association |
| • Shape | • Shadow |
| • Size | • Aspect |

Tone

- It is a basic element for all the image interpretation tasks
- The tone is referred as relative brightness which is influenced by intensity or total brightness and angle of illumination
- The degree of brightness is directly related to amount of energy reflected or emitted
- Human eye is capable of viewing 40-50 tones

Tone

- Tonal variation is analytically more noticeable when features are recorded and produced by sensors digitally than conventionally printed images (on papers or plastics)
- For example, a 8-bit image displayed in a combination of three primary colors (RGB) can have a total size of 256 possible combination of digital numbers

Texture

- Texture is the frequency of tonal change on an image which determines how smooth or rough the feature's surface is when visualized
- The texture can be coarse or fine, smooth or rough, even or uneven.
- The texture is strongly related to the spatial resolution of the image.
- As the scale of the image is reduced, the texture of any object or area of the image becomes progressively finer and ultimately disappear.

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Texture

- For an image interpreter, it becomes easy to differentiate two or more objects having similar tones based on their textural differences. Examples are metallic and non-metallic roads.

Shape

- The shape is a general form, configuration or outline of individual objects.
- In case of 3-D images, the objects's height also defines its shape.
- The shape is an important sign for the interpreter.
- For example,
 - Sprinkler's irrigated fields when seen in an image looks circular in shape.
 - Similarly, road, canal or river appears in a linear shape.

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Size

- The size of object is an important indication for feature discrimination and estimation of its approximate size in an image.
- If the interpreter has a pre-knowledge about an object visually, it is easier for him or her to identify unfamiliar neighbouring objects and estimate its approximate size.
- For example, presence of cropland can be sensed with the identification of canal passing nearby.

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Pattern

- The pattern is the spatial arrangement of individual objects in an image or aerial photograph into visibly distinct repetitive forms.
- Thus, the spatial orderly repeat for both natural and man-made objects helps the interpreter in recognizing them.
- For example, an orchard with planted trees are distinctly arranged at a certain spatial intervals can be easily discriminated with that of the forest tree stands.

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Association

- The association refers to the occurrence of certain features in relation to other recognizable objects or features present in the neighbourhood to the object in which the interpreter is interested.
- For example, the presence of water can be associated with inhabited or irrigated area.
- Similarly, mining activities can be associated with road/rail network.

Shadow

- The **shadow** is **important** for interpreters in **two** **opposing** **respects**:
 - The **shape** or outline of a **shadow** give a **profile** view of objects which **help** in **interpretation**. For **example**, **shadow** of various **tree** species or **cultural features** (**bridges**, **towers**) **help** in their **identification** and **area estimation**
 - Objects within **shadow** reflect little light and are **difficult** to be **differentiated** on an image which **creates difficulty** in **interpretation**. For **example**, **shadow** of a **tall building** may **hinders** the **delineation of the object on which** the **building's shadow** is **falling**

Shadow

- Similarly, **sunlit** and **sun-shadowed** side of a **hilly region** can help in interpreting **spatial distribution** of dominant **tree type/tree species** on both side

Aspect or Aspect Ratio

- The **aspect** is the **ratio** of **width of shape** to its **height** or it is the estimation of **how long** the **object is compared to its width**
- When the **width** is **larger than its height**, the **shape of the object** is **'landscape'** rather than **'portrait'**
- Aspect** of a **continuously long thin feature** can be easily **discernible even when they** are **narrower than the spatial resolution** of the **image**. Due to this factor, **roads**, **streams** etc. can be **identified** even in a **medium resolution image**

Image Interpretation Strategies

- Image interpretation** is **not a simple task** if **knowledge**, **skills** and **experiences** are **not matching** as there are a variety of features present on an image
- For **example**, **delineation** of the **path** of a **river** course appearing on the surface is **easy** **compare to** identify and delineate a **historical river valley**

Image Interpretation Strategies

- Therefore, the **rational thinking**, **imagination** **power** along with **subject** and **collateral knowledge** is a **necessity** for a **better image understanding**
- Sometimes, the image **information** is available in **pieces** that **need to be join together** by the interpreter to **know** the **complete information** about an object or phenomenon
- For **example**, **identification** of a **particular crop type** from imagery **without knowing** its **seasonal period** and **duration** may **misinterpret** the **outcome**

This table shows the Tones of Land Use/Land Cover appearing in different colors (SWAC, 2016). This depends on the spectral band combination and colors assigned.

	True Color	False Color	SWIR (GeoCover)
	Red: Band 3 Green: Band 2 Blue: Band 1	Red: Band 4 Green: Band 3 Blue: Band 2	Red: Band 7 Green: Band 4 Blue: Band 2
Trees and bushes	Olive Green	Red	Shades of green
Crops	Medium to light green	Pink to red	Shades of green
Wetland	Dark green to black	Dark red	Shades of green
Vegetation	Shades of blue and green	Shades of blue	Black to dark blue
Water			
Urban areas	White to light blue	Blue to gray	Lavender
Bare soil	White to light gray	Blue to gray	Magenta, Lavender, or pale pink

Types of aerial photograph

- Vertical
- Low oblique
- High oblique



Types of aerial photograph

- Vertical
- Low oblique (no horizon)
- High oblique



Types of aerial photograph

- Vertical
- Low oblique
- High oblique



Photogrammetry

- Technique of obtaining reliable measurements of objects from their photographic images
 - Heights of objects
 - Areas
 - Lengths
 - Density
 - Etc.

THANK YOU



SATELLITE REMOTE SENSING

By
Dr. K. S. Goudar

Introduction

What is satellite?

- An object orbiting around the sun, earth or any other colossal (Huge) body is known as a satellite.
- There are two major types of categorization when it comes down to satellites, one is natural and the other is man-made.



Introduction

Some of the examples of natural satellites are planets, moons, and comets. Jupiter has 67 natural satellites.

The earth has one permanent natural satellite, the moon we know, which causes the tides in the sea.

Sometimes other objects (like asteroids) can enter into temporary orbits of the earth and become a natural satellite for a span.



Introduction

Apart from these, the earth has many man-made satellites which are placed in the orbit and are used for different applications in communications and information gathering. As the term itself states, an artificial satellite is one that is put in our space by human efforts and follows the orbit of natural satellites.



Introduction

Since they have a very large view field, they can collect data a lot faster than instruments which can be used at ground level. Apart from this, their view into space beyond earth is not blocked by clouds, dust and other obscurities, due to which a satellite can view space a lot more efficiently than telescopes on earth.



Introduction

Currently, there are more than 2,500 man-made satellites orbiting the earth. Most of these are of Russian origin.

Care is taken to launch a satellite in **specific orbits** such that collisions never occur, these orbits can vary in nature.

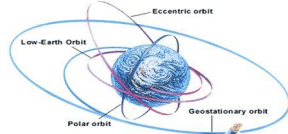


Introduction

Types of Satellites

Geostationary Satellite:

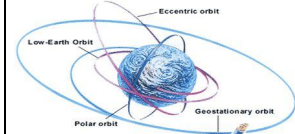
These satellites are placed into orbit at a distance of around 35,800 km from the earth's surface. They rotate in the same direction as the earth and one revolution of such satellites is the same as one day on earth (roughly 24 hours).



Introduction

This means that, as seen from earth, these satellites will appear to be at the same spot throughout. Hence, the name "geostationary" satellites.

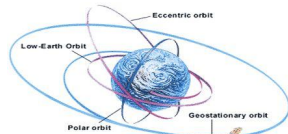
Most common uses for geostationary satellites are communications and weather based applications.



Introduction

Polar Satellite:

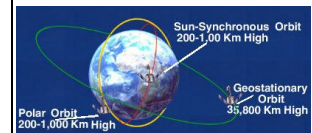
Polar satellites revolve around the earth in a north-south direction around the earth as opposed to east-west like the geostationary satellites. They are very useful in applications where field vision of the entire earth is required in a single day.



Orbit and Satellites

Types of orbit:

A geostationary orbit, often referred to as a **GEO orbit**, circles the Earth above the equator from west to east at a height of 36 000 km. As it follows the Earth's rotation, which takes 23 hours 56 minutes and 4 seconds, satellites in a GEO orbit appear to be 'stationary' over a fixed position. Their speed is about 3 km per second.



Orbit and Satellites

Types of orbit:

Geostationary transfer orbit

is an elliptical Earth orbit used to transfer a spacecraft from a low altitude orbit or flight trajectory to geostationary orbit. The apogee is at 36 000 km. When a spacecraft reaches this point, its apogee kick motor is fired to inject it into geostationary orbit.



Orbit and Satellites

Types of orbit:

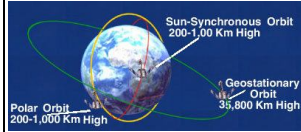
- A **low Earth orbit** is normally at an altitude of less than 1000 km and could be as low as 160 km above the Earth. Satellites in this circular orbit travel at a speed of around 7.8 km per second. At this speed, a satellite takes approximately 90 minutes to circle the Earth.



Orbit and Satellites

Types of orbit:

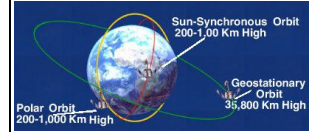
- **A low Earth orbit**, in general, these orbits are used for remote sensing, military purposes and for human spaceflight as they offer close proximity to the Earth's surface for imaging and the short orbital periods allow for rapid revisits. The International Space Station is in low Earth orbit.



Orbit and Satellites

Types of orbit:

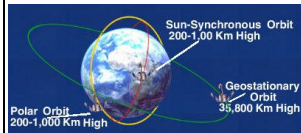
- **Medium low earth orbit:** This orbit takes place at an altitude of around 1000 km and is particularly suited for constellations of satellites mainly used for telecommunications. A satellite in this orbit travels at approximately 7.3 km per second.



Orbit and Satellites

Types of orbit:

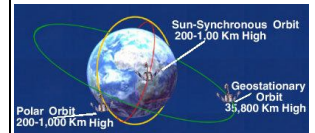
- As the name suggests, **polar orbits** pass over the Earth's polar regions from north to south. The orbital track of the satellite does not have to cross the poles exactly for an orbit to be called polar, an orbit which passes within 20 to 30 degrees of the poles is still classed as a polar orbit.



Orbit and Satellites

Types of orbit:

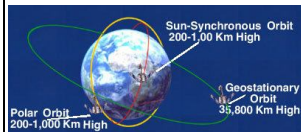
- These orbits mainly take place at low altitudes of between 200 to 1000 km. Satellites in polar orbit look down on the Earth's entire surface and can pass over the North and South Poles several times a day.



Orbit and Satellites

Types of orbit:

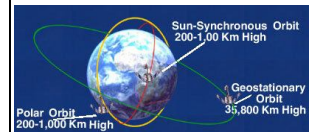
- **Sun synchronous orbit:** These are polar orbits which are synchronous with the Sun. A satellite in a sun synchronous orbit would usually be at an altitude of between 600 to 800 km.



Orbit and Satellites

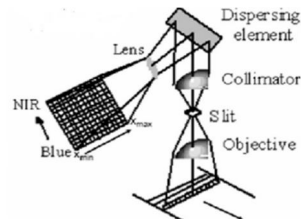
Types of orbit:

- Generally these orbits are used for Earth observation, solar study, weather forecasting and reconnaissance, as ground observation is improved if the surface is always illuminated by the Sun at the same angle when viewed from the satellite.



Types of scanning systems

Many electronic (as opposed to photographic) remote sensors acquire data using **scanning systems**, which employ a sensor with a narrow field of view (i.e. IFOV) that sweeps over the terrain to build up and produce a two-dimensional image of the surface.

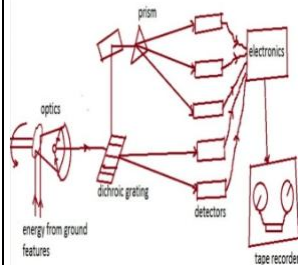


Types of scanning systems

A scanning system employs a detector. When photons of electromagnetic energy radiated/reflected from the terrain encounters the detector, an electrical signal is produced that varies in proportion to the number of photons. The electrical signal is amplified, recorded on magnetic tape and played back later to produce an image.

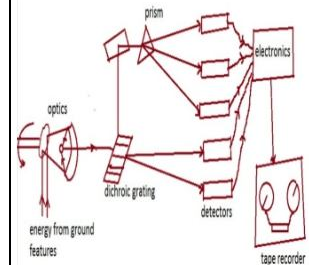
Types of scanning systems

Scanning systems can be used on both aircraft and satellite platforms and have essentially the same operating principles. A scanning system used to collect data over a variety of different wavelength ranges is called a **multispectral scanner (MSS)**, and is the most commonly used scanning system.



Types of scanning systems

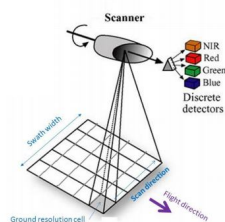
There are two main modes or methods of scanning employed to acquire multispectral image data - **across-track scanning**, and **along-track scanning**.



Types of scanning systems

Across-track scanner

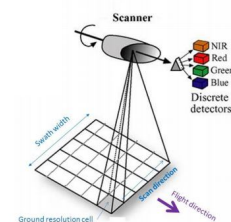
- Across-track scanner is also known as whisk-broom scanner. In across track scanner, rotating or oscillating mirrors are used to scan the terrain in a series of lines, called scan lines, which are at right angles to the flight line. As the aircraft or the platform moves forward, successive lines are scanned giving a series of contiguous narrow strips.



Types of scanning systems

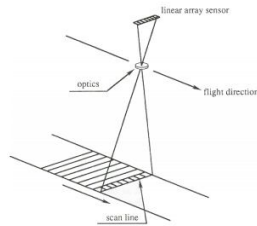
Across-track scanner

- The scanner thus continuously measures the energy from one side to the other side of the platform and thus a two-dimensional image is generated.



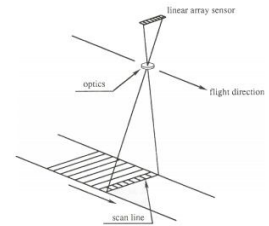
Types of scanning systems

- **Along-track scanner**
- It is also known as push-broom scanner. Along-track scanners also use the forward motion of the platform to record successive scan lines and build up a two-dimensional image, perpendicular to the flight direction.



Types of scanning systems

- **Along-track scanner**
- However, along-track scanner does not use any scanning mirrors, instead a linear array of detectors is used to simultaneously record the energy received from multiple ground resolution cells along the scan line. This linear array typically consists of numerous charged coupled devices (CCDs). A single array may contain more than 10,000 individual detectors.



Types of scanning systems

- **Thematic Mapper (TM)**
- It is an advanced multispectral scanner designed to achieve higher spatial, spectral and radiometric accuracy. It was introduced by NASA during the Landsat-4 mission. The TM used in the Landsat mission was operational in 7 bands.

Landsat TM spectral bands and their potential applications
(Source: <http://www.fsa.org>)

Band	Spectral range (µm)	Principal application
1	0.45-0.52	Coastal water mapping, soil-vegetation differentiation, deciduous-coniferous differentiation
2	0.52-0.6	Green reflectance by healthy vegetation
3	0.63-0.69	Chlorophyll absorption for plant species differentiation
4	0.76-0.90	Biomass surveys, water body delineation
5	1.55-1.72	Vegetation moisture measurement, snow-cloud differentiation
6	10.4-12.5	Plant heat stress measurement, other thermal mapping
7	2.08-2.35	Hydrothermal mapping

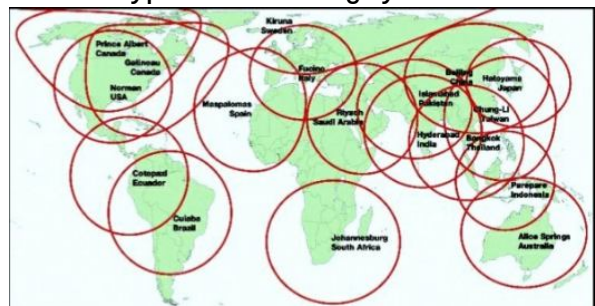
Types of scanning systems

- **Thematic Mapper (TM)**
- **Characteristics**
- Landsats 4 and 5 carry both MSS and TM sensors.
- Satellites orbit at an altitude of 705 km, with a 16 day cycle
- Satellites designed and operate to collect data over a 185 km swath (a broad area of strip).
- MSS and TM sensors detect reflected radiation from earth's surface in visible and near IR wavelengths.

Types of scanning systems

- **Thermal scanner**
- It is a special kind of across track multispectral scanner which senses the energy in the thermal wavelength range of the EMR spectrum. Thermal infrared radiation refers to electromagnetic waves with wavelength 3-14 µm.
- The atmosphere absorbs much of the energy in the wavelength ranging from 5-8 µm. Due to the atmospheric effects, thermal scanners are generally restricted to 3-5 µm and 8-14 µm wavelength ranges.

Types of scanning systems

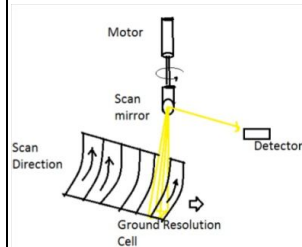


Current Landsat TM Ground Receiving Stations

Types of scanning systems

- **Circular scanners**

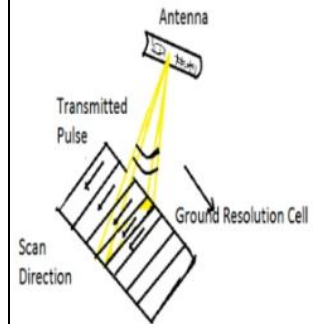
- In this, the scan motor and mirror are mounted with a vertical axis of rotation that sweeps circular path on the terrain.
- Only the forward portion of the sweep is recorded to produce images.
- Circular scanners are used for exploration purposes in aircraft.
- The images are displayed in real time on a screen in the cockpit to guide the pilot.



Types of scanning systems

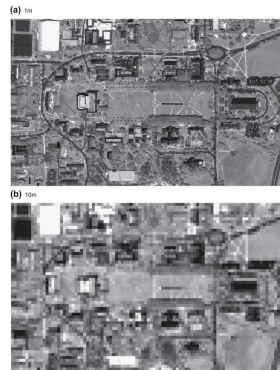
- **Side scanning system**

- It is primarily an active system which provides their own energy sources.
- The example given here is a radar system that transmits pulses of microwave energy to one side of the flight path and records the energy scattered from the terrain back to the antenna.



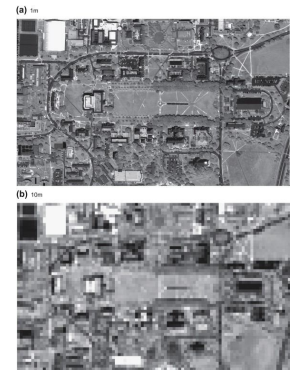
Resolutions of Image

- In the fields of cartography, high-resolution satellite data with a resolution of 5 to 10 meters in the panchromatic and 10 to 30 meters in the multi-spectral imaging mode may be suited to generate map products in the scale of 1: 50000 and 1: 100000.



Resolutions of Image

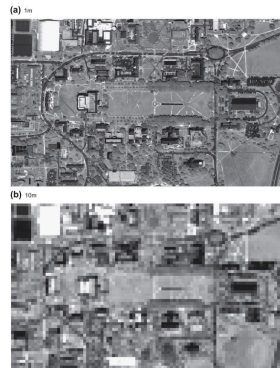
- the optical satellite imagery can be grouped into the following categories:
- **Low Resolution Optical Satellite Data:** 250m - some km spatial resolution by multi-spectral sensors like GEOS, Meteosat, NOAA, Vegetation and Modis.



Types of scanning systems

- **Medium Resolution**

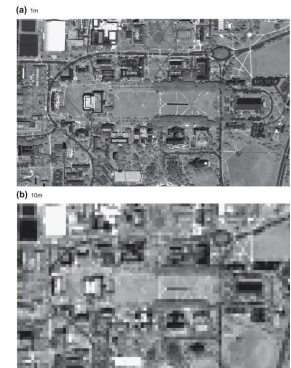
Optical Satellite Data: 80m - 180m spatial resolution by multi-spectral sensors like Landsat MSS, RESURS-01 (MSU-SK) and IRS-1C (Wide Field Sensor - WiFS).



Types of scanning systems

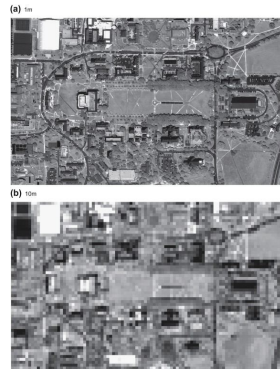
- **High Resolution Optical**

Satellite Data: 5m - 30m spatial resolution by panchromatic or multi-spectral sensors or analogue camera systems such as Landsat TM, SPOT PAN and MS, IRS-1C/D (PAN and LISS), KFA 1000, MK4, etc.



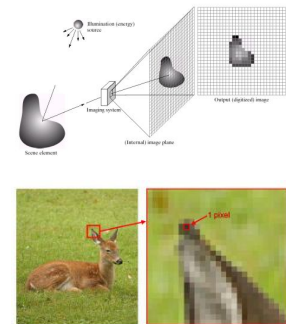
Types of scanning systems

- **Very High Resolution (VHR)**
Optical Satellite Data: 1m - 4m spatial resolution by panchromatic or multi-spectral sensors or analogue camera systems. For the private field of remote sensing applications at this time only analogue Russian satellite data such as KFA 3000 and KVR 1000 with a resolution of 2m have been made available.



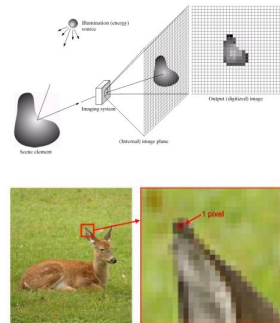
Digital image processing

- **What is digital image**
- Digital image is a presentation of two – dimensional image as a finite set of digital values called picture elements or pixels



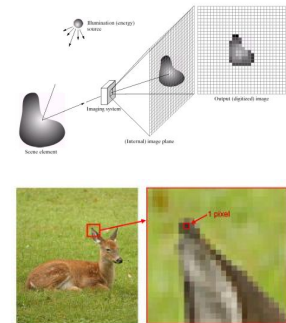
Digital image processing

- **What is digital image processing**
- Digital image processing focuses on two major tasks
 - Improvement of pictorial information for human interpretation
 - Processing of image data for storage, transmission and representation for autonomous machine perception.

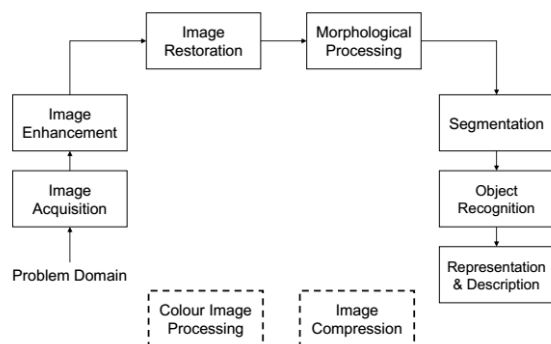


Digital image processing

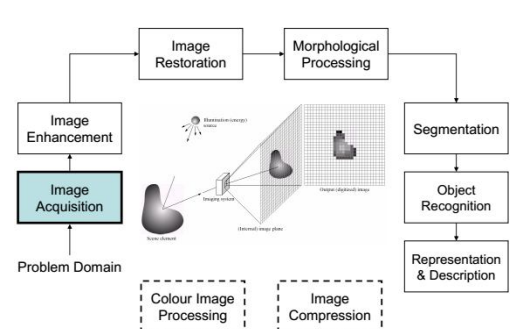
- **Key stages of image processing**
 - Image acquisition
 - Image enhancement
 - Image restoration
 - Morphological processing
 - Segmentation
 - Object recognition
 - Representation and description
 - Image compression
 - Color image processing

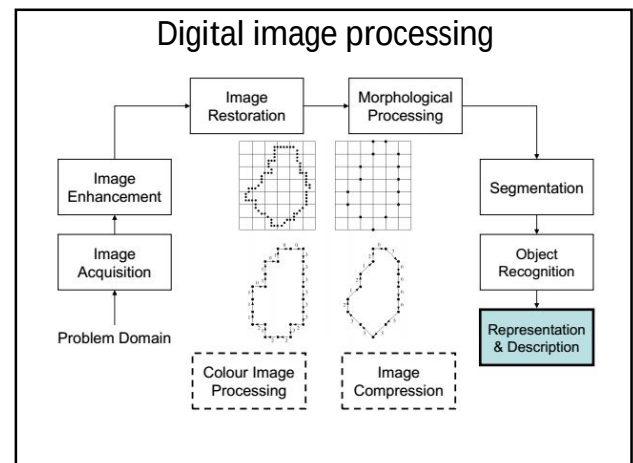
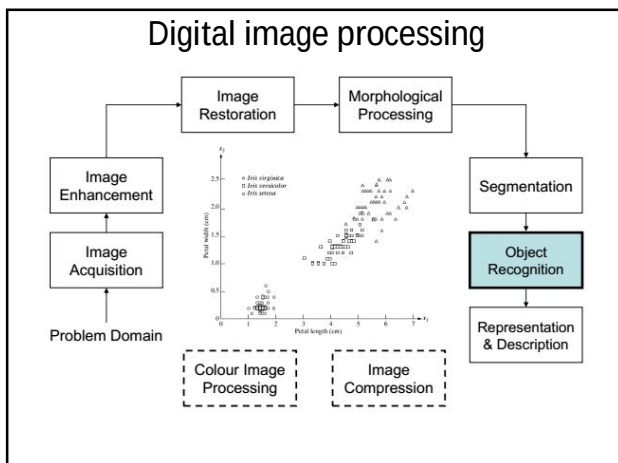
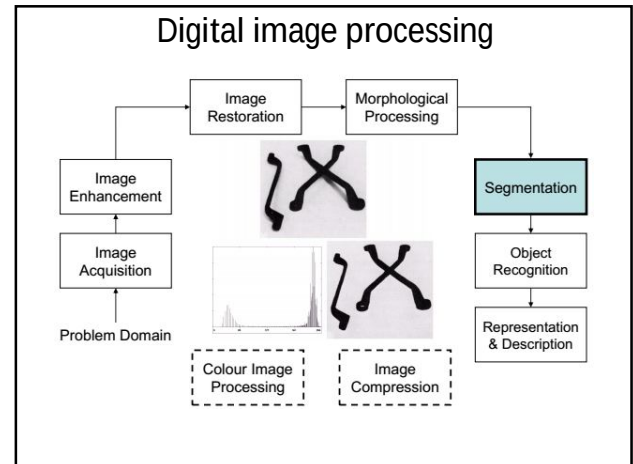
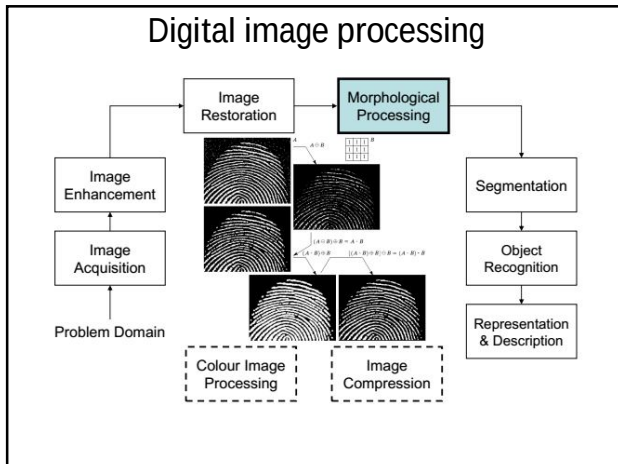
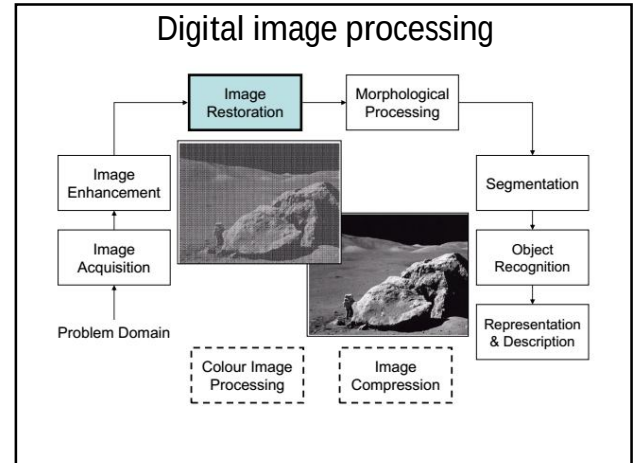
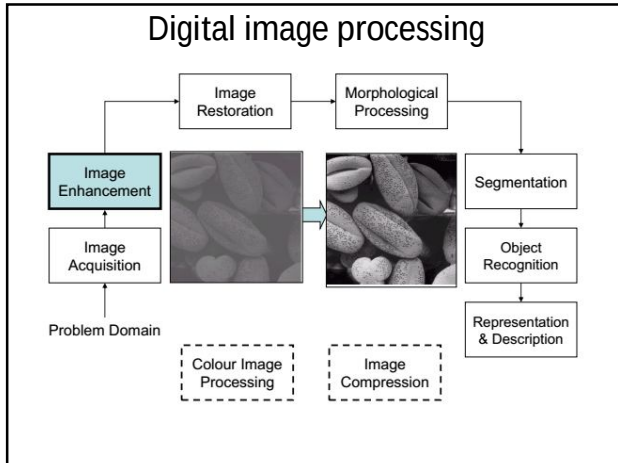


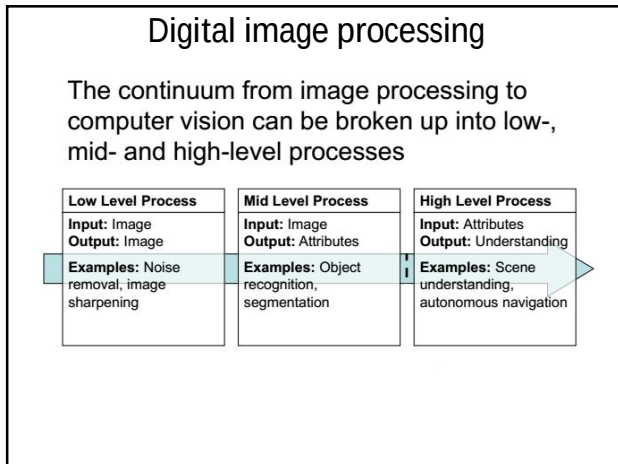
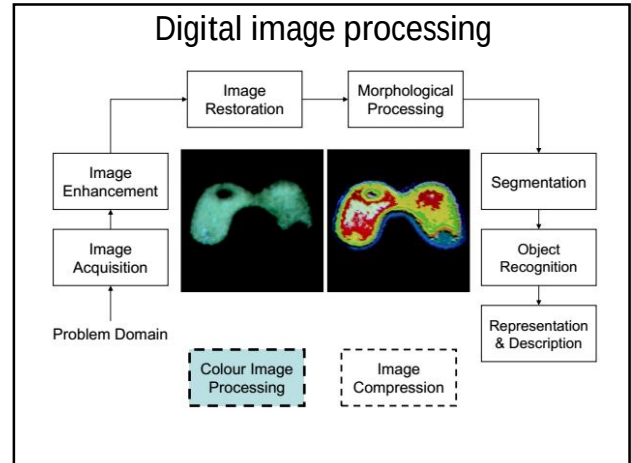
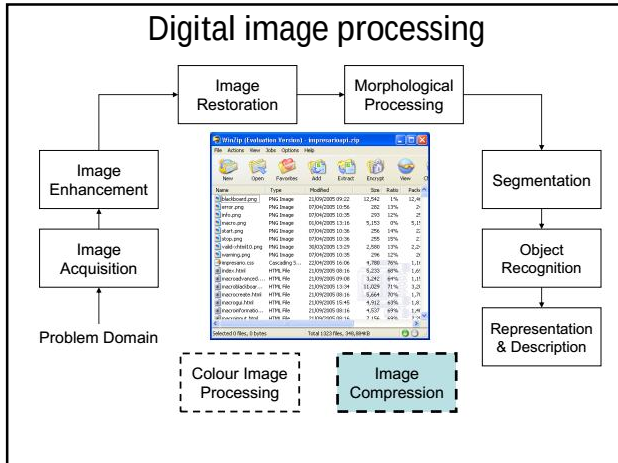
Digital image processing



Digital image processing







THANK YOU

BEST WISHES FOR REST OF LIFE