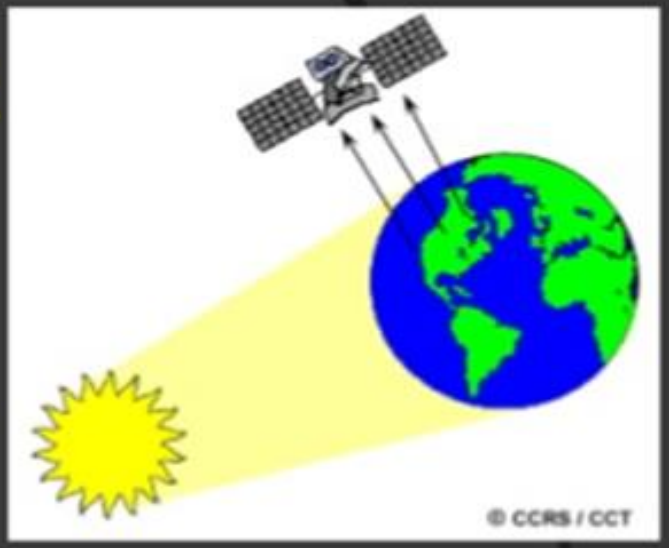
FUNDAMENTALS OF REMOTE SENSING

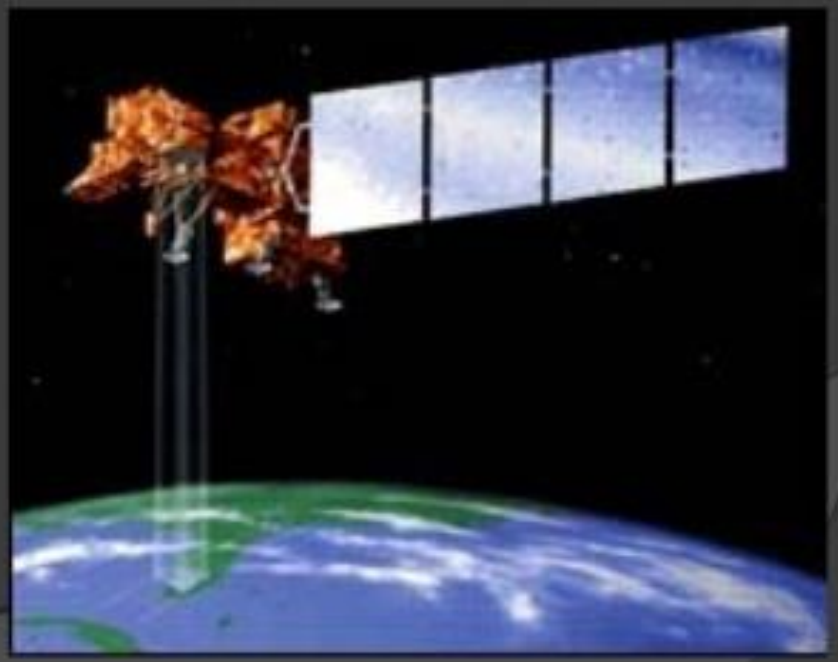
What is Remote Sensing?



Remote sensing is a method of obtaining information about the properties of an object without coming into physical contact with it.

Remote Sensing is a technology for sampling electromagnetic radiation to acquire and interpret non-immediate geospatial data from which to extract information about features and objects on the Earth's land surface, oceans, and atmosphere

- Dr. Nicholas Short



Who uses Remote Sensing and why?

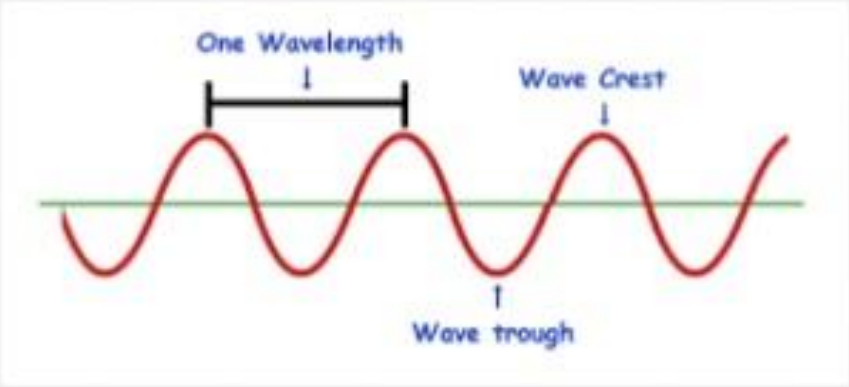
- the geographer, who looks for changes on the Earth's surface that need to be mapped;
- the forester, who needs information about what type of trees are growing and if they have been affected by disease or fire;
- the environmentalist, who wants to detect, identify and follow the movement of pollutants such as oil slicks on the ocean;
- the geologist, who is interested in finding valuable minerals;

- the farmer, who wants to keep an eye on how his crops are growing and if they've been affected by drought, floods, disease or pests;
- the ship captain, who needs to find the best route through the northern ice packs;
- the firefighter, who sends out his crews based on information about the size and movement of a forest fire.
- the Urban Planner, who wants to map and monitor land cover, land use, morphology (the study of the form of human settlements and the process of their formation and transformation) etc.

Components of Remote Sensing

- Electromagnetic Radiation
- Sensor
- Platform

- Electromagnetic Radiation (EMR) like radio waves, infrared (heat) waves make characteristic patterns as they travel through space. Each wave has a certain shape and length. The distance between peaks (high points) is called wavelength.

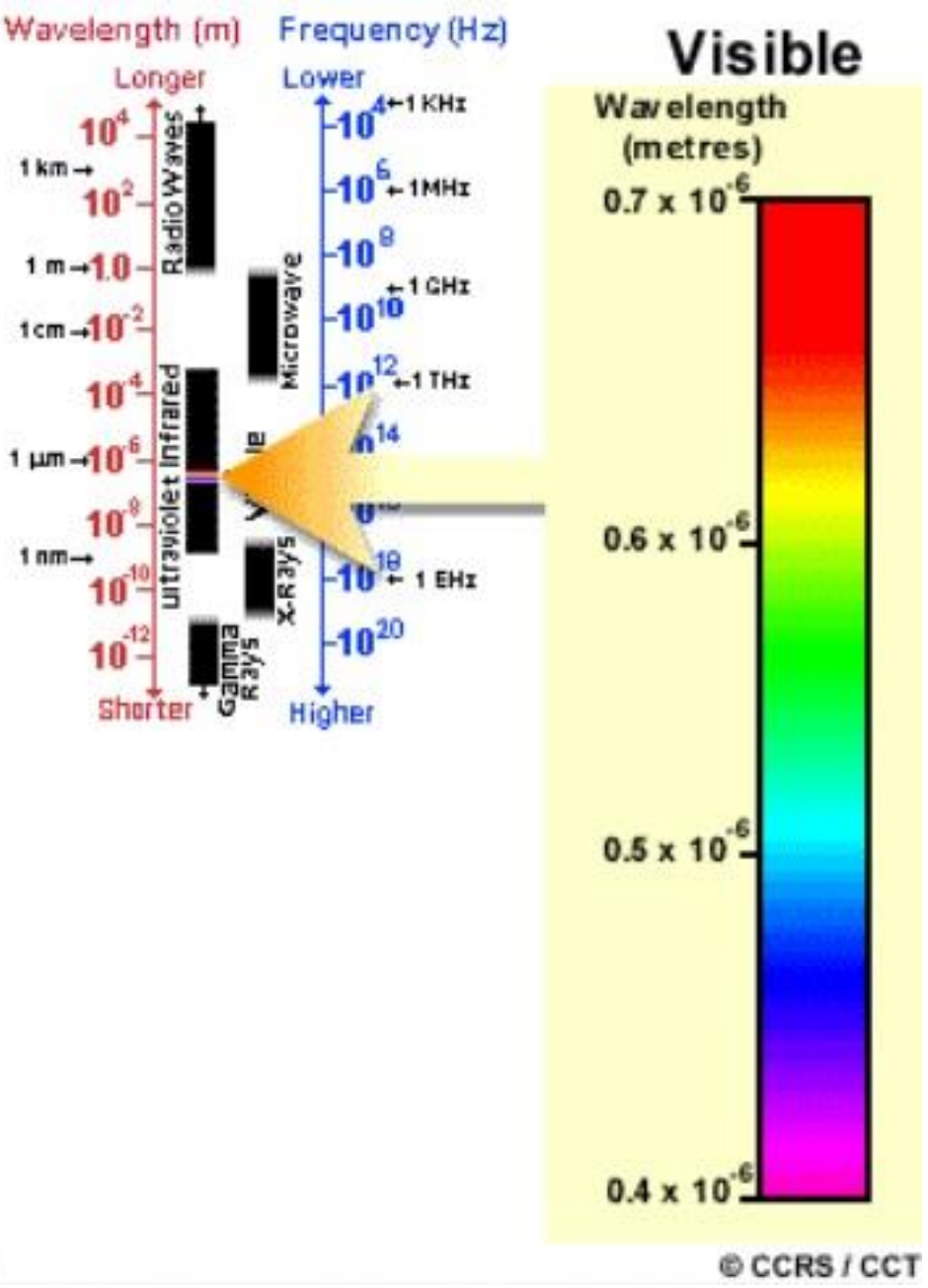


- The light which our eyes - our "remote sensors" - can detect is part of the **visible spectrum**. The visible wavelengths cover a range from approximately 0.4 to 0.7 μm (micrometre; 1 μm= 1×10^{-6} of a metre).

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.



Sensors

It is a device that receives electromagnetic radiations and converts it into a signal that can be recorded and displayed as either numerical data or an image.

Types of Sensors

- **Passive sensors-**

Passive system record energy reflected or emitted by a target illuminated by sun.

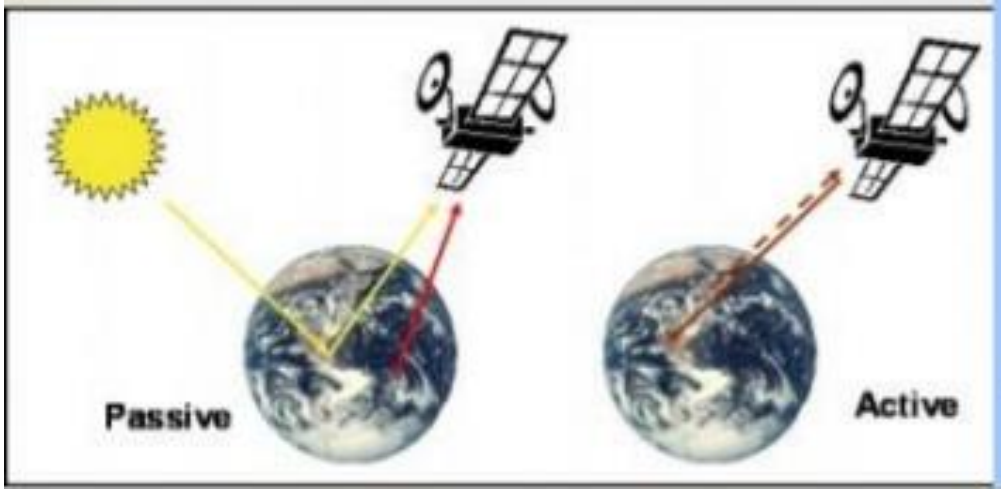
e.g. normal photography, most optical satellite sensors

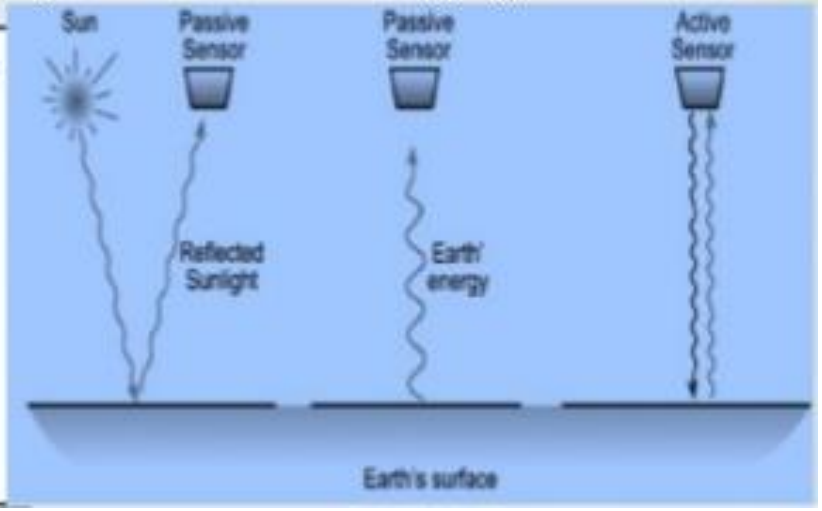
- **Active sensors-**

Active system illuminates target with energy and measure reflection.

e.g. Radar sensors, Laser altimeters

RADAR(Radio Detection and Ranging), LIDAR(Light Detection and Ranging)





Platform

A Platform is defined as the carrier for remote sensing sensors. There are three major remote sensing platforms:

- Ground-level platform (towers and cranes).
- Aerial platforms (Helicopters, low altitude aircraft, high altitude aircraft).
- Space borne platforms (space shuttles, polar-orbiting satellites, and geostationary satellites).

Fig. 1: Ground-Based Platform

Fig. 2: Airborne Platform

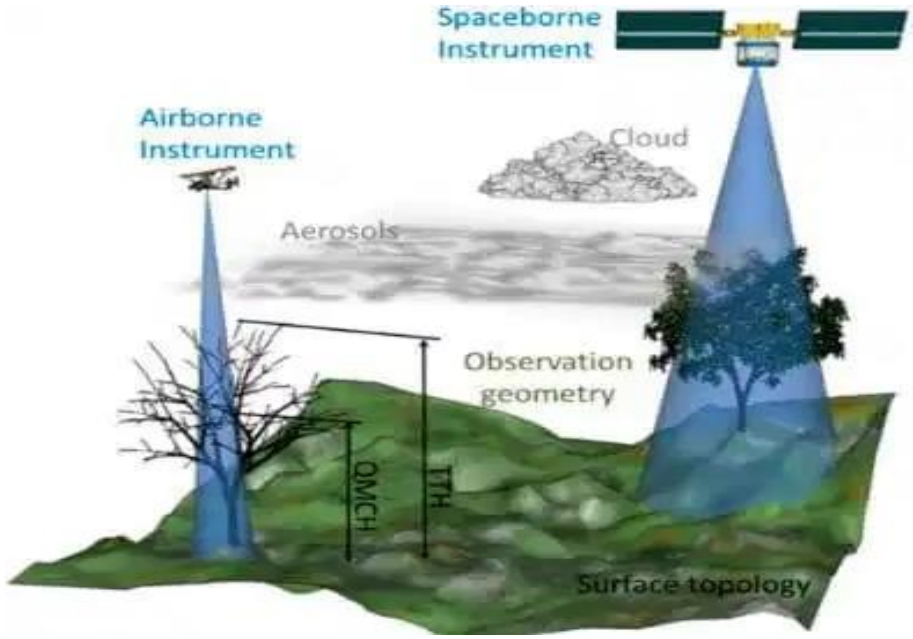
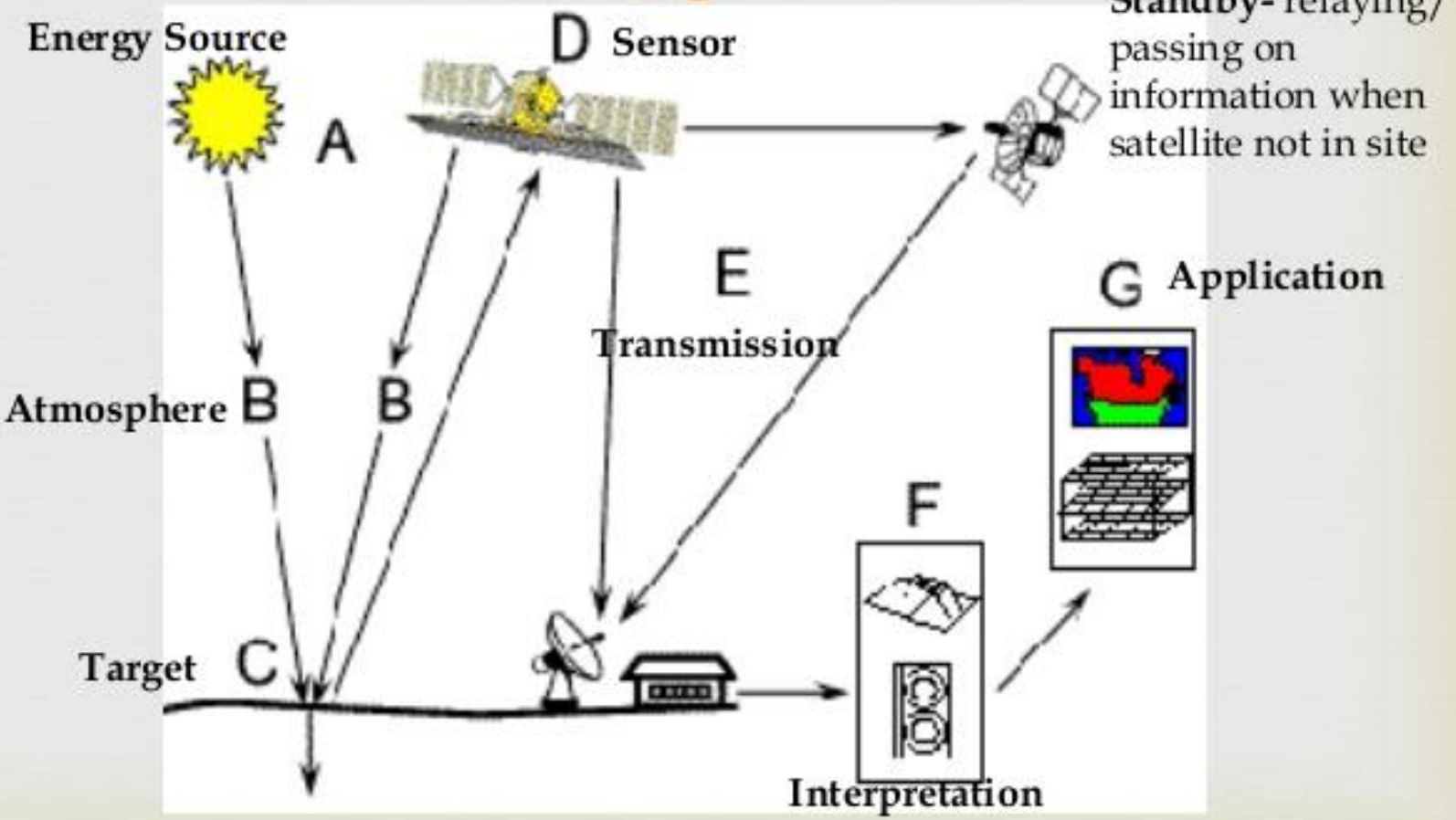


Fig. 3: Space-Based Platform

Elements Involved in Remote Sensing

- Energy Source or Illumination (A)
- Radiation and the Atmosphere (B)
- Interaction with the Object (C)
- Recording of Energy by the Sensor (D)
- Transmission, Reception and Processing (E)
- Interpretation and Analysis (F)
- Application (G)

Remote Sensing (RS) Process



1. 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.

2. 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.

3. 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.

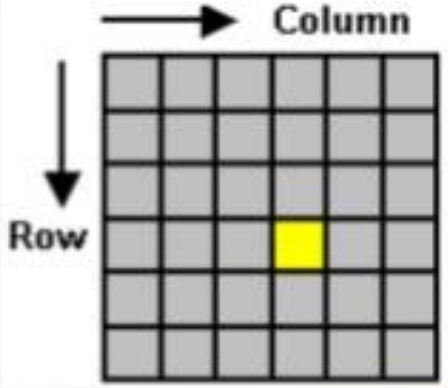
4. Recording of Energy by the Sensor (D) - after the energy has been scattered by, or emitted from the target, we require a sensor to collect and record the electromagnetic radiation.

5. 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).

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

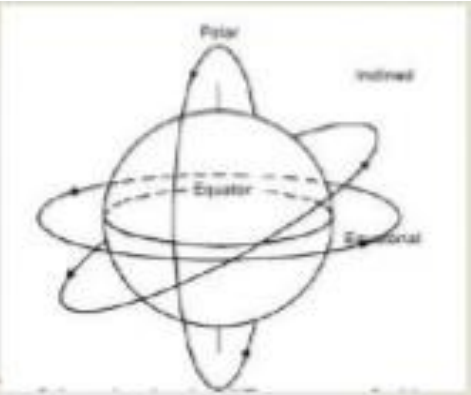
7. Application (G) - the final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem.

Data Recording



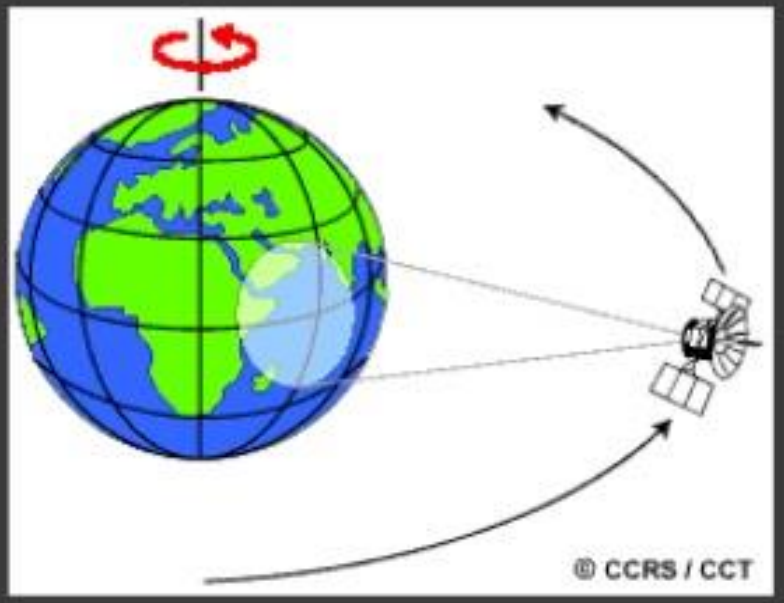
- An image is a two-dimensional representation of objects in a real scene. Remote sensing images are representations of parts of the earth surface as seen from space.
- A digital image comprises of a two dimensional array of individual picture elements called **pixels** arranged in columns and rows.
- Each pixel represents an area on the Earth's surface. A pixel has an **intensity** value and a **location address** in the two dimensional image.

Satellite Orbits



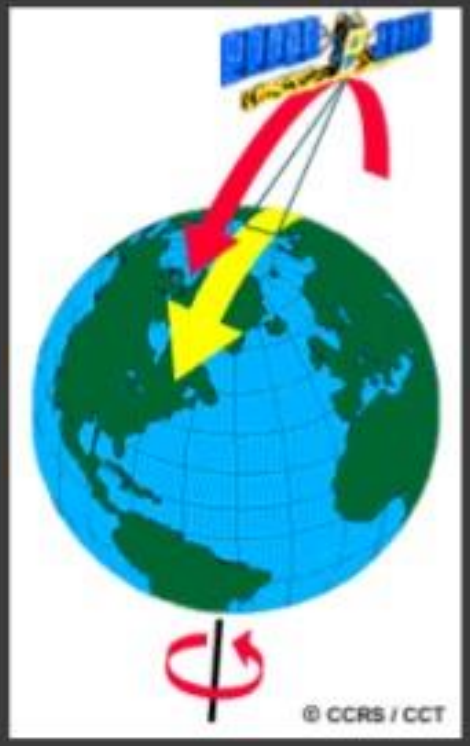
- The path followed by the satellite is called its orbit.
- Types of Satellite Orbits
  - Polar
  - Equatorial
  - Inclined
- Satellite orbits are designed according to the capacity and objective of the sensors they carry. Depending on their altitude, orientation and rotation relative to the earth, satellites can be categorized as-
  - Geostationary
  - Polar orbiting and Sun-synchronous

Geostationary Satellites



- In high altitude orbit (~35,800 km)
- Orbital period of satellite matches rotational speed of Earth
- Continuously observe same area on Earth
- Very high temporal resolution (minutes – hours)
- Usually used to monitor meteorological conditions and severe storm development, including hurricanes, tornadoes, and floods

Polar-Orbiting Satellites

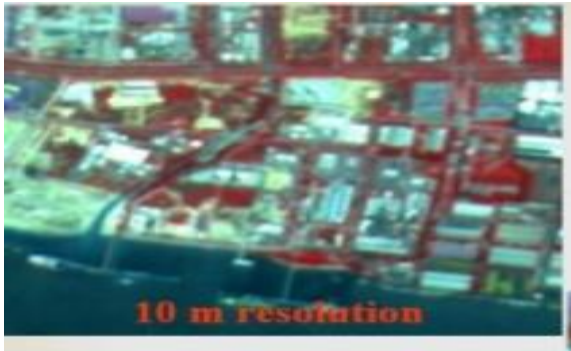


- In low altitude orbit (~700-800 km)
- Orbit around North and South Poles
- Earth rotates under satellite as it orbits, so each time satellite makes a pass over Earth, it observes a new area
- Polar-orbiting satellites observe same area on Earth once per day (or less)
- Low temporal resolution
- Global coverage!
- Used for a variety of applications, including air quality, land cover, water quality, and vegetation studies

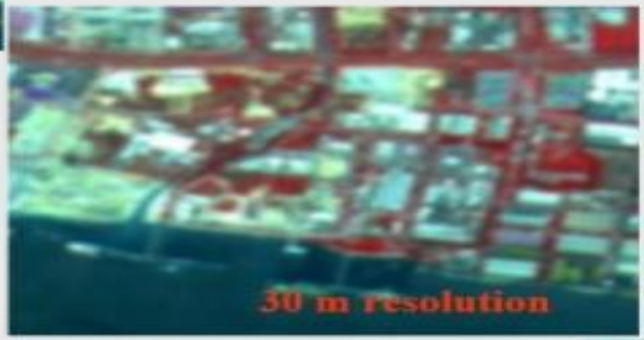
RESOLUTIONS

Ability of the system to render the information at the **smallest discretely separable quantity**

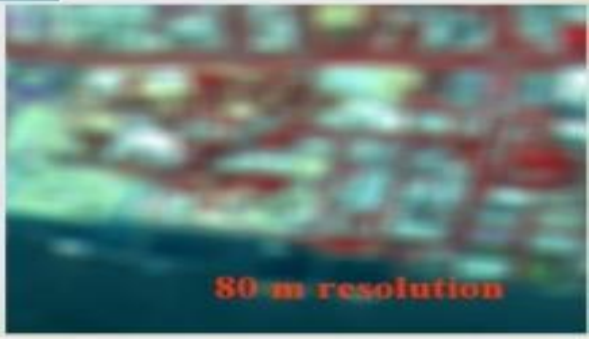
- in terms of distance (Spatial),
- wavelength band of EMR(Spectral),
- Time (Temporal) and
- Radiation (Energy)



Fine/ high resolution



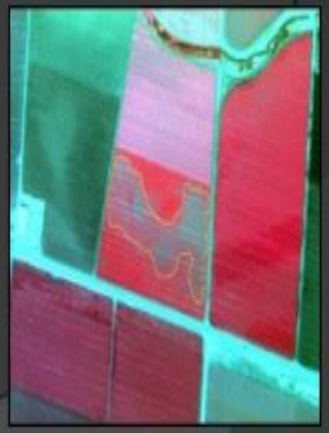
Coarse/ low resolution



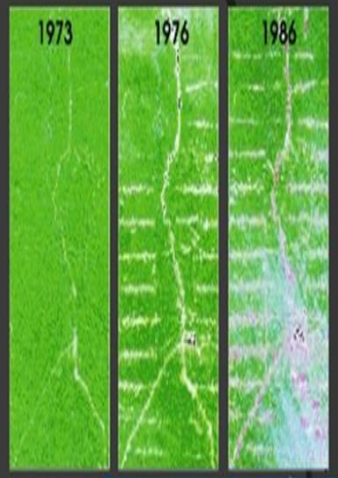
Source: http://www.crisp.nus.edu.sg/

Application of Remote sensing

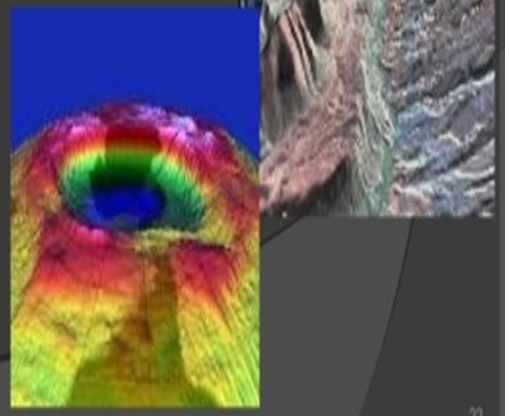
- Urbanization & Transportation
  - Updating road maps
  - Asphalt conditions
  - Wetland delineation
  - Urban Planning
- **Agriculture**
  - **Crop health analysis**
  - **Precision agriculture**
  - **Compliance mapping**
  - **Yield estimation**
  - Forest application



Application of Remote sensing

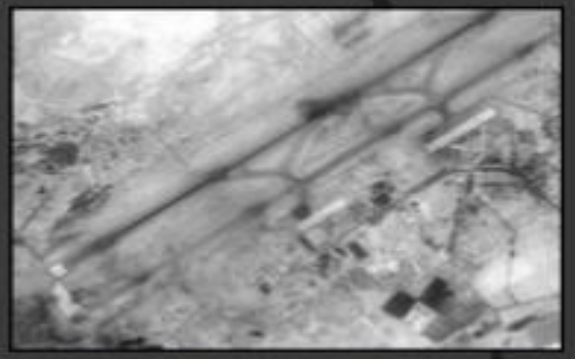


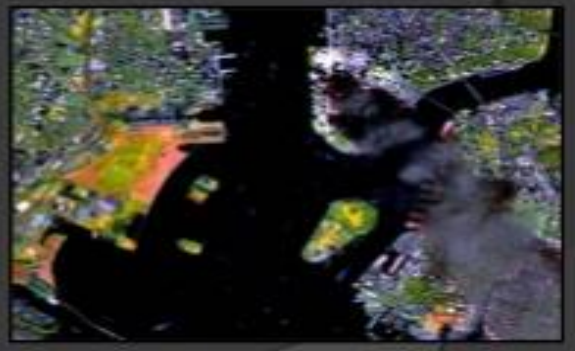
- Natural Resource Management
  - Habitat analysis
  - Environmental assessment
  - Pest/disease outbreaks
  - Impervious surface mapping
  - Lake monitoring
  - Hydrology
  - Landuse-Landcover monitoring
  - Mineral province
  - Geomorphology
  - Geology



Application of Remote sensing

- National Security
  - -Targeting
  - -Disaster mapping and monitoring
  - -Damage assessment
  - -Weapons monitoring
  - -Homeland security
  - -Navigation
  - -Policy
  - -Telecommunication planning
  - -Coastal mapping





Thank You