India

- Population – Nearly 20% of world’s population
- Area – Nearly 2.4%
- Adult literacy – Less than 50%
- 2060 – 1.8 billion population, 400 M tonne food requirement (181 M tonne availability)
- Per-capita forest wealth – 0.1 (lowest)
- Soil Erosion – 10 tonne per hectar
DEMAND OF THE DAY

- Monitoring and management of resources.
- Sustainable development.
- Disaster Mitigation
HAZARDS

- Natural Hazards
- Hazards Caused by Man
NATURAL HAZARDS

- Heavy toll of life
- Property loss
- Homeless and destitute people
DISASTER MANAGEMENT

Before the Event
- Prevention
- Preparedness

After the Event
- Relief
- Rehabilitation
- Prevention
DISASTER MITIGATION

- Mitigation – Reduce or lessen
  - Hazard assessment – Type, Frequency, Magnitude, Map of area likely to be affected.
  - Vulnerability assessment – Assessing degree of loss of population, buildings infrastructure, economic activities.
  - Risk Assessment – Quantifying numbers of lives likely to be lost, cost of damage to property
    - Preparation of maps, indicating risk areas
DISASTER MITIGATION

- **Restrictive zoning** – Acquisitions of hazardous areas, removal of unsafe structures, insurance and real-estate information
- **Protective engineering solutions**
- **Building codes** – Example: Earthquake resistance design code
- **Public Information**
DISASTER MITIGATION

➢ Disaster Preparedness – Activities intended to be prepared, once a disaster event is going to happen

▪ Preparation of disaster plan – Coordination of emergency services.
▪ Anticipating damage to critical facilities - Damage to main roads, hospitals etc.
▪ Damage inspection, repair and recovery procedures – Availability of trained personnel
DISASTER MITIGATION

- Communications and control center
- Disaster training exercises – Rehearsal
- Prepare evacuation plans
- Informing / training population
- Forecast, warning, prediction of disaster
DISASTER MITIGATION

- Disaster relief
  - Rapid damage assessment
  - Implementation of disaster response plan
  - Establish communication and infrastructure
  - Search and rescue operation
  - Speed of information – Real time information – Arial photogrammetry
  - Damage assessment – Quantification of damage
DISASTER MITIGATION

- **Requirement**
  - Large amount of data
  - Real time data
  - Tool to analyse and interpret data

- **Solution**
  - Remote sensing
  - GIS
REMOTE SENSING

- Information – Collection
  - Interpretation
- No physical contact
The invention of photography in 1839 made remote sensing (eventually) possible.

Remote sensing began in the 1860s as balloonists took pictures of the Earth's surface.

Pigeon fleets were another form of remote sensing in the early years.
HISTORY OF REMOTE SENSING

Wright Brothers and the earliest airplane.

Robert Goddard in 1926
HISTORY OF REMOTE SENSING

First Satellites

Explorer 1
1958

Sputnik (USSR)
1957

Vanguard 2
1959

NASA was founded in 1958 to advance American interests in space.

National Aeronautics and Space Administration
HISTORY OF REMOTE SENSING

**Explorer 7**

E7 (1959): First satellite with an instrument for meteorological remote sensing.

Designed by Verner Suomi, U Wisconsin

Jupiter C launch rocket
HISTORY OF REMOTE SENSING

Defense Meteorological Satellite Program (DMSP)
HISTORY OF REMOTE SENSING

INSAT: the Indian geostationary metsat
ELECTRO MAGNETIC ENERGY

- Energy that moves with the velocity of light
  \[(3 \times 10^8 \text{ m/s})\]
ELECTRO MAGNETIC SPECTRUM

The electromagnetic spectrum is divided into various regions based on wavelength and frequency. The spectrum includes:

- **Ultraviolet (UV)**: Wavelengths from about 0.1 to 0.4 nanometers (nm) or frequencies from about 7.5 to 30 terahertz (THz).
- **Visible Light**:
  - **UV**: 0.1 to 0.38 nm
  - **Blue (B)**: 0.4 to 0.495 nm
  - **Green (G)**: 0.495 to 0.565 nm
  - **Red (R)**: 0.565 to 0.71 nanometers
  - **Near Infrared (I.R.)**: 0.71 to 1.24 nanometers
- **Infrared (I.R.)**: Wavelengths from about 1.24 to 1000 nanometers or frequencies from about 0.001 to 1 terahertz (THz).

The spectrum also includes:

- **Gamma rays**: High-energy photons with wavelengths less than 0.1 nm.
- **X-rays**: Wavelengths from about 0.1 to 10 nanometers or frequencies from about 10 to 1000 terahertz (THz).
- **Microwaves**.
- **Television and radio**.

The chart shows the division of the spectrum into different regions based on their wavelength and frequency, with each region having specific applications and uses.
ELECTRO MAGNETIC SPECTRUM

- 0.4 µm – 0.7 µm – visible range
- 1 µm – 0.1 mm infrared
- 10 mm microwave
- 1 m and above radio wave
- $10^{-2}$ µm – 0.4 ultra violet
- $10^{-4}$ µm to $10^{-2}$ µm X-ray
- Less than $10^{-4}$ µm Gamma ray
INTERACTION MECHANISM

- Change in intensity
- Change in direction
- Change in wave length
- Change in Phase
REMOTE SENSING SYSTEMS

- Organic – Eye

- In-organic – Framing – Cameras – Vidicons – Scanning

- Ideal Source – Constant intensity for all wave lengths

- Ideal Sensor – Different intensity for different wave length
REMOTE SENSING SYSTEMS

- Ideal Medium
- Processor
- Storage
- User
REMOTE SENSING SYSTEMS

- Active Sensor – Own source
- Passive Sensor – Other source

Example

Camera without flash

Camera with flash
An eye in the sky that does not tell lie
TYPES OF SATELLITES

Geo-stationery

- Approximately – 36000 km altitude
- Velocity – 3075 m/s (Earth’s speed in its axis)
- Orbital period – 24 Hrs
- West to East
- Applications – Meteorological, Communication

Example: INSAT
TYPES OF SATELLITES

Sun Synchronous

- Lower altitude – 817 km
- High resolution

Example

IRS – 1C
IMPORTANT REMOTE SENSING SATELLITES

- LANDSAT – USA
  - 714 km
  - 16 days
  - 30 m resolution
  - 0.45 µm to 0.52 µm – coastal water mapping,
  - soil / vegetation – differentiation

- SPOT – FRANCE
  - 813 km
  - 10 m
  - 26 Days
  - Stereo
<table>
<thead>
<tr>
<th><strong>IRS 1A</strong></th>
<th>Operational Remote Sensing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>975 kg</td>
</tr>
<tr>
<td><strong>onboard power</strong></td>
<td>600 Watts</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>S-band, X-band and VHF (commanding only)</td>
</tr>
<tr>
<td><strong>Stabilization</strong></td>
<td>Three axis body stabilized (zero momentum) with 4 Reactions Wheels, Magnetic torquers</td>
</tr>
<tr>
<td><strong>RCS</strong></td>
<td>Monopropellant Hydrazine based with sixteen 1 thrusters</td>
</tr>
<tr>
<td><strong>Payload</strong></td>
<td>Three solid state Push Broom Cameras: LISS-1 (72.5 metre resolution), LISS-2A and LISS-2B (36.25 metre resolution)</td>
</tr>
<tr>
<td>Feature</td>
<td>Details</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td><strong>Operational Remote Sensing</strong></td>
<td>IRS 1A</td>
</tr>
<tr>
<td><strong>Launch date</strong></td>
<td>March 17, 1988</td>
</tr>
<tr>
<td><strong>Launch site</strong></td>
<td>Baikanur Cosmodrome</td>
</tr>
<tr>
<td><strong>Launch vehicle</strong></td>
<td>Vostok</td>
</tr>
<tr>
<td><strong>Orbit</strong></td>
<td>904 km PolarSun-synchronous</td>
</tr>
<tr>
<td><strong>Inclination</strong></td>
<td>99.08 deg</td>
</tr>
<tr>
<td><strong>Repetivity</strong></td>
<td>22 days (307 orbits)</td>
</tr>
<tr>
<td><strong>Local time</strong></td>
<td>10.30 a.m. (descending node)</td>
</tr>
<tr>
<td><strong>Life</strong></td>
<td>Three years (nominal)</td>
</tr>
<tr>
<td><strong>Orbital life</strong></td>
<td>Long</td>
</tr>
<tr>
<td><strong>Mission</strong></td>
<td>Operational Remote Sensing</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>975kg</td>
</tr>
<tr>
<td><strong>onboard power</strong></td>
<td>600 Watts</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>S-band, X-band and VHF (commanding only)</td>
</tr>
<tr>
<td><strong>Stabilization</strong></td>
<td>Three axis body stabilized (zero momentum) with 4 Reactions Wheels, Magnetic torquers</td>
</tr>
<tr>
<td><strong>RCS</strong></td>
<td>Monopropellant Hydrazine based with sixteen 1 Newton thrusters</td>
</tr>
<tr>
<td><strong>Payload</strong></td>
<td>Three solid state Push Broom Cameras LISS-1 (72.5 metre resolution), LISS-2A and LISS-2B (36.25 metre resolution)</td>
</tr>
<tr>
<td><strong>Launch date</strong></td>
<td>August 29, 1991</td>
</tr>
<tr>
<td><strong>Launch site</strong></td>
<td>Baikanur Cosmodrome Kazakhstan</td>
</tr>
</tbody>
</table>
# IRS 1B

<table>
<thead>
<tr>
<th><strong>Launch vehicle</strong></th>
<th>Vostok</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Orbit</strong></td>
<td>904km Polar Sun Synchronous</td>
</tr>
<tr>
<td><strong>Inclination</strong></td>
<td>99.08 deg</td>
</tr>
<tr>
<td><strong>Repetivity</strong></td>
<td>22 days</td>
</tr>
<tr>
<td><strong>Local time</strong></td>
<td>10.30 a.m. (descending node)</td>
</tr>
<tr>
<td><strong>Mission life</strong></td>
<td>Three years (nominal)</td>
</tr>
<tr>
<td><strong>Orbital life</strong></td>
<td>Long</td>
</tr>
<tr>
<td><strong>Mission</strong></td>
<td>Operational Remote Sensing</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>846kg</td>
</tr>
<tr>
<td><strong>onboard power</strong></td>
<td>415Watts</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>S-band (TIC) &amp; VHF</td>
</tr>
<tr>
<td><strong>Stabilization</strong></td>
<td>Three axis body stabilized (zero momentum) with 4 Reaction Wheels, Magnetic torquers</td>
</tr>
<tr>
<td><strong>RCS</strong></td>
<td>Monopropellant Hydrazine based RCS with 1 Newton thrusters (16 Nos.)</td>
</tr>
<tr>
<td><strong>Payload</strong></td>
<td>LISS-1 MEOSS (Mono-ocula Electro Optic Stereo Scanner)</td>
</tr>
<tr>
<td><strong>Launch date</strong></td>
<td>September 20, 1993</td>
</tr>
<tr>
<td><strong>Launch site</strong></td>
<td>SHAR Centre Sriharikota India</td>
</tr>
<tr>
<td><strong>Launch vehicle</strong></td>
<td>PSLV-d1</td>
</tr>
<tr>
<td><strong>Orbit</strong></td>
<td>Not realised</td>
</tr>
<tr>
<td><strong>Mission</strong></td>
<td>Operational Remote Sensing</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>1250kg</td>
</tr>
<tr>
<td><strong>onboard power</strong></td>
<td>809 Watts (generated by 9.6sq.metres Solar Panels)</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>S-band, X-band</td>
</tr>
<tr>
<td><strong>Stabilization</strong></td>
<td>Three axis body stabilized (zero momentum) with 4 Reaction Wheels, Magnetic torquer</td>
</tr>
<tr>
<td><strong>RCS</strong></td>
<td>Monopropellant Hydrazine based with sixteen 1 Newton thrusters &amp; one 11N thrusters</td>
</tr>
</tbody>
</table>
## IRS-1C

<table>
<thead>
<tr>
<th>Payload</th>
<th>Three solid state Push Broom Cameras: PAN (&lt;6 metre resolution) LISS-3 (23.6 metre resolution) and WiFS (189 metre resolution)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onboard tape recorder</td>
<td>Storage Capacity: 62 G bits</td>
</tr>
<tr>
<td>Launch date</td>
<td>December 28, 1995</td>
</tr>
<tr>
<td>Launch site</td>
<td>Baikanur Cosmodrome Kazakhstan</td>
</tr>
<tr>
<td>Launch vehicle</td>
<td>Molniya</td>
</tr>
<tr>
<td>Orbit</td>
<td>817 km Polar Sun-synchronous</td>
</tr>
<tr>
<td>Inclination</td>
<td>98.69deg</td>
</tr>
<tr>
<td>Repetivity</td>
<td>24 days</td>
</tr>
<tr>
<td>Local time</td>
<td>10.30 a.m</td>
</tr>
<tr>
<td>Mission life</td>
<td>Three years (nominal)</td>
</tr>
<tr>
<td>Orbital life</td>
<td>Long</td>
</tr>
</tbody>
</table>
IMPORTANT EVENTS

- Bhaskara-I - 07.06.1979
- Bhaskara-II - 20.11.1981
OTHER SATELLITES

- Quick Bird - October, 2001
  Resolution - 0.61 m

- Worldview -1
It is the reflectance value of an object recorded by the sensor.
SPECTRAL SIGNATURE

- It is the quantitative measurement of properties of an object at different wave length.
- It is the type characteristic of the object.
RESOLUTION

- Spatial resolution (pixel size)
- Spectral resolution (wave length region)
- Temporal resolution (repetitive)
- Radio metric resolution (DN value)
100 meter resolution
30 meter resolution
5 meter resolution
ATMOSPHERIC WINDOW AND BANDS

- Minimum scattering and absorption.
- Maximum transmission
REMOTE SENSING PROCESS

OBSERVATIONS
- Sensor – Mounted on satellites

RECORDING
- Photo film, Video tape, Magnetic tape

TRACKING ANTENNA AND COMMUNICATION LINK
- Ground station
REMOTE SENSING PROCESS

RECEIVING STATIONS

PRE-PROCESS

- Corrections – Removal of geometric and radiometric distortion
  - Motion of platform
  - Altitude
  - Curvature of earth
  - Non-uniformity of elevation
REMOTE SENSING PROCESS

PROCESSING

- Classification

FINAL DATA PRODUCT

- Digital Data
- FCC
- Satellite map
REMOTE SENSING PROCESS

Statement of Problem
- Identify criteria
- Formulate Hypothesis

Data Acquisition
- Digital data
- Purchase

Image Processing
- Select or configure

Initial Statistics Extracts
- Univariate and multivariate statistics to assess image quality
REMOTE SENSING PROCESS

1. Initial Display
2. Pre-processing
   - Radio metric correction
   - Geometric correction
3. Image Enhancement
   - For further digital analysis
   - For visual analysis
4. Thematic Information and Extraction
   - Perform analysis
   - Evaluate accuracy
REMOTE SENSING PROCESS

B

GIS
- Quarries

Solve
- Accept or reject the hypothesis
MULTI CONCEPT IN REMOTE SENSING

- Multispectral
  - Several bands

- Multistation
  - Several positions

- Multidate
  - Several dates
  - Dynamic change study
    or Temporal study

- Multipolarization
  - Different polarization

- Multidirectional

- Multienhanced
  - Filters – suppress or enhance data

- Multiuser
MULTI CONCEPT IN REMOTE SENSING

- Multispectral - Several bands

Ch. 1
Blue

Ch. 2
Green

Ch. 3
Red

Ch. 4
NIR

Ch. 5
MIR
ADVANTAGES OF REMOTE SENSING

- Real time data
- Area coverage
- Variety of themes
- Repetitive coverage
- Data of inaccessible area
- Different purposes and applications
- Digital data
CHALLENGES

- Continuity of services
- Explore new areas of application
- Human training
- Strengthen infrastructure
- International participation
- Global market
- Resolution, Temporal resolution and Cloud cover
- Storing of data
- Management of data
Flying Blind
We Live in Two Worlds

Natural World: Self-Regulating

Constructed World: Managed

... These Are Increasingly In Conflict
GIS

Context and Content

Seeing the Whole
- Patterns
- Linkages
- Trends

Managing Places
- Watersheds
- Communities
- Neighborhoods
- Districts
Abstracting the Real World
What is GIS?

- A Geographic Information System (GIS) is a computer-based system including software, hardware, people, and geographic information.

- A GIS can:
  - create, edit, query, analyze, and display map information on the computer.
Geographic Information System

- **Geographic** – 80% of government data collected is associated with some location in space

- **Information** - attributes, or the characteristics (data), can be used to symbolize and provide further insight into a given location

- **System** – a seamless operation linking the information to the geography – which requires hardware, networks, software, data, and operational procedures

...not just software!
...not just for making maps!
Who uses GIS?

- **International organizations**
  - UN HABITAT, The World Bank, UNEP, FAO, WHO, etc.
- **Private industry**
  - Transport, Real Estate, Insurance, etc.
- **Government**
  - Ministries of Environment, Housing, Agriculture, etc.
  - Local Authorities, Cities, Municipalities, etc.
  - Provincial Agencies for Planning, Parks, Transportation, etc.
- **Non-profit organizations/NGO’s**
  - World Resources Institute, ICMA, etc.
- **Academic and Research Institutions**
  - Smithsonian Institution, CIESIN, etc.
What can you do with a GIS?

• The possibilities are unlimited...
  ▪ Environmental impact assessment
  ▪ Resource management
  ▪ Land use planning
  ▪ Tax Mapping
  ▪ Water and Sanitation Mapping
  ▪ Transportation routing
  ▪ and more ...
• GIS data has a spatial/geographic reference

  ▪ This might be a reference that describes a feature on the earth using:

    • a latitude & longitude
    • a national coordinate system
    • an address
    • a district
    • a wetland identifier
    • a road name
Geography and Databases

- A GIS stores information about the world as a collection of thematic layers that can be linked together by geography.
GIS Provides Data Integration

- Roads
- Land Parcels
- Population
- Utilities
- Land Mines
- Hospitals
- Refugee Camps
- Wells
- Sanitation
Two fundamental types of data

- **Vector**
  - A series of x,y coordinates
  - For discrete data represented as points, lines, polygons

- **Raster**
  - Grid and cells
  - For continuous data such as elevation, slope, surfaces

- A Desktop GIS should be able to handle both types of data effectively!
Data Representation

Raster

Vector

Real World
Other features of a GIS

- Produce good cartographic products (translation = maps)
- Generate and maintain metadata
- Use and share geoprocessing models
- Managing data in a geodatabase using data models for each sector
Hint – having GIS software does not a cartographer make!

- Good to know something about these issues when creating a map and doing spatial analysis...
  - Scale/Resolution
  - Projection
  - Basic cartographic principles regarding design, generalization, etc.
GIS is (rapidly) evolving
GIS as part of your decision making process...

Problem Statement – ?????

Formulate the question

Observe, acquire data

Seek solutions

Analyze

Mitigate and change

Diagram courtesy of Michael Goodchild, UCSB
Case Study - I

- Use of satellite data for tectonic interpretation, North West Himalaya
- Location: 9 Districts of Punjab and Himachal Pradesh.
- Himalayan frontal fault, main boundary thrust, main central thrust.
- Generation of DEM
- Results: Thematic maps indicative of tectonic morphologies are prepared.
Case Study - II

- A quick appraisal of ground deformation in Indian region due to the October, 8th 2005 earthquake, Muzaffarbad, Pakistan.

- Area – Kashmir Valley

- Data – IRS P5 (Cartosat – I)
  IRS P6 (Resourcesat – I)
Case Study - II

[Map of earthquake locations with magnitudes indicated]
The post earthquake coverage of LISS-IV image showing landslides along Jhelum River to the East and West of Uri town are indicated by red solid circles. (a) & (b) Cartosat-I Images of post earthquake showing recent landslides.
Case Study - II

a) Complete collapse of Police station at UR1 town (34° 04’ 36.0”, 74° 03’ 56.8”)

b) The earthquake surveyed partially constructed house and at the background the large diagonal cracks in the side walls of the house, but the walls have not failed.
c) Fresh landslide in the steeply dipping hard red colour sandstone
d) Fresh land slide in the thick culluival deposit near Urusu Village, National Highway
Case Study - II

e) Sand boils along fishers in pasture

f) Lateral spreading in young alluvium