

5. Remote-Sensing Technology

Remote-sensing technology is becoming increasingly popular and widely used by researchers

Remote Sensing

Remote sensing is the science of collecting information about the Earth's surface without direct physical contact. Data is acquired using satellites, aircraft, UAVs (drones), and sensors mounted on spaceborne or airborne platforms. It works by detecting and analysing electromagnetic radiation reflected or emitted by objects on the Earth's surface. Different objects (soil, water, vegetation, buildings) have unique spectral signatures, which help in their identification and analysis. Sensors operate across-

1. Visible spectrum
2. Near and Thermal Infrared
3. Microwave (Radar)

Remote Sensing Works (Conceptual Understanding)

Passive sensors

1. Depend on sunlight (e.g., optical satellites).
2. Used for vegetation, land use, and water studies.

Active sensors

1. Emit their own radiation (e.g., RADAR).
2. Useful during night, cloud cover, and monsoon conditions.

Data products are processed using GIS and geospatial analytics to derive actionable insights.

Major Applications of Remote Sensing

Coastal Applications

1. Monitoring shoreline changes and coastal erosion.
2. Tracking sediment transport and coastal currents.
3. Mapping mangroves, coral reefs, estuaries, and tidal flats.
4. Supports coastal zone management and disaster mitigation against cyclones and storm surges.

Ocean Applications

1. Mapping ocean circulation and current systems.
2. Measuring sea surface temperature, wave height, and salinity.
3. Tracking sea ice, oil spills, and algal blooms.
4. Helps in sustainable fisheries management and marine resource planning.

Hazard Assessment and Disaster Management

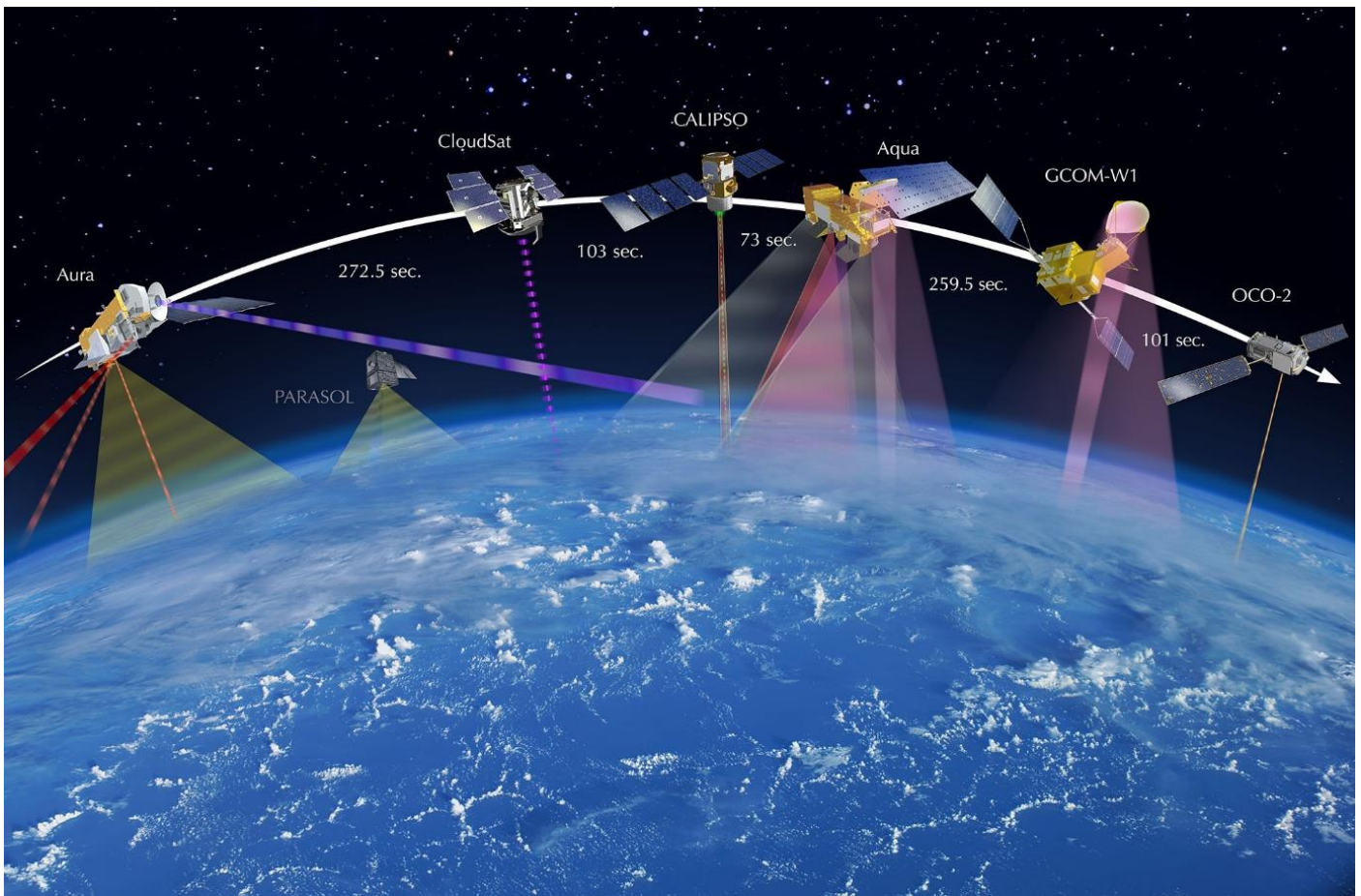
Monitoring and early warning of

1. Cyclones and hurricanes,
2. Floods and droughts,
3. Landslides and earthquakes,
4. Forest fires and coastal inundation.

Enables damage assessment, relief planning, and post-disaster rehabilitation. Forms the backbone of disaster preparedness strategies.

Natural Resource Management

1. Monitoring land use and land cover (LULC) changes.
2. Mapping wetlands, river basins, and wildlife habitats.
3. Assessing environmental degradation due to urbanisation and mining.
4. Helps balance development and ecological conservation.



Groundwater and Mineral Exploration

Identification of groundwater potential zones through geomorphology and lineament analysis.
Detection of mineral-bearing zones using spectral anomalies. Reduces cost and risk in exploration activities.

Forests and Ecology

1. Mapping forest cover, forest density, and fragmentation.
2. Identification of biodiversity hotspots and wildlife corridors.
3. Estimation of carbon stock and biomass, supporting climate commitments.
4. Inputs for forest conservation and REDD+ strategies.

Vegetation and Crop Health Monitoring

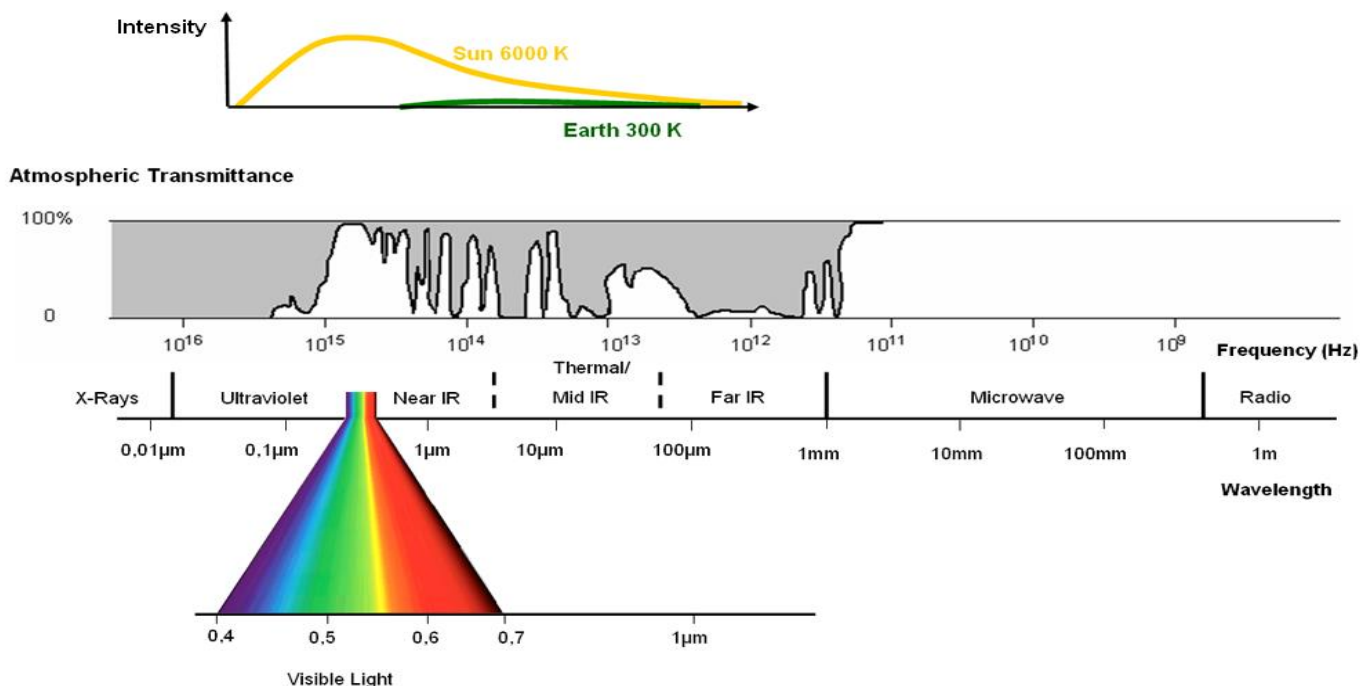
Plants strongly reflect near-infrared (NIR) and absorb red light. Indices such as NDVI help assess-

1. Crop vigour,
2. Forest health,
3. Drought stress and pest infestation.

Enables real-time ecosystem monitoring.

Agriculture

1. Crop area and yield estimation.
2. Soil moisture and drought assessment.
3. Precision farming and input optimisation.
4. Supports food security and farm advisories.



Urban and Regional Planning

1. Monitoring urban sprawl and infrastructure growth.
2. Mapping transport networks and utilities.
3. Assessing urban heat islands and pollution hotspots.
4. Facilitates smart city planning.

Importance of Remote Sensing – Provides reliable, large-scale, and periodic data for governance. Reduces dependence on time-consuming and costly ground surveys. Enhances border surveillance, maritime domain awareness, and internal security. Strengthens climate change mitigation and adaptation strategies. Positions India as a major player in space-based Earth observation systems.

Challenges in Remote Sensing

1. Limited public access to very high-resolution imagery.
2. Difficulty in integrating satellite data with ground-based field surveys.
3. Shortage of skilled professionals in advanced geospatial analytics and AI-based interpretation.
4. Dependence on foreign satellites for certain strategic datasets.
5. Need to balance open data policies with national security concerns.

India's Institutional and Policy Framework in Remote Sensing

ISRO's Remote Sensing Programme – Launch of Indian Remote Sensing (IRS) series. Cartosat satellites provide high-resolution imaging for mapping and defence. Strengthened India's self-reliance in Earth observation.

National Remote Sensing Centre (NRSC) – Operates under Indian Space Research Organisation. Provides geospatial data, decision-support systems, and disaster response services. Supports ministries, states, and national missions.

Forest Survey of India (FSI) – Publishes the India State of Forest Report (ISFR) every two years. Relies heavily on satellite-based forest assessment. Key input for forest policy and climate reporting.

Indian Space Policy 2023 – Encourages private sector participation in satellite data generation and applications. Promotes innovation in downstream geospatial services. Supports commercialisation of space-based data.

Digital India and Geospatial Governance – Integration of satellite and GIS data into e-governance platforms. Enhances transparency, service delivery, and citizen-centric planning.

Conclusion and Way Forward

Remote sensing is a strategic enabler for India's development, environmental sustainability, and national security. From forest monitoring and agriculture to disaster prediction and border surveillance, its role is indispensable. To fully harness its potential, India must

1. Improve data accessibility and interoperability,
2. Invest in skill development and geospatial education,
3. Upgrade processing infrastructure and AI integration.

With continued support from ISRO, national institutions, and enabling policies, remote sensing will remain a cornerstone of evidence-based governance and scientific advancement.

Source- <https://www.thehindu.com/sci-tech/science/what-remote-sensing-reveals-about-plants-forests-and-minerals-from-space/article70474634.ece>

