History of the Indian Remote Sensing Programme

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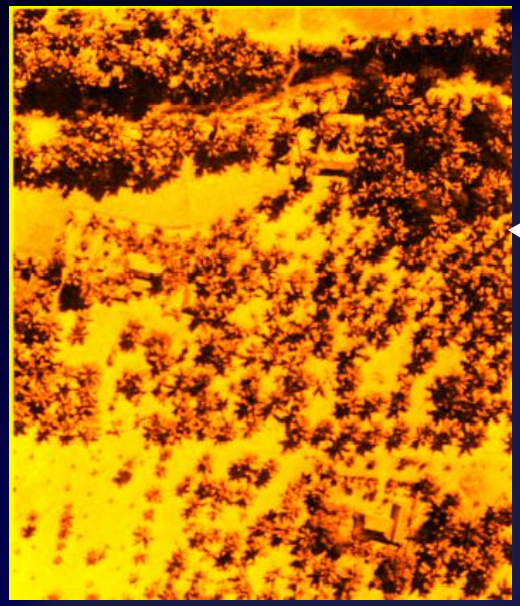
March 31, 2014

BEGINNING

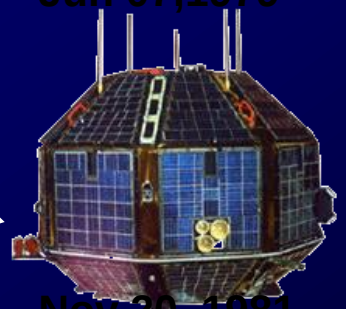


Aerial view of Grove Area
(Coconut Root Wilt Disease Study)

Stared with the pioneering experiment of detecting Coconut Root Wilt Disease using Color Infrared Film in 1970s by Prof. P. R. Pisharoty.

Bhaskara-I (1979) and Bhaskara-II (1981) – Experimental Remote Sensing Satellites provided the foundation for the operational Indian Remote Sensing Programme.

Jun 07,1979



Nov 20, 1981

The Result is operational Indian Remote Sensing Programme with the launch of IRS-1A on March 17, 1988

DURING 1980s

NRSA established Earth Station Complex at Annaram Village, Shadnagar, 59 km from Balanagar in 1979 to receive Landsat Data

1980-83: Landsat 2,3 & NOAA- 2, 3

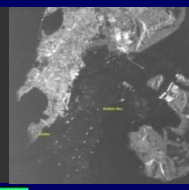
1983-88: Landsat 5, ERS, SPOT & NOAA

Today: Multimission Scenario - 4 Terminals (7.5m) - upto 960Mbps

EVOLUTION OF INDIAN EO SYSTEMS

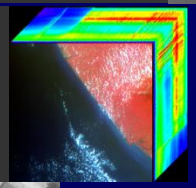
(Microwave Capability)

RISAT-1 (2012)
- C Band SAR (5.35 GHz)



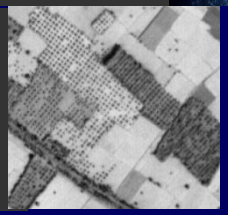
(Hyperspectral Capability)

IMS-1 (2008)
- HySI Sensor (64 bands, 506 m)
- TWSAT-MX (4 bands, 37 m)



(High Spatial Resolution & Stereo Capability)

TES, Cartosat-1, 2/2A/2B (1999, 2005, 2007, 2008, 2010)
- PAN : 2.5 m, 1m Fore +26° Aft: -5°



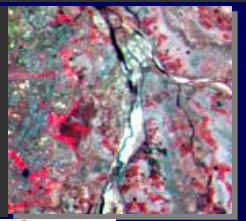
(Multi resolution, Frequent observations, Better radiometry)

Resourcesat-1/2 (2003, 2011)
- LISS-3: 23 m, 4 XS,
- LISS-4: 5.8 m, 3-XS,
- AWiFS: 56 m, 4-XS

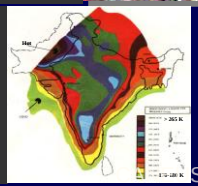
(High Repetivity/Revisit, High Spatial Resolution)

IRS-1C/1D (1995,1997)
- LISS-3: 23/70 m,
- Steerable PAN: 5.8 m,
- WiFS: 188 m

IRS-1A/1B/P2 (1988,1991,1994)
- LISS-I: 72.5m, 4XS
- LISS-II: 36.5m, 4XS



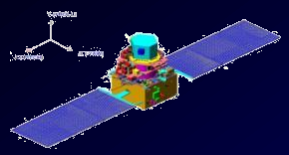
BHASKARA 1 /2 (1979,1981)
- TV Camera, Microwave Radiometer



Land Applications

.....towards enabling solutions

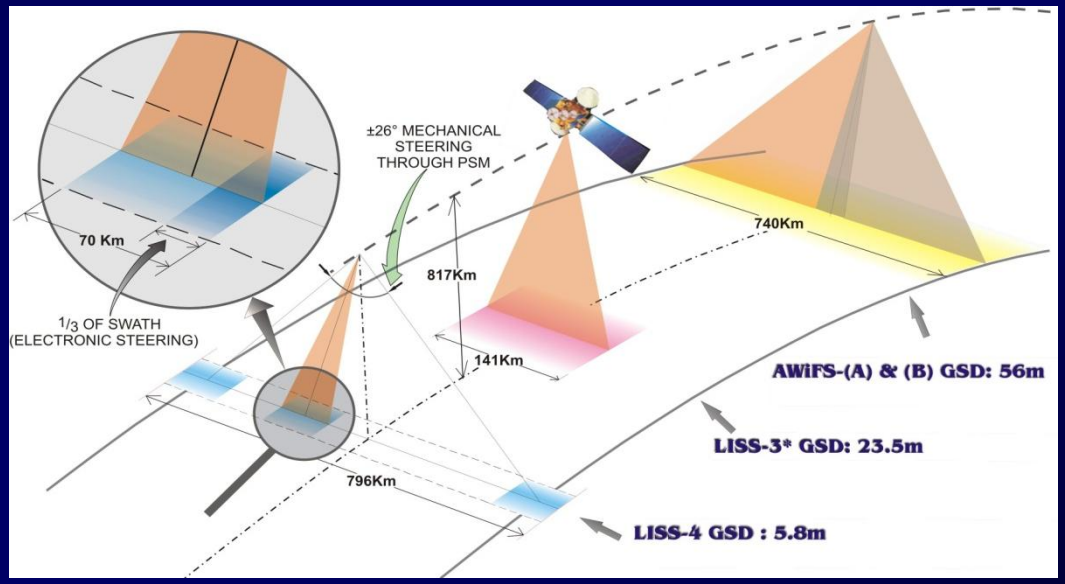
RESOURCESAT-1 / 2 (2003, 2011)



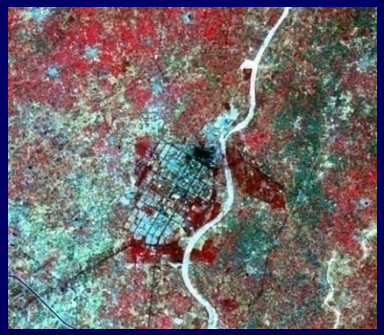
Agricultural applications

(field size, frequent observations, better radiometry)

- **LISS-4 Mx camera: 5.8m Resolution and 70 km swath**
- **LISS-3: 23.5m Resolution and 141 km Swath**
- **AWiFS: 56m Resolution and 740 km Swath**
- **Repetitivity: 5 days (AWiFS) to 24 days (LISS 3) &**
- **Revisit: 5 days (LISS 4) with tilting 26 deg tilt**

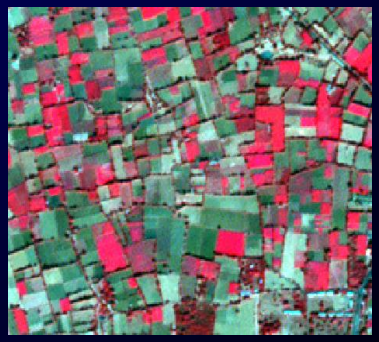


AWiFS



LISS-III

LISS-IV

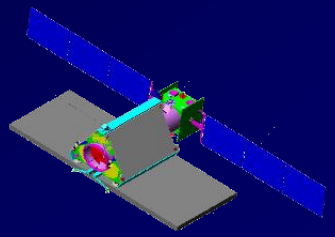


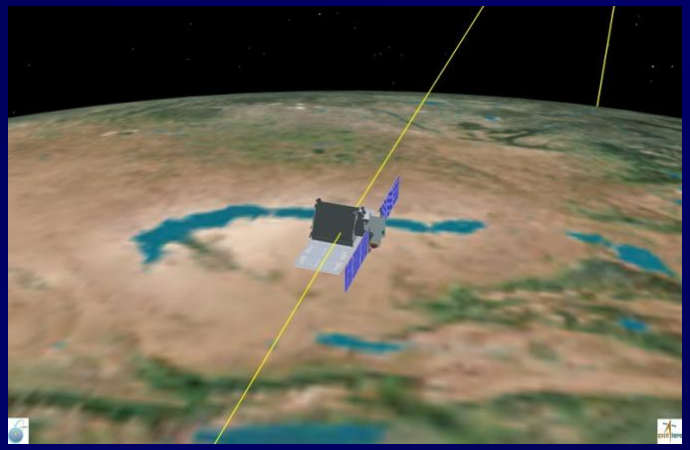
RISAT-1 (2012)

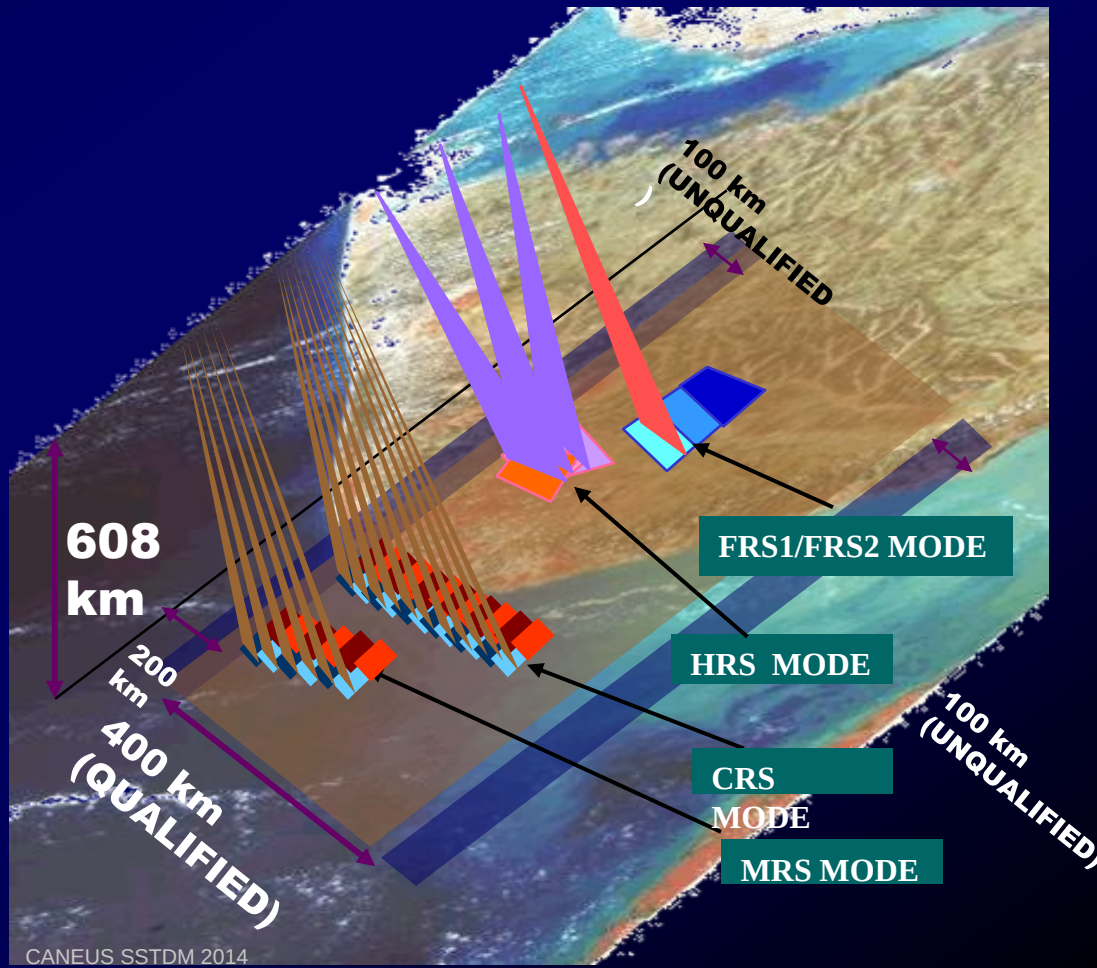
Space borne SAR in C-band at 5.35 GHz

- Stripmap FRS-1 / FRS-2 (Range Doppler/ Chirp Scaling)
- ScanSAR MRS & CRS (Range Doppler/Specan)
- Spotlight (modified sub-aperture) modes.

Single/ Dual / Quad Polarisation imaging with 3- 50 m Resolution & 10 - 240 km Swath







EVOLUTION OF INDIAN EO SYSTEMS: OCEAN

SARAL (2012)
Altika:
- Ka band (35.75 GHz) radar altimeter
- Dual Frequency microwave radiometer (23.8 and 37 GHz)

ARGOS: Data collection Platform

Oceansat-2 (1999)
OCM: 360m, 1420km swath, 8 XS
OSCAT: Ku Band Scatterometer
- 50km resolution; Ocean surface wind speed 4 m/sec to 24 m/sec

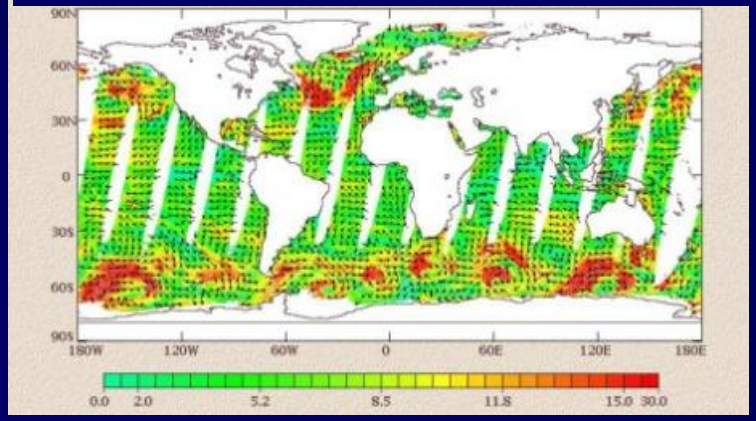
ROSA: Horizontal : 300 km; Vertical: 0.3 km (lower troposph.), 1-3 km (high troposph.)

IRS-P4 (Oceansat-1) (1999)
OCM: 360m, 1420km swath
8 XS (0.402-0.885 μm)
MSMR: Microwave Passive Radiometer
- 6.6, 10.65, 18, 21 GHz
- 150, 75, 50, 50 km resolution

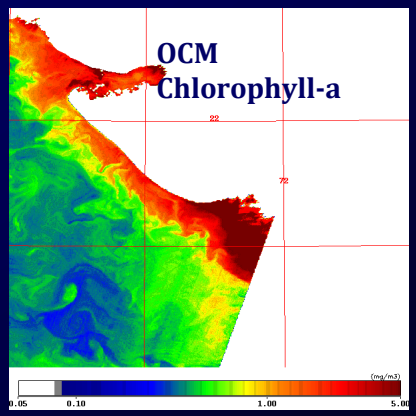
IRS-P3 (1996)
MOS-A/B/C Spectrometer:
- 500m, 200km swath,
- 18 XS (0.40-1.6 μ m)

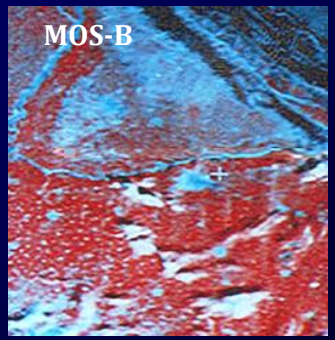
WiFS: 188m, 3 XS, 810 km

Global Wind Vector Product



Changes in OCM2:
- Band 765 nm → 740 nm to avoid O_2 absorption
- Band 670 nm → 620 nm for better quantification of suspended sediments

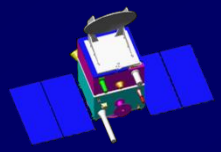




SARAL: SATELLITE WITH ARGOS AND ALTIMETER

Altika/SARAL mission belongs to the global altimetry system for the precise and accurate observations of ocean topography, circulation and sea surface monitoring

ISRO & CNES Collaboration

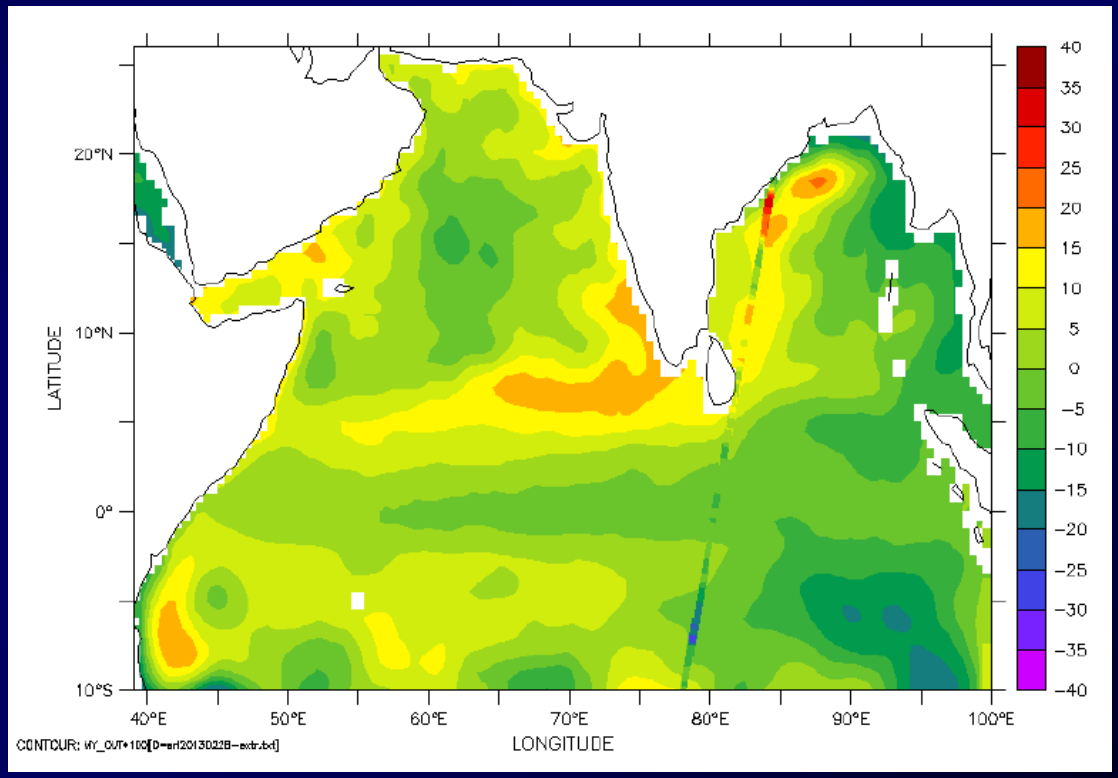


Mission:

- Sun-synchronous, polar orbiting satellite
- Inclination: 98.38 Deg.
- Altitude: ~800 km
- Repeat cycle: 35 days

Altika Payload:

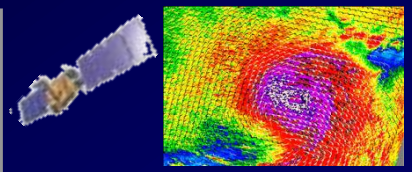
- Ka-band (35.75 GHz, BW 500 MHz) radar altimeter
- Dual-frequency microwave radiometer (23.8 & 37 GHz)
- DORIS
- Laser Retro-reflector Array



SARAL/AltiKA SSHA observation overpass over Indian Ocean on Feb 28, 2013 and SLA from POM model at 0.5 degree resolution.

EVOLUTION OF INDIAN EO SYSTEMS: ATMOSPHERE

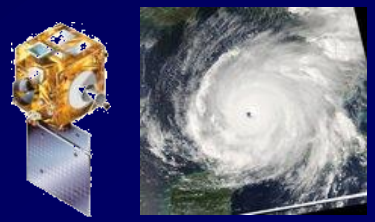
Meghatropics
(2011)
MADRAS, SCARAB, SAPHIR, GPS OCC.



Kalpana (VHRR) and INSAT-3A
(2001-2005)

VHRR:
- 2.0 km Vis,
- 8 km IR, WV

CCD: (only 3A)
- 1 km MS

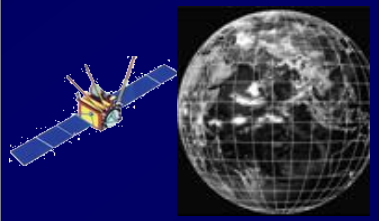


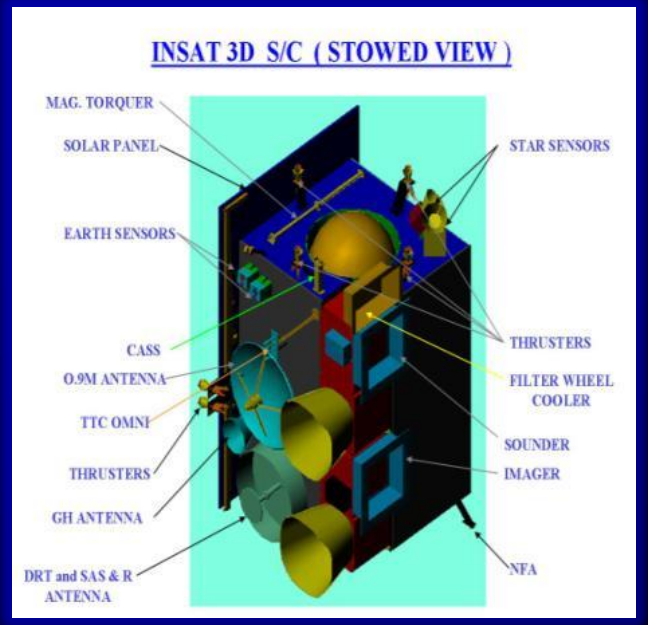
INSAT-3D
(2013)
Imager and Sounder

INSAT – 2D/ 2E
(1996-2000)

VHRR:
- 2.0 km Vis,
- 8 km IR, WV

CCD: (only 2E)
- 1 km MS



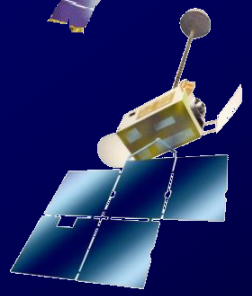


INSAT – 2A/ 2B/ 2C
(1991-95)

VHRR:
- 2.75 km Vis,
- 11 km IR

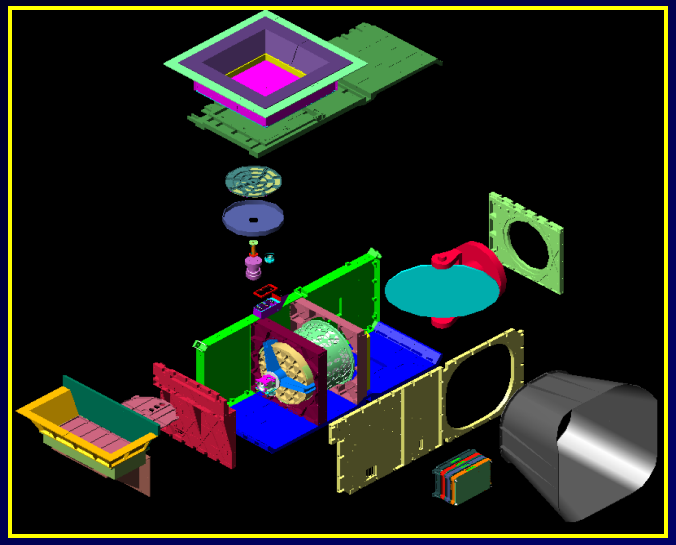
INSAT – 1A/ 1B/ 1C/ 1D
(1982-1990)

VHRR:
- 2.75 km Vis,
- 11 km IR



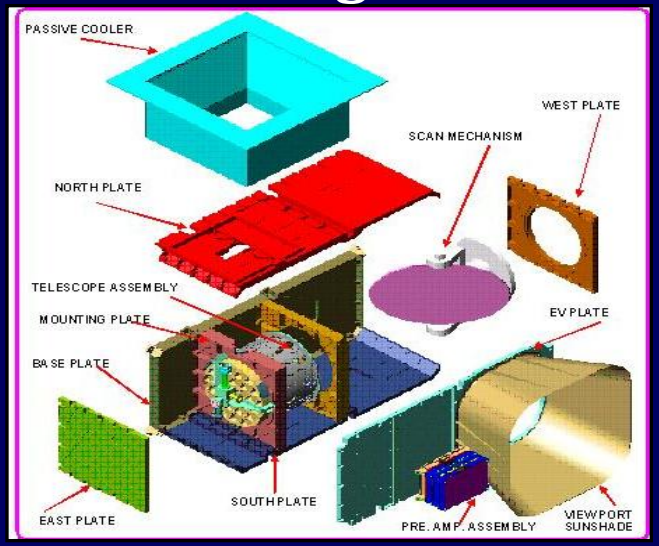
INSAT 3D Sounder

Sounder



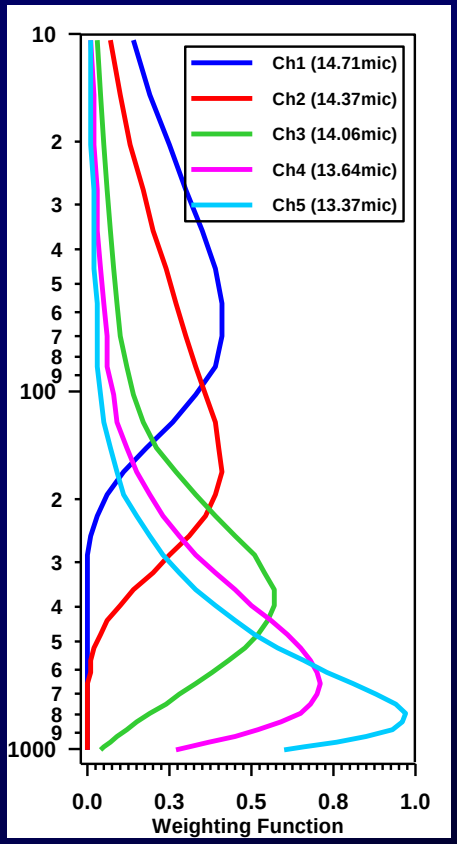
19 channel Sounder

Imager



Advanced 6-channel imager

Sensor	Bands (μm)	Spatial Res.
Imager	VIS (0.55-0.75), SWIR (1.55-1.70) MIR (3.8-4.0) WV (6.5-7.1) TIR1 (10.2-11.3), TIR2(11.5-12.5)	1km x 1km 4km x 4km 8km x 8km 4km x 4km
Sounder	19 channels	10km x 10km



INSAT-3D Weighting function over Indian Region (July)

Applications: Improved estimation of water vapour content, cloud, wind vector, upper tropospheric humidity, sea surface temperature and surface insolation

AIRBORNE MISSIONS

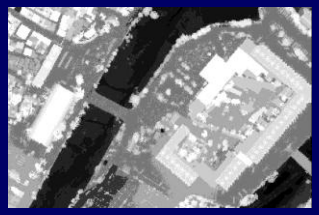
- **DMSAR**

  Freq: 5.35 GHz; Swath: 90, 56, 8 km; Resol:10, 5, 1 m; Look Angle : 84.5 MX; Altitude : 8 km.

Water Inundated regions of Dholka, near Ahmedabad

- **ALTM**

  ALS50 System; Laser: Nd-YAG; Wave length:1064 nm; Altitude: 500-4000 m; FOV:75 deg; IFOV:0.33 mrad



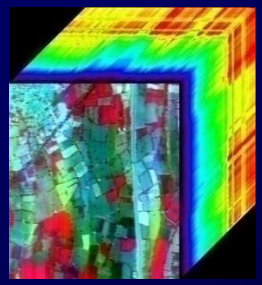
Part of Hyderabad City; Height Range:404 – 436m

- **AIRBORNE HYPERSPECTRAL**
  - AIMS

    Altitude: 6.473 km; Resol.: 4.4 m; Spectral Range: 456-889 nm; Bands: 143; Band Width: 3.3-4.1 nm

  - AHySI

    Spectral Range: 420-950 nm; Spectral sampling interval: 1.2 nm; Number of Bands:512



- **AIRBORNE TMC**

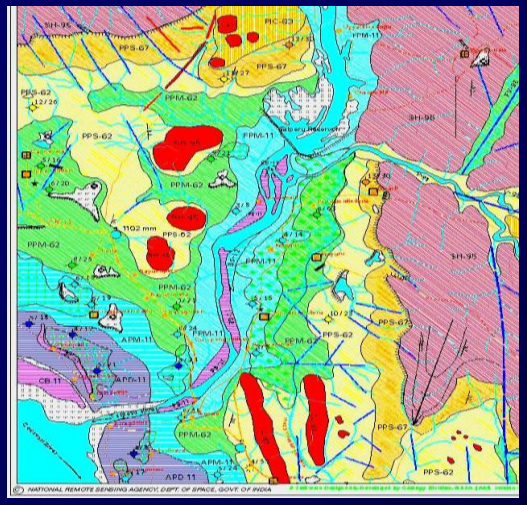
  IFOV: 50 microRad; Swath @ 5 km: 1 km; Spectral Range: 0.5-0.75 µm; Stereo Mode: Alongtrack Triplet

- **AIRBORNE DIGITAL CAMERA**

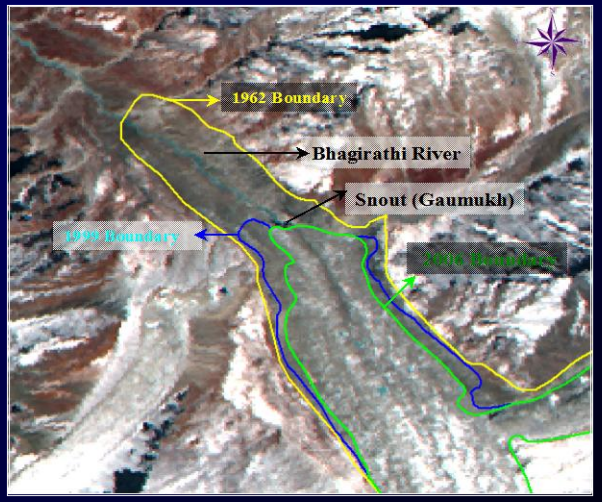
  Pixel: 9 microns; Focal length: 105 mm; FOV: 40 deg

INDIAN EO SYSTEM: ACHIEVEMENTS

- **Institutional Mechanism: National Natural Resources Management System**
- **Generating National level Inventories: Biennial Forest Cover, Land use, Wetland, Snow & Glaciers, Coastal Zone, Crops, Wasteland…**
- **Action Plans for Sustainable Development: Watershed, Ground water…**
- **Creating Decision Support Centre for Disaster Monitoring & Mitigation**



Ground water prospects map

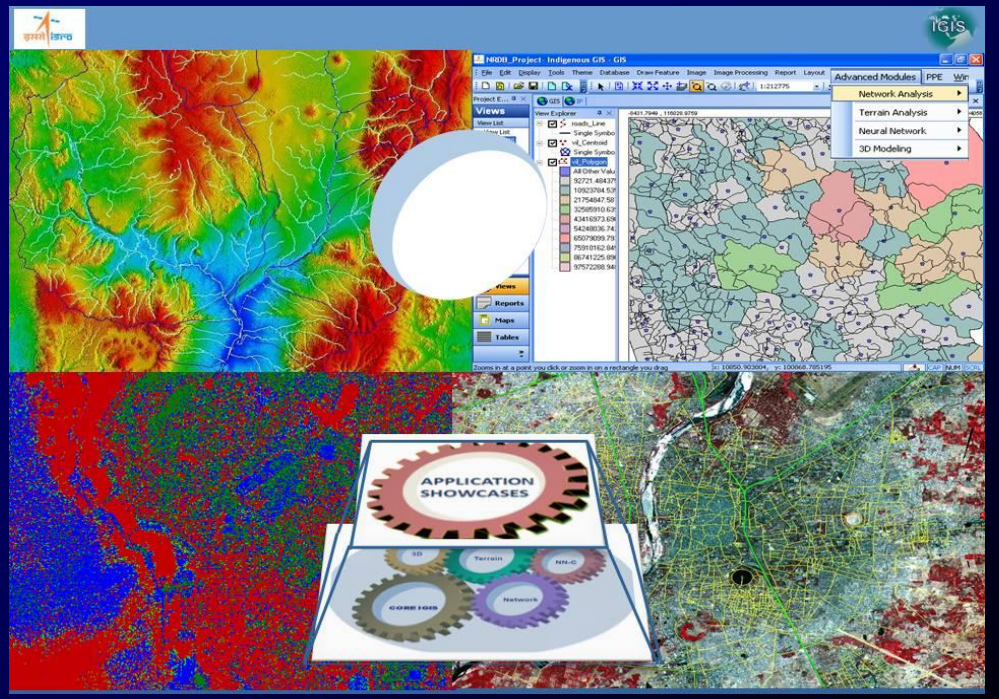


Glacier Monitoring

INDIAN EO SYSTEM: ACHIEVEMENTS

- Development of Delivery Mechanisms for grass-root reach (Village Resource Centre)
- Development of Indigenous software for Data processing
- Building up indigenous EO Infrastructure: Satellites, Payloads, Data Acquisition Systems, Data Processing and Application Capability
- Capacity Building: National and International (CSSTE-AP, Dehradun)

Village Resource Centre



IGIS

INDIA IN INTERNATIONAL PARTNERSHIP

- Bilateral and multilateral cooperation with Countries and International Organisations
- International sensors/satellites on Indian EO Satellites/launch vehicles

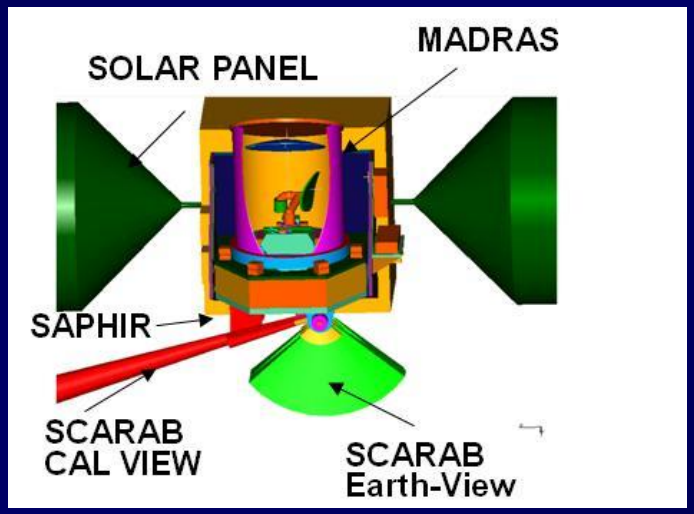
1st sounding rocket launch from the Indian soil - Nike-Apache

DLR's MOS on IRS-P3

ISRO-DLR Airborne SAR Mission

Chandrayaan-1

- **UK: Low Energy X-Ray Spect.**
- **Germany: Infrared Spect. (SIR-2)**
- **Sweden: Sub KeV Atom reflect. Analyser**
- **Bulgaria: Radiation Dose Monitor**
- **USA: Miniature SAR**
- **USA: Moon Mineralogy Mapper**

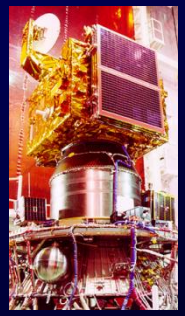


ISRO-CNES

Megha-Tropiques

SARAL

TUB-SAT

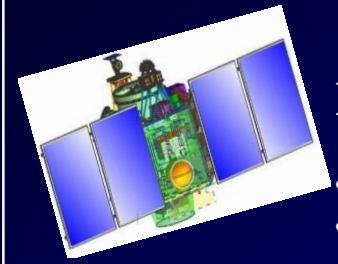


BIRD

EO MISSIONS - NEAR FUTURE

CARTOSAT-2E

High Resolution panchromatic and Multispectral Imaging



Payloads

- PAN (0.60 m, 10 km swath, 11 bit)
- Mx (2m , 10 km swath, 4 Xs, 11 bit)

Orbit : 500 km
Local time: 0930 hrs

RESOURCESAT-2A

To provide continuity for Resourcesat-2

Payloads

- LISS 4 (5.8 m, 70 km swath, 10 bit)
- LISS 3 (23 m, 141 km swath, 10 bit)
- AWiFS (56 m, 800 km swath, 12 bit)

Orbit : 817 km
Local time: 1030 hrs

CARTOSAT-3

Very High Resolution Panchromatic, Multispectral and Hyperspectral Mission

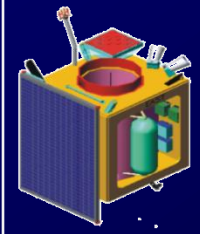
Payloads

- PAN (0.25 m, 16 km swath, 11 bit)
- Mx (1m , 16 km swath, 11 bit)
- HySI (12m, 5 km swath, 200 Xs)

Orbit : 450 km
Local time: 1030 hrs

GISAT/ GeoHR imager

Geosynchronous Orbit



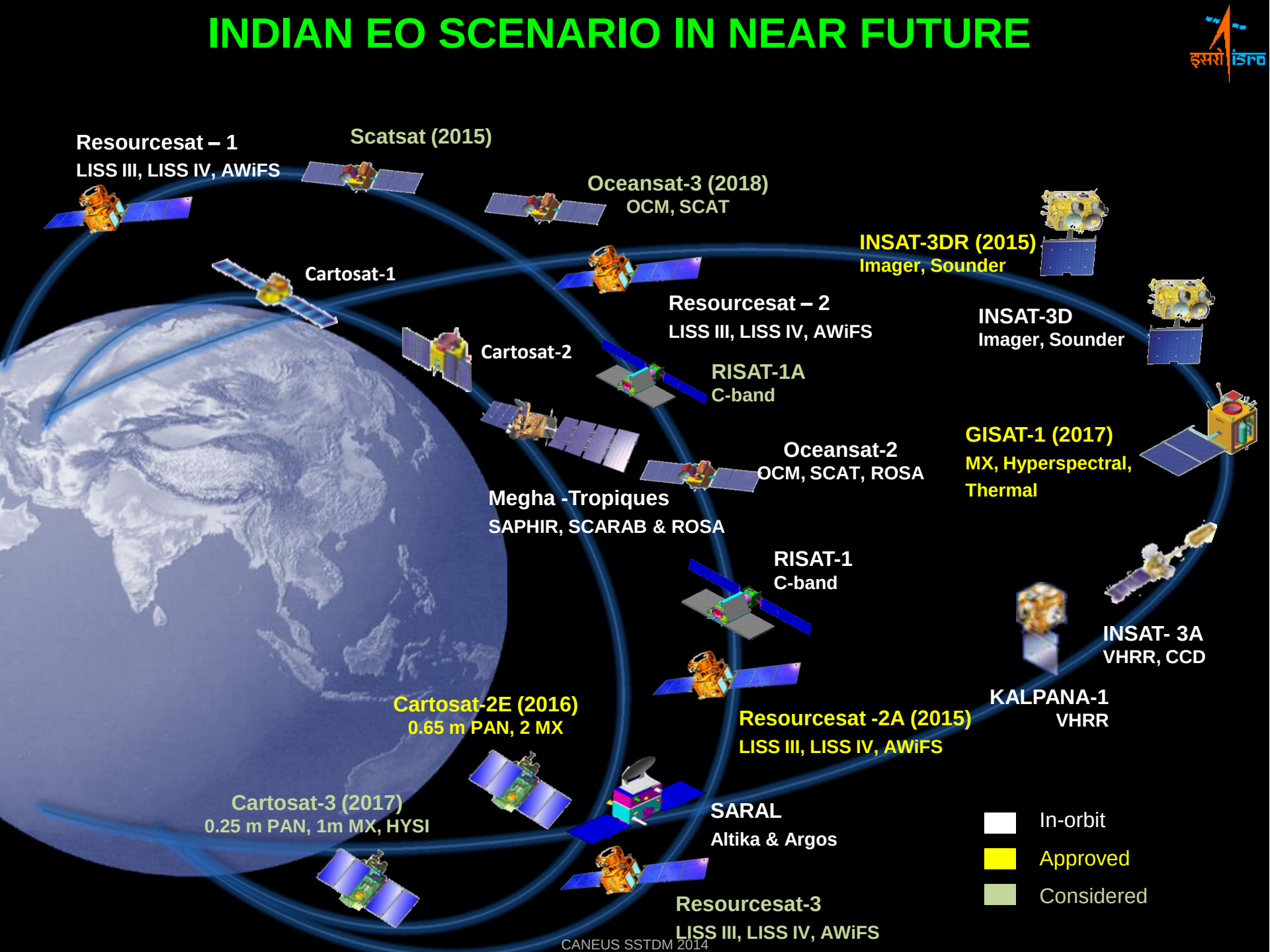
Payloads

- High resolution multi-spectral VNIR : 50m
- Hyper spectral VNIR: 320m
- Hyper spectral SWIR : 192m
- High resolution Multi-spectral: 1.5km

Orbit : 36000 km
Every 30 min
observations over India

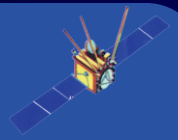
Thank You

INDIAN EO SCENARIO IN NEAR FUTURE



INDIAN EO PROGRAMME: DIMENSIONS

Space Infrastructure



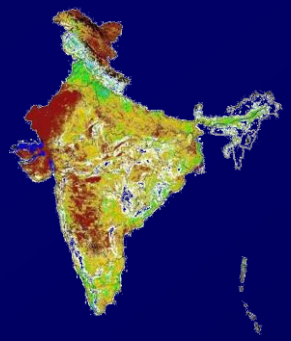
- Launch vehicle (PSLV, GSLV)
- Spacecrafts (LEO, GEO and beyond)
- Sensors (optical/microwave)

Ground Segment

- Data Acquisition and Processing
- International Ground stations
- TTC Network
- Cal-Val Programme

Applications

- Natural Resources & Environment
- Advanced R&D for land-atmosphere-ocean interactions
- Synergy between EO, Communication & Navigation



Institutionalization

- National Natural Resources Management System
- Involvement of stake-holders from the planning level

Capacity Building

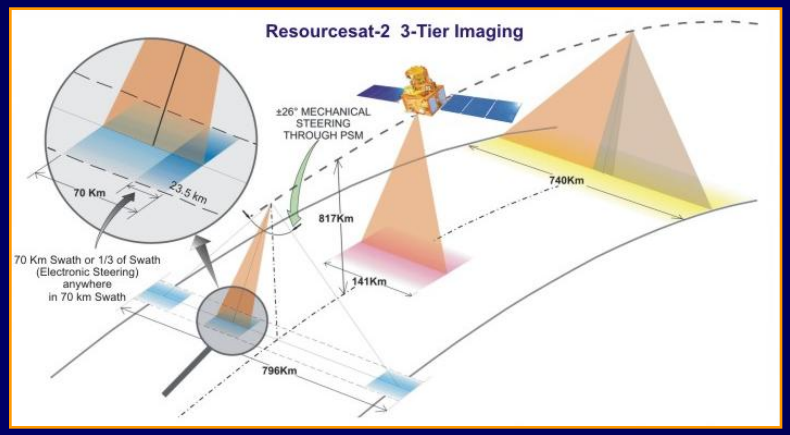
- Formal education through CSSTE-AP, IIRS, IITs….
- On-the job training

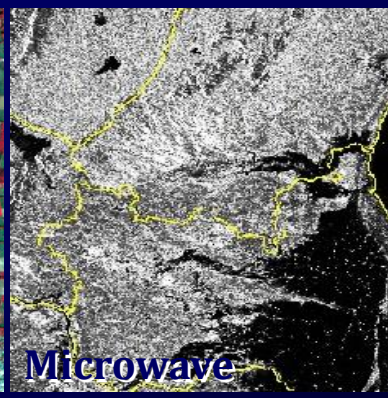
International Cooperation

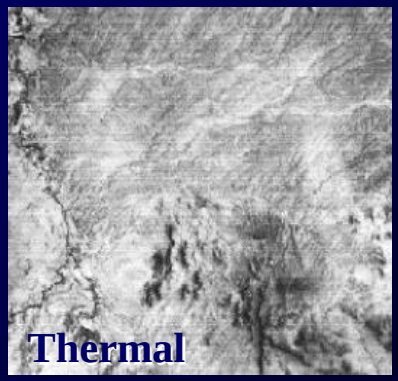
- Bilateral & Multilateral cooperation with various Countries & Int'l Organizations

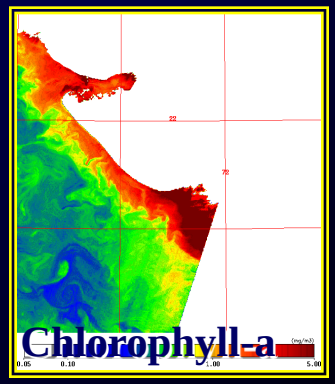
SPACE INPUTS FOR SUSTAINABLE DEVELOPMENT

- **Remote Sensing of Land**
  - Multi resolutions, multispectral bands and high repetivity – Optical and Microwave
  - Time series, long term observations
- **Atmospheric Observations**
  - Cloud motion vectors, rain rate, vertical profiles of temperature and humidity
- **Ocean Measurements**
  - Ocean colour, sea surface temperature, wind vector, fishery prospects
- **Communication and Navigation**
  - Broadcasting, Data Dissemination, Geolocation
- **In-situ Measurements**
  - AWS, Flux Towers, GT Sites
- **Image Processing and GIS Software - IGiS**







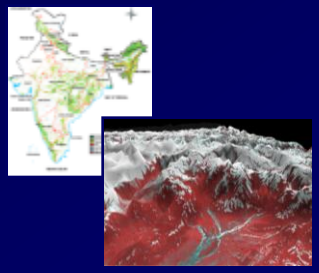


EO APPLICATIONS FOR SOCIETAL BENEFITS

Agriculture & Soils

- Crop Production Forecast
- Saline/ Sodic Soils mapping
- Agro-Met Services & Disaster Surveillance (pest, floods, drought)
- Horticulture development

SC-A



Bio Resources & Environment

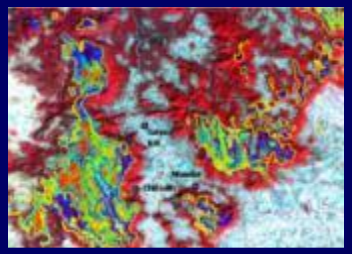
- Forest Cover & Type mapping
- Wetland Inventory & Conservation plans
- Biodiversity Characterization
- Desertification Status mapping
- Coastal, Mangroves, Coral related
- Snow & Glacier studies

SC-B

Cartography

- GCP Library for IRS Data correction
- Large Scale Mapping
- Topo-map updation - Satellite-based
- Digital Elevation Model (Carto-DEM)
- Cadastral Level mapping

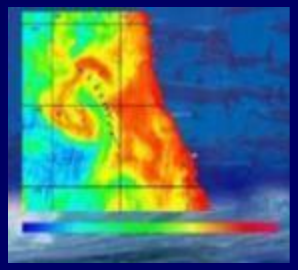
SC-C



Geology & Mineral Resources

- Landslide Hazard Zonation
- Mineral/ Oil Exploration, Mining Areas,
- Seismo-tectonic Studies
- Engineering & Geo-Environmental studies

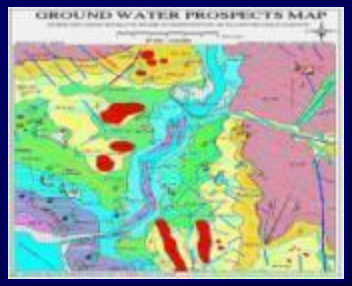
SC-G



Ocean and Meteorology

- Ocean Primary Productivity
- Ocean State Forecast (OSF)
- Storm Surge Modeling
- Regional Weather prediction
- Tropical Cyclones & Mesoscale studies
- Extended Range Monsoon Prediction

SC-O&M



Rural Development

- National Drinking Water Mission
- Wastelands Mapping/ Updation
- Watershed Development & Monitoring
- Land Records Modernization Plan

SC- R

EO APPLICATIONS FOR SOCIETAL BENEFITS

Urban Development

- Urban Sprawl Mapping of Major Cities
- Master/ Structure Plans
- Comprehensive Dev. Plans (CDP) of selected Cities/ Towns
- Base Map generation for Towns
- National Urban Information System

SC-U

Water Resources

- Irrigation Infrastructure assessment
- Water Resources Information System
- Command Area/ Irrigation Performance Evaluation
- Snow-melt Run-off Estimation
- Reservoir Capacity Evaluation
- Site Selection for Hydro-Power

SC-W

NR Census

- Periodic Inventory of Natural Resources under NR Census Programme:

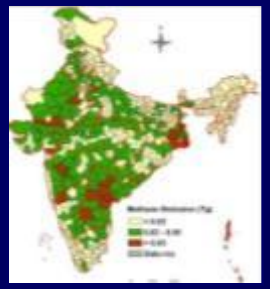
  Land use/ Land Cover, Soil, Geomorphology, Wetland, Land degradation, Snow & Glaciers, Vegetation

NRC

Disaster Management Support

- Operationally addressing various natural disasters like Flood, Cyclone, Drought, Landslide, Earthquake and Forest Fire
- R&D Studies on Early warning Systems, Decision Support Tools

DMS



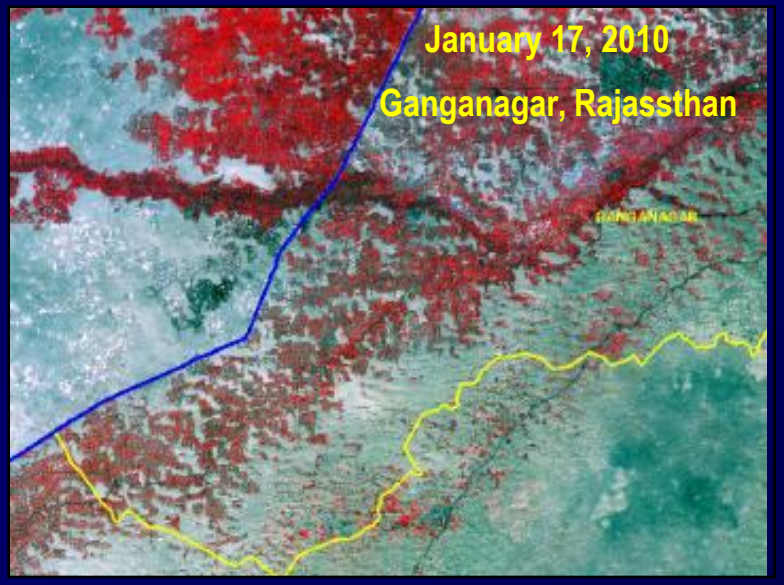
Climate Change Studies

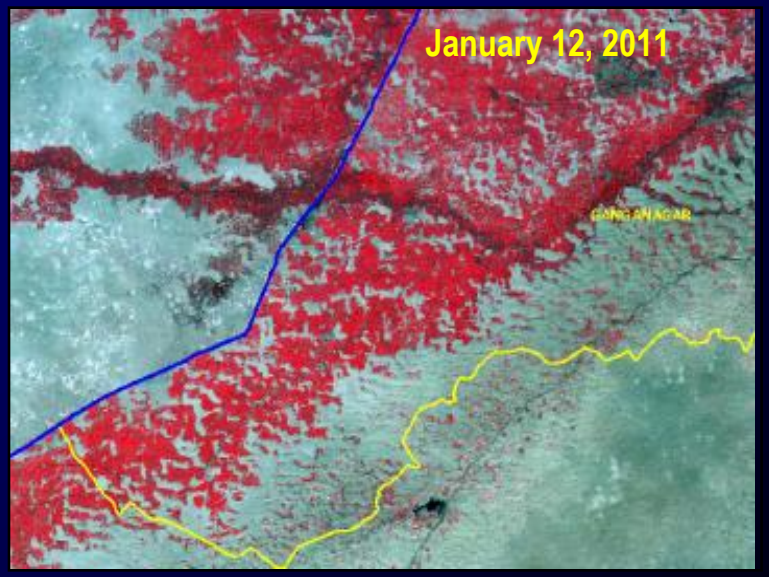
- Mapping the indicators, Monitoring the agents and Modelling the Impact
- Characterisation of climate variables (Land, Atmosphere & Oceans)
- Methane Emission, Timberline study, LU LC Change dynamics, etc.

NICES

REMOTE SENSING APPLICATIONS IN AGRICULTURE

- **Crop monitoring**
  - *Identification, inventory, regional change detection, yield forecast*
- **Crop intensification**
  - *Cropping pattern, crop rotation, crop diversity*
- **Wastelands & Watershed development**
  - *Extent and types, soil salinity and water logging*
- **Water resources**
  - *Surface water, ground water, command area management*
- **Precision farming and horticulture**
  - *Yield and nutrient variability, site suitability*
- **Drought Assessment**
  - *Soil moisture availability*
- **Climate Change in Agriculture**
  - *Methane emission*





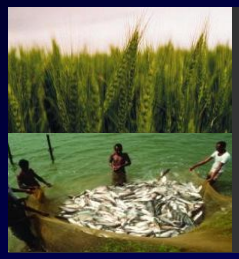
INDIAN EARTH OBSERVATION SYSTEM: GOALS

Provide Leadership and Continuity in Earth Observations through an Operational EO Infrastructure to

- Conduct periodic natural resources inventory, enable the national spatial data infrastructure and provide state of environment reports to the nation
- Maximize outreach of natural resources information in support of developmental efforts of government, industry and voluntary agencies
- Enable establishing ocean state forecasting system and facilitate improved weather forecasting
- Support information needs for disaster monitoring and mitigation
- Develop a better scientific understanding of the earth system, its processes and global change

INDIA'S PRIORITIES

- Surface Water Resources
- Ground Water Prospecting
- Snow & Glaciers



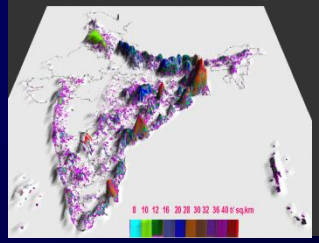
- Sustainable Agriculture
- Inland & Marine Fisheries
- Horticulture

- Weather Forecasting
- Ocean State Forecasting

- Forest Status
- Biodiversity
- Coastal Zone
- Environmental Impact

- Urban Planning
- Rural Roads
- Infrastructure Development

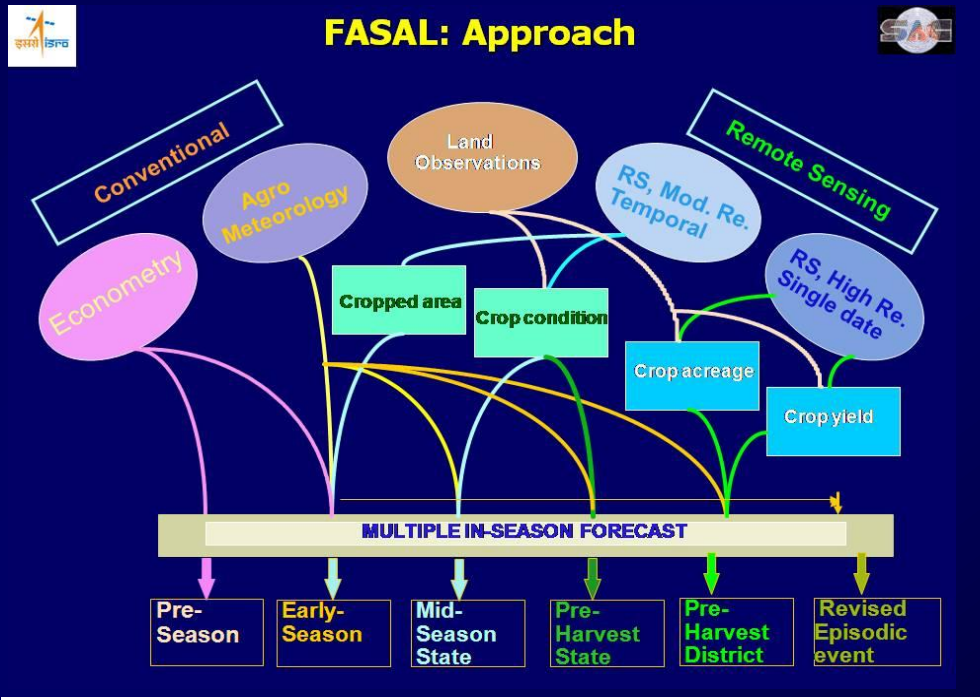
- Disaster Monitoring & Mitigation



- Global change Indicators
- Regional Climate Model
- Impact Assessment

CROP MONITORING - FASAL PROGRAMME - MNCFC

- Institutionalizing the operational Use of Remote Sensing data.
- Crop assessment and forecasting using various sources of information for multiple in-season crop assessment in near real-time.
- Integrated use of modern tools such as GIS, large data bases, modelling and networking



Mahalanobis National Crop Forecast Centre

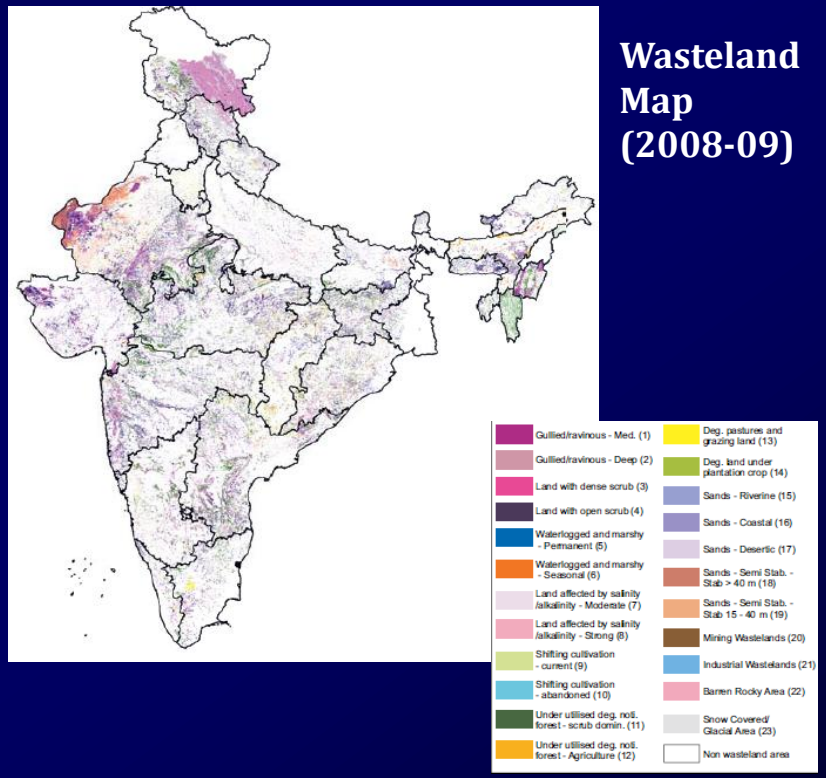
Crop	Area (Mha)	Production (Mt)	Date of Forecast
Jute, 2012	0.79	0.79	Aug, 1, 2012
Rice, (2011-12) 2012-13	37.13 (kharif) 37.96 (Kharif)	80.27 (kharif) 79.77 (kharif)	Jan. 06, 2012 Oct 4, 2012 (F2)
Wheat (2010-11) 2011-12	28.89 29.55	83.96 88.31	March 31, 2011 April, 12, 2012
Potato (2011-12)	1.58	31.25	Feb. 24, 2012
Mustard (2010-11) 2011-12	6.12 6.27	7.33 7.53	Jan., 31, 2011 Feb. 27, 2012

WASTELAND MONITORING

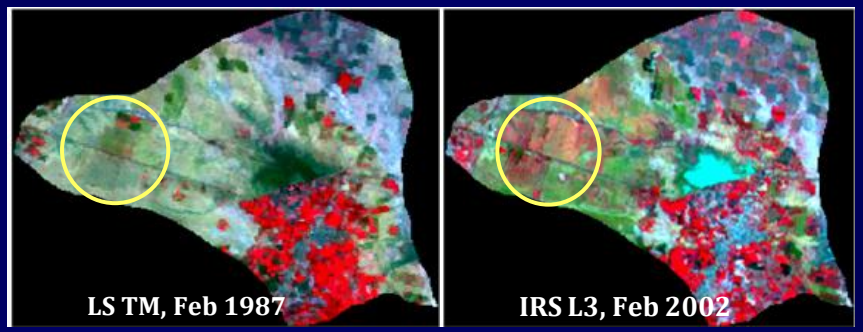
A Targeted Rural Development Programme: with village & watershed boundaries

- Bring culturable wastelands under cultivation
- Enhance food grain production
- Bring 30% under green cover

- National Wasteland Inventory Project (1986 - 2000)
- National Wasteland Updation Mission (2003 - 2004)
- Monitoring of the wasteland areas (2005-06)
- Wasteland Change Analysis - using three season LISS-III data of 2008-2009
- Coverage : Entire India in 1:50,000 scale
- No. of Wasteland categories : 28



Wasteland Map (2008-09)

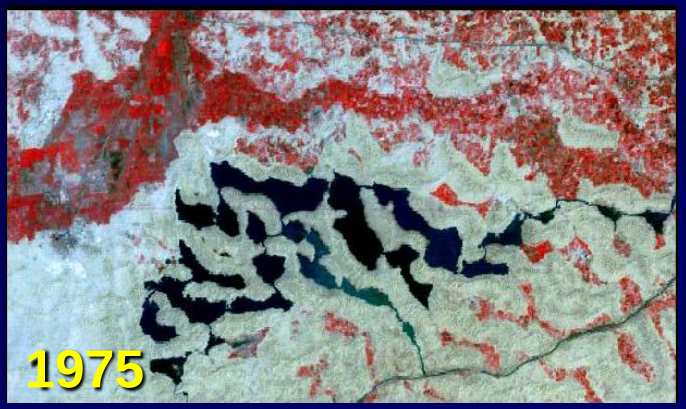


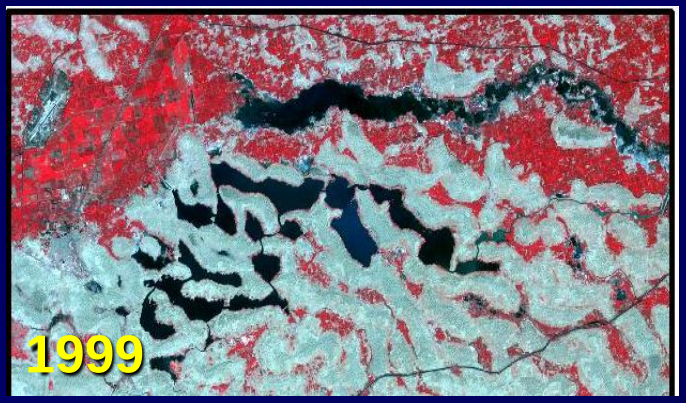
Area (Mha)	% of TGA	Year of Data
63. 85	20.17%	1986 -2000
55.27	17.45%	2003
47.22	14.91%	2005
46.73	14.76%	2009

IDENTIFICATION OF PROBLEMATIC SOILS

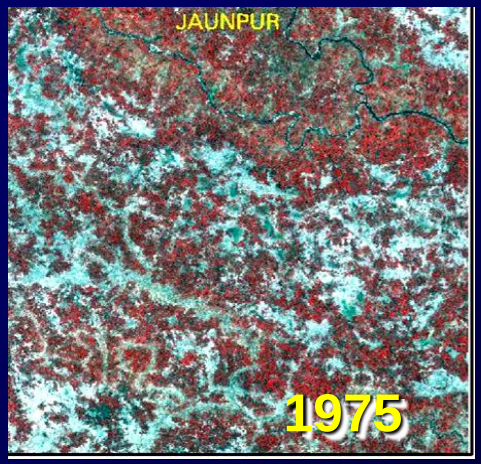
- Problematic soils have been mapped.
- Monitoring of the reclamation of the salt affected soils has also been done using muti-date satellite imagery
- Waterlogged areas – Mapped and monitored

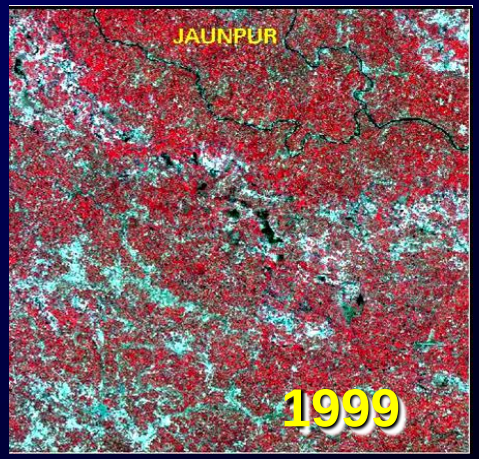
1 Strongly Saline- Sodic Soils
2 Moderately saline –Sodic Soils
3 Slightly saline – Sodic soils





Salt- Affected Soils in Part of Sharda Sahayak Command Area (Indo-Gangetic Plains), Jaunpur (UP)





1975 – 46,029 ha

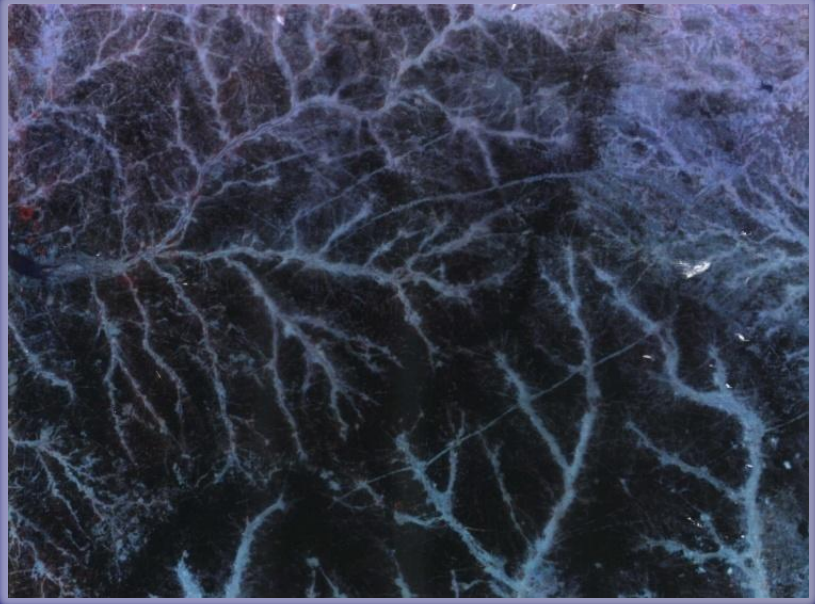
1999 – 28,749 ha

WATERSHED DEVELOPMENT

Integrated Mission for Sustainable Development (IMSD)

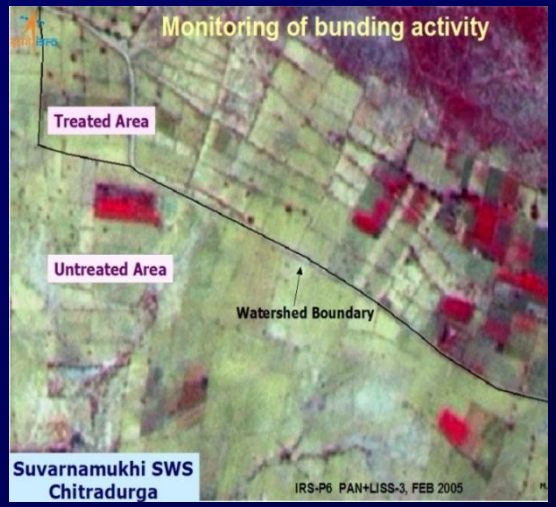
- Land & Water resources development plans for 84 Mha in 175 districts in country
- Detailed planning and implementation in many watersheds

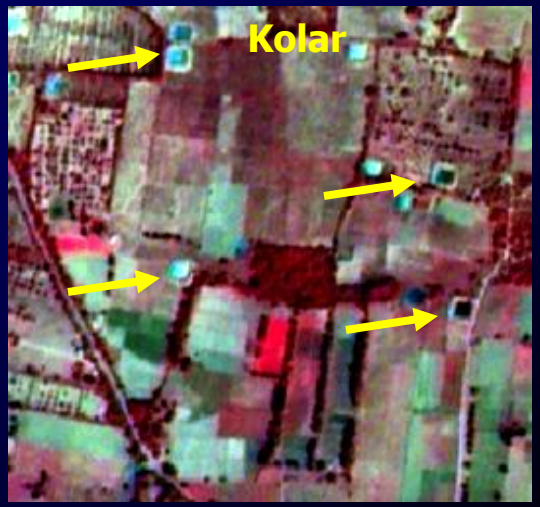
Characterisation & Prioritisation



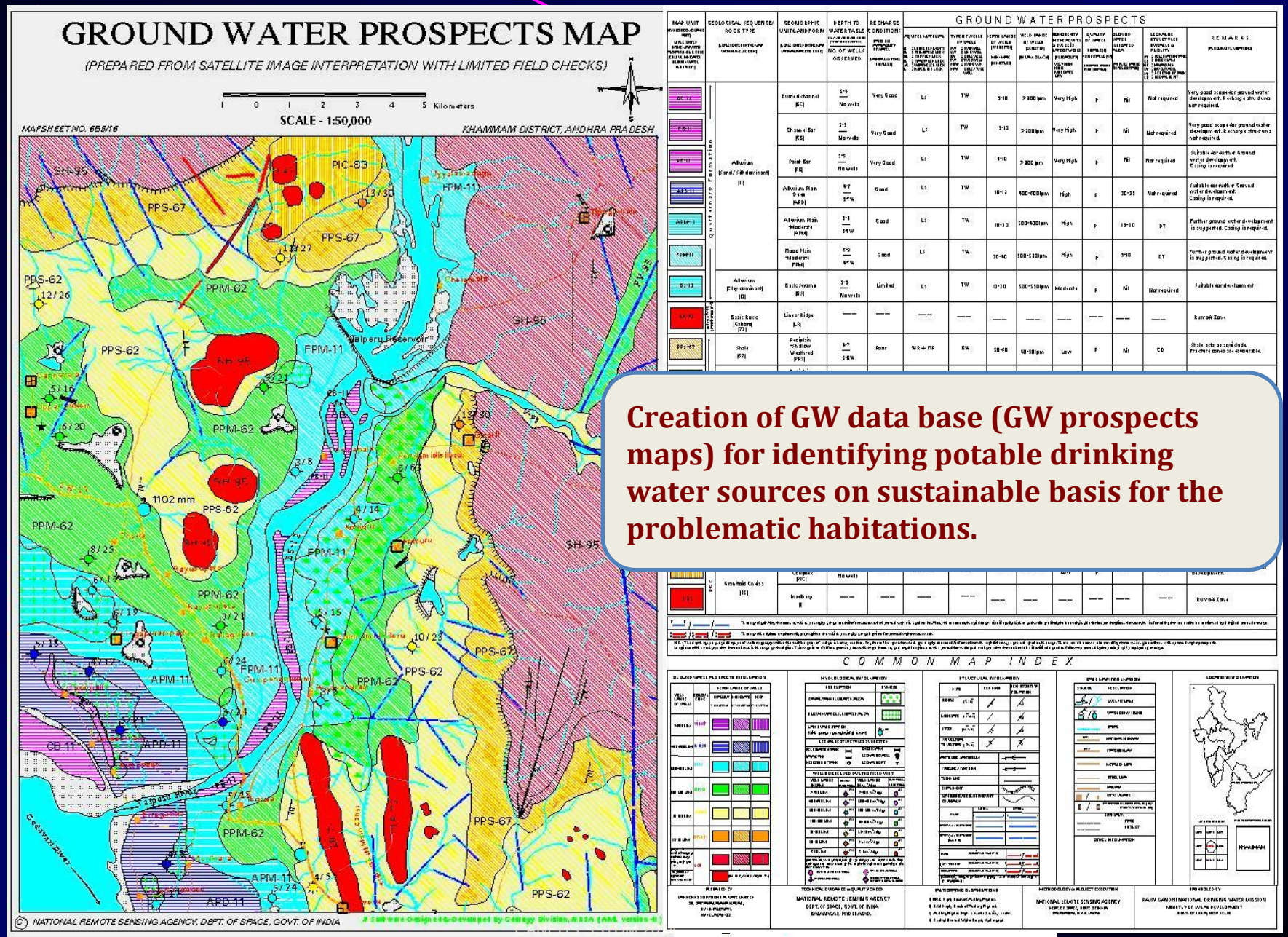
Space data in conjunction with collateral data has been used for

- **Characterisation** - land cover, morphometry, soil degradation, ground water availability
- **Prioritisation** - erosion
- **Development Plans** - Soil and moisture conservation plans
- **Monitoring** - Vegetation cover, Ground water level, Productivity



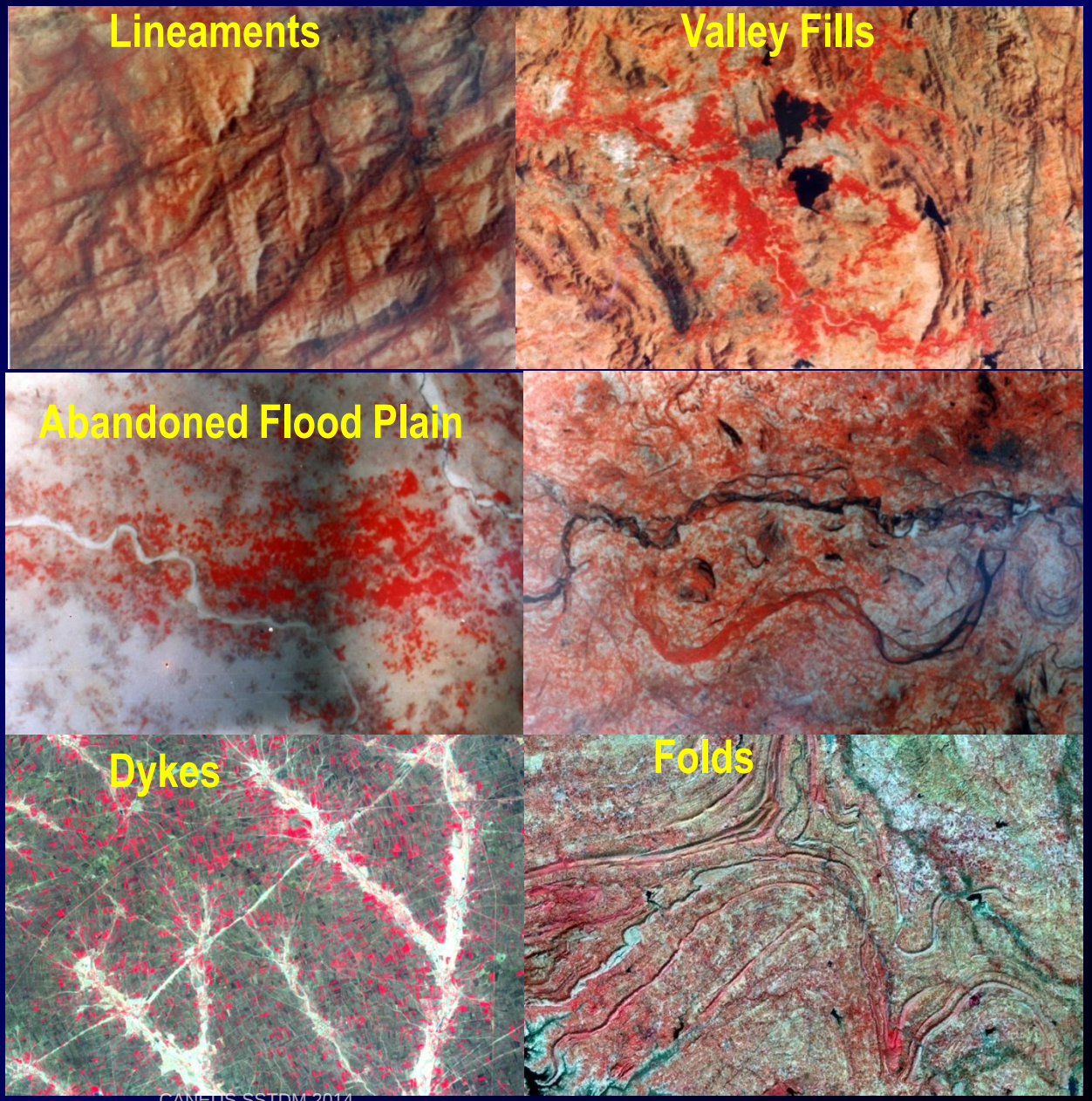


GROUND WATER EXPLORATION & RECHARGE

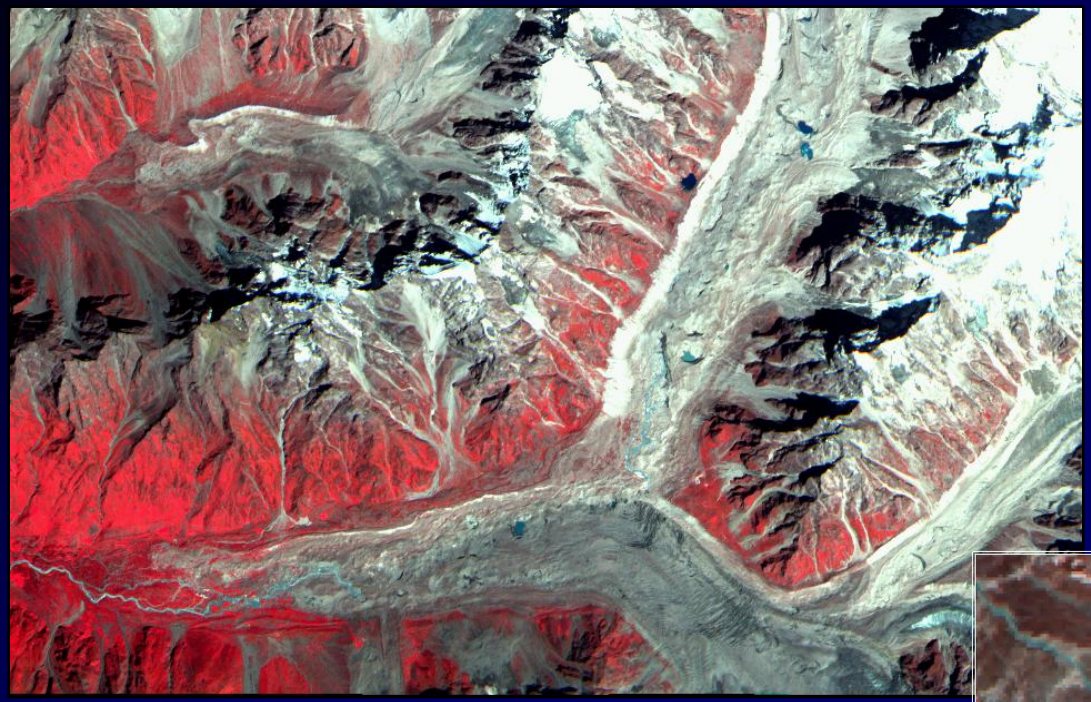


WATER RESOURCES

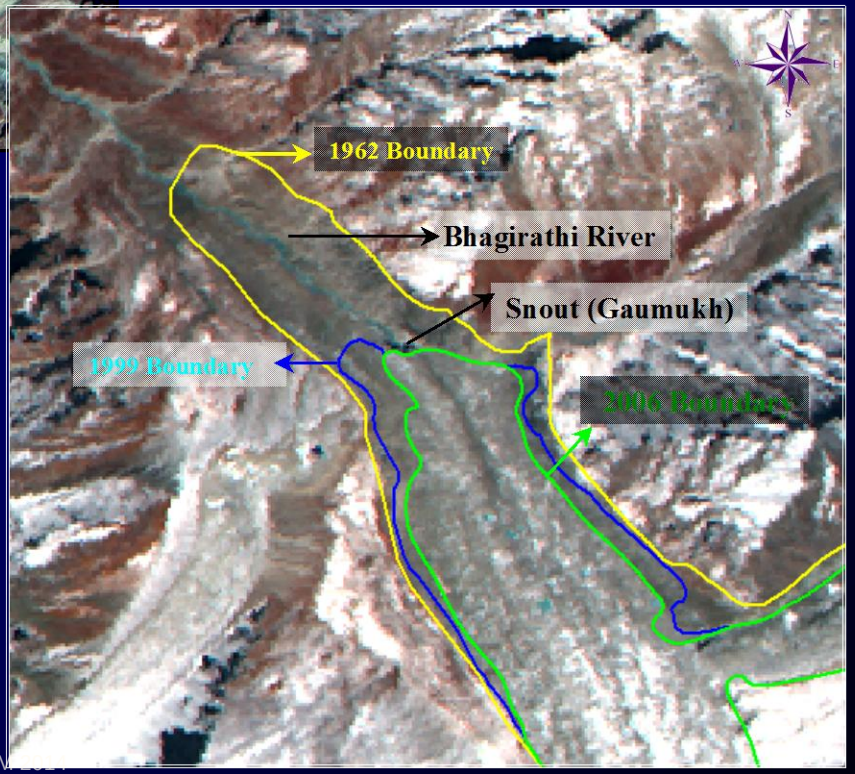
- Inventory of surface water bodies
- Performance evaluation of irrigation commands
- Groundwater exploration and recharge
- Snowmelt run-off (BBMB)
- Glacier inventory, retreat



GLACIER INVENTORY, RETREAT



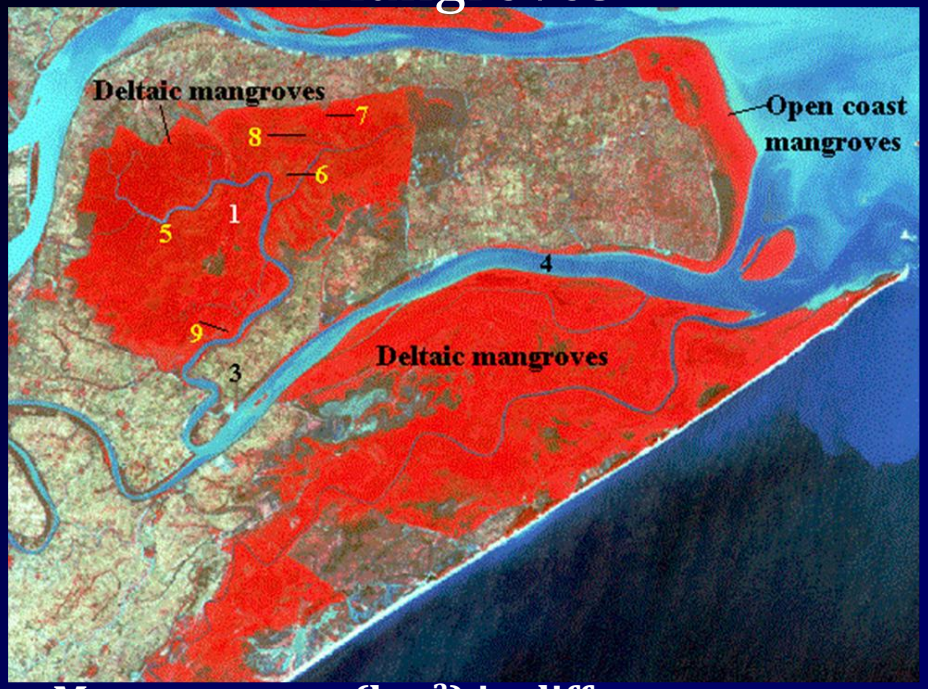
Jamdhar Glacier, Tons Basin



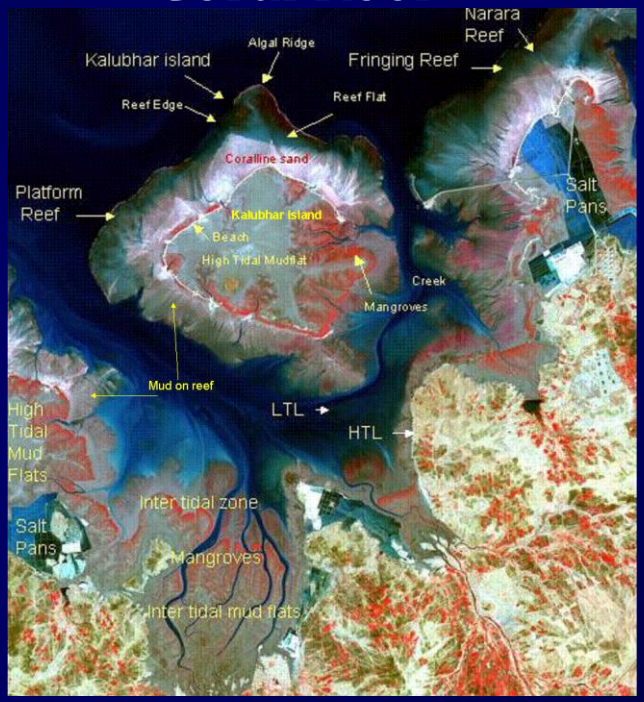
Basins	No. of Glaciers	Area (km^2) 1962	2001/04	Loss(%)
Chenab	359	1414	1110	21
Parbati	88	488	379	22
Baspa	19	173	140	19
Total	466	2075	1629	21

FORESTRY, ECOSYSTEM AND ENVIRONMENT

Mangroves

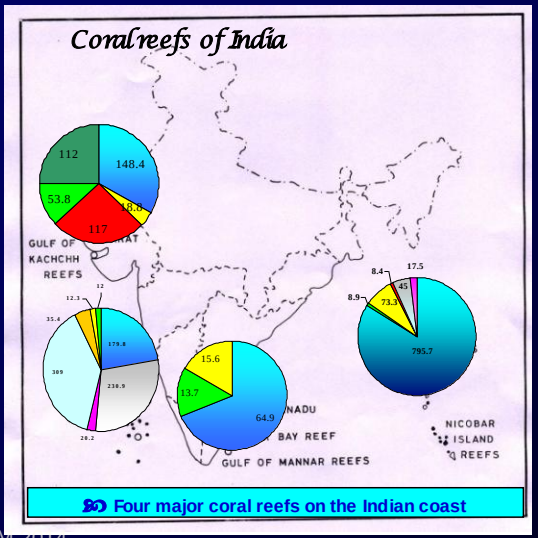


Coral Reef



Mangrove area (km^2) in different states

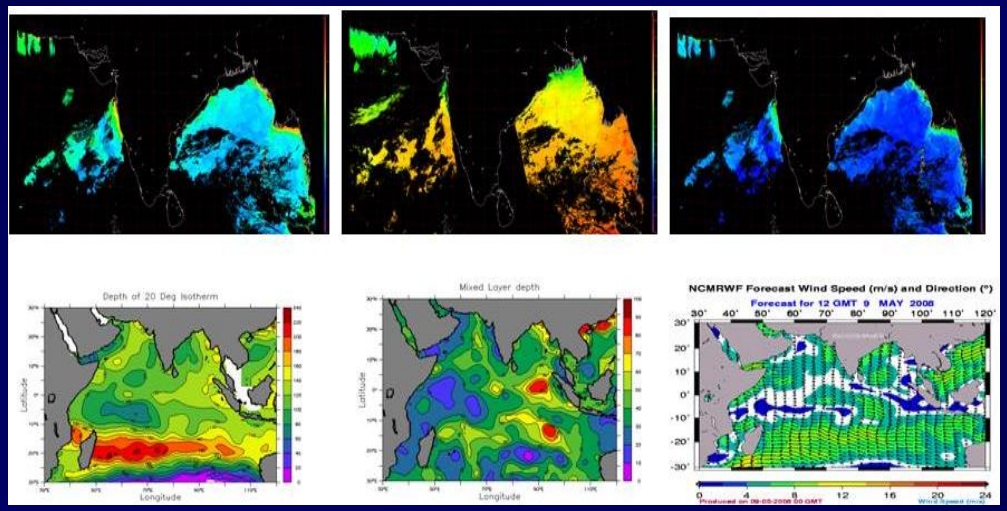
Region	Area (1986)	Area (1990-93)
Andaman & Nicobar	922.0	762.0
West Bengal	2067.0	1838.0
Orissa	203.0	187.0
Andhra Pradesh	322.0	380.0
Tamil Nadu	30.0	23.0
Karnataka	11.3	8.7
Goa	5.5	6.7
Maharashtra	124.0	222.0
Gujarat	767.0	1012.0
Total	4451.8	4439.4

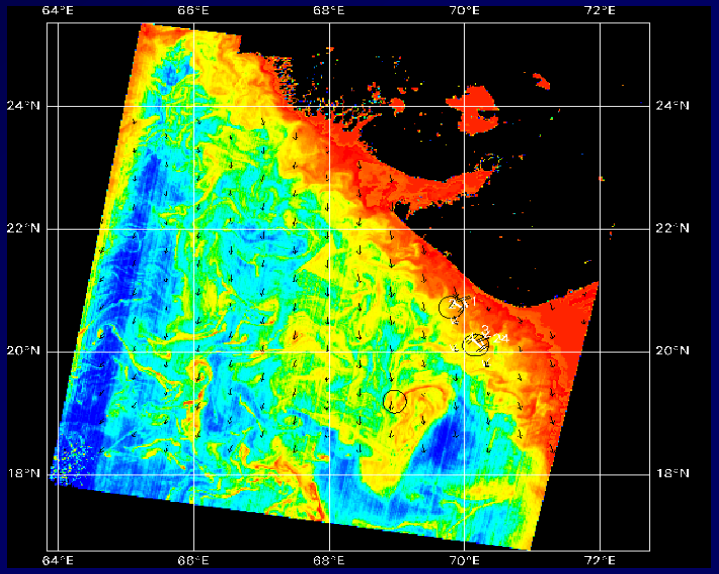


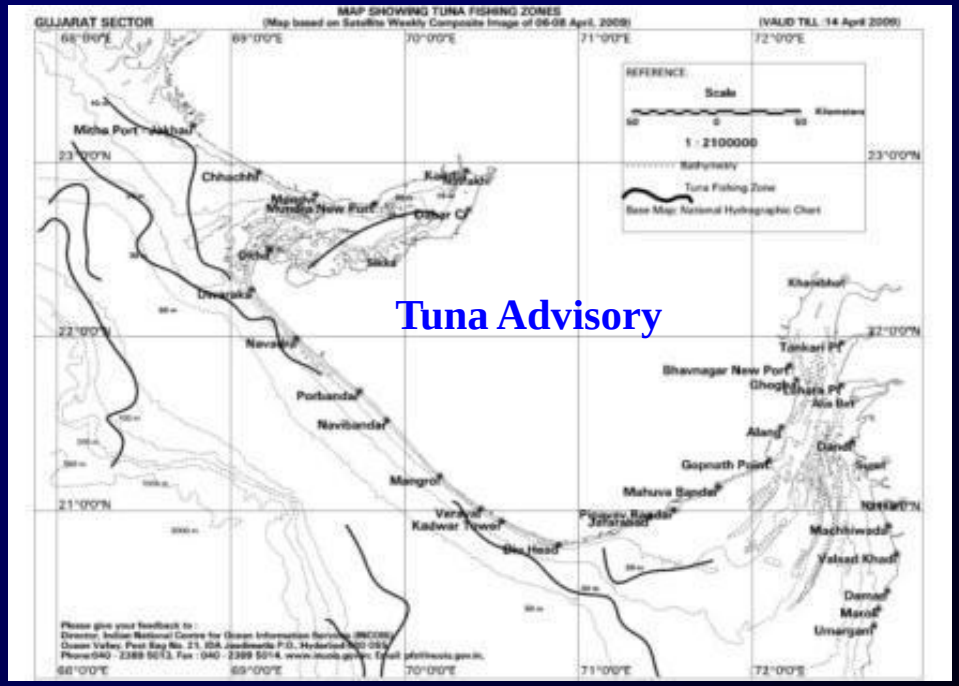
Reef flat
Algae/sea grass
Coralline shelf
Sand
Mud on reef
Vegetated RF
Coral head/ Reef patch
Lagoon
Cays

OCEAN BIOLOGY

- Potential Fishery Zone Forecast (integration of Chl, SST, winds)
- Primary productivity modeling
- Deep water productivity (Tuna)
- Bio-geo-chemical analysis for nitrate & carbon cycle





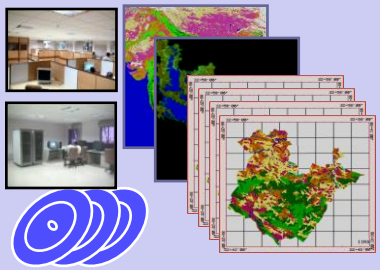


DISASTER MANAGEMENT SUPPORT (DMS) SYSTEM

Observational Systems
Satellite (GEO, LEO, All-weather), Aerial, Ground

Single-Window for Services Delivery
DMS-DSC

Multi-tier databases with query/ decision tools



Secured Commn
Fixed/ VPN, Mobile

Emergency Commn, Detection, Disaster Early Warning/ Alert, ..
CWDS, Ocean Databuoy, Seismic Stns networking, Tsunami Sensor (BPR), Digital/ DTH based DWS, Sat-Phone, Messaging terminal, Fishermen DAT, ...

Satellite Data & GIS layers
Damage assessment, Hazard zonation, mitigation planning, International Charter, Sentinel Asia, UN-SPIDER, ...

Disasters - Operationally addressed - Enabling States in mitigation efforts

Flood
Inundation monitoring
Damage assessment
Hazard zonation
Bank erosion studies

Cyclone
Inundation mapping
Damage assessment

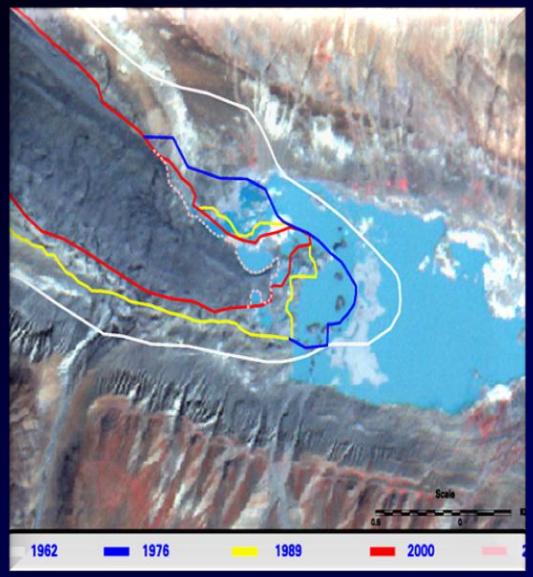
Drought
Monthly & End-of-Season Agri Drought Assessment

Earthquake
Damage Assessment

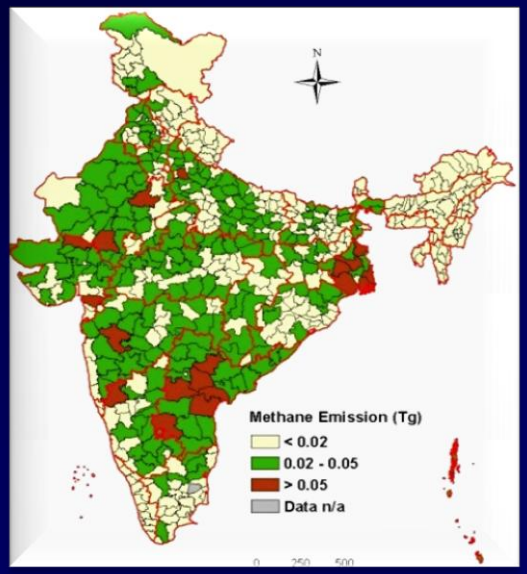
Landslide
Damage Assessment
Hazard zonation

Forest Fire
Active fire detection
Damage assessment

SPACE APPLICATIONS FOR CLIMATE CHANGE

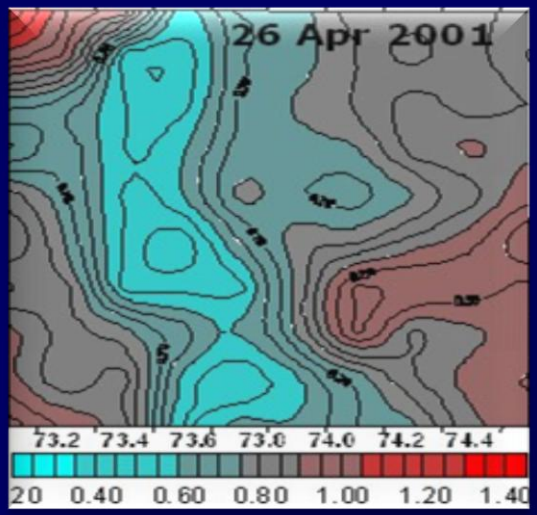


Himalayan Glacial Retreat



GHG Assessment (Methane)

Upward Shift in Timberline & Vegetation in Alpine Zone



Aerosol Optical Thickness Distribution

Sustainable Habitat	• Biodiversity Characterisation • Carrying Capacity Models • Coastal Ecosystems
Water Mission	• Water Resources Assessment • Flood Inundation & Damage Assessment
Himalayan Ecosystem	• Species Composition, Tree line • Ecosystem Characterization • Snow/ Glacier Dynamics
Green India	• Clean Development Mechanism • Sites For Bio-fuel Plantations • Biodiversity Conservation
Sustainable Agriculture	• Cropping Systems Analyses • Precision Agriculture • Land Degradation
Strategic Knowledge	• Sensor System Studies • Model Calibration • Aerosol Loading