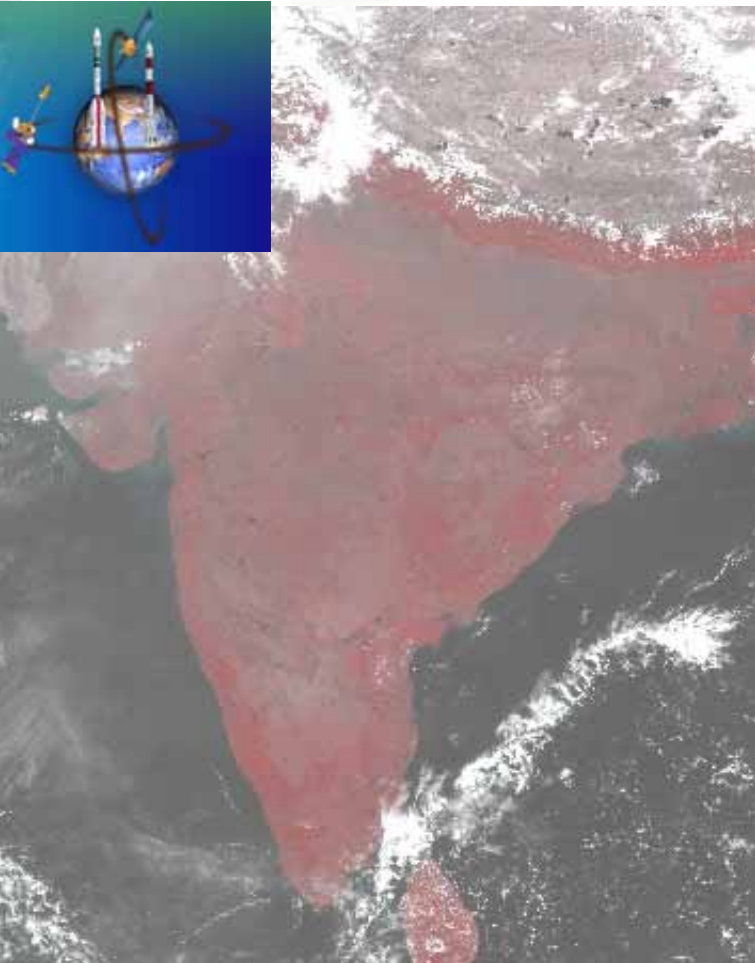


Indian Earth Observation Programme



for Sustainable Development:



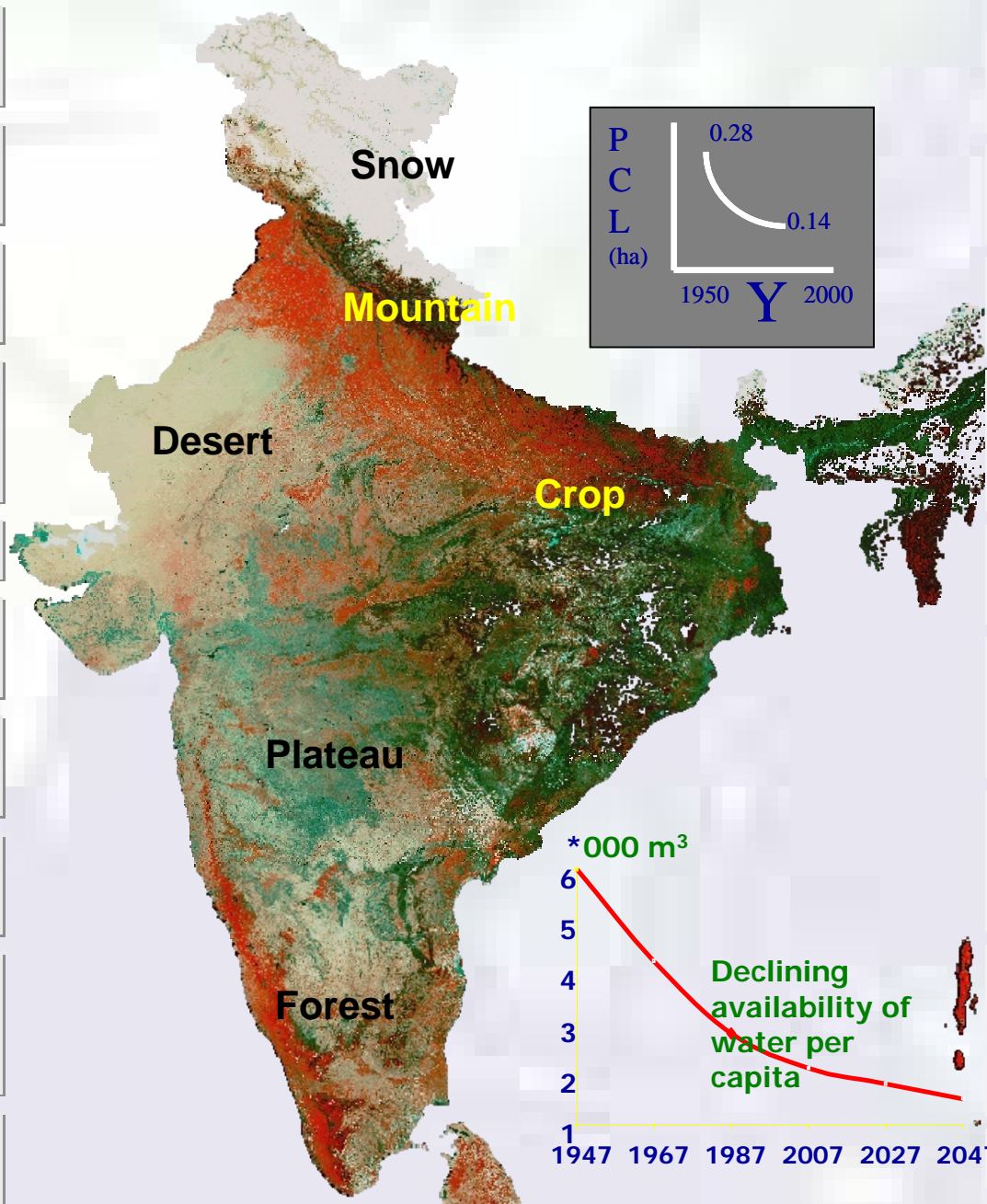
Shibendu S. Ray

Space Applications Centre
Indian Space Research Organisation
Ahmedabad, India
Email: ssray@sac.isro.gov.in

GEOSS Symposium on Integrated Observation for Sustainable Development in the Asia-Pacific Region, Tokyo, January 11-12, 2007

India: Resources & Challenges

- 3.27 M sq km Geographical Area
- Diverse Physiography
- 1.41M sq km Net Sown Area
- 2400x(240-320) km² of Indo-Gangetic plains
- 88 cm Rainfall
- 6.51 M tonnes of fish production
- 7516 km long Coastline
- 20.64 % Forest Cover
- >47000 species of flora & >89000 species of fauna
- 1.2 Billion Population



- Low Agricultural Productivity
- Accelerated Land Degradation
- Depleting water resources
- Reducing forest cover and biodiversity
- Degrading Coastal Resources
- Regular Occurrence of Disasters
- Inadequate Weather Forecasting
- Negative impact of climate change
- Energy crunch
- Health Divide

Indian EO Programme: Plans

..... we must be second to none in the applications of advanced technologies to the real problems of man and society.....

- 
- The background of the slide features a blue-tinted portrait of Vikram Sarabhai on the left. On the right, there is a graphic of the Earth with two rockets launching from the bottom, and a satellite in orbit above. The text is overlaid on this graphic.
- **Conduct periodic natural resources inventory, enable national spatial data infrastructure and provide state of environment reports to the nation,**
 - **Support information needs for disaster management system,**
 - **Maximize outreach of natural resources information in support of developmental efforts of government, industry and voluntary agencies,**
 - **Develop a better scientific understanding of the earth system and its processes,**
 - **Enable an information service for public and society based on EO**

Indian EO Programme: Dimensions



Space Infrastructure

- Launch vehicles (PSLV, GSLV)
- Spacecrafts (LEO, GEO and beyond)
- Sensors (Optical/Microwave)

Ground Segment

- Data Acquisition and Processing
- International Ground stations
- Cal-val programme
- TTC Network

Applications

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

Capacity Building

- Formal education through CSSTE-AP, IIRS, IITs....
- Technology transfer & on-the job training
- RESPOND programme

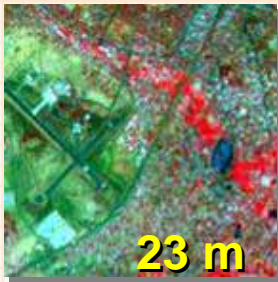
Institutionalization

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

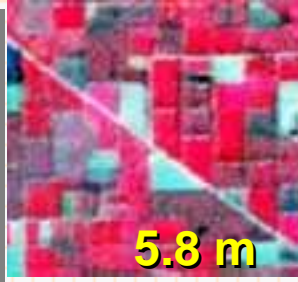
International Cooperation

- Bilateral and multilateral cooperation with various countries and international Organisations

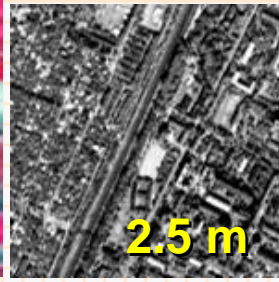
Indian EO Systems – Evolution



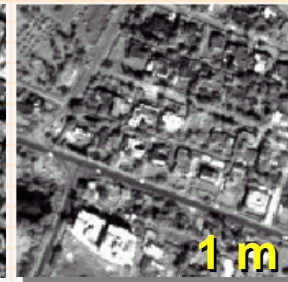
23 m



5.8 m



2.5 m



1 m

IRS-P5
cartosat-1
PAN : 2.5 m
Fore +26° Aft: -5°

IRS-P6
resourcesat-1
LISS-3: 23 m, 4 XS,
LISS-4: 5.8 m, 3-XS,
AWIFS: 56 m, 4-XS

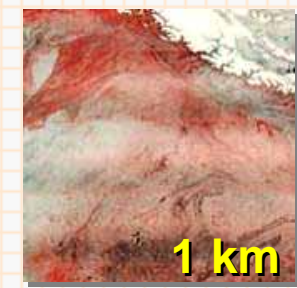
IRS-P4
oceansat-1
OCM, MSMR

INSAT-2E
operational Met
CCD (1 km res;
every 30 min)

IRS-1C/1D
operational 2G
LISS-3: 23/70 m, Steerable
PAN: 5.8 m, WiFS: 188 m

IRS-P2 **research** **IRS-P3**
LISS-2 WiFS, MOS,
X-Ray

IRS-1A & 1B
operational-1G
LISS-1&2: 72/36 m,
4 Bands, VIS & NIR



1 km

RS-D1
experimental
BHASKARA 1 /2

1979 1981 1988 1991 1994 1995 1996 1997 1999 2003 2005


Earth Observation Applications towards Societal Benefit



Sustainable Agriculture

A composite image showing a lush green rice paddy field in the foreground and a person working in a field in the background.


Weather Forecasting

A satellite image of a tropical cyclone or hurricane swirling over the ocean.

Water Security

A composite image showing a woman carrying a metal pot on her head and two people in a rural setting.

Understanding Climate Change

A satellite image of the Earth showing a large-scale atmospheric phenomenon, possibly a climate model or satellite data visualization.


Ecosystem Management & Protection

A composite image showing a map of India and a close-up of a tree trunk with a large hole, possibly from a termite.


Energy Resources Management

A photograph of green leaves and a tree, representing renewable energy sources.

Conserving Biodiversity

A composite image showing a colorful bird, a frog, and a snake, representing various species.

Human Health

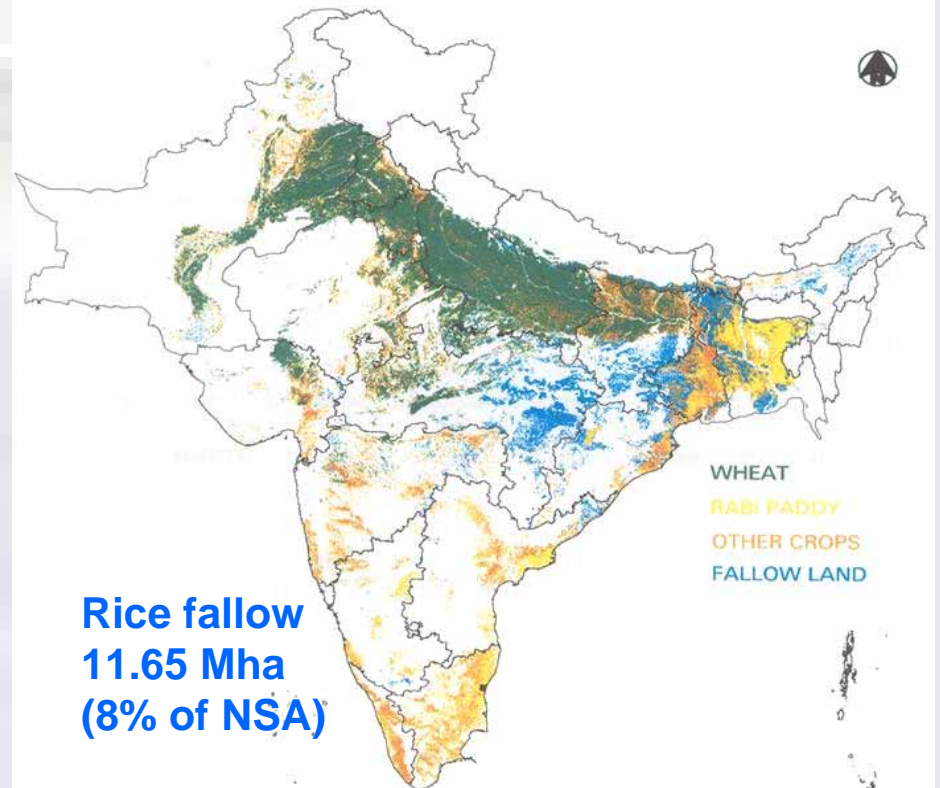
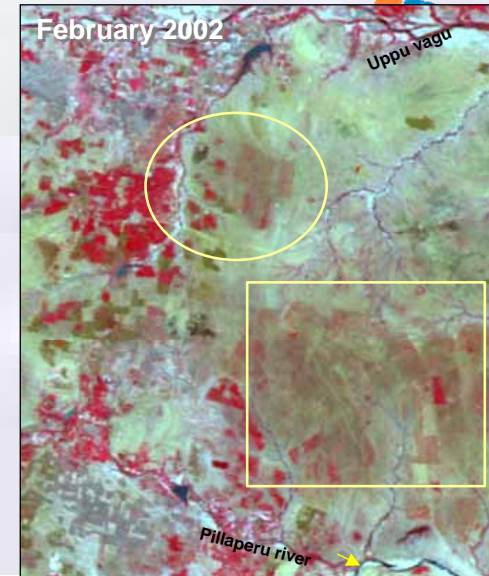
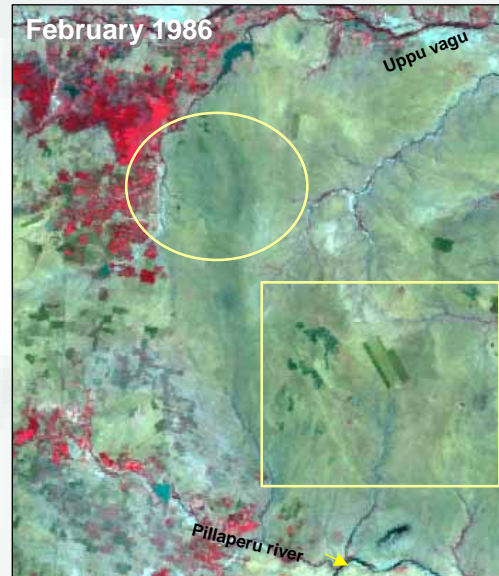
A photograph of a doctor in a white coat examining a patient lying in a hospital bed.

Disaster Support

A photograph of a flooded area with people and buildings, representing a natural disaster.

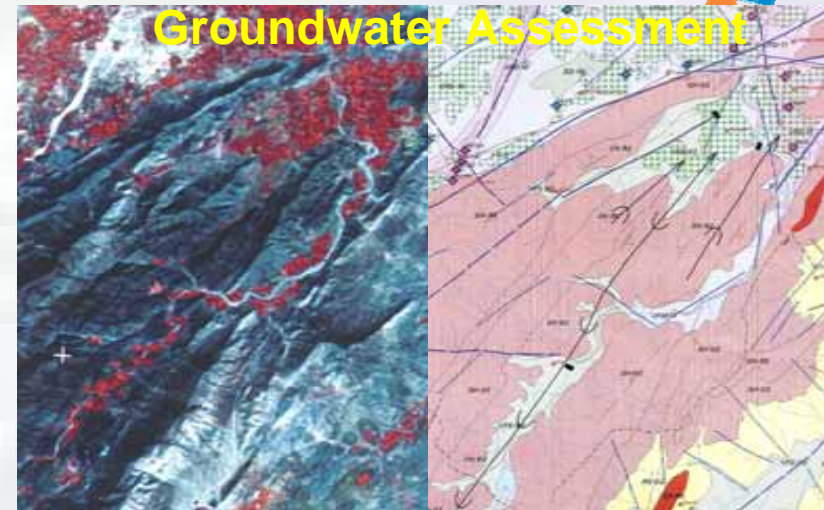
Sustainable Agriculture

- **Increase area under agriculture**
 - Identify culturable wastelands / marginal lands
- **Increase cropping intensity**
 - Improved cropping practices like cultivation in Kharif/post-Kharif fallows
- **Increase productivity**
 - Retention/improvement of soil fertility
 - Site-specific management of agriculture
 - Increase area under HYVs
- **Crop Production Forecasting (FASAL)**
- **Potential Fishing Zone Forecast**

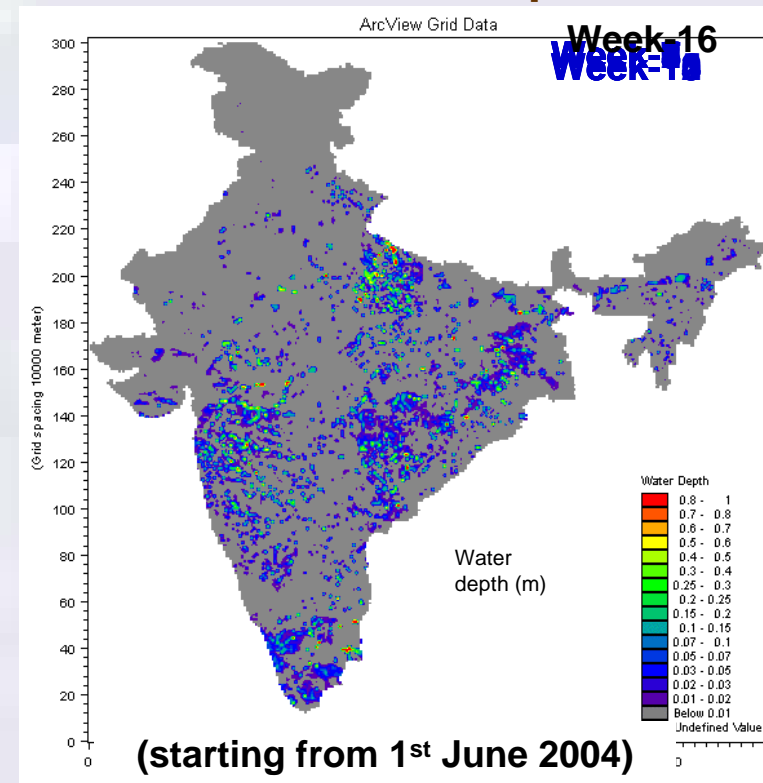


Water Security

- Development of spatial information system on groundwater resource
- National Water balance modelling
- Glacier inventory, retreat, Snowmelt run-off, snow physics
- Inventory of surface water bodies
- Performance evaluation of irrigation commands
- Integrated Watershed Development



Overland Water Depth

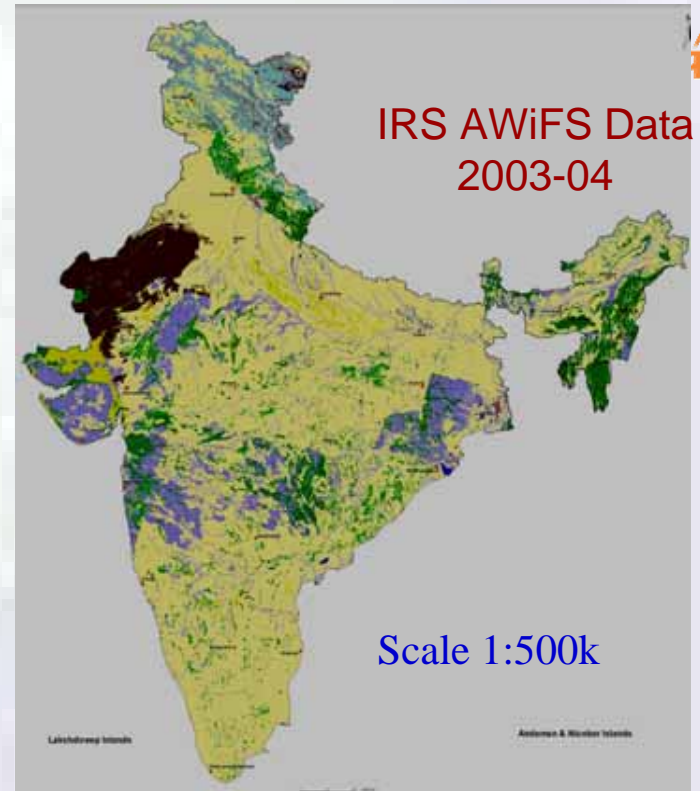


RGNDWM: Implementation & Feedback

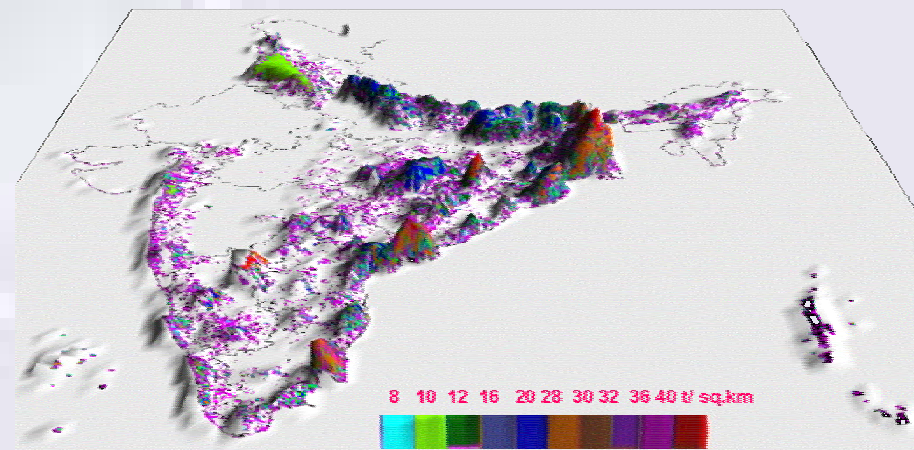
State	No. of Wells Drilled as per Ground Water Maps	Success Rate (%)
Andhra Pradesh	29873	90.0
Chattisgarh	19,503	90.0
Gujarat	34	100.0
Karnataka	5213	93.0
Madhya Pradesh	7730	92.0
Kerala	10,430	90.0

Environment & Ecosystems

Desertification Status Map of India

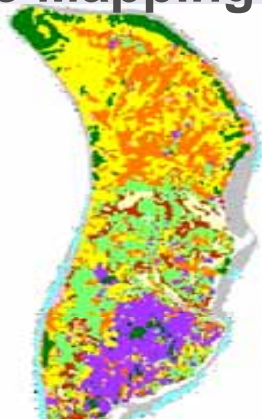


Methane Emission From Rice-ecosystem-RS/GIS Approach



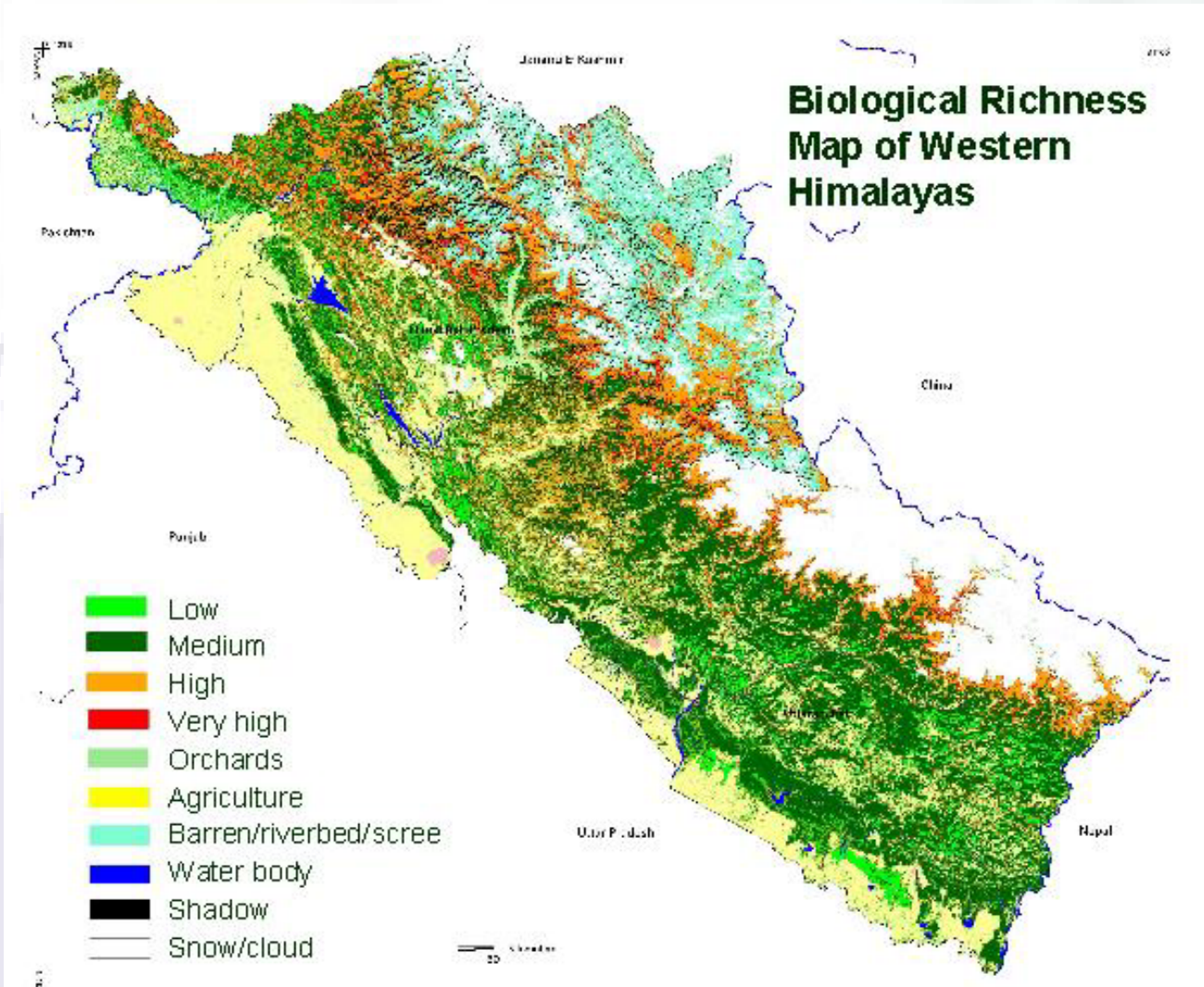
- Desertification Monitoring
- Environmental Impact Assessment of Agriculture
- Forest extent, type and density, Monitoring afforestation/ deforestation, Encroachment
- Wetland inventory/conservation
- Coastal, Mangroves and Coral reefs studies

Coastal Zone Mapping



Biodiversity

Understanding, monitoring and conserving biodiversity



India's biodiversity

**Flora: 7.0% of world's
Fauna: 6.5% of world's**

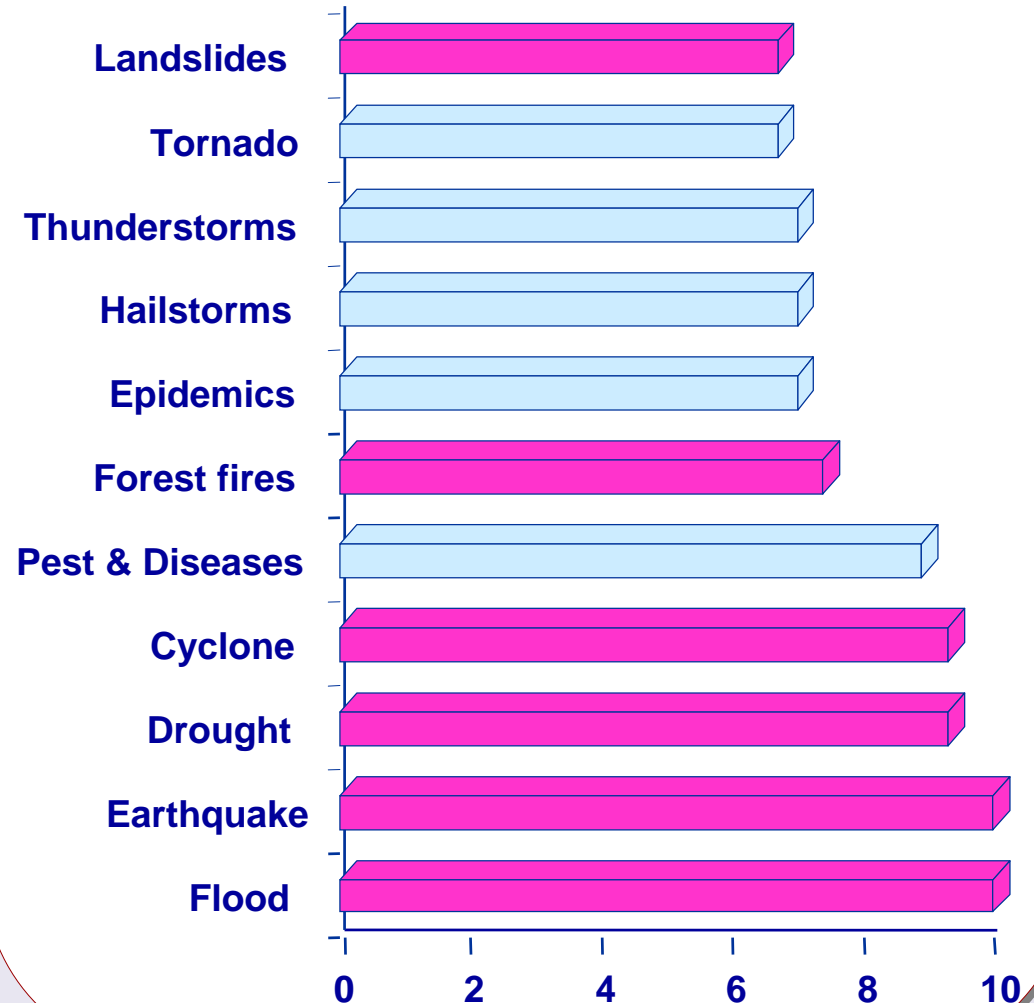
Vulnerability:

- 5700 Km Long Coastline - Cyclone-prone
- 40 Mha - Flood-prone
- 68% of Net Sown Area (116 Districts) - Drought-prone
- 55% Total Area - Seismic Zones III - V
- Sub-Himalayan/ Western Ghats - Landslide-prone

The Indian Sub-Continent is among the World's Most Disaster-prone Areas

Severity Index (Last 50 yrs Data)

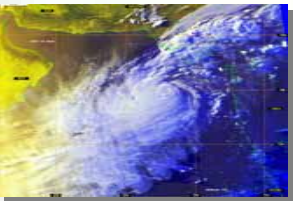
Analysis based on Extent affected (Population, Area); Loss to Economy, Lives; Frequency of incidence



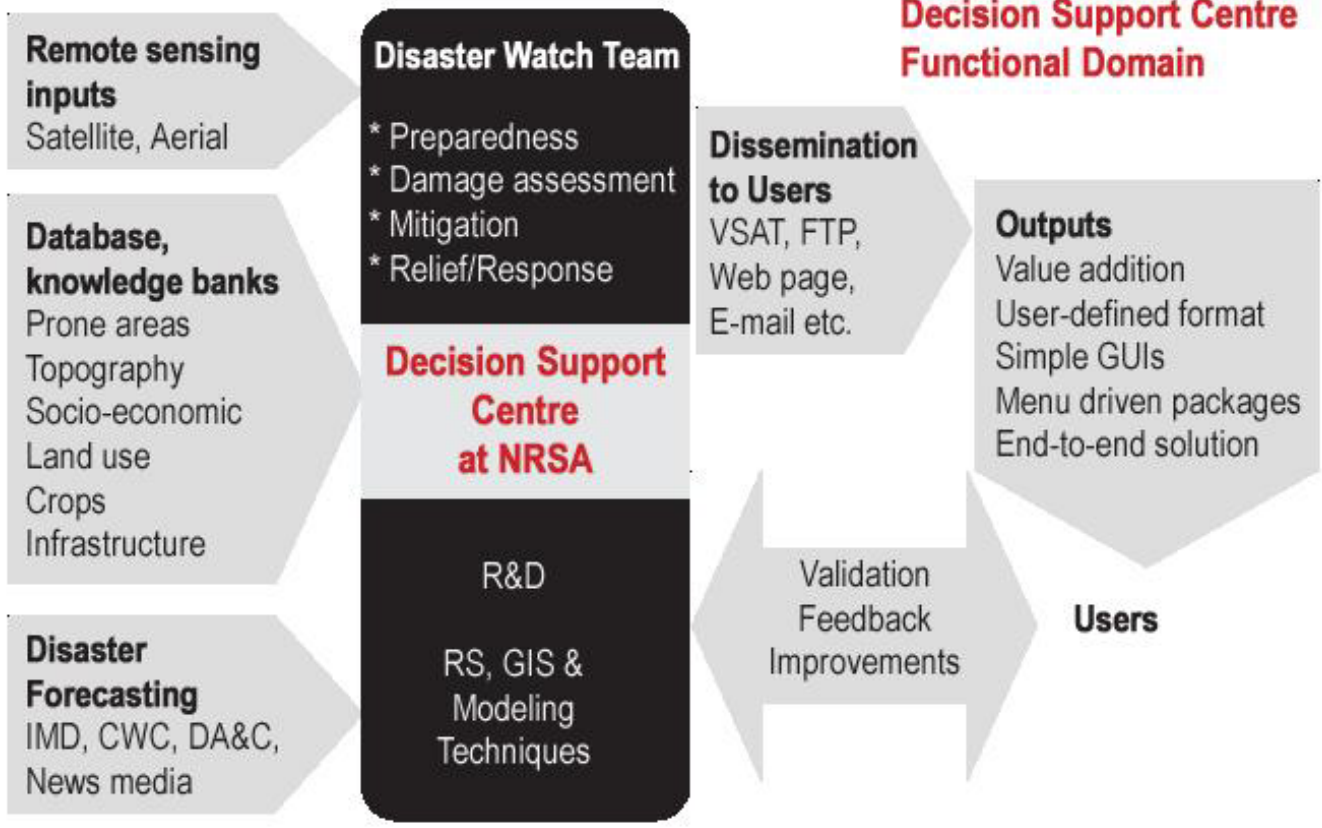
ISRO Disaster Management Support Services



- Monitoring of major natural disasters using satellite and aerial data,
- Development of appropriate geospatial techniques/tools,
- Creation of digital database,
- Acquisition of close contour data for hazard prone areas using ALTM,
- Strengthening the communication back-bone,
- Development of air-borne SAR (DMSAR) towards all-weather monitoring capability,
- Establishment of a Decision Support Centre at NRSA as a single-window service provider and
- Support the International Charter on Space and Major Disasters, as a signatory.



Disaster Mitigation



National Database for Emergency Management

National Database for Emergency Management (NDEM)

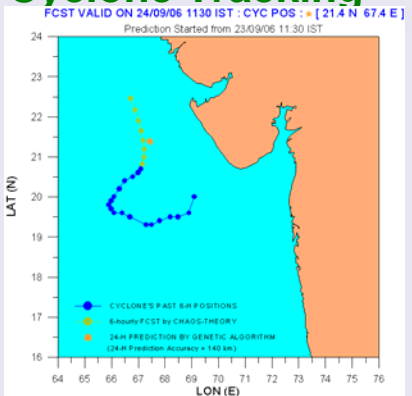
Technical Document

Submitted to
Technical Group for NDEM

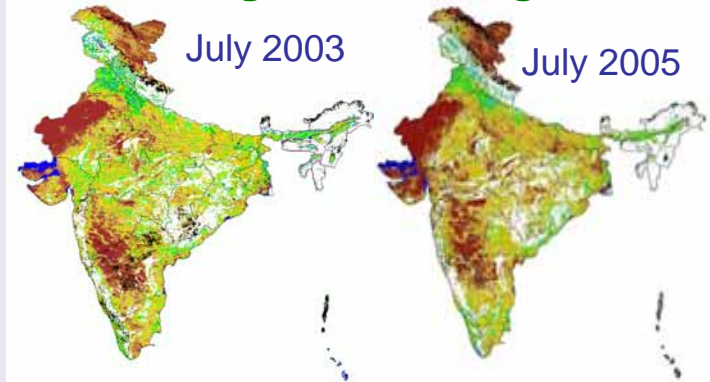
Task Team
National Remote Sensing Agency
Department of Space Government of India
Balanagar, Hyderabad

September 2005

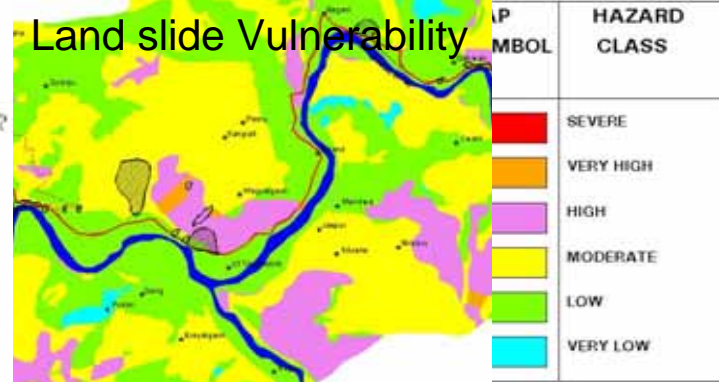
Cyclone Tracking



Drought Monitoring

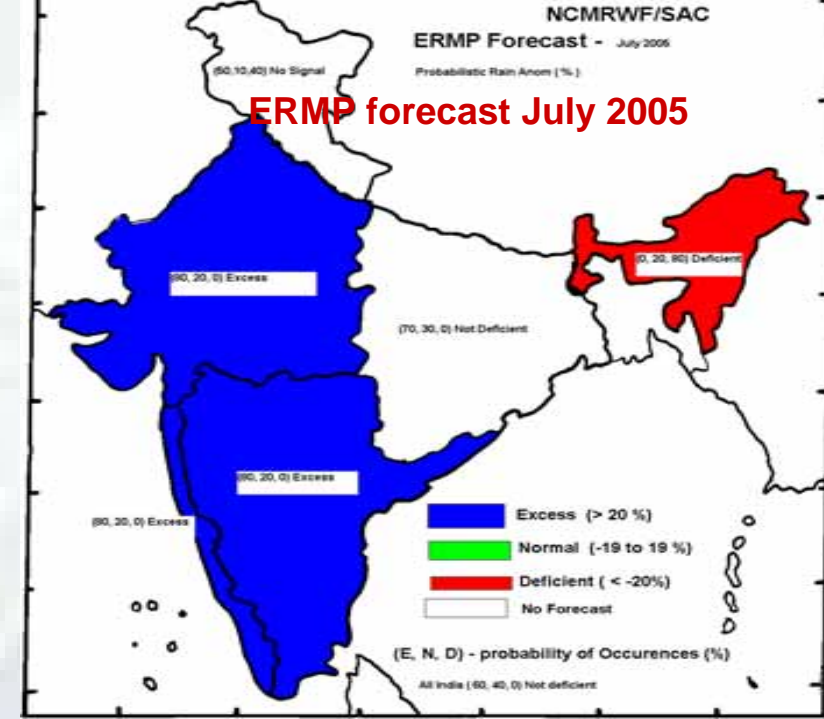


Landslide Hazard Zonation



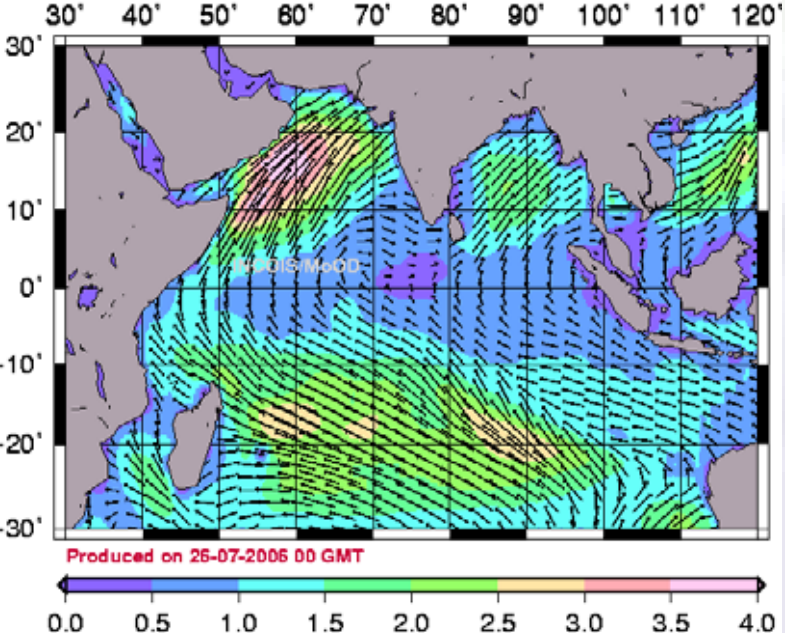
Weather and Climate

- Extended Range Monsoon Forecasting
- Ocean State Forecasting
- Cyclone Track and intensity prediction
- Regional Climate Models
- Weather forecasting for satellite launching
- Glacial Retreat In Himalayas caused by Climate Change

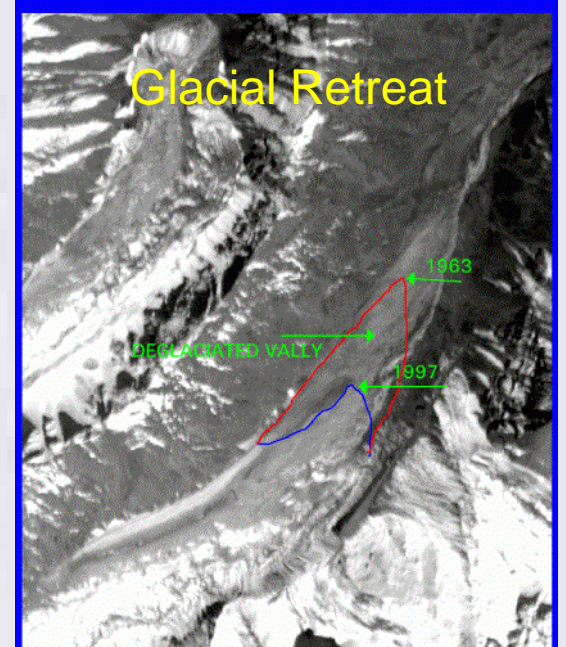


Significant Wave Height (m) and Direction (°)

Forecast for 12 GMT 27 JULY 2006



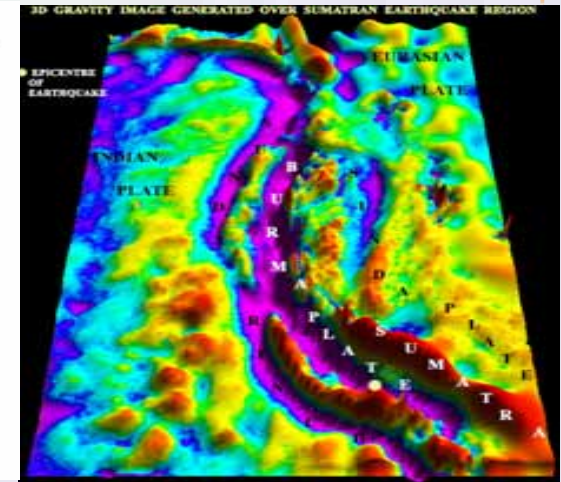
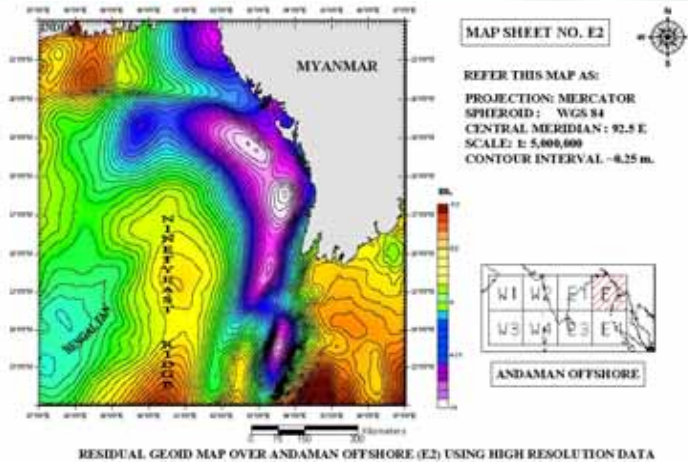
Altimeter information for Indian Ocean using wave models and satellite wind.



Energy

Improving management of energy resources

Gravity Modelling for Petroleum Exploration



Mining activities

NTPC

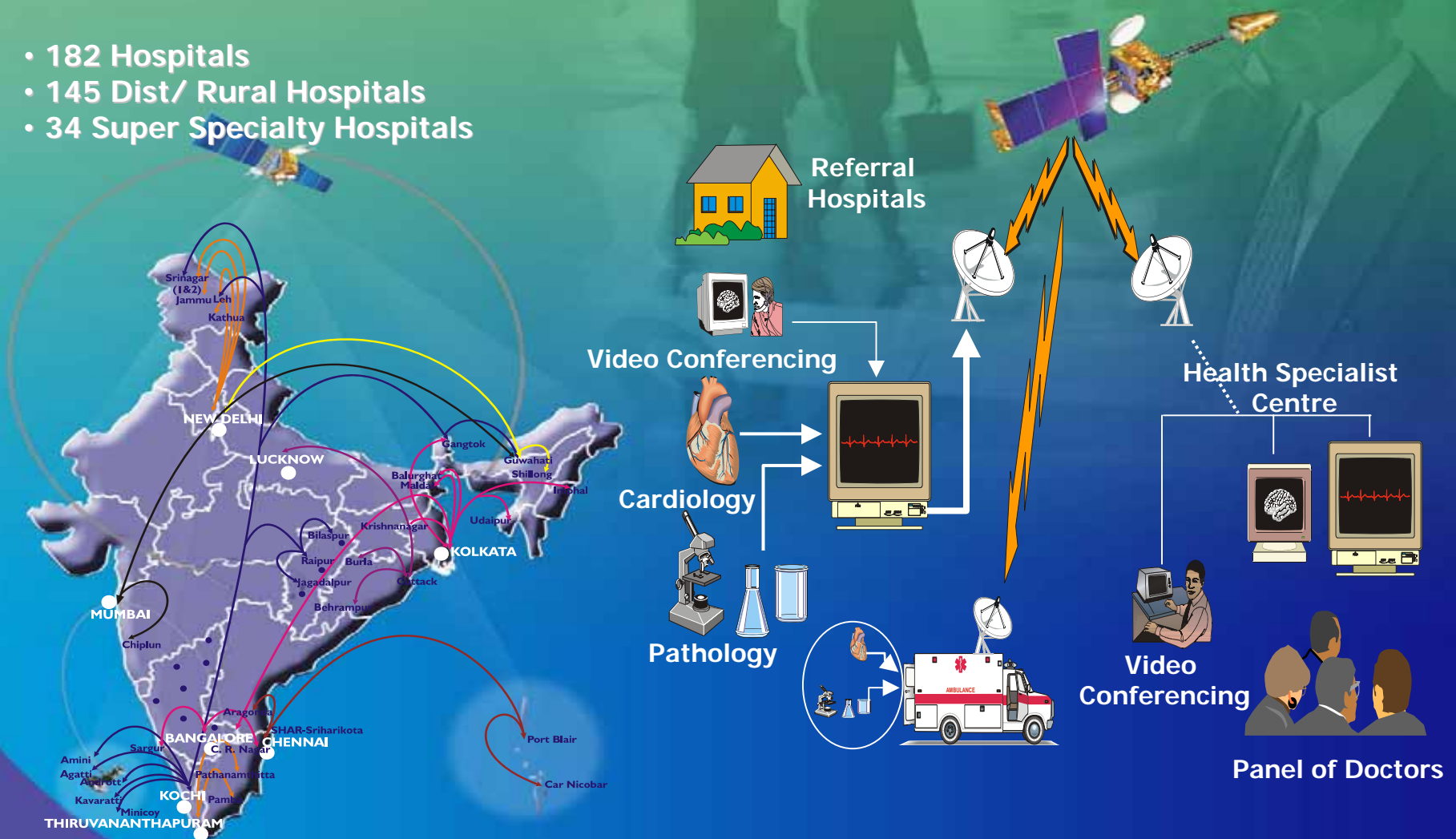
Korba Coal Mines and environments, Chattisgarh



- Possible applications of remote sensing and GIS towards site suitability for bio-fuel plantation, hydropower projects and optimal pipeline routing

Telemedicine in India

- 182 Hospitals
- 145 Dist/ Rural Hospitals
- 34 Super Specialty Hospitals



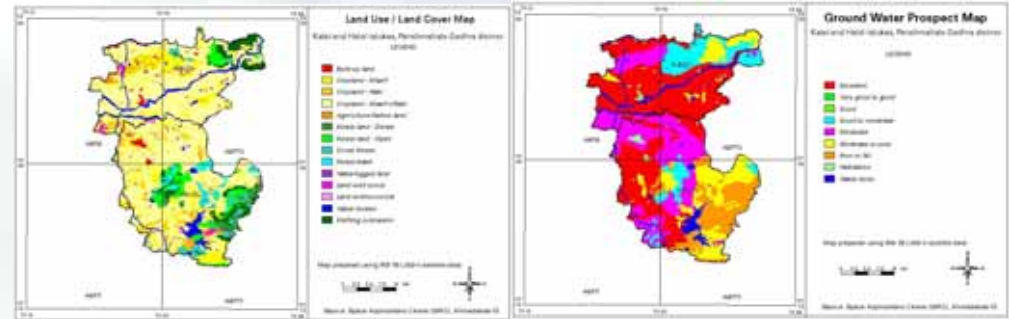
More than 160,000 patients benefited.

Transverse Area: Data Management



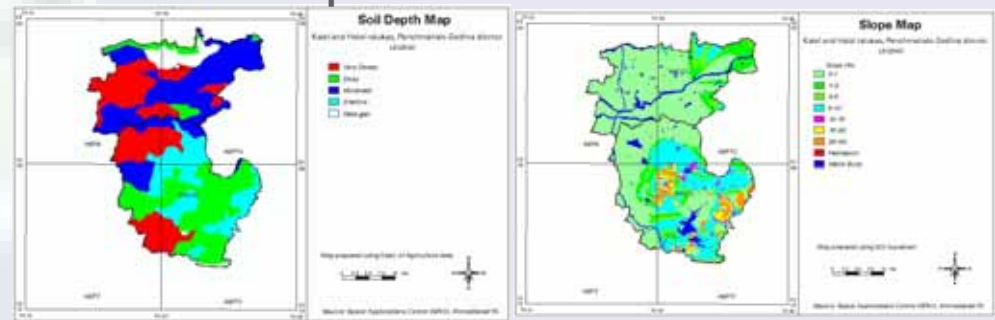
Natural Resources Data Base (NRDB)

- Creation of databases of spatial information, with common standards and accessibility
- Databases created on 1:50,000 scale for 21 states & UTs in the country
- Include 21 primary layers viz. land use, geomorphology, soil, etc.
- 8 derived layers such as groundwater prospects, slope etc. and action plans



Land use map

Groundwater Prospects map



Soil map

Slope map

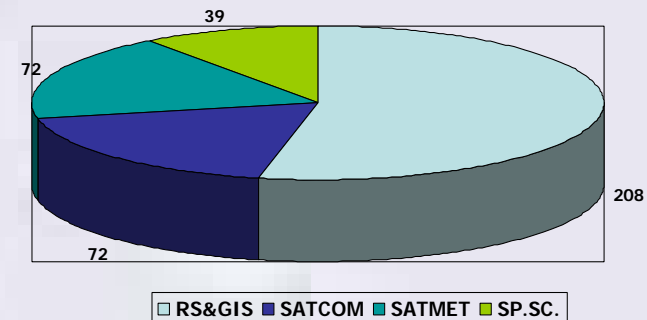


Land Resources Action Plan Water Resources Action Plan

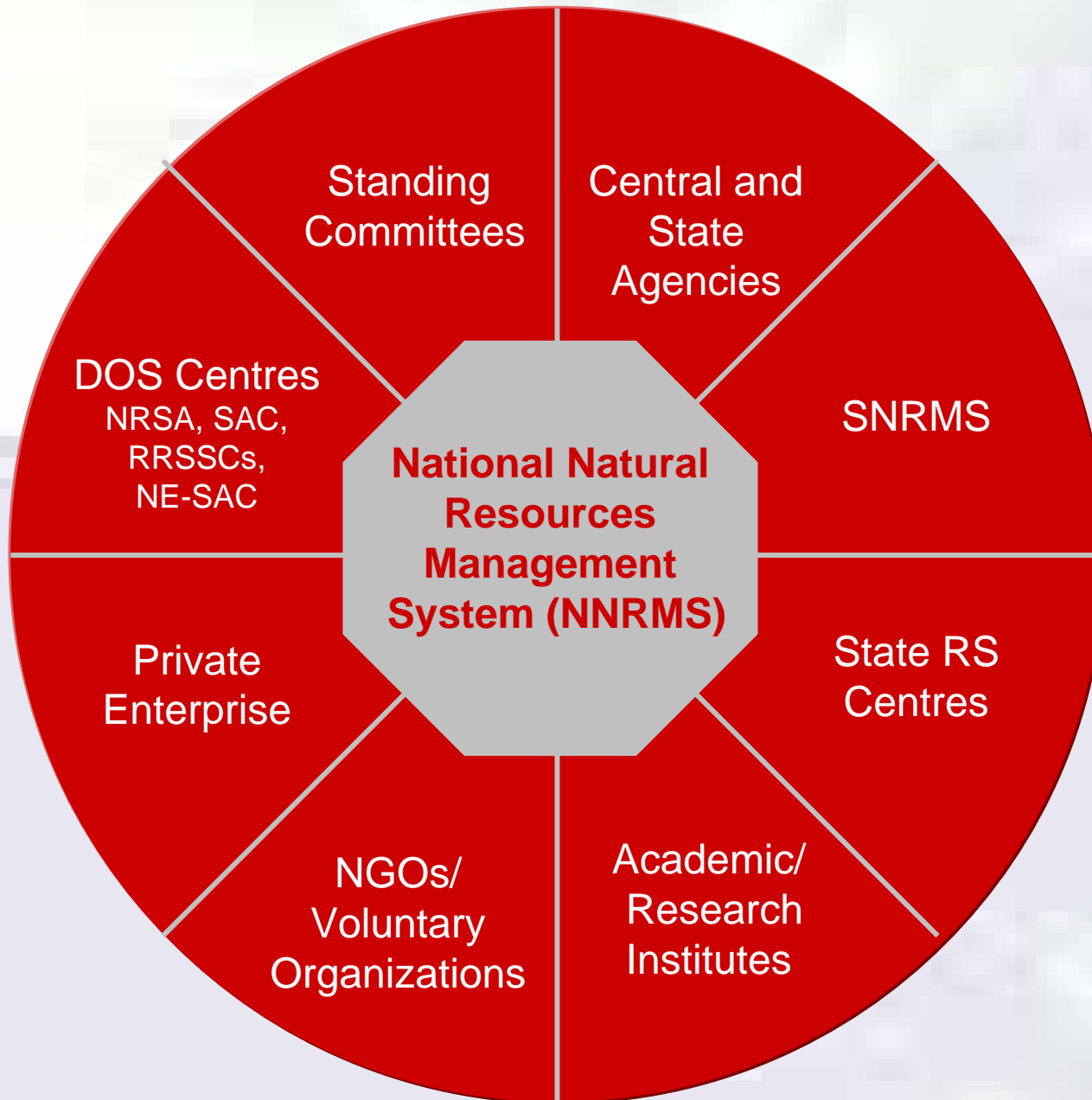
Transverse Area: Capacity Building

Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP)

- Established in Nov 1, 1995
- 10 Countries signed agreement to establish CSSTEAP (Current Membership: 15)
- Provides Training and education in:
 - ❑ Remote Sensing and Geographic Information Systems (RS & GIS)
 - ❑ Satellite Meteorology & Global Climate (SATMET)
 - ❑ Satellite Communications and Global Positioning Systems (SATCOM)
 - ❑ Space and Atmospheric Sciences (Space Science)
- 669 Students trained so far, including 391 P.G.Diploma



Transverse Area: User Engagement



Synergy of EO & Satellite Communications

Village Resource Centres

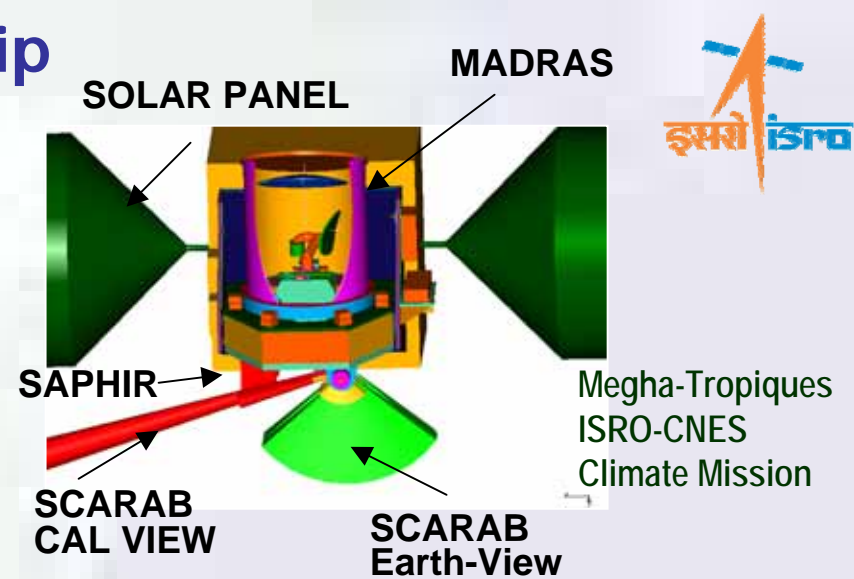


Provide key technological solutions for development using space and other modern tools

- ✦ Provide connectivity, resource and weather information
- ✦ Synergies of remote sensing, communications and navigation using satellite and other modern mean
- ✦ VSAT network using INSAT for main centres
- ✦ Advisories on land and water resources, cropping patterns, weather, markets
- ✦ Education and health amenities through linkage with institutions

India in International Partnership

- Bilateral cooperation with 32 countries in Asia, Europe, North America and Latin America
- Multilateral cooperation with United Nations, Inter-Governmental Organisations and International Non-Governmental Entities (incl. GEOSS)
- Launching of sensors/satellites of many countries on Indian EO satellites/launch vehicles
- ISRO-CNES joint mission- Megha-Tropiques
- International Ground Stations
- Training & Education for Asia-Pacific
- Hosting International Conferences (ISPRS-TCIV, APRSAF-2007, GEOSS workshop.....)



GEO-GOA



ISRO/IEEE/ISPRS/OGC Workshop

The User and the GEOSS Architecture VI Applications in Public Health for The Indian Ocean Region

September 26, 2006, Goa, India



- Attended by 42 participants including 14 foreign participants
- 8 Lectures and one demonstration
- 4 Breakout Groups Meeting on GEO User and Architecture, Public Health and GIS, Telemedicine and OGC: Open Standards for GEOSS Interoperability
- Details available on www.commission4.isprs.org

Lighting of Lamp



Lecture



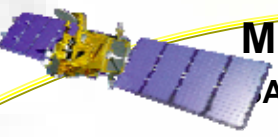
Breakout Meeting



Plenary Session



Indian EO Missions – Road Ahead



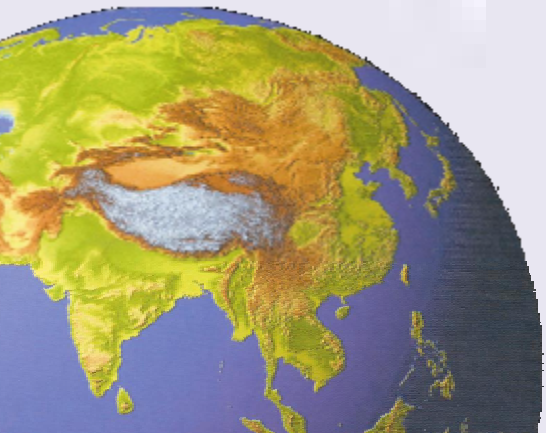
MEGHA-TROPIQUES
APHIR, SCARAB & MADRAS



INSAT-3D
VHRR: 6 bands/1 km (V&SWIR), 4 km (MIR-Split-TIR), 8 km (WV)
19 Channel SOUNDER



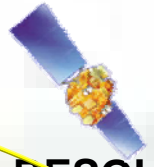
TWSAT



2006-07

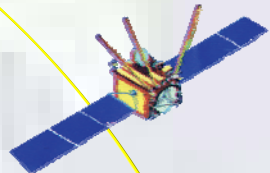


CARTOSAT-2
PAN - 1.0 m, 11 km

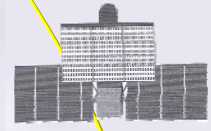


RESOURCESAT – 2
LISS III – 23 m ; 140 km; 4Xs
LISS IV - 5.8 m ; 3Xs
AWiFS - 60 m; 370 x 2 km

2008-09



OCEANSAT-II
SCAT, OCM



RISAT-1
C-band SAR; 3-50 m
Multi-Pol; Multi mode



Altika+Argos

2009-10



Geo-HR-Imager

2010-12



RESOURCESAT – 3
CARTOSAT-3
TES Hys.
DM-SAR
OCEANSAT-3

Thank you.