Recent Earth Observations/ Space Technology Applications for Societal benefits in India

Indian Space Research Organisation

UN-COPUOS

Scientific and Technical Subcommittee, 47th Session

Vienna, February 08-19, 2010

Indian EO System

Geo stationary

Sun Synchronous

1988 INSAT-1D VHRR

1992 INSAT-2A VHRR

1993 INSAT-2B VHRR

1999 INSAT-2E VHRR, CCD

2002 KALPANA-1 VHRR

2003 INSAT-3A VHRR,CCD

2008 IMS-1 (2008)

2007/ 08 CARTOSAT-2 &2A PAN

2005 CARTOSAT-1 PAN, F/A

2003 RESOURCESAT LISS 3;LISS 4; AWIFS

2001 TES Step& Stare PAN

1999 OCEANSAT OCM & MSMR

1995/97 IRS-1C/1D LISS-3, PAN & WIFS

1996 IRS-P3 WIFS, MOS X-Ray

1988/91 IRS-1A & 1B LISS-1&2

64 bnds

2.5 m

< 1 m

5.8 m

23 m

24 days

55 m

5 days

188 m

5 days

360 m

2 days

1 km

30 min.

Aerial

Digital Camera

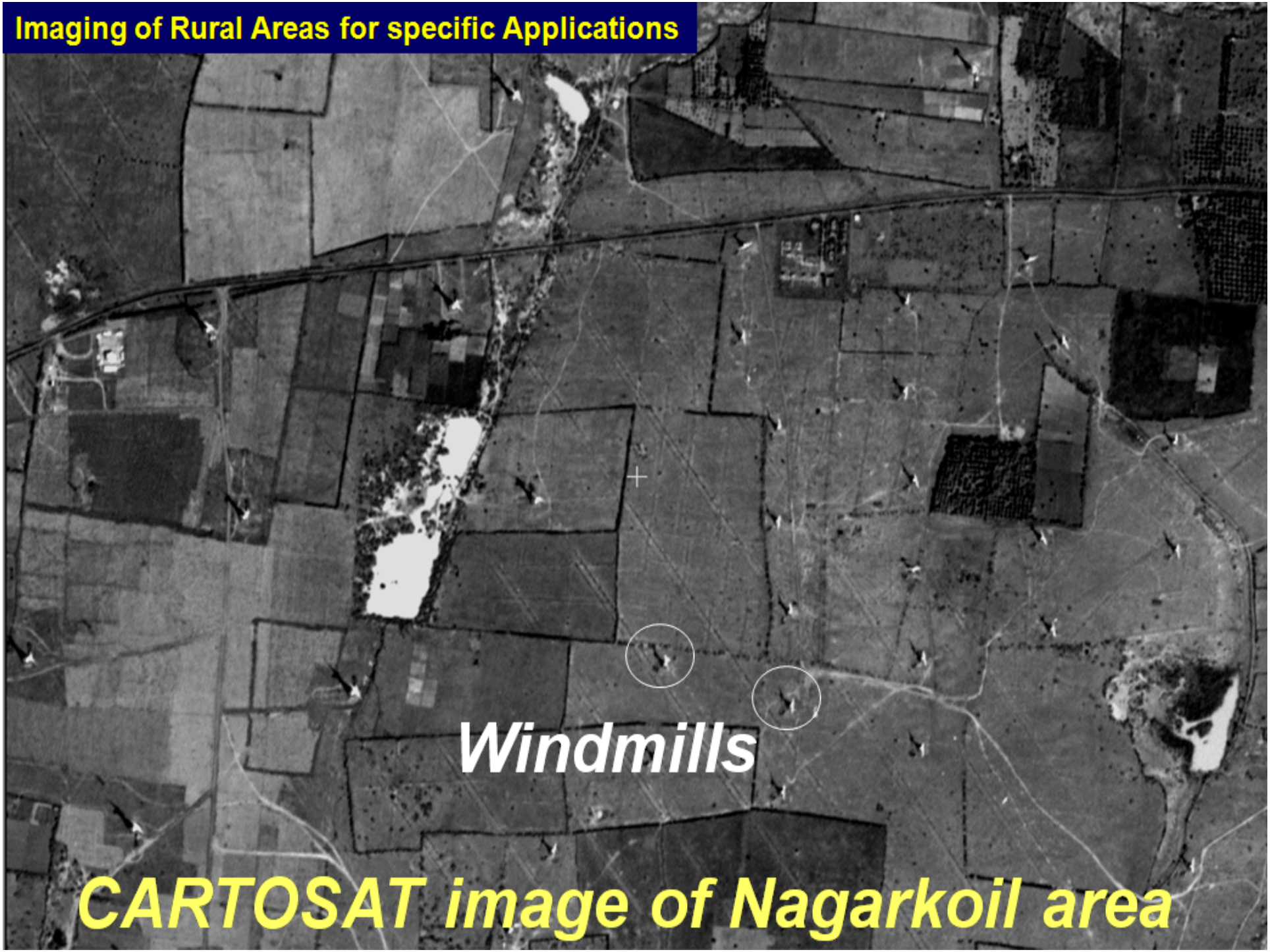
Laser Terrain Mapper

Submetre

ALTM

A Valuable infrastructure in Space for monitoring Natural Resources AND Environment

Imaging of Rural Areas for specific Applications



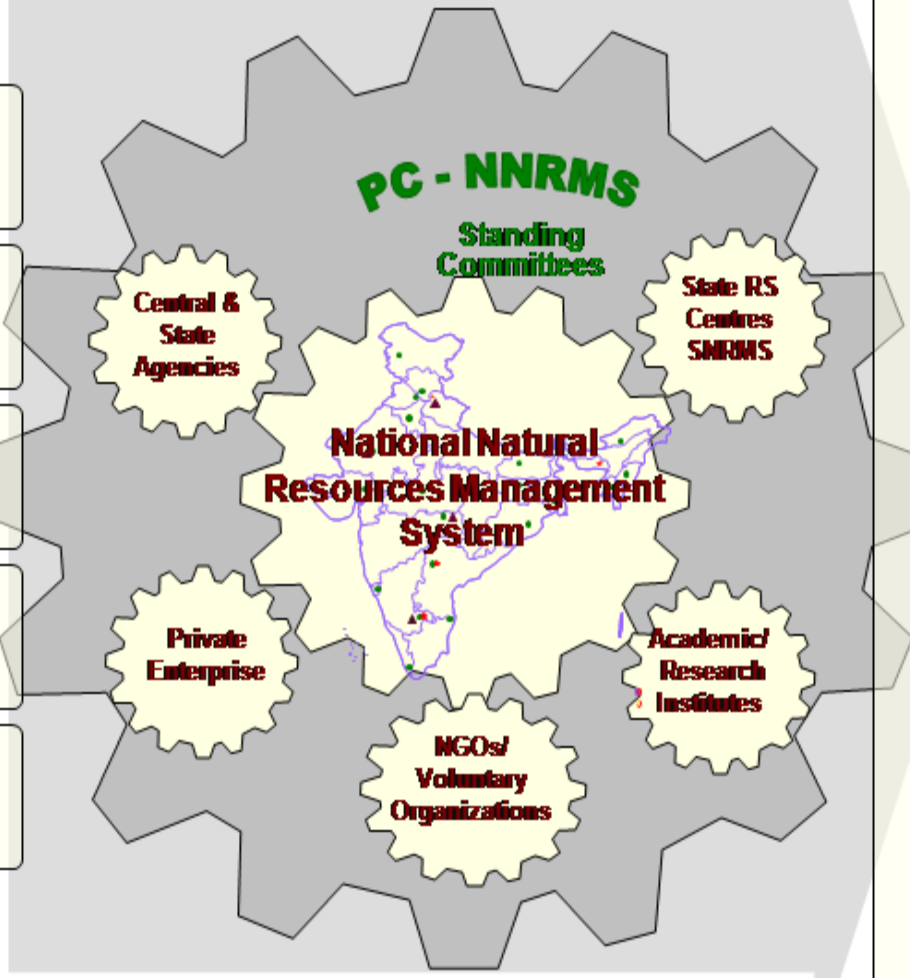
CARTOSAT image of Nagarkoil area

National Natural Resources Management System

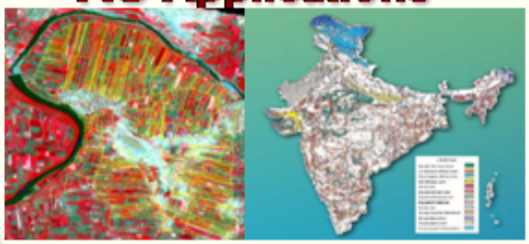
An Applications Driven Programme

National Priorities

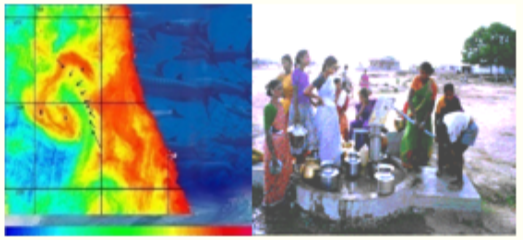
- Food Security & Poverty Alleviation
- Infrastructure: Social & Physical
- Natural Resources Assets Build-up
- Disaster Management Support
- Weather & Climate Studies



RS Applications



- Agro-informatics
- Potential Fishing zones
- Drinking Water Mission
- Wasteland inventory
- Watershed Development
- Urban Info. System
- Rail/Road/Pipeline alignment
- Flood monitoring, Drought Assessment, Cyclone warning
- Landslide hazard zonation



…in sync with country's priorities…

State Infrastructure - Remote Sensing Application Centres

..... NNRMS integrates data/info from Remote Sensing into the Nat ional / Regional / Local systems with appropriate technical, managerial and organisational linkages

– NNRMS Mandate

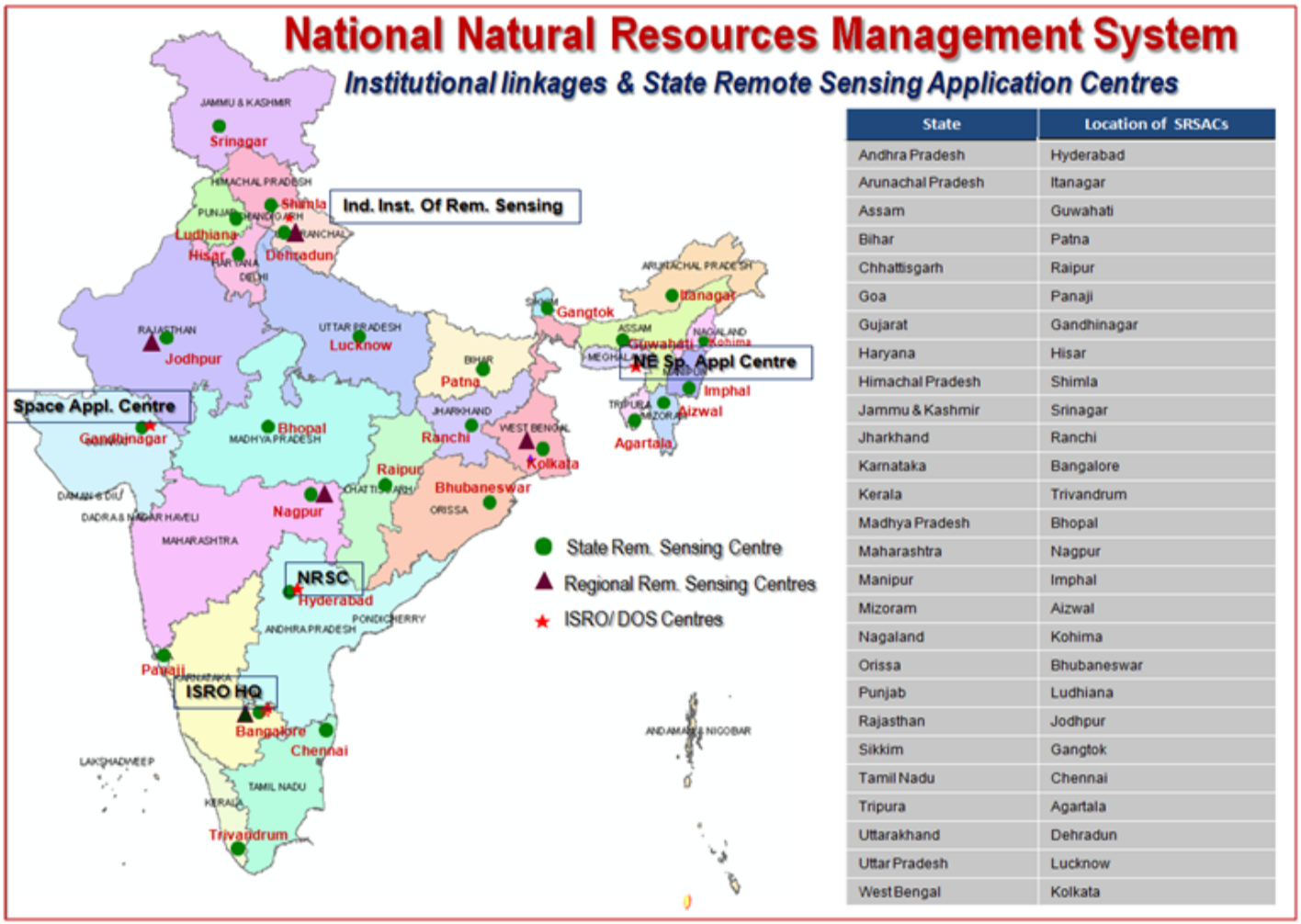
NNRMS Standing Committees
Chair: Secretaries of GoI

- Agriculture & Soils
- Water Resources
- Bioresources
- Geology & Mineral Resources
- Rural Development
- Urban Development
- Oceanography & Meteorology
- Cartography
- Training & Technology

STATE RS CENTRES

↕

STATE/DISTRICT DEPARTMENTS



State	Location of SRSACs
Andhra Pradesh	Hyderabad
Arunachal Pradesh	Itanagar
Assam	Guwahati
Bihar	Patna
Chhattisgarh	Raipur
Goa	Panaji
Gujarat	Gandhinagar
Haryana	Hisar
Himachal Pradesh	Shimla
Jammu & Kashmir	Srinagar
Jharkhand	Ranchi
Karnataka	Bangalore
Kerala	Trivandrum
Madhya Pradesh	Bhopal
Maharashtra	Nagpur
Manipur	Imphal
Mizoram	Aizwal
Nagaland	Kohima
Orissa	Bhubaneswar
Punjab	Ludhiana
Rajasthan	Jodhpur
Sikkim	Gangtok
Tamil Nadu	Chennai
Tripura	Agartala
Uttarakhand	Dehradun
Uttar Pradesh	Lucknow
West Bengal	Kolkata

Forecasting Agriculture output using Space, Agro-meteorology & Land based observations (FASAL)

Nationwide Multiple Wheat & Rice Crop Forecasting

- In-season Crop Forecasts
- Impact of Drought & Flood Assessment
- Early Warning – Crop condition & Stress Scenario
- FASAL Centre /NCFC with Ministry of Agriculture

Forecasts

Crop	Year	Acreage (mha)	Production (mt)
Rice	2008-09	35.97	78.37
Rice * (Except TN)	2009-10	30.66	63.61
Wheat	2008-09	26.96	73.59

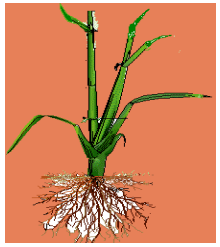
Final Estimate

Spectral, Agromet & Econometric Models
- Integrated Yield Models

Third Estimate

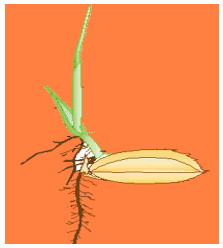
Spectral – Agromet Models
- Space Images
- Meteorological data
- Ground data

Second Estimate



Agromet Models
- Space Images
- Ground Data
- Temp./Rainfall

First Estimate



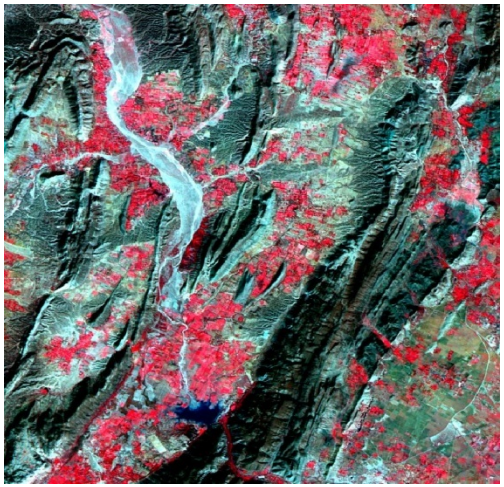
Econometric Models

Pre-harvest Production Forecast at National, State and District levels for Major Crops like Paddy, Wheat, Sorghum, Rapeseed, Mustard, ...

Groundwater Exploration & Recharge

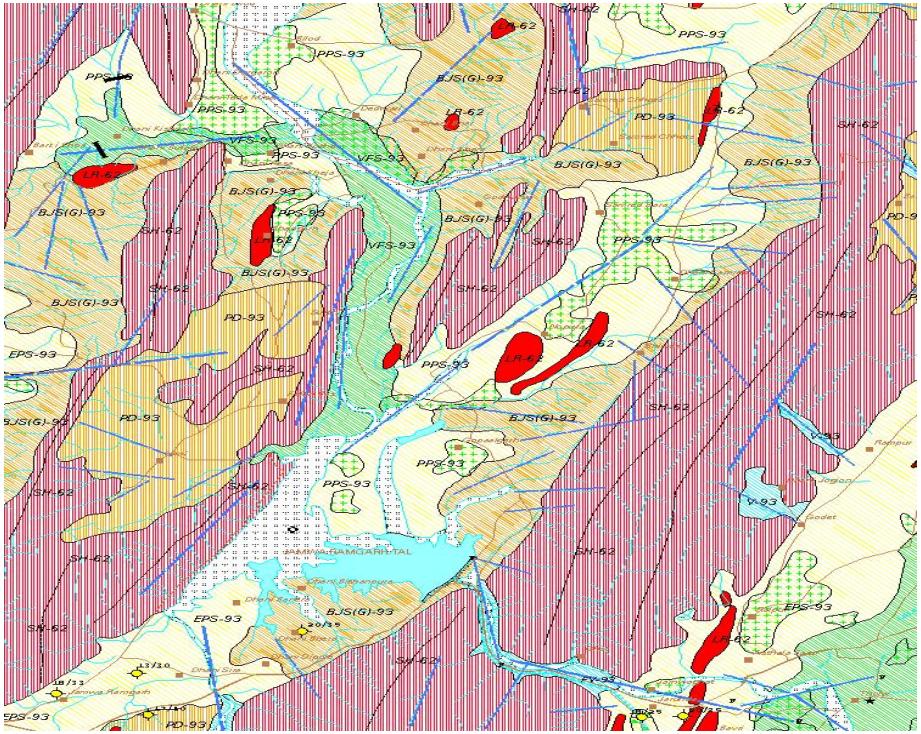
Rajiv Gandhi National Drinking Water Mission

- 1.6 billion (28%) lack safe drinking water; 5 M die per year
- 1.5 billion people depend on GW for drinking
- GW Pumping > natural recharge @ 160 billion m^3/year

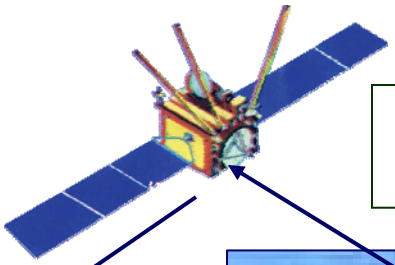


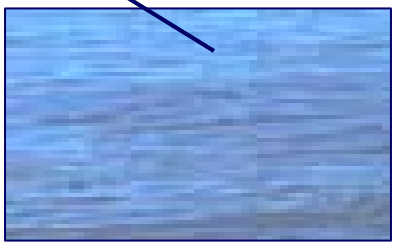
- Yield 400-800 Depth <30m
- Yield 200-400 Depth 30-80m
- Yield 100-200 Depth 30-80m
- Yield 50-100 Depth 30-80m
- Yield 10-50 Depth >80m
- Prospects limited to valleys
- Run-off zone (Yield in lpm)

- 10 States covered; for 10 more, work ongoing
- 275,000 + Bore wells drilled with 90% + Success rate
- 7,000 + Recharge structures constructed



Potential Fishing Zone

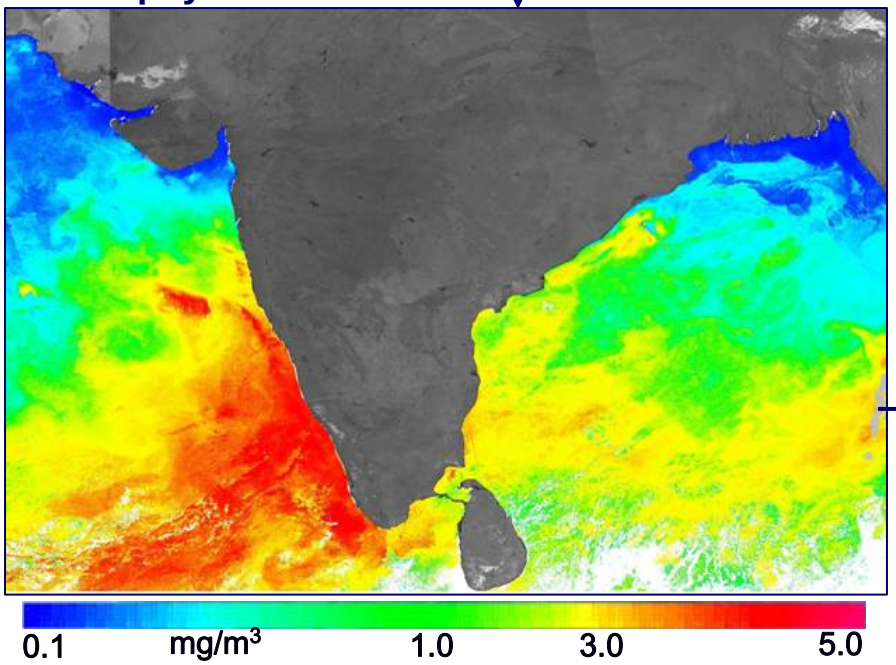




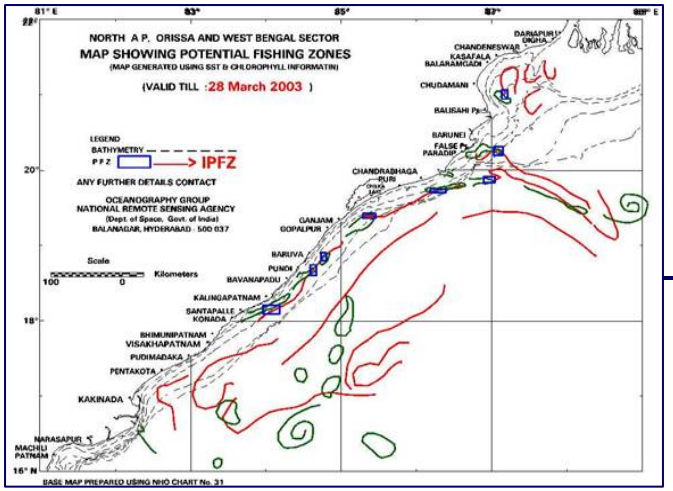
Estimated Users: > 30000
No. of Nodes : > 370

Mode of Dissemination
SMS, Radio, TV, Web, Kiosks, Telephone, Fax, Email

Chlorophyll Distribution



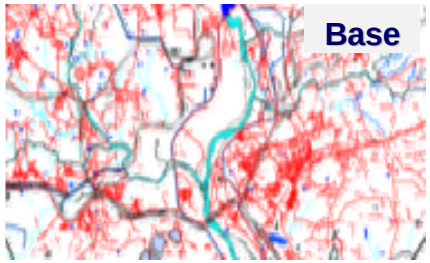
PFZ Map

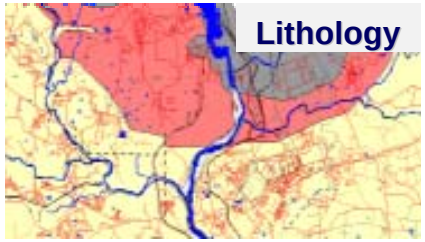


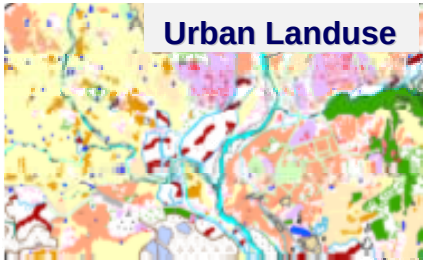
National Urban Information System (NUIS)

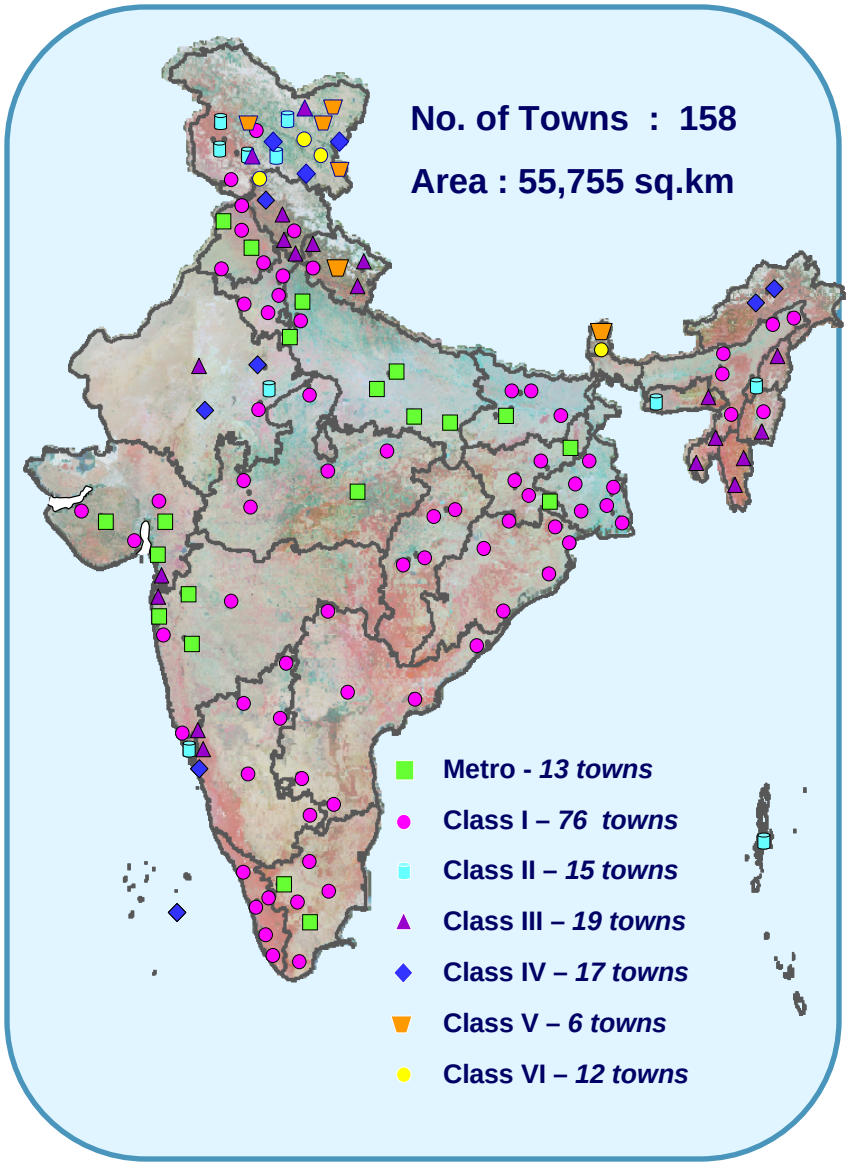
Towards administering Towns/ Cities in a Scientific Manner

- Multi scale (10K, 2K,1K) hierarchical Urban Geospatial database
- For supporting Urban Planning, Infrastructure development, e-governance, ..







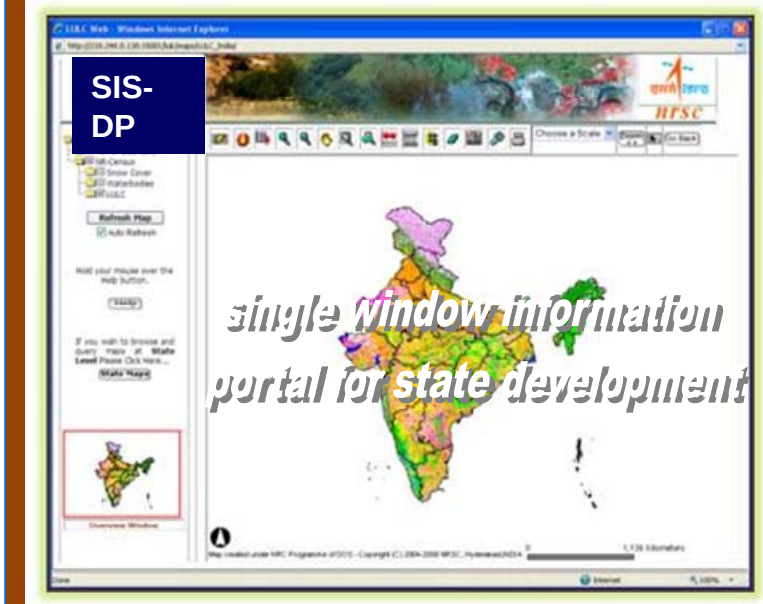


Space based information support for decentralized planning (SIS-DP)

ICT enabled geospatial platform using space based data for planning and carrying out developmental activities in a decentralized and speedy manner involving local bodies

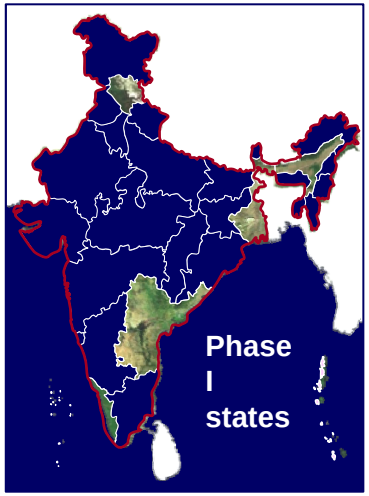
Main work involve:

- Mapping at 1:10k scale
- Integrating with existing database
- Linking stake holding departments data,
- Development of information system for the state/ district towards developmental plan preparation
- Capacity building



Benefits

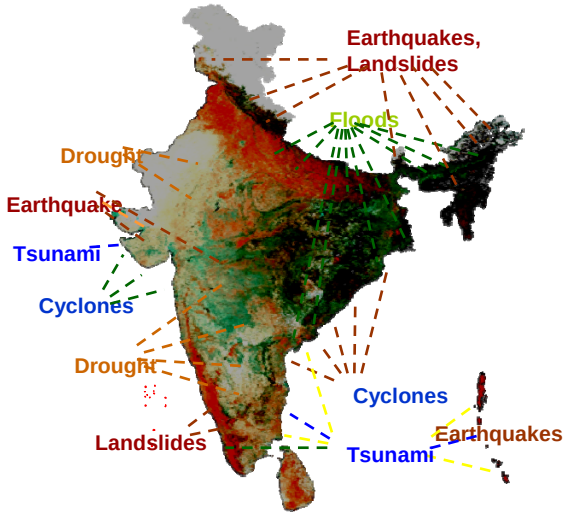
Agriculture & Marketing
Health & Family welfare
Education
Electrification
Irrigation
Public works
Road connectivity
Disaster management
Panchayat development
Fisheries
Land reforms
Tourism
....



Disaster Management Support (DMS) System

India's Vulnerability to Disasters

- 12% of land (40 mha) - Flood prone
- 8% of land (5,500 km coast) - Cyclone prone
- Over 65% of land under cultivation - Drought prone
- ~ 25% land - Earthquake prone (zone IV-V)
- Himalayan & Western Ghats - Landslide prone
- A & N Islands, parts of East Coast, and Gujarat coast - Tsunami prone

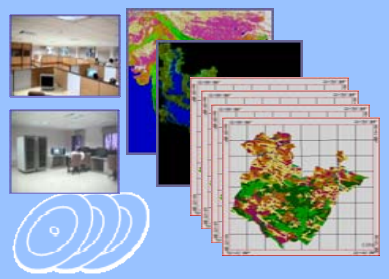


Space Technology in mitigating Disasters

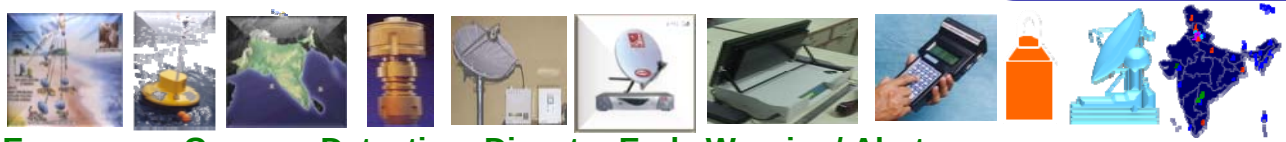
Observational Systems
Satellite (GEO, LEO, All-weather), Aerial, Ground

Single-Window for Services Delivery
DMS-DSC

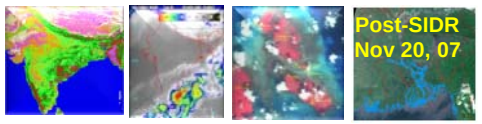
Multi-tier databases with query/ decision tools



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, …

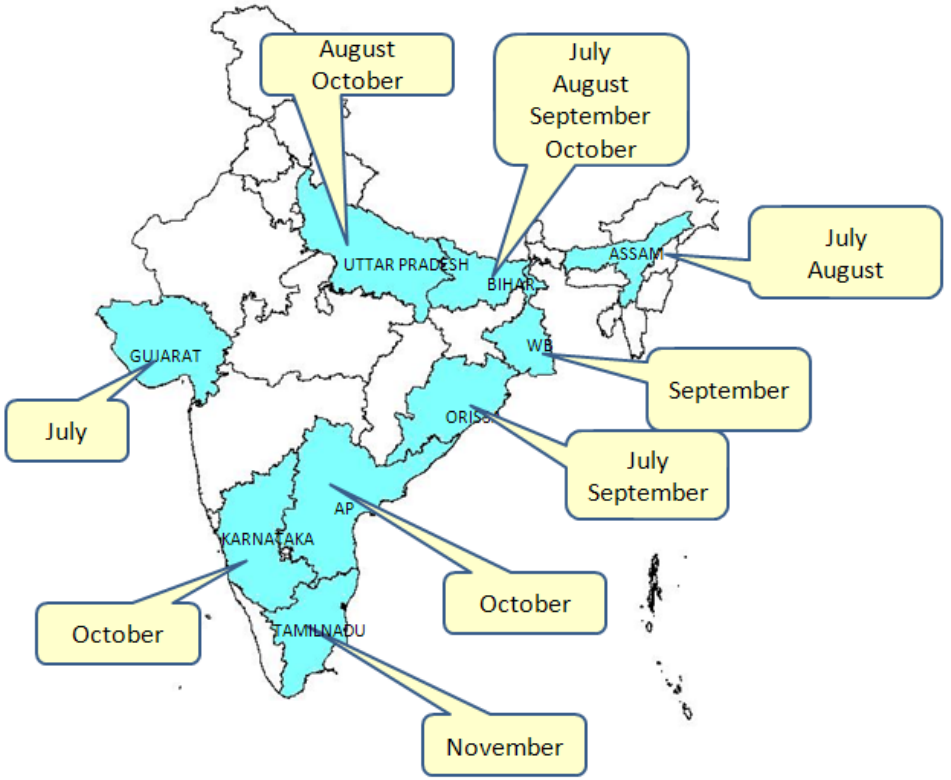


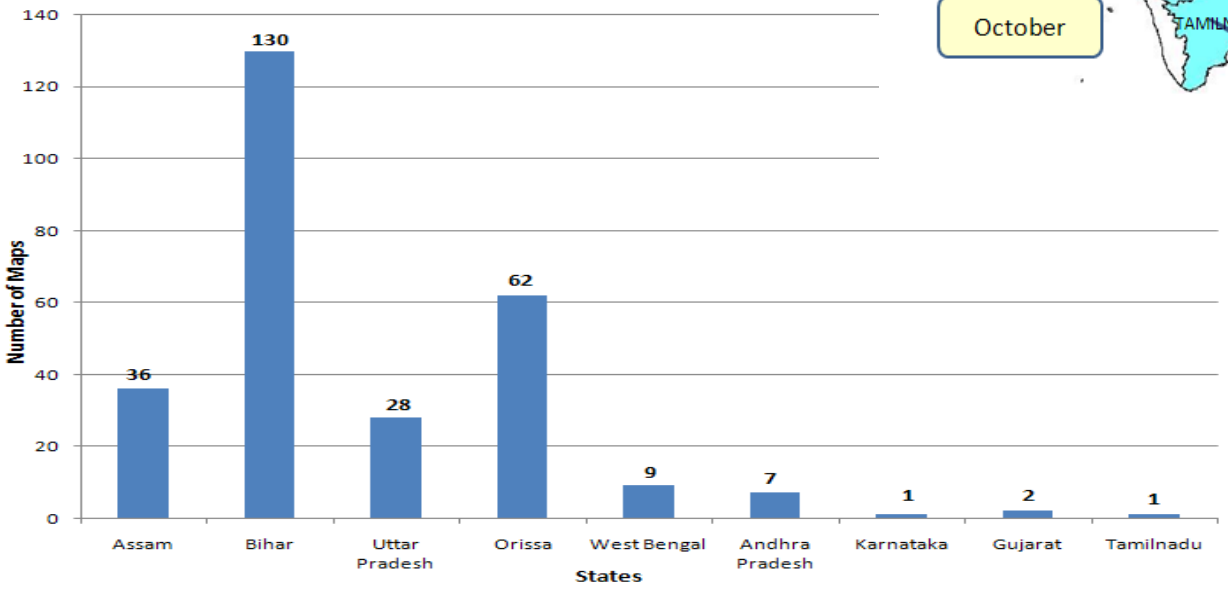
Satellite Data & GIS layers
Damage assessment, Hazard zonation, mitigation planning

International Commitments: International Charter (Space & Major Disasters) , ESCAP, GEOSS, GEOS, Sentinel Asia, UN-SPIDER, …

Floods in India -2009

- During 2009, Floods in 9 states were mapped.
- More than 275 flood maps were disseminated
- This information was used for relief management
- Encouraging feed back was received from Govt of Bihar, Govt of Karnataka on the utility of these maps



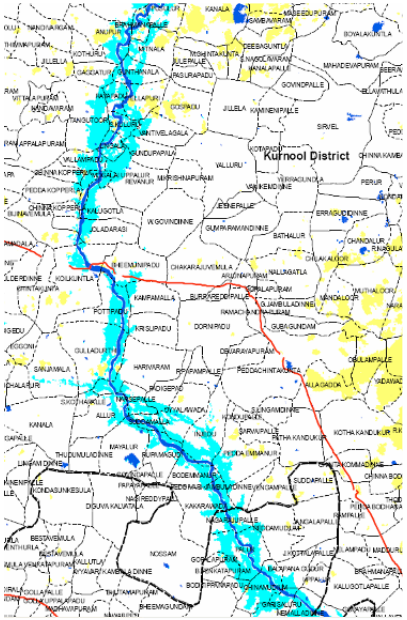


Mapping of Floods

2009: Floods in 9 states; 275 flood maps disseminated

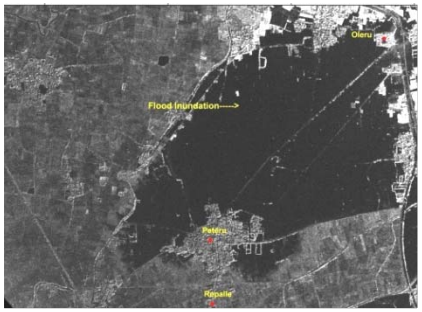
IRS-P6 AWiFS NCC satellite image of 05-Oct-2009

Floods due to Kundu River in Kurnool, Andhra Pradesh

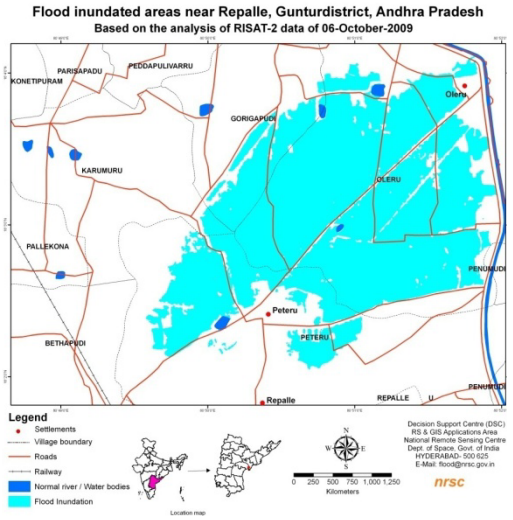


Flood Map

Andhra Pradesh Floods – 2009
Repalle Breach RISAT-2 data of 6-Oct-09



RISAT-2 data of 6-Oct-09



Flood Map

DMS Programme: Disasters Operationally Addressed

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

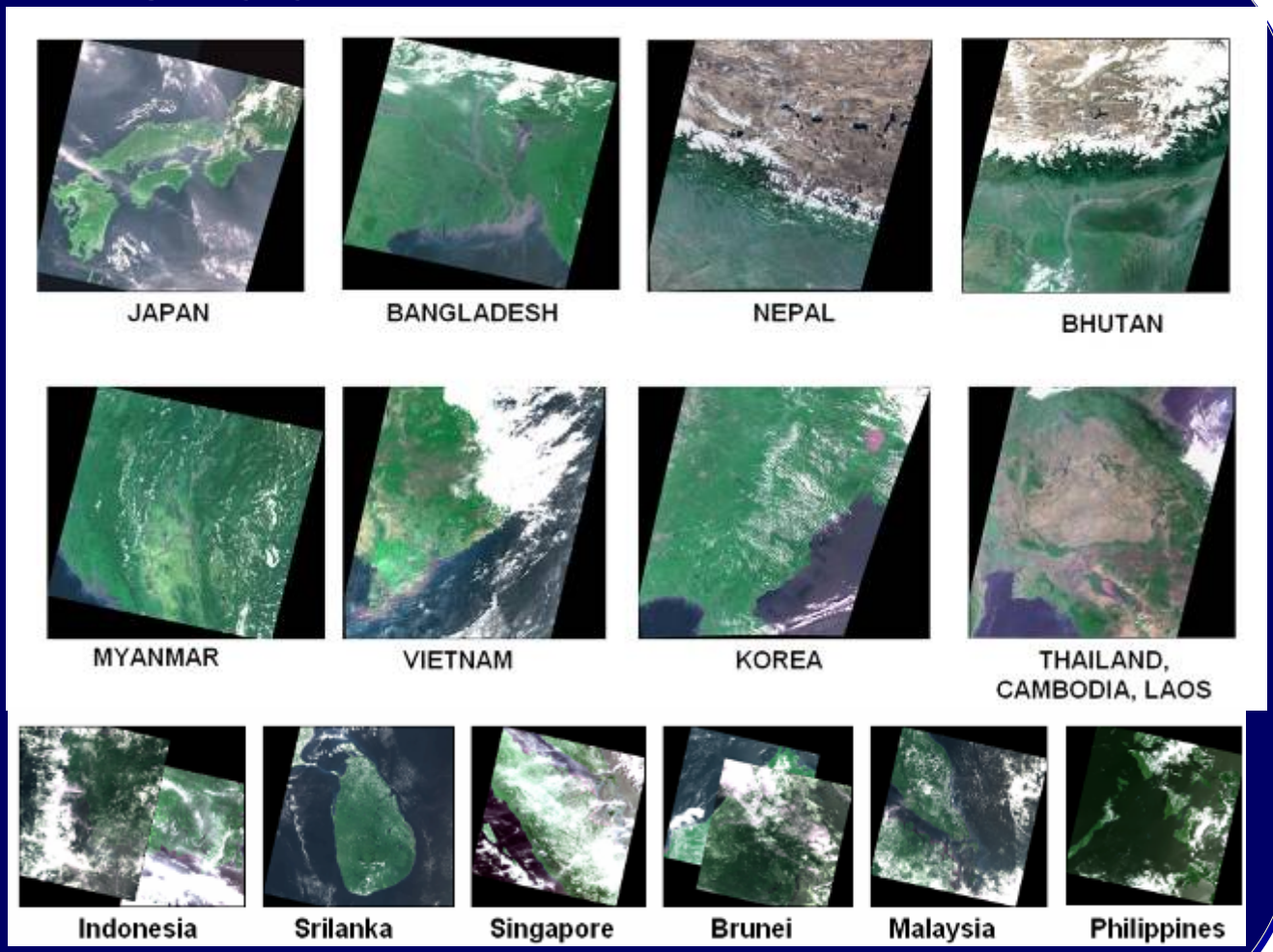
Landslide
Damage Assessment
Hazard zonation

Forest Fire
Active fire detection
Damage assessment

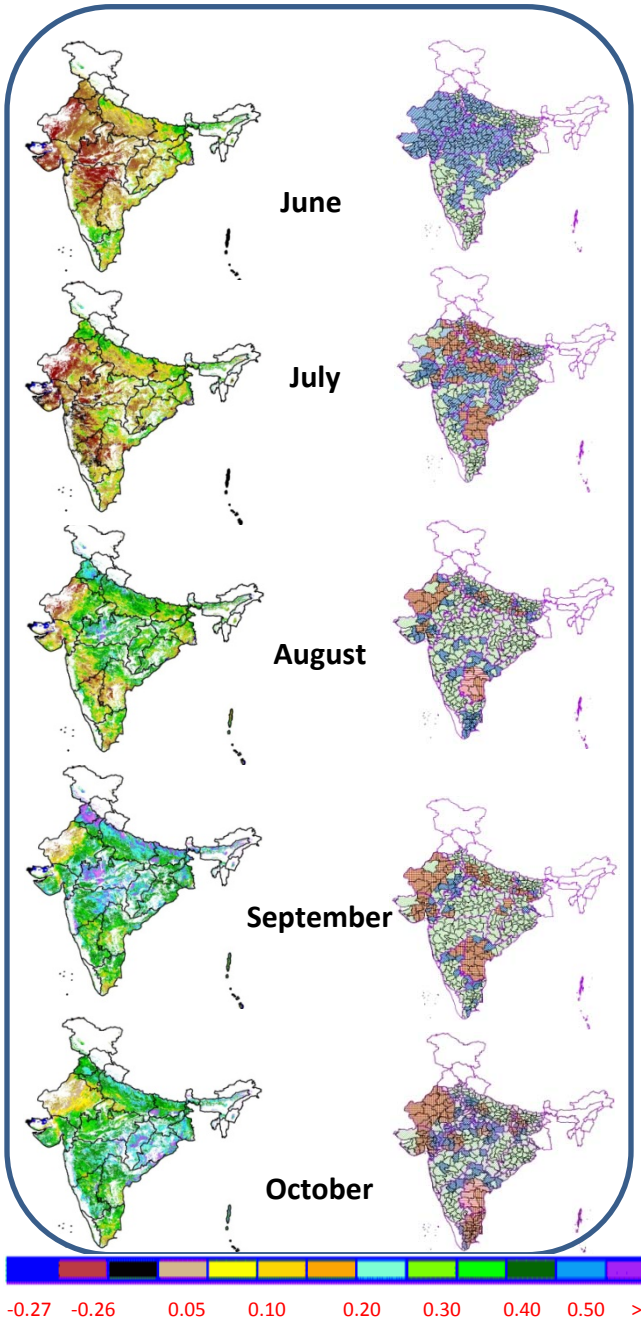
SA/ Digital Asia (DA) Server
Data, Info. Uploaded to SA Server at NRSC

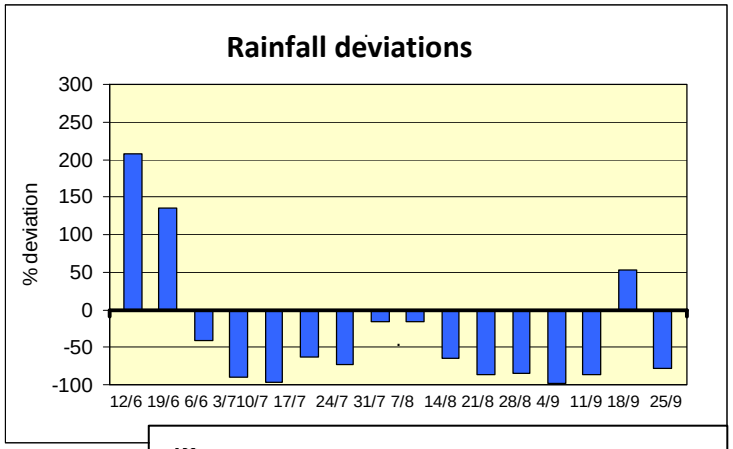
IRS - AWiFS Data

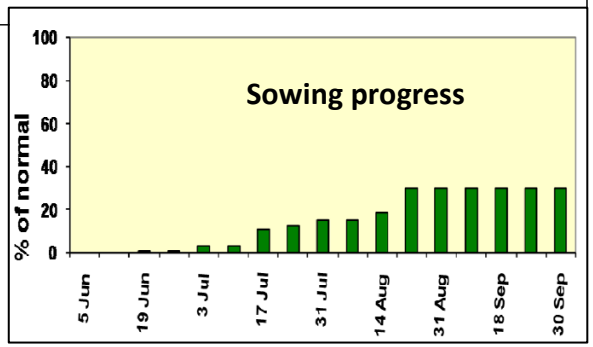
Bangladesh
Bhutan
Cambodia
Japan
ROK
Laos PDR
Myanmar
Nepal
Thailand
Vietnam
Indonesia
Srilanka
Malaysia
Singapore
Brunei
Philippines



National Agricultural Drought Assessment & Monitoring System



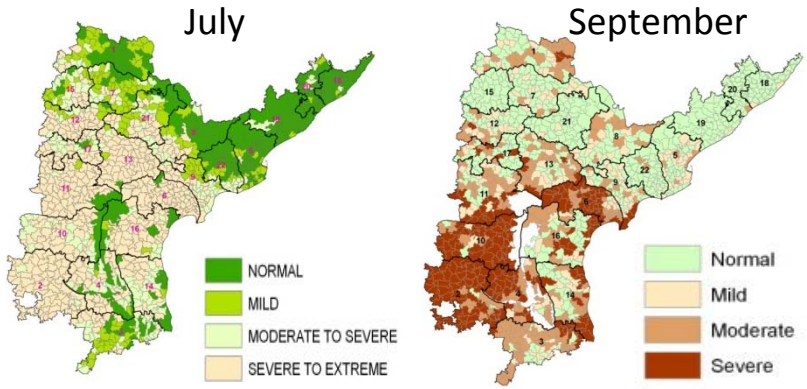




Integration with ground data

No. of districts under drought	
June	215 dist
July	226 dist
Aug	124 dist
Sep	115 dist
Oct	179 dist

Normal
Mild Drought
Moderate Drought
Severe Drought



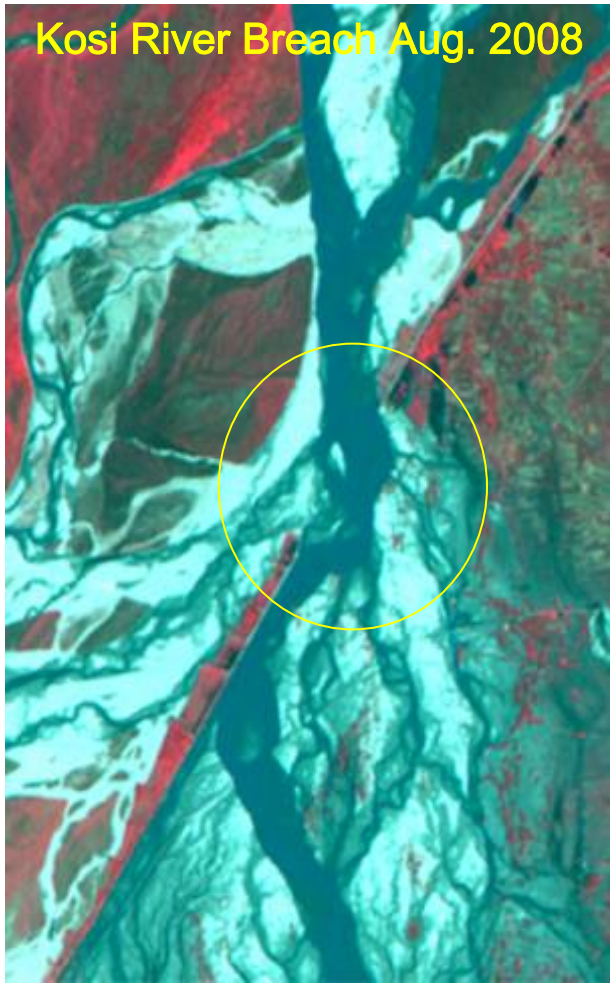
District/ Sub-District Level Drought Monitoring

Responding to SA Emergency Requests:

Responding to Emergency Requests:

(During 2008 & 2009)

i. Australian Floods, Jan 2008;
ii. Indonesia floods February, 2008
iii. Cyclone –NARGIS, May 2008
iv. China Earthquake, May 2008
v. Japan Earthquake, Jun & Jul, 2008
vi. Nepal flood, Aug 2008
vii. Laos, flood Aug 2008
viii. Thailand Flash flood, Nov. 2008
ix. Australian Forest fire Feb 2009
x. Laos PDR Flood , Feb 2009
xi. Australia Floods Feb, 2009
xii. Australia Oil Slick Mar, 2009
xiii. Philippines flood Mar, 2009
xiv. Indonesia Flash flood Mar, 2009
xv. Vietnam flood April, 2009
xvi. Indonesia Volcano Eruption May 2009
xvii. Vietnam floods (Recent) Jul 2009



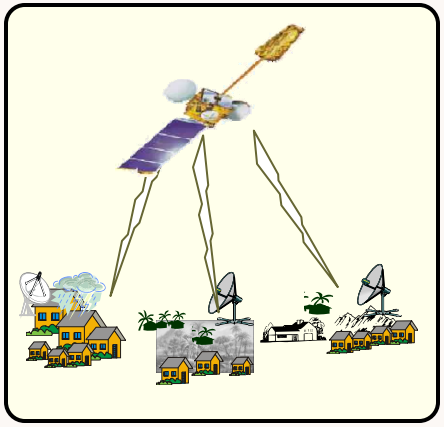
Responded to all requests. Pre-event data provided / available on SA server for most of the events.

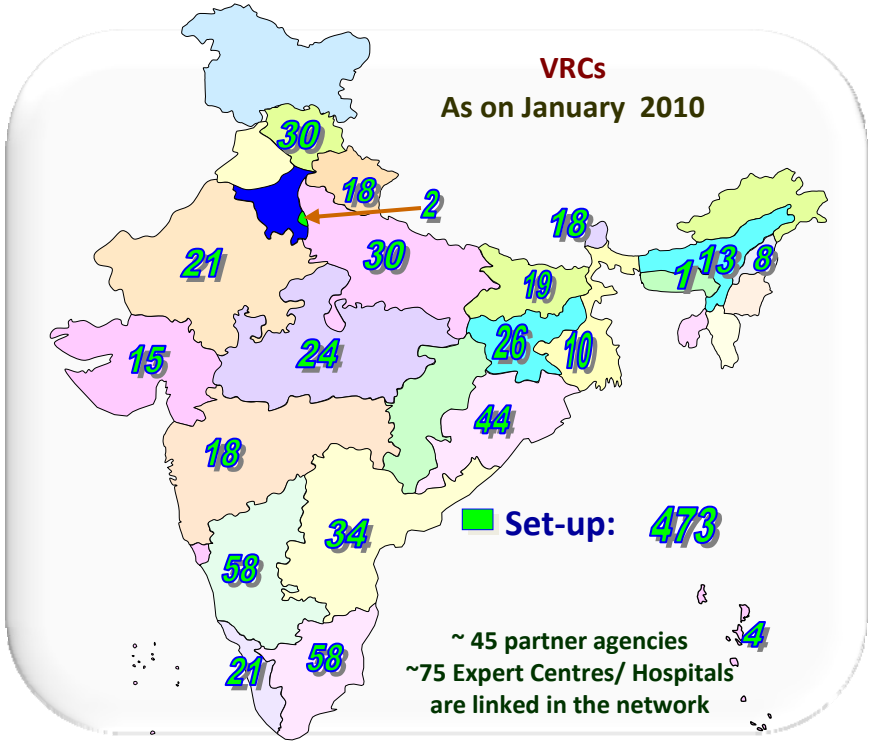
Village Resource Centres (VRCs)

For Empowering Rural Community

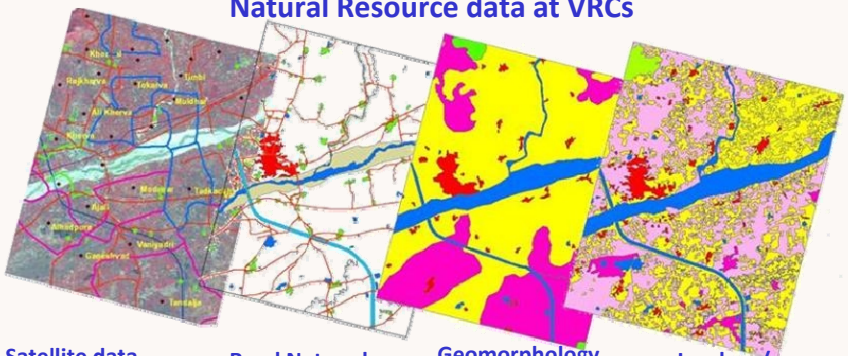
Components of VRC

- Two way audio-video link via satellite
- Advisory related to Agri., Fisheries, …
- Natural Resources Information
- Tele-Education, Tele-Healthcare, …
- Disaster related
- Skill Development
- ……





Natural Resource data at VRCs



Satellite data | Road Network | Geomorphology | Landuse/cover

Over 6000 programmes conducted, more than 4 lakh people benefited

VRCs: A Snapshot of Activities

Over 6000 programmes conducted, around 4 lakh people benefited

Advisories on Agri. - Pest, diseases, water management, seeds, organic farming, horticulture, floriculture, crop insurance, agro meteorology, livestock etc.

Education, Training, Skill Dev for Livelihood support - E-Learning, computer literacy, supplementary teaching, nursing, plumbing, electrician, automobile, house wiring, etc.

Healthcare - Awareness creation, child & women healthcare, eye-care, dermatology consultations, traditional/ herbal medicine, cardiac check - ECG camps, health camps, yoga classes etc.

Natural Resources Management - Watershed based planning, ground & surface water management, wasteland development, etc.

Social Empowerment - Right to Information (RTI), domestic violence, career plan/ counseling, job opportunities, legal advisories, etc.

Others - Summer camps for children, interactions with members of Panchayats/ SHGs, workshops, local news papers, screening of educational CDs, etc.

Tele-Education and Tele-Medicine

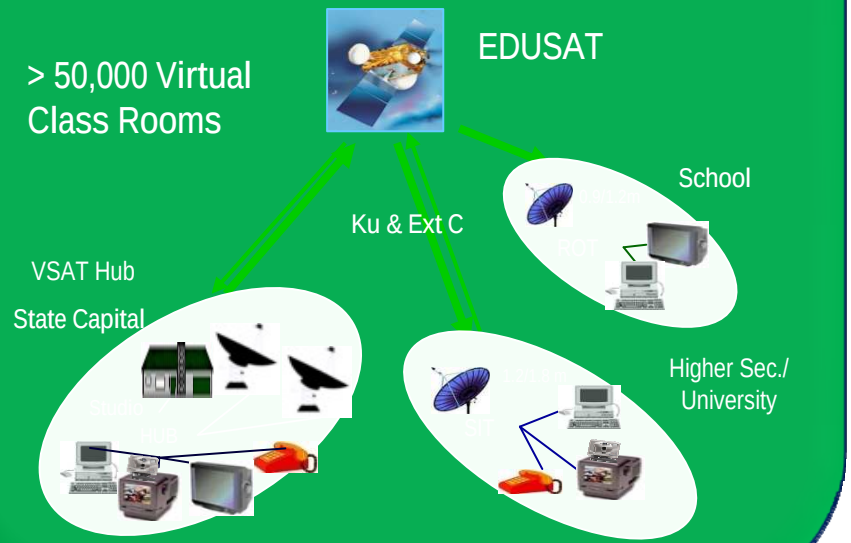
Tele-Education

Training & Dev. Communication Channel (1995)

Jhabua Dev. Communications Project (1996)

GRAMSAT Pilot Project (Current)

EDUSAT Utilization Prog (Current)



Tele-Medicine

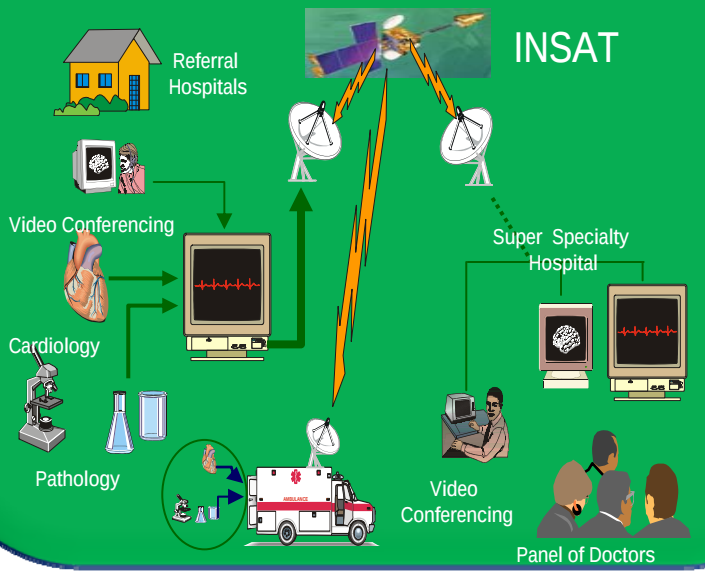
382 Hospitals

307 Dist/ Rural Hospitals

59 Specialty Hospitals

16 Mobile Units

> 650,000 Patients treated



Broadcast

Television Broadcasting

Direct To Home (DTH)

TV & Radio Networking

Communication

Speech Circuits on Trunk Routes

VSAT Connectivity

Mobile Applns

Mobile Satellite Service

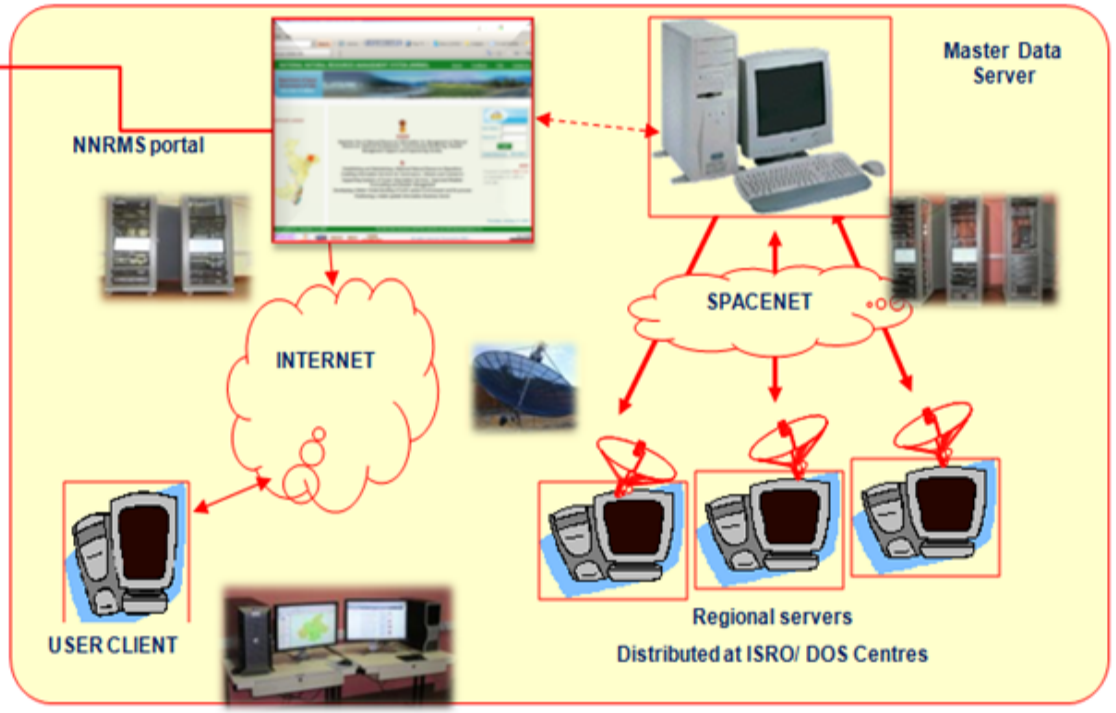
Search and Rescue

Satellite Navigation

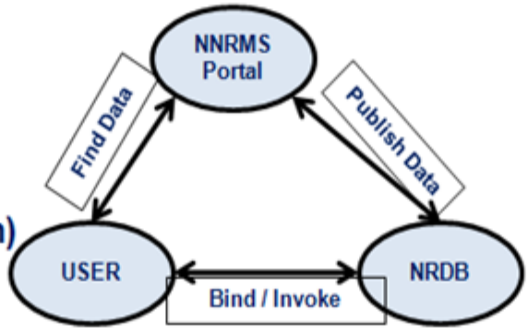
NNRMS Portal – Network Overview

Natural Resources Data Base – For Planning and Development

- Standardised GIS database of all Thematic & infrastructure layers
- Provide spatial data/ value added services to User Community
- Linked also through India's NSDI



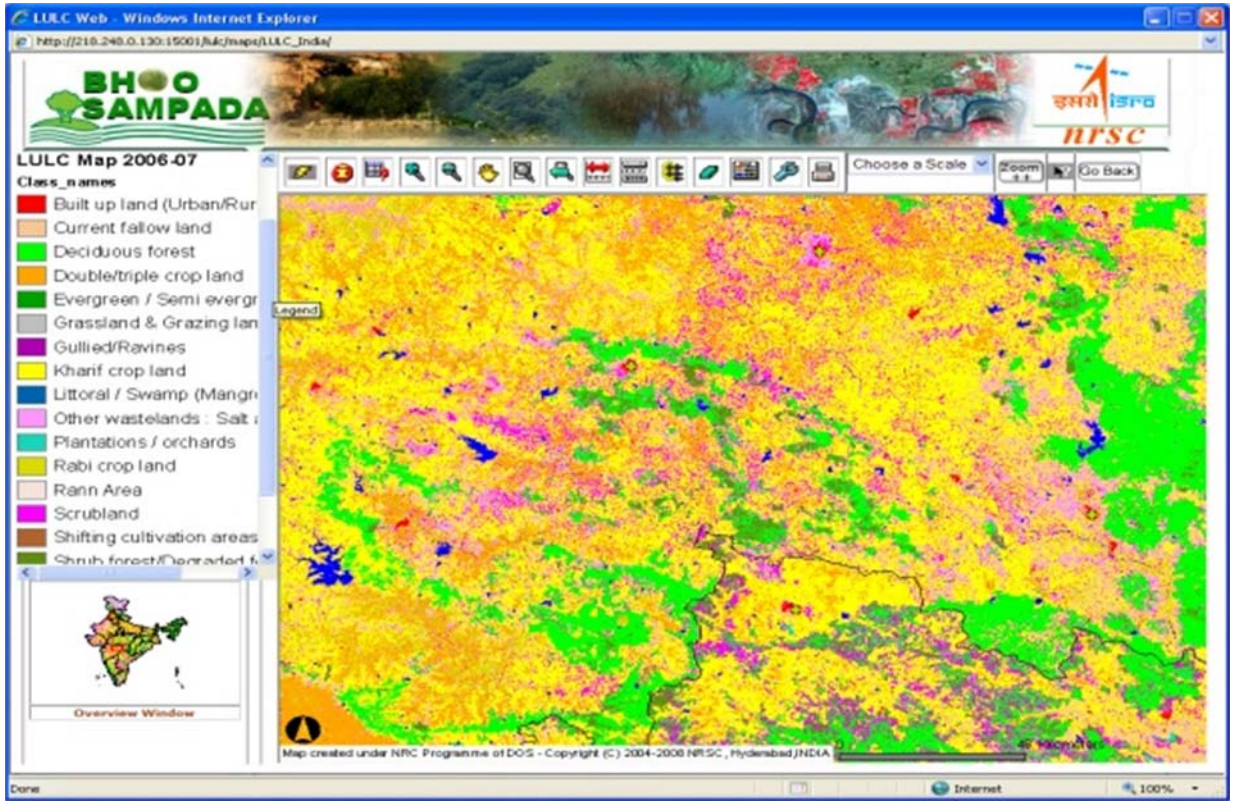
- Search on Theme, Layer, Scale, AOI, and Year of Mapping
- Complete description about Spatial Data (Spatial Information, Project Description)
- Order and Get Data



BHOOSAMPADA

Land Use / Land Cover Information in Web

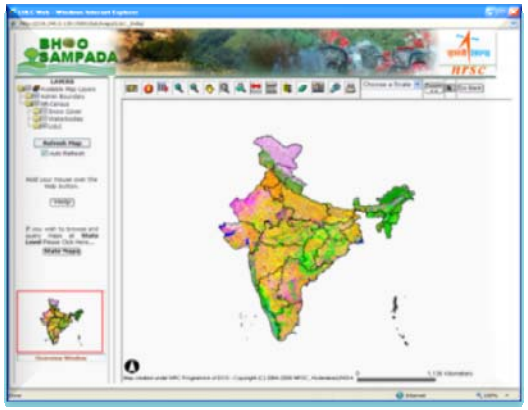
- Interactive GIS Application
- Land use/ land cover on 1:1M and 1:250 K
- Seasonal Water spread and Snow cover
- Temporal data of 2004-07
- Dissemination through NNRMS Portal



Information Delivery through Web Portals

Bhuvan

Bhoosampada



FASAL

ISRO-NNRMS

PC-GIS

PMO-GIS

IN-FRASS

NRDB

BIS

IBIN

WALIS

Meta-data, Reports, User-Registry, Access, ..

Information Management & Dissemination

Specialized Data Sources

- IRS Satellite Data → Bhuvan → Satellite Image Visualization
- NRDB → NNRMS Portal → Spatial Data Visualization
- AWS → MOSDAC → AWS Data in Spatial Domain
- Value Added EO Products → Information Services → Spatial Data and Information
- DMSP/ NDEM → Information Services

Customized Theme Specific Applications

- DSC Web
- Bhoosampada
- BIS, IBIN
- India-WRIS
- FASAL
- .....
- Future Spatial Info Systems

Web based Services for
- Satellite Data Visualization
- Spatial Data Query and Visualization
- Real time Data Viewing
- Theme based Services
- Data and Information Dissemination

Spatial Data and Information + OGC – Services (WMS, WFS, WCS) + Authorization → **Unified portal Planned** → User Community

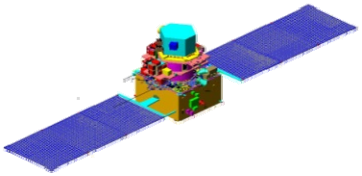
Indian EO Satellites - Near Future

Cartosat-2B

- PAN: < 1m Resolution; 10 km Swath; 5 days repetivity

- *Cadastral and infrastructure mapping and analysis*

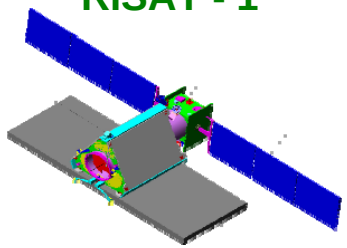
Resourcesat-2



- LISS-4 Mx: 5.8m Resolution; 70 Km swath; 5 days; 26deg tilt
- LISS-3: 23.5m Resolution; 141 Km Swath; 24 days
- AWiFS: 56m (N) / 70m Resolution; 740km Swath; 5 days

- *Crop discrimination, vegetation dynamics, natural resources applications, disaster management*

RISAT - 1



- C band SAR 5.35 GHz frequency; 5 imaging modes
- single, dual & quad polarisation modes
- 18.3 to 48.6º look angle; 20.1-54.5º orbit incidence angle
- In sun-synchronous 500-600km orbit

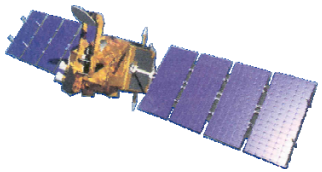
- *Agriculture, soil moisture, flood & water spread, geology, snow & glaciers, forest & oceanography.*

INSAT-3D

- 6 Channel Imager with 1km resolution for Vis, SWIR; 4km for MIR, TIR; 8km for WV
- 10 Channel Sounder with 10x 10km resolution

- *Clouds, ST, WV image, mesoscale temperature and humidity profiles.*
- *Improved Understanding of Meso-scale Systems*

MeghaTropiques



- SAPHIR: 10Km Horizontal Resolution to study the Water vapour profile
- SCARAB: 40Km Horizontal Resolution to study the outgoing fluxes at TOA
- MADRAS: 10, 18, 23, 37, 89, 157 GHz to study Precipitation and Cloud properties

- *Climate and weather applications in tropical region (rain rate, water vapour, humidity profiles, radiative budget)*
- *Contributing to Global Precipitation Mission (GPM)*

SARAL

- Satellite with ARgos and ALtika
- Ka-band Altimeter (~35.5GHz)
- Dual frequency Radiometer (23.8/36.8 GHz)
- A DORIS receiver
- Laser Retro-reflector Array

- *Sea surface heights, wind speed, wave heights, currents*

Thank You All