EO data use for Water Resource Management in India

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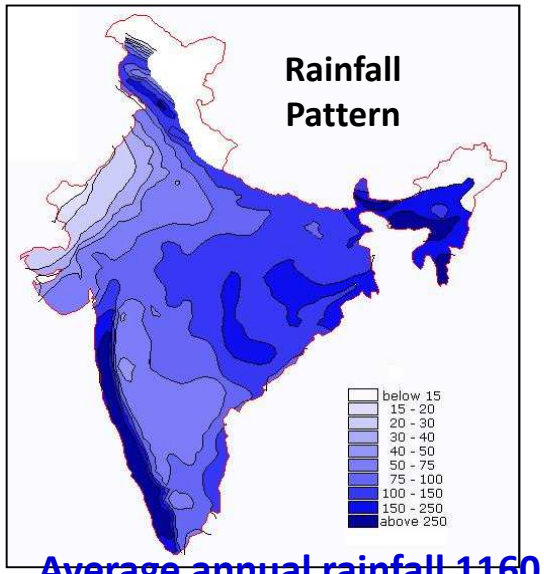
India: Water Resources At a Glance

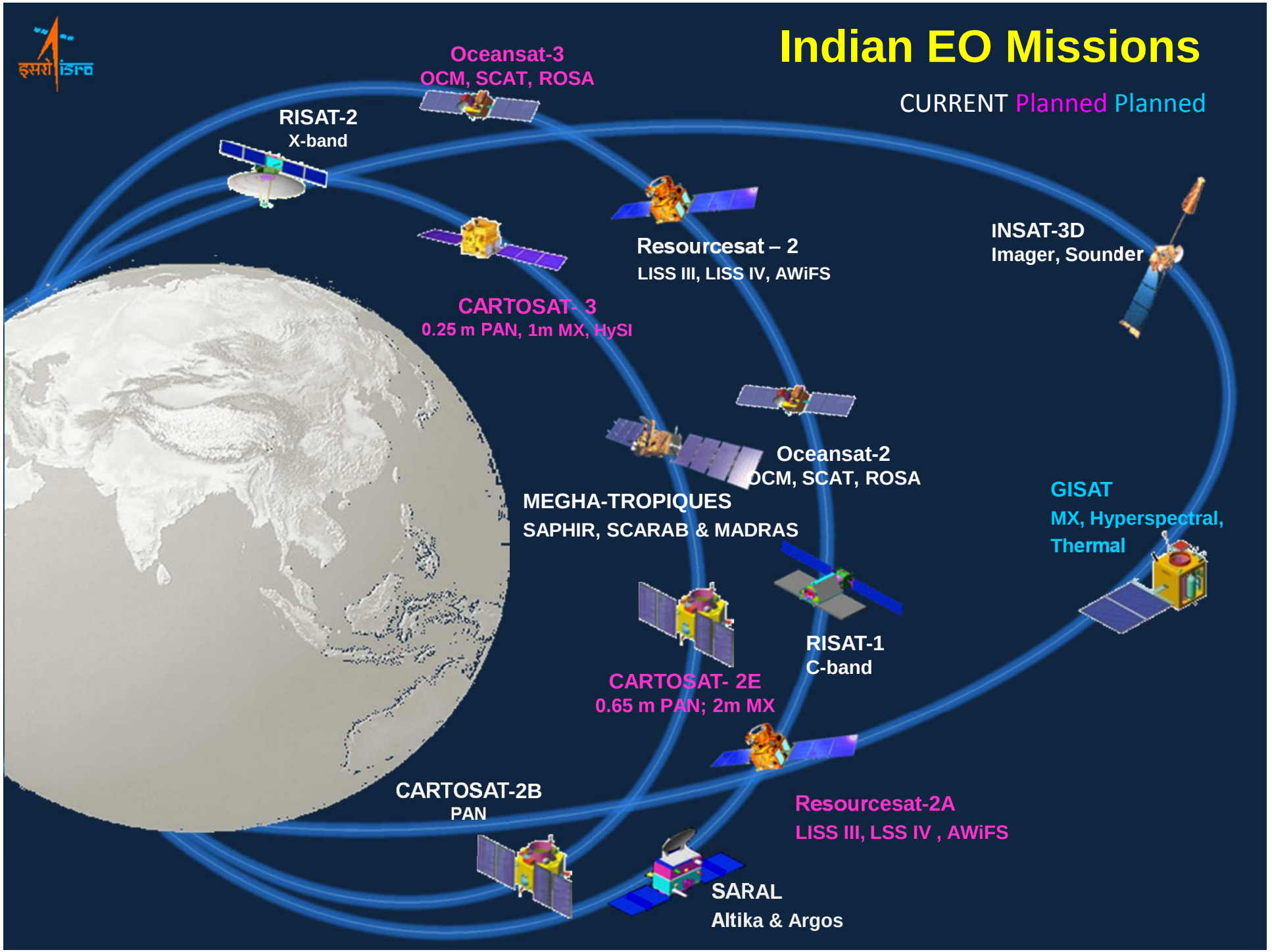
- Area as % of World Area: 2.4%
- Population as % of World Population: 17.1%
- Water as % of World Water: 4%



- Average annual rainfall 1160 mm *(world*
- 132 in per capita availability
- 122 in water quality
- Range 150 -11690 mm
- Rainy days 5-150,
- Most rain 15 days in 100 hrs
- PET 1500-3500 mm

Water Resource at a glance	Quantity (BCM)	%
❖ Ann. precipitation (Incl. snowfall)	4000	100
❖ Avg ann. potential flow in rivers	1869	46.7
❖ Estimated utilizable water resources	1123	28.1
✓ Surface water	690	17.3
✓ Replenishable GW	433	10.8
✓ Current utilization (of total)	634	15.85
✓ Current utilization (of utilizable)	634	56.45
✓ Storage created /utilizable water	225	20.03
✓ Storage (under construction)	171	15.22
❖ Water need in 2050	1450	129
❖ Deficit	327	29
✓ Interlinking can give us	200	17.8

Source : Earth trends 2003, IEA 2005, NIH 2005, CWC 2011


Indian EO Missions
CURRENT Planned Planned
Oceansat-3
OCM, SCAT, ROSA
RISAT-2
X-band
Resourcesat – 2
LISS III, LISS IV, AWiFS
INSAT-3D
Imager, Sounder
CARTOSAT- 3
0.25 m PAN, 1m MX, HySI
Oceansat-2
OCM, SCAT, ROSA
MEGHA-TROPIQUES
SAPHIR, SCARAB & MADRAS
GISAT
MX, Hyperspectral, Thermal
RISAT-1
C-band
CARTOSAT- 2E
0.65 m PAN; 2m MX
CARTOSAT-2B
PAN
Resourcesat-2A
LISS III, LSS IV , AWiFS
SARAL
Altika & Argos

EO for Water Resources

- Water Resources Assessment
- Inventory - Glacial Lakes/Water bodies
- Water Budgeting & Water Balance Modelling
- Hydrological & Snowmelt Runoff Modeling

- Irrigation Performance Evaluation
- Surface Water Logging & Soil Salinity/Alkalinity Mapping

- Reservoir Sedimentation
- Flood Mapping & Damage Assessment
- Flood Forecasting & Inundation Simulation

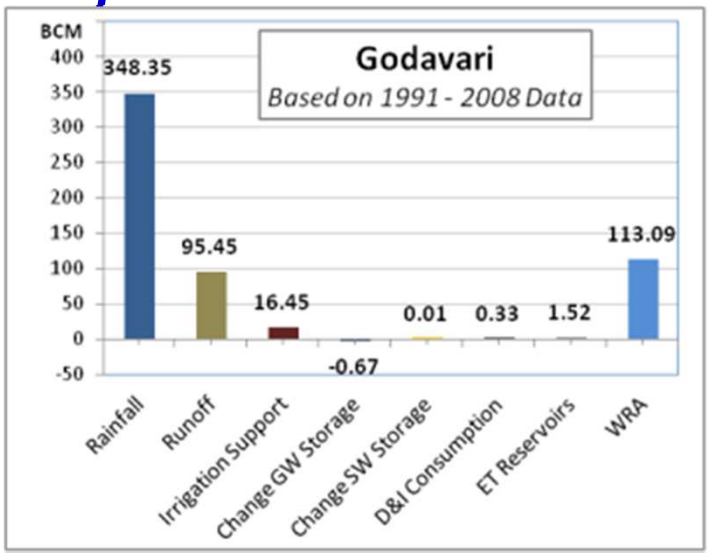
- interlinking of rivers
- Canal alignment & Land irrigability (Pre-feasibility)
- Ranking of hydropower sites
- Dams Submergence Area Analysis
- Catchment area analysis
- Flood Hazard Zone Mapping

- Rehabilitation & Relocation Studies
- Irrigation Infrastructure Mapping &
- Assessment Potential Created

… GEOSPATIAL INFORMATION SYSTEM & DSS PLATFORM

Water Resource Assessment

- Water Resources Assessment
  - *Reassessment with new & EO inputs*



113.09 BCM

CWC Previous Assessment

110.54 BCM

based on 1967-85 data

- Water Budgeting & Water Balance Modelling
  - *Use Spatial distributed modeling*
- Inventory - Glacial Lakes/Water bodies

- Hydrological & Snowmelt Runoff Modeling

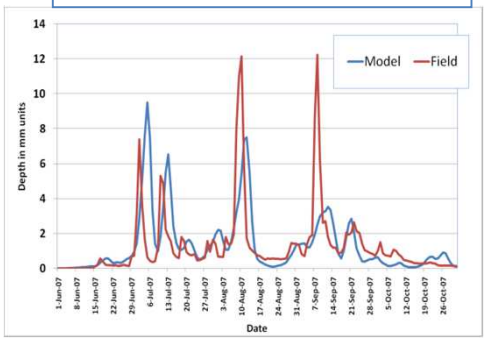
Estimation of Water Balance Components

- ***Systematic estimation of Water balance components is useful for***

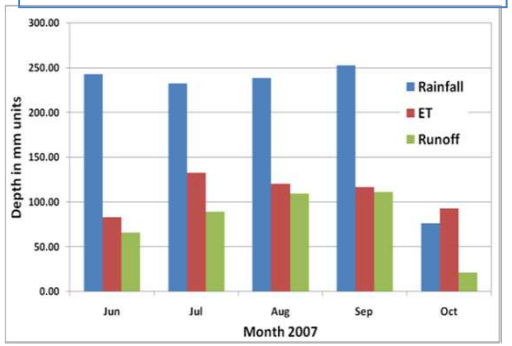
  Water resources assessment ; Water management; Drought Assessment; Weather research & forecast; Climate change studies

- ***Initial Results – Godavari River Basin – Jun to Oct 2007***

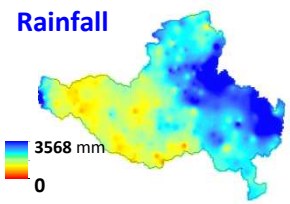
Daily Discharge at Siripur



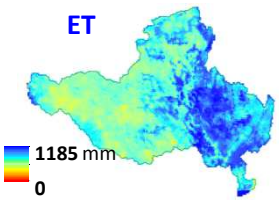
Seasonal Water Balance Components



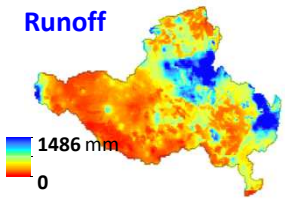
Rainfall



ET



Runoff



- ***Objectives***

  To develop and setup frame work for generation of grid-wise, water balance components

  To conduct field experimentation for calibration and validation of model outputs

  To generate periodic geo-spatial products describing grid-wise water balance components for the entire country

- ***Hydrological Model Setup - VIC Model***

  Open source; Grid-wise water and energy balance; Daily / sub-daily time step; Variable infiltration capacity along soil column; Vegetation phenology

- ***Input Data***

  Terrain - *Topographic, Soil, LULC, LAI, Albedo, Irrigation, Census*

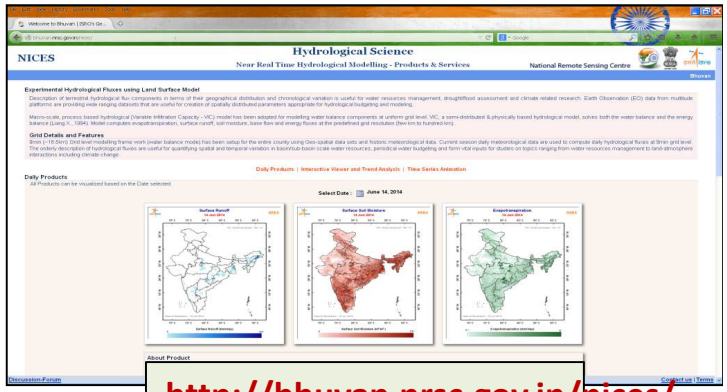
  Meteorological – *Rainfall, Temperature, …*

  Hydrological - *River discharge, Reservoir Storage / Releases, GW levels, …*

- ***3 min x 3 min (~5.5km) Grid-wise data base***

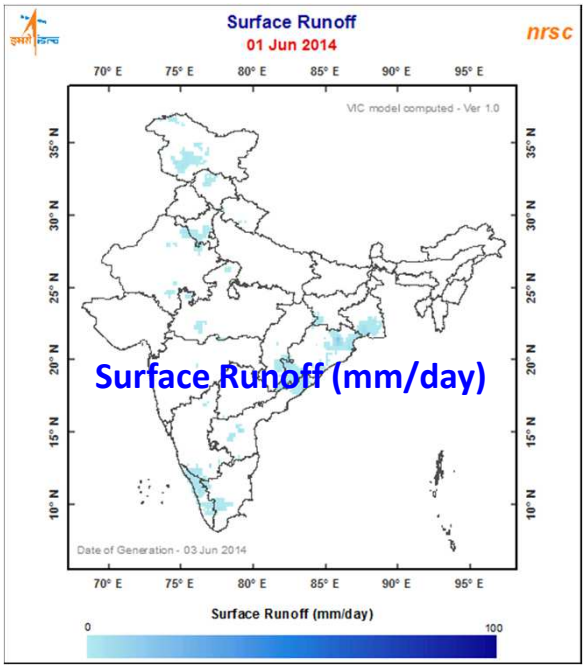
Hydrology Services

- Experimental model computed hydrological products (Version 1.0)
- Water balance computations using VIC-3L hydrological model using geo-spatial data & near real time meteorological data
- 9 min (~16.5 km) resolution at 24 hr time-step

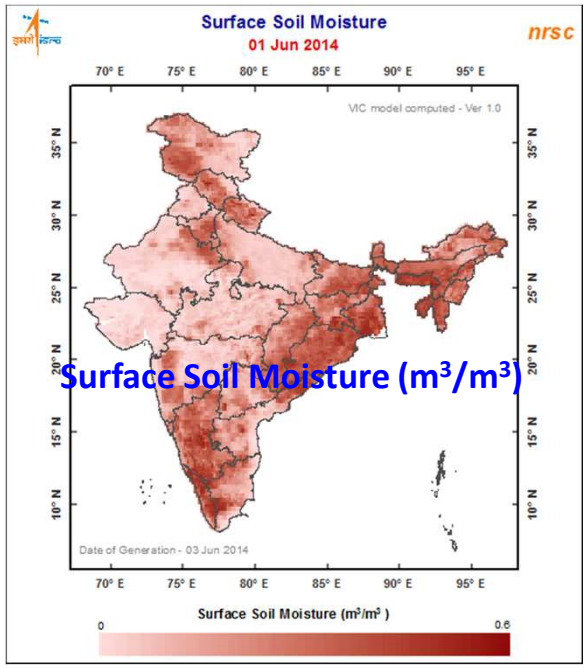


http://bhuvan.nrsc.gov.in/nices/

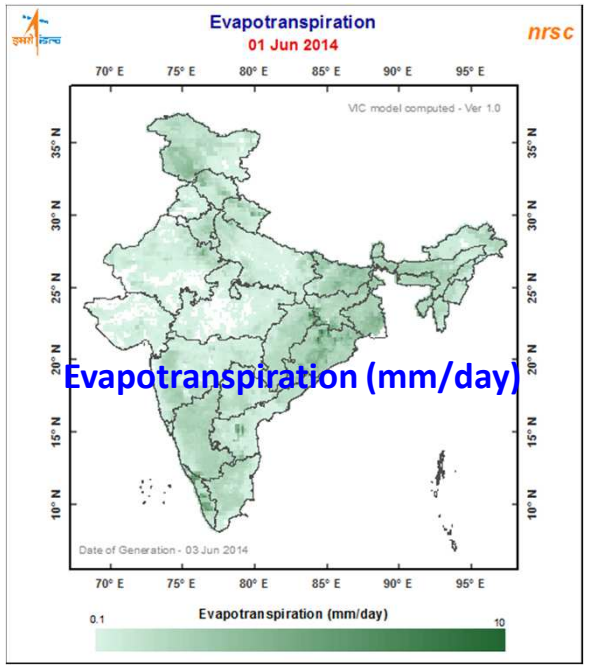
Time Series Visualisation: 1/Jun/2014 to 15/Jun/2014



Surface Runoff (mm/day)



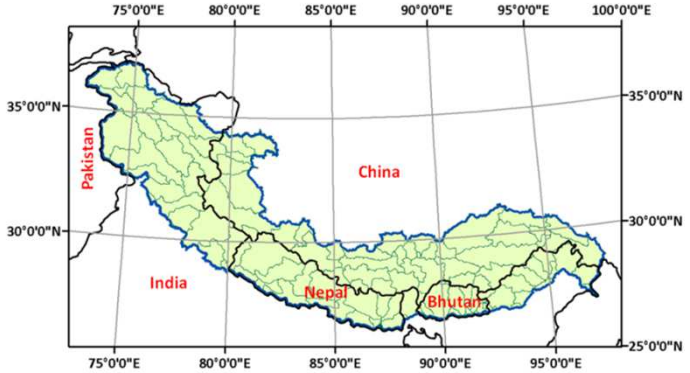
Surface Soil Moisture (m^3/m^3)



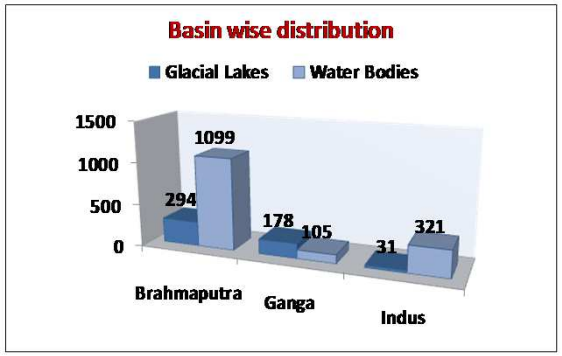
Evapotranspiration (mm/day)

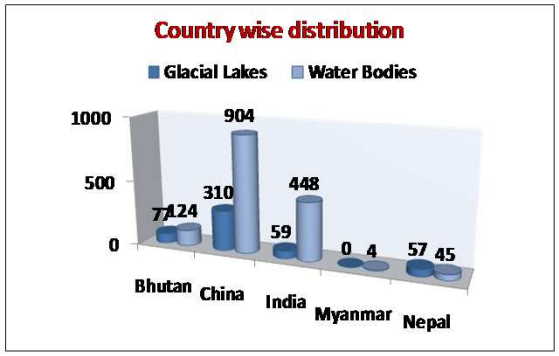
Inventory & Monitoring of Glacial Lakes/Water Bodies

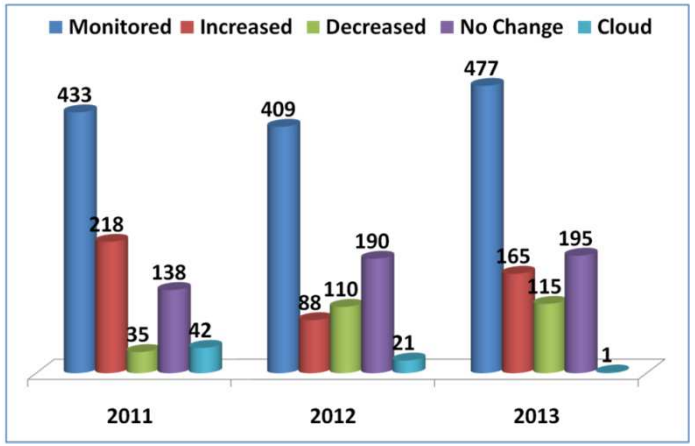
- Inventory of glacial lakes/water bodies in the Himalayan region of Indian River basins using satellite data (spatial extent > 10ha)
- Monitoring the spatial extent changes of the lakes/water bodies (> 50ha) on monthly basis during June to October months for 5 years, succeeding the inventorying year

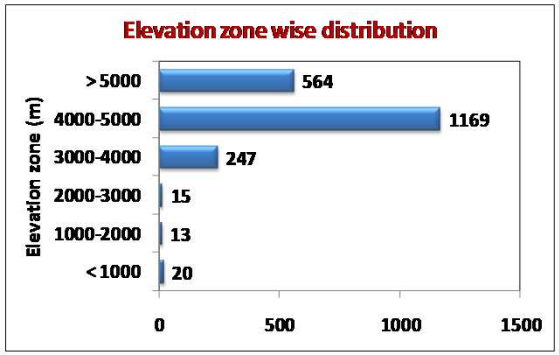


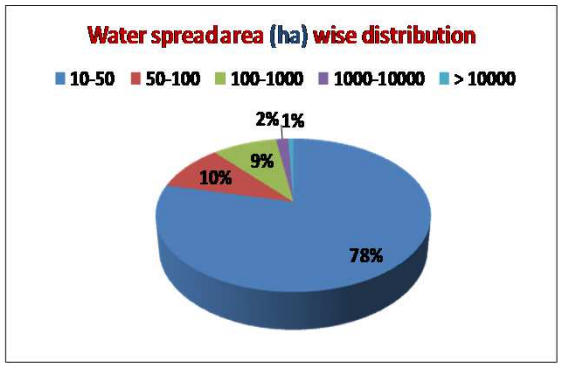
Inventory of glacial lakes/water bodies - AWiFS 2009







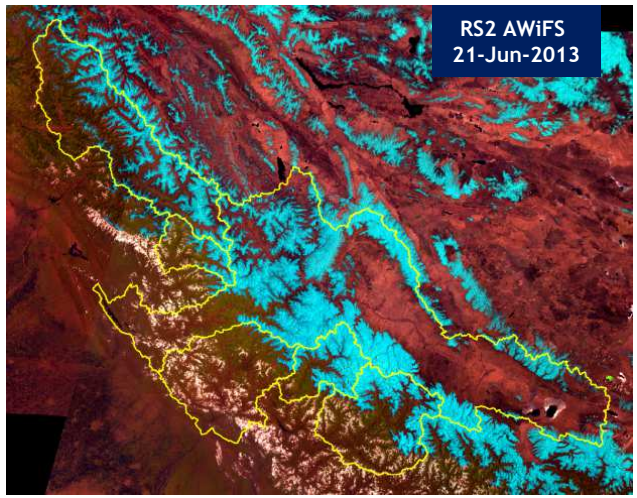




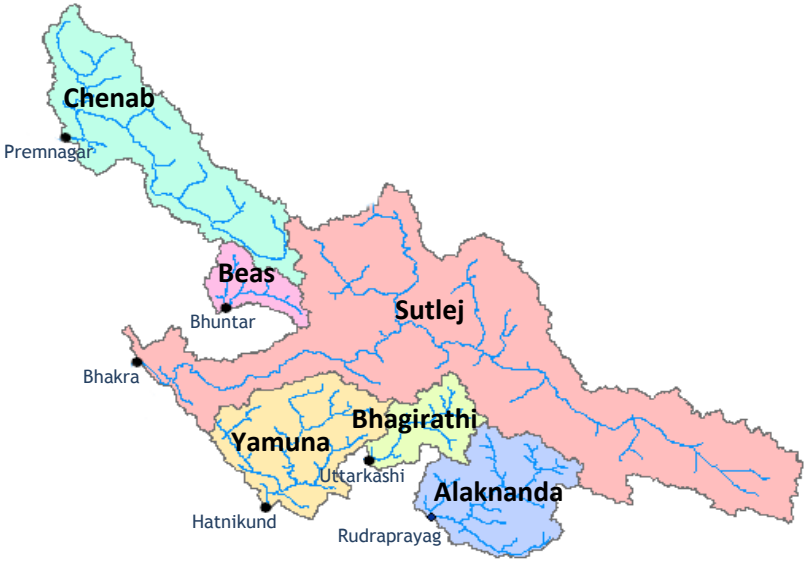
RISAT-1 SAR: 25-Aug-2013

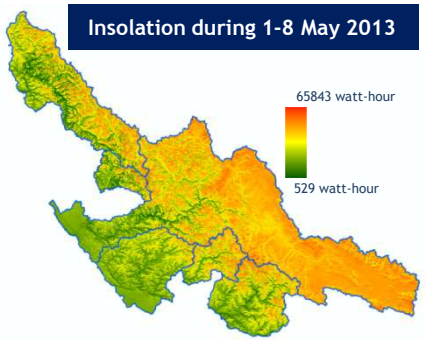
Snowmelt Runoff Forecasting

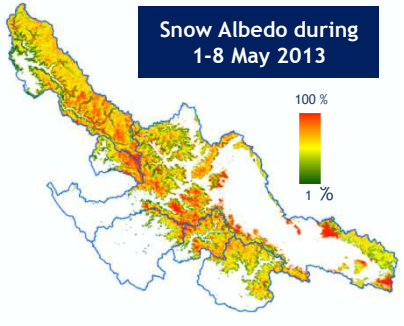
Seasonal Snowmelt Forecast (April-May-June)



Basin	Seasonal Forecast Apr-Jun 2013 (MCM)
Alaknanda	2,320
Bhagirathi	1,040
Beas	800
Chenab	6,520
Sutlej	3,700
Yamuna	960



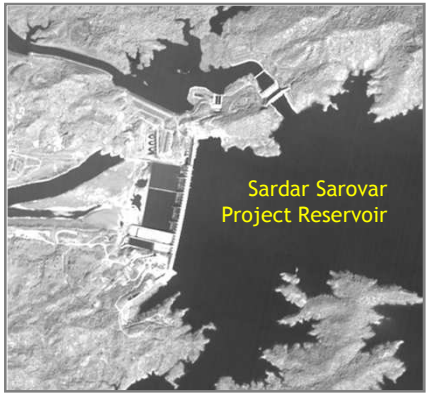


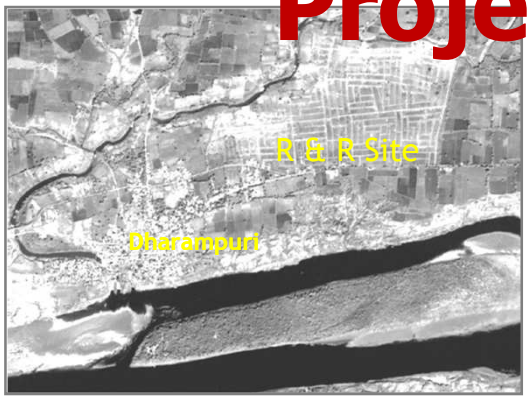


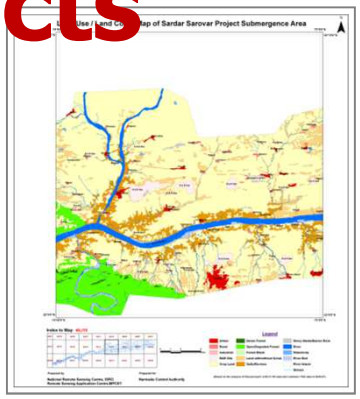
Water Resources Planning

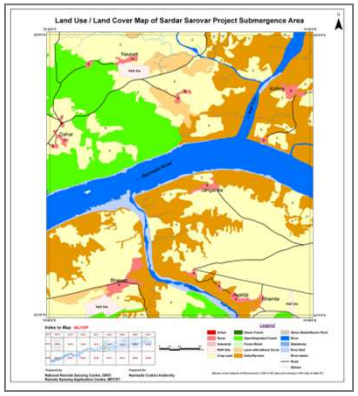
- interlinking of rivers
- Canal alignment & Land irrigability (Pre-feasibility)
- Ranking of hydropower sites
- Dams Submergence Area Analysis
- Catchment area analysis
- Flood Hazard Zone Mapping

Water Resources Planning - New Projects







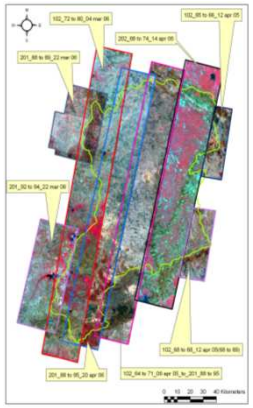


SSP

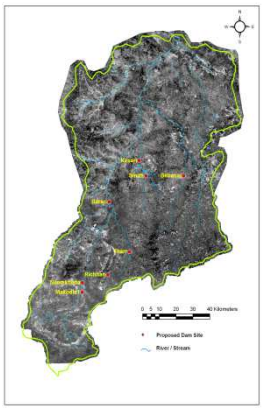
Terrain and Topographic information derived from high resolution data from Cartosat-1 PAN and LISS IV MX supports -
Effective implementation of R & R program, Infrastructure Planning, Rehabilitation Management and Foreshore Regulation

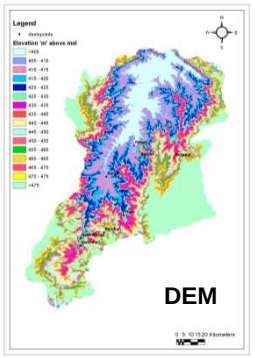
Ken Betwa

LISS IV (5.8m)

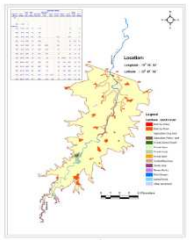


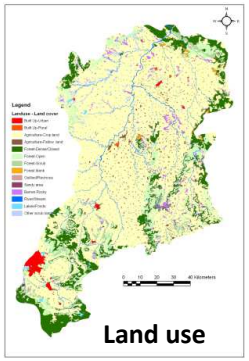
Cartosat-1 (2.5m)



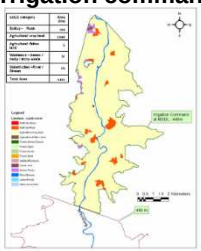


Submergence Contours





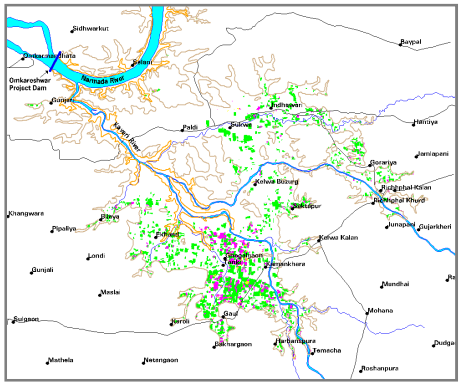
Irrigation command

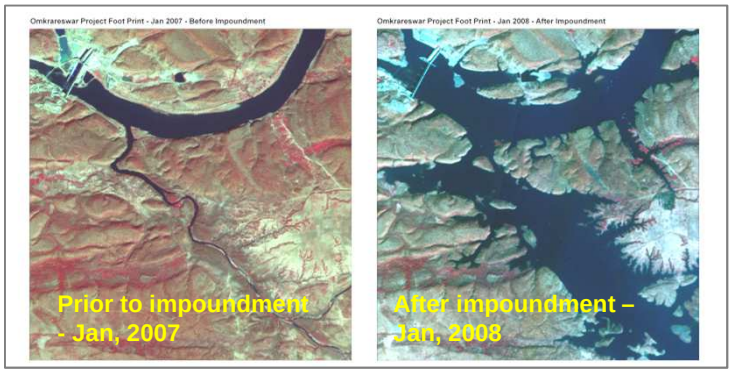


Digital elevation and land use / land cover information derived from high resolution data from Cartosat-1 PAN and LISS IV MX supports -
Pre-feasibility analysis, site evaluation and inputs for DPR preparation

Omkareswar

Satellite data prior to first impoundment of reservoir provides -
Status of ground conditions and their suitability & readiness for impoundment

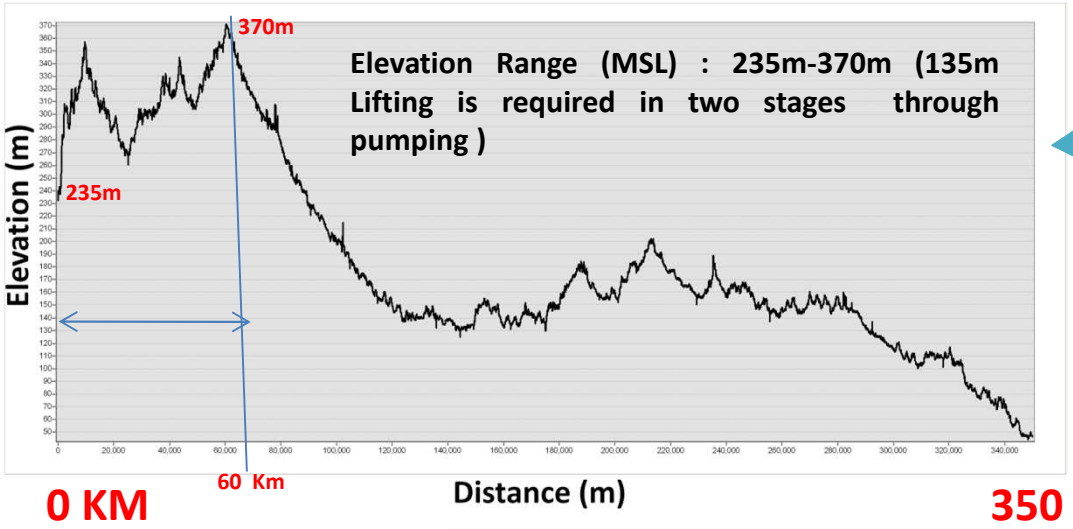




Water Pipe alignment studies : Mettur-Poondi , Tamilnadu

Drinking Water Augmentation to Chennai City

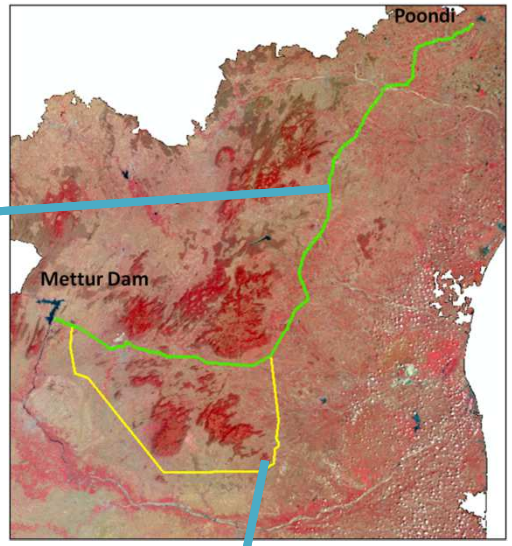
Water pipe line Alignment – Mettur to Poondi



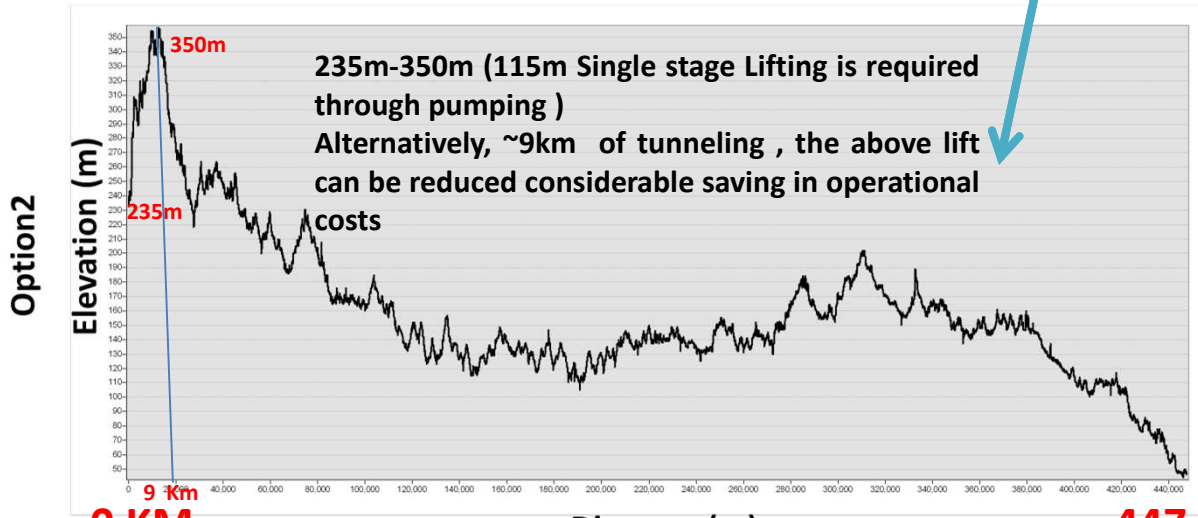
Elevation Range (MSL) : 235m-370m (135m Lifting is required in two stages through pumping)

0 KM

350 KM



Surface Profiles over selected Path



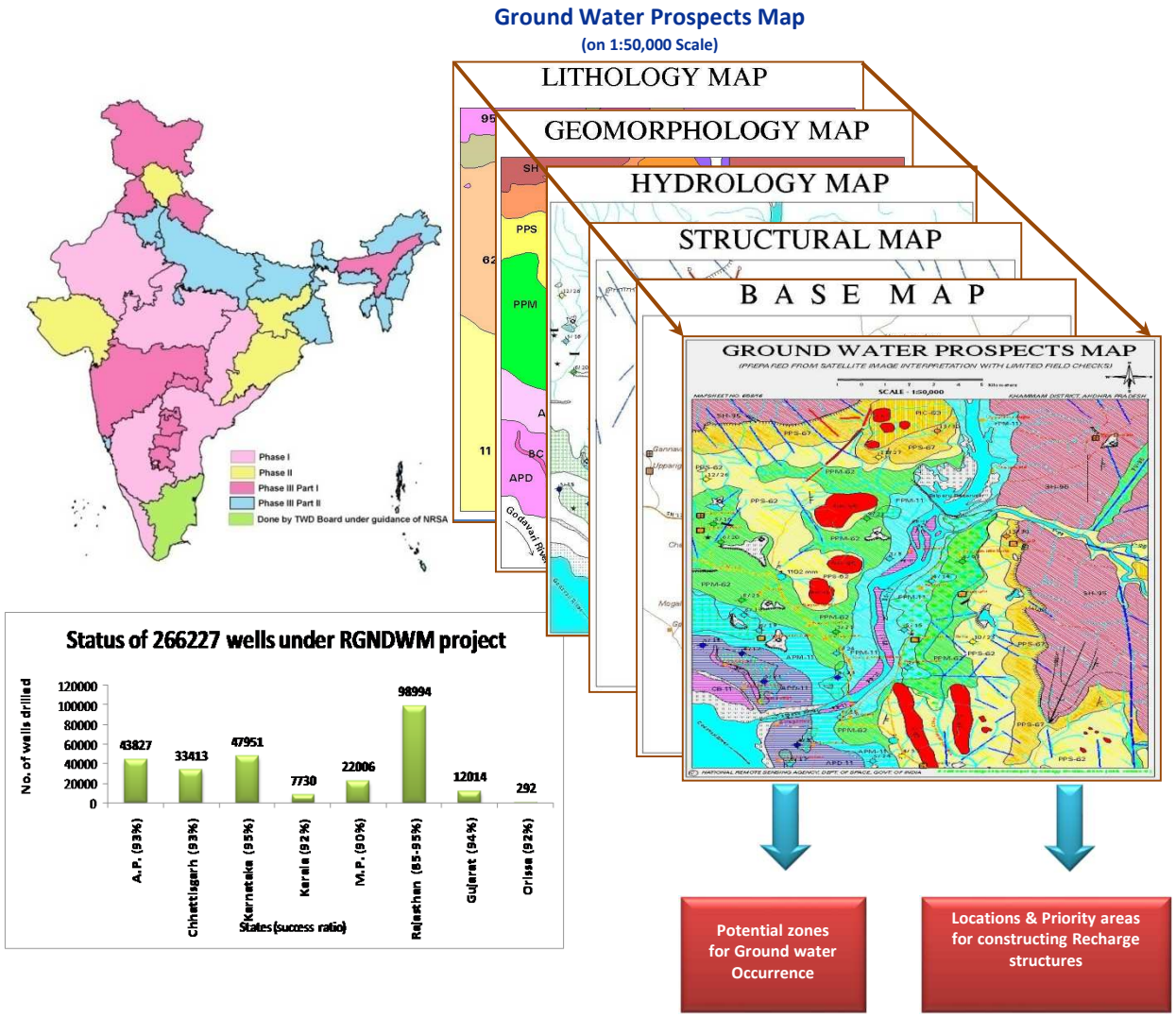
235m-350m (115m Single stage Lifting is required through pumping)
Alternatively, ~9km of tunneling , the above lift can be reduced considerable saving in operational costs

0 KM

447 KM

Ground Water Management

The Ground Water prospects maps prepared using satellite data combining with ground hydrogeological information facilitated narrowing down the target zones for selection of well sites and also planning recharge structures to improve the sustainability of sources wherever required.



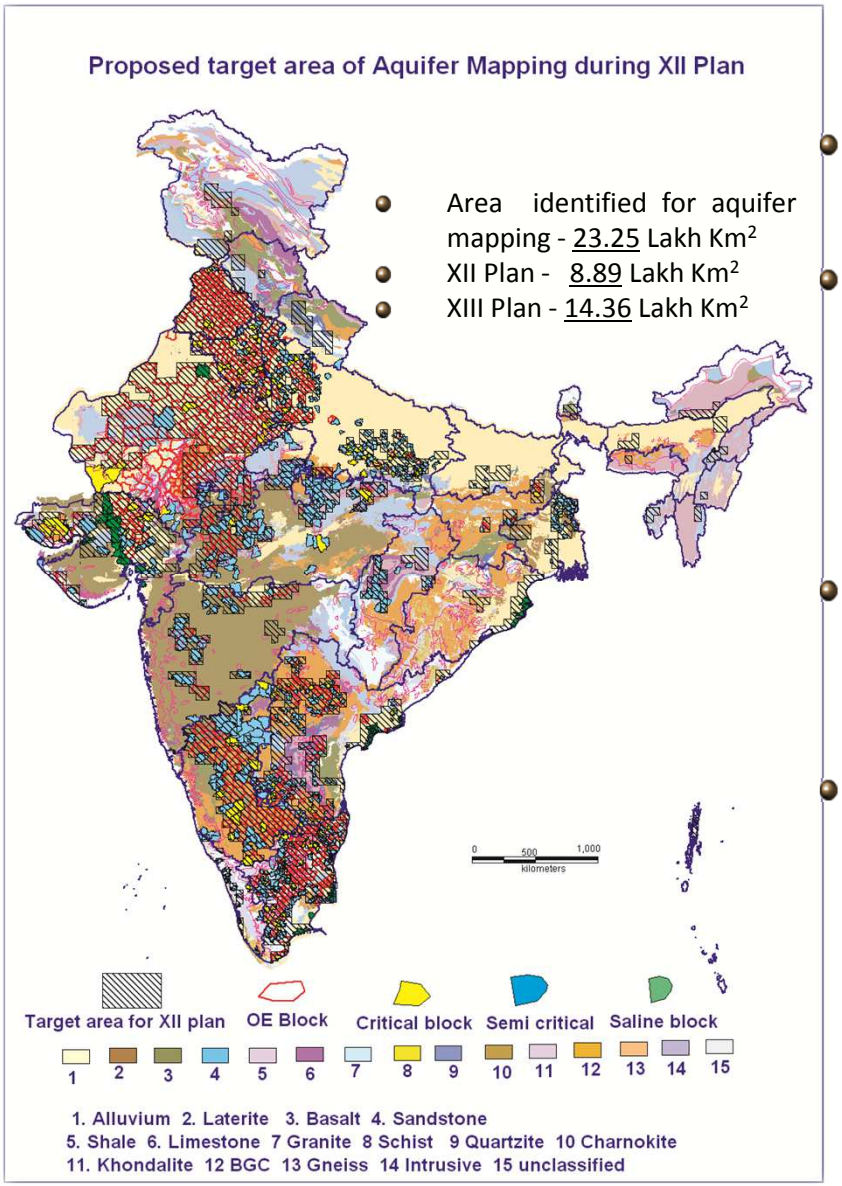
RGNDWM: Creation of ground water data base (Ground water prospects maps) for identifying potable drinking water sources for the problematic habitations (1;50,000) : ISRO with PI's

GW Information System by NRSC,CGWB

Pilot project on micro level aquifer mapping for sustainable GW Management

CGWB,NGRI,ISRO & Others

National Project on Aquifer Management



Objectives

- Delineation and characterisation of Aquifers in 3D on 1:50,000 scale in priority areas and on 1:10,000 scale in limited areas
- Formulation of Aquifer Management Plans

Pilot Study

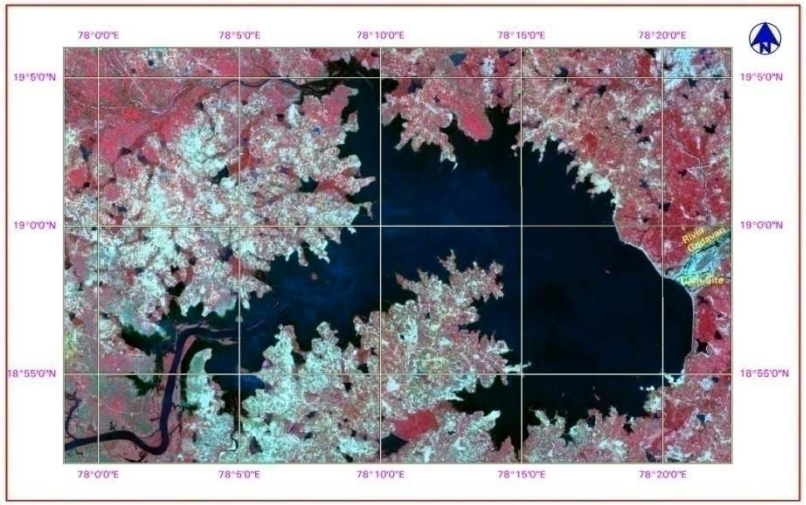
- CGWB has taken up pilot projects on aquifer mapping in six areas spread over five states Rajasthan, Bihar, Maharashtra, Karnataka and Tamil Nadu.
- These pilot studies are expected to yield standard methodologies and protocols for up-scaling the project to National Level.

WR Monitoring & Hazard Forcasting

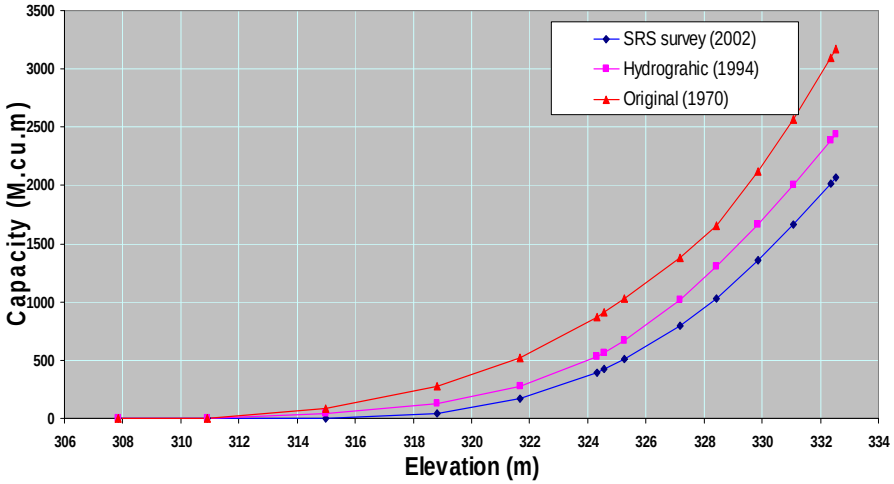
- Reservoir Sedimentation
- Flood Mapping & Damage Assessment
- Flood Forecasting & Inundation Simulation

Reservoir Sedimentation Assessment

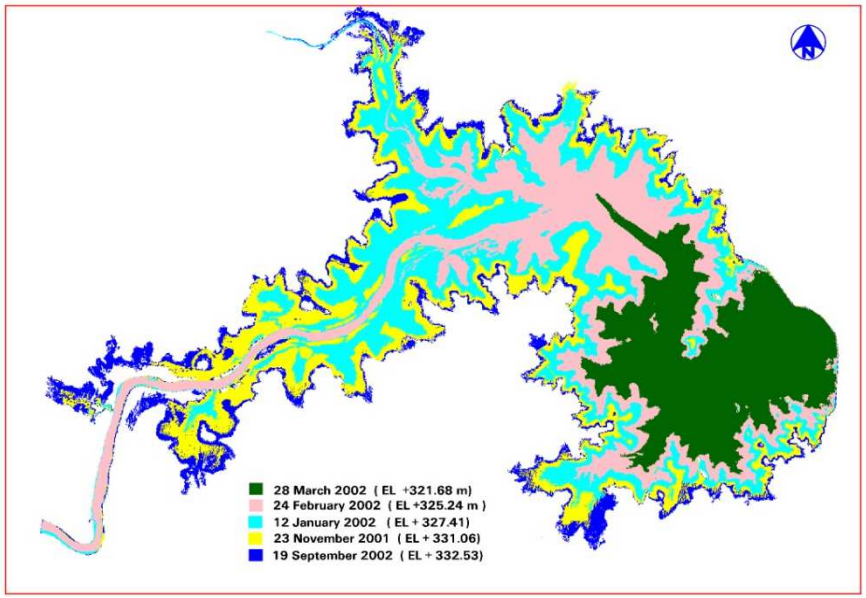
Satellite Image (FCC) of SRSP Reservoir



Elevation-Capacity curve of SRSP Reservoir



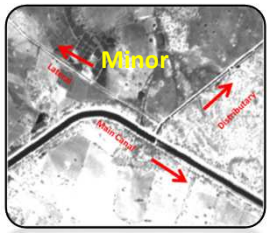
Waterspread area depletion pattern during 2001-02

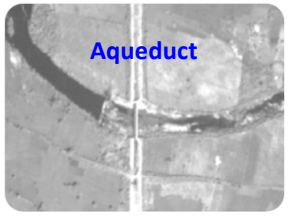


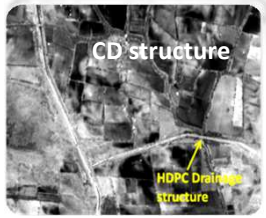
- **Gross capacity assessed to be 2070.164 M.Cu.m. in year 2002**
- **34.74 % capacity (1101.773 MCM)is lost since impoundment in 1970.**

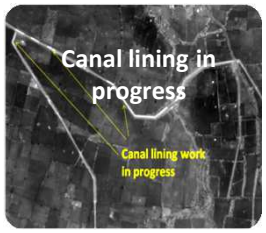
National Action Plan for Sedimentation Assessment of 124 Reservoirs

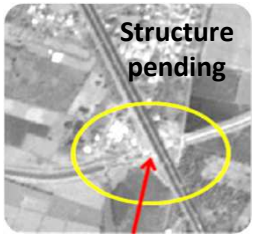
Assessment of Irrigation Potential Created

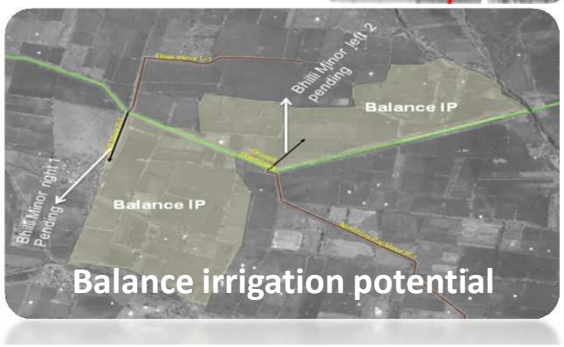


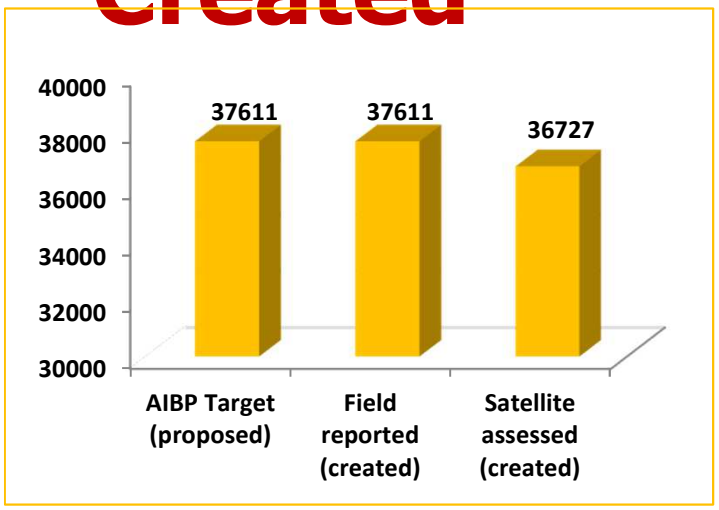


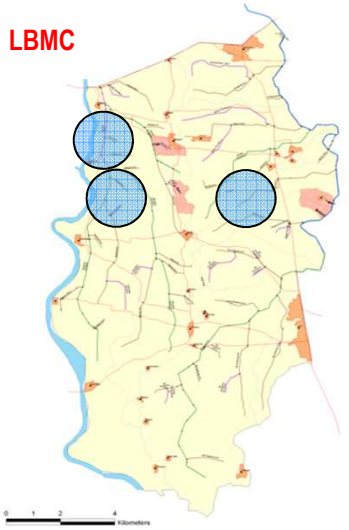


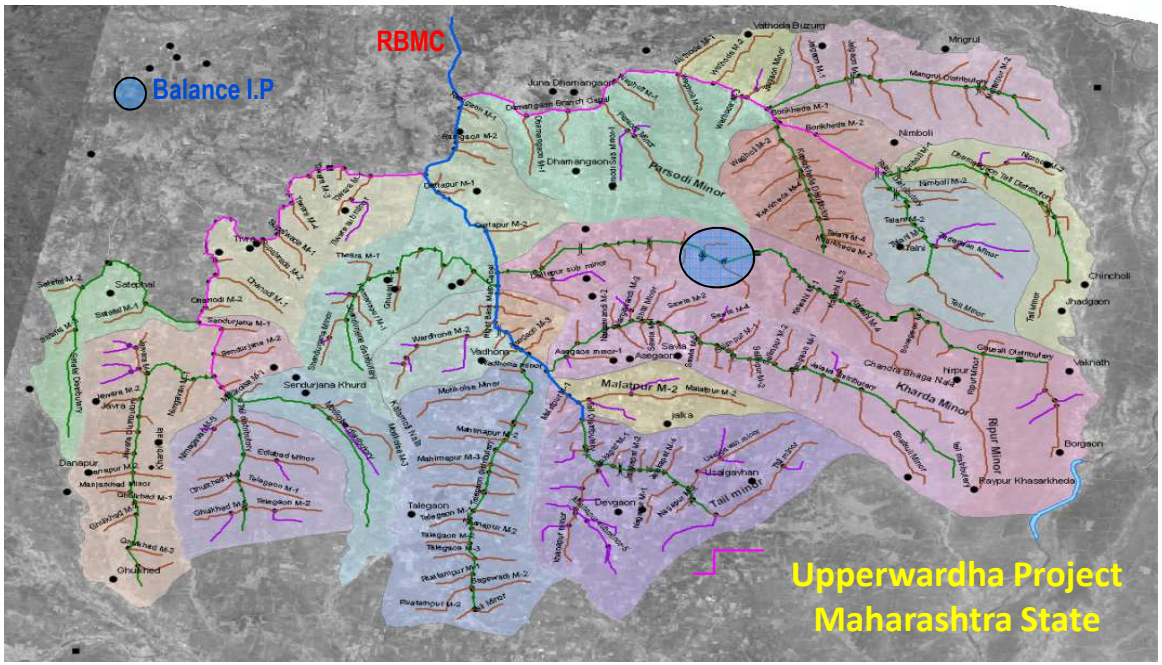








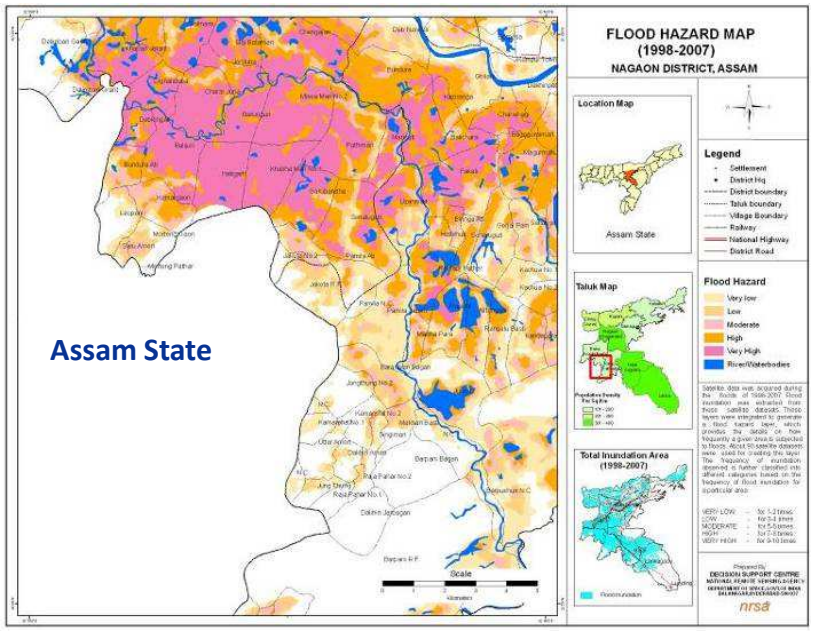




Satellite assessed Irrigation Potential created is slightly lower than field reported

Flood Management

Flood Hazard Zonation

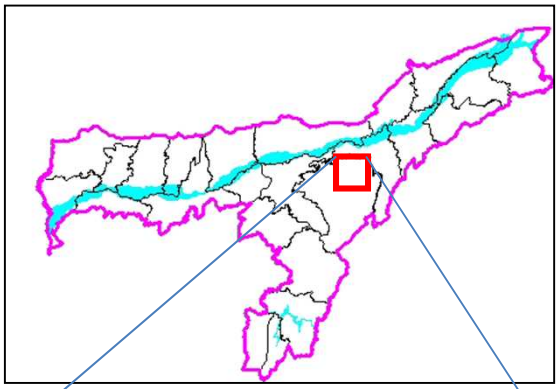


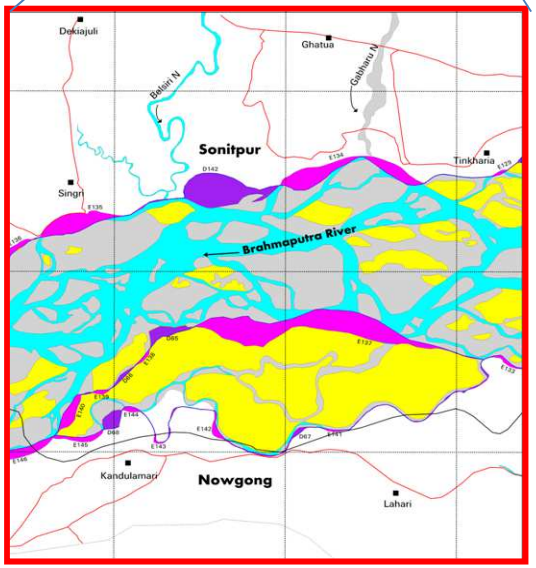
Assam State

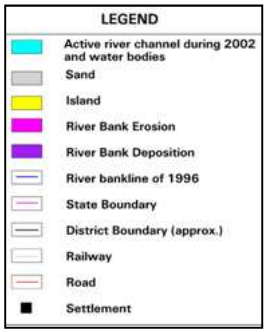
S No	Hazard Severity	Area affected (Ha.)	Length of Road submerged (Kms)	Length of Rail submerged (Kms)	Villages affected (Nos.)
1	Very Low	75955	944	50	2051
2	Low	41291	362	24	1924
3	Moderate	38594	215	13	1725
4	High	26807	144	3	1191
5	Very High	8548	20	0	314

River Morphological Studies

(River configuration & Bank erosion studies)



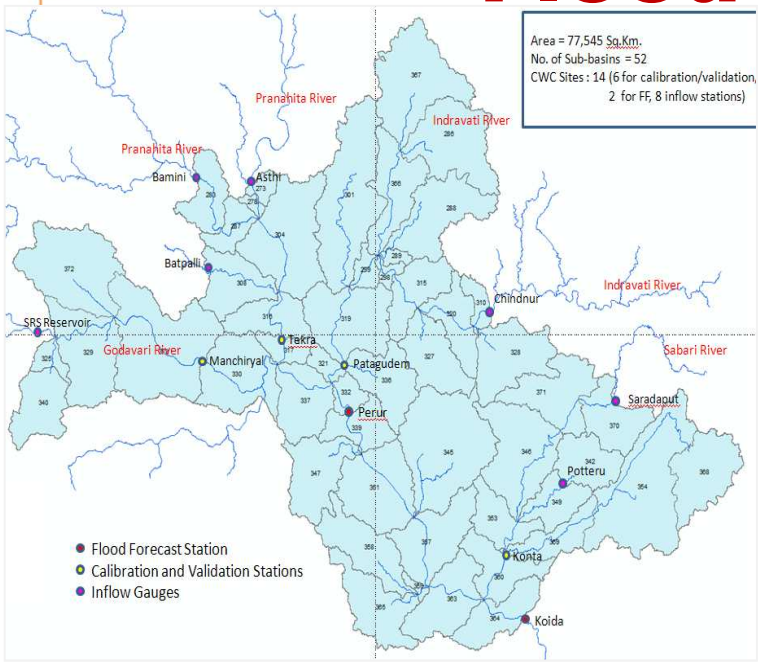




So far few selected rivers in selected stretches have been studied by CWC & ISRO

A Comprehensive morphological studies for 15 vulnerable rivers is initiated by CWC with ISRO's guidance involving Academia

Flood Forecasting



Godavari Basin

Static Data

-Land use/land cover, Soil texture, DEM

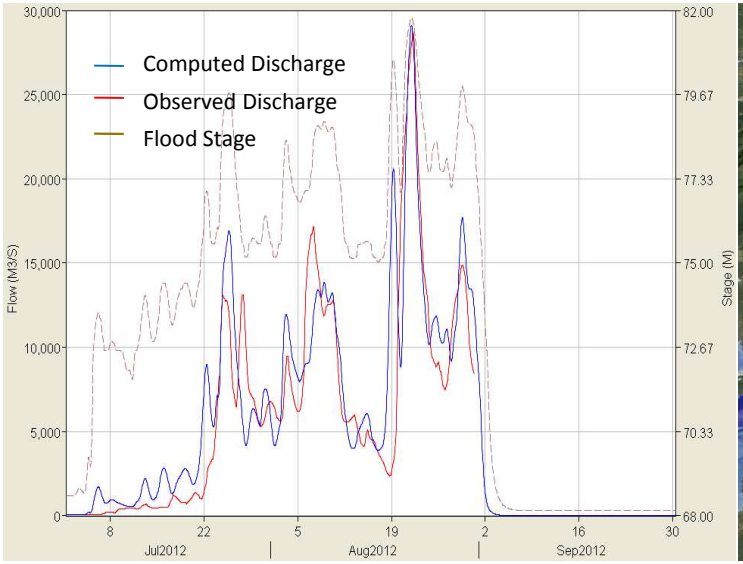
-Topographic and Hydraulic Parameters of sub-basins and Channels

Dynamic Data

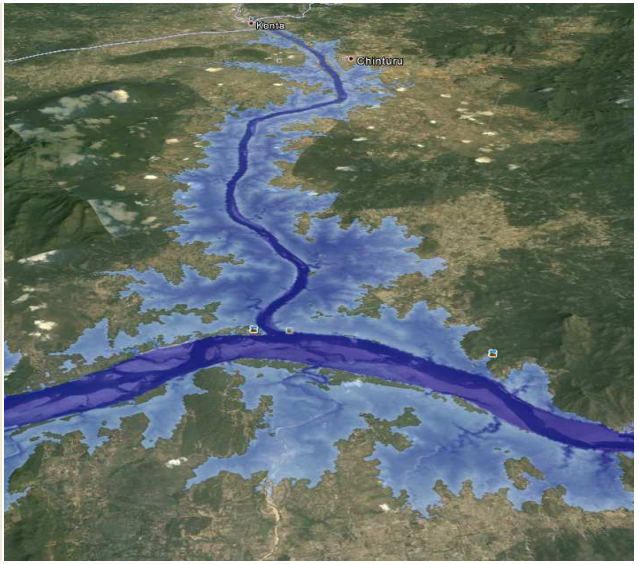
- Real-time 3 hr. Rainfall and discharge data
- Daily Rainfall Data in near real-time
- Rainfall forecast grids at 3 hr frequency
- Monthly ET data, and Rating curves

Real-time validation

- The model was calibrated, validated & operationally used in 2010 and 2012 using real-time hydro- met. data obtained from CWC and IMD
- Flood alerts were given during the 2012 monsoon season
- Inundation simulations were done using ALTM DEM of Sabari Floodplains



Flood Forecast Hydrograph at Perur



Inundation simulation in Sabari River using ALTM DEM (on Bhuvan)

Modelling Environment:

HEC-HMS, HEC-Geo HMS, HEC-RAS, HEC-Geao RAS (public domin softwares)

Development of similar models to other frequent flood prone rivers of the country.

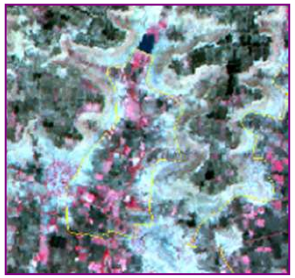
Mahanadi
Brahmani-Baitarani,
Kosi
Ghagra
Gandak, and
Krishna River Basins

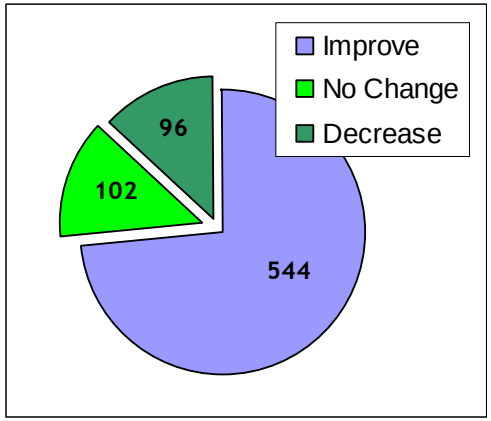
WR Program/ Project Evaluation

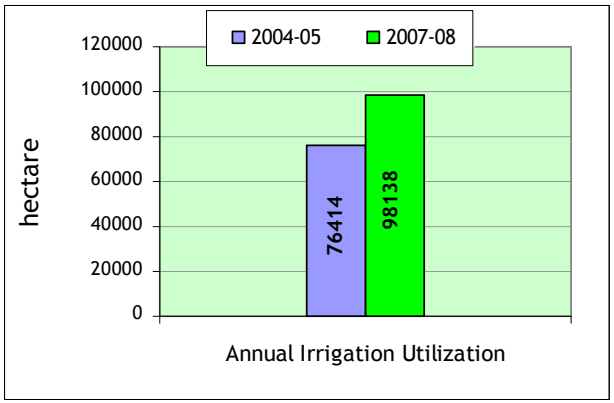
- Irrigation Performance Evaluation

- Surface Water Logging & Soil Salinity/Alkalinity Mapping

- Tank Irrigation Rehabilitation evaluation



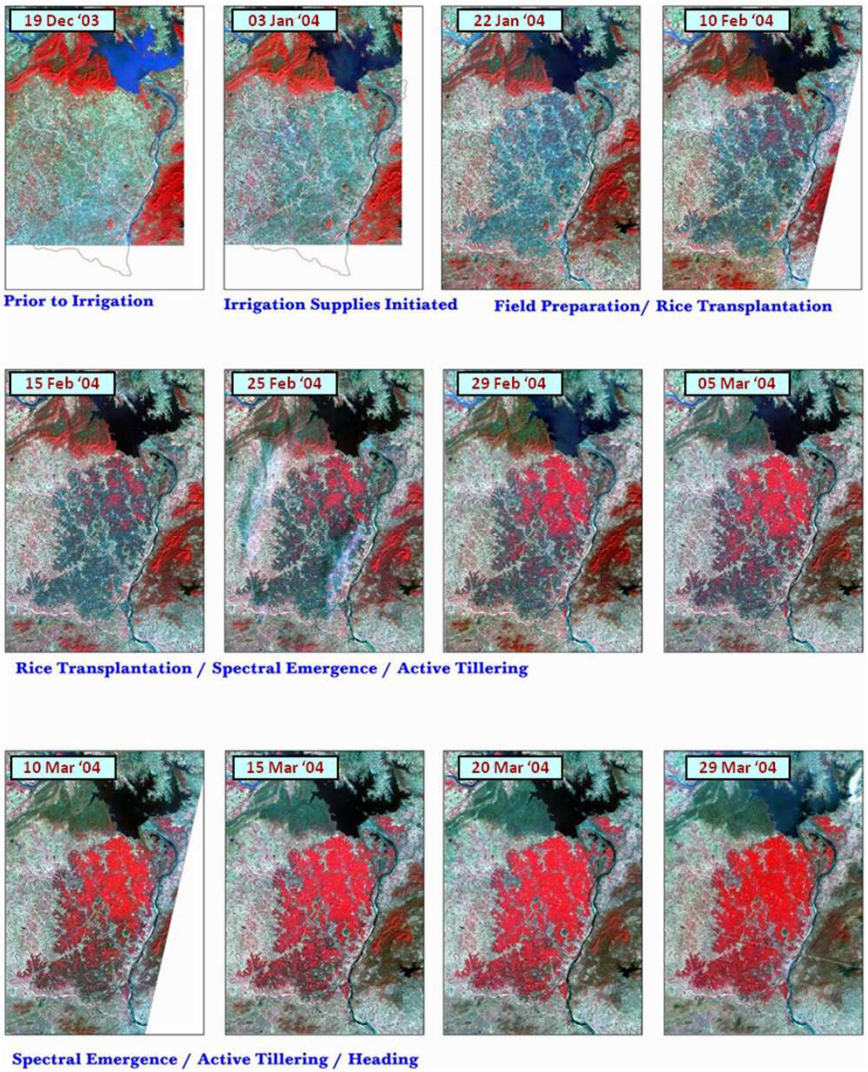




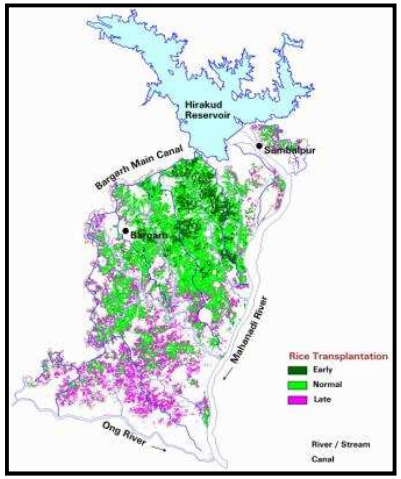
Overall Performance of 742 Tanks

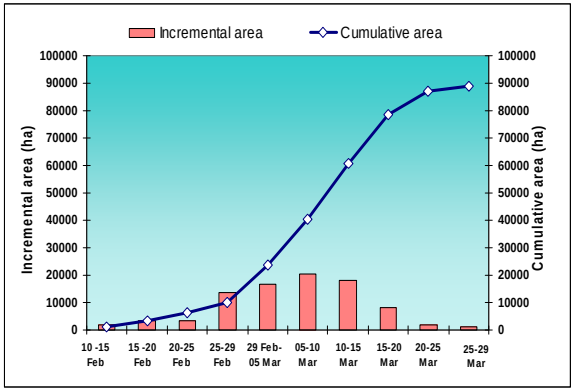
Irrigation System Performance Evaluation

Progression of 2003-04 Rabi Season Crop Area

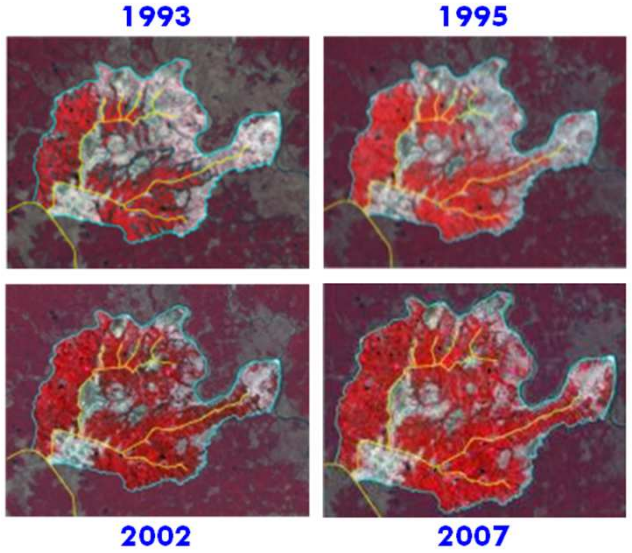


In-Season Inputs for Improved Water Distribution





Impact of Improvement Interventions



India-Water Resources Information System (India-WRIS)

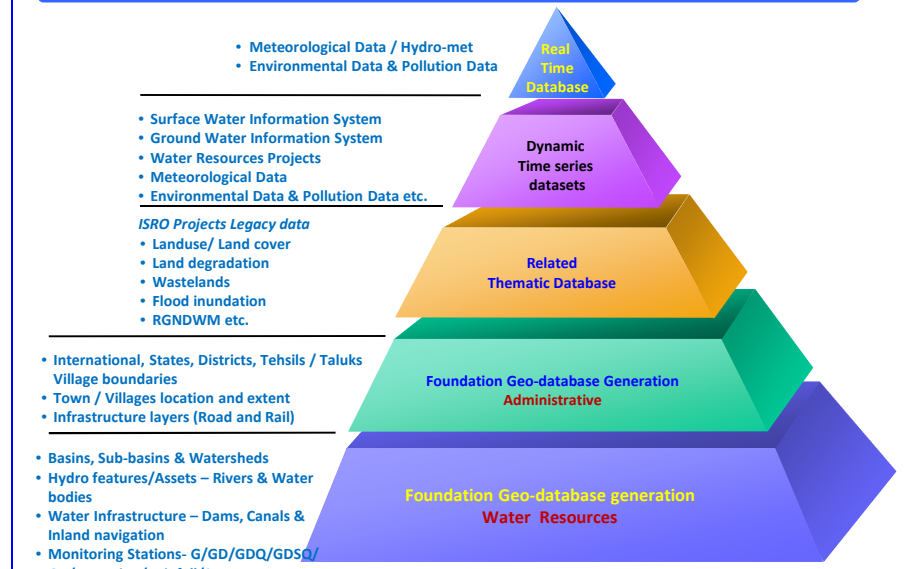
A 'Single Window solution' for comprehensive, authoritative and consistent data & information of India's water resources

GUI of India-WRIS V 4.0

http://www.india-wris.nrsc.gov.in

6 modules - WRIS In
12 Main information systems and
36 Sub-information systems
95 Spatial layers
more than **700 attributes,**
5-100 years data

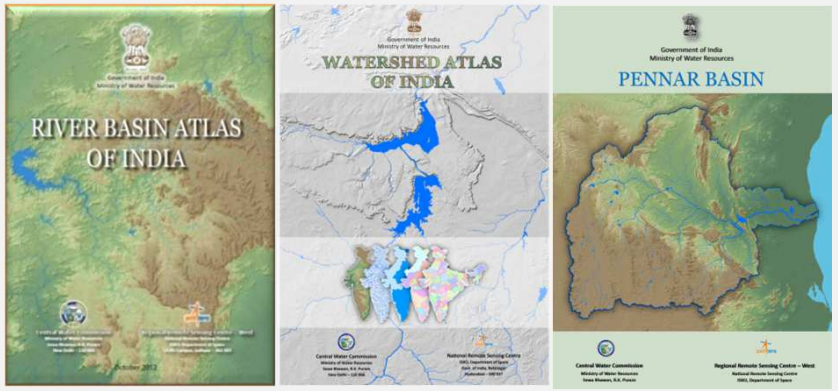
Data types & Designing information System



12 Main Information Systems

1. **Base Data Info Systems**
   1. Administrative
   2. Region
   3. Infrastructure
   4. Terrain
2. **Surface Water Info Systems**
   5. Water Resource Division
   6. Basin
   7. Watershed
   8. River
   9. Surface Water Body
   10. Water Resources Projects
   11. Command Area
   12. Minor Irrigation
   13. Canal
3. **Ground Water Info Systems**
   14. Aquifer / Litholog
   15. Ground Water Level
   16. Ground Water Potential (RGDWM)
4. **Hydro - Met Info Systems**
   17. Meteorological
   18. Climate
   19. Hydro - Observation
   20. Flood Forecasting
5. **Water Quality Info Systems**
   21. Surface Water Quality
   22. Ground Water Quality
6. **Snow Cover / Glacier Info Systems**
   23. Snow Cover / Glacier
7. **Inland Navigation Waterways Info Systems**
   24. Inland Navigation Waterways
8. **Inter - Basin Transfer Links Info Systems**
   25. Inter - Basin Transfer Links
9. **Hydro - Met Extremes**
   26. Flood
   27. Drought
   28. Extreme Events
10. **Land Resources Info Systems**
    29. Land Use / Land Cover
    30. Land Degradation
    31. Wasteland
    32. Soil
11. **Water Tourism Info Systems**
    33. Water Tourism
12. **Socio Economic Info Systems**
    34. Rural
    35. Urban

India-WRIS Publications



Thank You

http://bhuvan.nrsc.gov.in
http://www.india-wris.gov.in
http://www.nrsc.gov.in
http://www.isro.gov.in