GEOSPATIAL INPUTS TOWARDS

Policy perspective, related initiatives and programs in India

Natural Capital Accounting and Valuation of Ecosystem Services Project

T. RAVISANKAR,
Group Director, LRUMG, RSAA
National Remote Sensing Centre (NRSC) / ISRO
Department of Space, Hyderabad

Date: 12-Oct- 2017 (Thursday)

Venue: DOSD of MoSPI, New Delhi

EARTH OBSERVATION SYSTEMS

- Natural Resources Inventory, analysis and Monitoring
- Towards Meeting Sustainable Development Goals
- Disaster Management Support
- Governance, Planning, Monitoring and Decision Support….etc

NR Census Themes

IRS Data

Land Degradation

Geomorphology

Wasteland

Soils

Ground water

Wetlands

Biodiversity

Forest &

Land Use Land

Snow Cover /Glacier

LULC-250K
LULC-50K
LAND DEGRADATION

SOIL
GROUND WATER
VEGETATION TYPE
BIODIVERSITY
WASTELAND
GEOMORPHOLOGY

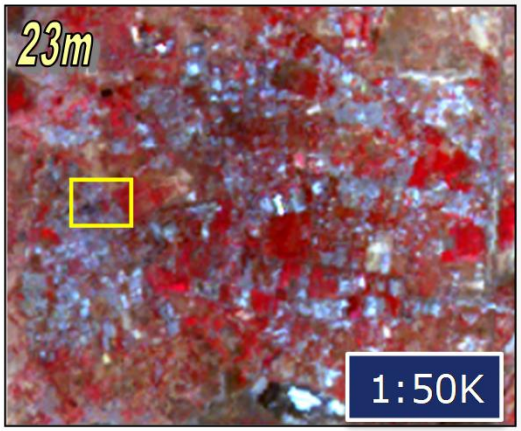
SNOW/GLACIERS
WETLANDS

BHOOSAMPADA

GEOSPATIAL TOOLS IN THE ASSESSMENT OF ES

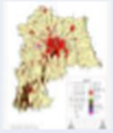
- Ecosystem services are produced by organisms (Ecosystem Service Providers) & their activities (Ecological processes and functions) which are invariably related to the physical environment – Ecosystem
- There are several drivers of change affecting the ecosystems, ecological processes, organisms and hence the ecosystem services
- Mapping of the ESPs, habitats, ecosystem, landscape, watershed based on bio-physical variables
- Monitoring at various spatial and temporal resolutions – tracing the drivers of change

LAND USE LAND COVER INVENTORY USING SATELLITE DATA

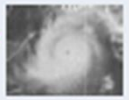


Tarapur, Maharashtra

EO APPLICATIONS

Theme	Major Activities	
Water Resources	• Resources assessment • Information products	• Hydrologic modeling & services • Customised BHUVAN applications
Agriculture	• Agricultural drought vulnerability • Crop intensification and insurance • Decision Support Systems for crops	• Expansion and management of Horticulture crops • Inventory & evaluation of high value crops
Land Resources Inventory and Monitoring	• National Level LULC mapping at 1:250K & !:50K and Land Degradation mapping at 1:50K • Soil Health Cards	• Monitoring and Evaluation of Watersheds using Geospatial Techs. • GIS Implementation of Mahatma Gandhi NREGA ASSETS
Urban Studies & Geo-informatics 	• AMRUT at 1:4,000 scale geospatial database for 500 cities • Creation of 1:50K scale geospatial database for NCR regional Plan -2021: and change analysis	• Housing for all PMAY (Urban) : Monitoring beneficiary house construction through geo-tagging • Geospatial technology for GAIL pipeline monitoring and surveillance

Forestry and Ecology	• Forest monitoring: Actionable alerts on annual forest loss locations
	• Forest Fire: Near real time forest fire alerts
		• Carbon Cycle Studies:
		  • VCP : Vegetation Carbon Pool
		  • SVF : Soil & Vegetation – Atmosphere Fluxes – Flux Towers, RS-based modelling

ISRO DMS Programme 	• Natural Disasters - Monitoring/ Damage Assessment • National Database - NDEM	• International Charter on Space & Major Disasters, SPIDER, Sentinel Asia, ... • Capacity Building on DMS Training Prog
Geosciences	• Mineral exploration & Geo-environment • Hydrogeology	• Geohazards & Geodynamics

LAND USE MAPPING SYSTEM

LEVEL	SCALE	DATA SOURCE	FREQUENCY	METHOD
1.National	1:500,000	Medium Resolution (56 m) Satellite data	annually	Digital classification
2.State	1:250,000	Medium Resolution (24 m) Satellite data	Once in five years	Digital classification
2.District	1:50,000	Medium Resolution (24 m) Satellite data	Once in five years	On-screen interpretation
3. Village	1:10,000	High resolution satellite data (2.5 m)	Once in eight years	On-screen interpretation
4. Cadastral ??	1:5,000	Very High resolution satellite data (<1 m) / cadstre	Once in 3 years in LUZ only	On-screen interpretation

Land use and Land cover Mapping

Annual Basis

1:250,000 mapping using AWiFS data

Digital Classification Approach
Eight Cycles Completed from 2004

Five yearly Basis

1:50,000 mapping using IRS LISS III data

Visual Interpretation
2005-06 as base year

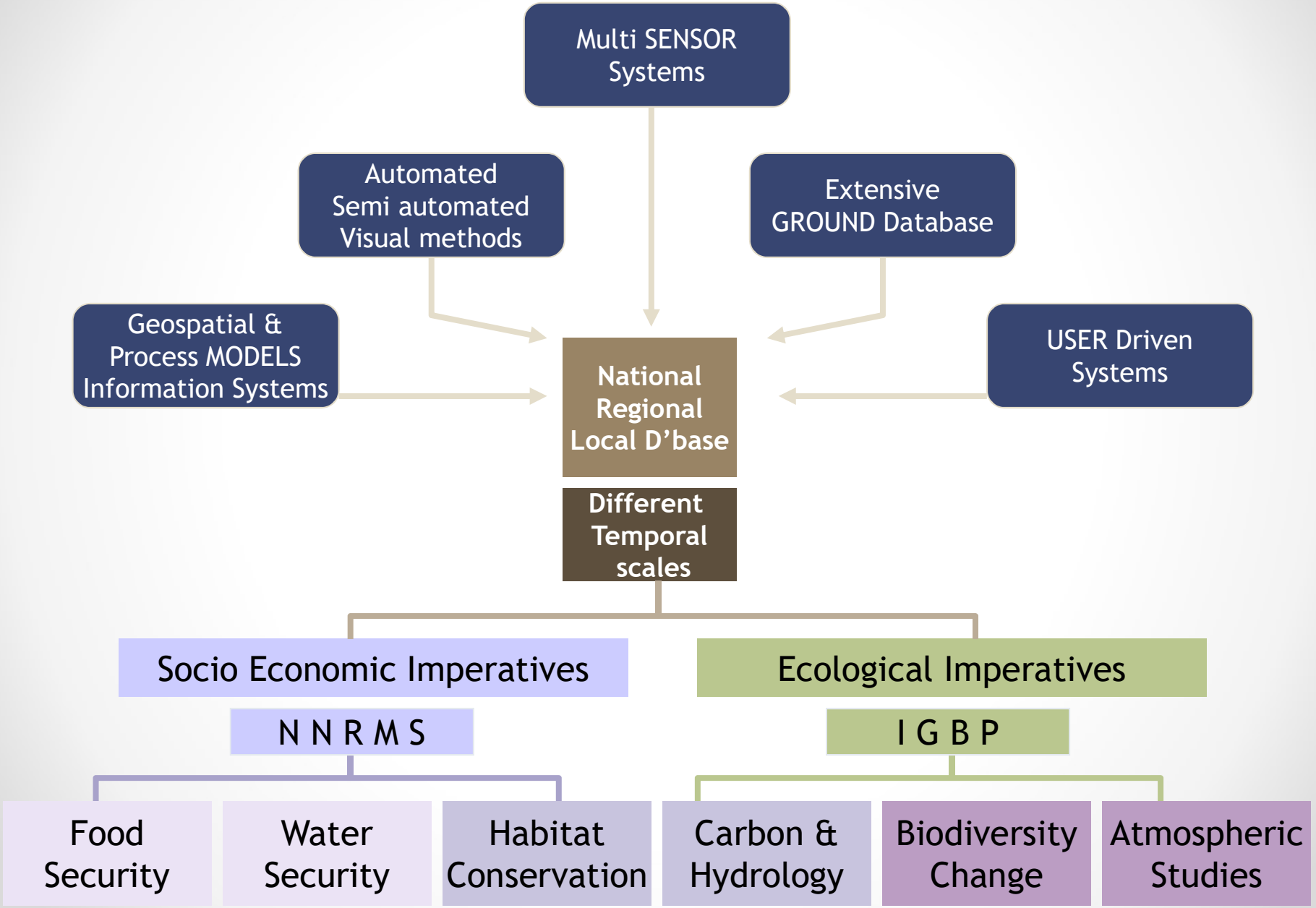
2005- 06 / 2011-2012
Change Assessment through Updation of vector layers

1:25,000 mapping using IRS LISS IV data

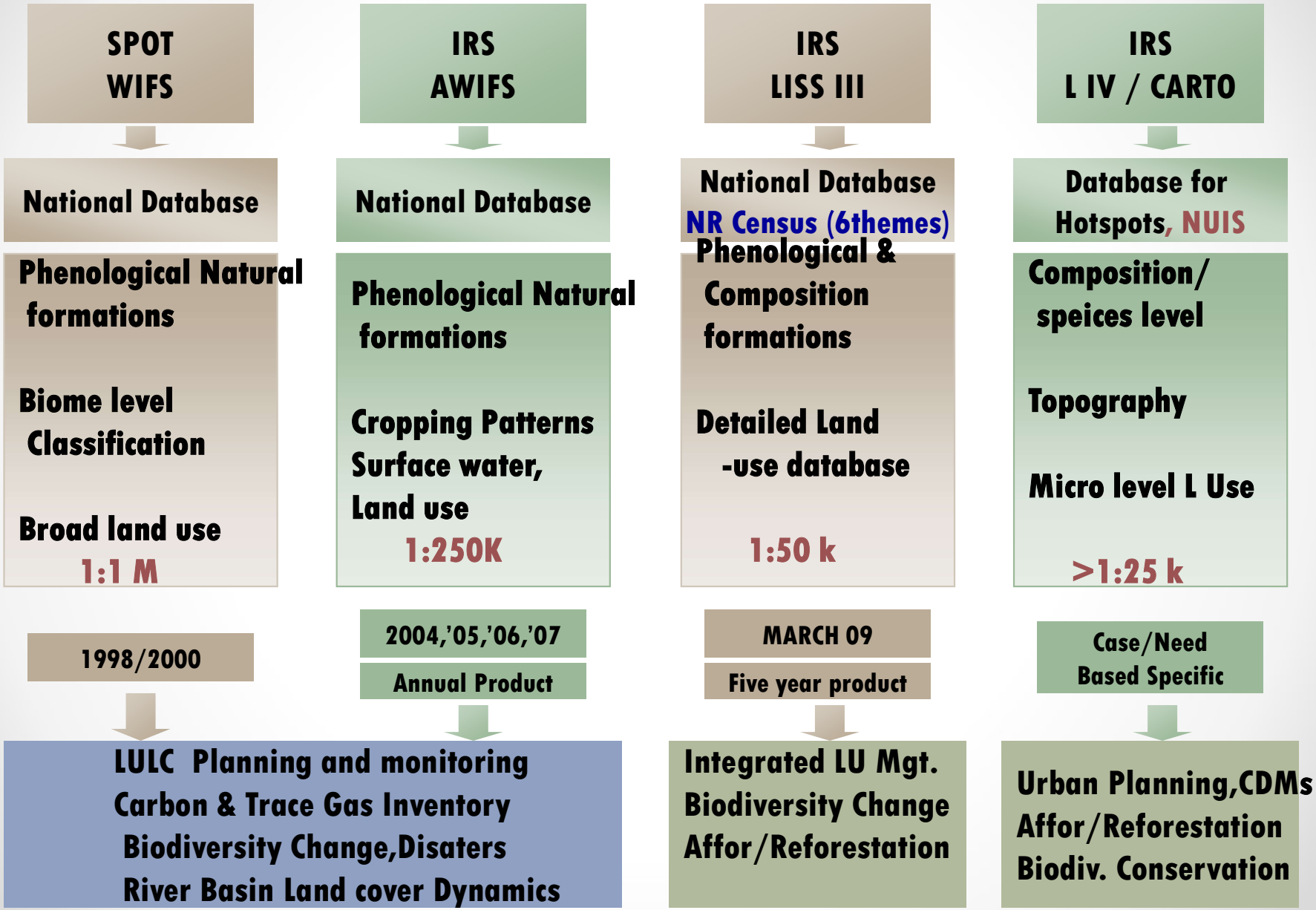
Visual Interpretation Of major areas of change

Minimum of 50 sites Representative of major ecosystems

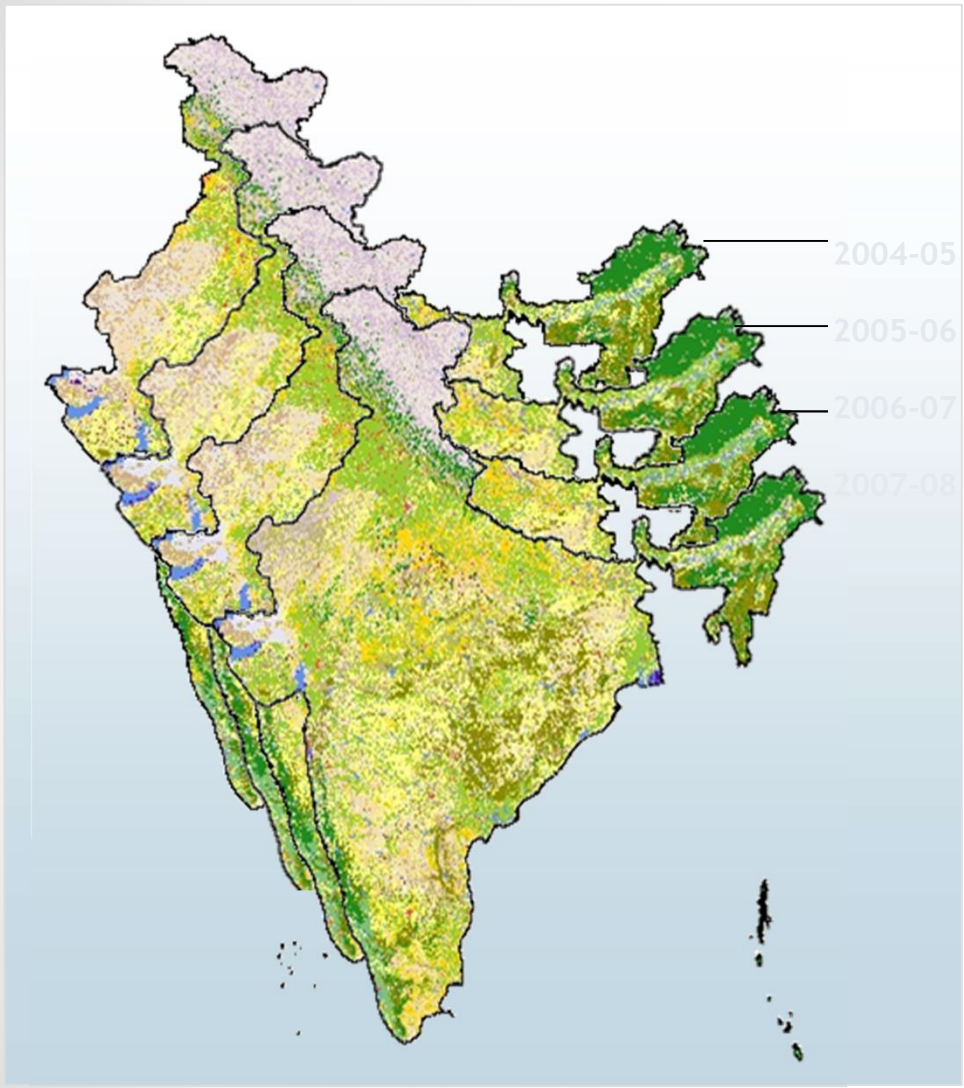
Land Cover and Land Use Change Research

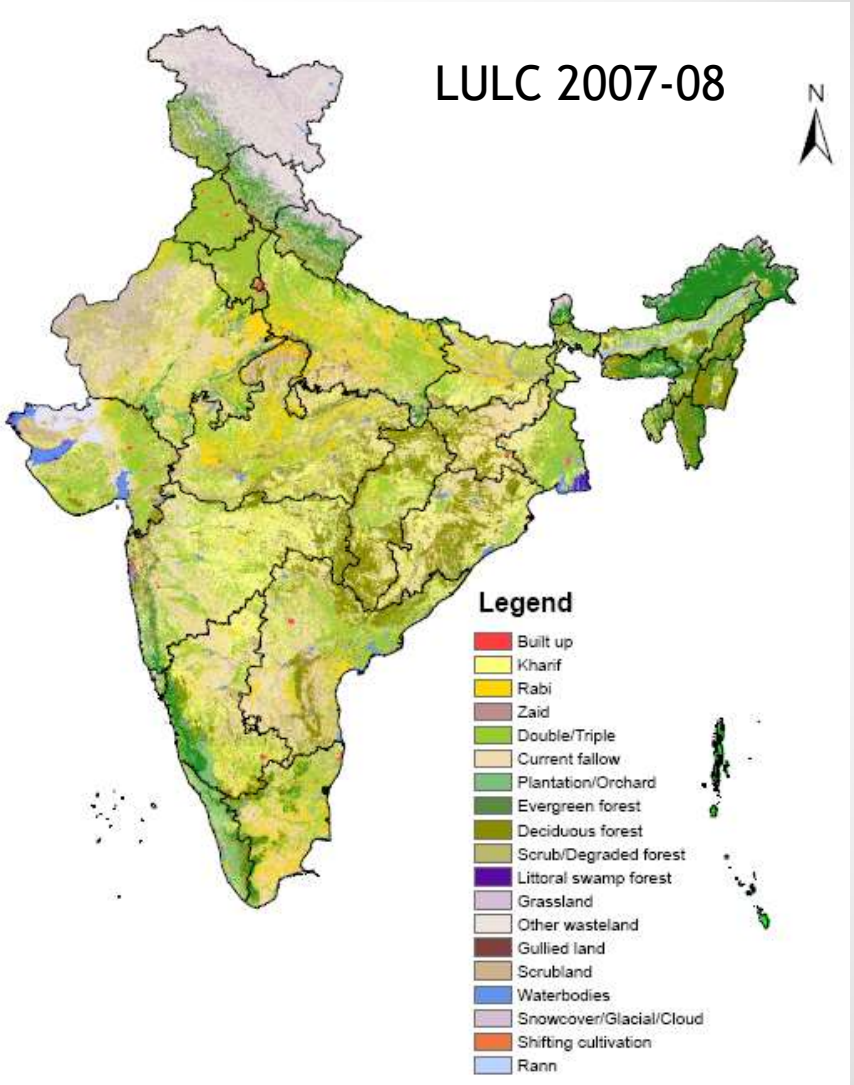


L U L C Databases & Application



National Land use Land cover Map using Multi-temporal AWiFS data

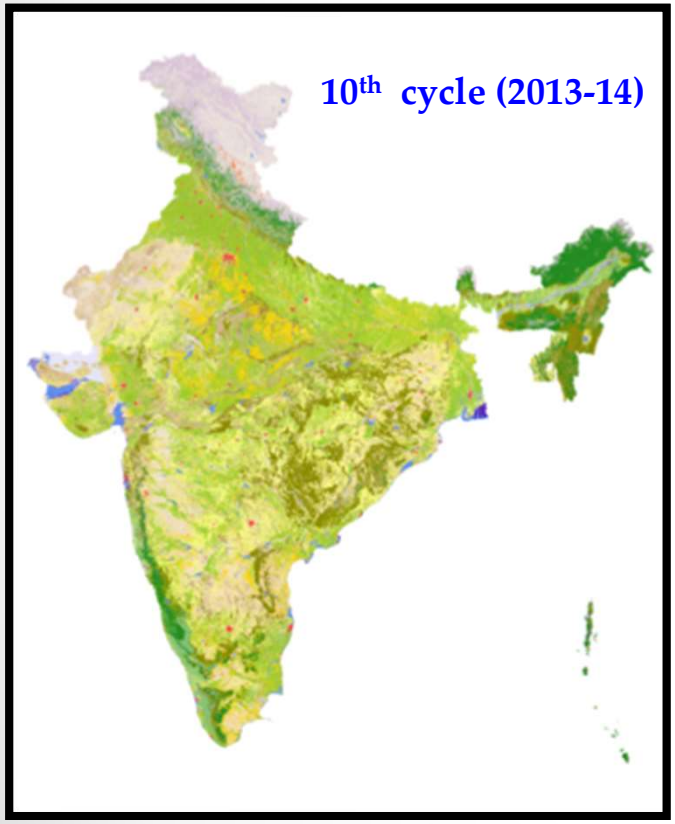




All interim Kharif and integrated LULC assessments were completed as per the schedule and reports were submitted by 31st December of each year

NRC-NATIONAL LAND USE AND LAND COVER MAPPING USING MULTITEMPORAL AWIFS DATA

- End of season of assessment of Kharif, rabi and integrated LULC at the end of yr
- 13ycles completed.
- Temporal analysis carried out to find consistently cropped and fallow areas



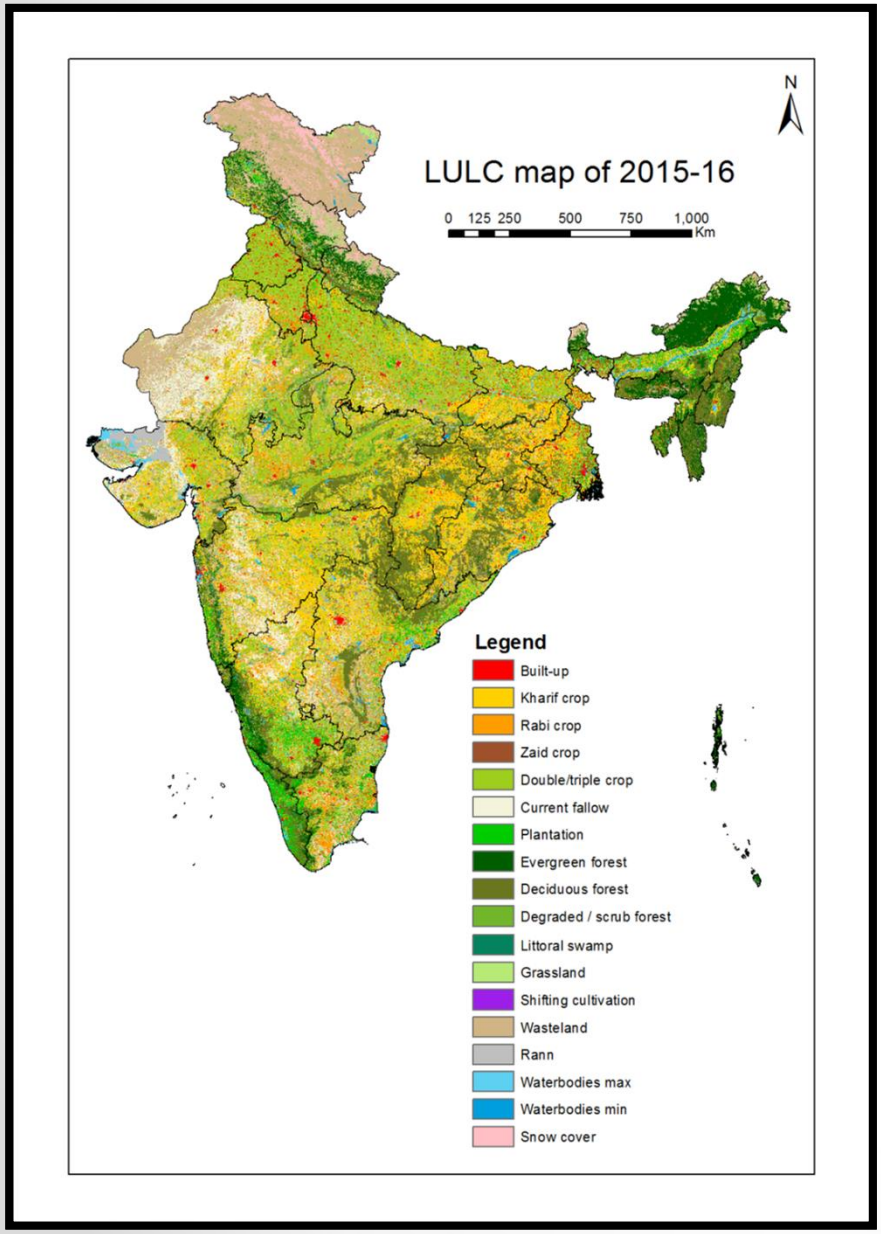
Built-up
Kharif
Rabi
Zaid
Double /Triple crop
Fallow
Plantation
Evergreen forest
Deciduous forest
Degraded forest
Mangroves
Grasslands
Wastelands
Gullied/ravines
Scrubland
Water bodies
Snow
Shifting cultivation
Rann

YEAR	NET SOWN AREA (Mha)
2004-05	140.8
2005-06	144.0
2006-07	143.7
2007-08	139.7
2008-09	145.0
2009-10	143.9
2010-11	149.3
2011-12	149.0
2012-13	148.2
2013-14	148.5

Study area: India
Sensor: Resourcesat-1 / 2 AWiFS.
Study duration: 2004-05 to 2018-19 (15 cycles)

No. of requests Served : 275
No. Of Unique Organizations / Users registered for data : 132 / 257
Volume of the Data provided : ~16.25 GB

NATIONAL LAND USE AND LAND COVER MAPPING USING MULTITEMPORAL AWiFS DATA



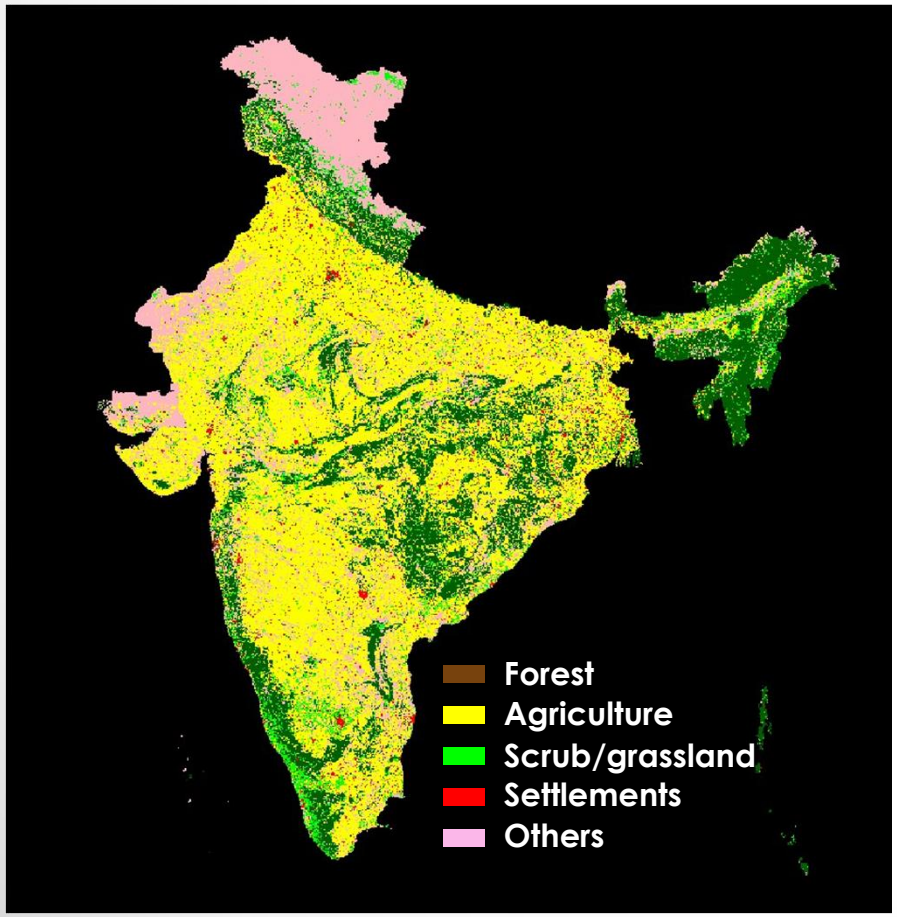
Areas in million ha

S. No	Class name	2014-15	2015-16
1	Built-up	9.74	9.74
2	Kharif crop	45.29	57.02
3	Rabi crop	18.59	15.03
4	Zaid crop	1.54	0.28
5	Double/triple crop	67.68	65.31
6	Current fallow	30.79	28.58
7	Plantation	9.46	9.46
8	Evergreen forest	17.29	17.28
9	Deciduous forest	46.94	46.91
10	Degraded/scrub forest	10.80	10.98
11	Littoral swamp	0.44	0.44
12	Grassland	2.39	2.37
13	Shifting cultivation	0.22	0.07
14	Wasteland	47.26	44.72
15	Rann	1.63	1.63
16	Waterbodies max	9.76	9.77
17	Waterbodies min	3.01	2.39
18	Snow cover	4.30	5.14
	Net Sown Area	**133.10**	**137.64**
	Total Forest cover	**75.47**	**75.61**

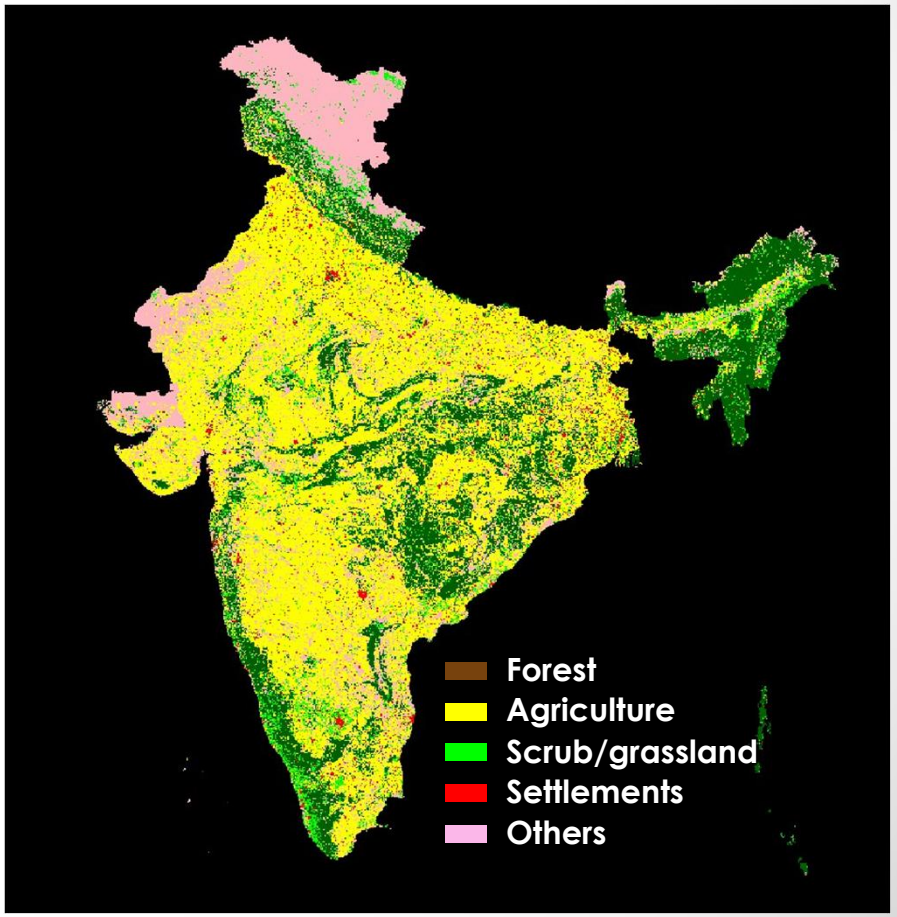
Indian National Communication to UNFCCC

Remote Sensing based Inputs to Land use, land-use Change and Forestry (LULUCF)

LU/LC – 2009-'10 Integrated with FSI-FC

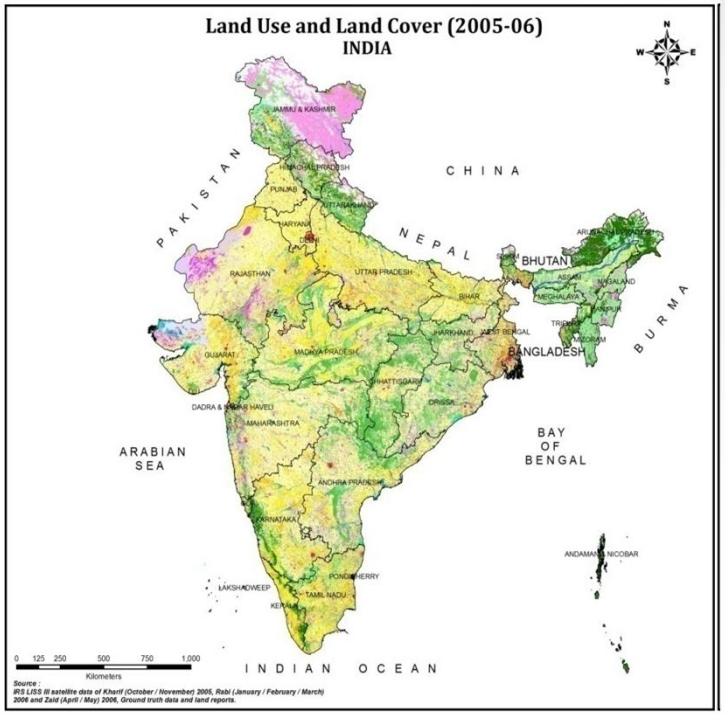


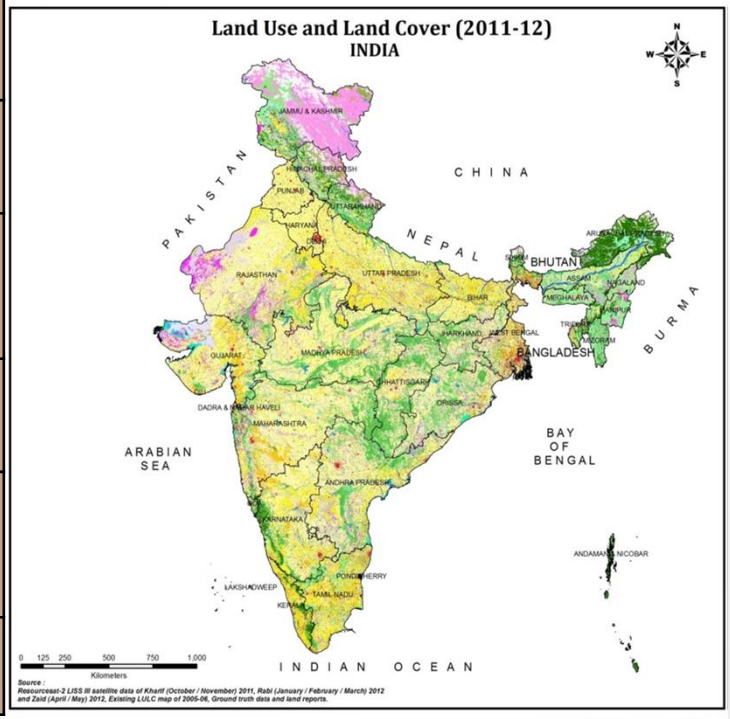
LU/LC – 2012-13 Integrated with FSI-FC



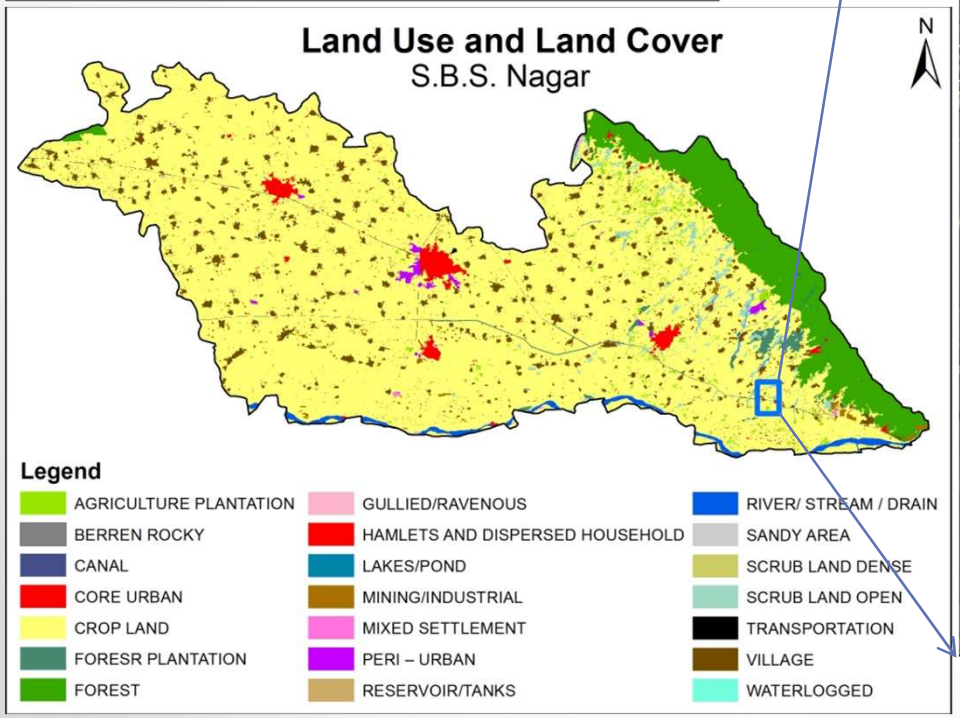
Statistics and Change in Land Use and Land Cover – 50K

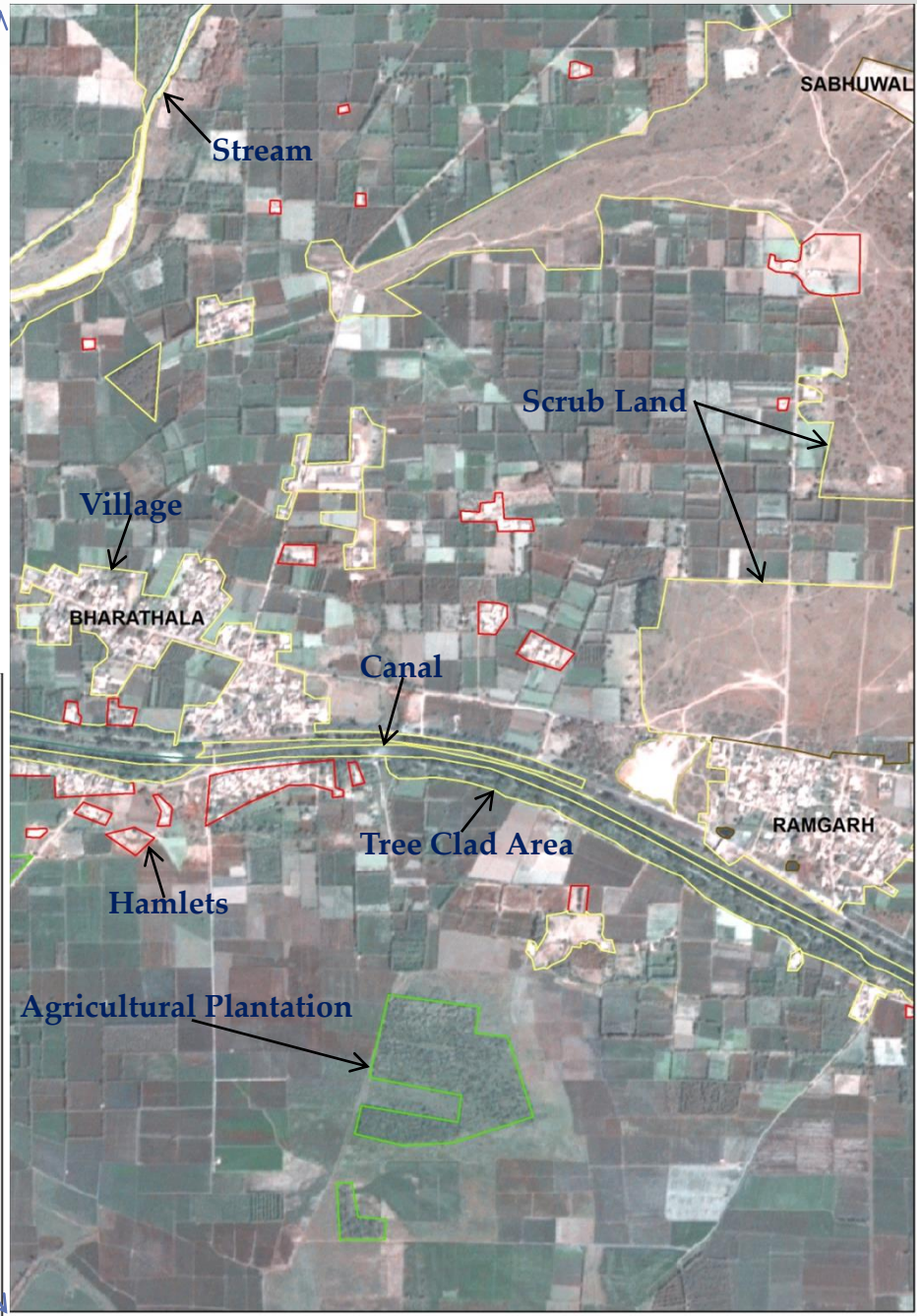
Level 1 Class	TOTAL (sq.km)			
	2005-06	2011-12	Change	% TGA
Built Up	100039.84	106240.88	6201.04	0.19
Agricultural Land	1798669.03	1801940.70	3271.66	0.10
Forest	738516.02	741125.71	2609.69	0.08
Grazing land	35329.84	34907.03	-422.81	-0.01
Wastelands	370538.33	376306.71	5768.37	0.18
Wetlands	23700.54	23018.05	-682.50	-0.02
Water bodies	107501.94	110900.18	3398.23	0.10
Snow & others	112967.21	92823.50	-20143.71	-0.61
Grand Total	3287263	3287263	0.00	0.00





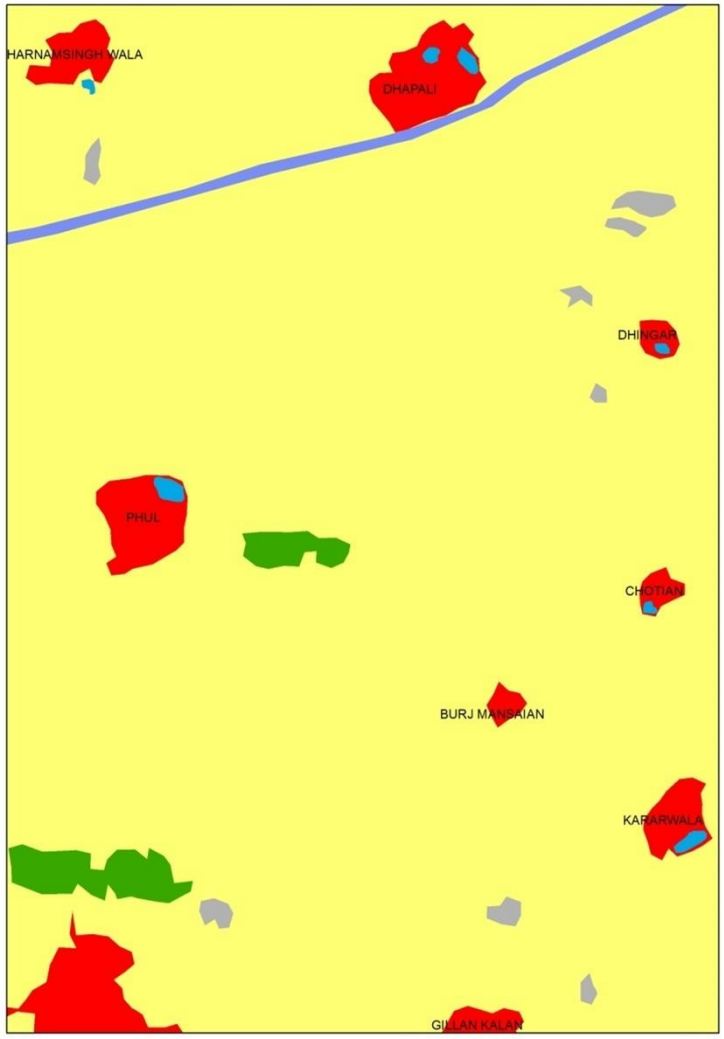
Punjab
PATHANKOT
GURDASPUR
AMRITSAR
HOSHIARPUR
TARN TARAN
KAPURTHALA
JALANDHAR
S.B.S. NAGAR
RUPNAGAR
FIROZPUR
MOGA
LUDHIANA
FATEHGARH SAHIB
FARIDKOT
BARNALA
FAZILKA
MUKTSAR
BATHINDA
SANGRUR
PATIALA
MANSA


Land Use and Land Cover
S.B.S. Nagar
N
Legend
AGRICULTURE PLANTATION
BERREN ROCKY
CANAL
CORE URBAN
CROP LAND
FORESR PLANTATION
FOREST
GULLIED/RAVENOUS
HAMLETS AND DISPERSED HOUSEHOLD
LAKES/POND
MINING/INDUSTRIAL
MIXED SETTLEMENT
PERI – URBAN
RESERVOIR/TANKS
RIVER/ STREAM / DRAIN
SANDY AREA
SCRUB LAND DENSE
SCRUB LAND OPEN
TRANSPORTATION
VILLAGE
WATERLOGGED

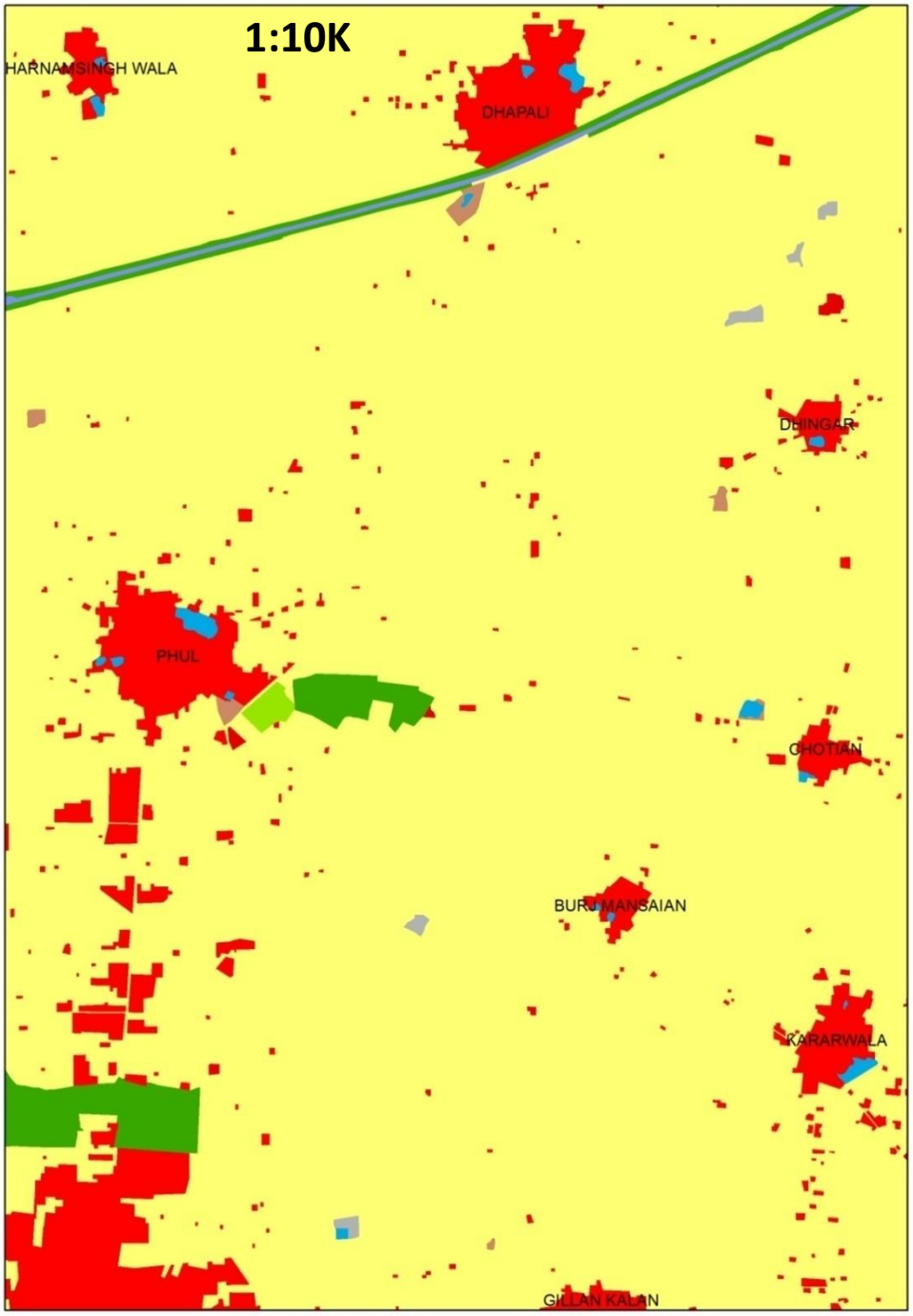

Stream
SABHUWAL
Scrub Land
Village
BHARATHALA
Canal
Tree Clad Area
RAMGARH
Hamlets
Agricultural Plantation

Part of Bathinda District

1:50K



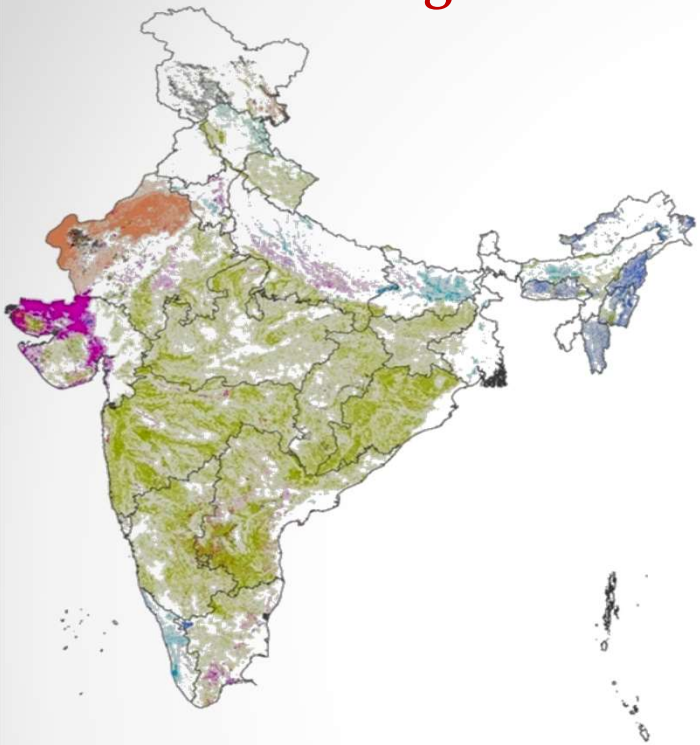
1:10K



Legend

- CANAL
- CROP LAND
- FOREST
- WATER LOGGED
- LAKES/PONDS
- LAND WITH SCRUB
- LAND WITHOUT SCRUB
- BUILT UP
- AGRICULTURAL PLANTATIONS
- RIVER
- SANDY-DESERTIC LAND

Land Degradation Assessment using multi temporal satellite data



Water Erosion

Wind erosion

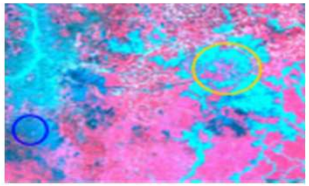
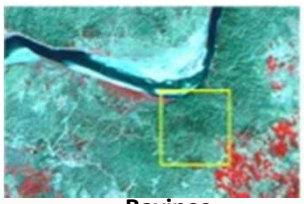
Water logging

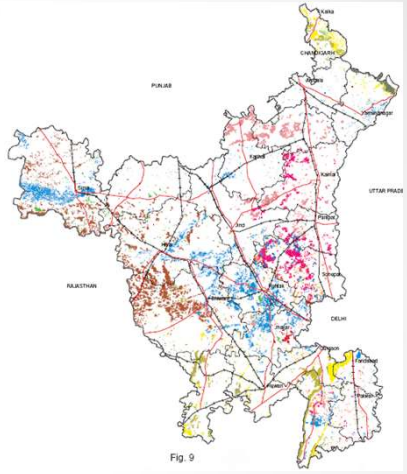
Salinisation / Alkalisation

Acidification

Glacial

Anthropogenic

Satellite data	Ground photo
Salt affected soil	
	
Water logging	
Sheet erosion	
	
Ravines	



Haryana

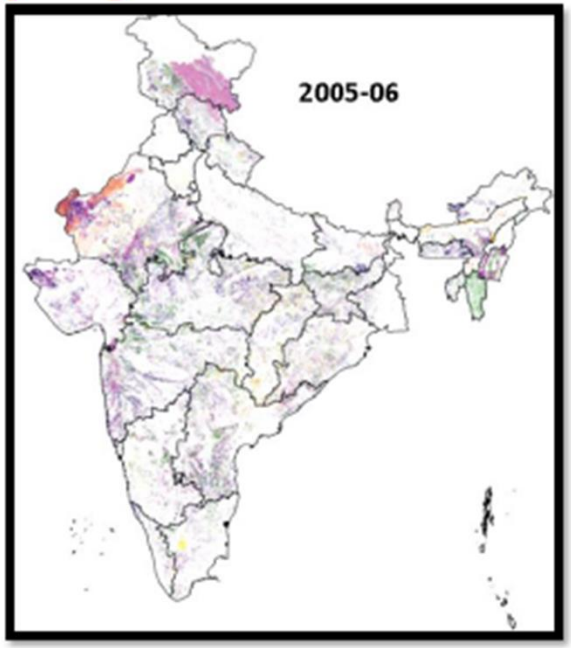
Utility

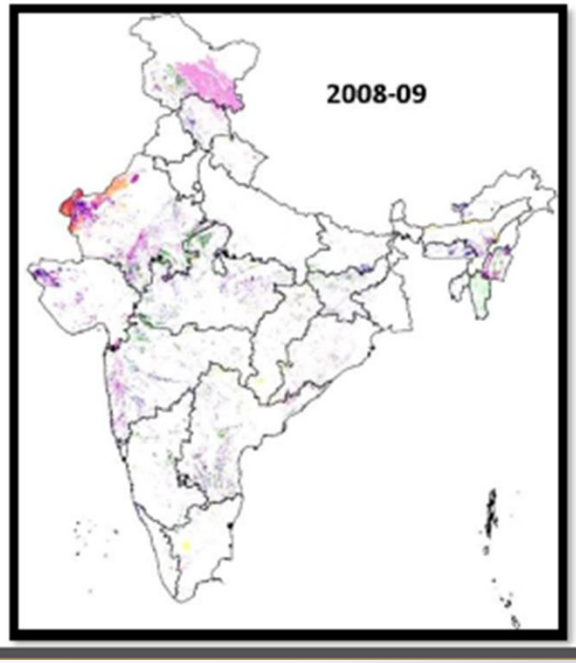
- Identification of degraded lands for improving productivity
- Reclammation of degraded lands
- Monitoring of degraded lands
- Prioritization of watersheds for treatment
- Environmental studies

National Wastelands Mapping

- Wasteland mapping 1982-1984 1:1M
- Wastelands Inventory on 1:50K: 1986-2000 + 2003-2004
- Monitoring of Wasteland on 1 : 50K: 2005-2006 & 2008-09
- Wasteland Change Analysis 2014-2015 - to be initiated
- Methodology
  - First 3 cycles created using visual methods using single season (rabi) data
  - 3rd and 4th cycles adopting on-screen method and using 3 season data. Change analysis carried out.
  - 5th cycle will be done using web based approach

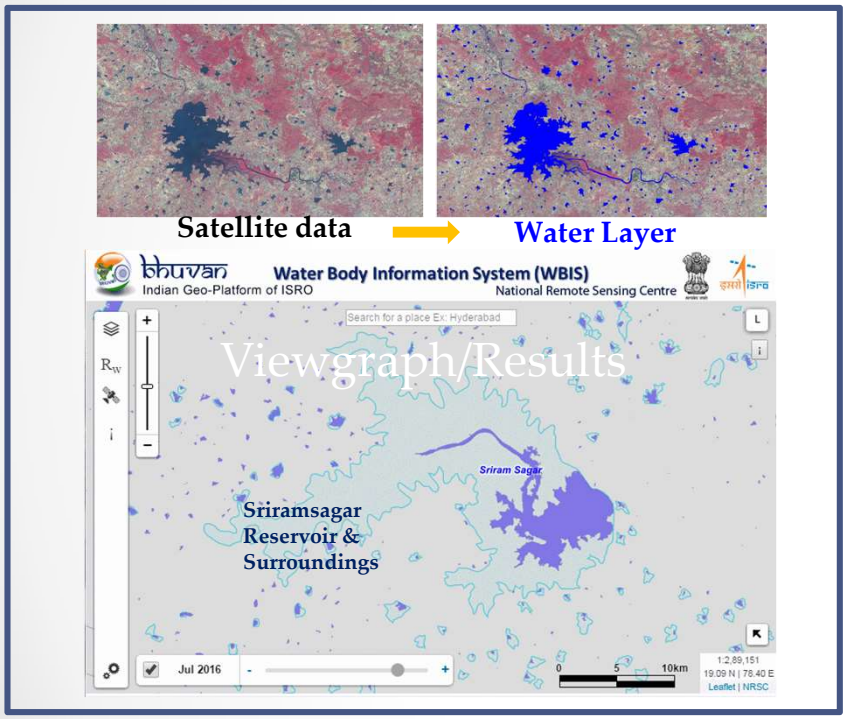
Users: Ministries – MRD, Power, Agriculture, MoUD etc., for greening, agriculture, plantation, watershed development; industrial & infrastructure development etc.





Water Bodies Information System (WBIS)

- Surface Water bodies dynamics for the entire country derived from multi-sensor satellite data and hosted on a Web enabled Water Bodies Information System (WBIS)



- *Satellite data is processed in Automatic Chain in Near Real Time*
- *Surface Water bodies dynamics is provided through Water Bodies Information System (WBIS) and Bhuvan*
- *Visualisation & Analytics provided for at Individual water body & Region level*
- *Water Bodies are monitored*

  Once in 5 Days (for size > 50Ha)

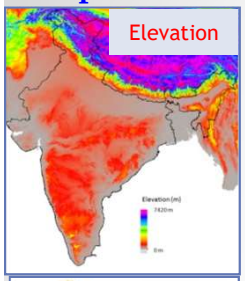
  Once in a Month (for size > 2 Ha)

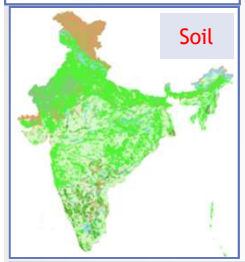
  Once in a Season (for size > 0.25Ha)

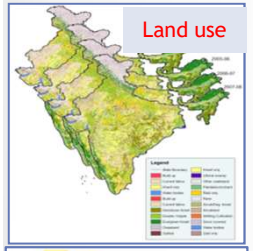
✓ **Surface water bodies information is useful for State & Central Irrigation Departments for : 1) Pre & Post Monsoon scenario (2) Sustainability Analysis : Inland fisheries (3) Hydrological Drought Assessment and (4) Surface Storage Quantification**

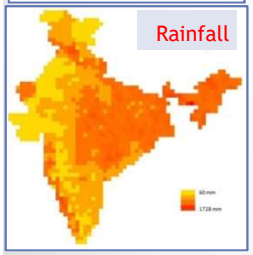
Operational Web-based National Hydrological Modeling System

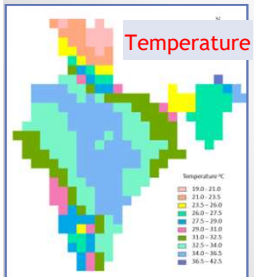
Input dataset







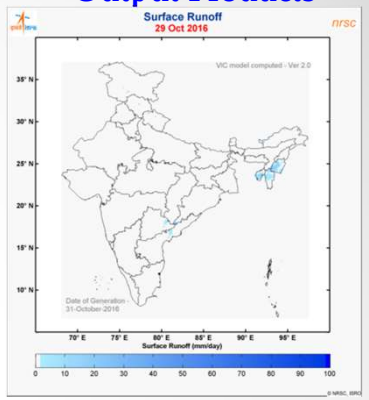




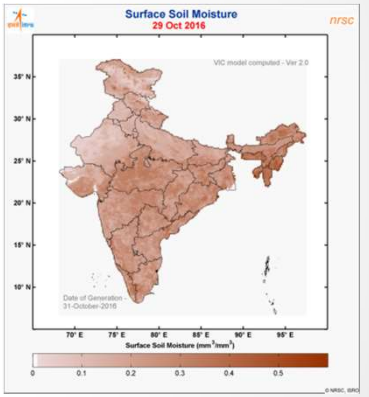
Hydrological Modeling Framework

- Variable Infiltration Capacity Hydrological Model
  - *Open source; Grid-wise water and energy balance*
  - *Sub-grid heterogeneity of Land cover*
  - *Soil depth-wise hydrological response*
  - *Vegetation phenological changes*
  - *Daily / sub-daily time step*
- 9 min (~16.5km), 3 min (~ 5.5km) Grid-wise data base
- Geo-spatial data
  - *Terrain - Topographic, Soil (NBSSLUP), LULC (NRC-250k), LAI, Albedo*
  - *Meteorological - Rainfall, Temperature, … (IMD & CPC)*
  - *Hydrological - River discharge, Reservoir Storage/Releases, GW levels, …*
- Daily Web Products (9 min (~16.5km), 3 min (~ 5.5km)
  - *Surface Runoff*
  - *Soil Moisture*
  - *Evapotranspiration*

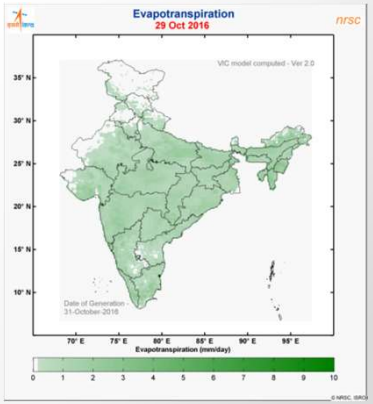
Output Products



Runoff

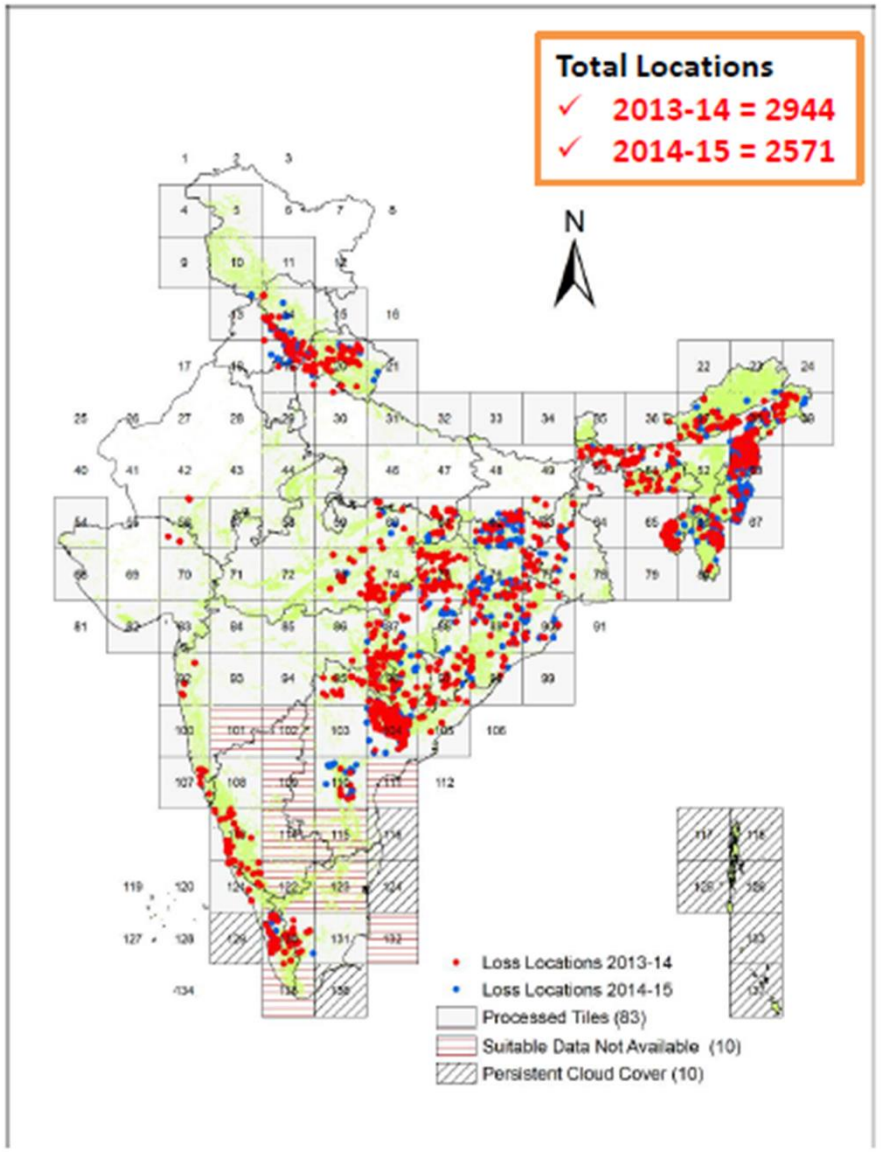


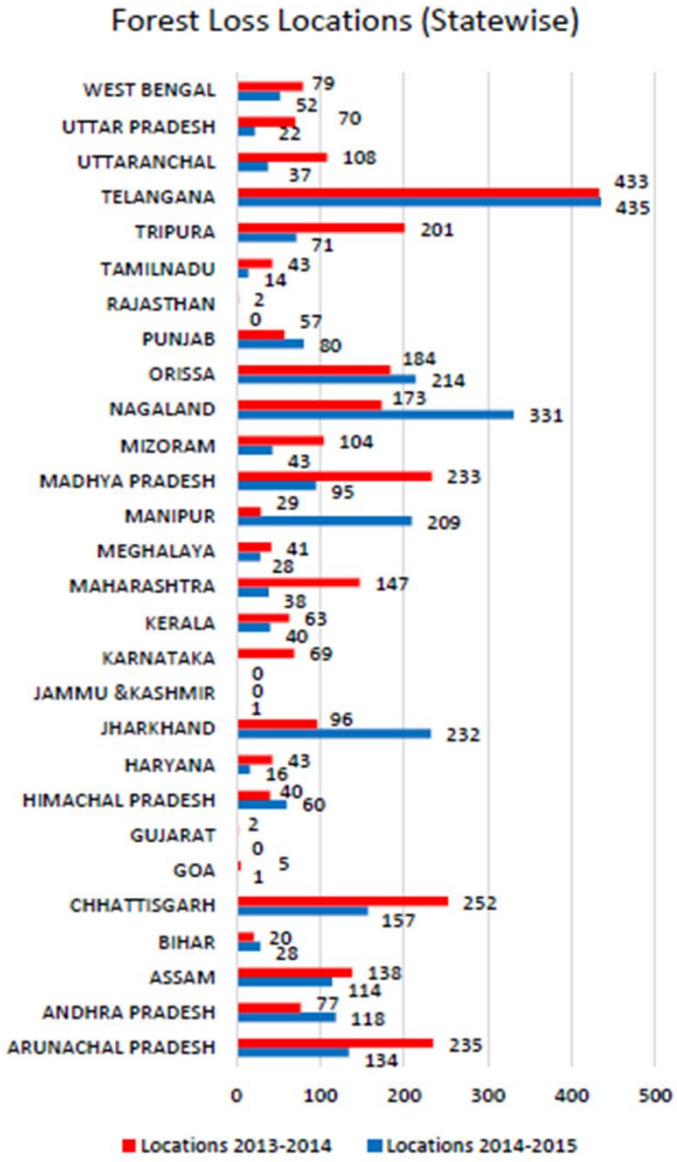
Soil Moisture



Evapotranspiration

Actionable Alerts on Annual Forest Loss Locations – Results for 2015





Location of loss reported (centroid of polygon); Area of loss is not reported

Monitoring and Evaluation of IWMP Watersheds using Geospatial Technologies

Study Area
- IWMP watersheds in Entire India

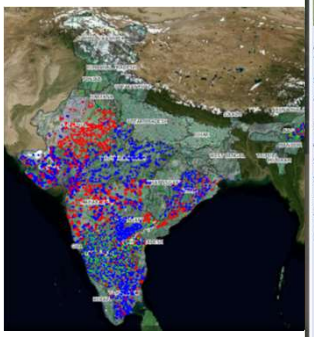
Total Micro-watersheds covered : ~75000

Srishti : Web GIS using IRS High Resolution image base for monitoring and evaluation

Drishti : Android Application for Real time Field inventory and uploading to server using Geo-tagged Photo

User: Dept of Land Resources, Min of Rural Development

Srishti



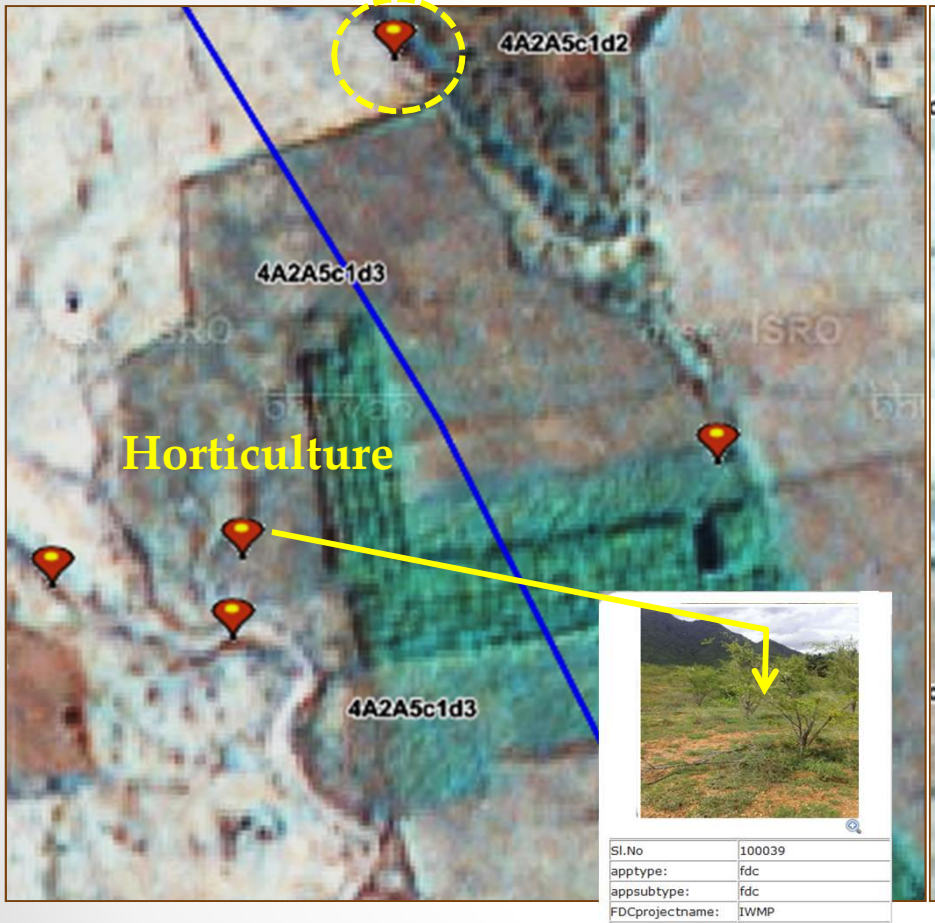
Drishti

6.3 Lakh Drishti photos uploaded as on date

Budget : IWMP – Rs 35.03 Cr Duration : 2015-16 to 2020

950 OFFICIALS OF DIFFERENT STATES TRAINED IN 17 WORKSHOPS

IWMP II Project Theni Dist., Tamilnadu



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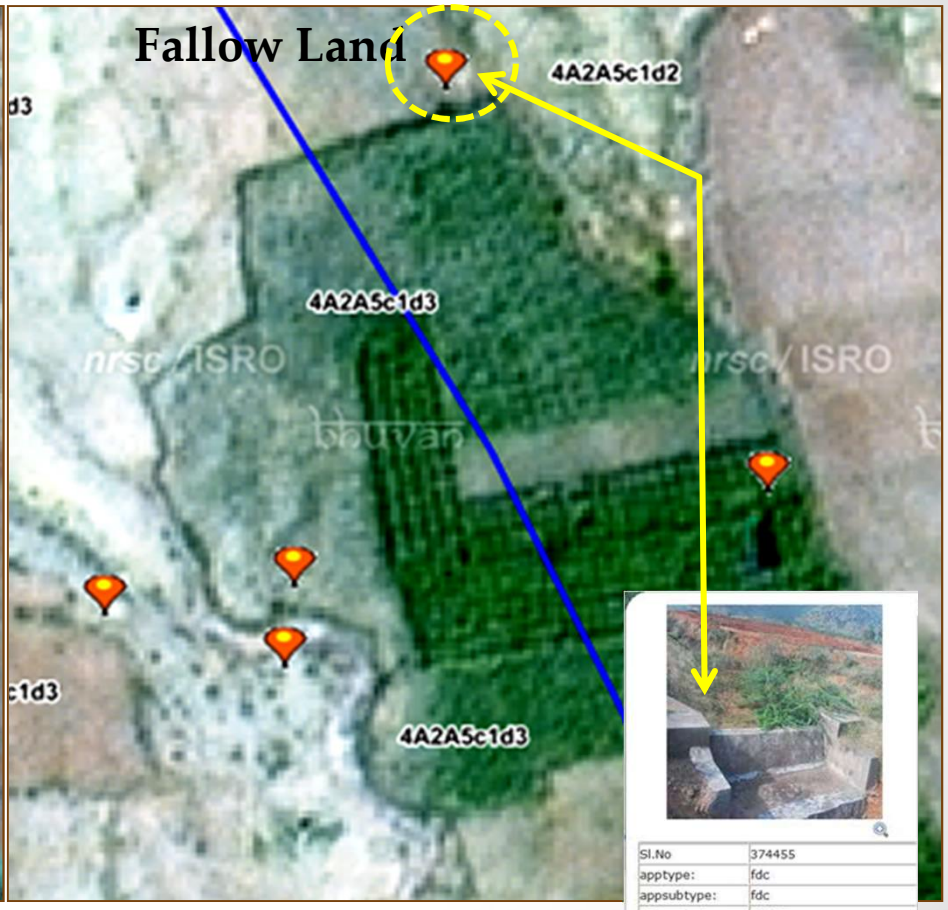
FDCprojectname:	IWMP
themename:	IWMPFDC
profilename:	LM
observername:	rajathi
org:	DWDA/Theni
mobileno:	9003485753
creationtime:	2015-10-6 14:26:54
uuid:	39a9d88965ac5ba5
deviceid:	THN/IWMP -II
LivelihoodMeasures:	Horticulture
StatusOfActivity:	Completed
Location:	devangar polytechnic

2009 Satellite Image



Sl.No	374455
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FDCprojectname:	IWMP
themename:	IWMPFDC
profilename:	CivilworkSM
observername:	Balamurugan
org:	DWDA theni
mobileno:	9788144483
creationtime:	2016-1-22 15:40:41
uuid:	cd8c50b742155354
deviceid:	bmurugan21878@gmail.con
CivilWorks:	Check Dam
StatusOfActivity:	Completed
Location:	Devangar polytechnic

Feb, 2014 Satellite Image

Monitoring of Farm Ponds in Watersheds

BHUVAN – Indian Geo-Platform of ISRO

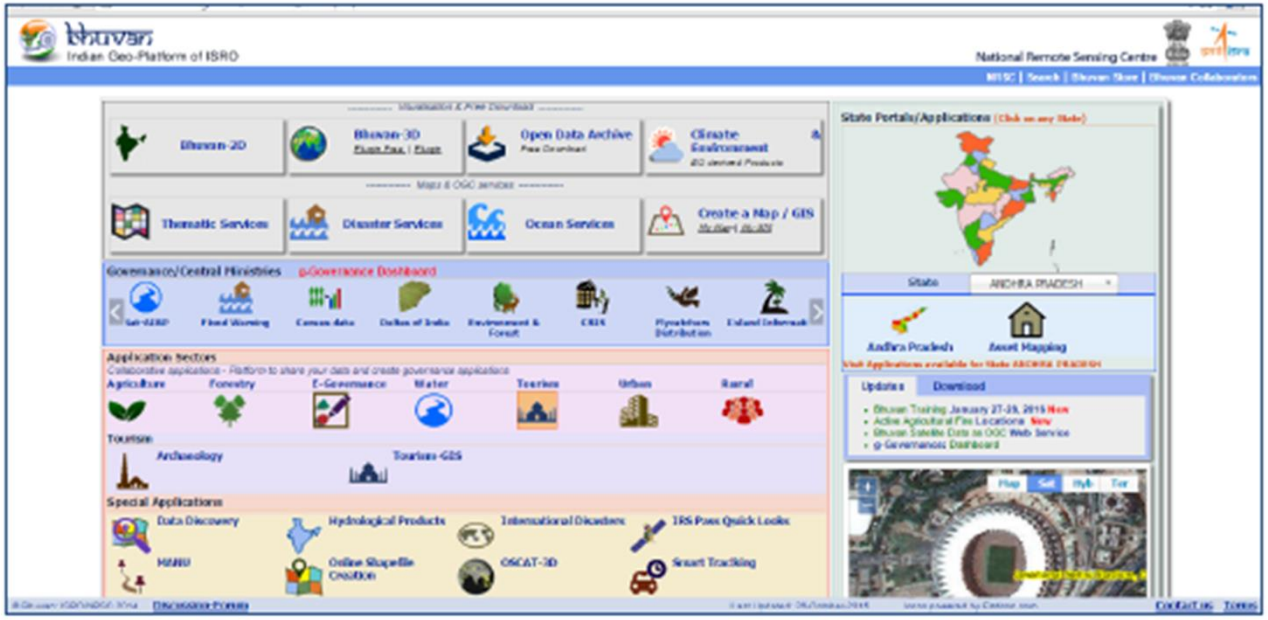
Visualization (23 TB) and Free Download (110 GB)

Maps & OGC Services (~7000+)

Applications (200+)

State Portals (30)

Crowd Sourcing (14 M)



- More than 1 lakh Registered users
- 36K unique visitors/day
- 6.38 lakhs free download

2009 Visualisation → **2012** Mashups → **2015 onwards** G-Governance Applications

THANK YOU

NATURAL RESOURCES CENSUS PROJECT

Land Degradation Mapping using IRS LISS-III data on 1:50,000 scale

LAND DEGRADATION MAP

Uttar Pradesh

ID	Process	Type-Severity	Symbol	Area (ha)
1	Water erosion (A)	Sheet erosion - Slight (1)		228282
2		Sheet erosion - Moderate (2)		540265
3		Sheet erosion - Severe (3)		127998
4		Rills (4)		66639
5		Gullies (5)		490463
6		Ravines - Shallow (6)		113862
7		Ravines - Moderately deep to deep (7)		149465
8	Wind erosion (B)	Sheet erosion -Slight (1)		NIL
9		Sheet erosion - Moderate (2)		NIL
10		Sheet erosion - Severe (3)		NIL
11		Stabilized dunes (4)		NIL
12		Partially stabilized dunes (5)		NIL
13		Un-stabilized dunes (6)		NIL
14	Water logging (C)	Surface ponding - Seasonal (1)/ Permanent (2)		413583
15		Subsurface waterlogged (3)		51114
16	Salinisation / Alkalisation (D)	Saline - Slight (1) /Moderate (2) /Severe (3)		174
17		Sodic - Slight (4) /Moderate (5) /Severe (6)		72419
18		Saline Sodic - Slight (7) /Moderate (8) /Severe (9)		533246
19		Rann (10)		NIL
20	Acidification (E)	Acidic – Moderate (1) / Severe (2)		NIL
21	Glacial (F)	Frost heaving (1)		NIL
22		Frost Shattering (2)		NIL
23	Anthropogenic (G)	Industrial effluent affected areas (1)		NIL
24		Mining and dump areas (2)		4735
25		Brick kiln (3)		10760
26	Others (H)	Mass movement / mass wastage (1)		NIL
27		Barren rocky / Stony waste (2)		59239
28		Miscellaneous-RiverineSands/Sea Ingress etc (3)		24566

Note: Symbol and area statistics are for dominant land degradation type-severity. All degraded classes are shown in Colour

District Boundary

State Boundary

Rail line

Major Roads

Location Map

Data Source: Three season IRS P6 L-III data of 2005-06 with adequate field checks and chemical analysis

Partner Institution(s)

IIRS, 4, Kalidas Road, Dehradun
Remote Sensing Application Centre
Uttar Pradesh
Janki puram, Kursi Road Lucknow

Enrichment

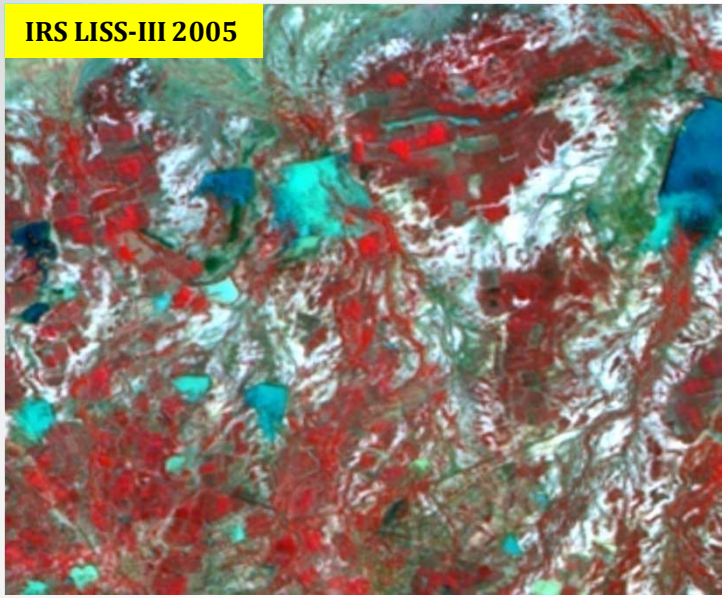
National Bureau of Soil Survey and Land use Planning (ICAR), Amaravati Road, Nagpur

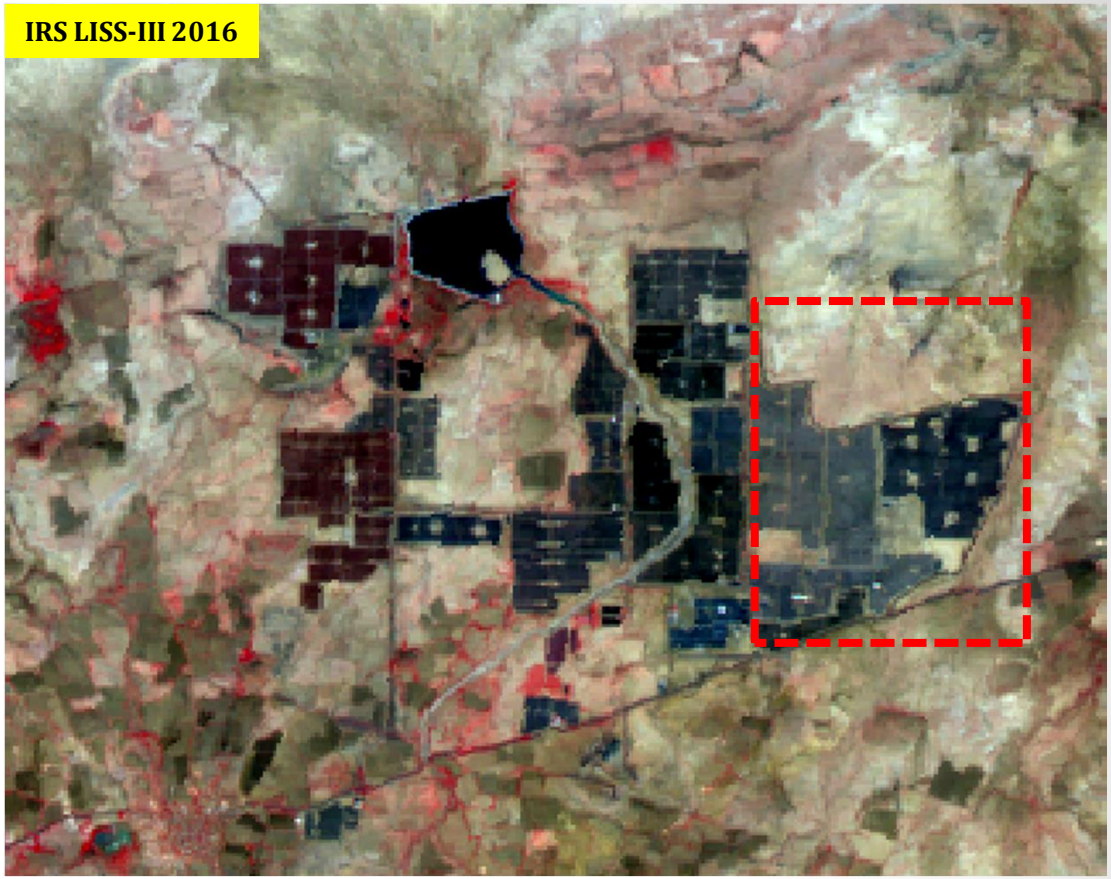
Coordination

Soil and Land Resources Assessment Division, LRUMG, RSA-A, National Remote Sensing Centre, ISRO, Dept. of Space, Govt. of India Hyderabad

© National Natural Resources Management System, ISRO, 2012

Wastelands (Conversion & Utilisation)





Wasteland to solar power generation,
Charanka solar park Radhanpur,
one among 44 such projects in Gujarat State

Path/ Row : 91/55

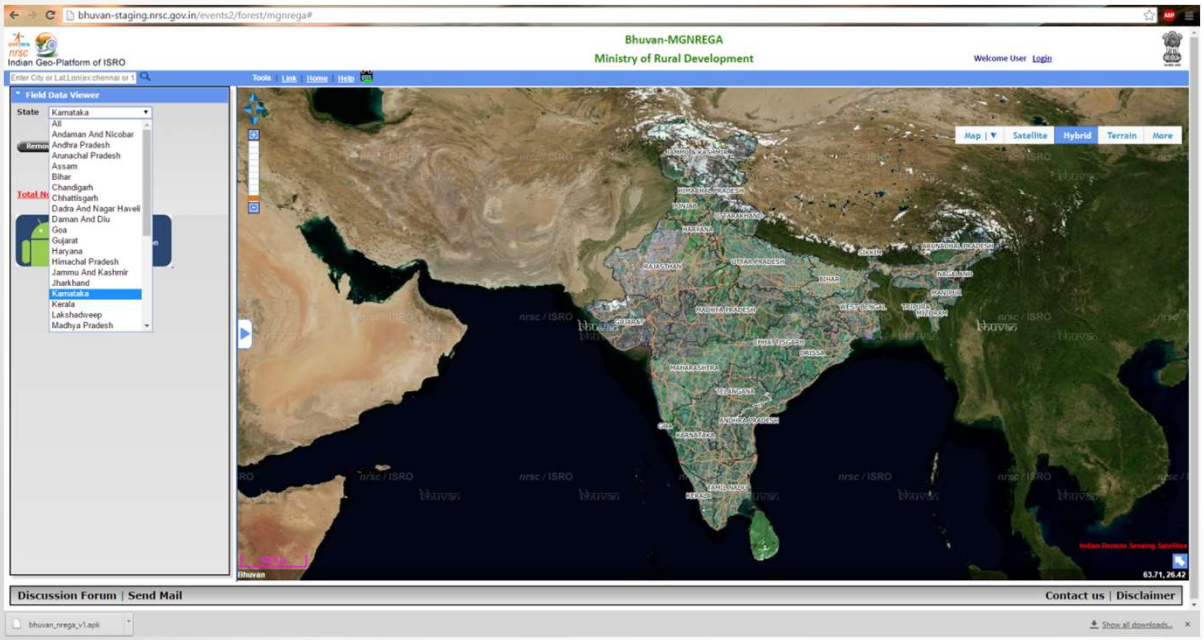
23^0 54' 35" N
$71^0$12' 04" E

IRS LISS III (05-06)
IRS LISS III (11-12)
IRS LISS III (15-16)

GIS Implementation of Mahatma Gandhi NREGA Assets

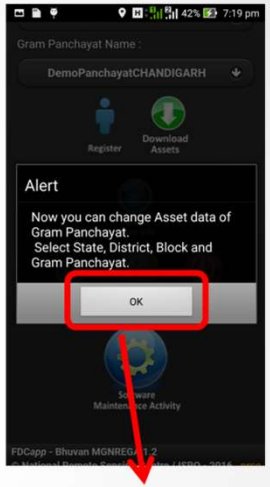
Web Portal

- Registration
- State GIS Nodal Officer
- District GIS Nodal Officer
- GIS Asset Supervisor (Block) ⟷ MGNREGA Spatial Enumerator / MGNREGA Spatial Enumerator / MGNREGA Spatial Enumerator

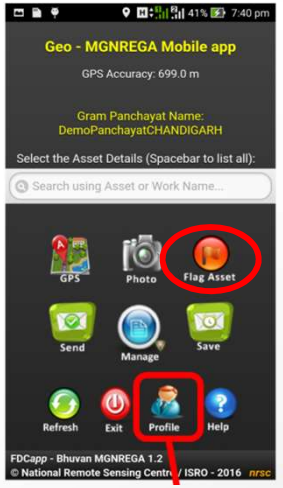


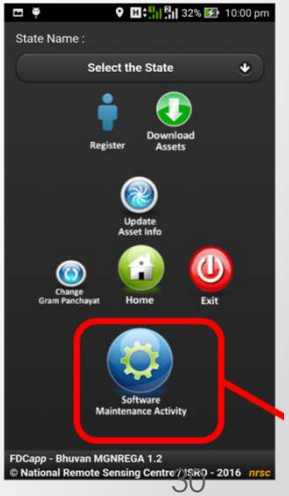
Mobile App

Step-1: Click on "Change Gram Panchayat"



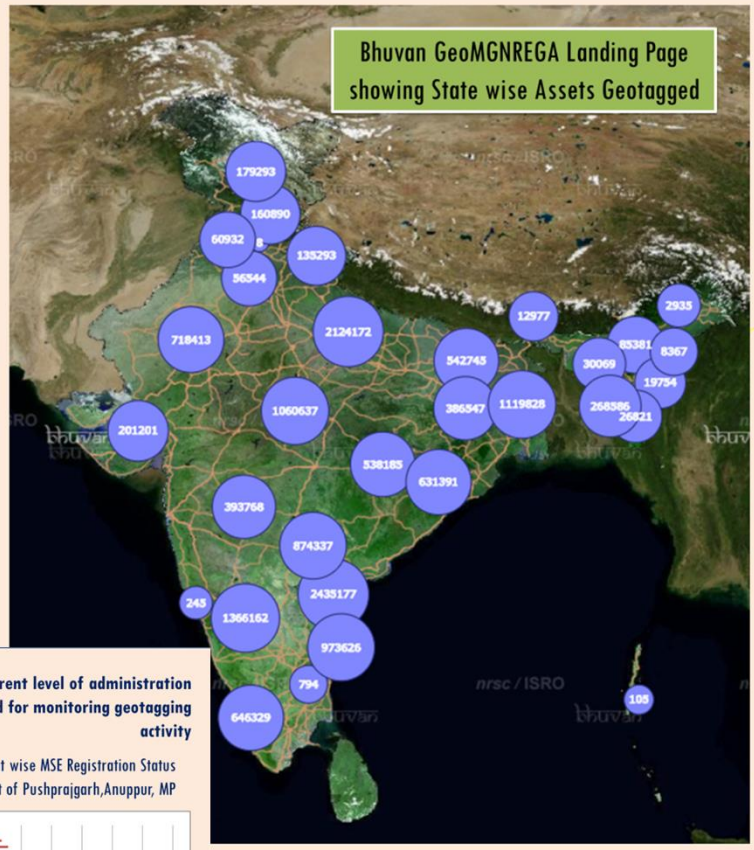
Step-2

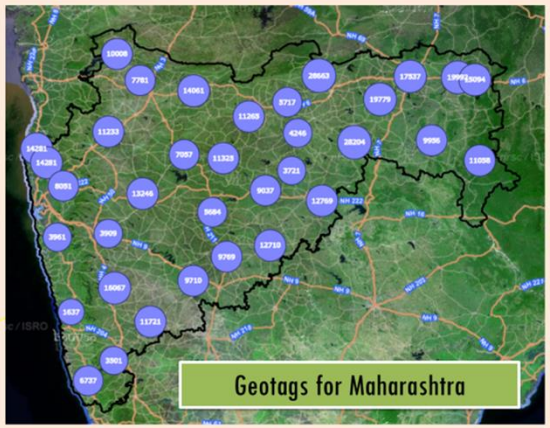


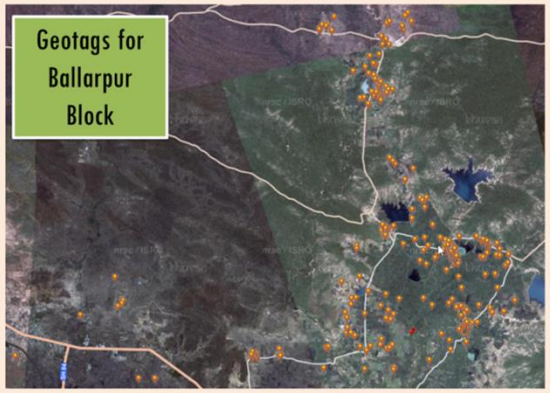


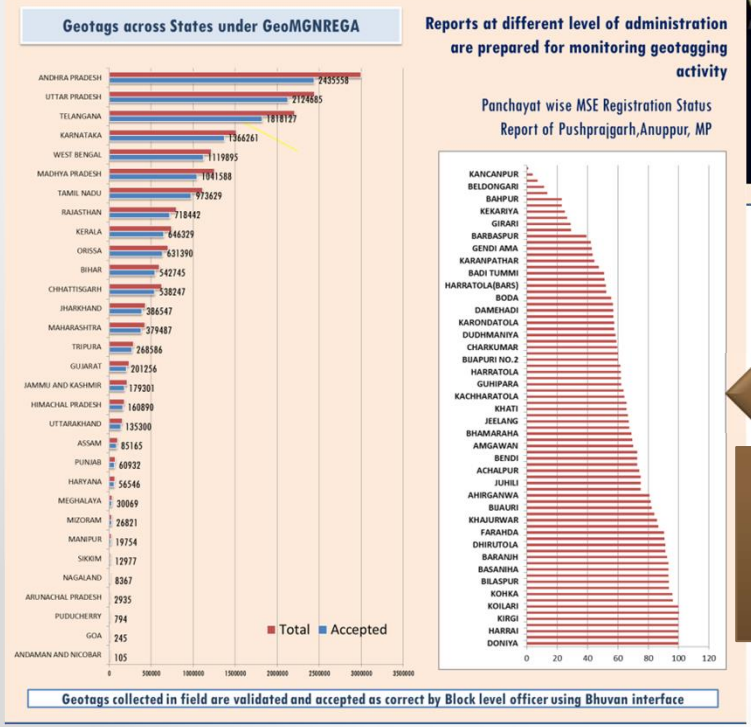
Solution Implemented for Governance

Visualisation across geography









Geotags collected in field are validated and accepted as correct by Block level officer using Bhuvan interface

Statewise Geotags & Panchayat level

18.AUG.17

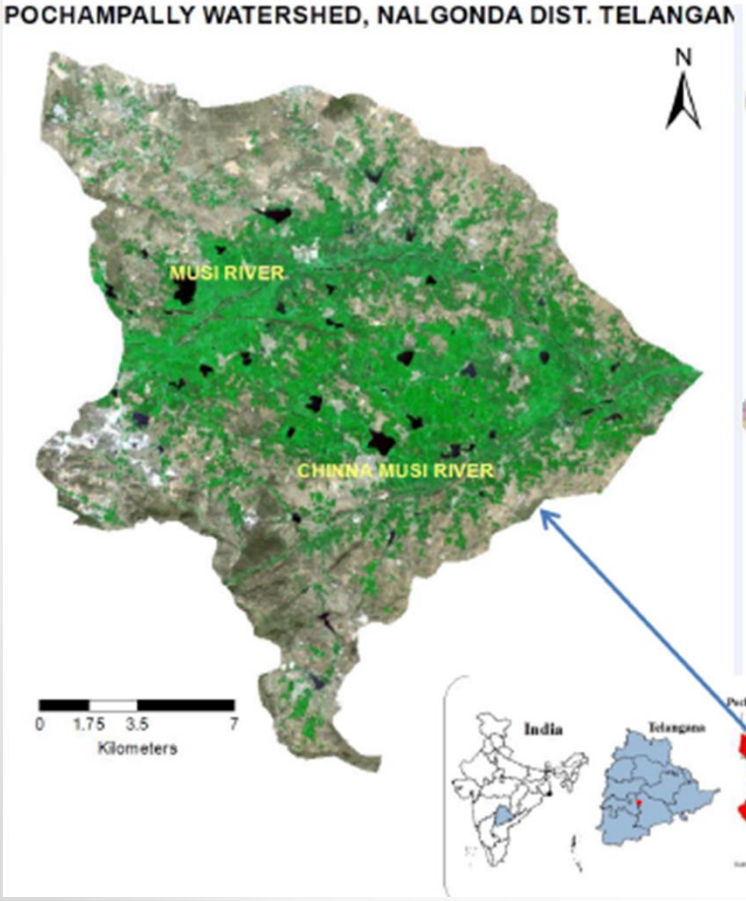
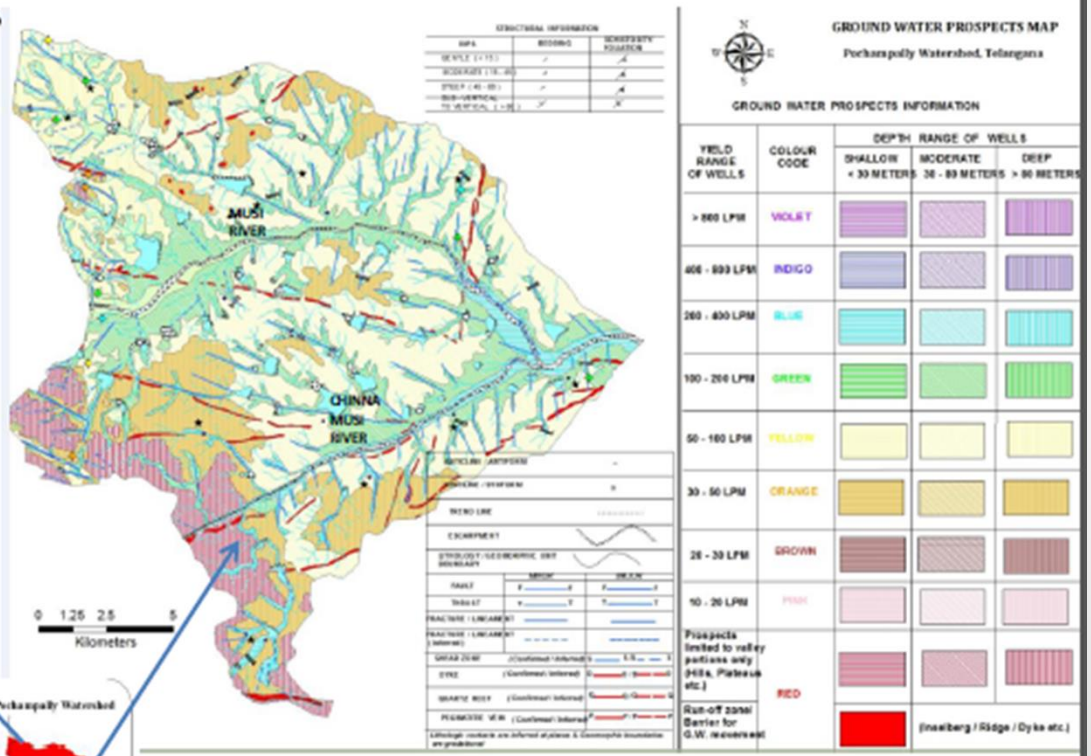
Geotagged	2.09 Cr
	2.04 Cr
Moderate	1.81 Cr
	0.24 Cr

National Rural Drinking Water Programme

(RAJIV GANDHI NATIONAL DRINKING WATER MISSION)

- Groundwater prospect in 1:50,000 scale map full India Completed
- Groundwater quality mapping is under progress, out of 29 states 5 states completed, other are in advance stage

Resourcesat 1 LISS III, NCC Image



GROUNDWATER PROSPECT MAP
Pochampally Watershed, Nalgonda Dist. Telangana