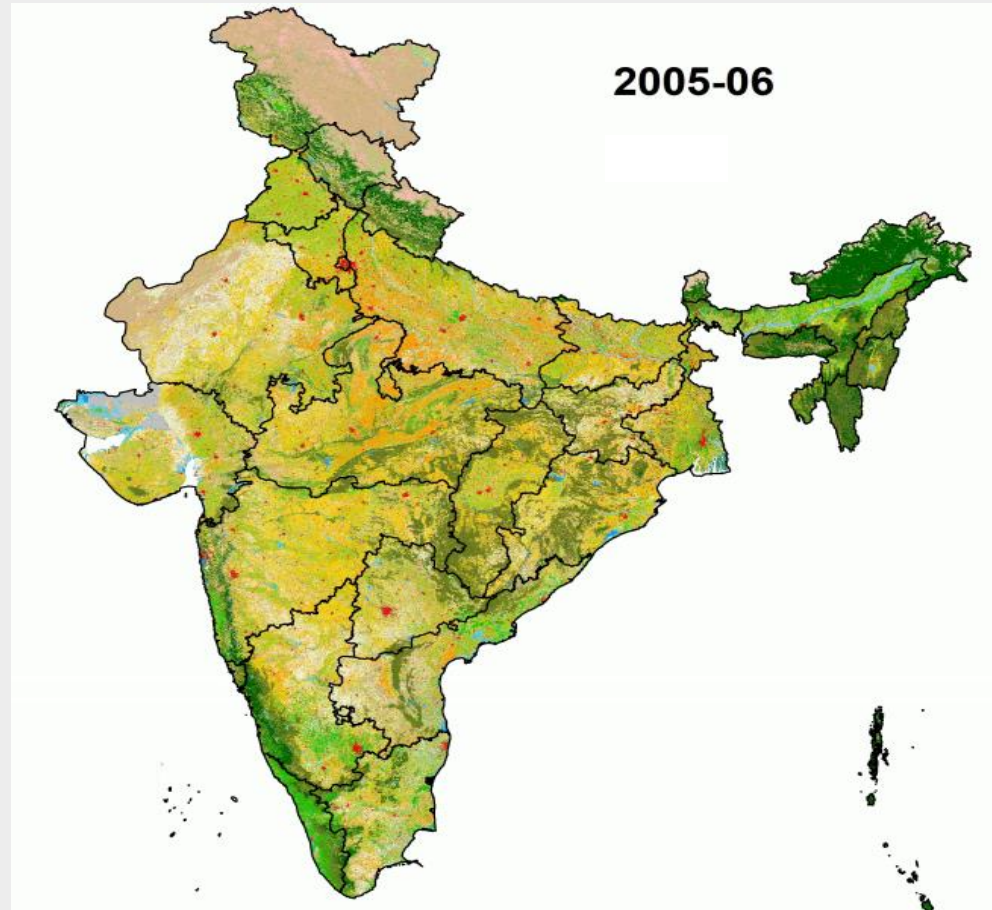


Remote Sensing based LCLUC Activities of ISRO



Dr. Prakash Chauhan, FNASc
Director
Indian Institute of Remote Sensing
Dehradun-248001, India
prakash@iirs.gov.in

Current Operational Remote Sensing Capabilities of ISRO

Natural Resources Inventory & Disaster Management

RESOURCESAT- 2 & 2A



- Three tier imaging : 56 m / 23 m / 5.8 m
- Revisit Capability : 03 / 11 / 03 days

Large Scale Mapping, Infrastru. Planning & Cartography

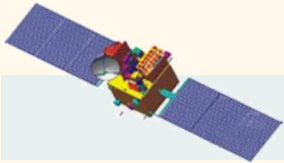
**CARTOSAT-1, CARTOSAT-2 (3) & 2S (1),
CARTOSAT-3**



- 2.5 m Stereo imaging
- Sub-meter PAN and 1.5 m Multi-spectral
- 0.5m PAN with 1 m MX

Oceanography

OCEANSAT-2 ; SARAL ; SCATSAT-1



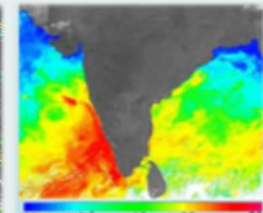
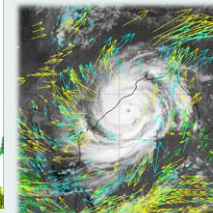
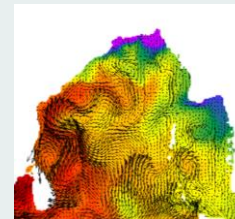
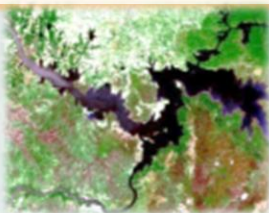
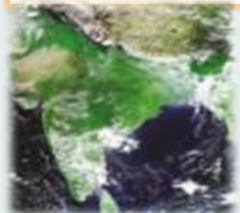
- Ocean color 360 m with 2 days revisit
- PFZ, Ocean State Forecast
- Ocean Altimetry, Surface Wind Vector

Weather & Climate

INSAT 3D & 3DR ; MEGHA-TROPIQUES



- 6 channel Imager – 48 images per day
- 19 Channel Sounder – Atm. Profiles
- Radio Occultation – humidity profiles



ISROs Vision and Strategy : Remote Sensing Applications



Remote Sensing Applications

Land Resources Assessment

Natural Resources Census	<ul style="list-style-type: none"> Annual Land use/ Land cover at 1:250,000 (13 cycles since 2004-05) 5yr interval Land use/ Land cover (1:50k) – 3 cycles since 2005-06 Land Degradation (1:50,000)
	<ul style="list-style-type: none"> Waste Land mapping and monitoring (1:50,000) – 2 Cycles
Soil Health	<ul style="list-style-type: none"> GIS Technology support for Soil Health Card Repository and Fertilizer blend advisories Digital Soil Maps
Land Development	<ul style="list-style-type: none"> Carbon Neutrality, Predictive Soil Mapping, Soil Carbon, Water Logging, Solar potential sites, Sustainable Development
Largescale Mapping for Action Plans	<ul style="list-style-type: none"> 10,000 scale mapping - Land degradation, Soil resources

Rural Development

Rural Assets	<ul style="list-style-type: none"> GIS implementation of Mahatma Gandhi Rural Employment Guarantee Act (MGNREGA), PMKSY
Watershed Development	<ul style="list-style-type: none"> GIS Technology support for online repository Post-Implementation impact monitoring (IWMP, NABARD Watersheds) GIS based planning of watershed schemes

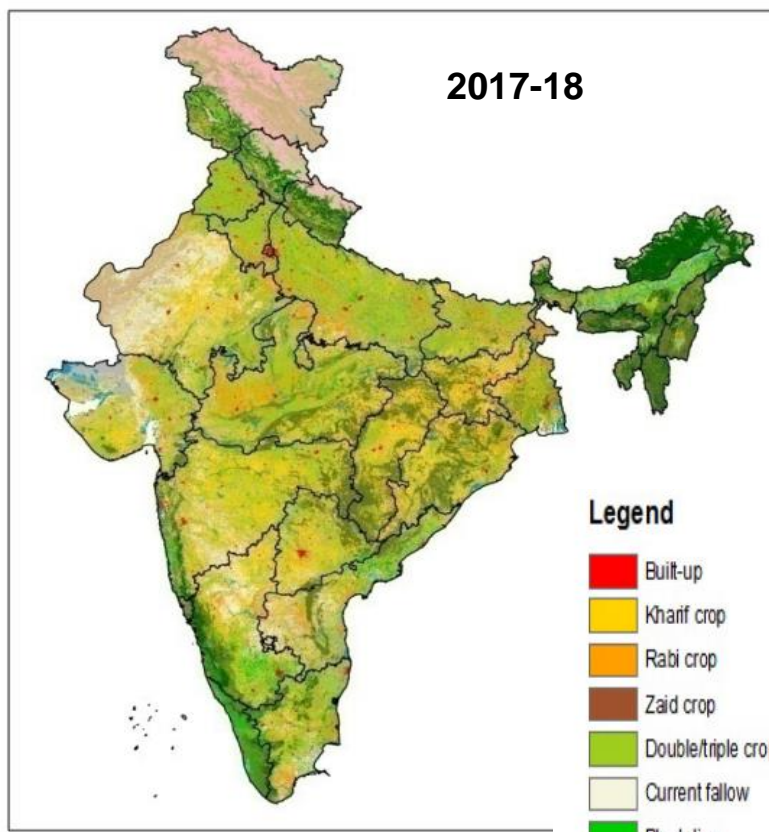
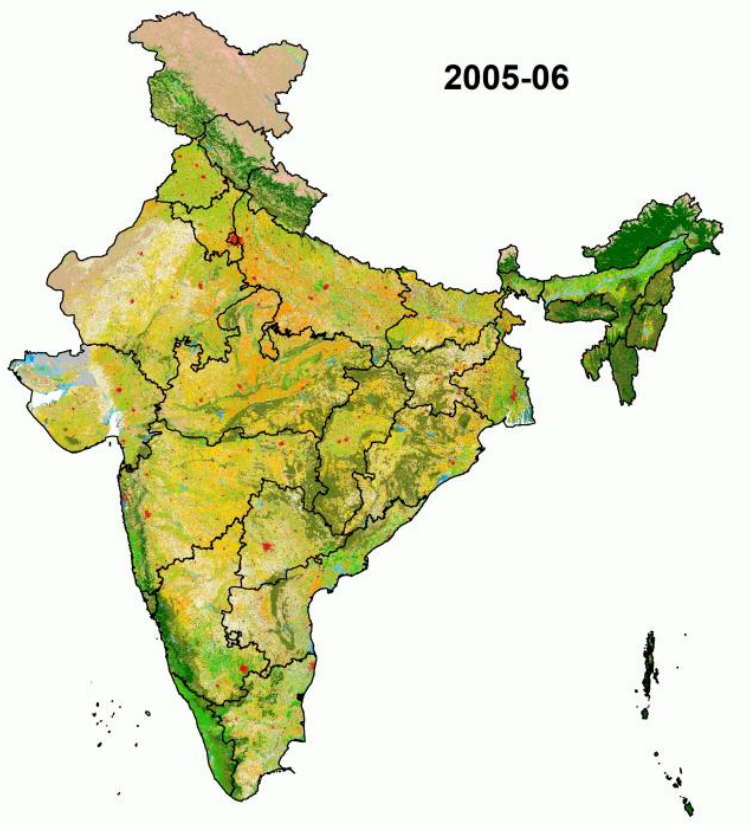


Wasteland to solar power generation

Land Use Land Cover Mapping

Annual Land Use / Land Cover (LULC) map of India with Kharif and Rabi sown areas since 2004-05 at 56m resolution (~1:250K) every year and 50K mapping at 5 year interval using IRS data.

1:250k (Annual Time-series)

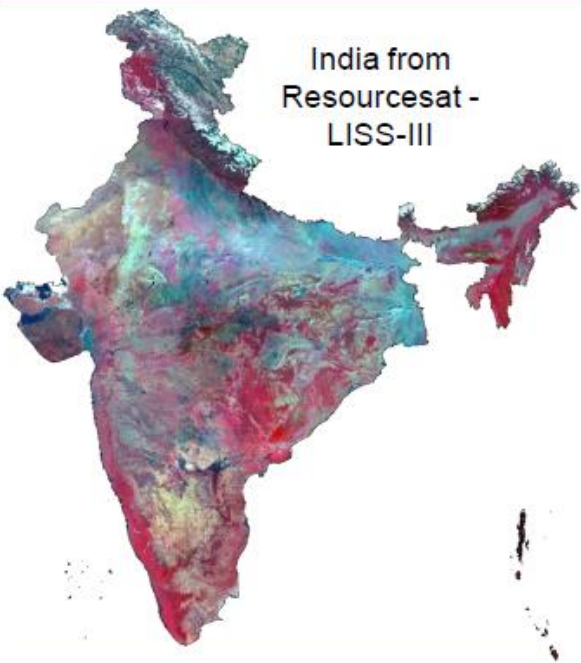


Legend

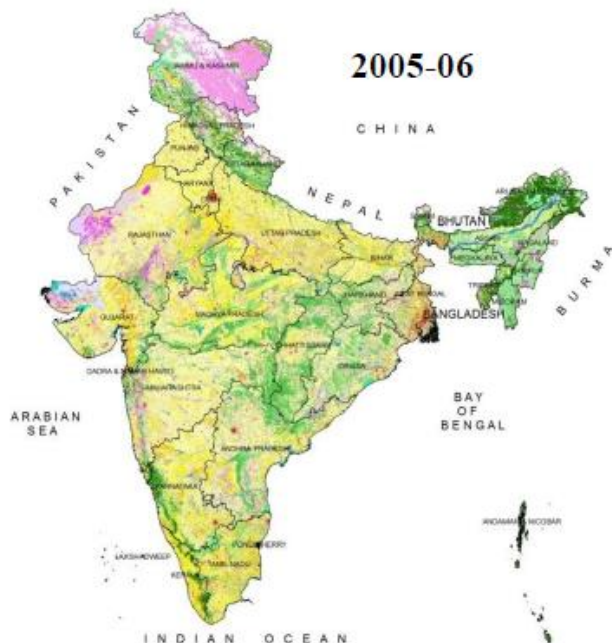
- | | |
|--------------------|-------------------------|
| Built-up | Degraded / scrub forest |
| Kharif crop | Littoral swamp |
| Rabi crop | Grassland |
| Zaid crop | Shifting cultivation |
| Double/triple crop | Wasteland |
| Current fallow | Rann |
| Plantation | Waterbodes max |
| Evergreen forest | Waterbodes min |
| Deciduous forest | Snow cover |

NRC: Land Use/land Cover Mapping on 1:50K using LISS III

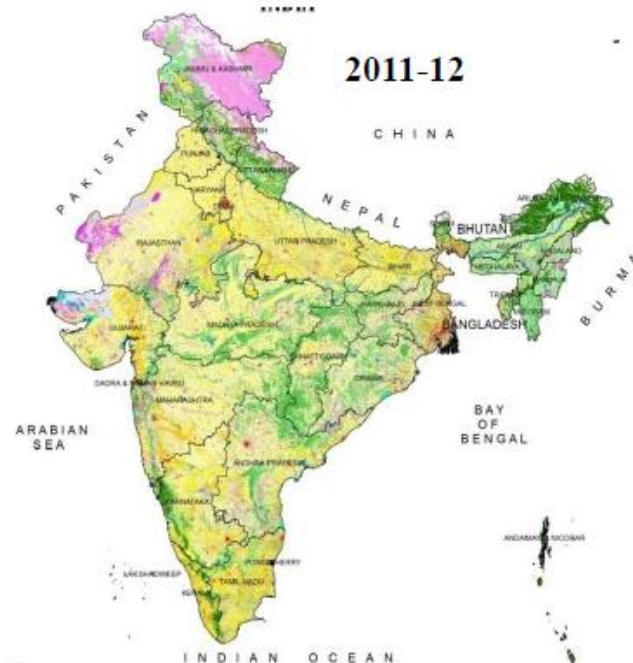
India from Resourcesat - LISS-III



2005-06



2011-12



Built Up

- Urban-Compact (Continuous)
- Urban-Sparse (Discontinuous)
- Vegetated/ Open Area
- Rural
- Industrial Area
- Ash/ Cooling Pond/ Effluent etc
- Mining - Active
- Mining - Abandoned
- Quarry

Agricultural Land

- Kharif
- Rabi
- Zaid
- Cropped in two seasons
- Cropped in more than two seasons
- Fallow Land
- Agricultural Plantation
- Aquaculture

Forest

- Evergreen/ Semi - Dense/ Closed
- Evergreen/ Semi - Open
- Deciduous - Dense/ Closed
- Deciduous - Open
- Forest Plantation
- Scrub Forest
- Swamp/ Mangroves - Dense/ Closed
- Swamp/ Mangroves - Open
- Tree Clad Area - Dense/ Closed
- Tree Clad Area - Open

Grass/Grazing

- Alpine/ Sub-Alpine
- Temperate/ Sub Tropical
- Tropical/ Desertic

Wastelands

- Salt Affected Land
- Gullied Land
- Ravinous Land
- Scrub Land - Dense/ Closed
- Scrub Land - Open
- Sandy Area - Desertic
- Sandy Area - Coastal
- Sandy Area - Riverine
- Barren Rocky

Wetlands

- Natural (Ox-bow lake/ Cut-off meander etc)
- Manmade (Water logged/ Saltpans etc)
- Lagoons/ Creeks/ Mud flats etc
- Saltpans

Water bodies

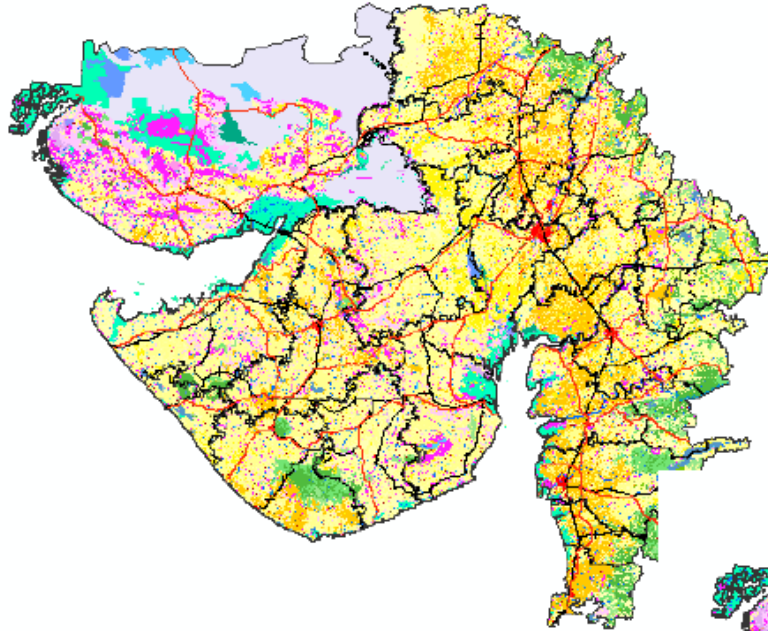
- River - Perennial
- River - Non Perennial
- Canal/ Drain
- Lakes/ Ponds - Permanent
- Lakes/ Ponds - Seasonal
- Reservoir/ Tanks - Permanent
- Reservoir/ Tanks - Seasonal

Snow/Others

- Snow
- Shifting Cultivation - Current
- Shifting Cultivation - Abandoned
- Rann

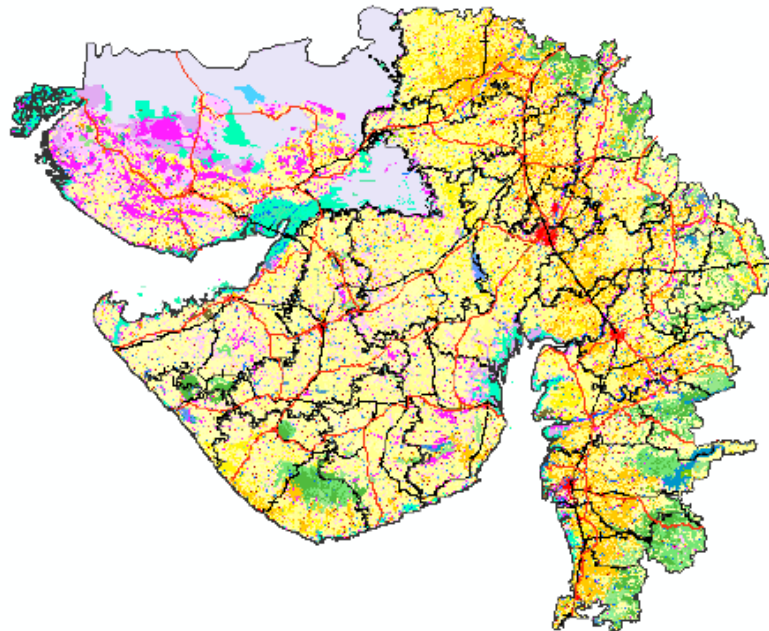
Land Use / Land Cover Maps: Gujarat

2011-12



2011-12 & 2015-16

2015-16



Legend

Built Up	
Urban-Compact (Continuous)	Urban-Sparse (Discontinuous)
Vegetated/ Open Area	Rural
Industrial Area	Mining - Active
Agricultural Land	
Kharif	Rabi
Zaid	Cropped in two seasons
Fallow Land	Agricultural Plantation
Aquaculture	
Forest	
Evergreen/ Semi - Dense/ Closed	Evergreen/ Semi - Open
Deciduous - Dense/ Closed	Deciduous - Open
Forest Plantation	Scrub Forest
Tree Clad Area - Dense/ Closed	Tree Clad Area - Open
Grass/Grazing	
Alphiner/ Sub-Alpine	Temperate/ Sub Tropical
Wastelands	
Scrub Land - Dense/ Closed	Scrub Land - Open
Sandy Area - Riverine	Barren Rocky
Wetlands	
Natural (Ox-bow lake/ Cut-off meander etc)	
Water bodies	
River - Perennial	River - Non Perennial
Lakes/ Ponds - Permanent	Lakes/ Ponds - Seasonal
Reservoir/ Tanks - Permanent	Reservoir/ Tanks - Seasonal
Snow/Others	
Snow	Shifting Cultivation - Current
	Shifting Cultivation - Abandoned

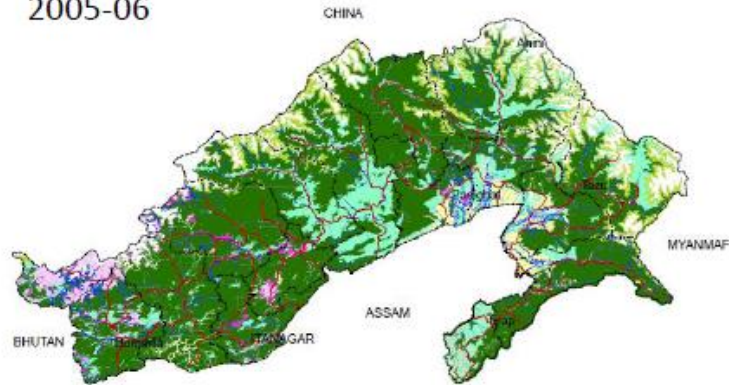
MAJOR CHANGES (11-12 to 15-16)

- ❖ Increase in Built-up (111.65 sq. km)
- ❖ Decrease in Agriculture land (64.17sq. km)
- ❖ Decrease in Wasteland (60.20sq. km)

Land Use / Land Cover Map: Arunachal Pradesh

2005-06, 2011-12 & 2015-16

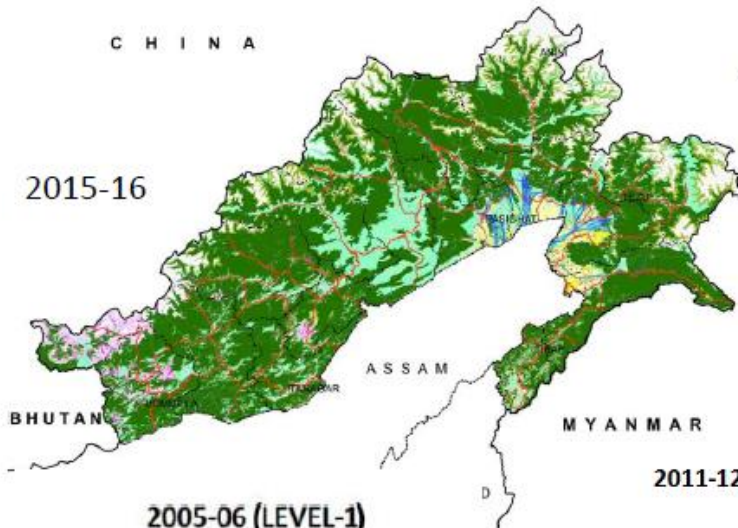
2005-06



2011-12



2015-16



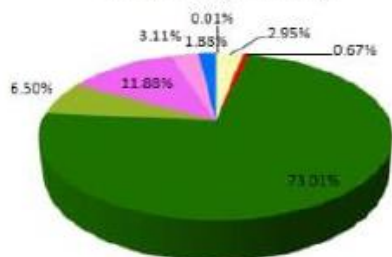
Legend

Built Up	
[Red]	Urban-Compact (Continuous)
[Light Red]	Urban-Sparse (Discontinuous)
[Light Green]	Vegetated/ Open Area
[Dark Green]	Rural
[Brown]	Industrial Area
[Orange]	Mining - Active
Agricultural Land	
[Yellow]	Kharif
[Light Yellow]	Rabi
[Light Green]	Zaid
[Light Green]	Cropped in two seasons
[Light Green]	Fallow Land
[Light Green]	Agricultural Plantation
[Blue]	Aquaculture
Forest	
[Dark Green]	Evergreen/ Semi - Dense/ Closed
[Light Green]	Evergreen/ Semi - Open
[Light Green]	Deciduous - Dense/ Closed
[Light Green]	Deciduous - Open
[Light Green]	Forest Plantation
[Light Green]	Scrub Forest
[Light Green]	Tree Clad Area - Dense/ Closed
[Light Green]	Tree Clad Area - Open
Grass/Grazing	
[Light Green]	Alpine/ Sub-Alpine
[Light Green]	Temperate/ Sub Tropical
Wastelands	
[Pink]	Scrub Land - Dense/ Closed
[Light Pink]	Scrub Land - Open
[Light Blue]	Sandy Area - Riverine
[Light Pink]	Barren Rocky
Wetlands	
[Light Green]	Natural (Ox-bow lake/ Cut-off meander etc)
Water bodies	
[Blue]	River - Perennial
[Light Blue]	River - Non Perennial
[Light Blue]	Lakes/ Ponds - Permanent
[Light Blue]	Lakes/ Ponds - Seasonal
[Light Blue]	Reservoir/ Tanks - Permanent
[Light Blue]	Reservoir/ Tanks - Seasonal
Snow/Others	
[Light Green]	Snow
[Light Green]	Shifting Cultivation - Current
[Light Green]	Shifting Cultivation - Abandoned

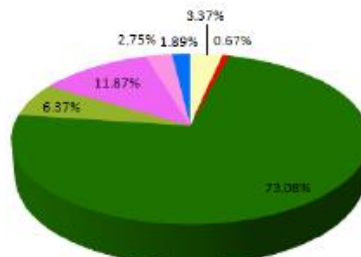
MAJOR CHANGES (11-12 to 15-16)

- ❖ Increase in agriculture (31.69 sq. km)
- ❖ Decrease in wasteland (441.29 sq. km.)
- ❖ Shifting cultivation increased by 841.57 sq. km
- ❖ Decrease in forest 514.31 sq. km.

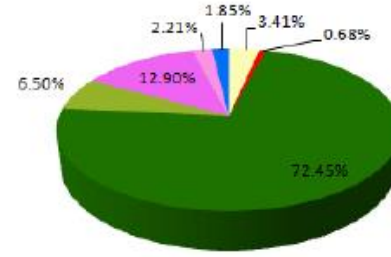
2005-06 (LEVEL-1)



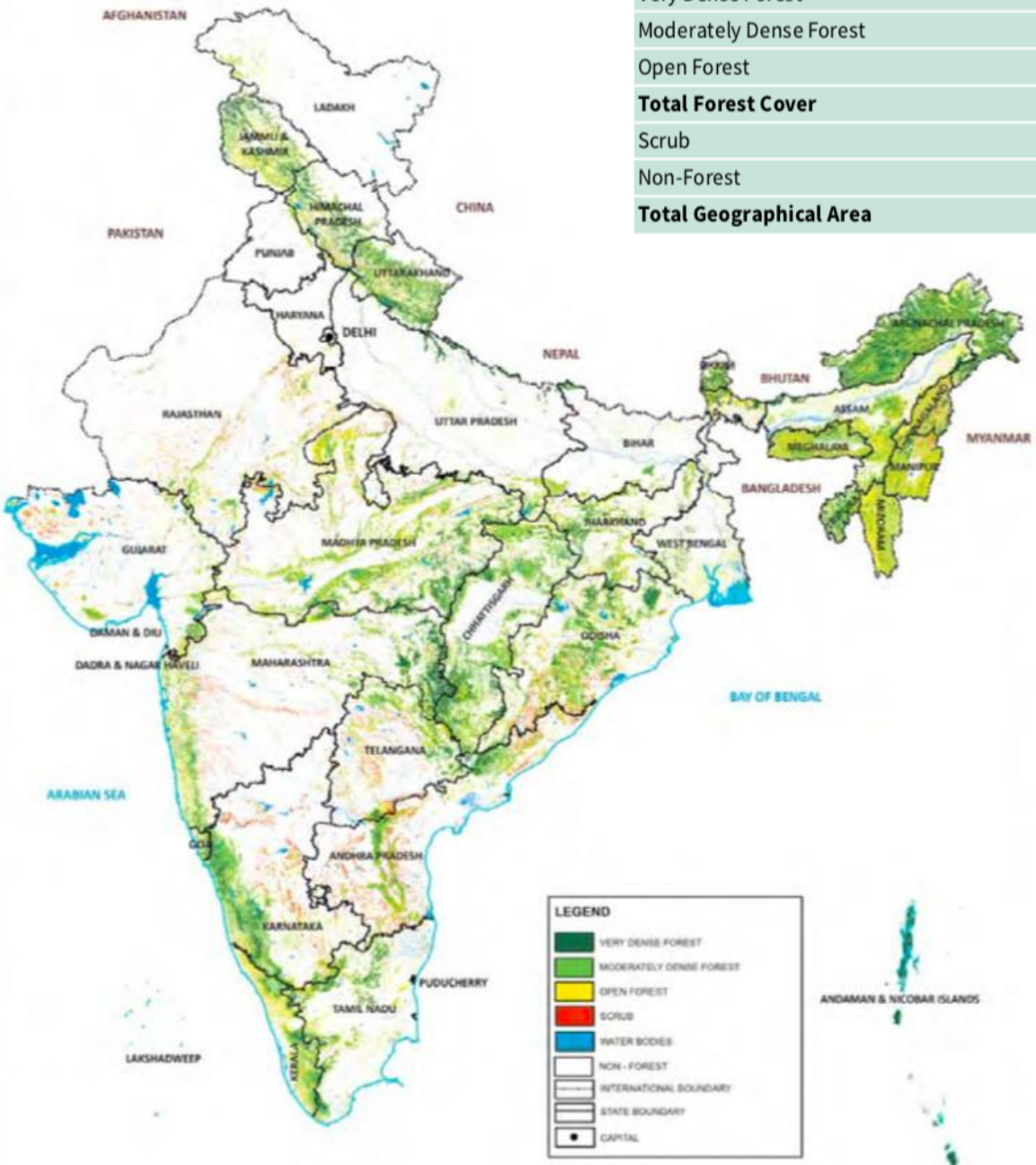
2011-12 (LEVEL-1)



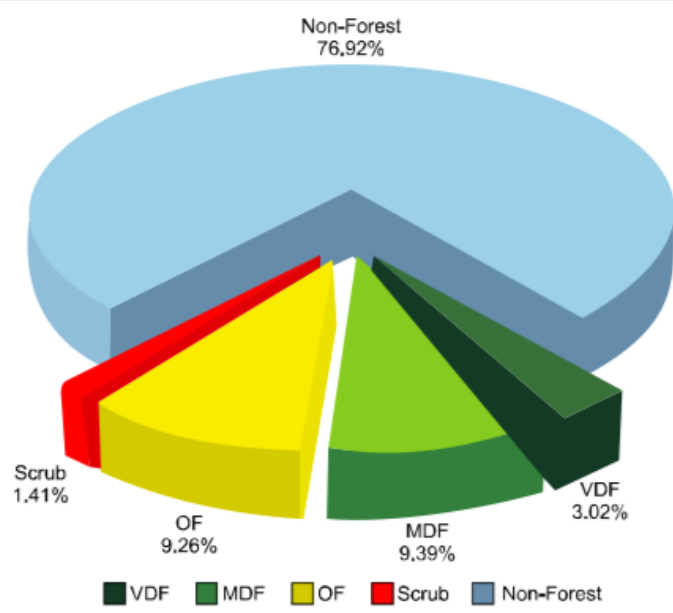
2015-16 (LEVEL-1)



Class	Area (sq km)	Percentage of Geographical Area
Very Dense Forest	99,278	3.02
Moderately Dense Forest	3,08,472	9.39
Open Forest	3,04,499	9.26
Total Forest Cover	7,12,249	21.67
Scrub	46,297	1.41
Non-Forest	25,28,923	76.92
Total Geographical Area	32,87,469	100.00

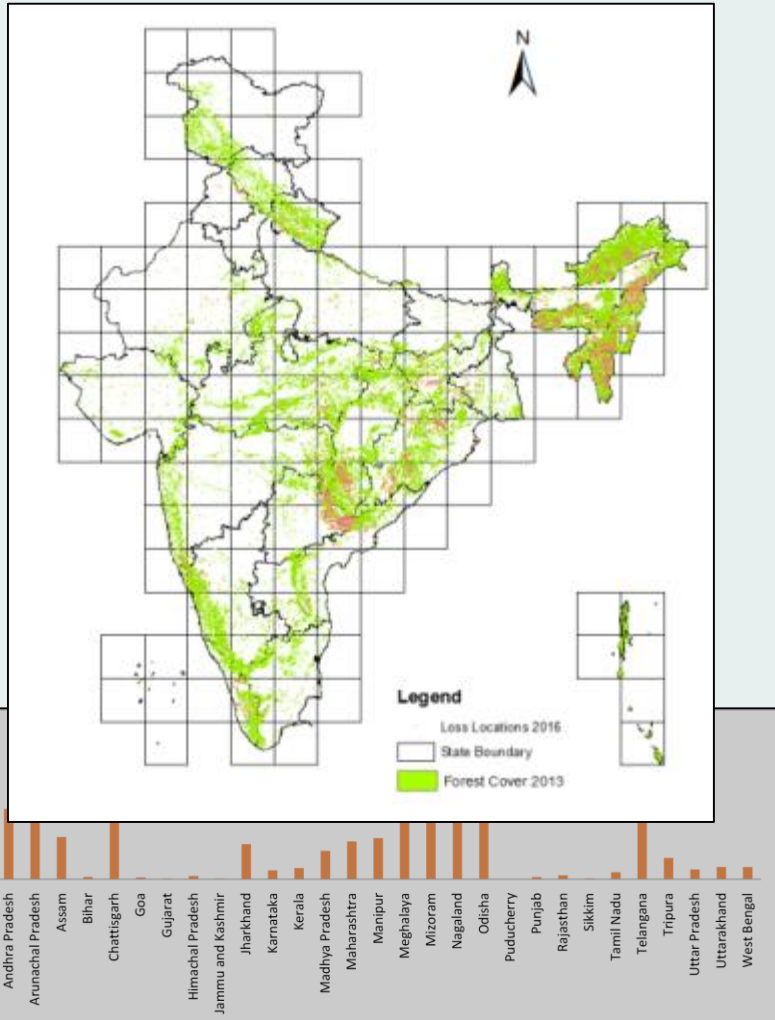


Forest Type Map of India 2019 by FSI



Forest Cover Loss

Actionable alerts from IRS AWiFS based Forest Cover Loss Locations at National Level for 2015-16 (Third) cycle



Telangana State



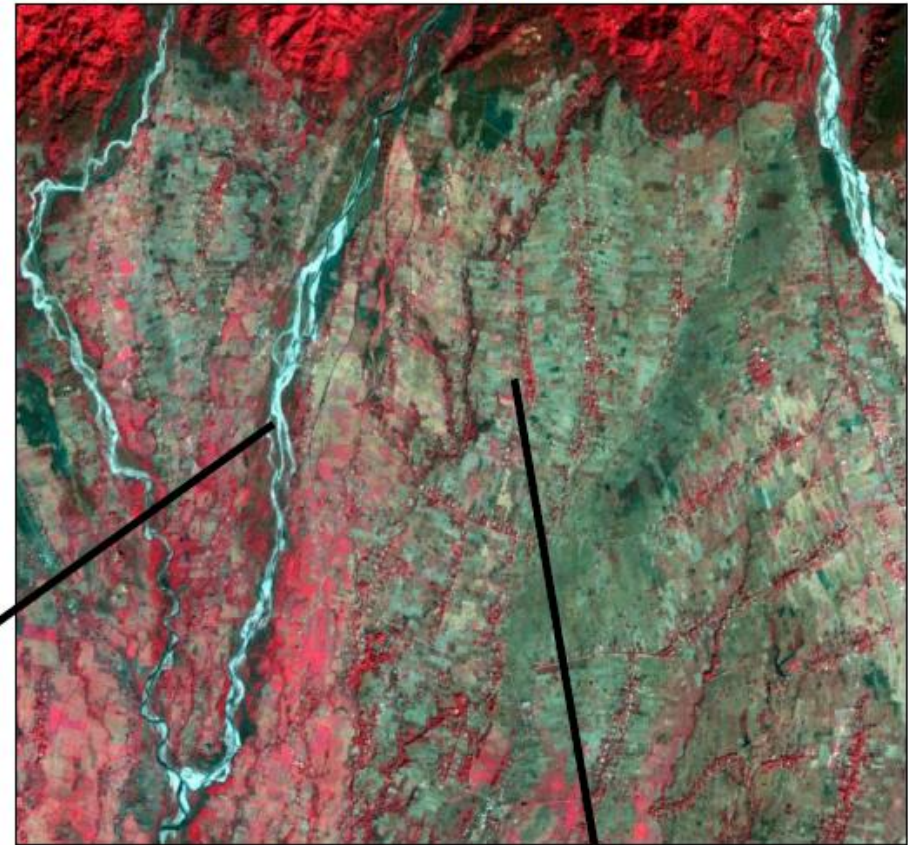
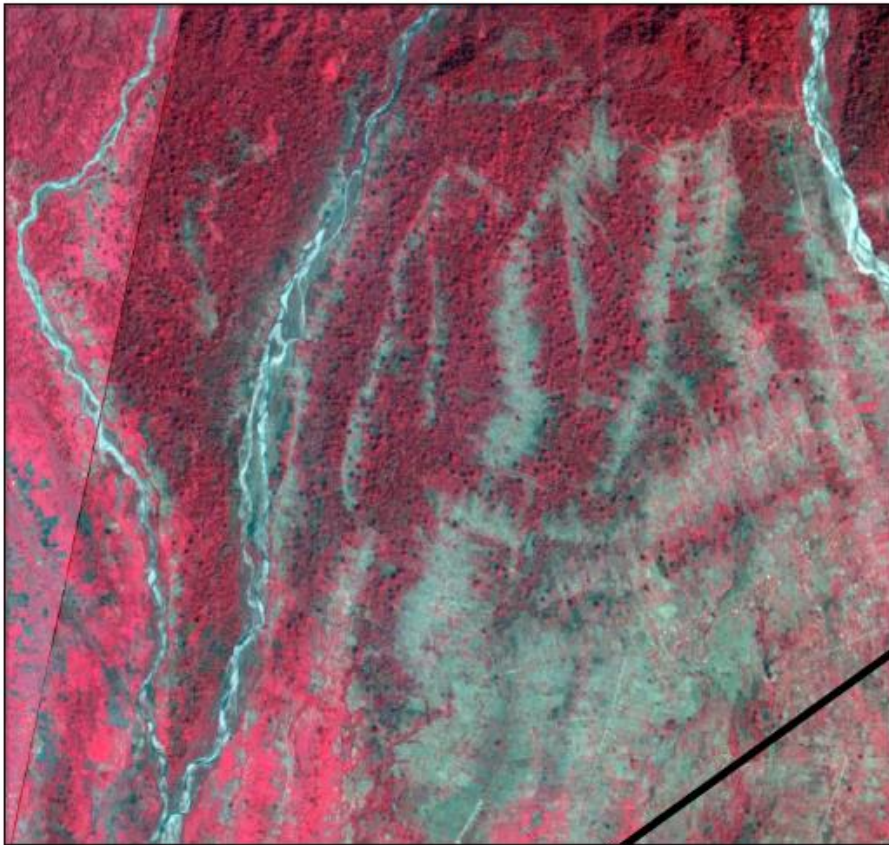
- Total Locations of 4992 are observed (2015-16 Cycle).
- 20% of points are validated with high resolution images and ~90% accuracy was obtained.
- Forest loss locations are published on Bhuvan and available to state forest departments

LULC Change in selected Hotspot Area

Sonai Rupai Wildlife Sanctuary - Assam

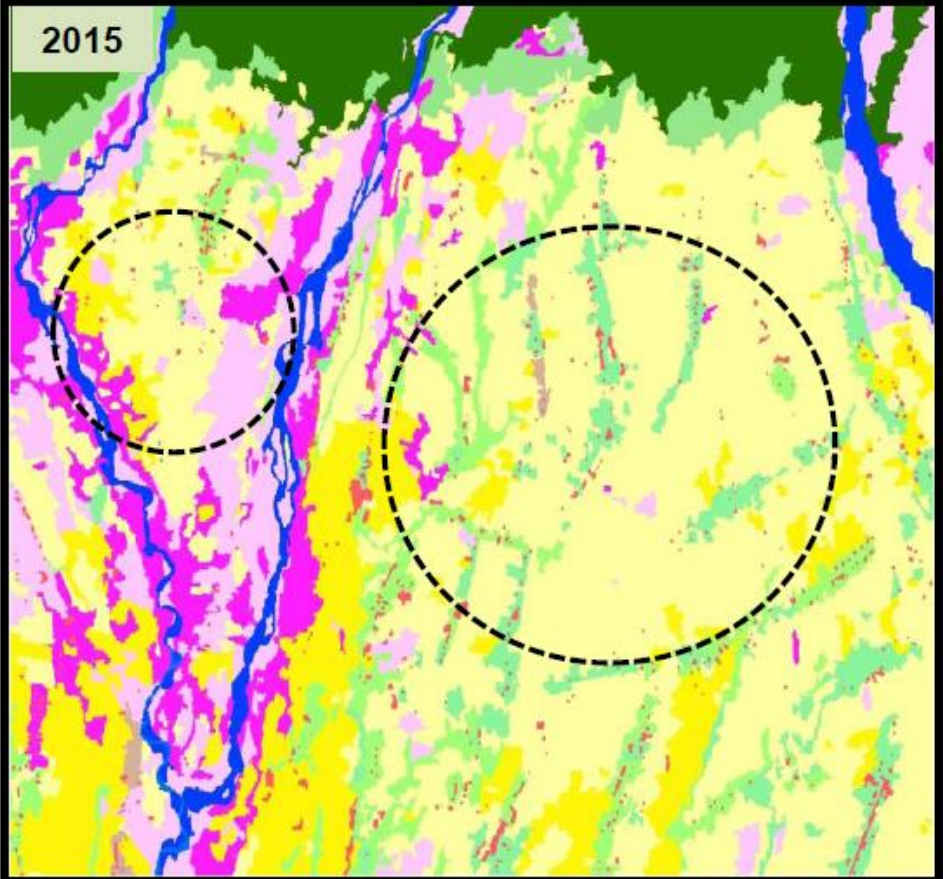
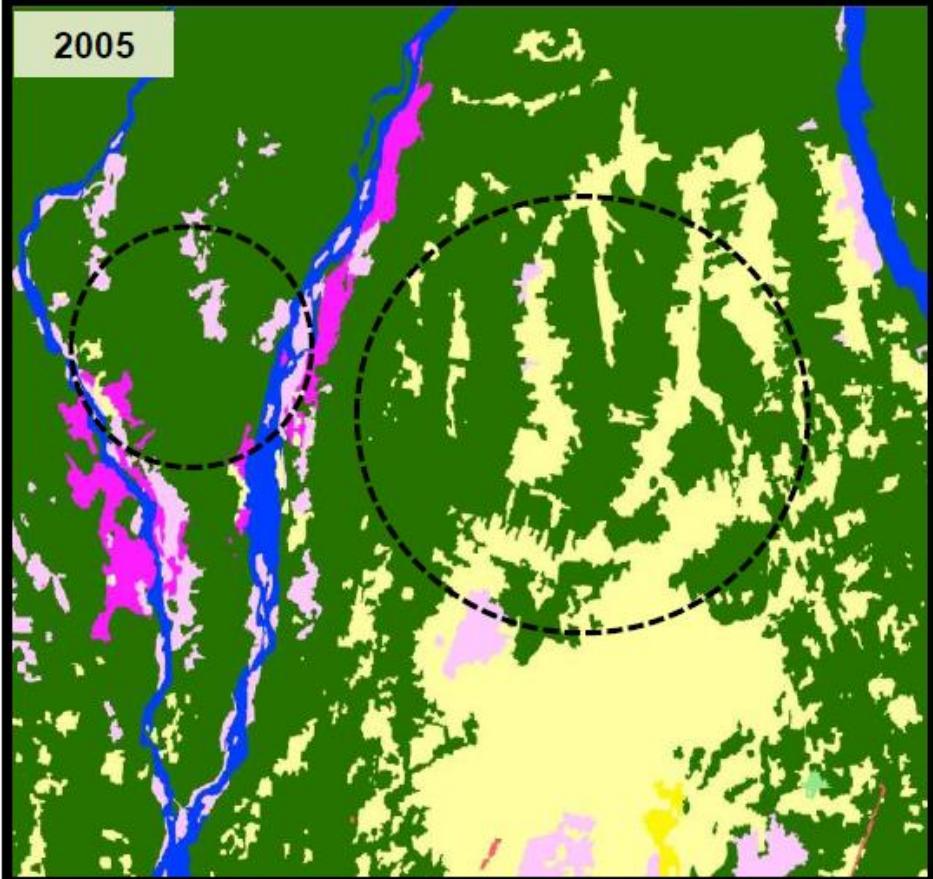
2005

2015



LULC Change in selected Hotspot Area

Sonai Rupai Wildlife Sanctuary - Assam



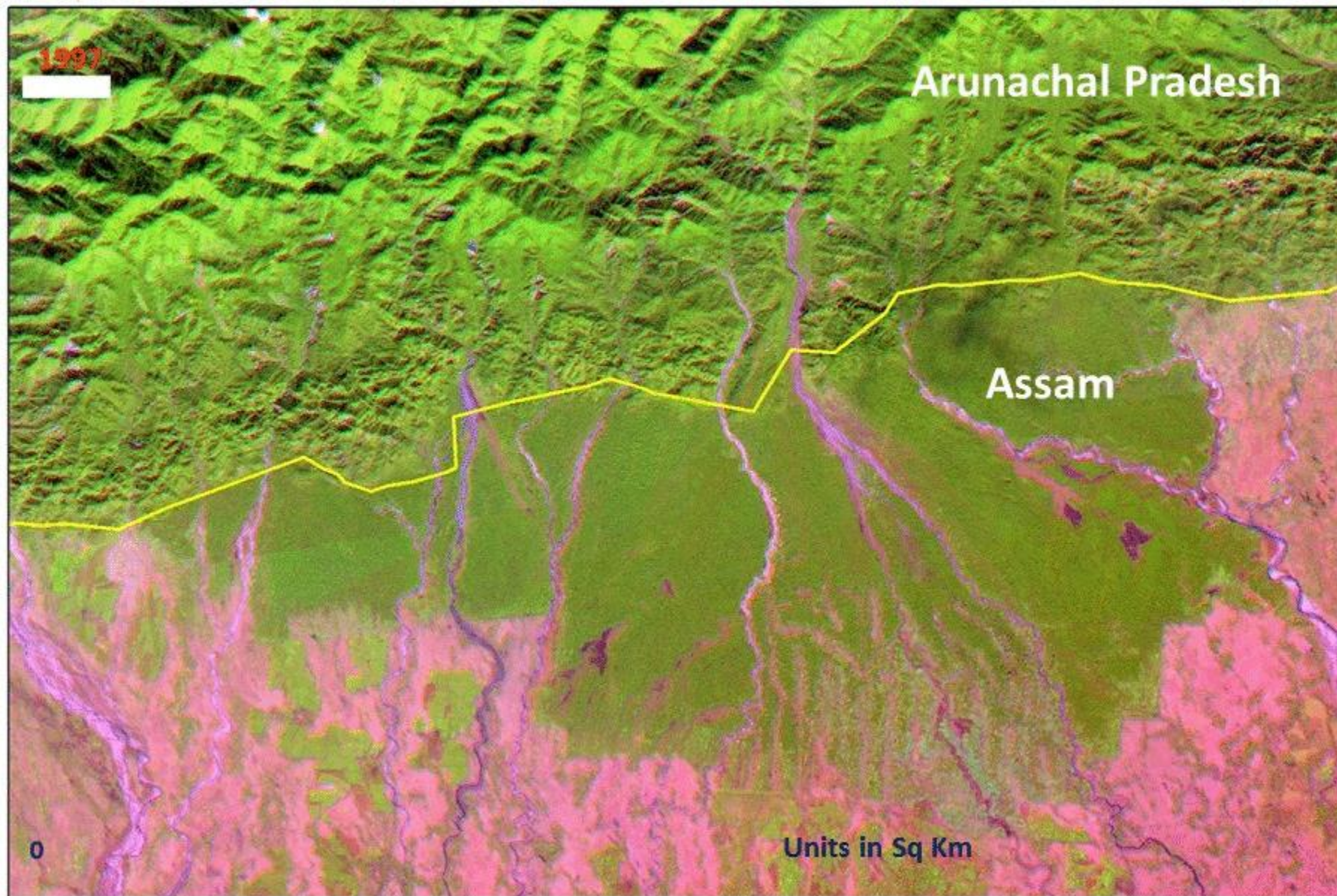
- | | | | |
|---------------------------|--------------------------|---------------------|---------------------|
| Built-up | Agricultural plantations | Swamp/ Mangroves | Wetlands |
| Rural | Aquacultures | Wastelands | Wetlands |
| Industry / Mining | Forests | Shrub / Scrub lands | Water bodies |
| Agricultural Lands | Forests | Sandy areas | Water bodies |
| Crop lands | Forest Plantations | Barren areas / Rann | |
| Fallow land / Bare areas | | | |

Major Transformations →

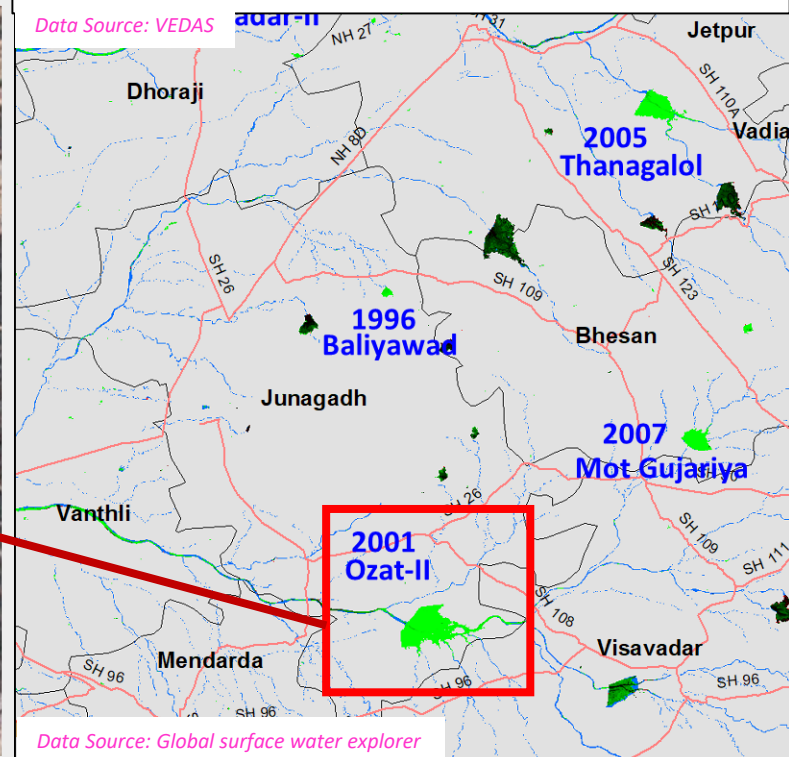
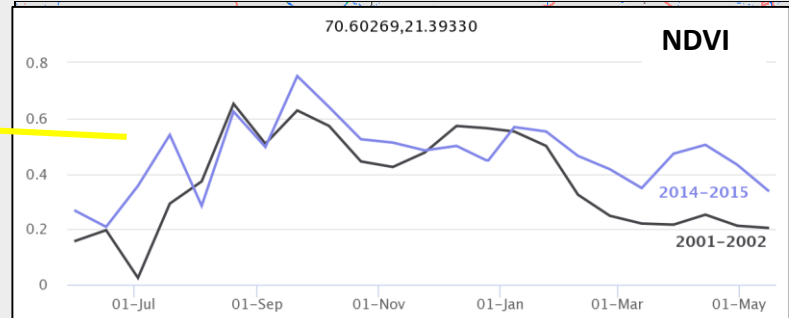
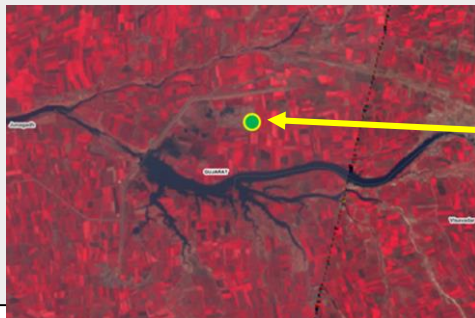
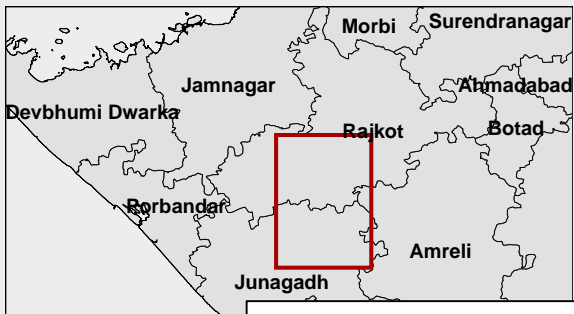
Increased in
 Croplands : 32.93 %
 Built up : 1.34 %
 Wasteland: 11.08 %

Decreased in
 Forest : 45.20 %
 Water body : 0.50 %

Large Scale Deforestation in Assam



LCLUC due to Watershed Development Program in Gujarat State, India

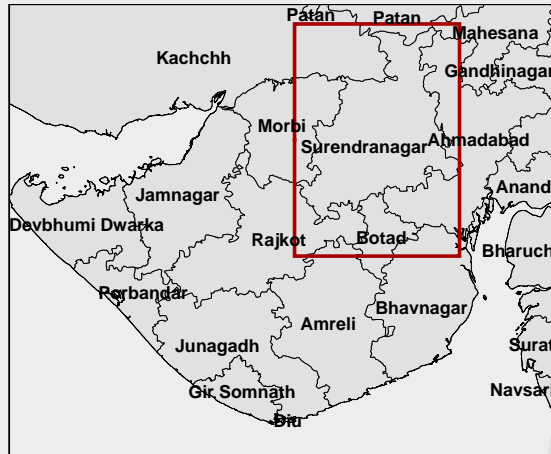


Data Source: Google Earth

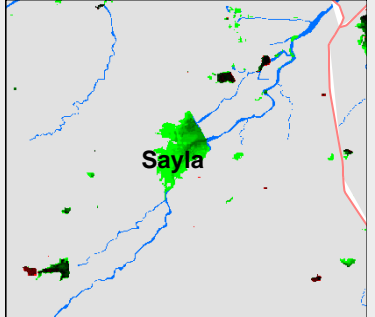
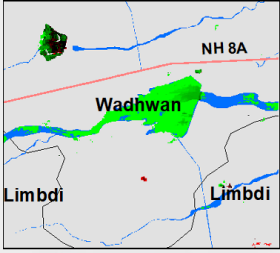
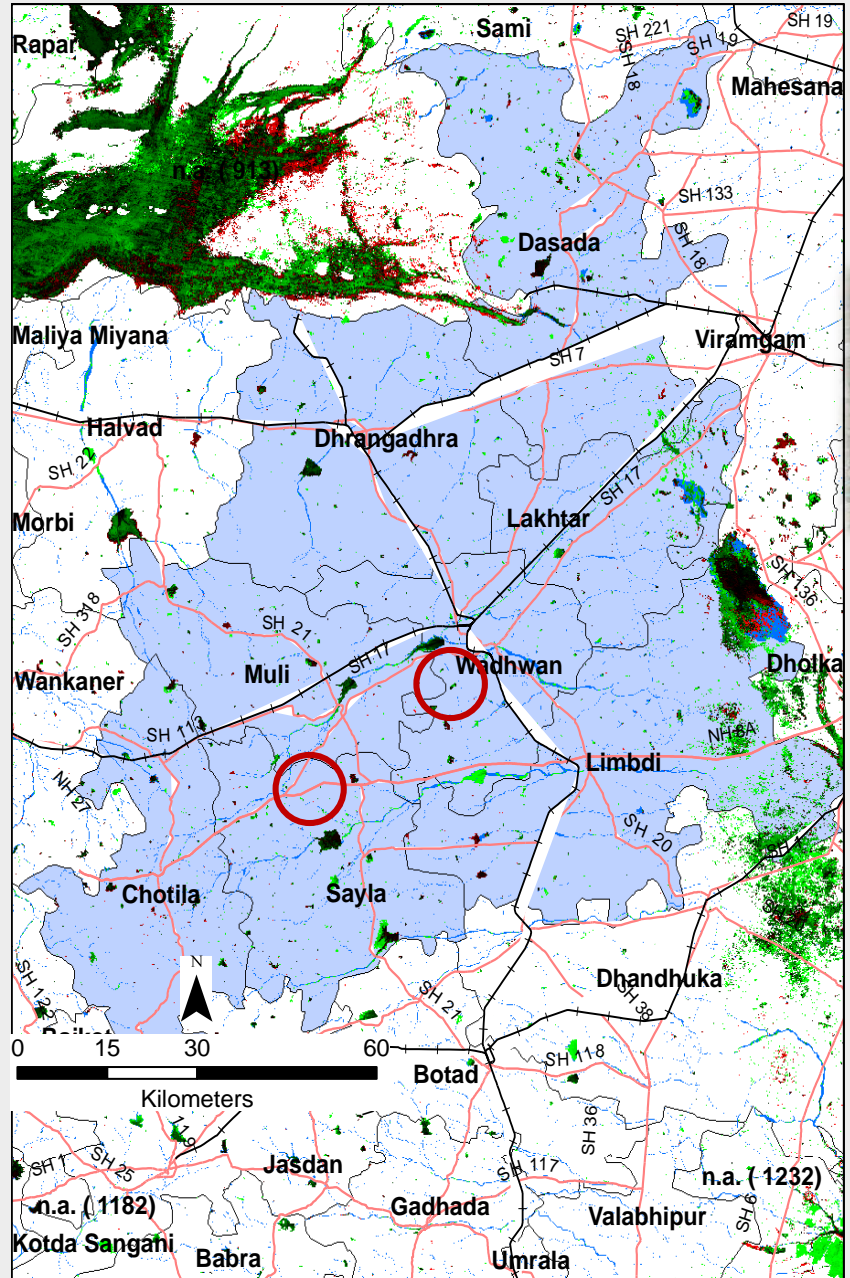
Data Source: Global surface water explorer

LCLUC due to Watershed Development Program in Gujarat State, India

Surendranagar District Water Harvesting Structures



Structure Name	Structure Observed	Water spread max (ha)	Year
Limdi (Bhogavo II)	1997-98	398	Nov 2017
-		173	Nov 2017

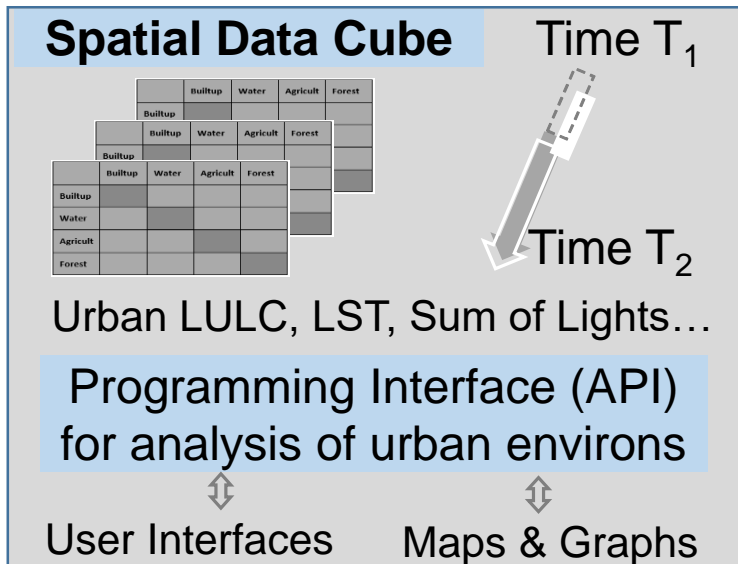


Data Source: Global surface water explorer

URBAN INFORMATICA

A Customized Spatial Data Cube of Urban Environs

- Uses Google Earth Engine (GEE) Apps/ platform to visualise/ analyse urban sprawl, growth modeling, LST pattern, night-time data analysis, air pollution, etc. and correlation with socio-economic attributes.
- Integration of Global Human Settlement Layer (GHSL), Global Surface Water, Night-time lights, Sentinel-5P, MODIS LST, Landsat time-series, etc.
- User-defined AOIs/ administrative boundaries, Image and graphical outputs



GOVERNMENT OF INDIA
INDIAN INSTITUTE OF REMOTE SENSING
INDIAN SPACE RESEARCH ORGANISATION

Urban Informatica

A customized solution based on Spatial Data-Cube principles for studying urban environs intended for general use by Urban Planners and Engineers affiliated to Town and Country Planning Offices, Academic and Research Institutions, etc. for extracting space-based information on urban sprawl, growth modeling, population, pollution, surface water, green spaces, land surface temperature (LST), etc. It contains a multidimensional data modeling solution to analyse and establish correlation between variables depicting urban surfaces based on time-series remote sensing data available on Google Earth Engine (GEE) platform. Global Human Settlement Layer (GHSL), Global Human Settlement - Population (GHS-POP) and Global Surface Water Explorer (GSWE) data for entire country has been integrated in web user interface. It also contains the time-series night-time data of DMSP-OLS and VIIRS sensors and does correlation analysis between sum of lights and various socio-economic attributes. It provides a framework to extract temporal information and also builds inter-relationship between various indicators. The information can be extracted at country, state or district level, or based on area of interest (AOI) as defined by the user. It is also possible to extract various spectral indices for defined AOIs.

[Proceed](#)

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INDIAN SPACE RESEARCH ORGANISATION

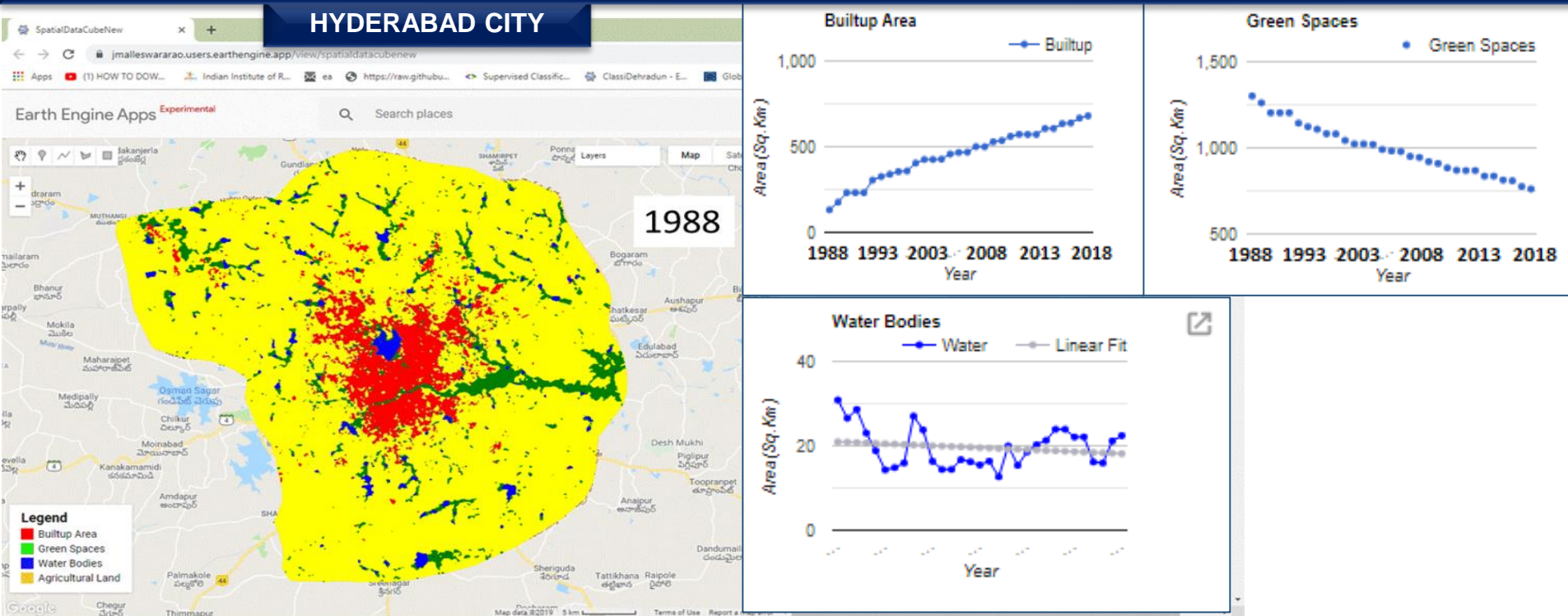
- Urban Sprawl**: Remote Sensing (RS) data provides an important data sets to monitor urban sprawl or growth over a period of time. This is one of the forth... [Read More](#)
- Urban Growth Modeling**: In order to ensure sustainable urban development, it is imperative to develop predictive models of urban growth. These models not only... [Read More](#)
- Night Time Lights (NTL)**: Night time datasets are able to detect low level of lights coming from earth surface on a daily basis for the entire globe. Thus making it p... [Read More](#)
- Global Human Settlement Layer (GHSL)**: Global spatial information on physical size and density of settlements organized in four epochs from Landsat image collections (1975, 1990... [Read More](#)
- Global Surface Water Explorer**: Dataset developed using expert systems, visual analysis and in-situ field recording under Copernicus Programme at 30 m spatial resolution with... [Read More](#)
- Air Pollution**: The atmospheric concentration of ozone, methane, formaldehyde, aerosol, carbon monoxide, nitrogen oxide, and sulphur dioxide, as well as d... [Read More](#)
- Global Urban Population**: This spatial raster dataset at 250 m (0.25 arcsec) and 1 km (30 arcsec) resolution depicts the distribution of population, expressed as the numb... [Read More](#)
- Land Surface Temperature**: The day/night Terra/Aqua Level 3 Moderate Resolution Imaging Spectroradiometer (MODIS) land surface temperature (LST) 1 km product is used t... [Read More](#)
- Urban Toolbox**: Urban toolbox is designed to provide 3-variables or multivariate relationship among two variables or more. It is also envisaged to incorporat... [Read More](#)
- Spectral Indices For Urban Areas**: It contains various spectral indices, namely Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Normalized DVI... [Read More](#)

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<https://urban.iirs.gov.in/>

Alpha version

CUSTOMISED SPATIAL DATA CUBE OF URBAN ENVIRONS



URBAN GROWTH MODELING

Urban suitability map is prepared based on the accessibility to the nearest roads and slope of the terrain. This Growth Model considered the criteria of Agricultural/Barren lands converted to Builtup

Urban Accessibility and Suitability Maps:

Urban Accessibility Map

Urban Suitability Map

Clear Data

Model Validation and Accuracy:

LULC Map:2008

LULC Map:2018

Predict Map for 2018

Validation Accuracy

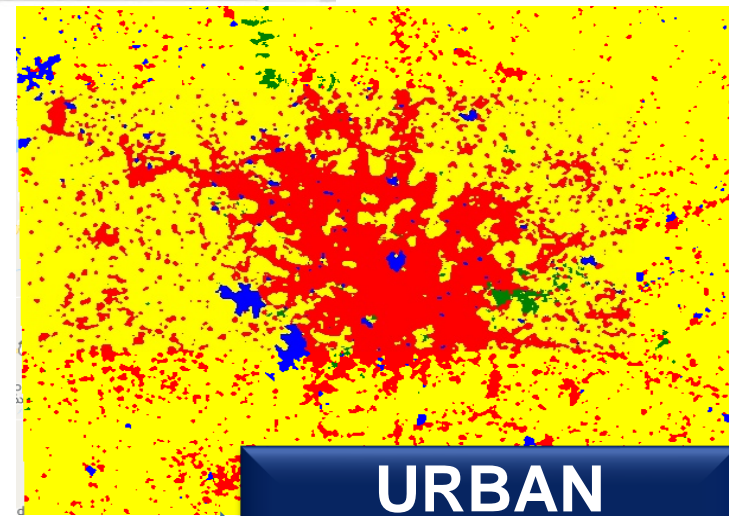
Future Urban Growth Prediction:

Predict Map 2028

Predict Map 2038

Predict Map 2048

Predicted Urban Growth for 2048



User friendly GUI using Open Data Cube Architecture for time-series data analysis

URBAN INFORMATICA

Major user of LULC can be grouped into following three major category:

1. **Weather and climate prediction:** Land cover interacts with the atmosphere, which leads to regulation of the hydrologic cycle and energy budget, and as such is needed both for weather and climate prediction. E.g. Land Surface Parameterizations (LSPs), produce databases of albedo, surface roughness, evapotranspiration and respiration.
2. **Process involving carbon cycle:** It acts as both sources and sinks of carbon. So, to measure rates of deforestation, afforestation, and regrowth play a significant role in the release and sequestering of carbon
3. **Societal need:** Availability of food, fuel, timber, fibre, and shelter resources for human populations, so it is a critical indicator of other ecosystem services such as biodiversity, many national/global applications like watershed management and agricultural productivity etc.

Thank You