LAND USE LAND COVER MAPPING

Dr.T.RAVISANKAR

Group Director, LRUMG / RSAA
National Remote Sensing Centre (NRSC) / ISRO Hyderabad – 500625 INDIA

TECHNICAL TALK AT OUATBHUBANESWAR ON 14-10-2017

INTRODUCTION

Identifying, delineating and mapping land cover is important for global monitoring studies, resource management, and planning activities

Identification of land cover establishes the baseline from which monitoring activities (change detection) can be performed.

Remote sensing methods can be employed to classify the types of land use in a practical, economical and repetitive fashion, over large areas.

important considerations during LULC mapping are:

- **Purpose- scientific studies, policy, planning or management purposes.**
- **Thematic content - needed for few cover types or for all cover types**
- **Scale - locally, regional scales, or continental to global scales.**
- **Data- RS data limit type and accuracy of information that may be extracted.**
- **Methodology – visual or digital or automatic or semi-automatic**

The purpose and thematic content help determine the classes that must be differentiated in the land cover product, i.e. the mapping legend. The scale, together with the legend, determines the remote sensing data source appropriate to the mapping problem.

SOURCES OF LAND USE/COVER INFORMATION

A. **CONVENTIONAL**

Revenue records compiled by the Directorate/Bureau of Economic and Statistics (DES/BES) ***which is mainly tabular.***

Topographical maps from Survey of India represent very broad land cover categories. ***These maps mainly provide topographical information.***

Land use Atlas from NATMO are mainly small scale and are secondary compilations.

Soil Survey organizations (NBSS&LUP and AIS&LUS) generate soil and land capability maps for specific project/ areas.

B. REMOTE SENSING BASED

- **LULC Maps at different scales from NRSC using satellite data / Aerial**
- **Photos**

LAND USE LAND COVER

Although the terms land cover and land use are often used interchangeably, their actual meanings are quite distinct.

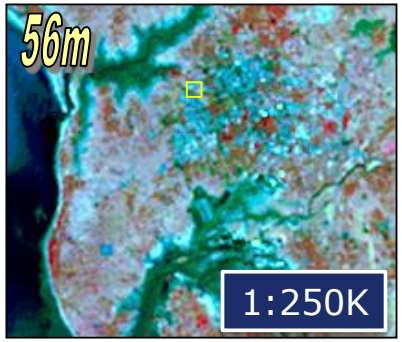
LAND COVER

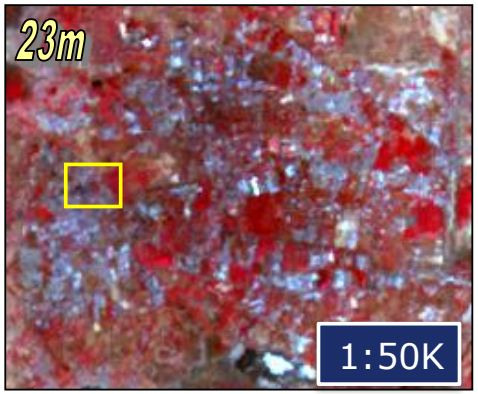
- Land cover refers to the surface cover on the ground - vegetation, urban infrastructure, water, bare soil etc.
- Identification, delineation and mapping land cover is important for monitoring studies, resource management, and planning activities.
- Identification of land cover establishes the baseline from which monitoring activities can be performed.

LAND USE

- Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture.
- Land use applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the land use changes from year to year.
- This knowledge will help develop strategies to balance conservation, conflicting uses, and developmental pressures.

LAND USE LAND COVER INVENTORY USING SATELLITE DATA





Tarapur, Maharashtra

FIVE FACTORS IN LULC MAPPING

1. Objectives
2. Classification Scheme
3. Mapping Scale
4. Data Source
5. Analysis technique

CHARACTERISTICS OF CLASSIFICATION SYSTEM

Classification system should meet following criteria:

- 85 percent or greater interpretation accuracy;
- Repeatable results among interpreters and from one time of sensing to another;
- Geographically extensible;
- Suitable for use with data from different seasons;
- Effective use of subcategories to permit use of data from ground surveys and large scale imagery;
- Aggregation of categories must be possible;
- Comparison with future land use data should be possible; and
- Multiple uses of land should be recognized i.e. segments having multiple activities, each activity should be included

LULC CLASSIFICATION SYSTEMS - INTERNATIONAL SCENARIOS

Sl.	Classification System	Organ. / Country	L– I	L-II	L-III	Remarks
1	NRC-LULC50K	India	8	31	54	Meeting user requirements of various Indian user department
2	NRC-AWiFS	India	9	19	--	Emphasis on Area under agriculture
3	DES / BES	India	5/9			Statistical compilation
4	Globeland 30	China	10			Global coverage using USGS free data
5	IGBP	Global	17			Elementary LC more suited for climate modeling
6	Anderson (USGS)	USA	9	37	--	Flexibility given to user for L-III and L-IV
7	CORINE 2000	Whole Europe	5	15	44	Intended for 100,000 scale LC database and tuned for application in climate modeling
8	FAO - LCCS	10 African Country	Dichotomous – 8 Modular ~ 40K			Flexible enough to adopt various geographical regios of the world
9	LCM 2007	U.K.	23			Three cycles using SPOT imagery
10	USGS Mod.	USA (Florida)	9	41	190	Suitable for Aerial based mapping and confined for Florida

BALNAS – LC and LU Classification, Australian LU Mapping (L-I:6 , L-II:33, and L-III:136) etc.

SCALE - METHOD - OUTPUT

Sl.	Classification System	Organ. / Country	Scale	Method	Output
1	NRC-LULC50K	India	1:50K	Knowledge based	Vector
2	NRC-AWiFS	India	1:250K	Digital, rule based	Raster
3	DES / BES	India	Statistical	Survey	Table
4	Globeland 30	China	1:50K	Mix (MLC, SVM, Dec. tree + Object + Knowledge)	Raster
5	IGBP	Global	1:1m	Digital	Raster
6	Anderson (USGS)	USA	Defined for 1:250K (L-II)	Only classification	Vector/Raster
7	CORINE 2000	Whole Europe	MMU 25 ha	On screen visual interpretation	Vector
8	FAO - LCCS	10 African Country	Dynamic scale	Visual interpretation	Vector
9	LCM 2007	U.K.	MMU 0.5ha	N.A.	Vector (MMU 0.5ha) & Raster 25m, 1km

Classification adopted for land-utilization statistics(DES)

OLD FIVE FOLD CLASSIFICATION

1. Forests
2. Area not available for cultivation
3. Other cultivated land, excluding current fallows
4. Fallow lands
5. Net area sown

NEW NINE FOLD CLASSIFICATION

1. Forests
2. Land put to non-agricultural uses
3. Barren & unculturable land
4. Permanent pastures & other grazing lands
5. Miscellaneous tree crops & groves, not included in the net area sown.
6. Culturable waste
7. Fallow land, other than current fallows
8. Current fallows
9. Net area sown

Old : 5 classes
New : 9 classes

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

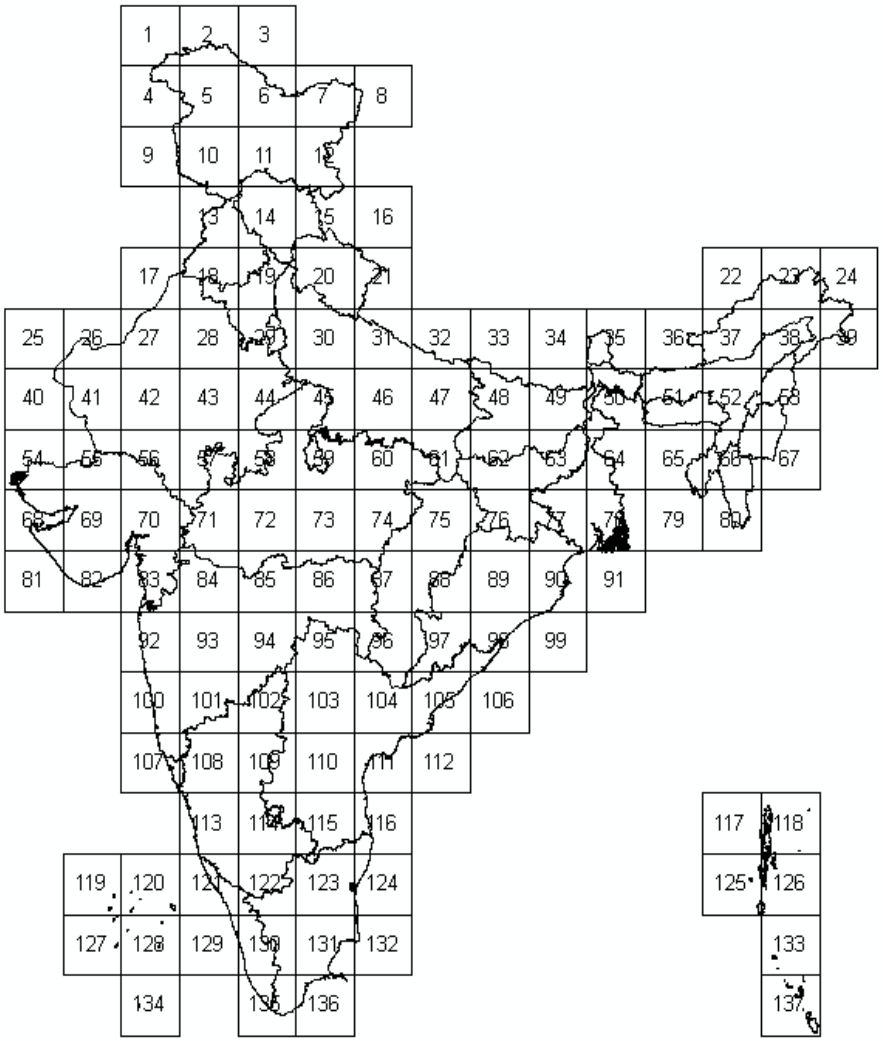
Minimum of 50 sites Representative of major ecosystems

LAND USE / LAND COVER CLASSIFICATION INDIA –AWIFS 1:250k

S.No	Land Use / Land Cover Class
	Built up land
1	Built up land(Urban / Rural)
	Agriculture
2	Kharif crop land
3	Rabi crop land
4	Zaid crop land
5	Double crop land (Area sown more than once)
6	Current fallow land
7	Plantations / orchards
	Forest
8	Evergreen / Semi-Evergreen forest
9	Deciduous forest
10	Shrub / degraded / Scrub Forest
11	**Littoral Swamp / Mangrove / Fresh water Swamp**
12	Grassland & Grazing Land
	Wastelands
13	Other Wastelands : Salt Affected Land / Sandy Area / Mine dumps / Industrial waste / Dumps / Barren rock / Stony waste / Sheet rock
14	Gullied / Ravines
15	Land with shrub / scrub
16	Land without shrub / scrub
	Water bodies
17	Rivers / Streams/ Lakes / Ponds / Reservoir / Tanks / Ash pond / Cooling Pond / Wetland / Waterlogged areas
18	**Shifting cultivation areas**
19	**Snow Covered / Glacial area**

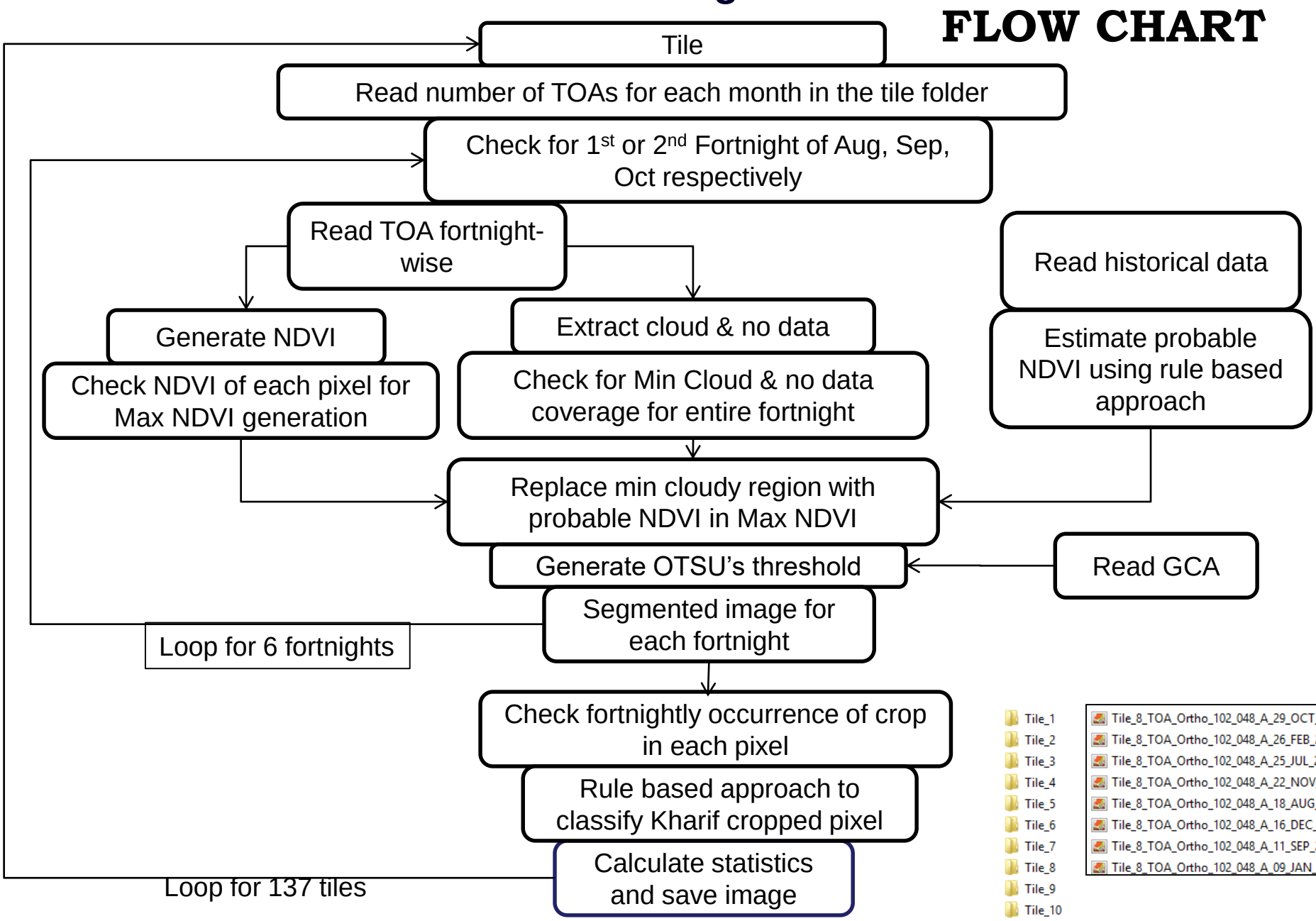
Level-I: 9 classes
Level-II: 19 classes

5. Net Sown Area estimation using AWiFS



200 Km tiling scheme
Total=137 tiles

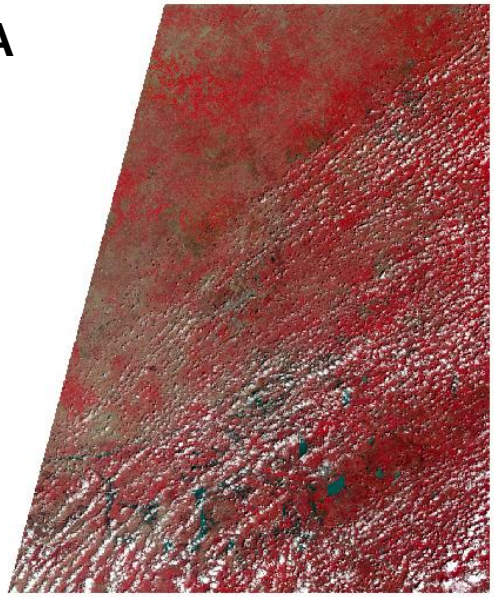
5. Net Sown Area estimation using AWiFS



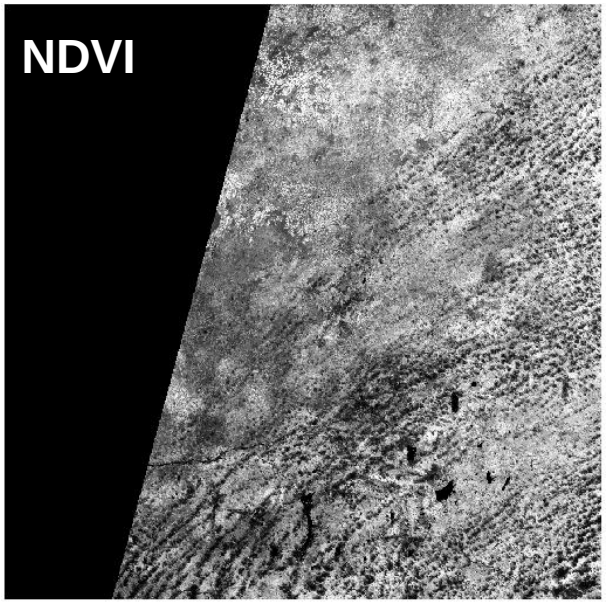
5. Net Sown Area estimation using AWiFS

Tile 42 (03_SEP_2016)

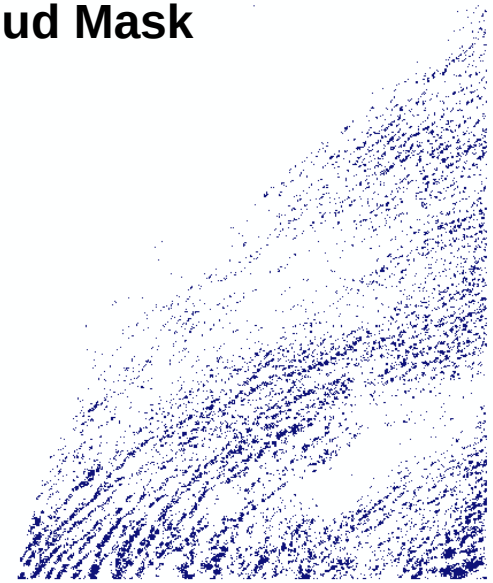
TOA



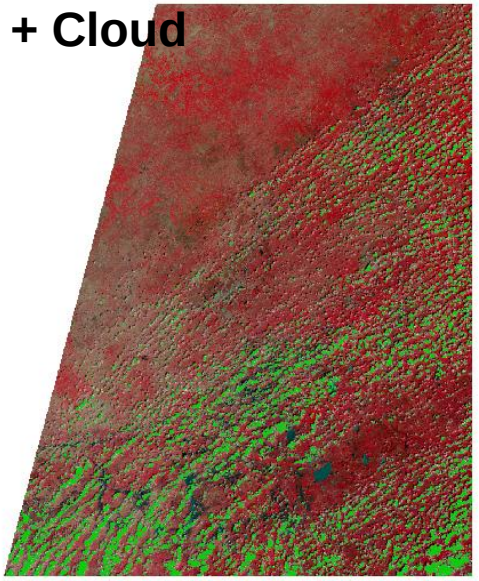
NDVI



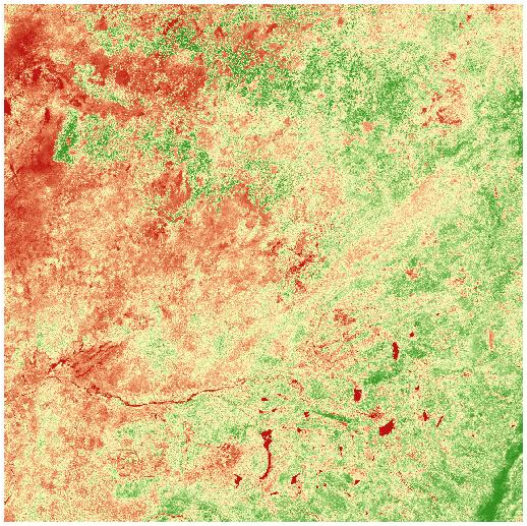
Cloud Mask

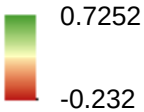


TOA + Cloud



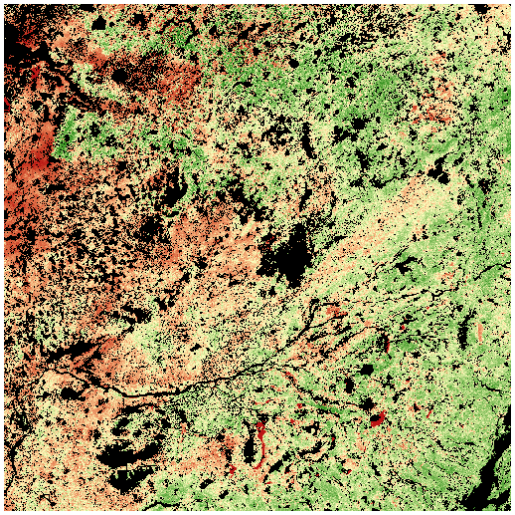
5. Net Sown Area estimation using AWiFS





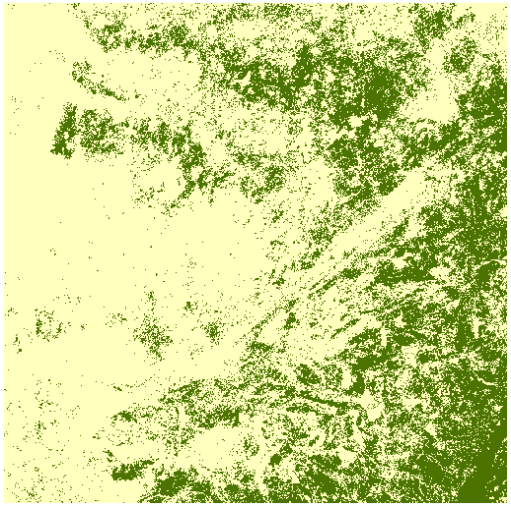
NDVI

Not in GCA



GCA + NDVI

Customised OTSU Thresholding

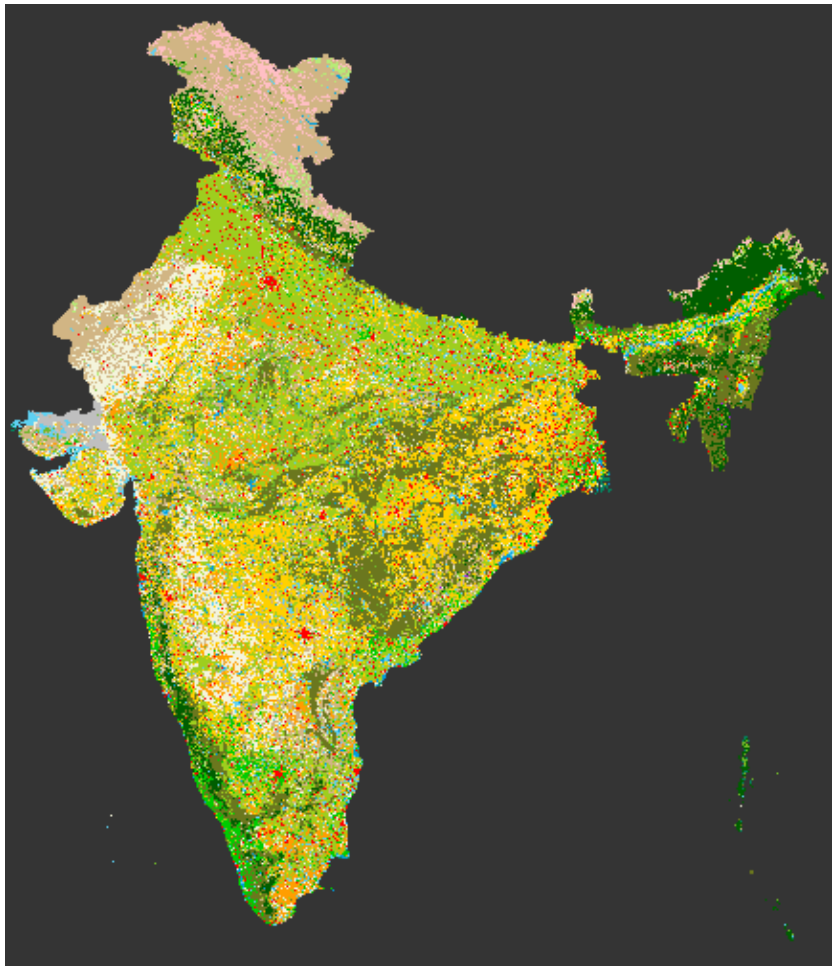


Net Sown Area

Other LULC class

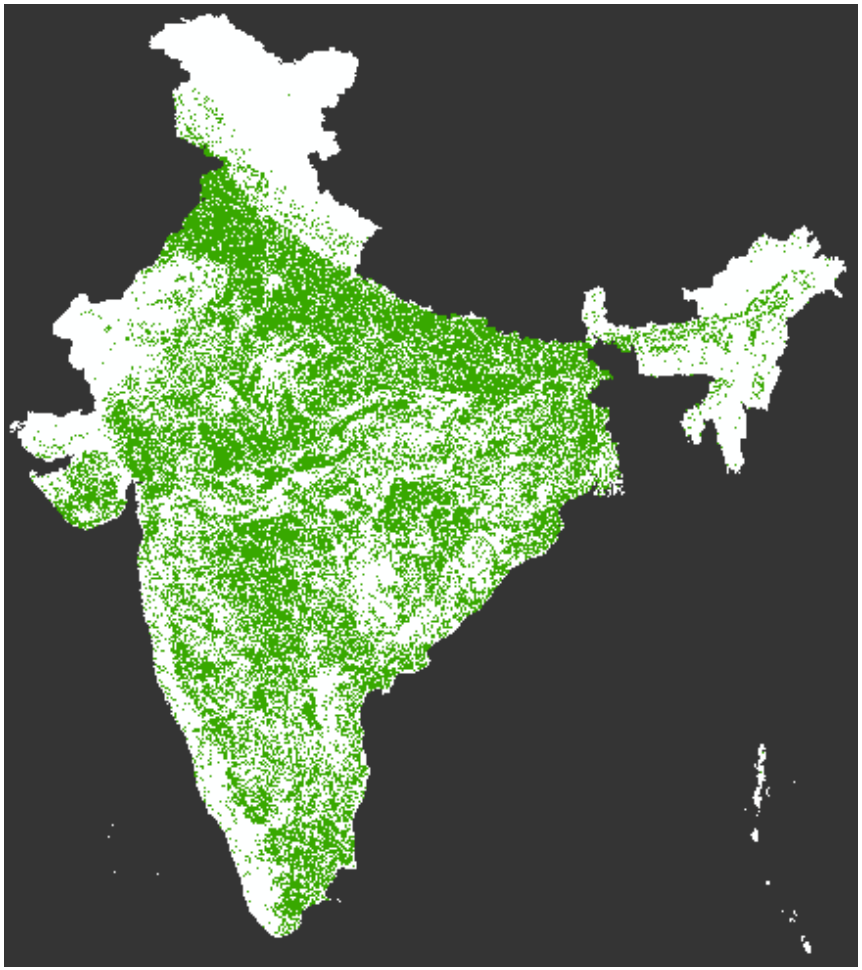
Net Sown Area

5. Net Sown Area estimation using AWiFS



LULC 2015-16

- Builtup
- Kharif crop
- Rabi crop
- Zaid crop
- Double/triple crop
- Current Fallow
- Plantations
- Evergreen forest
- Deciduous forest
- Degraded/scrub forest
- Littoral swamp
- Grasslands
- Shifting cultivation
- Wastelands
- Rann
- Waterbodies max
- Waterbodies min
- Snow cover

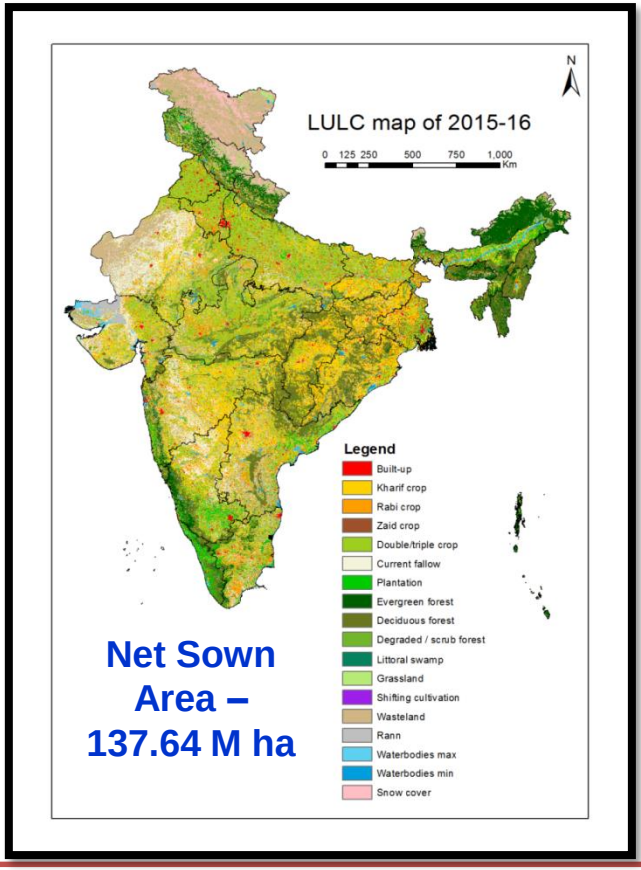


NSA 2015-16

- Net Sown Area

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 year .
- 10 cycles completed.
- Temporal analysis carried out to find consistently cropped and fallow areas



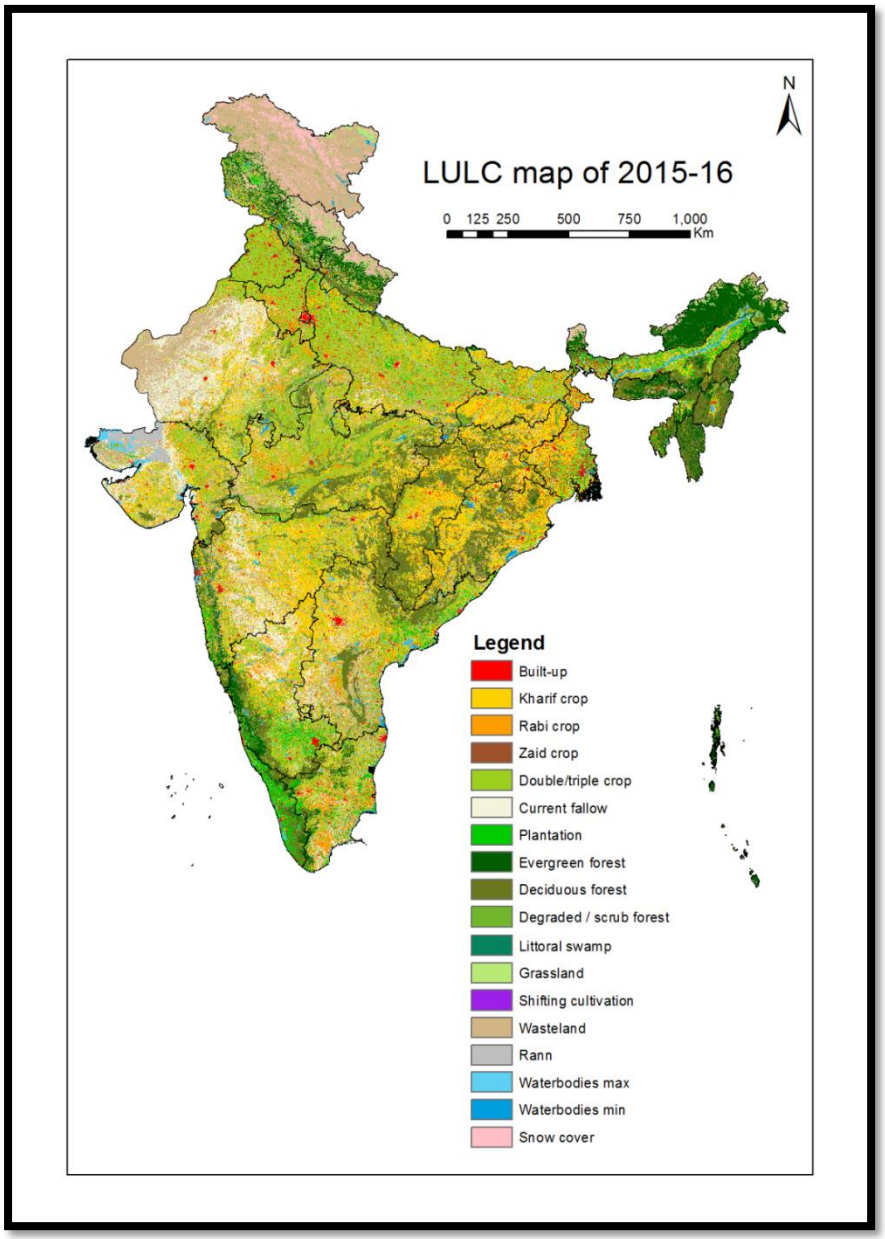
- Built-up
- Kharif
- Rabi
- Zaid
- Double /Triple crop
- Fallow
- Plantation
- Evergreen forest
- Deciduous forest
- Degraded forest
- Mangroves
- Grasslands
- Wastelands
- Gullied/ravines
- Scrubland
- Water bodies
- Snow
- Shifting cultivation
- Rann

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

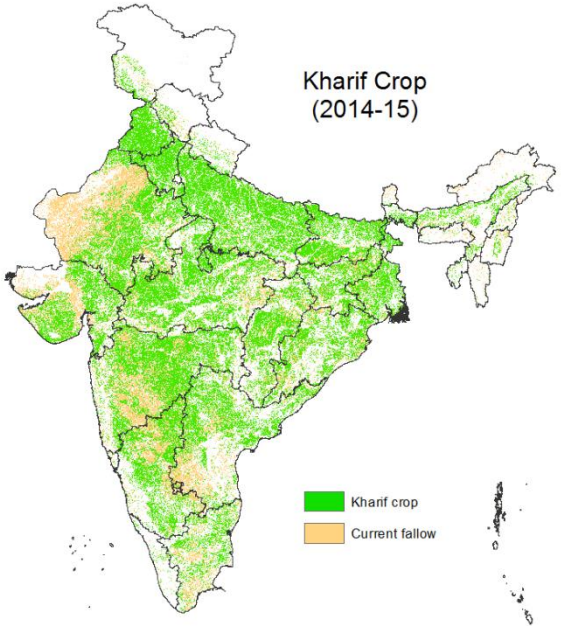
NATIONAL LAND USE AND LAND COVER MAPPING USING MULTITEMPORAL AWiFS DATA

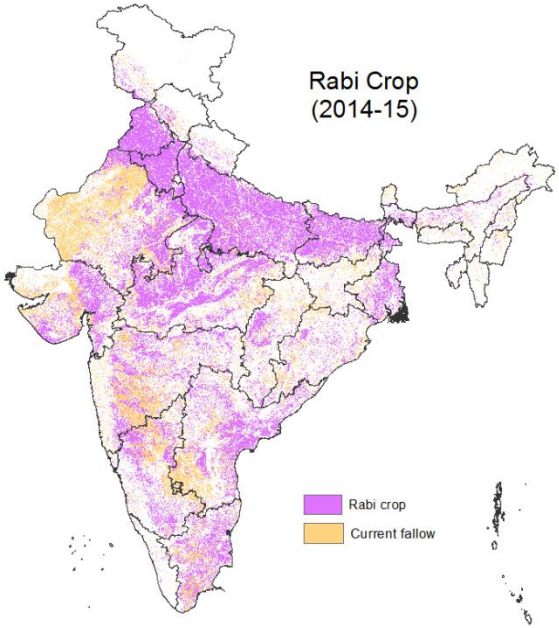


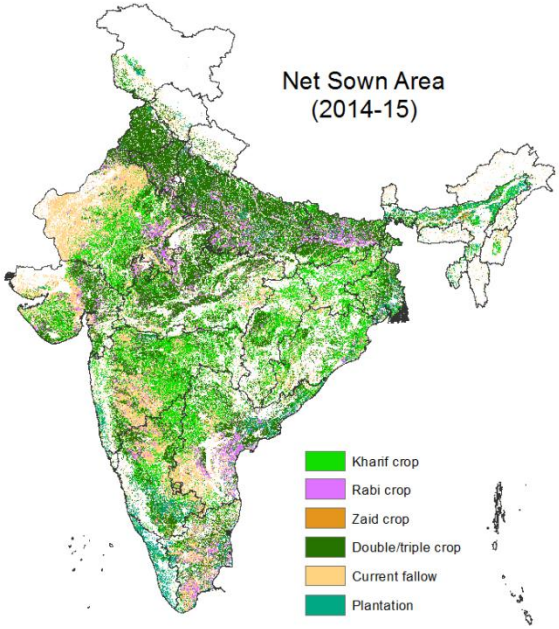
Areas in million ha

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**

Cropped Area in 2014-15





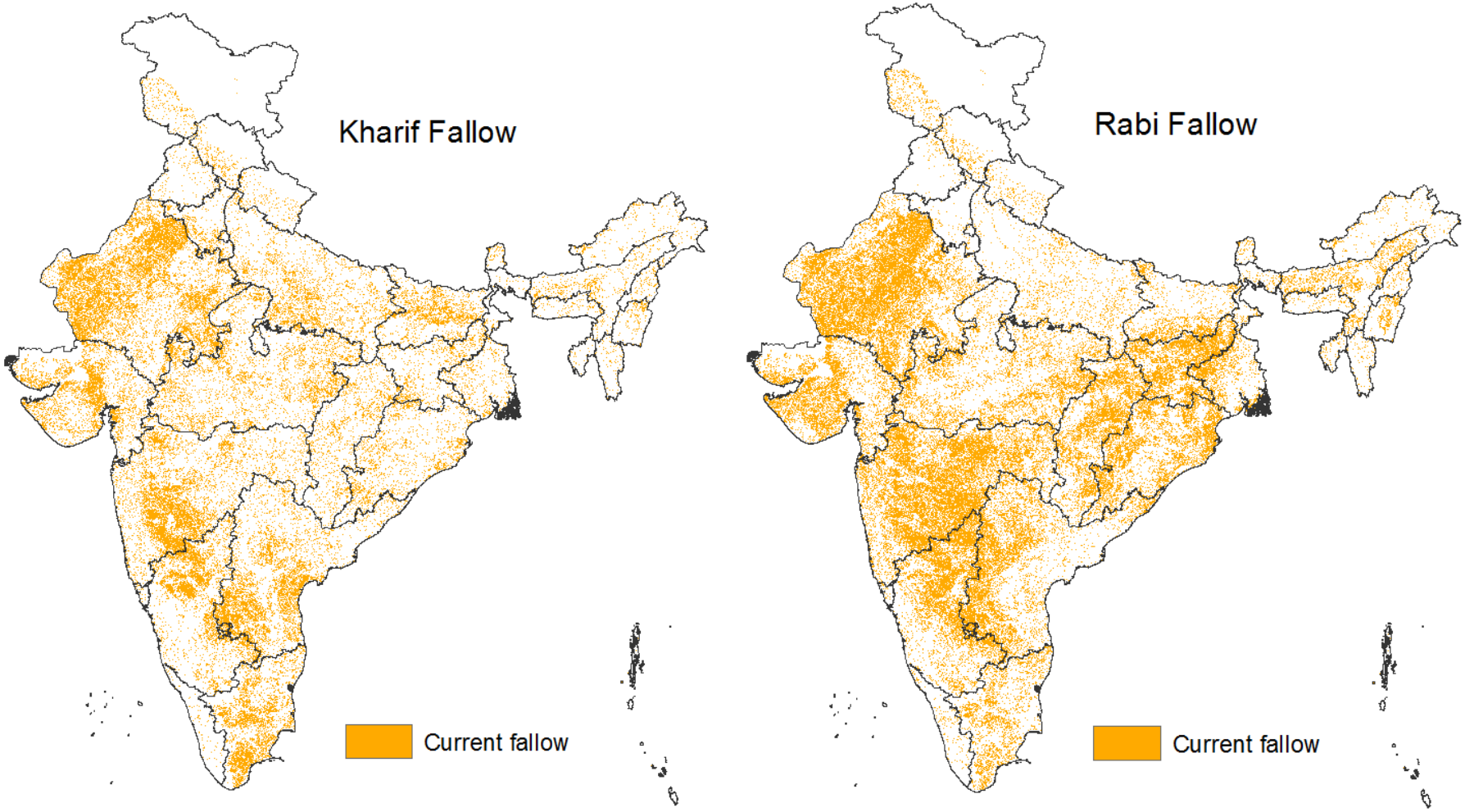


Kharif Cropped Area **Rabi Cropped Area** **Net Sown Area**

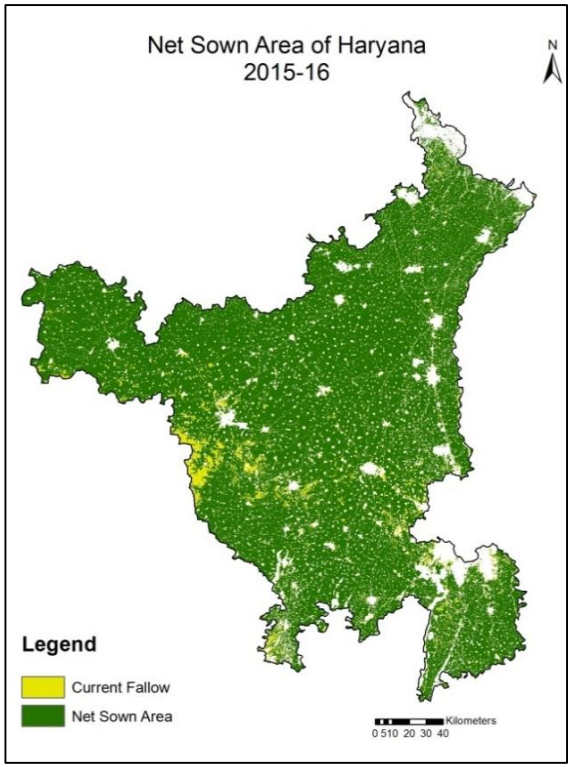
Map of Fallow land - Kharif

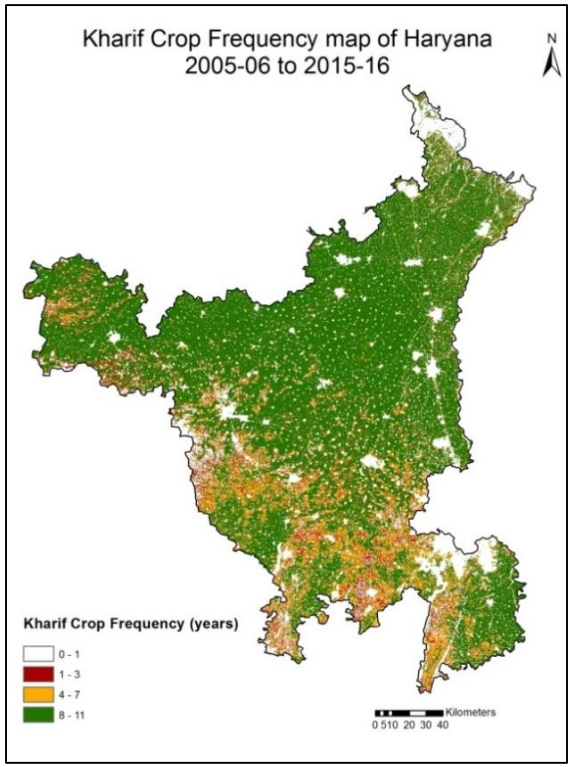
Map of Fallow land - Rabi

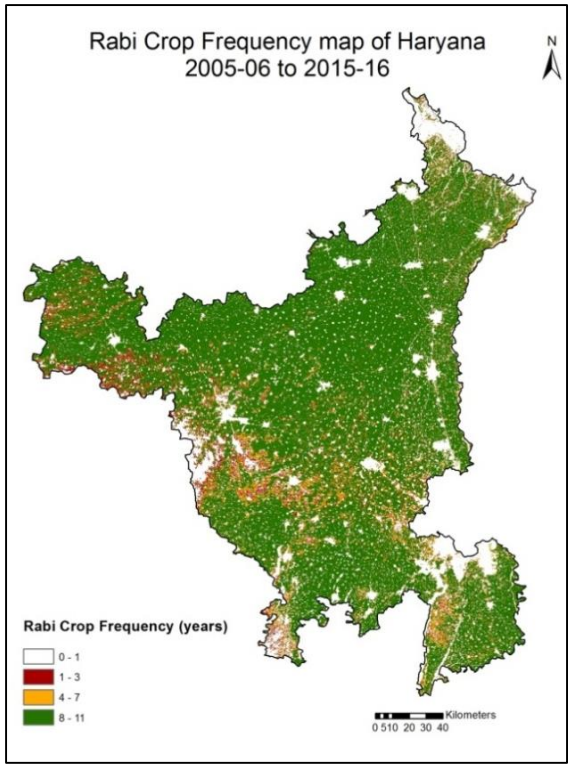
2014-15



AWIFS LULC (1:250000) - HARYANA

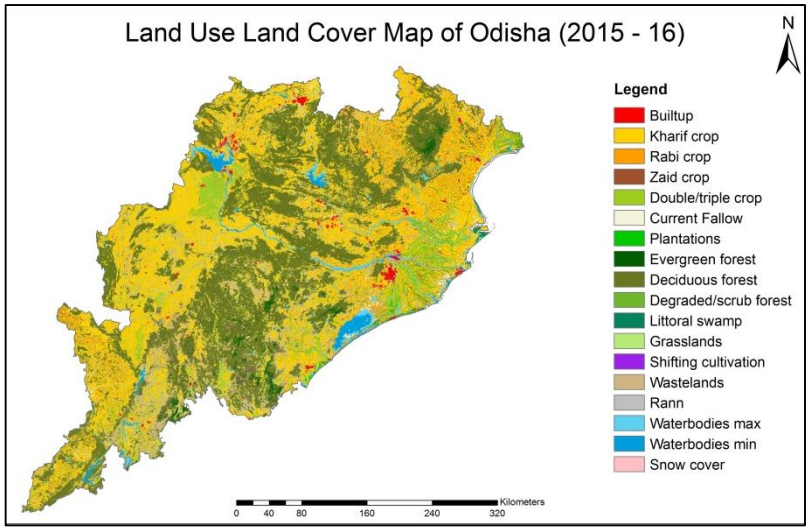




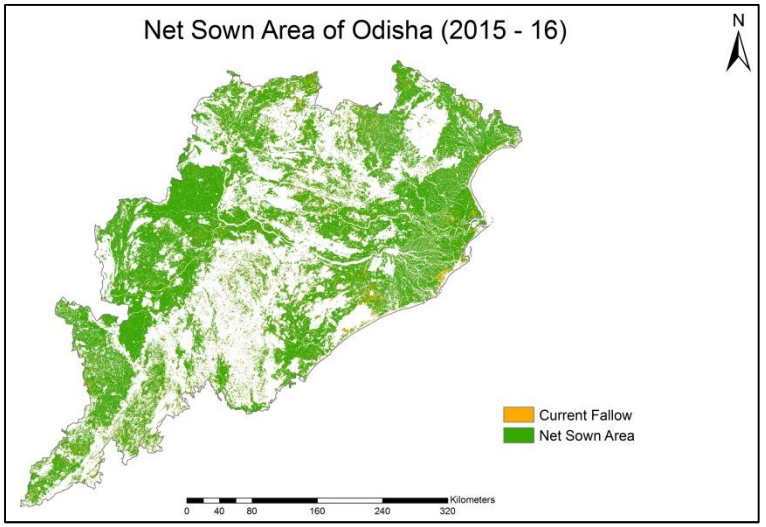


AREA STATISTICS

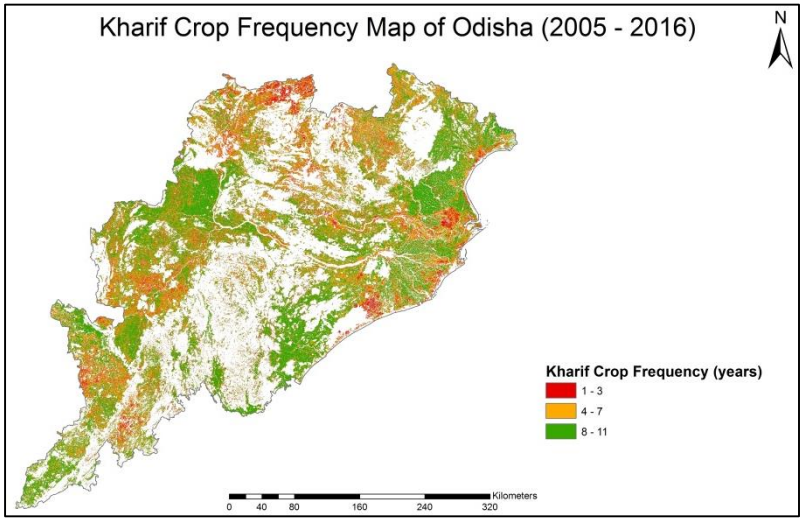
	Areas in lakh ha										
LULC class	2005 - 06	2006 - 07	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14	2014 - 15	2015 - 16
Kharif Crop	27.36	28.22	30.94	31.49	24.38	33.58	28.51	27.22	29.24	30.87	28.42
Rabi Crop	23.76	30.05	31.73	27.04	29.42	31.46	28.51	31.10	32.13	34.82	33.88
Net Sown Area	31.52	32.60	33.04	32.74	31.20	33.87	32.32	33.00	32.44	35.88	34.92
Current fallow	5.88	4.82	4.39	4.71	6.20	3.59	5.11	4.43	4.95	1.59	2.57



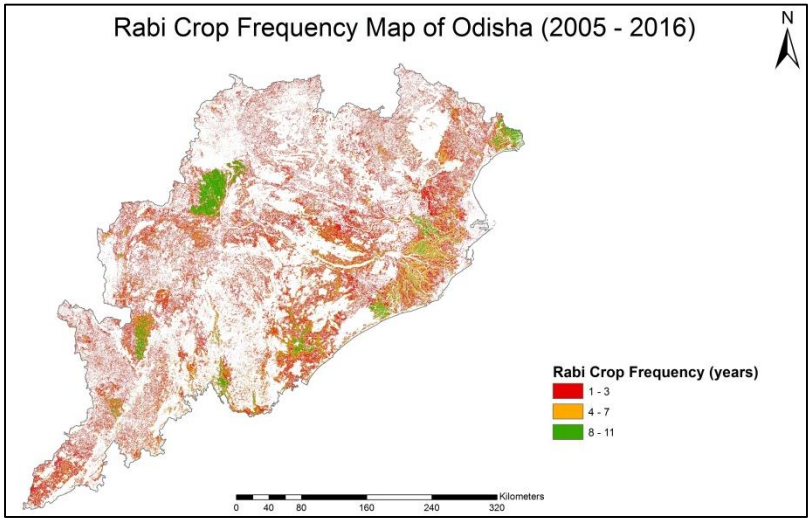
Land Use Land Cover map -2015-16



Net Sown Area - 2015-16



Kharif frequency map (2005 – 2016)



Rabi frequency map (2005 – 2016)

NRC Land Use / Land Cover on 1: 50 K (NNRMS)

No. of Cycles : 2 completed

Data Used: Resourcesat-1/ RS-2 LISS-III data

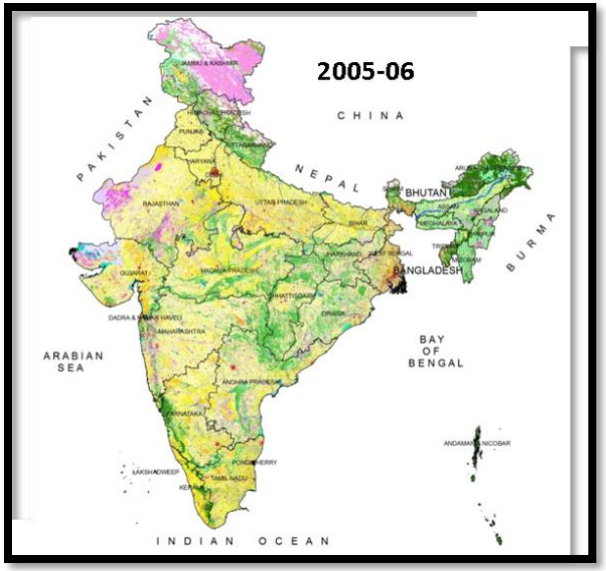
Seasons: 3 seasons Kharif / rabi /Zaid

Methodology : On-screen visual interpretation

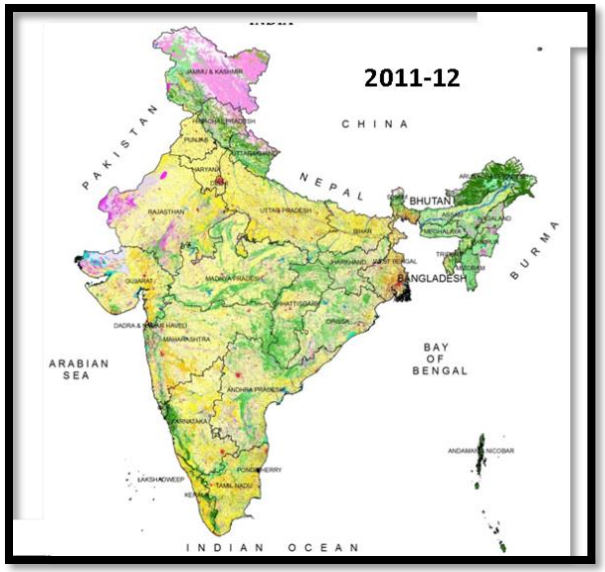
LULC change analysis enabled identification of 120 hotspots in the country.

- **Monitoring Land Use/Land Cover Change in Selected Hot Spots of India on 1:10,000 scale - one site from each state**

LULC – 2005-06



LULC – 2011-12



NRC Land Use / Land Cover 50K Classification System

L - 1	L-II	L-III
Built Up	Urban Built-up	Built up - Compact (Continuous)
		Built up - Sparse (Discontinuous)
		Vegetated / Open Area
	Rural	Rural
	Industrial	Industrial area
		Ash / Cooling Pond / effluent and other waste
	Mining / Quarry	Mining – Active
		Mining - Abandoned
		Quarry
Agricultural land	Cropland	Kharif
		Rabi
		Zaid
		Cropped in 2 seasons
		Cropped in >2 seasons
	Fallow land	Fallow land
	Agriculture Plantation	Agriculture Plantation
	Aquaculture	Aquaculture

L - 1	L-II	L-III
Forest	Evergreen / Semi evergreen	Dense / Closed
		Open
	Deciduous (Dry / Moist / Thorn)	Dense / Closed
		Open
	Forest Plantation	Forest Plantation
	Scrub Forest	Scrub Forest
	Swamp / Mangroves	Dense / Closed
		Open
	Tree Clad Area	Dense / Closed
		Open
Grass/ Grazing	Alpine / Sub-Alpine	Alpine / Sub-Alpine
	Temperate / Sub Tropical	Temperate / Sub Tropical
	Tropical / Desertic	Tropical / Desertic

NRC Land Use / Land Cover Classification System contd….

L - 1	L-II	L-III
Wetlands	Inland	Natural (Ox-bow lake, cut-off meander, waterlogged etc.)
		Manmade (Water logged, saltpans etc.)
	Coastal	Lagoon, creeks, mud flats etc.
		Saltpans
Waterbodies	River	Perennial
		Non Perennial
	Canal / drain	Canal / drain
	Lake / Ponds	Permanent
		Seasonal
	Reservoir / Tank	Permanent
		Seasonal

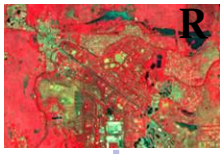
L - 1	L-II	L-III
Wastelands	Salt Affected Land	Salt Affected Land
	Gullied / Ravinous land	Gullied
		Ravinous
	Scrub land	Dense / closed
		Open
	Sandy area	Desertic
		Coastal
		Riverine
	Barren rocky	Barren rocky

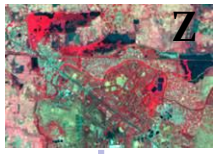
L - 1	L-II	L-III
Snow, Shifting cultivation & Rann	Snow	Snow
	Shifting cultivation	Current
		Abandoned
	Rann	Rann

Level – I : 8 classes
Level – II: 31 classes
Level – III: 54 classes

METHODOLOGY

Resourcesat LISS-III image





GCPs collection (Master image)

NNRMS Parameters

Geo-rectification

Legacy data

Enhancement | Resampling | Indicies

LULC – 250K, Wasteland | FSI, Biodiversity | Census-2001 data | Dist. Profile & Other data

Head's up interpretation

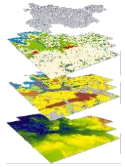
(On screen vectorisation)

QAS

Ground truth / L-IV data

Information system

Geo database creation



Geo database

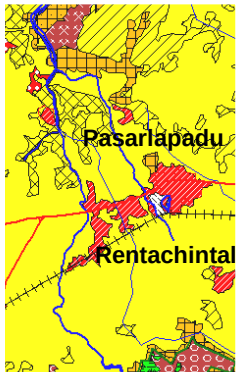
State mosaic of Composite layers

Application Processes

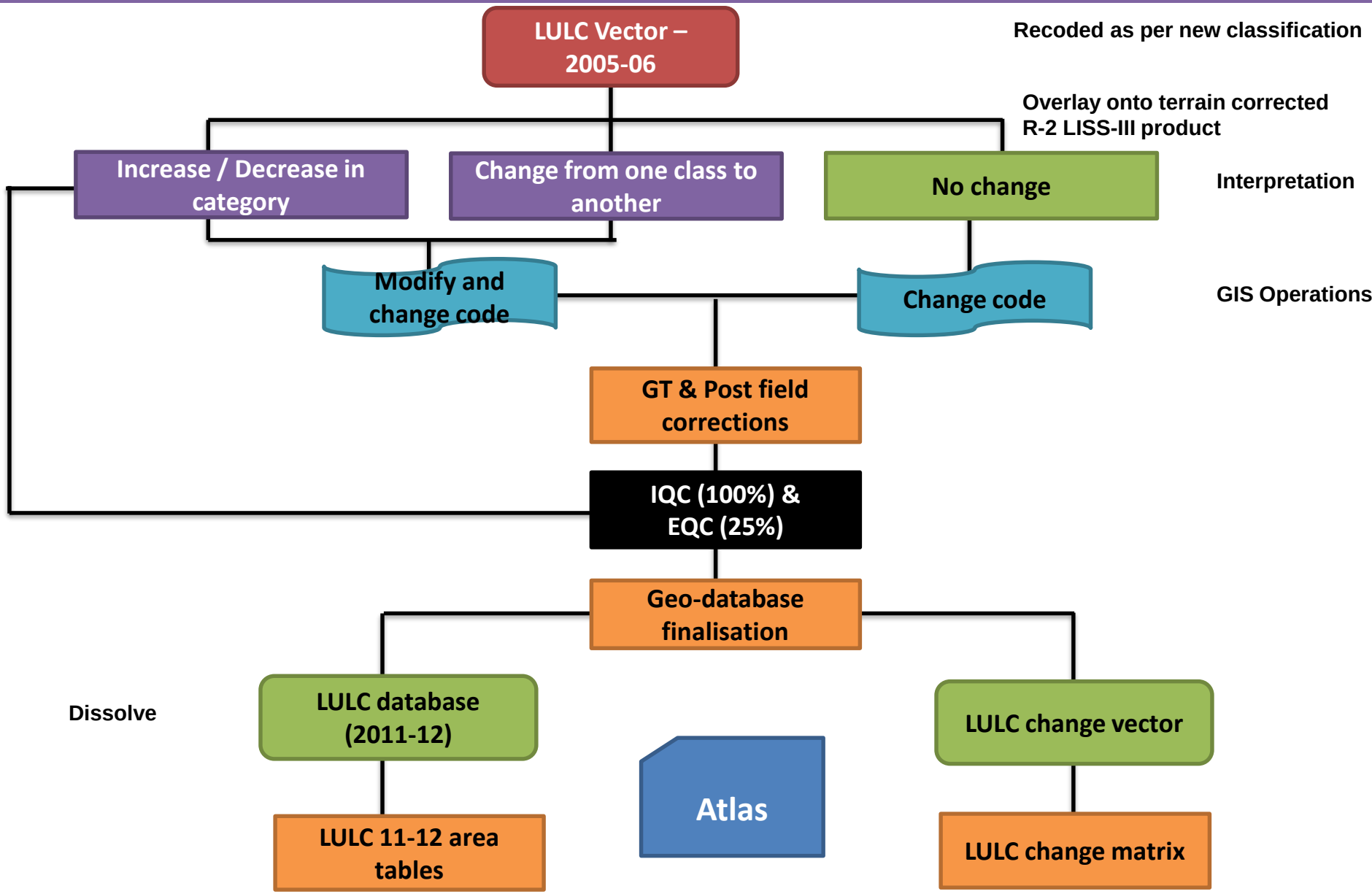
WEB

Final outputs

Area calculations | Analysis | Atlas / Reports

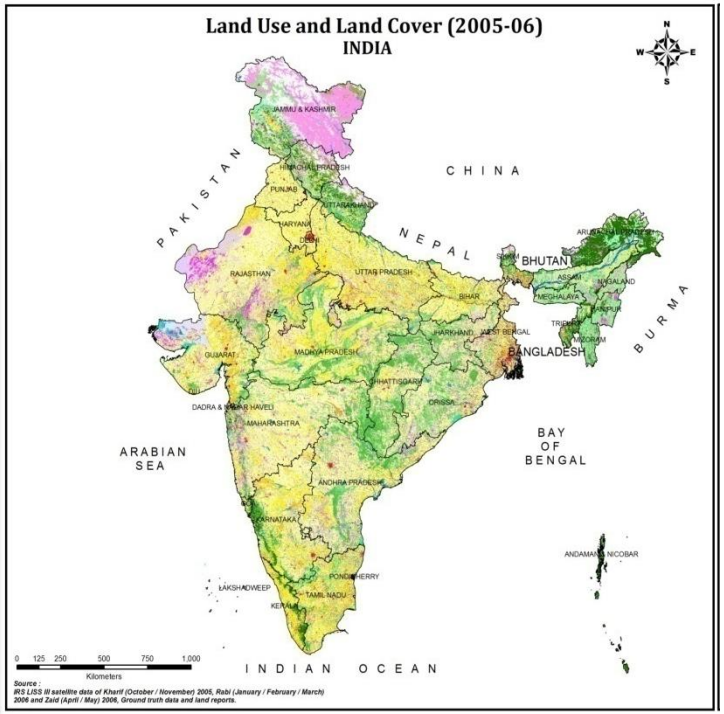


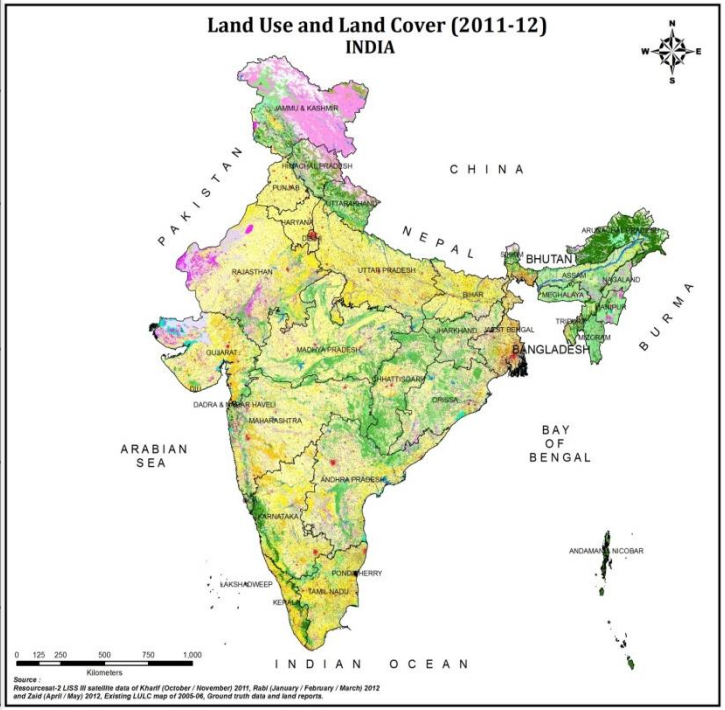
LULC Change Mapping Methodology



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





Land Use/Land Cover Mapping (Third Cycle) – 2015-16

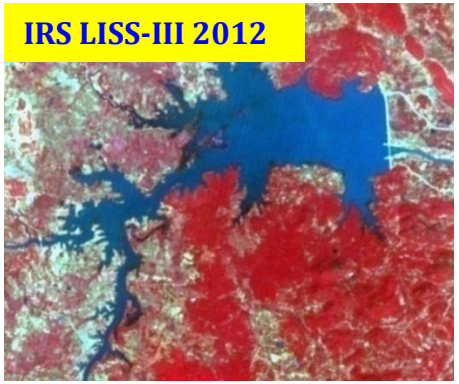
Objectives

- Generate spatial database on land use/land cover for 2015-16;
- Generate land use/land cover change database, change matrix with respect to 2011-12 and
- Identify areas of major change.

Deliverables

- Spatial database on LULC for 2015-16;
- LULC change database, change matrix with respect to 2011-12 and Atlas.

Start Date 01-April-2016 **End Date** 31-March-2018



Utility

Locating suitable sites for industries ,
Afforestation of wastelands
Planning for optimal use of natural resources
Climatic change and environmental monitoring
Identifying areas for establishing SEZ

User Ministries
MoRD,
MNRE,
MOA&FW,
MoUD

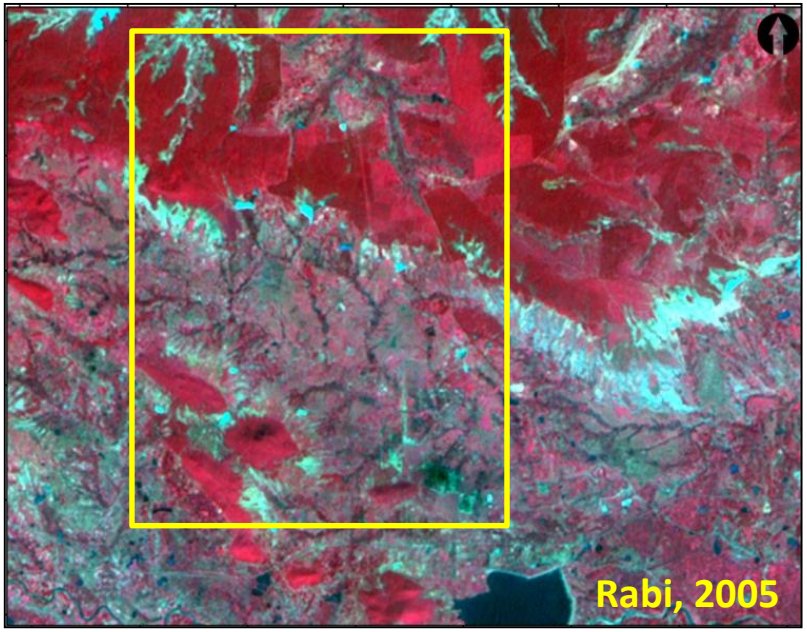
Path/ Row : 101/58
20^0 45' 35" N
86^0 39' 39" E

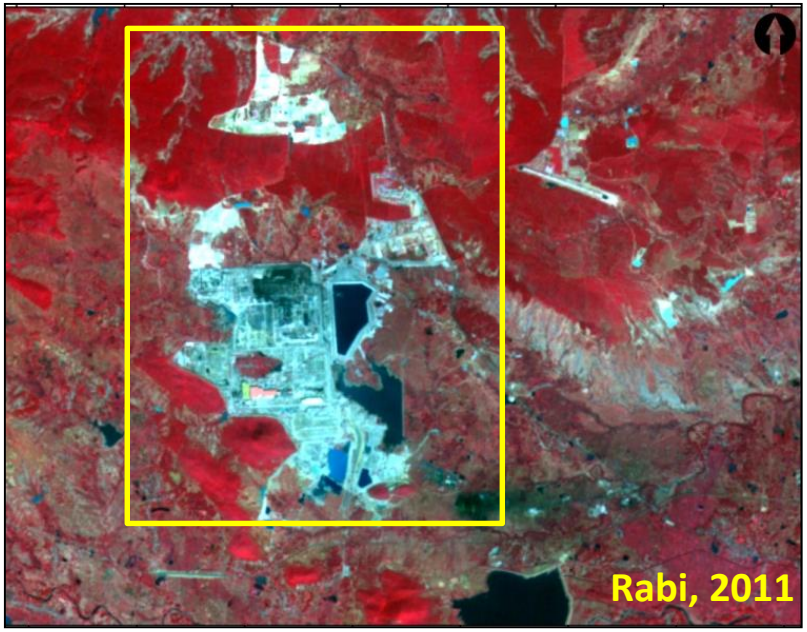
IRS LISS III (05-06)
IRS LISS III (11-12)
IRS LISS III (15-16)

Monitoring Land Use/Land Cover at 1:50,000 scale

- Helps to identify the areas of major change -2005-06 vs 2011-12 ;
- Enables to bring out maps of LULC transformations
- To identify the areas where major land cover change is prevalent for for further monitoring

Impact of industrialisation on agriculture, Angul District, Odisha

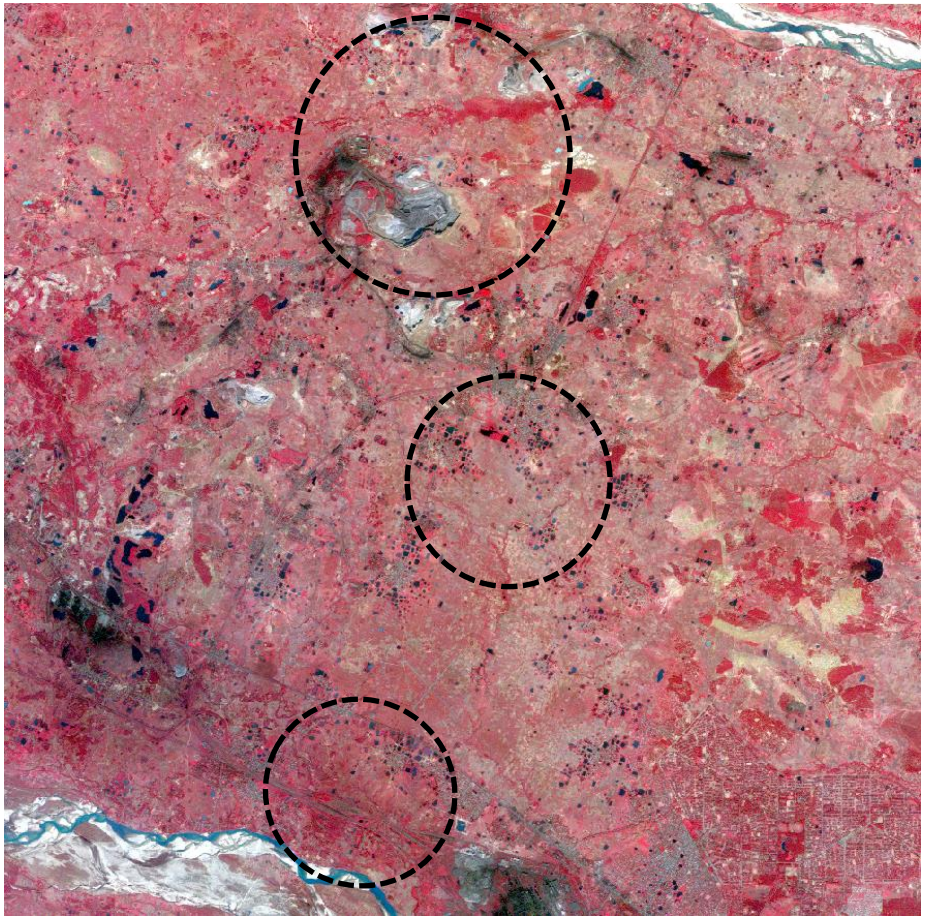




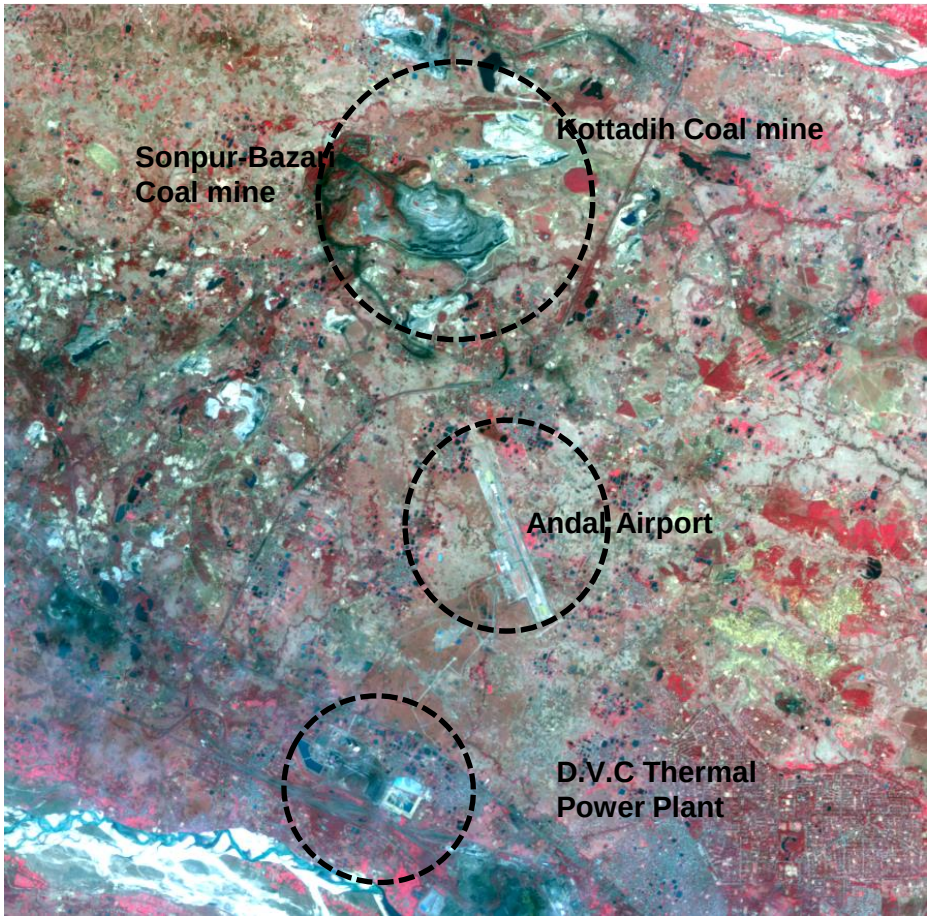
Land Use / Land Cover Change

Andal, Burdwan District, West Bengal

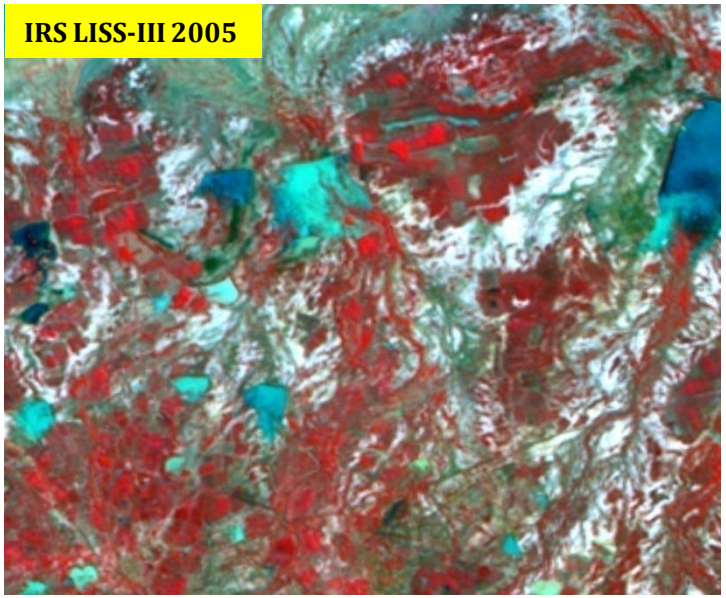
IRS- P6, LISS-4, 29th Jan, 2005

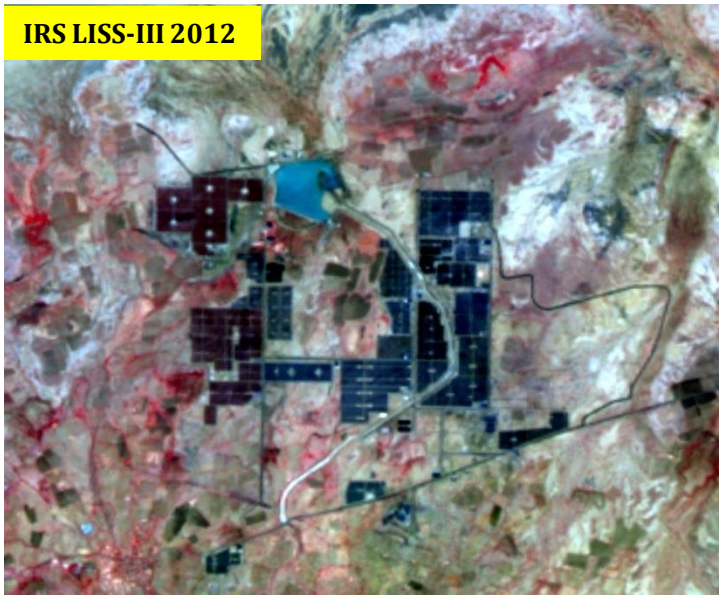


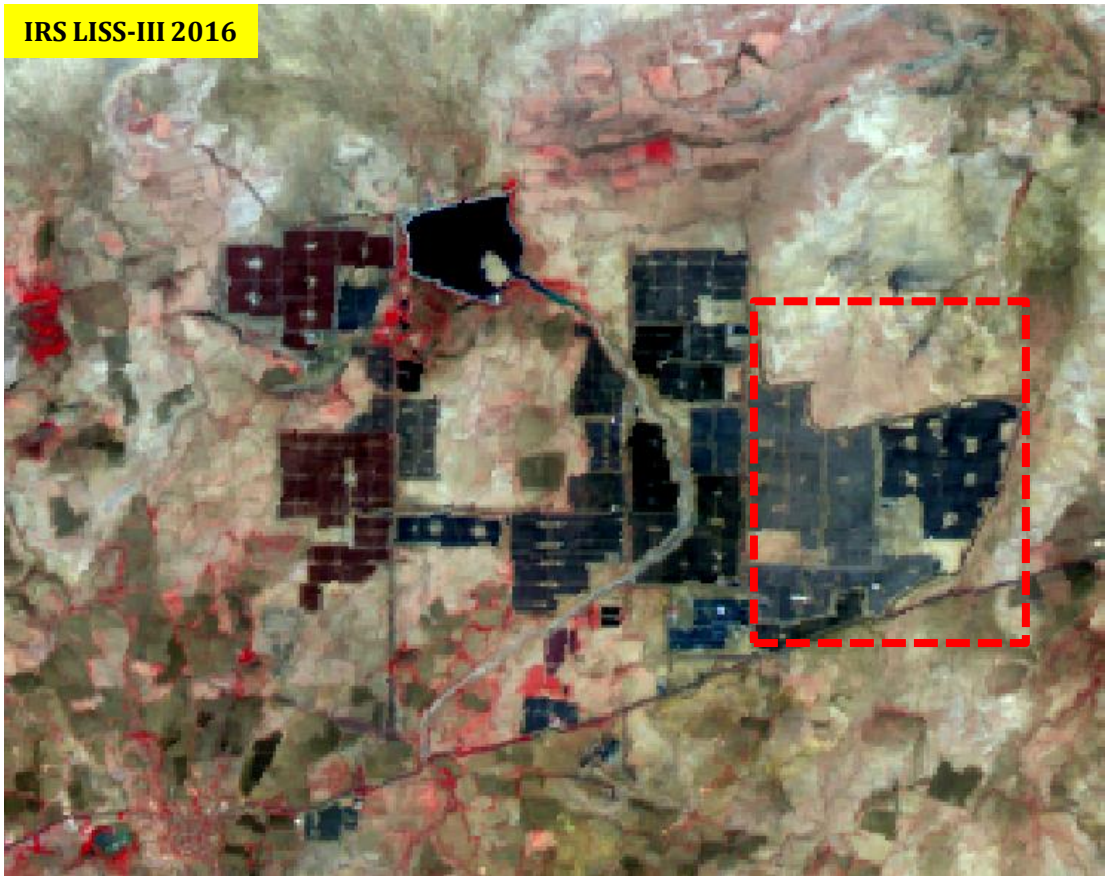
IRS- R2, LISS-4, 12th Jan, 2015



Wastelands (Conversion & Utilisation)







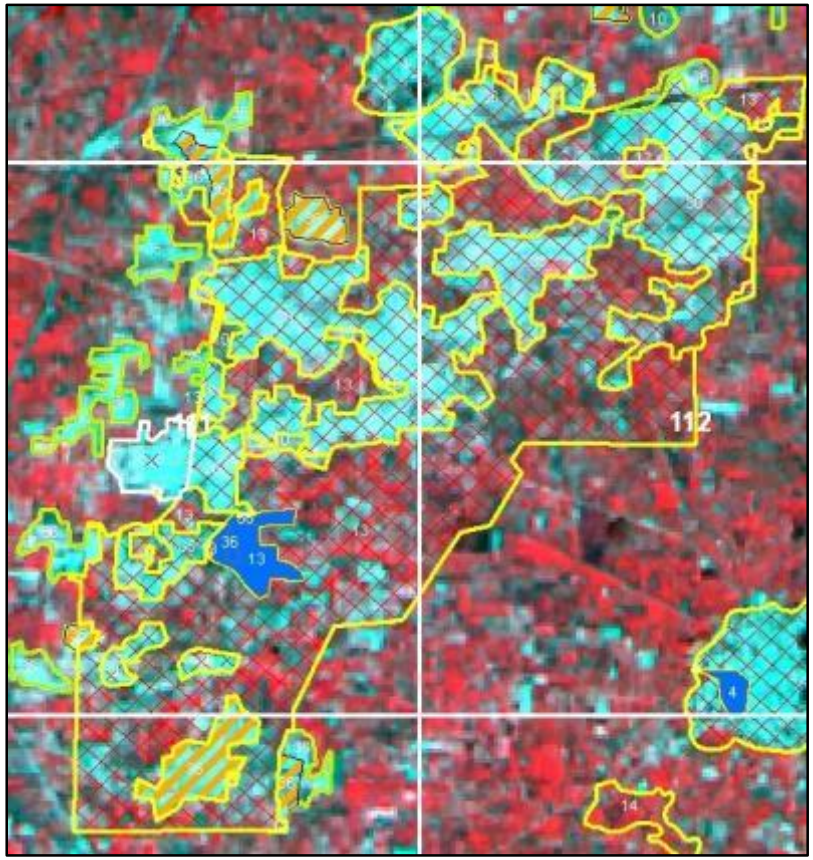
Wasteland to solar power generation,
Charanka solar park Radhanpur,
one among 44 such projects in Gujarat State

Path/ Row : 91/55

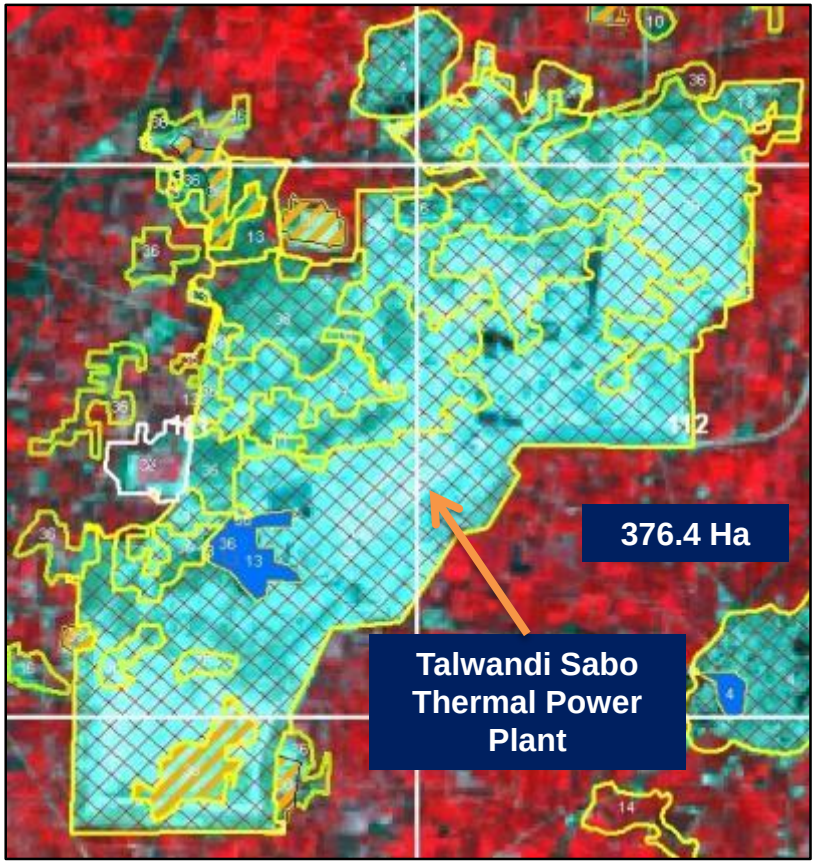
23^0 54' 35" N
$71^0$12' 04" E

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

Sample change areas – Mansa District, Punjab



2005-06 Rabi Image



2011-12 Rabi Image

Agriculture land (Rabi crop area) to Industrial Area (CC)

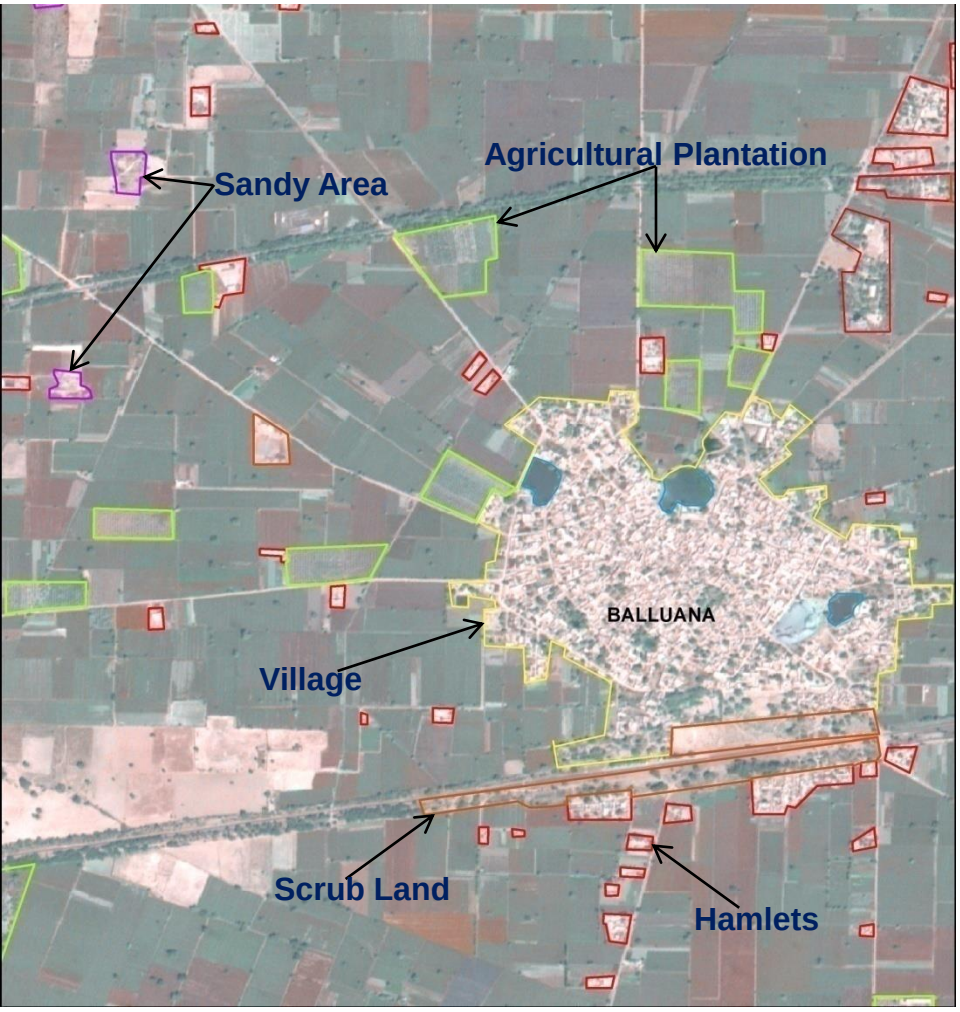
S I S D P - PROJECT 1:10K

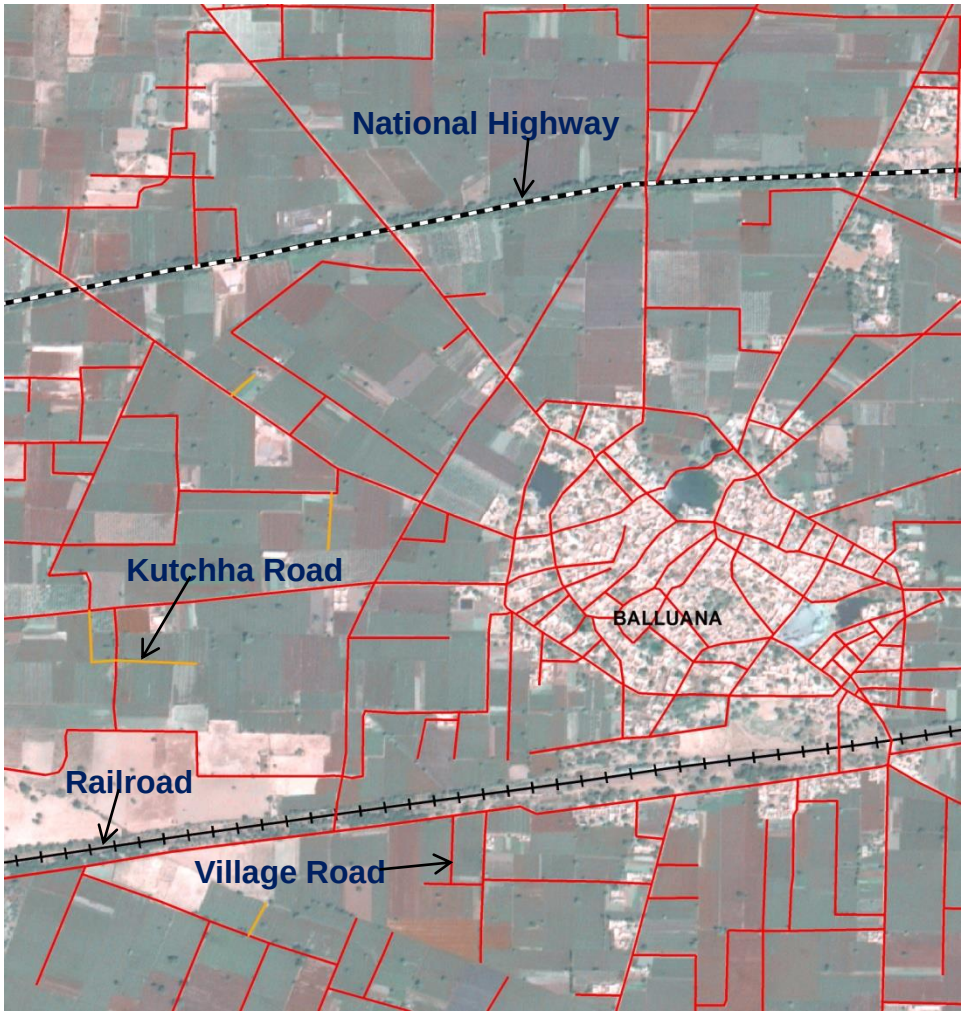
Land Use / Land Cover Classification for 1:10,000 scale mapping

Sl.	Potential of LISS-IV Mx and Cartosat-1 Pan merged imagery for LULC Classification			LULC classes contemplated under SIS-DP	
	LEVEL - I	LEVEL - II	LEVEL - III		
1	Built Up			Built Up	
2		Built Up (Urban)		Built Up (Urban)	Built Up (Urban)
3			Residential		
4			Mixed Built Up area		
5			Recreational		
6			Public and semipublic		
7			Communications		
8			Public Utilities & facility		
9			Commercial		
10			Reclaimed land		
11			Vegetated Area		
12			Transportation	Transportation	Transportation
13		Built Up (Rural)		Built Up (Rural)	Built Up (Rural)
14			Built Up area (Rural)		
15		Mining / Industrial area		Mining/Industrial	Mining/Industrial
16			Industrial		
17			Mine/Quarry		
18			Industrial/Mine dump		
19			Ash/Cooling/Tailing pond		
20			Abandoned mine pit		
21			Land fill area		
22	Agricultural Land			Agricultural Land	
23		Crop Land		Crop land	Crop land
24			Kharif Crop		
25			Rabi Crop		
26			Zaid Crop		
27			Two crop area		
28			More than two crop		
29		Fallow			
30			Current Fallow		
31			Long Fallow		
32		Plantation		Agriculture plantation	Agriculture plantation
33			Agriculture Plnt.		
34			Horticulture Plant		

35			Agro Horticulture Plnt.		
36		Aquaculture/pisciculture		Aquaculture / Pisciculture	Aquaculture / Pisciculture
37	Forest				
38		Evergreen Semi Evergreen		Forest	Dense
39			Dense/Closed		
40			Open		
41		Deciduous (Dry/Moist/Thorn)			
42			Dense/Closed		
43			Open		Open
44		Scrub Forest			
45		Forest Blank			
46		Tree Clad Area			
47			Dense		
48			Open		
49		Forest Plantation		Forest plantation	Forest plantation
50		Littoral/Swamp Forest (Mangrove/Forest Water Swamp)		Mangrove/Swamp Area	Mangrove/Swamp Area
51			Dense		
52			Open		
53	Natural/Semi natural grassland & Grazing land			Grassland & Grazing land	Grassland & Grazing land
54		Alpine/Sub-Alpine			
55		Temperate/Sub tropical			
56		Tropical/Desertic			
57		Man made Grass lands			
58	Wastelands			Wastelands	
59		Salt affected land		Other wasteland	
60			Saline		Salt affected
61			Sodic		
62			Saline / Sodic		
63		Gullied / Ravinous land			
64			Gullied		Gullied / ravinous
65			Shallow Ravinous		
66			Deep Ravinous		
67		Waterlogged	Waterlogged		Waterlogged
68		Scrub land		Scrub land	Scrub land Dense
69			Dense scrub		Scrub land Open

70			Open scrub		
71		Sandy area		Sandy areas	Sandy areas
72			Desertic		
73			Coastal		
74			Riverine		
75		Barren Rocky/Stony waste		Barren rocky	Barren rocky
76	Water bodies			Water bodies	
77		River/Stream		River/Stream/Drain	River/Stream/Drain
78			Perennial		
79			Dry		
80		Canal/Drain			
81			Lined		
82			Unlined canal and drain		
83		Lakes/ponds		Lakes/Ponds	Lakes/Ponds
84			Perennial		
85			Dry		
86		Reservoir/Tanks		Reservoir/Tanks	Reservoir/Tanks
87			Perennial		
88			Dry		
89	Snow covered/Glacial area				Snow / Glacial area





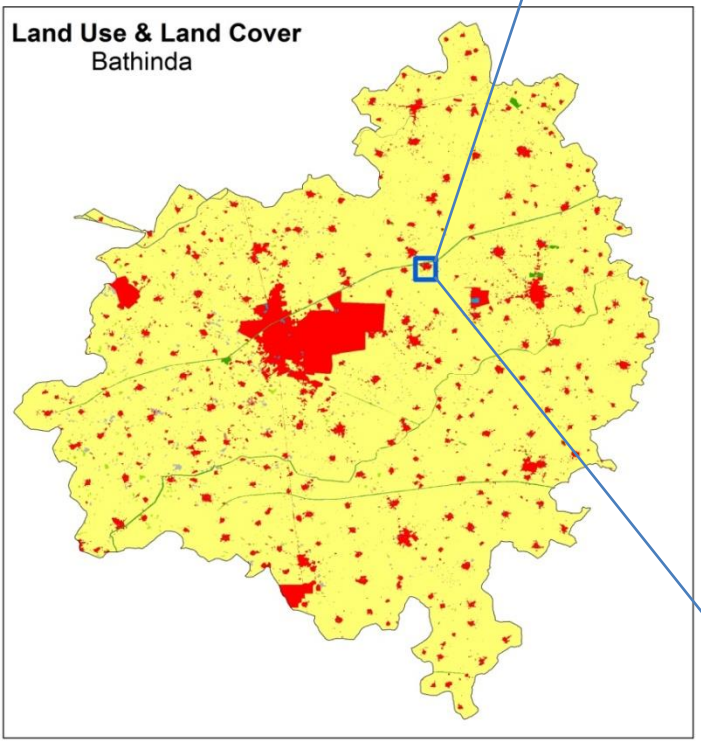
Legend

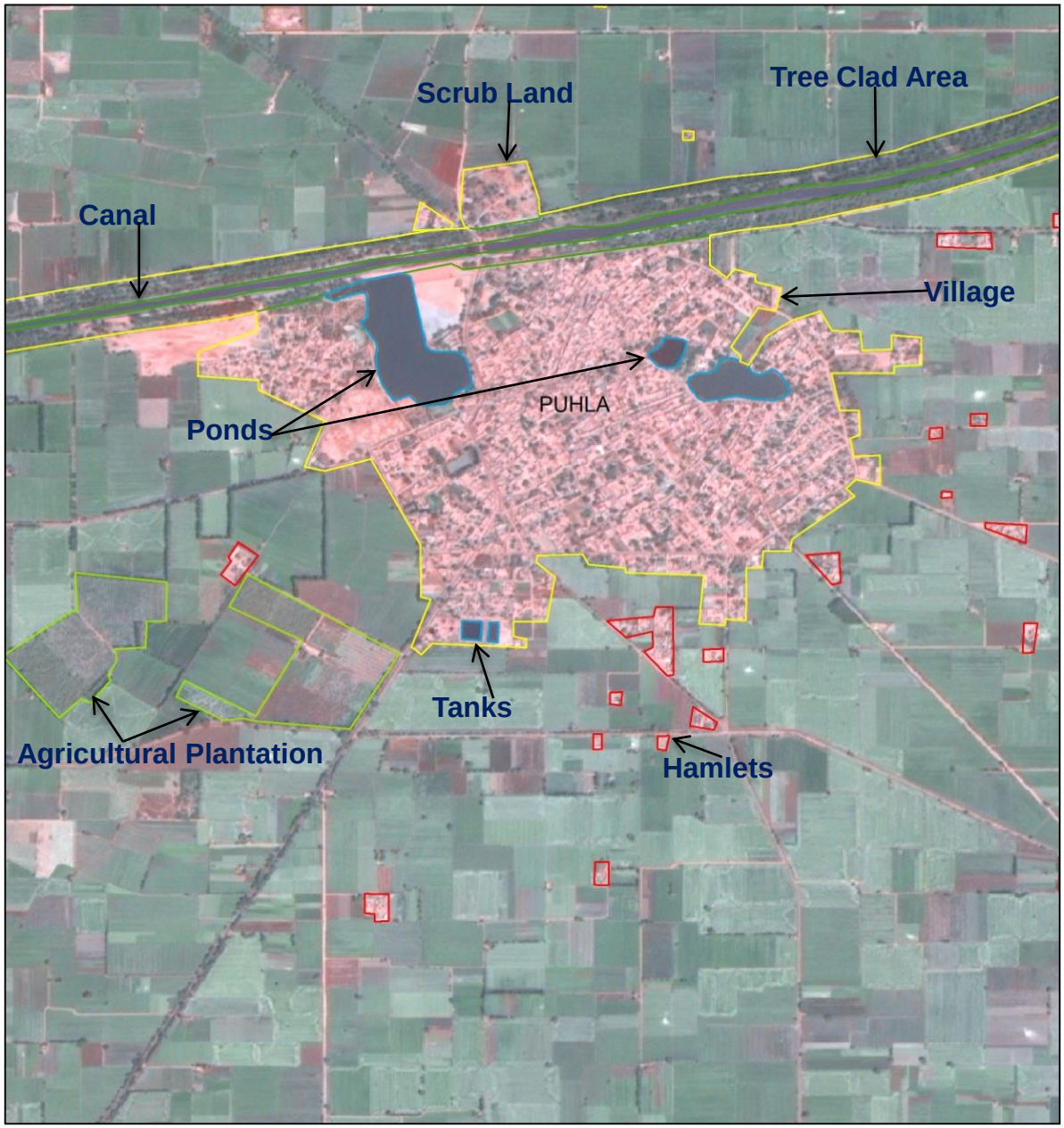
- Aquaculture
- Crop Land
- Agricultural Plantation
- Built Up
- Forest
- Forest Plantation
- Canal
- Lakes / Ponds
- River / Stream / Drain
- Sandy Area
- Scrub Land Dense
- Scrub Land Open
- Waterlogged

Legend

- Branch Canal
- Distributary Canal
- Main Canal
- River
- Stream
- Kutchha Road
- City Road
- District Road
- National Highway
- State Highway
- Village Road
- Railroad


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

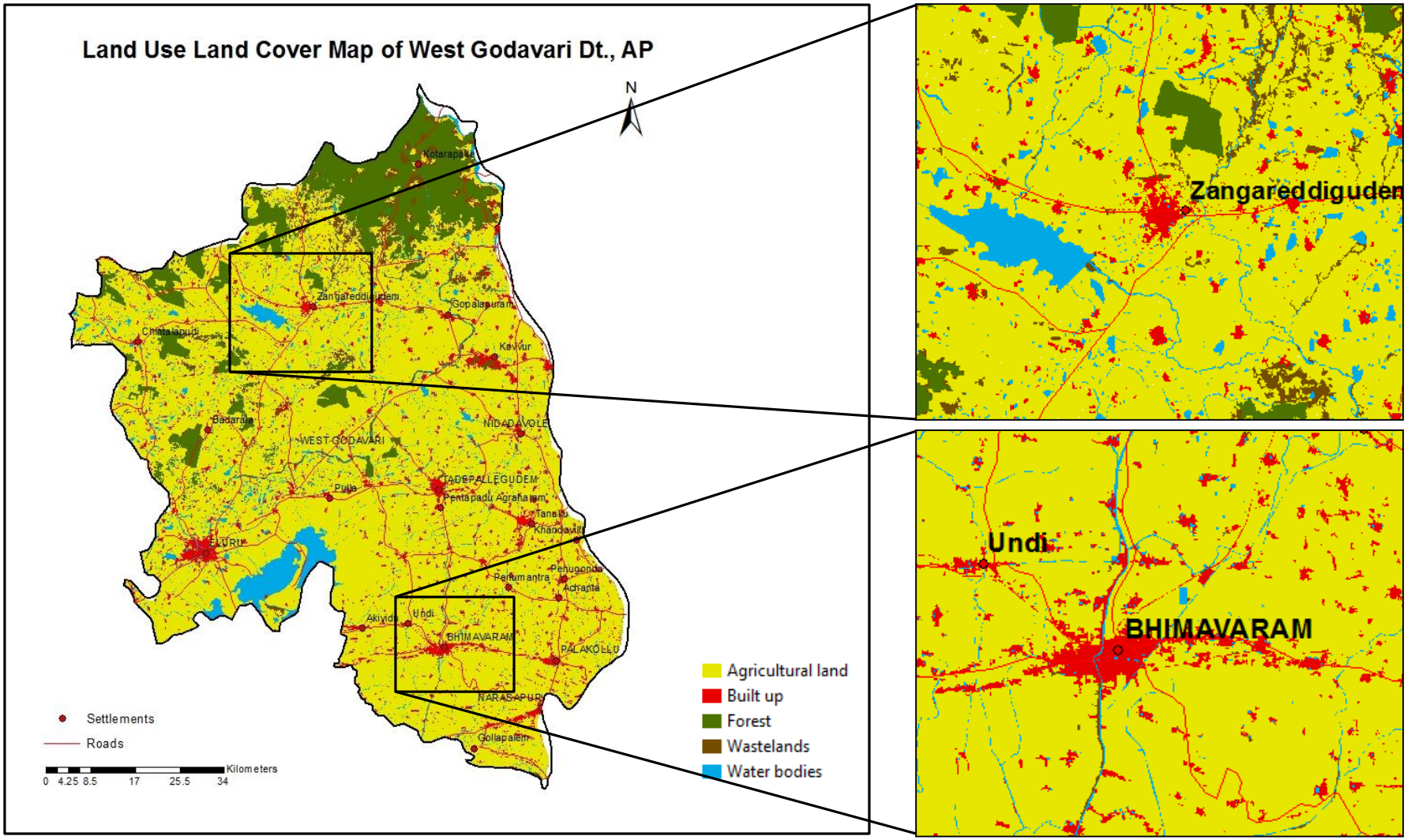

Land Use & Land Cover
Bathinda


Scrub Land
Tree Clad Area
Canal
Village
PUHLA
Ponds
Tanks
Agricultural Plantation
Hamlets

Comparison of LULC50K & 10K

COMPARISION OF LULC AREA ESTIMATE FOR BHATINDA DISTRICT, PUNJAB							
Sl	NRC LULC 50K	Area (in ha.)	SIS-DP Land Cover 10K	Area (in ha.)	Difference	% Diff to TGA	% diff per class
1	Builtup - Compact	4221.62	Core Urban	4610.34			
2	Builtup - Sparse	4511.38	Peri Urban	414.79			
3	Builtup - Vegetated	4764.73	Village	11768.53			
4	Builtup - Rural	13843.15	Mixed Settlement	6626.11			
5			Hamlet & Dispersed Household	2441.53			
6			Transportation	125.32			
A	**Builtup**	**27340.88**	**Builtup**	**25986.61**	1354.26	0.40	4.95
7	Industrial area	2670.01	Mining /Industrial	3049.75			
8	Industrial - Ash / Cooling Pond	344.02					
9	Mine / Quarry - Mine - Active	73.65					
10	Quarry	644.07					
B	**Mining / Industrial**	**3731.74**	**Mining / Industrial**	**3049.75**	682.00	0.20	18.28
11	Cropland - Kharif	1906.21					
12	Cropland - Rabi	737.32	Cropland	303819.53			
13	Cropped in 2 season	294223.94					
14	Cropped More than 2 season	3013.45					
15	Cropland - Fallowland	592.24					
C	**Cropland**	**300473.16**	**Cropland**	**303819.53**	-3346.37	-0.98	-1.11
16	Agricultural Plantation	1473.22	Agricultural Plantation	1427.99			
D	**Agricultural Plantation**	**1473.22**	**Agricultural Plantation**	**1427.99**	45.24	0.01	3.07
17	Forest - Dec. - Dense	94.37	Forest	261.73			
18	Forest - Dec. - Open	77.90					
19	Tree Clad Area - Dense	1707.92	Forest Plantation	1411.60			
E	**Forest**	**1880.18**	**Forest**	**1673.33**	206.85	0.06	11.00
20	Scrubland - Dense	9.44	Scrubland - Dense	138.65			
21	Scrubland - Open	620.97	Scrubland - Open	478.76			
22	Sandy Area - Desertic	3391.58	Sandy Area	2177.59			
23			Barren Rocky	0.69			
24			Waterlogged	1.43			
F	**Wastelands**	**4021.98**	**Wastelands**	**2797.11**	1224.87	0.36	30.45
25	Canal Drain	393.95	Canal / Drain	182.70			
26	Lake / Pond - Permanent	406.06	Lake / Pond	645.17			
27	Reservoir / Tank - Perm	378.82	Reservoir / Tank	237.28			
28			River / Stream / Drain	276.73			
29			Aquaculture / Pisciculture	3.81			
G	**Waterbody**	**1178.83**	**Waterbody**	**1345.68**	-166.85	-0.05	-14.15
	Total Geographical Area	**340100.00**		**340100.00**			

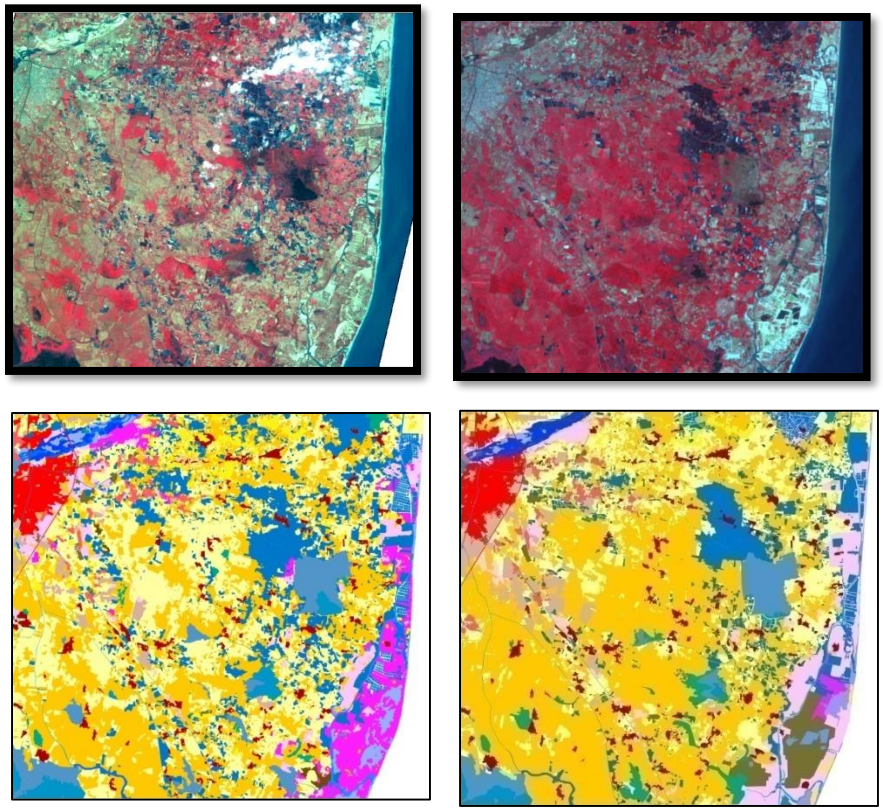
LAND USE LAND COVER MAP (1:10,000 scale)



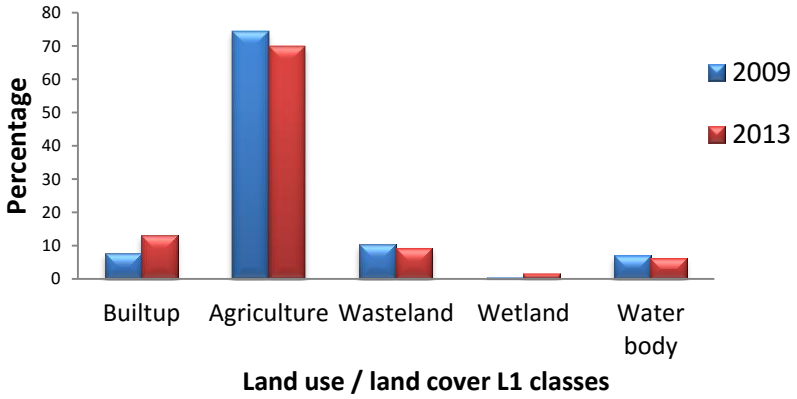
Land Use / Land Cover Classification Results

A study in part of Nellore district, Andhra Pradesh

2009 2013



L1 Classes	2009 (area in sq. km)	2013 (area in sq. km)	Change	% change w.r.t TGA
Built up	31.03	52.40	21.37	5.28
Agriculture	300.85	282.99	-17.86	-4.42
Wasteland	41.91	37.41	-4.50	-1.11
Wetland	2.46	6.39	3.93	0.97
Water body	28.21	25.27	-2.94	-0.73
Total Geographical Area (TGA) : 404.46 sq. km				



Built-up
- Compact
- Sparse
- Vegetated / Open areas
- Rural

- Industry / Mining

Agricultural Lands
- Crop lands
- Fallow land / Bare areas
- Agricultural plantations

- Aquacultures

Forests
- Forests
- Forest Plantations
- Swamp/ Mangroves

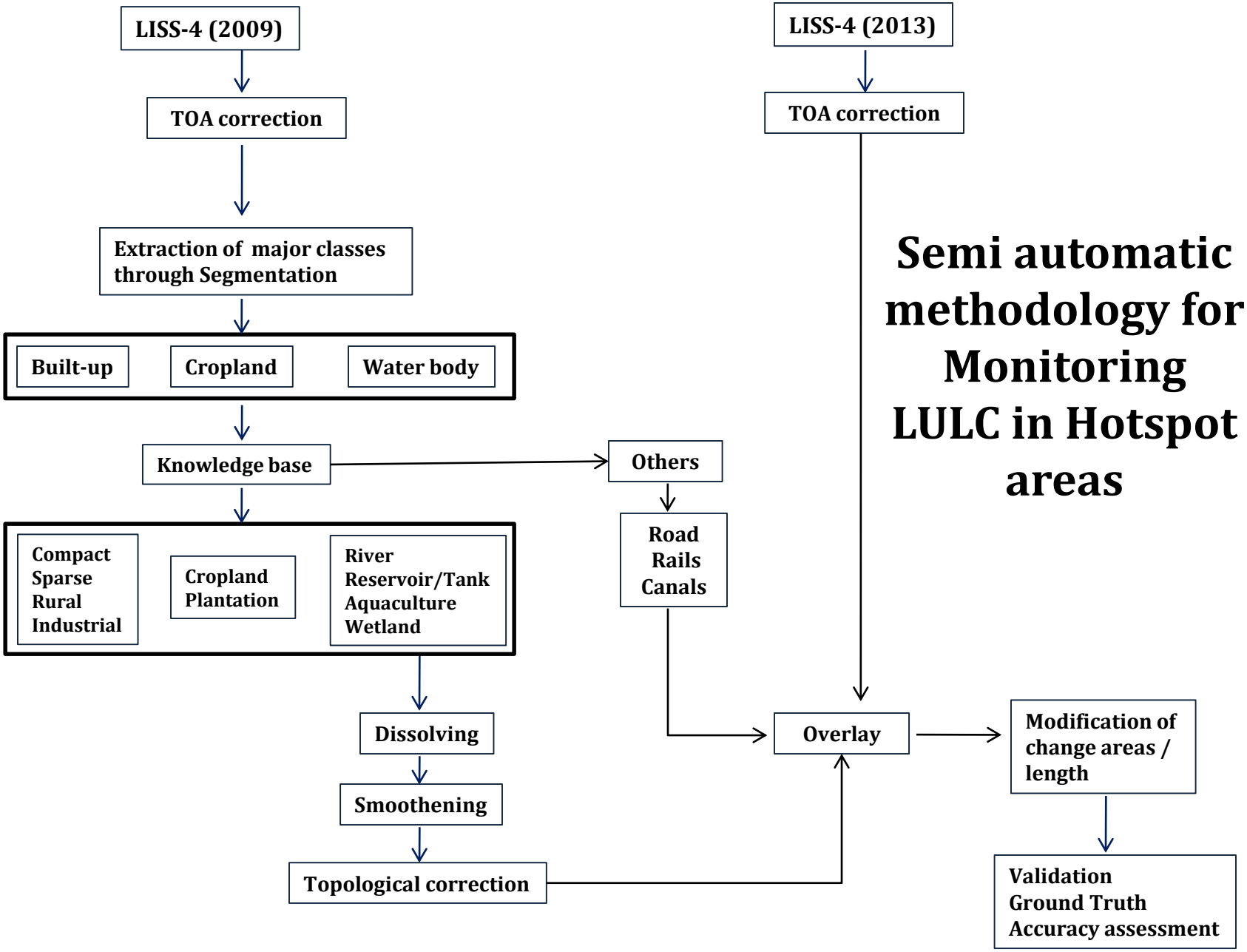
Wastelands
- Shrub / Scrub lands
- Sandy areas
- Barren areas / Rann

Wetlands
- Wetlands

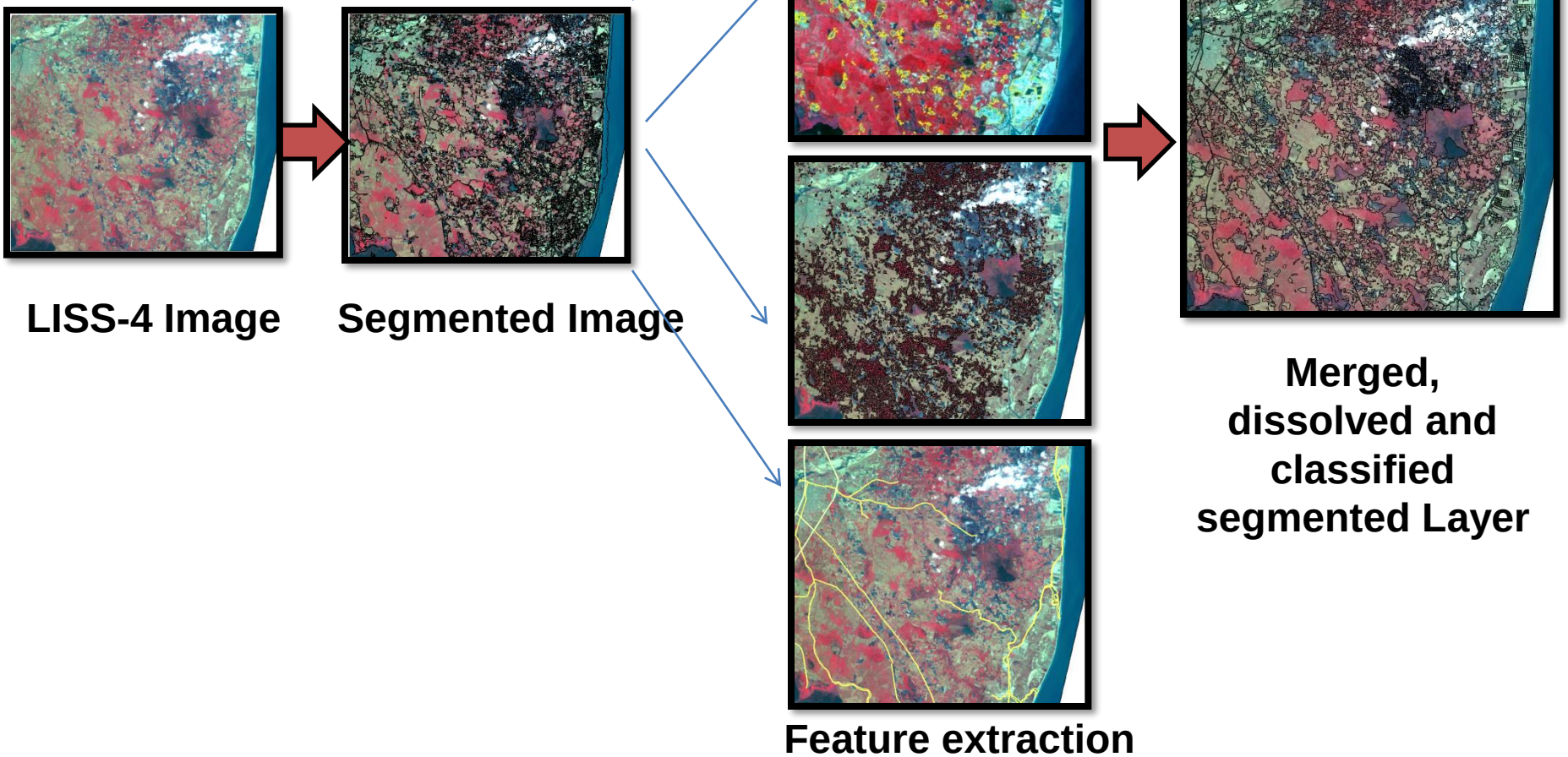
Water bodies
- Water bodies

Snow/Others
- Snow / Glaciers
- Shifting cultivations

METHODOLOGY

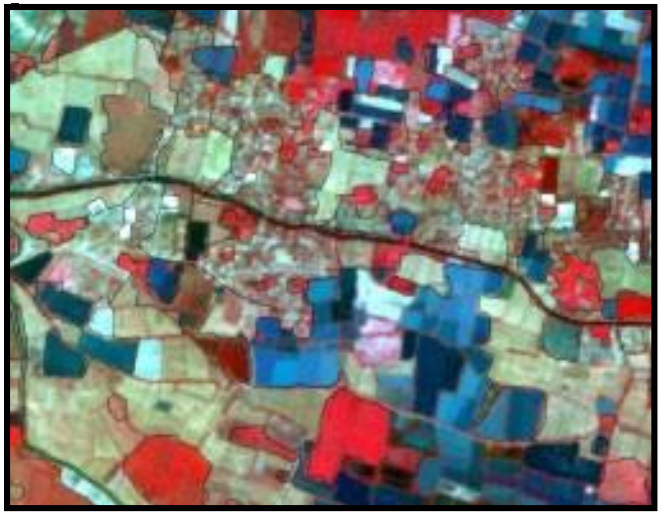


Steps for LULC Classification output

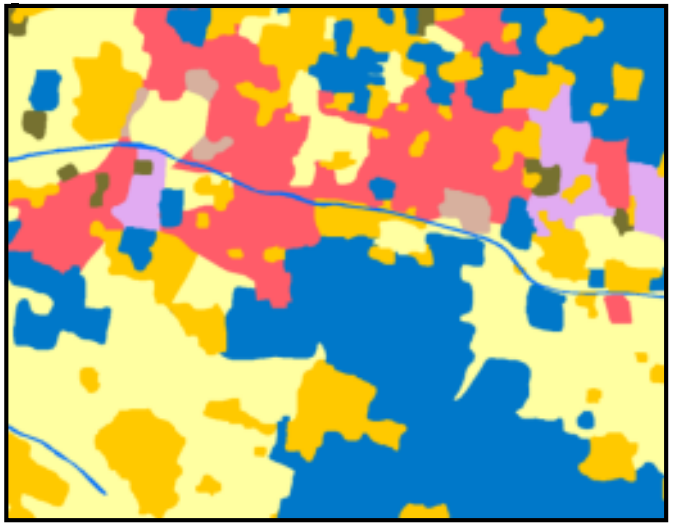


Monitoring Land Use/Land Cover at 1:10,000 scale

Major Changes- Aquaculture to Agriculture: Parts of Nellore Dt., AP



2009



2013

Built-up
- Compact
- Sparse
- Vegetated / Open areas
- Rural

Industry / Mining

Agricultural Lands
- Crop lands
- Fallow land / Bare areas
- Agricultural plantations

Aquacultures

Forests
- Forests
- Forest Plantations
- Swamp/ Mangroves

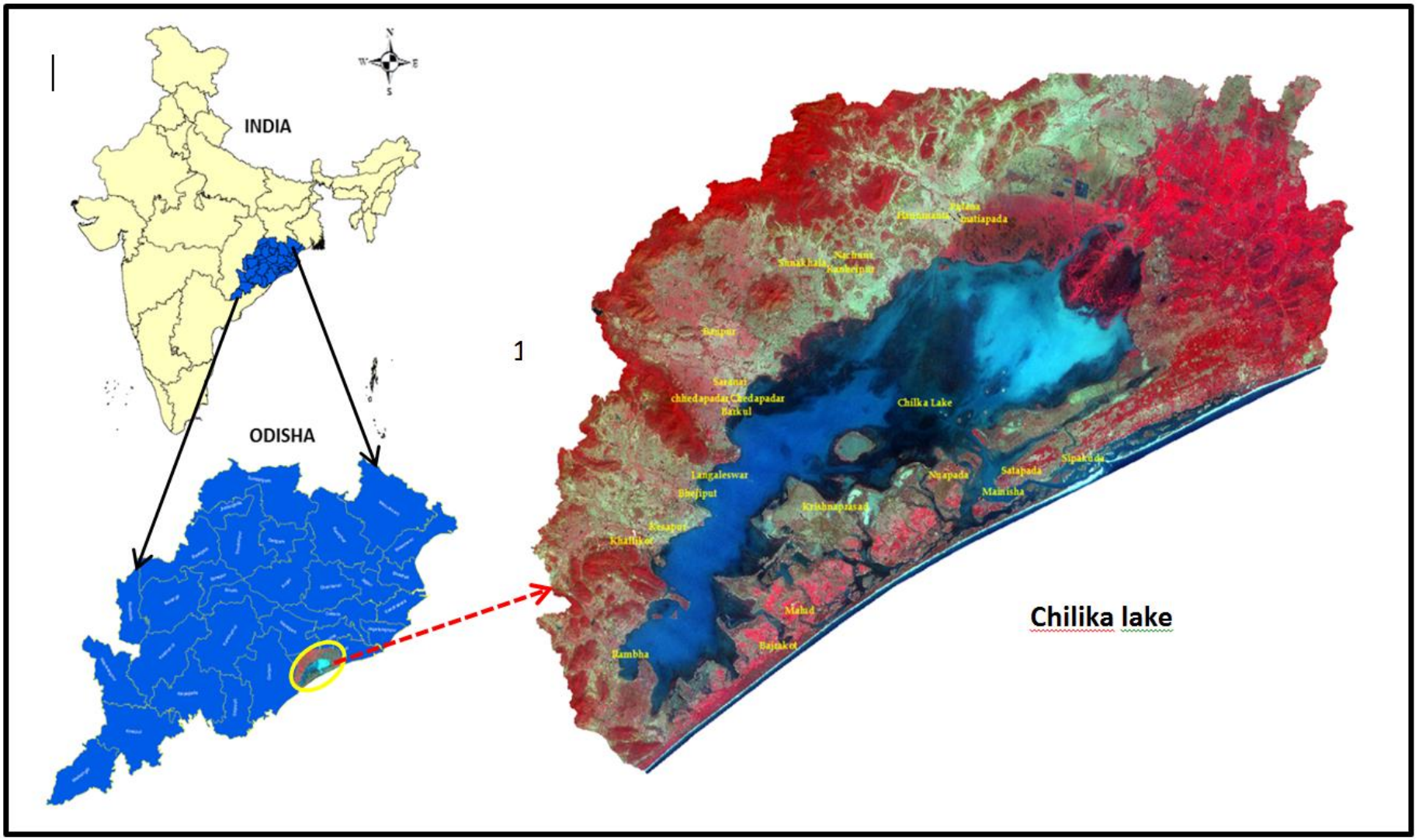
Wastelands
- Shrub / Scrub lands
- Sandy areas
- Barren areas / Rann

Wetlands
- Wetlands

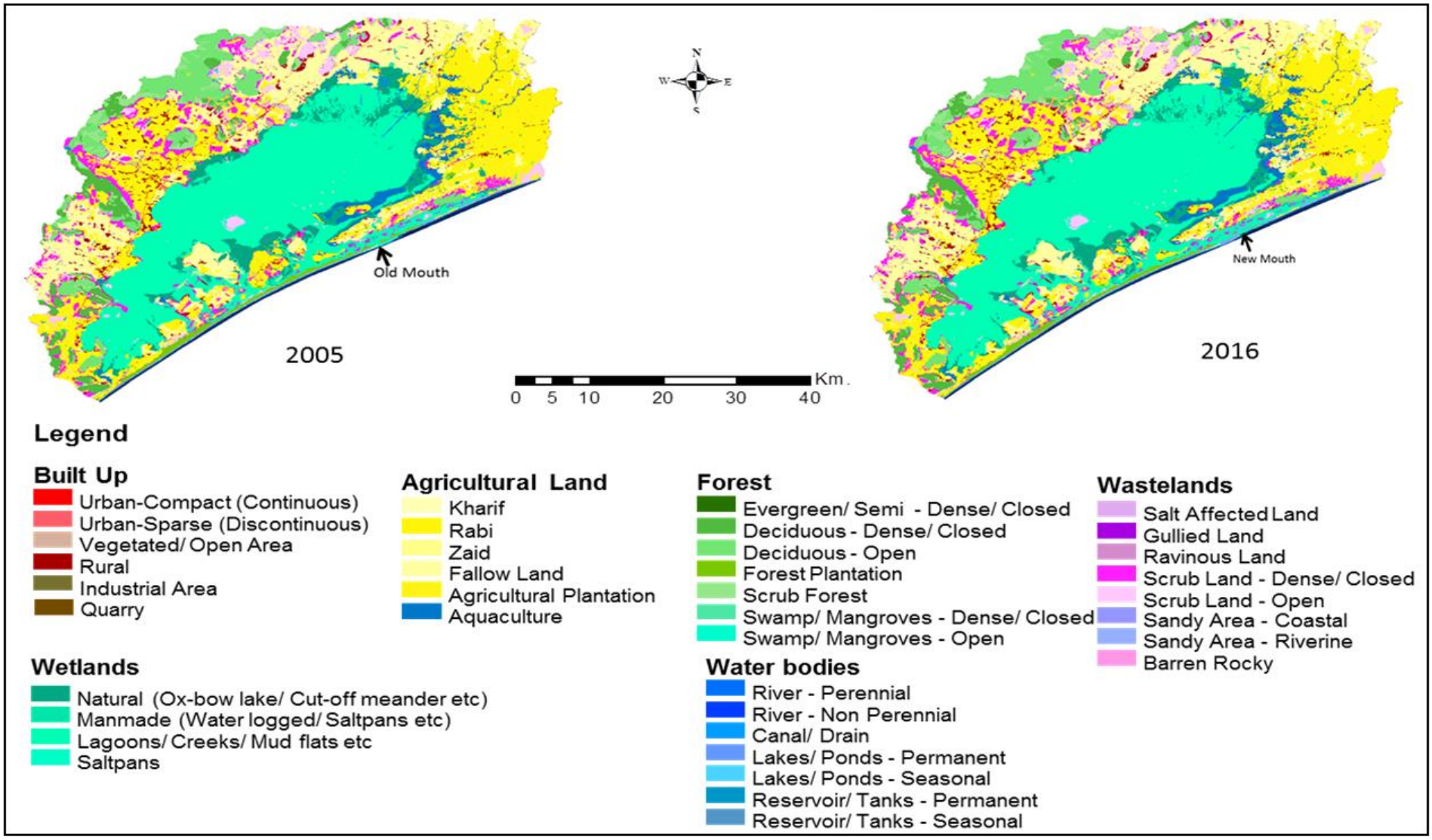
Water bodies
- Water bodies

Snow/Others
- Snow / Glaciers
- Shifting cultivations

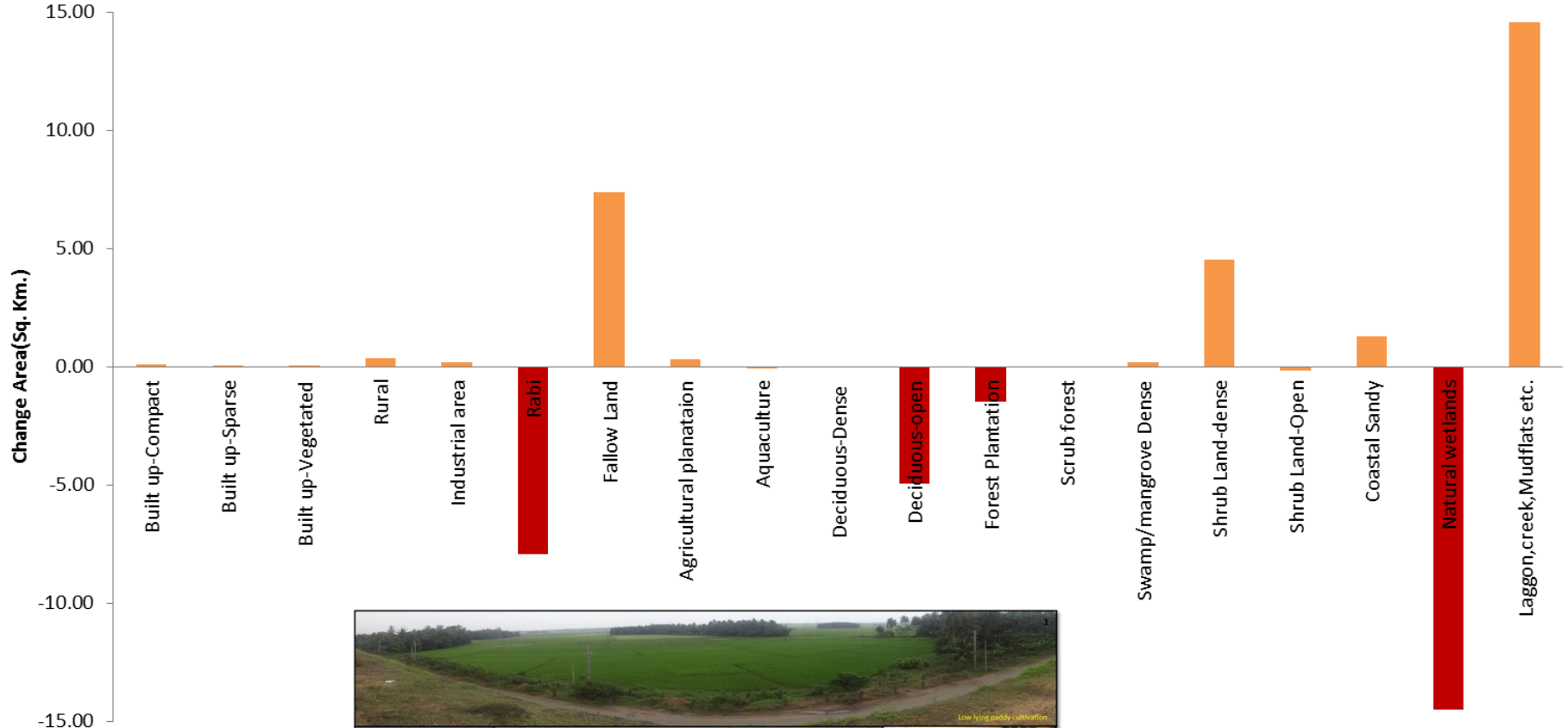
MONITORING LAND USE/LAND COVER CHANGE TRAJECTORIES IN SELECTED HOT SPOTS OF INDIA

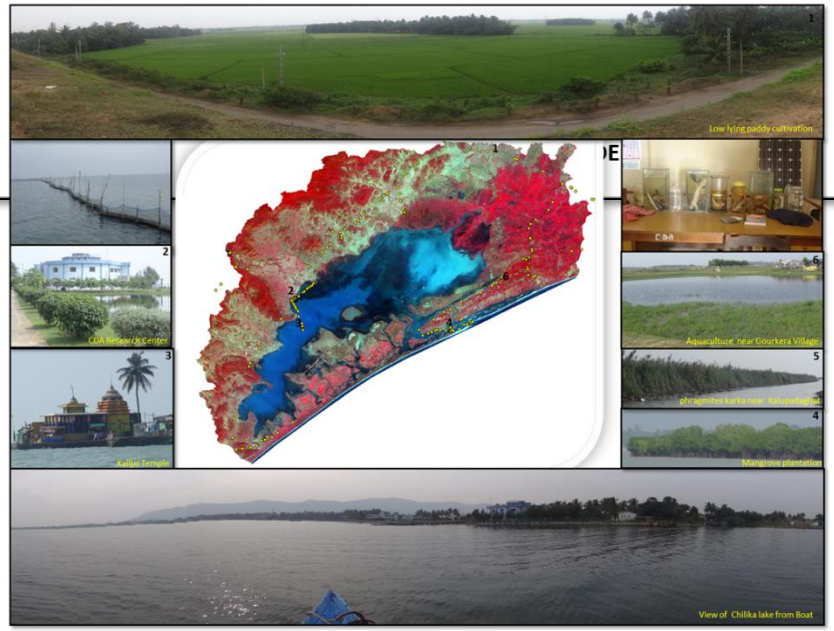


LAND USE /LAND COVER

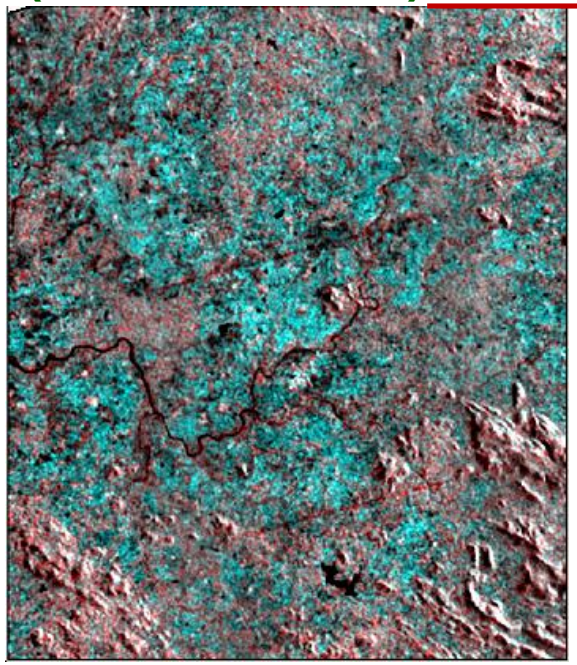


Change Statistics

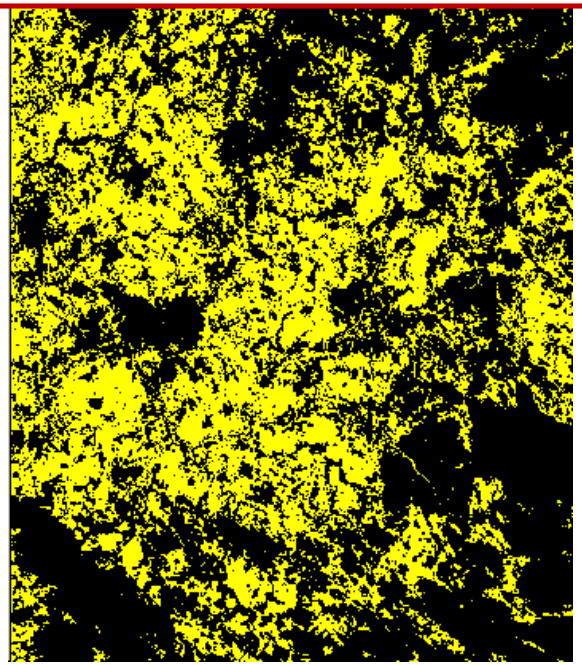




(HH-HV-HV:: R-G-B) ESTIMATION OF KHARIF CROP AREA FROM RISAT-1 & AWiFS

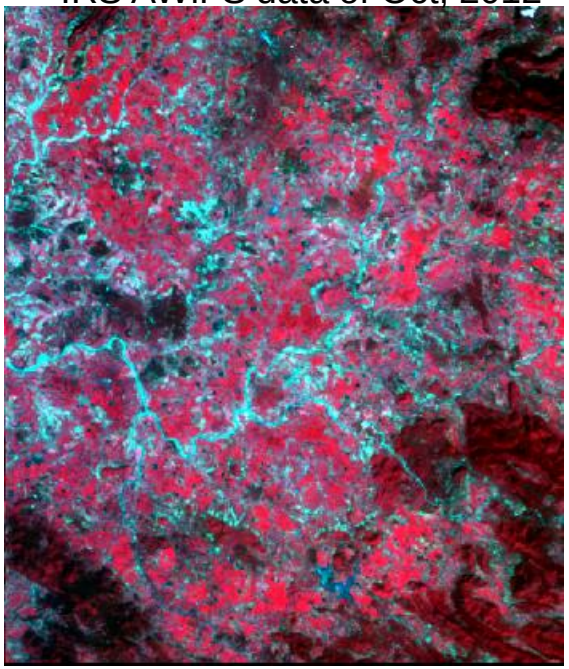


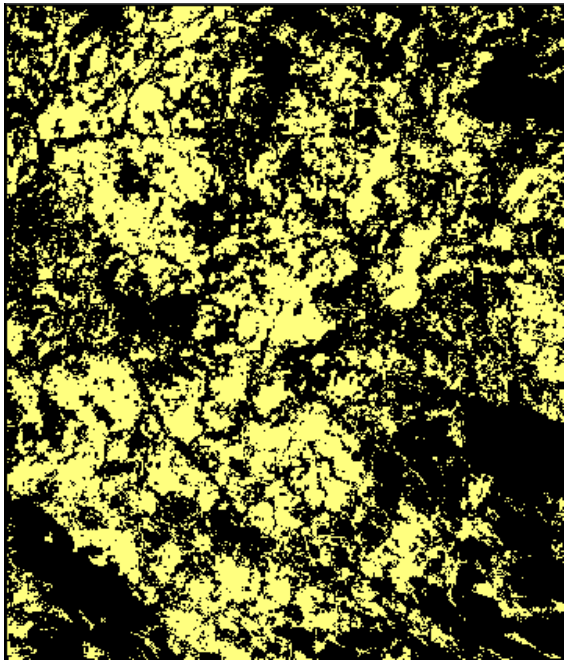
IRS AWiFS data of Oct, 2012



RISAT-1 CRS data of 9th Sep 2012

Part of Orissa

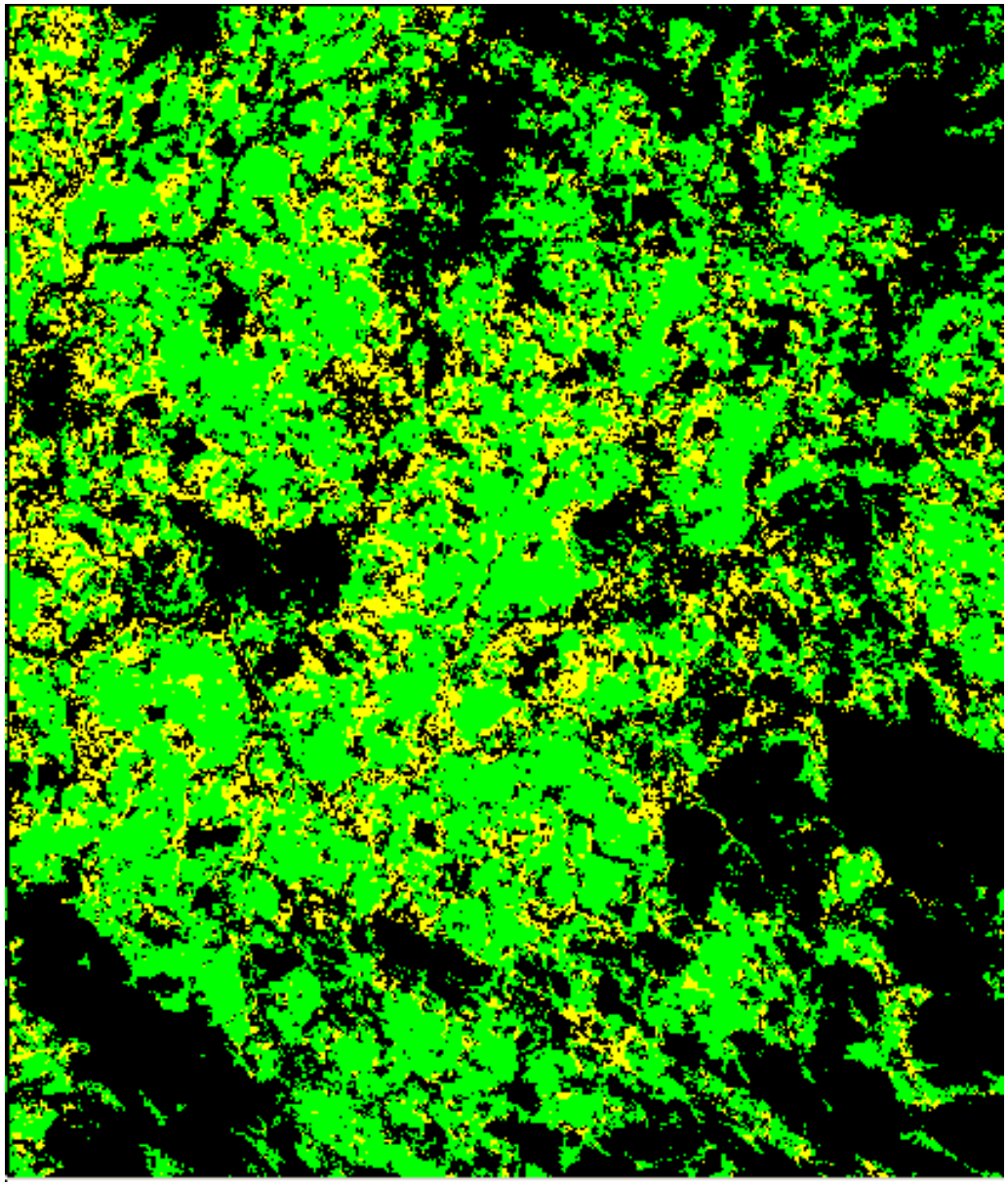




Kharif crop from RISAT-1
54,120 ha

Kharif crop from AWiFS
52,443 ha

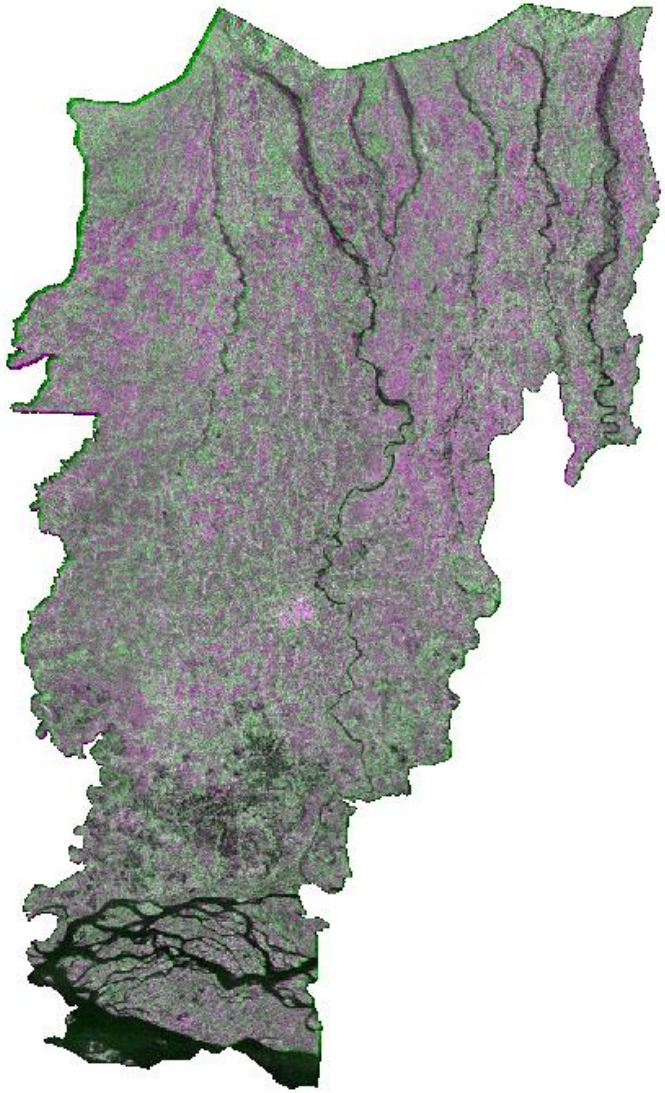
ESTIMATION OF KHARIF CROP AREA FROM RISAT-1 & AWiFS



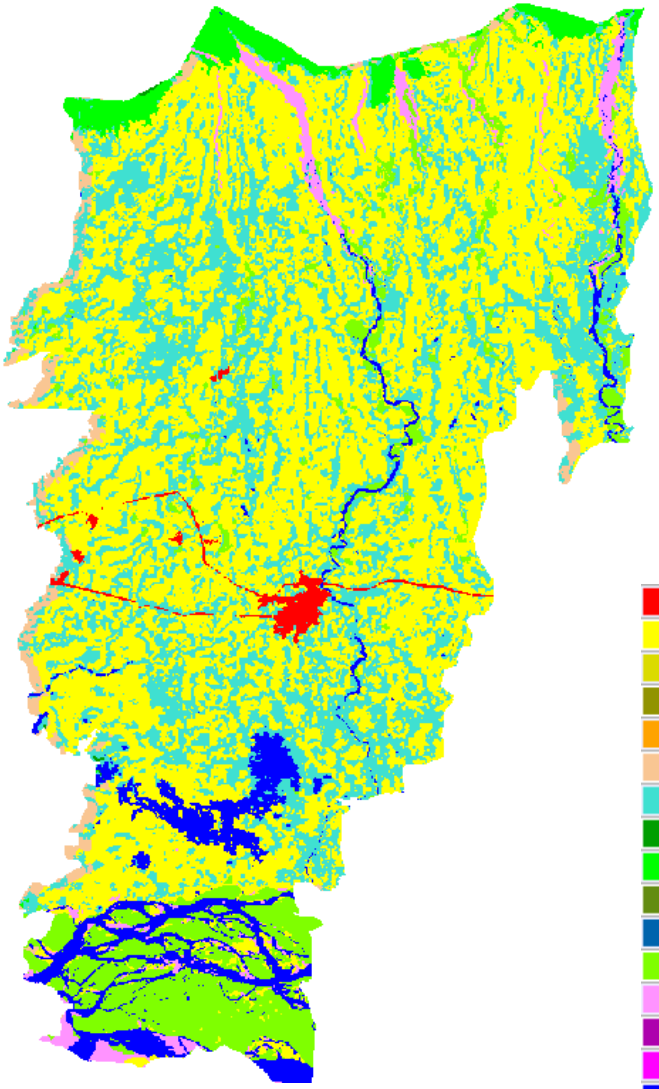
Kharif crop from RISAT-1
54,120 ha

Kharif crop from AWiFS
52,443 ha

Land use land cover mapping of Nalbari district using RISAT-1 data of 09-09-12



RISAT-1 data
HH (R)-HV (G)-HH (B)



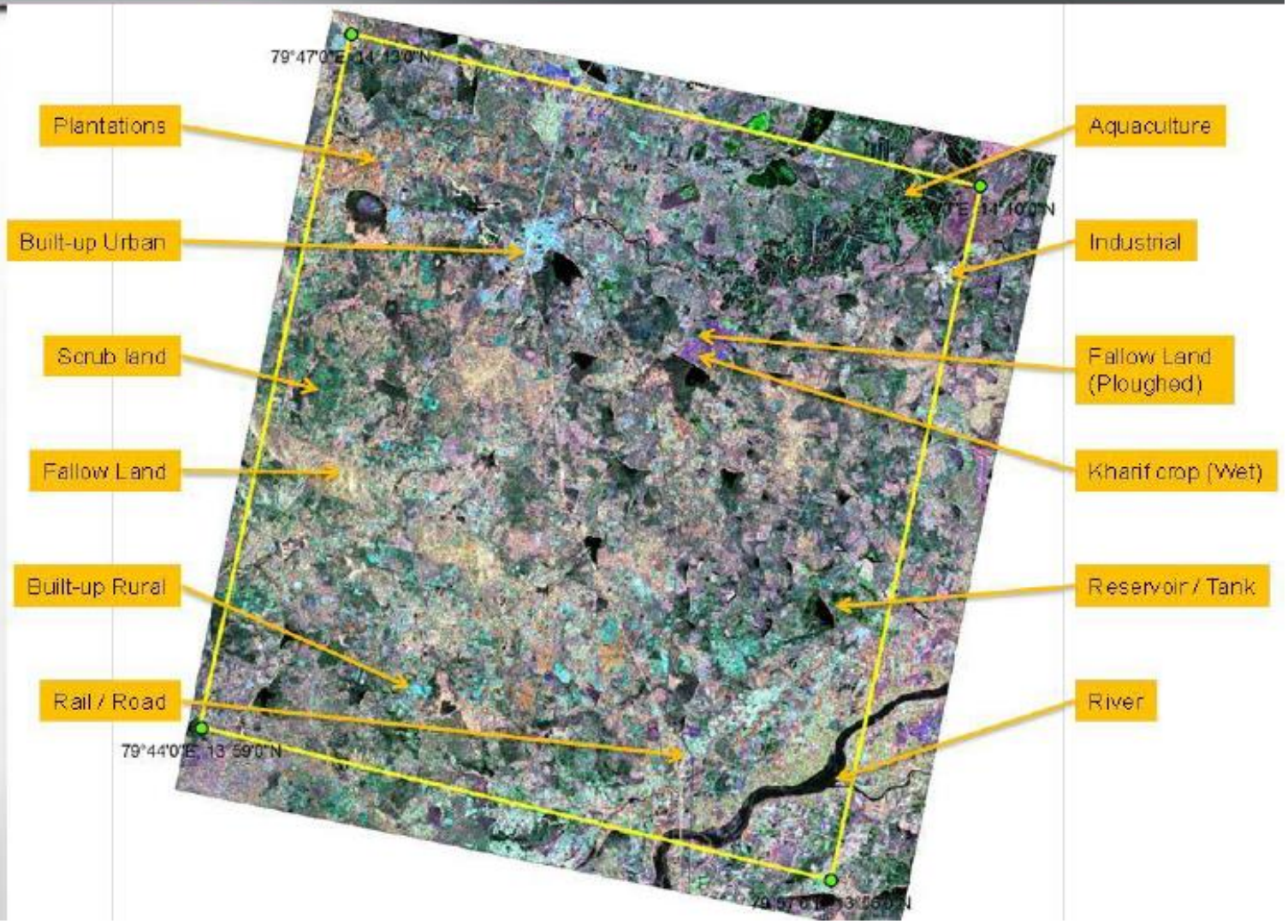
Digitally classified data

Statistics

	Built-up land
	Kharif crop land
	Rabi crop land
	Zaid Crop land
	Double/Triple crop land
	Current Fallow land
	Plantation / Orchard
	Evergreen / Semi-evergreen
	Deciduous Forest
	Degraded Forest
	Littoral/Swamp/Mangrove
	Grassland & Grazing Land
	Other Waste lands
	Gullies/Ravines
	Scrub land
	Water Bodies

Land Use / Land Cover inventory using Multi-Temporal RISAT SAR Data

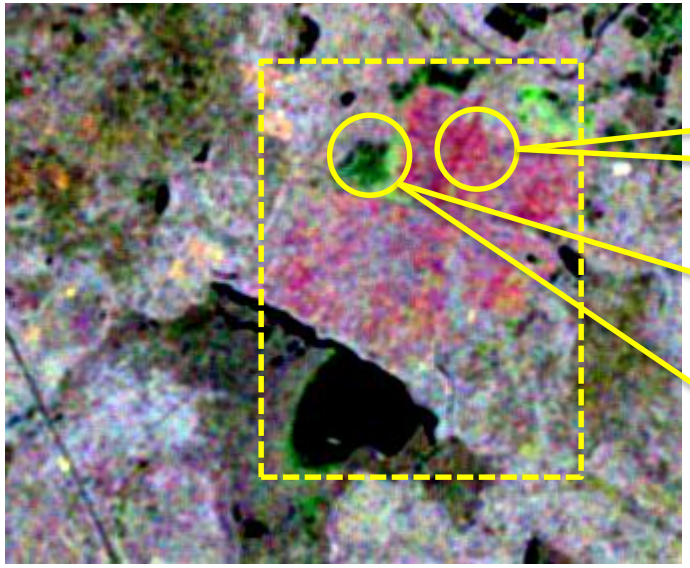
Identification Class

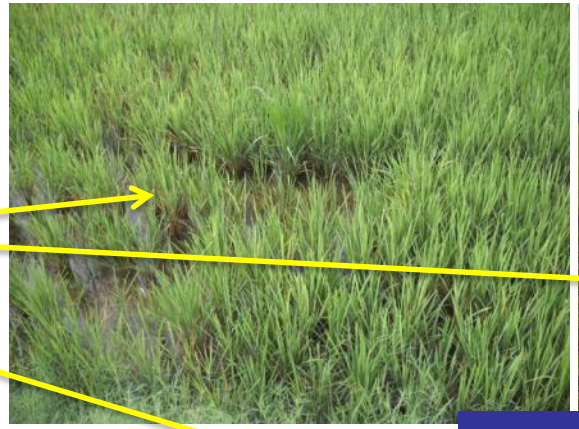


Inc. Angle: 46.20d
DOP: 23rd Aug 2011

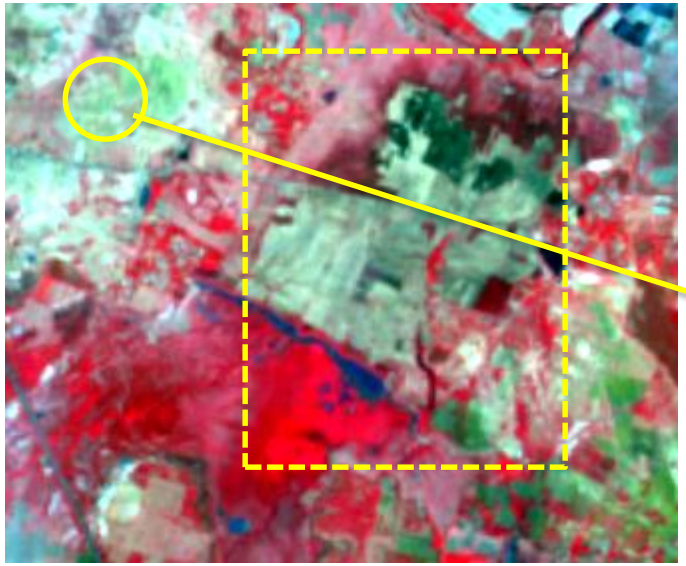
RGB image: VH, VV & HH

Ground Truth

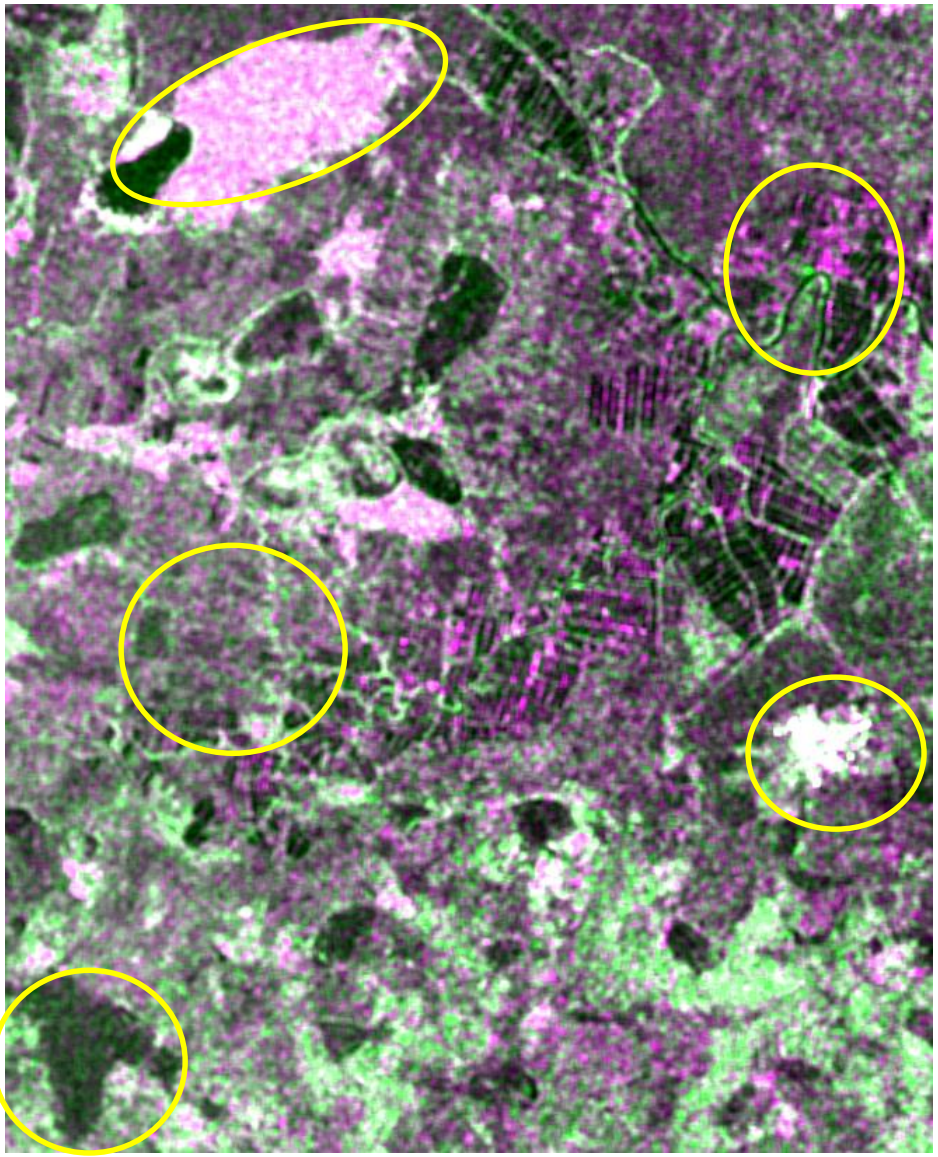




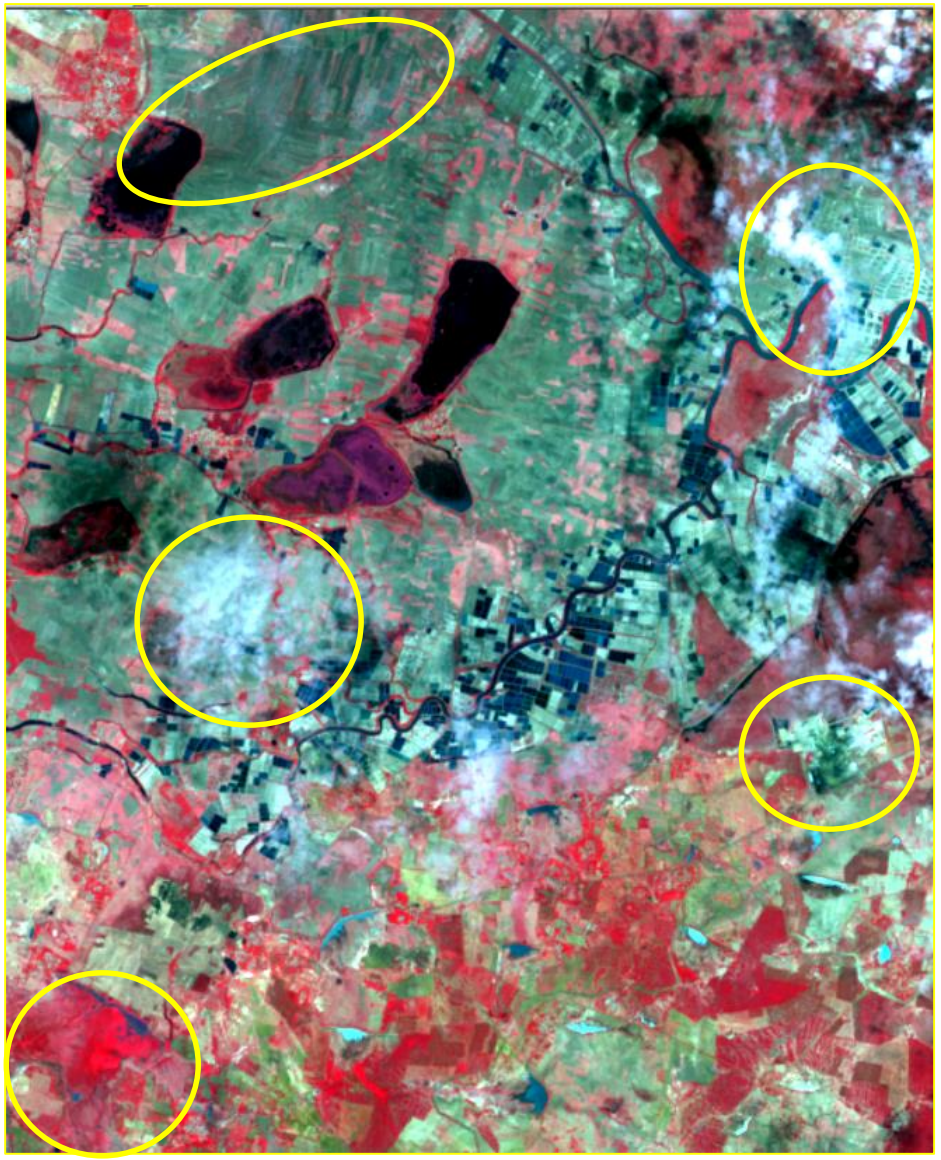
Crop land



Scrub land

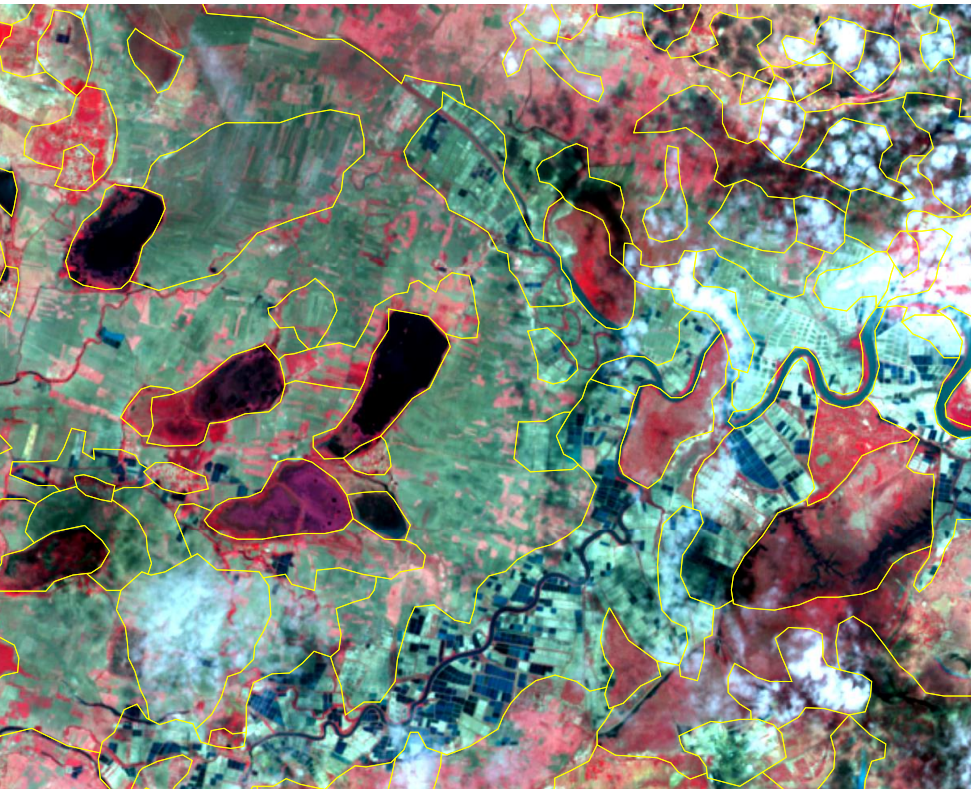


RISAT – 1, DOP: 11th Aug 2012
RGB image: Media DN HH, HV, HH, Pixel Size: 18 m

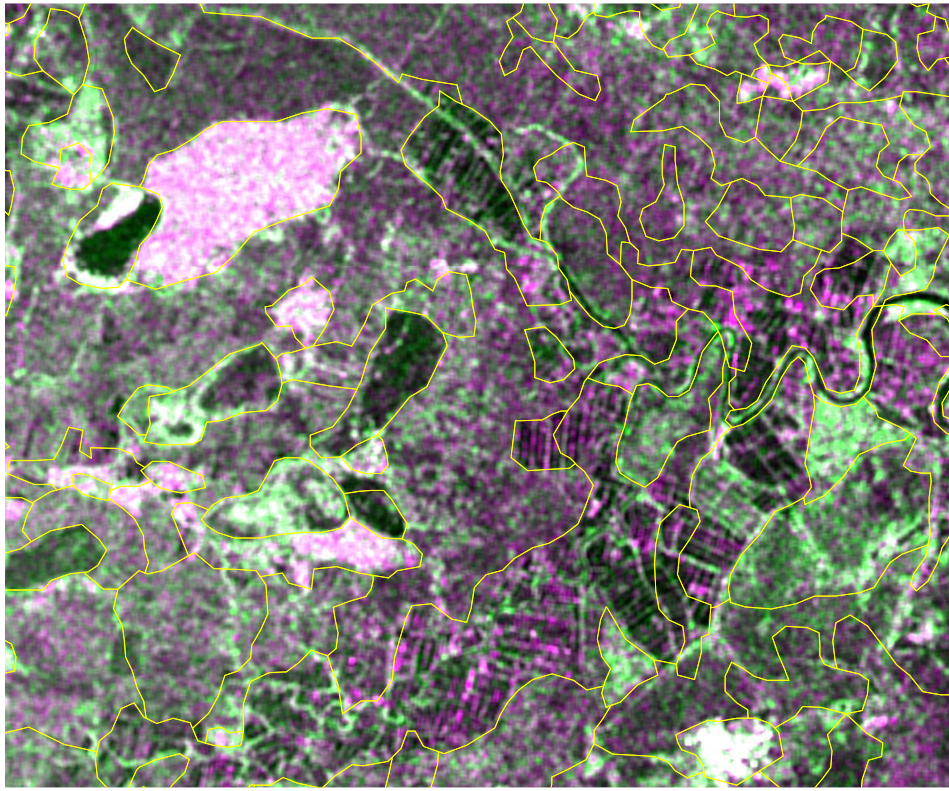


Resourcesat-2, LISS-III, DOP: 02nd October 2012
RGB image: Band 2,3,4, Pixel Size: 24 m

Use of Microwave Data for updation of Land Use / Land Cover Information



Resourcesat-2, LISS-III, DOP: 02nd October 2012
RGB image: Band 2,3,4, Pixel Size: 24 m



RISAT – 1, DOP: 11th Aug 2012
RGB image: Media DN HH, HV, HH, Pixel Size: 18 m

Improvement in Cropland, Aquaculture and LC at cloud infested areas

HYPERSPECTRAL DATA APPLICATION IN LULC STUDY

The accuracy of the thematic map produced from automatic digital classification depends on many factors like classification algorithm, parameters used in the classifier, size of the training samples etc.

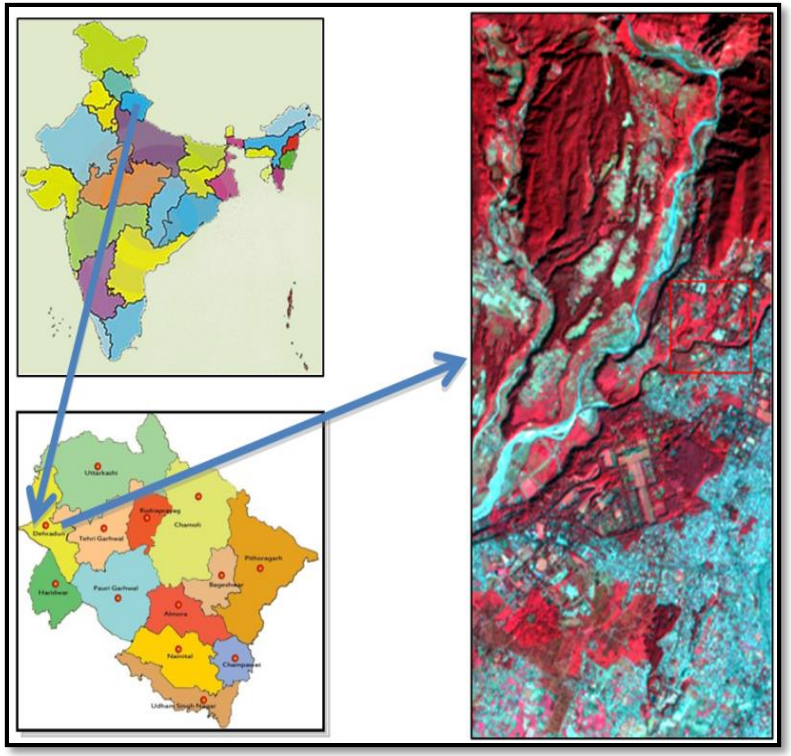
The space borne hyperspectral(HS) datasets have a medium to coarse spatial resolution with high spectral information leading to many mixed pixels in the image.

Hence, finding too many pure pixels from the image for training the classifier is a challenging task for HS datasets.

The conventional multispectral image classifiers like Maximum Likelihood require at least 10*n(n – number of bands) training pixels for classification. Hence, advanced classifiers like Spectral Angle Mapper, Support Vector Machines, Artificial Neural Networks, Random Forests etc. were designed for specifically classifying the HS datasets.

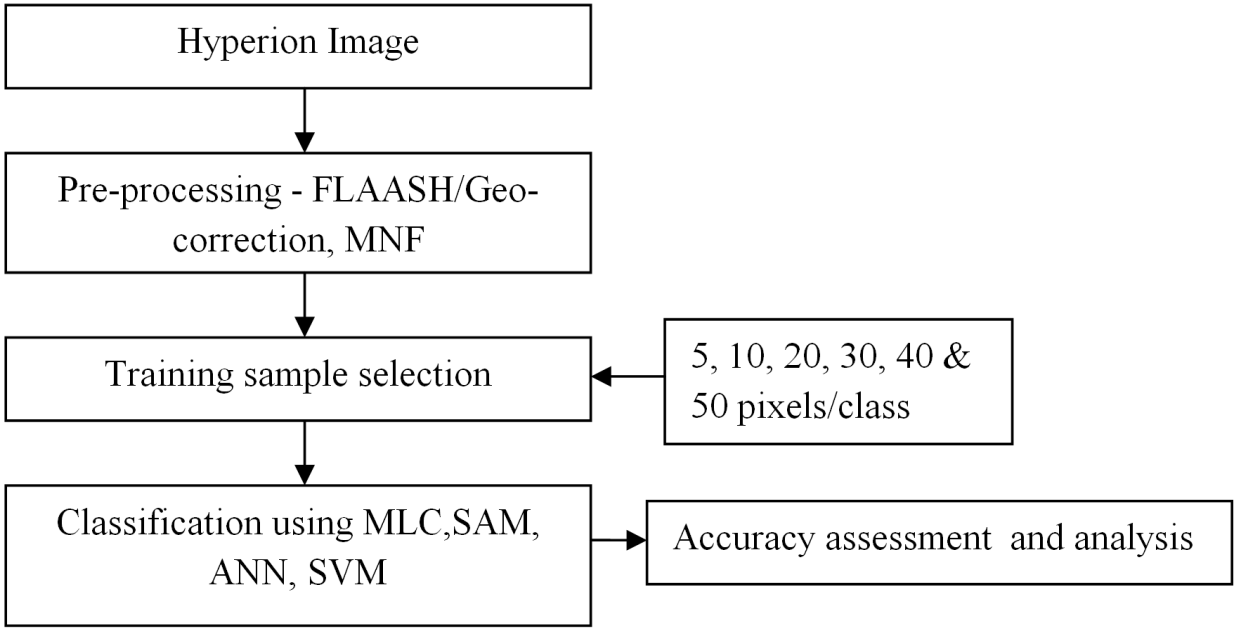
STUDY AREA AND DATASETS

- The Hyperion image of Dehradun area was used for the current study. Hyperion image has a spatial resolution of 30m with 242 bands in the VNIR regions with 5-10nm sampling interval.
- The obtained Hyperion image was pre processed and a final of 143 bands were used for the study.
- Field spectra was collected from the area using field spec hand held spectro-radiometer.



Specifications	Hyperion
Sensor	Push broom
Date of pass	2 Dec 2009
Spatial Resolution	30m
Spectral resolution	242 bands (400-2500nm)
Swath	7.5km
Temporal resolution	209days
Radiometric resolution	14bit
Sensor altitude	705km
Band width	<10nm

METHODOLOGY



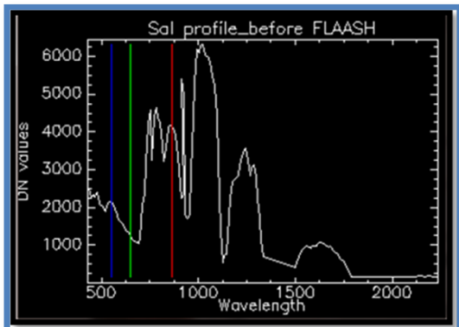
- The radiometrically corrected image contained 143 bands and is used as input into FLAASH tool for converting into reflectance.
- Dimensionality reduction is performed using Minimum Noise Fraction method.
- Equal number of training samples for all the classes were collected from the image (with a good distribution).

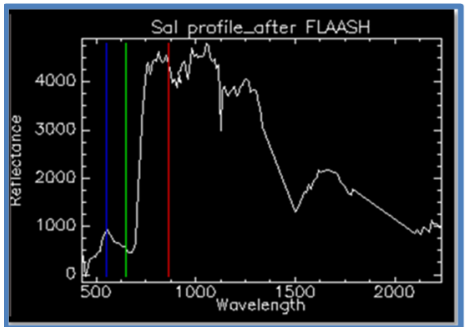
RESULTS – pre processing & sample collection

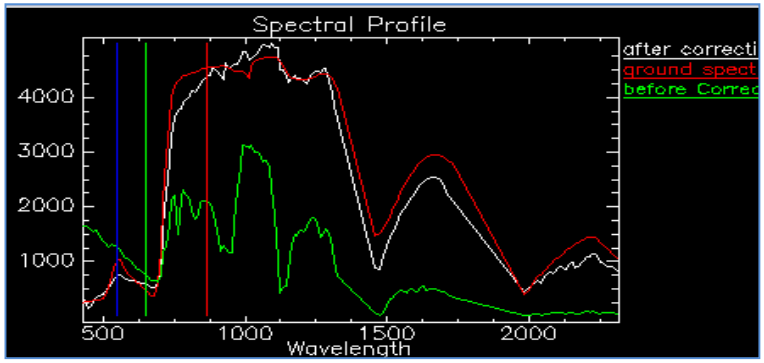
Bad band removal

↓

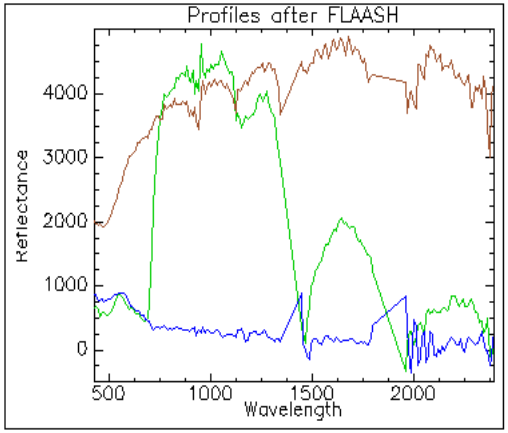
Vertical stripe removal → Atmospheric correction using FLAASH → Minimum Noise Fraction

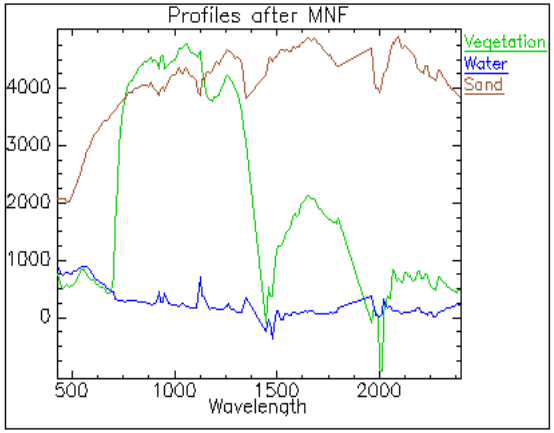


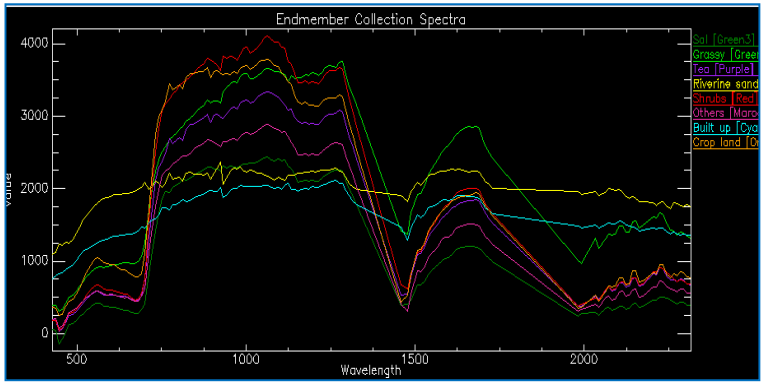




Comparison of profiles with ground spectra





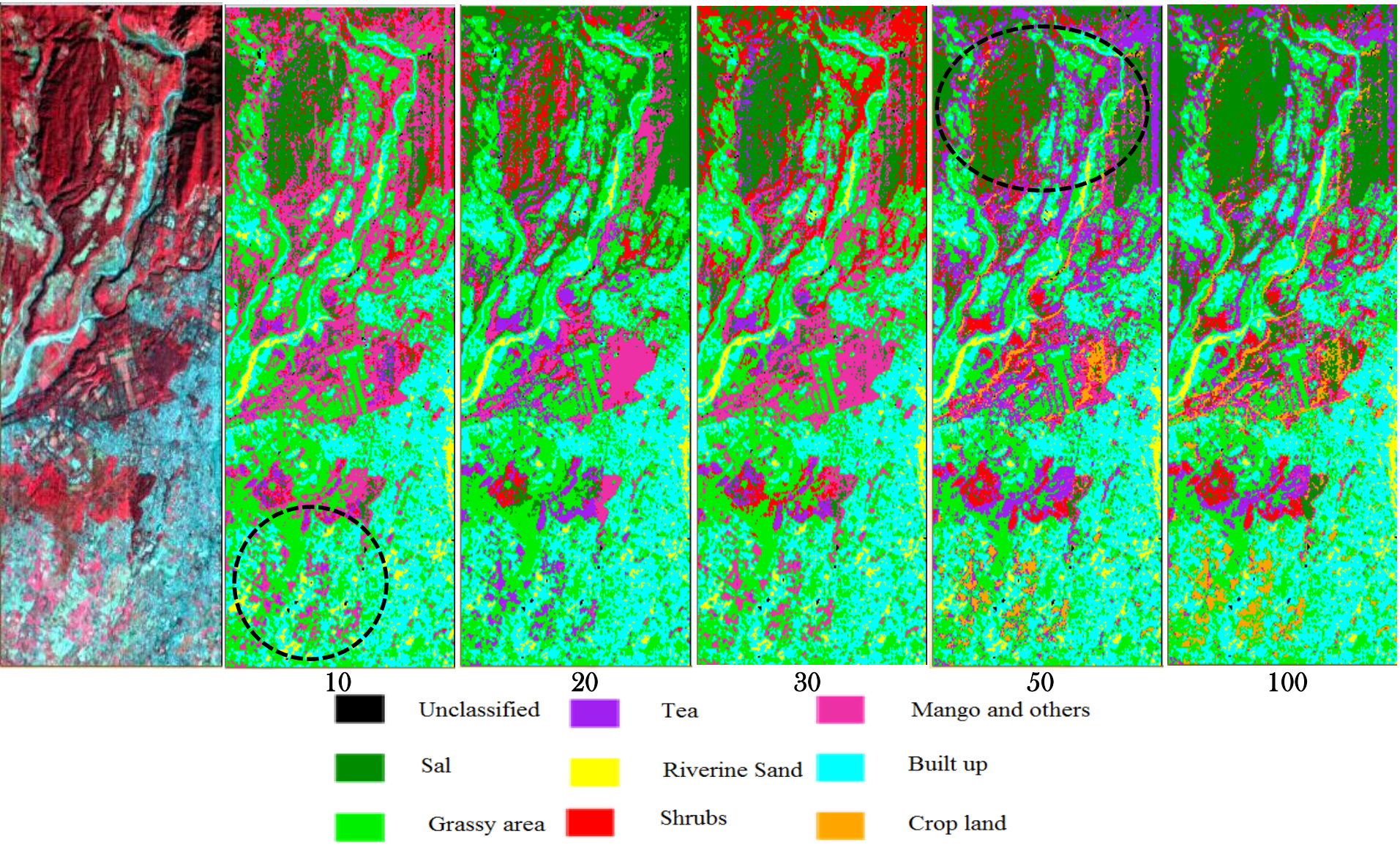


View of various end members collected

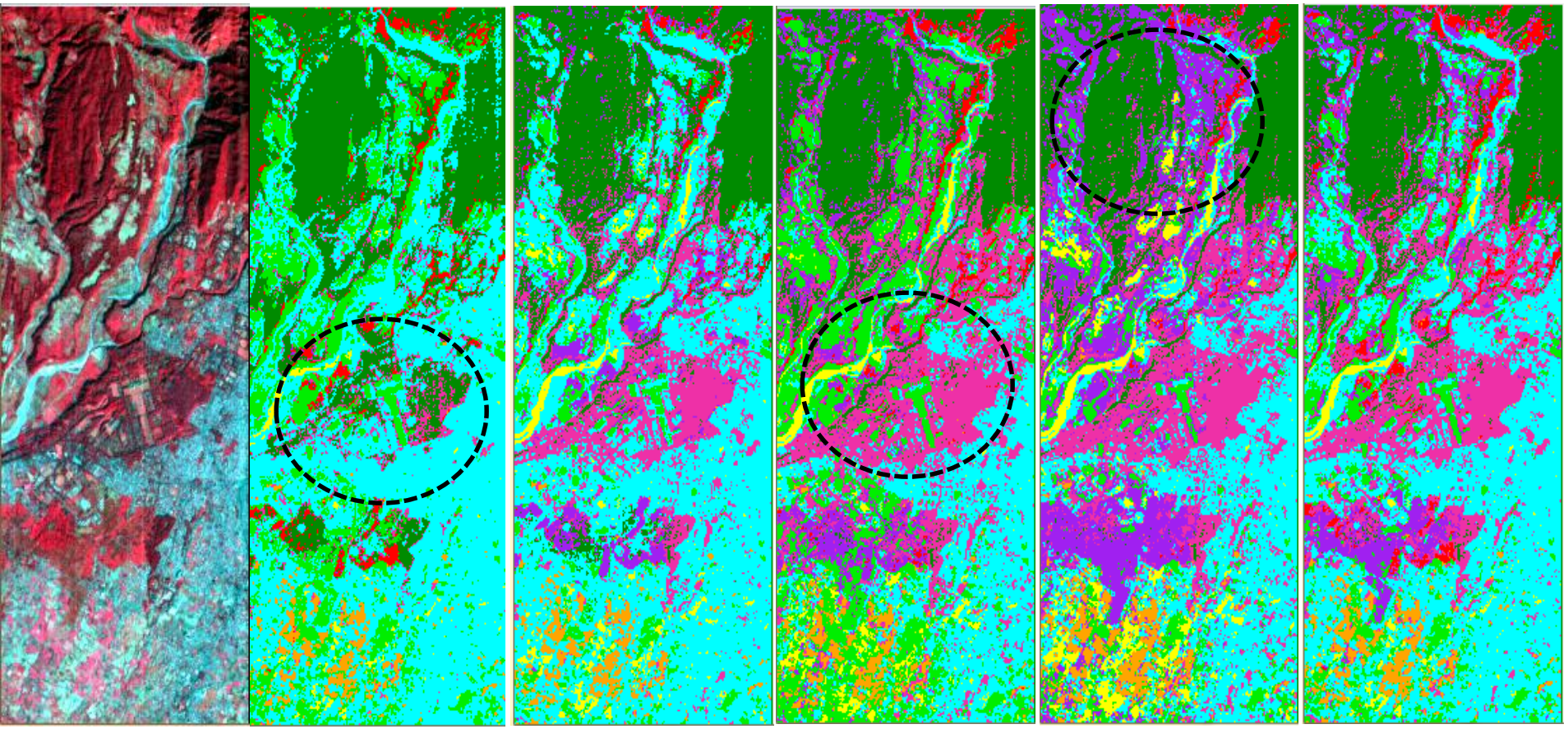
Atmospheric mode: Tropical
Aerosol mode: rural
Ground elevation: 0.105km
Water absorption column : 1135nm

Eigen value cut of : 2.509 (67.52-2.50)
MNF bands used for inverse : 23
SNR before MNF : 0.4025
SNR after MNF : 0.5124

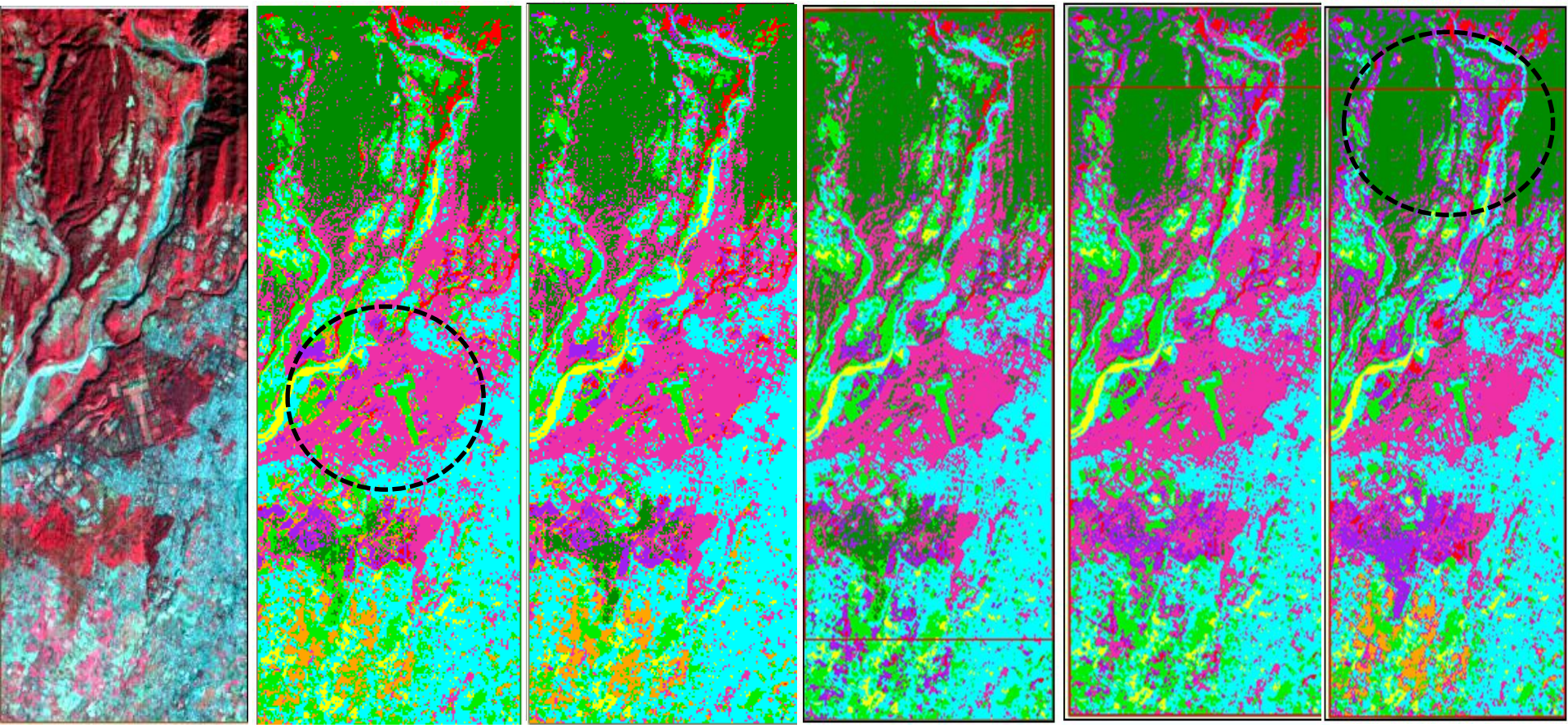
RESULTS- SAM classification



RESULTS- ANN classification



RESULTS- SVM classification



10 20 30 50 100

Unclassified
Tea
Mango and others
Sal
Riverine Sand
Built up
Grassy area
Shrubs
Crop land

CONCLUSIONS

- Support Vector Machine classifier outperformed the other classifiers with a very low training sample size of 10.
- ANN algorithm gave an edge over SVM with a training size of 30 pixels.
- However, as the training sample size increased, misclassifications were found in the final outputs.
- This was due to the impurity of the training pixels collected from the image.
- The training momentum and RMSE error for assigning the pixel to a class are the important parameters for ANN classification.
- For SVM classification, all the four existing kernels were tested and the RBF kernel followed by Polynomial kernel were found to be reliable.

Limitations

- Generalizing the size of the training sample is a challenging task as it depends on the homogeneity and spectral & spatial properties of the image.

LULC CHANGE MODELING

To provide answers to the following critical questions:

- **Which factors (biophysical, socio-economic) or processes drive the LULC changes and why?**
- **What is the spatio-temporal distribution of LULC changes?**
- **What will be the future LULC patterns?**

…Ultimately to help decision makers in sustainable land-use planning

Types of LULC Models

- **Empirical – Statistical models:** **(univariate/multivariate/logistic regression)**

- **Stochastic models:** **(Transitional probability models; e.g. CA-Markov Models)**

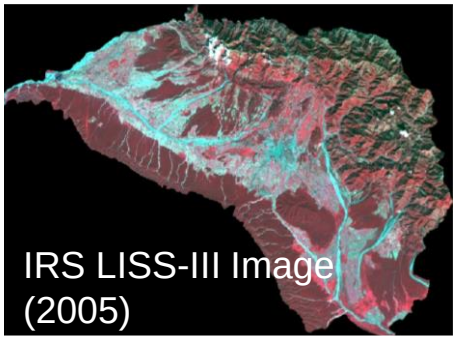
- **Optimization models**
  (generally based on economic theory, e.g. maximizing profit, minimising loss; Agent Based Models)

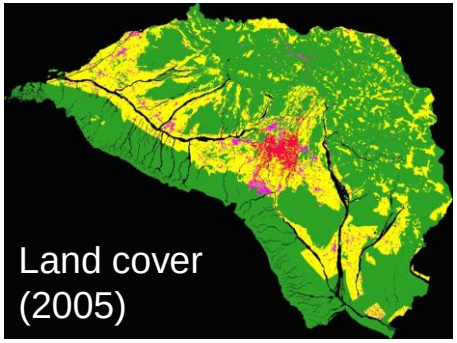
- **Dynamic (process-based) models**
  (simulate spatio-temporal patterns of LULC through interaction of biophysical and human processes)

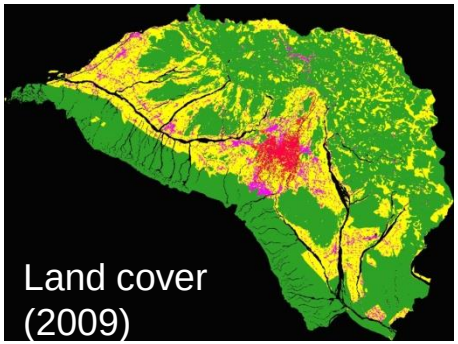
- **Hybrid models**

(Source: Lambin et al., 2001; Lambin, 2004; Orekan, 2007)

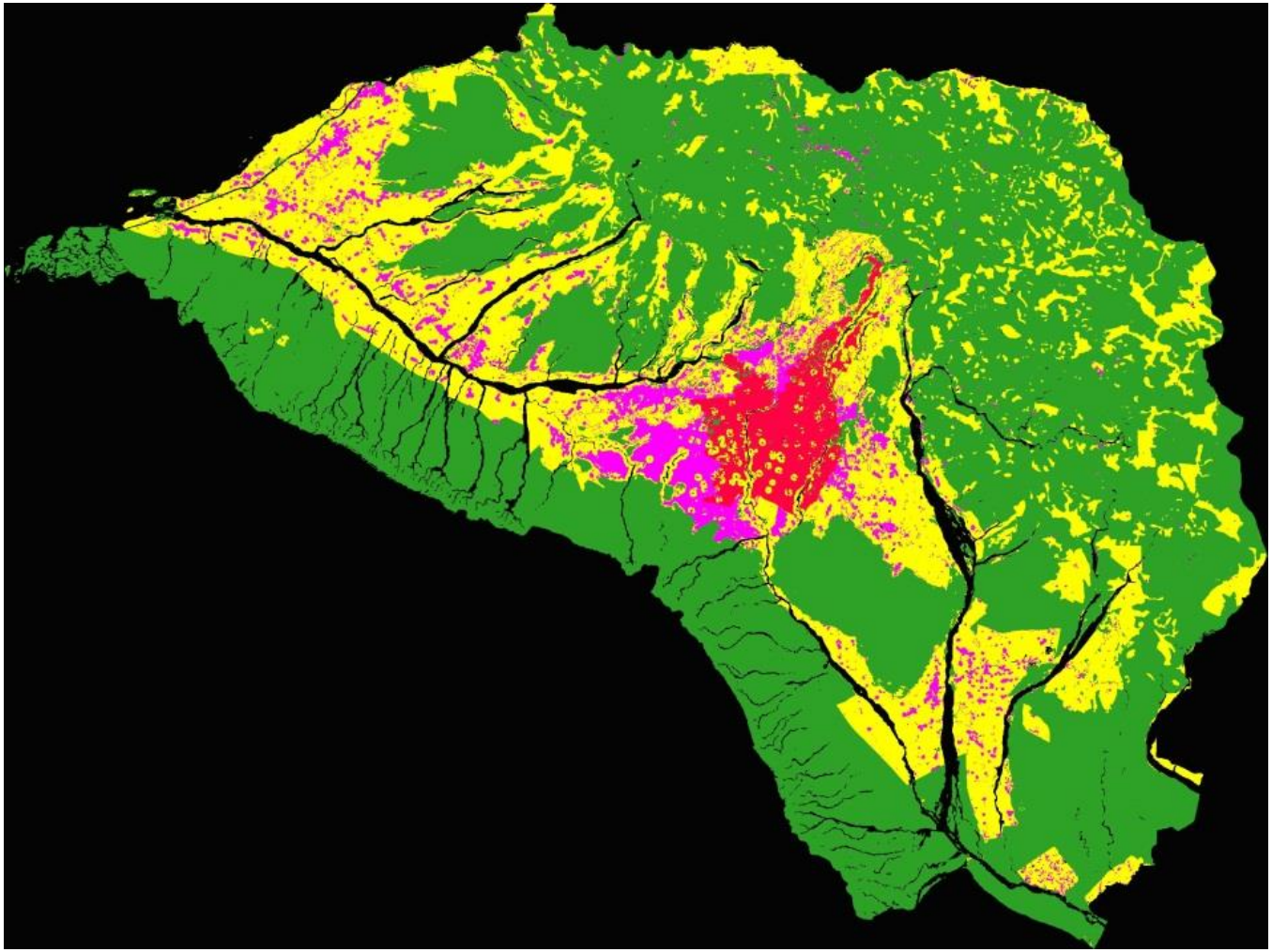
Simulation of Land Cover Scenarios in Doon Valley







Simulated (2021) – Business-as-usual scenario



- Urban built-up
- Non urban built-up
- Natural and Semi-Natural Vegetation
- Cultivated and Managed Areas

Utilization of LULC Database – Future Plans

- Creation of National Level Seamless data for Information System Development
- Development of LULC Monitoring System
- Web based services and analytical tools to serve the database
- Modeling to understand dynamics of LUCC and its drivers
- Exploration of alternate data sets (Microwave, HRS etc) for improved information generation

nrsc

THANKS