

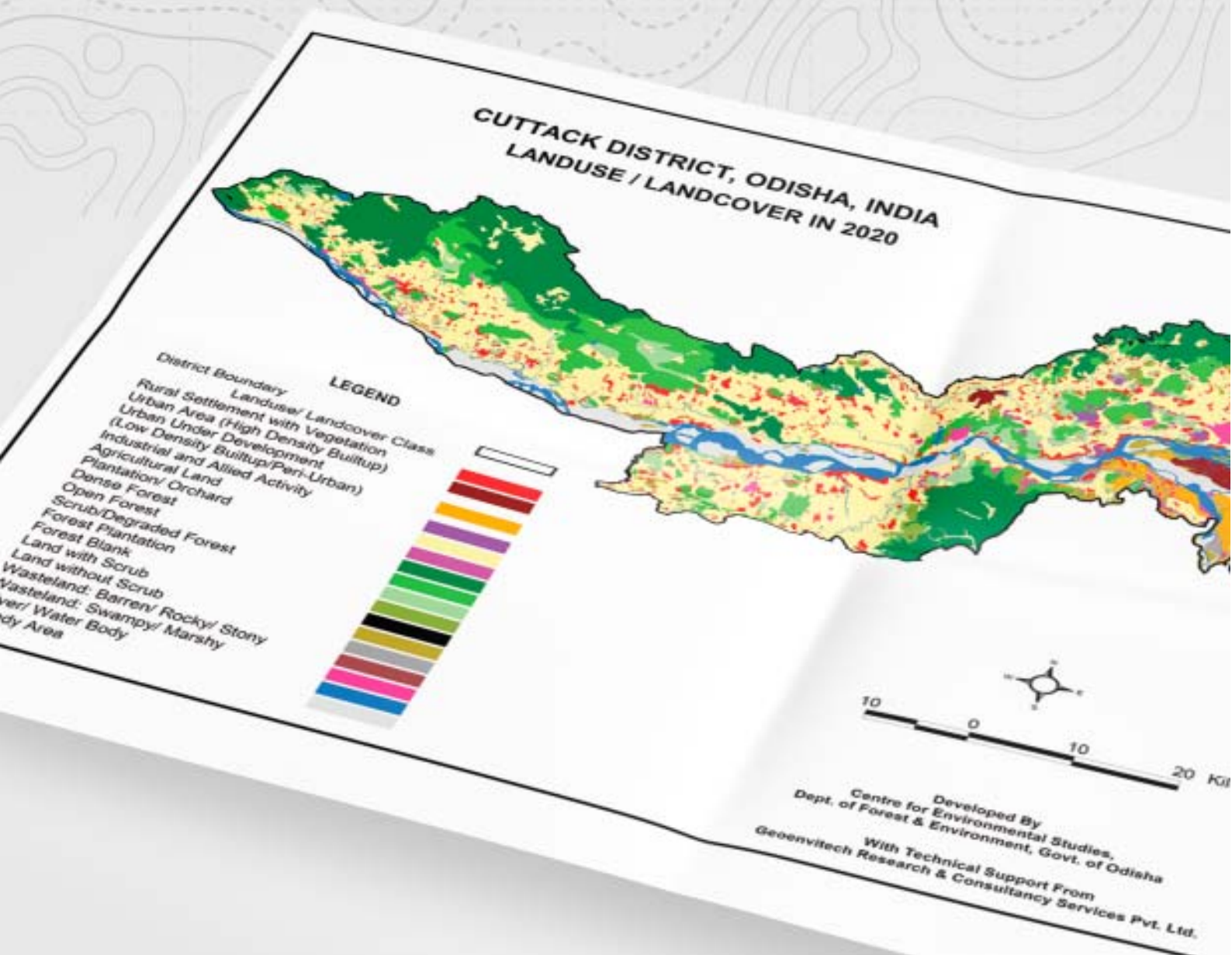


# DEVELOPMENT OF **GIS Based Prakriti Maps**

on

## **Landuse/Landcover Mapping & Change Analysis**

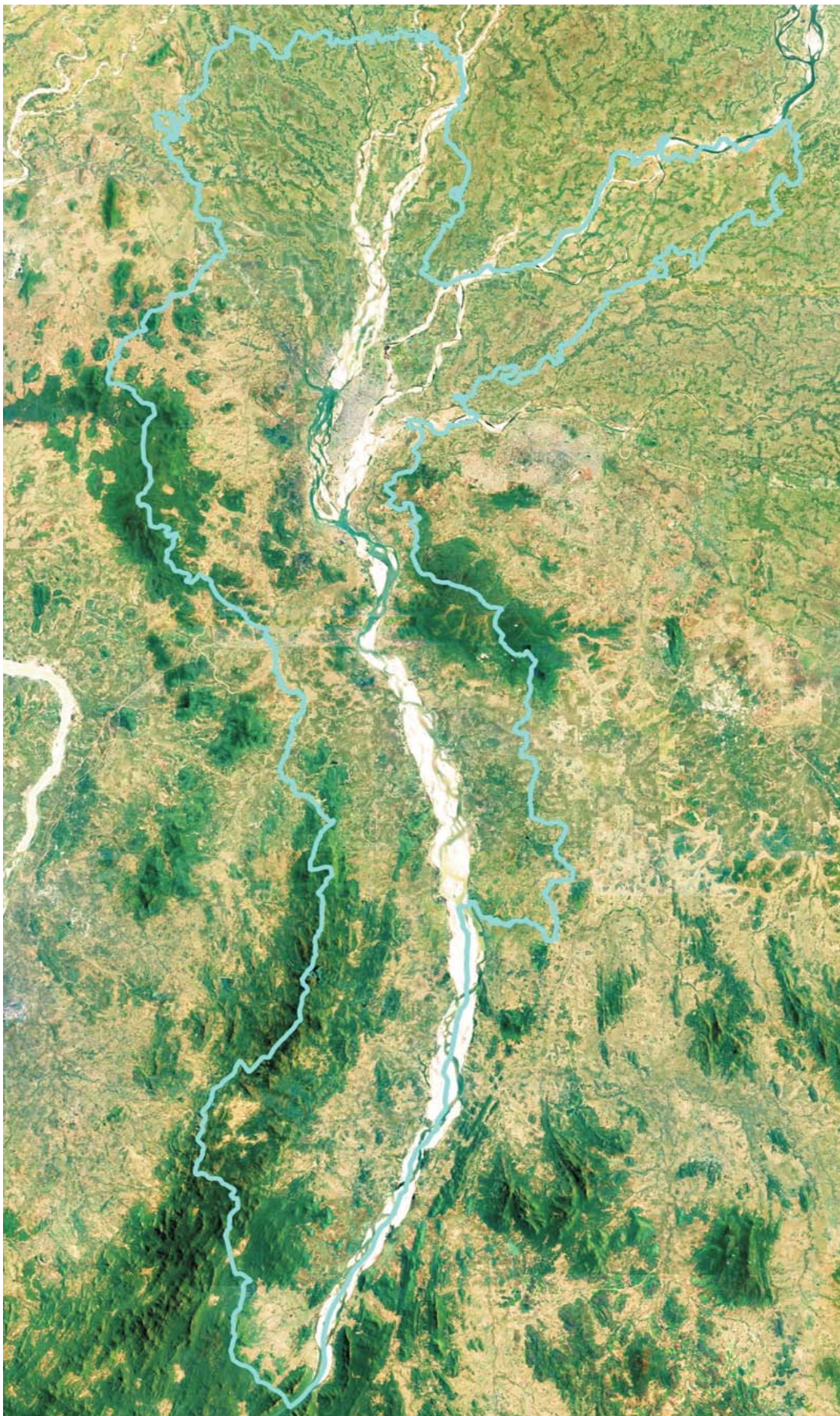
2010 to 2020 of Cuttack District, Odisha



**STATE ENVIS HUB, ODISHA**  
Centre for Environmental Studies  
Forest, Environment & CC Department



**Google Earth Map  
Cuttack District**





## **GIS MAPS UNDER GRIDSS**

### **Development of Remote Sensing & GIS based Prakriti Maps on Land use/Land cover mapping & change analysis (2010 to 2020) of Cuttack District, Odisha**

#### **THEMES**

- Land use/Land cover
- Remote Sensing
- Geographical Information System
- Cuttack District, Odisha, India
- Land Use Pattern in Cuttack District
- Methodology of Present Assignment
- Flow Diagram of Methodology
- Index Map of Cuttack District
- Land use/Land cover Map 2010
- Land use/Land cover Map 2020
- Map Showing Major Changes 2010-2020
- Land use/Land cover Area Statistics 2010 Vs 2020
- Change Analysis Matrix
- Major Land use/Land cover Change Area

#### **LAND USE / LAND COVER**

- Land is definitely one of the most important natural resource, since life and developmental activities are based on it.
- Land use refers to the type of utilization to which man has put the land and Land cover refers to natural cover of land (like forest, water body etc.)
- Land use and Land cover data are essential for planners, decision makers and those concerned with land resources management.
- Land use and Land cover change is the conversion or transformation of different Land use/ Land cover types over time and is the result of complex interactions between humans and the physical environment. Land use/ Land cover change is a major driver of global change and has a significant impact on ecosystem processes, biological cycles and biodiversity.
- Land use/ Land cover (LULC) change detection helps the policy makers to understand the environmental change dynamics to ensure sustainable development.
- The main reason behind the LU/LC changes includes rapid population growth, rural-to-urban migration, reclassification of rural areas as urban areas, lack of valuation of ecological services, poverty, ignorance of biophysical limitations, and use of ecologically incompatible technologies.

## REMOTE SENSING

- Remote Sensing is the process of acquisition of information about an object or phenomenon without making physical contact with the object.
- Now a days, the Remote Sensing predominantly refers to acquiring information regarding earth surface features or resources through capturing and recording reflected/ radiated/ emitted energy by sensors onboard satellites.
- Satellite images have added a new dimension to the precise and accurate digital mapping of Land use/ Land cover even in inaccessible areas. Because the sensors onboard remote sensing satellites capture the ground reality without any manipulation.
- However the precision and accuracy depends upon the recentness as well as the resolution (spatial as well as radiometric) of the satellite image.
- Remote sensing has become an important tool applicable to developing and understanding the global, physical processes affecting the earth.
- Remote Sensing, integrated in GIS environment, has now revolutionized the Land use/ Land cover change analysis through mapping of multi-temporal satellite images.

## GEOGRAPHICAL INFORMATION SYSTEM (GIS)

- GIS is an integrated system of computer hardware and software capable of capturing, storing, retrieving, manipulating, analyzing, and displaying geographically referenced (spatial) information for the purpose of aiding development-oriented management and decision-making processes.
- GIS helps create individual layers for similar or homogeneous types of features, which can be overlaid at will for integrated analysis.
- For Land use/land cover mapping and change analysis, the Remote Sensing provides input data in terms of multi-temporal satellite images.
- The GIS provides the geoinformatics platform for digital processing, enhancement and interpretation of these multi-temporal satellite images, development of multiple GIS layers for different years Land use/ Land cover, Land use/Land cover class attribute coding, overlaying/ integration of such multiple time series GIS layers, area statistics generation, reclassification and deriving change areas accurately and precisely.
- So the present assignment makes an attempt to utilize Remote Sensing Data/Imagery and GIS for digital mapping of Land use/ Land cover and change analysis for Cuttack District of Odisha, India.

## CUTTACK DISTRICT, ODISHA, INDIA

- Cuttack district is one of the 30 districts of Odisha state in India.
- Cuttack district is one of the centrally located districts of Odisha. It lies between 84°58' to 86° 20' East longitude and between 20°03' to 20°40' North latitude. It is bounded by the Dhenkanal district in north Puri district in south, Kendrapada in the east and Boudh district in the west.

- It is located in the coastal part of the state and its administrative headquarters are located in the city of Cuttack.
- As of 2011 Census, after Ganjam, it is the second most populous district of Odisha, with a population of 26,24,470.
- The district is spread over a geographical area of 3,932 km<sup>2</sup>.
- The district accounts for 2.53 percent of the state territory and shares 6.25 percent of the state population. The density of population of the district is 667 per sq. km. as against 270 person per sq.km of the state. It has 1950 villages (including 94 un-inhabited villages) covering 14 blocks 15 Tahasils and 3 Subdivisions.

### LAND USE PATTERN IN CUTTACK DISTRICT

- The land utilization pattern for the years 2006-07 and 2017-18 has been compared in the below given table. This is as per District Statistical Handbook, Directorate of Economics & Statistics, Govt. of Odisha.

Land use Utilization Pattern (Area in Sq. Km.)

<b>Land use Type</b>	<b>2017-18</b>	<b>2006-07</b>
Forest	300.69	269.95
Land put to non agricultural use	776.33	740.13
Barren and Non-cultivable land	95.72	144.25
Permanent pastures and other grazing land	122.73	123.51
Land under misc. Tree/crop/grove and not included in Net Area Sown	87.82	97.58
Cultivable waste	146.28	152.63
Old Fallows	199.84	195
Current Fallows	458.91	131.67
Net Area Sown	1148.07	1489.08

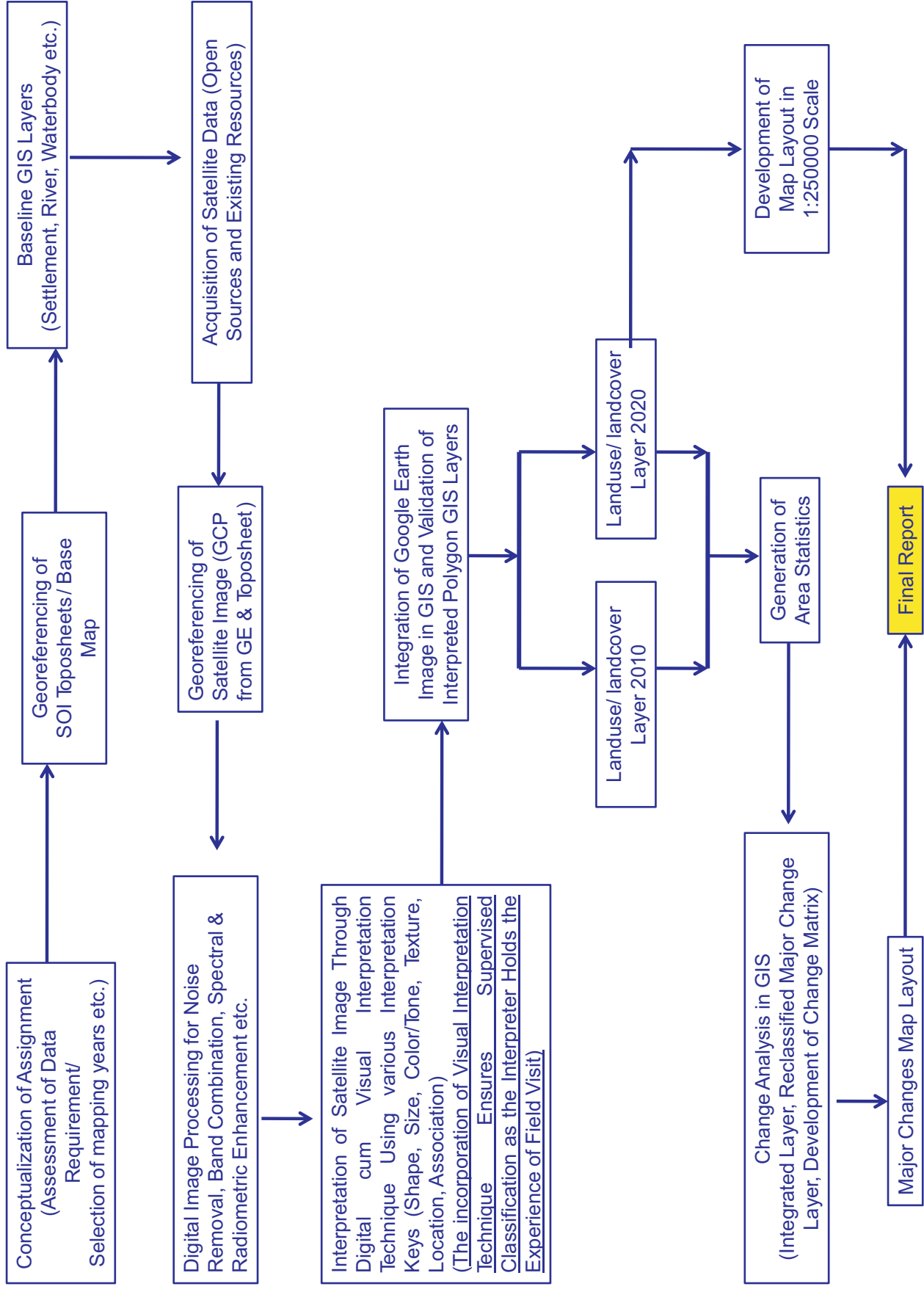
This data indicates that the district is predominated by agricultural land and higher density of settlements (being one of the populous districts of the state).

### METHODOLOGY OF PRESENT ASSIGNMENT

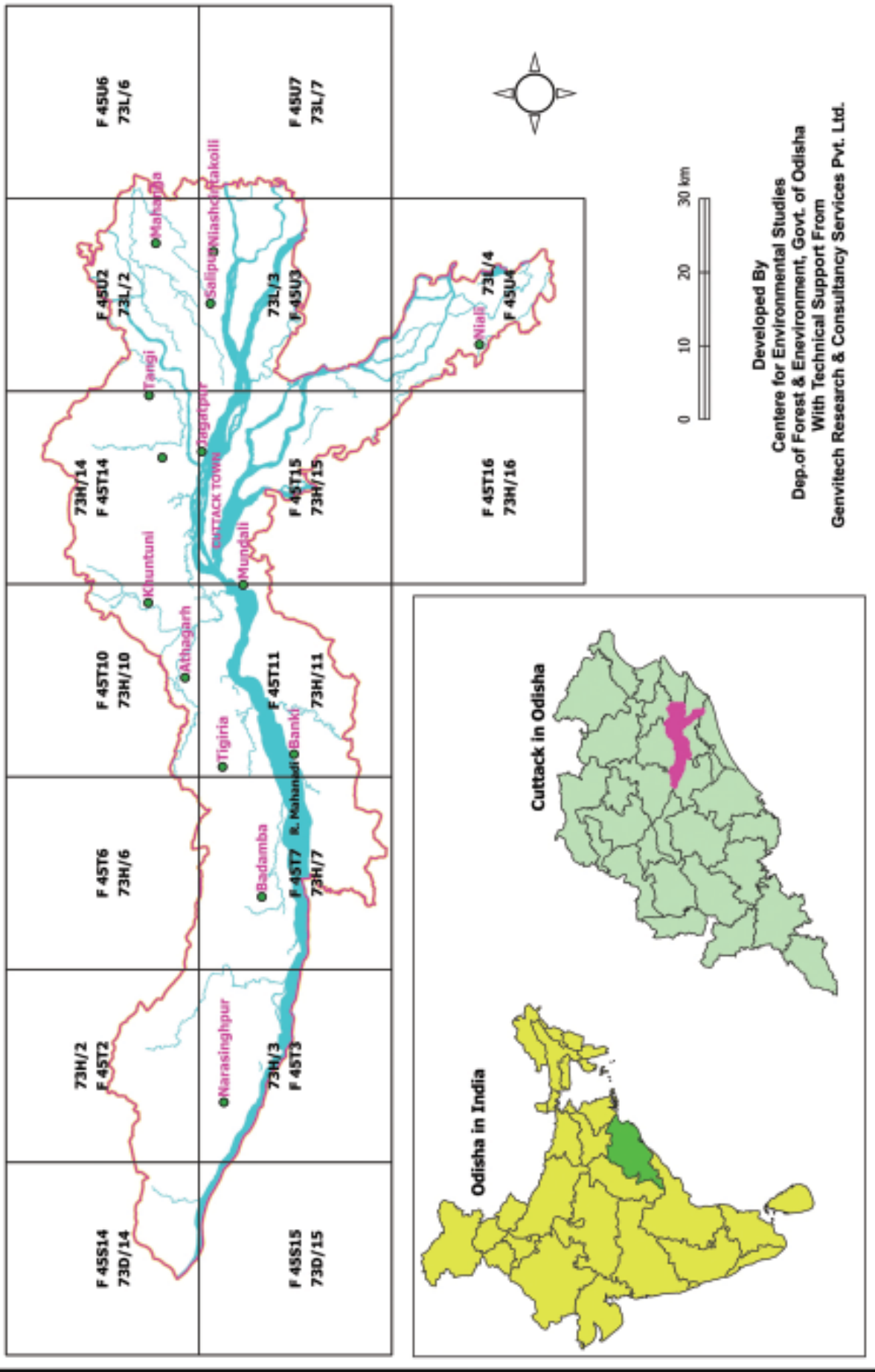
- The land utilization pattern given previously here are from compilation of secondary sources and describe the broad pattern of land use.
- In order to cater various planning and management needs, a detailed, precise and larger scale digital mapping of Land use/ Land cover is the need of the hour.
- Further, the Land use/Land cover over earth surface changes over time and this dynamics of Land use/Land cover is the driver of environmental, climatic and many other changes over our globe.

- So monitoring or analysis of such Land use/ Land cover changes is an essential task before us, which can guide our future course of action towards ensuring sustainable development.
- In this context, Centre for Environmental Studies, Dept. of Forest & Environment, Govt. of Odisha has made an attempt to carry out a pilot study of Remote Sensing & GIS based multi-temporal Land use/ Land cover mapping and change analysis for Cuttack district of Odisha.
- In this regard, Geovitech Research & Consultancy Services Pvt. Ltd., has provided technical support for Remote Sensing and GIS based services.
- In this present assignment various satellite images have been used as detailed below:
- AWiFS image of IRS P6 of December 2010
- MSI image of Sentinel 2 of January 2020
- OLI & TIRS Image of Landsat 8 of November 2020
- Google Earth Images of 2010 and 2020
- These satellite images have been processed and enhanced in QGIS.
- The 16 numbers of OSM/ Topomaps encompassing whole Cuttack district have been georeferenced and mosaicked in QGIS for development of baseline layers.
- The satellite images have been interpreted in digital cum visual interpretation technique to develop polygon GIS layers in QGIS for the year 2010 and 2020.
- The attributes (Land use/ Land cover class) have been coded in layers and layers have been edited with correction of geometrical errors.
- Finally the layers for the both years have been validated by integrating Google Earth images in QGIS.
- Unlike the hard copy maps (where the scale of map is static), the GIS interface is dynamic. So, in order to ensure mapping of smaller Land use/ Land cover units, the interpretation has been done in 1: 50000 scale and 1: 10000 scale (especially in urban, peri-urban, settlement, industrial and probable change areas).
- The Land use/Land cover classification system has been used based on the Standards and Guidelines defined in:
  - IMSD- Technical Guidelines 1995, NRSA, DoS, Govt. of India.
  - NNRMS Node Design & Standards 2000, ISRO, Govt. of India.
  - Wasteland Atlas of India 2011, MoRD & DoS, Govt. of India.
- The final classification system is based on Level 2 and Level 3 of above mentioned guidelines with little improvisation based on local conditions.
- The flow diagram of methodology is given below:

# FLOW DIAGRAM OF METHODOLOGY



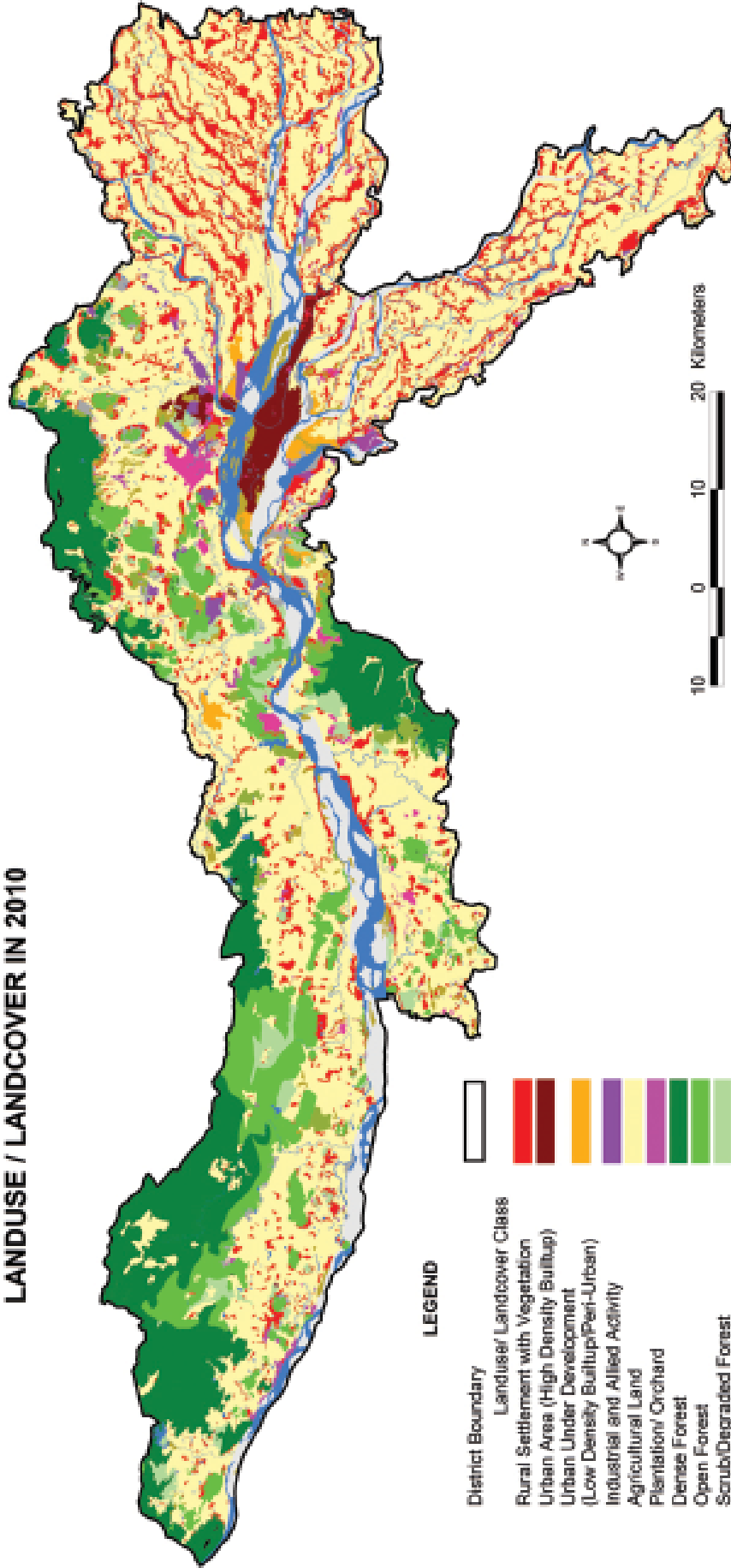
# CUTTACK DISTRICT IN ODISHA, INDIA WITH TOPOMAP INDEX



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# CUTTACK DISTRICT, ODISHA, INDIA LANDUSE / LANDCOVER IN 2010



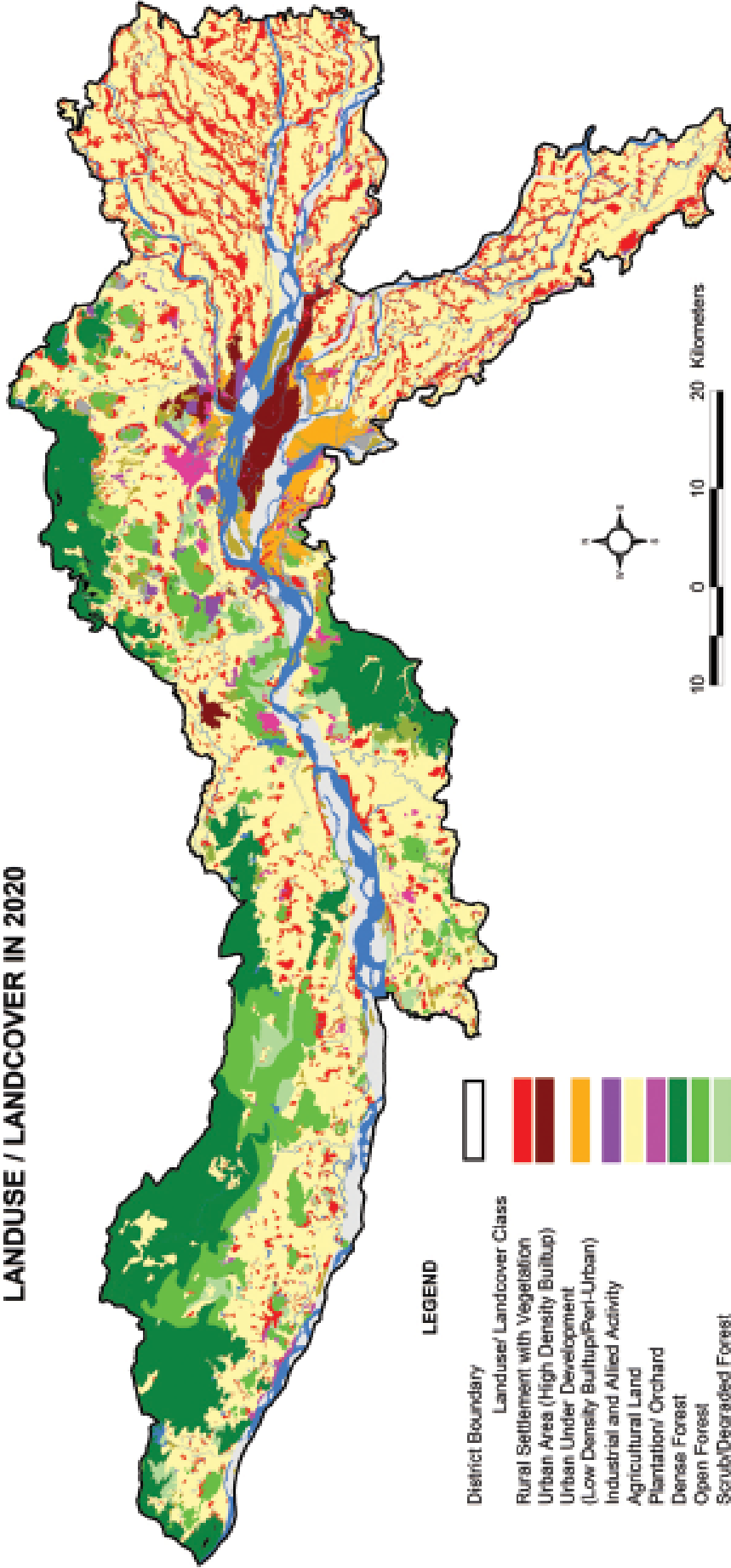
## LEGEND

- District Boundary
- Landuser' Landcover Class
- Rural Settlement with Vegetation
- Urban Area (High Density Builtup)
- Urban Under Development
- Urban (Low Density Builtup/ Peri-Urban)
- Industrial and Allied Activity
- Agricultural Land
- Plantations/ Orchard
- Dense Forest
- Open Forest
- Scrub/Degraded Forest
- Forest Plantation
- Forest Blank
- Land with Scrub
- Land without Scrub
- Wasteland: Barren/ Rocky/ Stony
- Wasteland: Swampy/ Marshy
- River/ Water Body
- Sandy Area





















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# CUTTACK DISTRICT, ODISHA, INDIA LANDUSE / LANDCOVER IN 2020

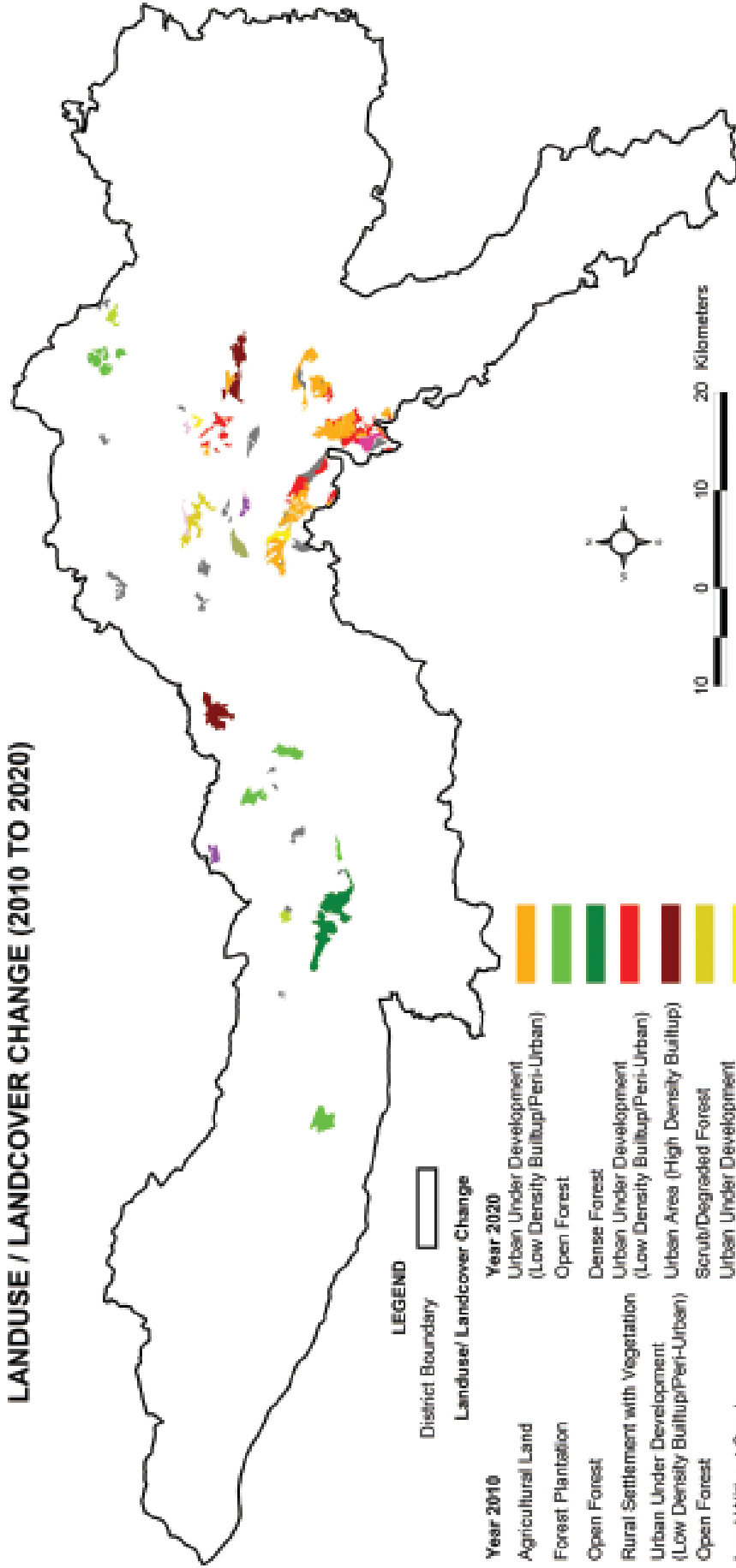


## LEGEND

-  District Boundary
-  Landuse/ Landcover Class
-  Rural Settlement with Vegetation
-  Urban Area (High Density Builtup)
-  Urban Under Development
-  (Low Density Builtup) Peri-Urban
-  Industrial and Allied Activity
-  Agricultural Land
-  Plantation/ Orchard
-  Dense Forest
-  Open Forest
-  Scrub/Degraded Forest
-  Forest Plantation
-  Forest Blank
-  Land with Scrub
-  Land without Scrub
-  Wasteland: Barren/ Rocky/ Stony
-  Wasteland: Swampy/ Marshy
-  River/ Water Body
-  Sandy Area

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 With Technical Support From  
 Geovintech Research & Consultancy Services Pvt. Ltd.

# CUTTACK DISTRICT, ODISHA, INDIA LANDUSE / LANDCOVER CHANGE (2010 TO 2020)



## LEGEND

District Boundary

Landuse/ Landcover Change

Year 2010	Year 2020
Agricultural Land	Urban Under Development (Low Density Builtup/Peri-Urban)
Forest Plantation	Open Forest
Open Forest	Dense Forest
Rural Settlement with Vegetation	Urban Under Development (Low Density Builtup/Peri-Urban)
Urban Under Development (Low Density Builtup/Peri-Urban)	Urban Area (High Density Builtup)
Open Forest	Scrub/Degraded Forest
Land Without Scrub	Urban Under Development (Low Density Builtup/Peri-Urban)
Agriculture Land	Land With Scrub
Industrial & Allied Activity	Land Without Scrub
Land With Scrub	Forest Plantation
Scrub / Degraded Forest	Open Forest
Land With Scrub	Land Without Scrub
Others	Others

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## LAND USE/LAND COVER AREA STATISTICS 2010 VS 2020

Code	Land use/ Land cover Class	Year 2010		Year 2020		Change	
		Area (in sq. km.)	Percentage	Area (in sq. km)	Percentage	Area (in sq. km)	Percentage
1	Rural Settlement with Vegetation	409.374	10.41	396.399	10.08	-12.975	-0.33
2	Urban Area (High Density Builtup)	52.132	1.33	62.781	1.60	+10.649	+0.27
3	Urban Under Development (Low Density Builtup/ Peri-urban Area)	23.545	0.60	54.358	1.38	+30.813	+0.78
4	Industrial & Allied Activity Area	24.009	0.61	25.199	0.64	+1.19	+0.03
5	Agriculture Area	1875.524	47.70	1850.072	47.05	-25.452	-0.65
6	Plantation/ Orchard	13.361	0.34	14.467	0.37	+1.106	+0.03
7	Dense Forest	519.224	13.21	531.740	13.52	+12.516	+0.31
8	Open Forest	298.533	7.59	298.014	7.58	-0.519	-0.01
9	Scrub / Degraded Forest	96.521	2.45	96.742	2.46	+0.221	+0.01
10	Forest Plantation	38.732	0.99	27.862	0.71	-10.87	-0.28
11	Forest Blank	3.851	0.10	3.851	0.10	0	0
12	Land With Scrub	68.691	1.75	65.358	1.66	-3.333	-0.09
13	Land Without Scrub	34.906	0.89	34.107	0.87	-0.799	-0.02
14	Wasteland: Barren/ Rocky	0.539	0.01	0.539	0.01	0	0
15	Wasteland: Swampy/ Marshy/ Waterlogged	39.086	0.99	39.040	0.99	-0.046	0
16	River/ Water Body	237.770	6.05	238.085	6.06	+0.315	+0.01
17	Sandy Area	190.939	4.86	192.524	4.90	+1.585	+0.04
18	Brick Kiln (Industrial & Allied Activity)	5.264	0.13	0.863	0.02	-4.401	-0.11
	<b>Total</b>	<b>3932.000</b>	<b>100.00</b>	<b>3932.000</b>	<b>100.00</b>	<b>0</b>	<b>0</b>

## LAND USE/LAND COVER CHANGE ANALYSIS MATRIX

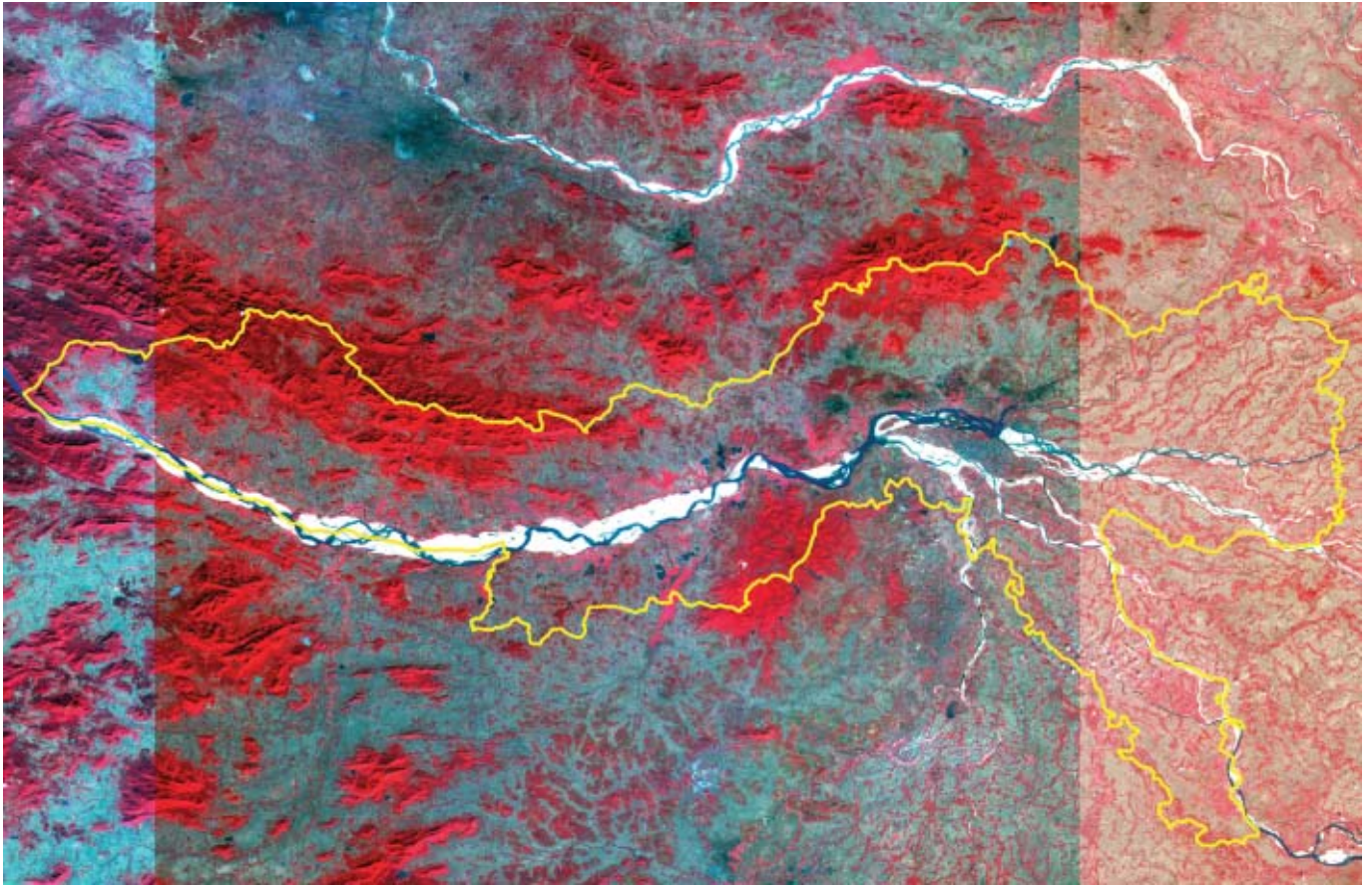
CODE	LANDUSE/ LANDCOVER IN YEAR 2020																		2010 TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	395.852		11.623		1.899														409.374
2		52.132																	52.132
3		10.649	12.888	0.008															23.545
4				24.009															24.009
5			24.774	0.119	1848.173	0.026						2.425				0.007			1875.524
6						13.361													13.361
7						519.224													519.224
8						12.516	281.559	4.219											298.533
9							2.089	91.199				1.919							96.521
10							12.984			25.748									38.732
11											3.851								3.851
12				0.898			1.037	1.324	2.114			59.718	2.015				1.585		68.691
13	0.547		2.574	0.119		1.080	0.345					0.989	29.252						34.906
14														0.539					0.539
15				0.046											39.040				39.086
16																237.770			237.770
17																	190.939		190.939
18												0.307	2.840					0.069	5.264
2020 TOTAL	396.399	62.781	54.358	25.199	1850.072	14.467	531.740	298.014	96.742	27.862	3.851	65.358	34.107	0.539	39.040	238.085	192.524	0.863	3932.000

**LAND USE/LAND COVER CHANGE ANALYSIS**  
**(Area Statistics of Major Changes)**

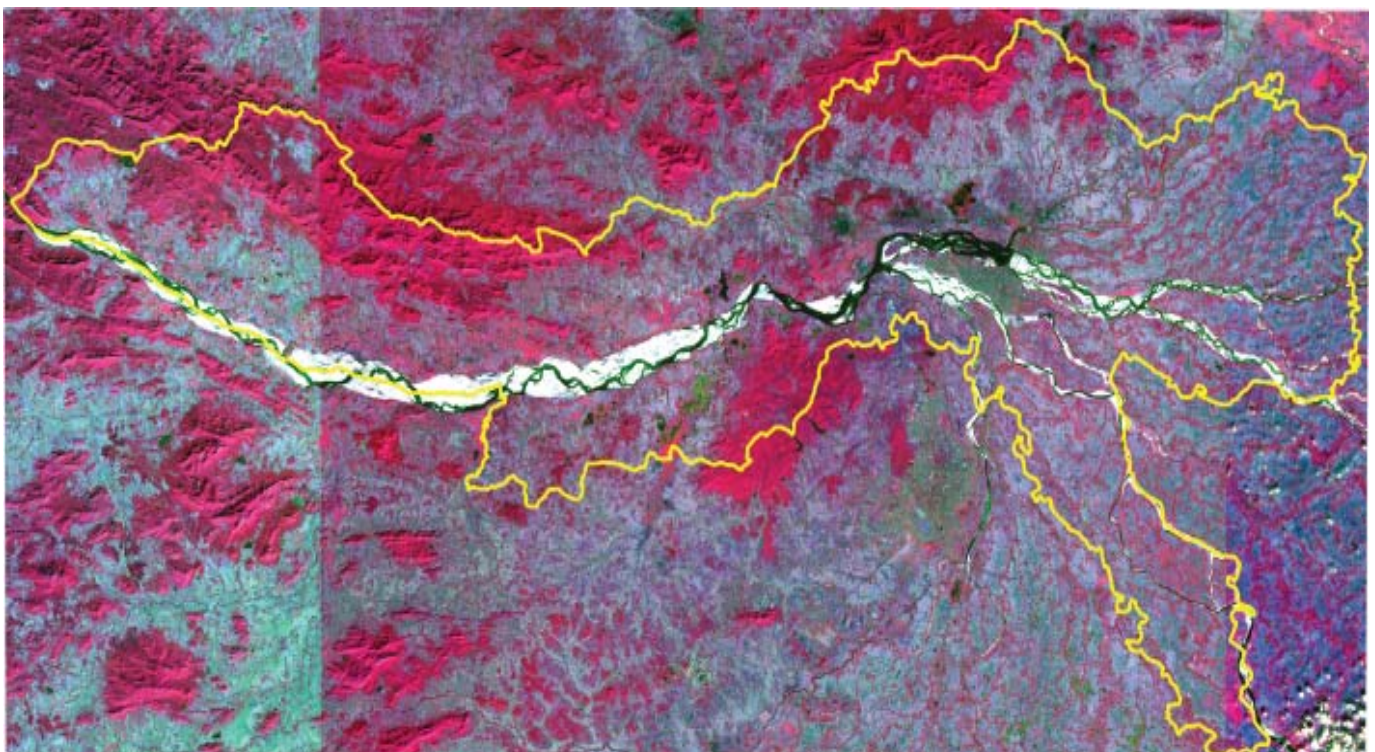
Land use/Land Cover Year 2010		Land use/Land Cover Year 2020		Area (in sq. km.)
Code	Class	Code	Class	
5	Agriculture Area	3	Urban Under Development (Low Density Builtup/Peri-urban Area)	24.774
10	Forest Plantation	8	Open Forest	12.984
8	Open Forest	7	Dense Forest	12.516
1	Rural Settlement with Vegetation	3	Urban Under Development (Low Density Builtup/Peri-urban Area)	11.623
3	Urban Under Development (Low Density Builtup/ Peri-urban Area)	2	Urban Area (High Density Builtup)	10.649
8	Open Forest	9	Scrub / Degraded Forest	4.220
13	Land Without Scrub	3	Urban Under Development (Low Density Builtup/Peri-urban Area)	2.575
5	Agriculture Area	12	Land With Scrub	2.425
18	Brick Kiln (Industrial & Allied Activity)	13	Land Without Scrub	2.210
12	Land With Scrub	10	Forest Plantation	2.114
9	Scrub / Degraded Forest	8	Open Forest	2.089
12	Land With Scrub	13	Land Without Scrub	2.015
9	Scrub / Degraded Forest	12	Land With Scrub	1.919
1	Rural Settlement with Vegetation	5	Agriculture Area	1.899
12	Land With Scrub	17	Sandy Area	1.585
12	Land With Scrub	9	Scrub / Degraded Forest	1.324
9	Scrub / Degraded Forest	3	Urban Under Development (Low Density Builtup/Peri-urban Area)	1.314
18	Brick Kiln (Industrial & Allied Activity)	3	Urban Under Development (Low Density Builtup/Peri-urban Area)	1.185
13	Land Without Scrub	6	Plantation/ Orchard	1.080
12	Land With Scrub	8	Open Forest	1.037



**FCC SATELLITE IMAGE OF DECEMBER 2010  
(IRS P6 AWiFS3 Scenes Mosaicked)**



**FCC SATELLITE IMAGE OF JANUARY 2020  
(Sentinel 2 MSI 3 Scenes Mosaicked)**



## DEVELOPED BY



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