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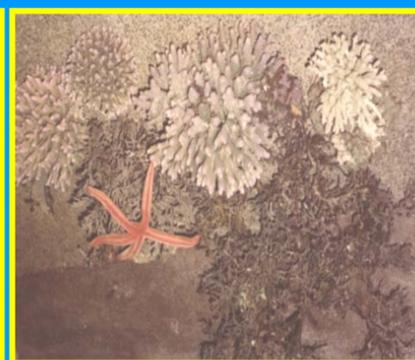
NATIONAL WETLAND ATLAS: ORISSA



Sponsored by
Ministry of Environment and Forests
Government of India



Space Applications centre
Indian Space Research Organisation
Ahmedabad – 380 015



This publication deals with the updated database and status of wetlands, compiled in Atlas format. Increasing concern about how our wetlands are being influenced has led to formulation of a project entitled “National Wetland Inventory and Assessment (NWIA)” to create an updated database of the wetlands of India. The wetlands are categorised under 19 classes and mapped using satellite remote sensing data from Indian Remote Sensing Satellite: IRS P6- LISS III sensor. The results are organised at 1: 50, 000 scales at district, state and topographic map sheet (Survey of India reference) level using Geographic Information System (GIS). This publication is a part of this national work and deals with the wetland status of a particular State/Union Territory of India, through text, statistical tables, satellite images, maps and ground photographs.

The atlas comprises wetland information arranged into nine sections. How the NWIA project work has been executed highlighted in the first six sections viz: Introduction, NWIA project, Study area, Data used, Methodology, and Accuracy. This is the first time that high resolution digital remote sensing data has been used to map and decipher the status of the wetlands at national scale. The methodology highlights how the four spectral bands of LISS III data (green, red, near infra red and short wave infra red) have been used to derive various indices and decipher information regarding water spread, turbidity and aquatic vegetation. Since, the aim was to generate a GIS compatible database, details of the standards of database are also highlighted in the methodology.

The results and finding are organised in three sections; viz: Maps and Statistics, Major wetland types, and Important Wetlands of the area. The Maps and Statistics are shown for state and district level. It gives details of what type of wetlands exists in the area, how many numbers in each type, their area estimates in hectare. Since, the hydrology of wetlands are influenced by monsoon performance, extent of water spread and their turbidity (qualitative) in wet and dry season (post-monsoon and pre-monsoon period) are also given. Similarly the status of aquatic vegetation (mainly floating and emergent types) in two seasons is also accounted for. Status of small wetlands are also accounted as numbers and depicted in maps as points. Wetland map also show important ancillary information like roads/rail, relevant habitations. False Colour Composite (FCC) of the satellite image used (any one season) is shown along with the derived wetland map to give a feeling of manifestation of wetlands in remote sensing data and synoptic view of the area. The status of some of the important wetlands like Ramsar sites, National Parks are shown with recent field photographs.

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NATIONAL WETLAND ATLAS: *ORISSA*

**Sponsored by
Ministry of Environment and Forests, Government of India**

As a part of the project on National Wetland Inventory and Assessment (NWIA)

September 2010

**Space Applications Centre (ISRO), Ahmedabad
and
Orissa Space Applications Centre, Bhubaneswar**

First Publication: September 2010, Space Applications Centre (ISRO), Ahmedabad



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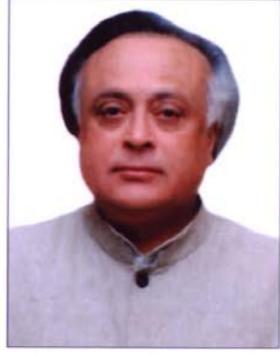
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Citation: National Wetland Atlas: Orissa, SAC/EPISA/AFEG/NWIA/ATLAS/28/2010, Space Applications Centre (ISRO), Ahmedabad, India, 204p.

Available from: Space Applications Centre, ISRO, Ahmedabad – 380 015, India

Production: SAC carried out the work jointly with Orissa Space Applications Centre, Bhubaneswar Sponsored by Ministry of Environment and Forests, Govt. of India.

जयराम रमेश
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18TH JANUARY 2010

MESSAGE

It gives me great pleasure to introduce this Atlas, the latest in a series, prepared by Space Applications Centre, Ahmedabad in connection with the National Wetland Inventory and Assessment Project.

This Atlas maps and catalogues information on Wetlands across India using the latest in satellite imaging, one of the first of its kind. Wetlands are areas of land critical ecological significance that support a large variety of plant and animal species adapted to fluctuating water levels. Their identification and protection becomes very important.

Utility-wise, wetlands directly and indirectly support millions of people in providing services such as food, fiber and raw materials. They play important roles in storm and flood control, in supply of clean water, along with other educational and recreational benefits. Despite these benefits, wetlands are the first target of human interference and are among the most threatened of all natural resources. Around 50% of the earth's wetlands are estimated to already have disappeared worldwide over the last hundred years through conversion to industrial, agricultural and residential purposes. Even in current scenario, when the ecosystem services provided by wetlands are better understood - degradation and conversion of wetlands continues.

Aware of their importance, the Government of India has formulated several policies and plans for the conservation and preservation of these crucial ecosystems. Realising the need of an updated geospatial data base of these natural resources as the pre-requisite for management and conservation planning, National Wetland Inventory and Assessment (NWIA) project was formulated as a joint vision of Ministry of Environment & Forestry, Govt. India, and Space Applications Centre (ISRO). I am told that the latest remote sensing data from Indian Remote Sensing satellite (IRS P6) have been used to map the wetlands. The present atlas is part of this project and highlights the results of the study state in terms of statistics of various types of wetlands, extent of water, aquatic vegetation and turbidity in pre and post monsoon period. I also note that special efforts are made to provide detailed information of important wetlands like Ramsar sites, National Parks etc.

I am certain that this Atlas will raise the bar in developing such database and will be of great use for researchers, planners, policy makers, and also members of the general public.


(Jairam Ramesh)



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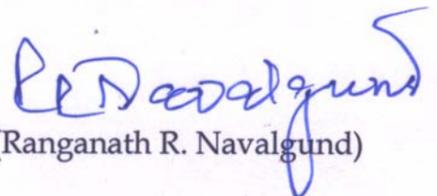
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FOREWORD

Wetlands defined as areas of land that are either temporarily or permanently covered by water exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry. Wetlands are one of the most productive ecosystems and play crucial role in hydrological cycle. Utility wise, wetlands directly and indirectly support millions of people in providing services such as storm and flood control, clean water supply, food, fiber and raw materials, scenic beauty, educational and recreational benefits. The Millennium Ecosystem Assessment estimates conservatively that wetlands cover seven percent of the earth's surface and deliver 45% of the world's natural productivity and ecosystem services. However, the very existence of these unique resources is under threat due to developmental activities, and population pressure. This calls for a long term planning for preservation and conservation of these resources. An updated and accurate database that will support research and decision is the first step towards this. Use of advanced techniques like Satellite remote sensing, Geographic Information System (GIS) is now essential for accurate and timely spatial database of large areas. Space Applications Centre (ISRO) took up this challenging task under the project "NWIA" (National Wetland Inventory and Assessment) sponsored by Ministry of Environment & Forests. To account for numerous small yet important wetlands found in the country, mapping at 1:50,000 scales has been taken up. Two date IRS LISS III data acquired during pre and post monsoon season are used for inventory to account for wet and dry season hydrology of wetlands. The map outputs include the status of water spread, aquatic vegetation and turbidity. Ancillary layers like road/rail, habitations are also created. Very small wetlands below the mappable unit are also identified and shown points. The results are compiled as Atlases of wetlands for states/Union Territories of India. This Atlas highlights results for a particular state/UT and hopes to improve our understanding of the dynamics and distribution of wetlands and their status in the area.

I congratulate the team for bringing out this informative atlas and sincerely hope that this will serve as a useful source of information to researchers, planners and general public.

January 25, 2010


(Ranganath R. Navalgund)

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ACKNOWLEDGEMENTS

The project "National Wetland Inventory & Assessment (NWIA)", is sponsored by Ministry of Environment & Forestry (MoEF), Govt. of India and executed by Space Applications Centre, ISRO, Ahmedabad. We are grateful to Dr. Ranganath R. Navalgund, Director, Space Applications Centre, for his encouragement to take up this challenging task and formulation of the project team for timely implementation. Earnest thanks are also due to Dr. Jai Singh Parihar, Dy. Director, Earth, Ocean, Atmosphere, Planetary Sciences and Applications Area, Space Applications Centre, for providing overall guidance and support to the project. The present Atlas for the state of Orissa is a part of the "National Wetland Atlas.

This project has benefited from the wisdom of many people. It is a pleasure to acknowledge the contributions made by the wetland experts especially to Prof. C.K. Varshney, Former Dean, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, Prof. A.R. Yousuf, The University of Kashmir, Srinagar, Prof. Pradeep Shrivastava, Head, Wetland Research Centre, Barakatullah University, Bhopal, Dr. Prikshit Gautam, Director, WWF-India, Dr. S. Narendra Prasad, Salim Ali Centre for Ornithology and Nature, Coimbatore and Dr. R.K. Suri, Additional Director, Ministry of Environment and Forests, Govt. of India, New Delhi, and the database experts from ISRO who participated in the peer Review meeting to finalise the "Wetland Classification System" followed in this project

We acknowledge the positive role played by 16th SC-B (Standing Committee on Bioresources and Environment) of NNRMS (National Natural Resources Management System) meeting in formulating this project. We are extremely thankful to the members of the "Steering Committee" of the project, under the chairmanship of Dr E J James, Director – Water Institute, Karunya University, for their periodical review, critical comments and appreciation of the efforts by the project team. We are thankful to SC-B under the chairmanship of Secretary, MoEF, for periodic review of the progress of the project and guidance towards timely completion of the work. We acknowledge the valuable contributions made by Dr J K Garg, the then scientist of SAC for his active role in formulation of this project, co-authoring the procedure manual document.

We are grateful to Dr G V Subramanyam, Adviser, MoEF, for his very active and positive role for implementation of the project. We are thankful to Dr Jag Ram, Director, MoEF and Dr Harendra Kharwal, MoEF for their support in budget and project management related issues. We are thankful to the "Technical Review" team of SAC for critical comments and suggestion to finalise the Atlas. We acknowledge the support received from Dr P S Roy, Dy Director, NRSC and Dr S Sudhakar, Head, LRD, NRSC in terms of valuable suggestions and providing the geo-referenced image of NRC-LU&LC project for use as master image in this project. We acknowledge the efforts put by Dr R D Shah, Mr Pragnesh Kumar Vaishnav and Ms Yatisha P Vaishnav, Geology Department, M G Science Institute, Ahmedabad in finalization of GIS database.

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1.0 INTRODUCTION

It is increasingly realized that the planet earth is facing grave environmental problems with fast depleting natural resources and threatening the very existence of most of the ecosystems. Serious concerns are voiced among scientists, planners, sociologists, politicians, and economists to conserve and preserve the natural resources of the world. One of the difficulties most frequently faced for decision making is lack of scientific data of our natural resources. Often the data are sparse or unconvincing, rarely in the form of geospatial database (map), thus open to challenges. Thus, the current thrust of every country is to have an appropriate geospatial database of natural resources that is based on unambiguous scientific methods. The wetland atlas of Orissa, which is part of the National Wetland Atlas of India, is an attempt in this direction.

1.1 Wetlands

Wetlands are one of the crucial natural resources. Wetlands are areas of land that are either temporarily or permanently covered by water (Westlake & Pratt, 2006). This means that a wetland is neither truly aquatic nor terrestrial; it is possible that wetlands can be both at the same time depending on seasonal variability. Thus, wetlands exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant plants and soil or sediment characteristics. Because of their transitional nature, the boundaries of wetlands are often difficult to define. Wetlands do, however, share a few attributes common to all forms. Of these, hydrological structure (the dynamics of water supply, throughput, storage and loss) is most fundamental to the nature of a wetland system. It is the presence of water for a significant period of time which is principally responsible for the development of a wetland. One of the first widely used classifications systems, devised by Cowardin *et al.*, (1979), was associated to its hydrological, ecological and geological aspects, such as: marine (coastal wetlands including rock shores and coral reefs, estuarine (including deltas, tidal marshes, and mangrove swamps), lacustrine (lakes), riverine (along rivers and streams), palustrine ('marshy'- marshes, swamps and bogs). Given these characteristics, wetlands support a large variety of plant and animal species adapted to fluctuating water levels, making the wetlands of critical ecological significance. Utility wise, wetlands directly and indirectly support millions of people in providing services such as food, fiber and raw materials, storm and flood control, clean water supply, scenic beauty and educational and recreational benefits. The Millennium Ecosystem Assessment estimates conservatively that wetlands cover seven percent of the earth's surface and deliver 45% of the world's natural productivity and ecosystem services of which the benefits are estimated at \$20 trillion a year (Source : www.MAweb.org). The Millennium Assessment (MA) uses the following typology to categorise ecosystem services:

- Provisioning services : The resources or products provided by ecosystems, such as food, raw materials (wood), genetic resources, medicinal resources, ornamental resources (skin, shells, flowers)
- Regulating services : Ecosystems maintain the essential ecological processes and life support systems, like gas and climate regulation, water supply and regulation, waste treatment, pollination etc.
- Cultural and Amenity services : Ecosystems are a source of inspiration to human culture and education through recreation, cultural, artistic, spiritual and historic information, science and education
- Supporting services : Ecosystems provide habitat for flora and fauna in order to maintain biological and genetic diversity

Despite these benefits, wetlands are the first target of human interference and are among the most threatened of all natural resources. Around 50% of the earth's wetlands is estimated to already have disappeared worldwide over the last hundred years through conversion to industrial, agricultural and residential developments. Even in current scenario, when the ecosystem services provided by wetlands are better understood - degradation and conversion of wetlands continues. This is largely due to the fact that the 'full value' of ecosystem functions is often ignored in policy-making, plans and corporate evaluations of development projects.

1.2 Mapping and Geospatial technique

To conserve and manage wetland resources, it is important to have inventory of wetlands and their catchments. The ability to store and analyse the data is essential. Digital maps are very powerful tools to achieve this. Maps relate the feature to any given geographical location has a strong visual impact. Maps are thus essential for monitoring and quantifying change over time scale, assist in decision making. The technique used in the preparation of map started with ground survey. The Survey of India (SOI) topographic maps are the earliest true maps of India showing various land use/cover classes including wetlands. Recent years have seen advances in mapping technique to prepare maps with much more information. Of particular importance is the remote sensing and geographic information system (GIS) technique. Remote sensing is

now recognized as an essential tool for viewing, analyzing, characterizing, and making decisions about land, water and atmospheric components.

From a general perspective, remote sensing is the science of acquiring and analyzing information about objects or phenomena from a distance (Jensen, 2000; Lillesand and Keifer, 1987). Today, we define satellite remote sensing as the use of satellite borne sensors to observe, measure, and record the electromagnetic radiation (EMR) reflected or emitted by the earth and its environment for subsequent analysis and extraction of information. EMR sensors includes visible light, near-, mid- and far-infrared (thermal), microwave, and long-wave radio energy. The capability of multiple sources of information is unique to remote sensing. Of specific advantage is the spectral, temporal, and spatial resolution. Spectral resolution refers to the width or range of each spectral band being recorded. Since each target affects different wavelengths of incident energy differently, they are absorbed, reflected or transmitted in different proportions. Currently, there are many land resource remote sensing satellites that have sensors operating in the green, red, near infrared and short wave Infra red regions of the electromagnetic spectrum giving a definite spectral signature of various targets due to difference in radiation absorption and reflectance of targets. These sensors are of common use for land cover studies, including wetlands. Figure 1 shows typical spectral signature of few targets from green to SWIR region. Converted to image, in a typical false colour composite (FCC) created using NIR, red and green bands assigned as red, green and blue colour, the features become very distinct as shown in Figure 2. In FCC, the vegetation thus appears invariably red (due to high reflection in NIR from green leaves).

Since the early 1960s, numerous satellite sensors have been launched into orbit to observe and monitor the earth and its environment. Most early satellite sensors acquired data for meteorological purposes. The advent of earth resources satellite sensors (those with a primary objective of mapping and monitoring land cover) occurred, when the first Landsat satellite was launched in July 1972. Currently, more than a dozen orbiting satellites of various types provide data crucial to improving our knowledge of the earth's atmosphere, oceans, ice and snow, and land. Of particular interest to India is the indigenous series of satellites called Indian Remote Sensing satellites (IRS series). Since the launch of the first satellite IRS 1A in 1987, India has now a number of satellites providing data in multi-spectral bands with different spatial resolution. IRS P6/RESOURCESAT 1 is the current generation satellite that provides multi-spectral images in spatial resolution of 5.8 m (LISS IV), 23.5 m (LISS III) and 56m (AWiFS). Over the past few decades, Indian remote sensing data has been successfully used in various fields of natural resources (Navalgund *et al*, 2003).

Development of technologies like Geographic Information System (GIS) has enhanced the use of RS data to obtain accurate geospatial database. GIS specialises in handling related, spatially referenced data, combining mapped information with other data and acts as analytical tool for research and decision making. During the past few decades, technological advances in the field of satellite remote sensing (RS) sensors, computerized mapping techniques, global positioning system (GPS) and geographic information system (GIS) has enhanced the ability to capture more detailed and timely information about the natural resources at various scales catering to local, regional, national and global level study.

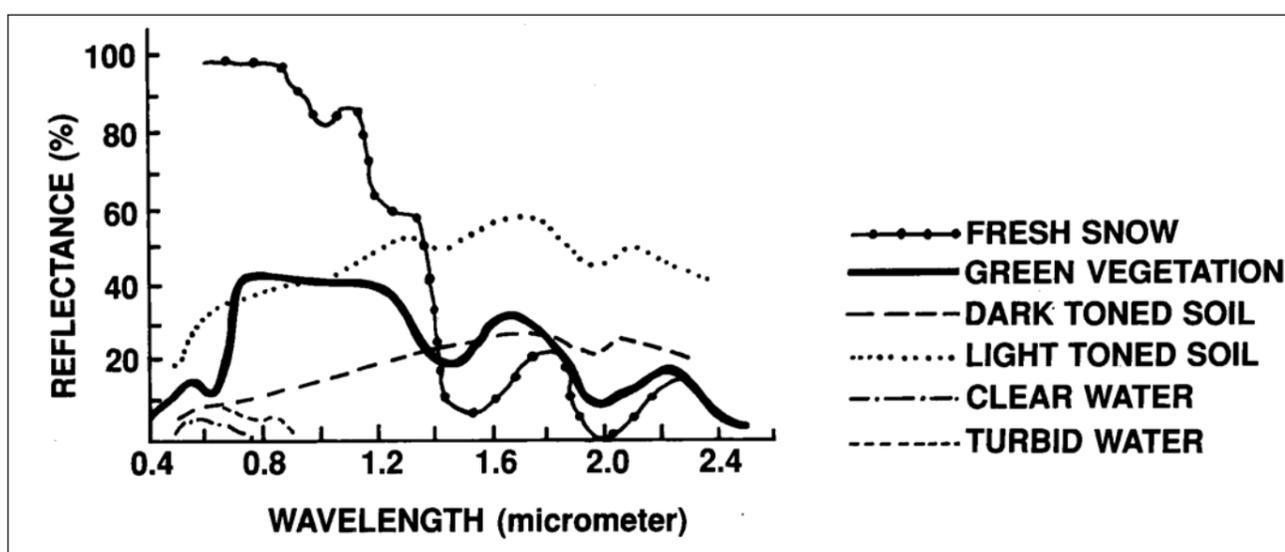


Figure 1: Spectral Signature of various targets

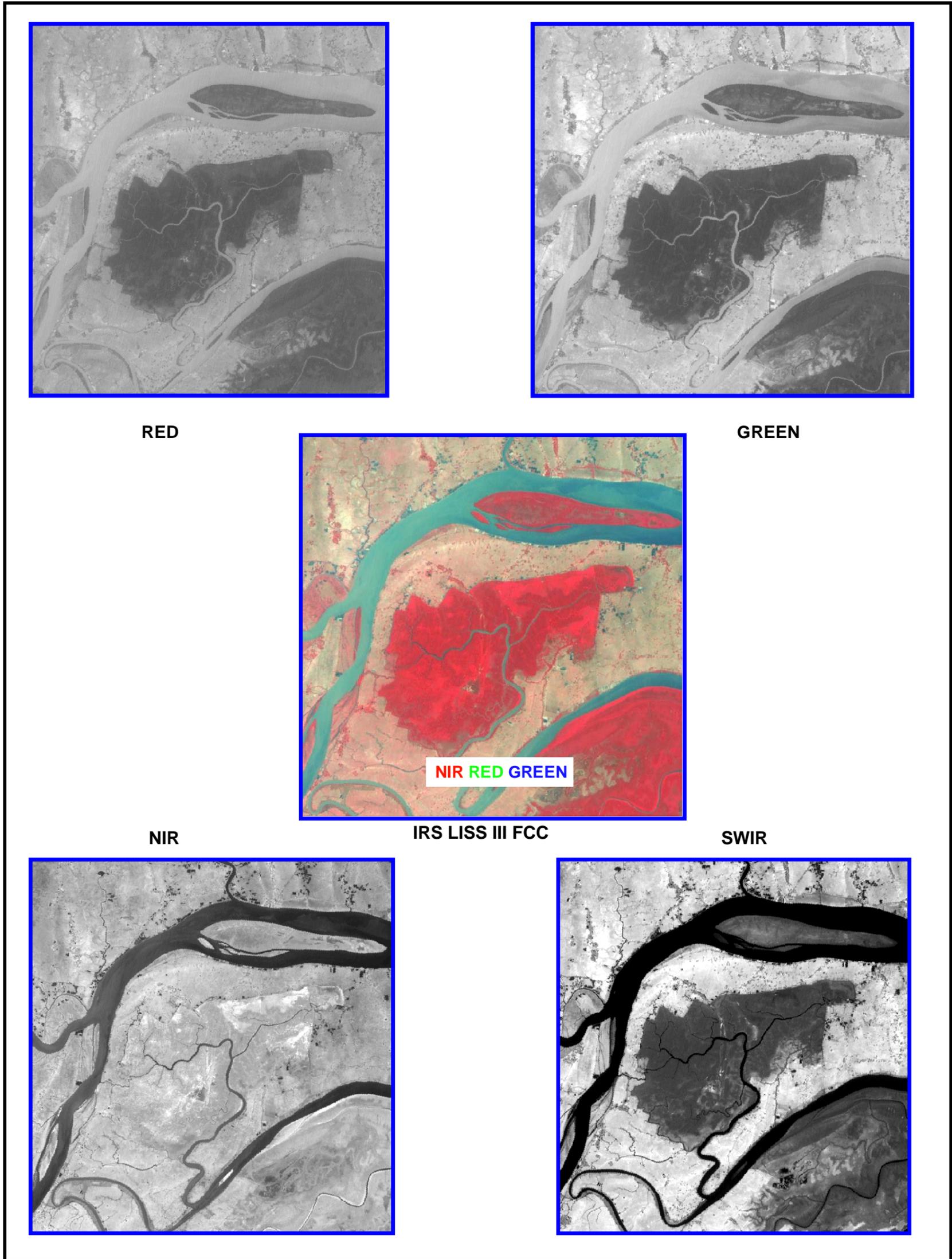


Figure 2: Various land features as they appear in four spectral bands and in a typical three band FCC

1.3 Wetland Inventory of India

India with its large geographical spread supports large and diverse wetland classes, some of which are unique. Wetlands, variously estimated to be occupying 1-5 per cent of geographical area of the country, support about a fifth of the known biodiversity. Like any other places in the world, there is a looming threat to the aquatic biodiversity of the Indian wetlands as they are often under a regime of unsustainable human pressures. Sustainable management of these assets therefore is highly relevant. Realising this, Govt. of India has initiated many appropriate steps in terms of policies, programmes and plans for the preservation and conservation of these ecosystems. India is a signatory to the Ramsar Convention for management of wetland, for conserving their biodiversity and wise use extending its scope to a wide variety of habitats, including rivers and lakes, coastal lagoons, mangroves, peatlands, coral reefs, and numerous human-made wetland, such as fish and shrimp ponds, farm ponds, irrigated agricultural land, salt pans reservoirs, gravel pits, sewage farms, and canals. The Ministry of Environment and Forests has identified a number of wetlands for conservation and management under the National Wetland Conservation Programme and some financial assistance is being provided to State Governments for various conservation activities through approval of the Management Action Plans. The need to have an updated map database of wetlands that will support such actions has long been realized.

Mapping requires a standard classification system. Though there are many classification systems for wetlands in the world, the Ramsar classification system is the most preferred one. The 1971 Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat is the oldest conservation convention. It owes its name to its place of adoption in Iran. It came into being due to serious decline in populations of waterfowl (mainly ducks) and conservation of habitats of migratory waterfowl. Convention provides framework for the conservation and 'wise use' of wetland biomes. Ramsar convention is the first modern global intergovernmental treaty on conservation and wise use of natural resources (www.ramsar.org). Ramsar convention entered into force in 1975. Under the text of the Convention (Article 1.1) wetlands are defined as:

“areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters”.

In addition, the Convention (Article 2.1) provides that wetlands:

“may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands”.

The first scientific mapping of wetlands of India was carried out during 1992-93 by Space Applications Centre (ISRO), Ahmedabad, at the behest of the Ministry of Environment and Forests (MoEF), Govt. of India using remote sensing data from Indian Remote Sensing satellite (IRS series). The mapping was done at 1:250,000 scale using IRS 1A LISS-I/II data of 1992-93 timeframe under the Nation-wide Wetland Mapping Project. Since, no suitable wetland classification existed for comprehensive inventory of wetlands in the country at that time, the project used a classification system based on Ramsar Convention definition of wetlands. The classification considers all parts of a water mass including its ecotonal area as wetland. In addition, fish and shrimp ponds, saltpans, reservoirs, gravel pits were also included as wetlands. This inventory put the wetland extent (inland as well as coastal) at about 8.26 million ha (Garg *et al*, 1998). These estimates (24 categories) do not include rice/paddy fields, rivers, canals and irrigation channels.

Further updating of wetland maps of India was carried out by SAC using IRS P6/Resourcesat AWiFS data of 2004-05 at 1:250,000 scale. In recent years, a conservation atlas has been brought out by Salim Ali Centre for Ornithology and Natural History (SACON, 2004), which provide basic information required by stakeholders in both wetland habitat and species conservation. Space Applications Centre has carried out many pilot projects for development of GIS based wetland information system (Patel *et al*, 2003) and Lake Information system (Singh *et al*, 2003).

2.0 NATIONAL WETLAND INVENTORY AND ASSESSMENT (NWIA) PROJECT

Realising the importance of many small wetlands that dot the Indian landscape, it has been unanimously felt that inventory of the wetlands at 1:50,000 scales is essential. The task seemed challenging in view of the vast geographic area of our country enriched with diverse wetland classes. Space Applications Centre with its experience in use of RS and GIS in the field of wetland studies, took up this challenging task. This is further strengthened by the fact that guidelines to create geospatial framework, codification scheme, data base structure etc. for natural resources survey has already been well established by the initiative of ISRO under various national level mapping projects. With this strength, the National Wetland Inventory and Assessment (NWIA) project was formulated by SAC, which was approved and funded by MoEF.

The main objectives of the project are:

- To map the wetlands on 1:50000 scale using two date (pre and post monsoon) IRS LISS III digital data following a standard wetland classification system.
- Integration of ancillary theme layers (road, rail, settlements, drainage, administrative boundaries)
- Creation of a seamless database of the states and country in GIS environment.
- Preparation of State-wise wetland atlas

The project was initiated during 2007. The first task was to have a classification system that can be used by different types users while amenable to database. An expert/peer group was formed and the peer review was held at SAC on June 2007 where wetland experts and database experts participated and finalized the classification system. It was agreed to follow the classification system that has been used for the earlier project of 1:250,000 scale, with slight modification. Modified National Wetland Classification system for wetland delineation and mapping comprise 19 wetland classes which are organized under a Level III hierarchical system. The definition of each wetland class and its interpretation method was finalized. The technical/procedure manual was prepared as the standard guideline for the project execution across the country (Garg and Patel, 2007). The present atlas is part of the national level data base and deals with the state of Orissa

2.1 Wetland Classification System

In the present project, Modified National Wetland Classification system is used for wetland delineation and mapping comprising of 19 wetland classes which are organized under a Level III hierarchical system (Table 1). Level one has two classes: Inland and coastal, these are further bifurcated into two categories as: natural and man-made under which the 19 wetland classes are suitably placed. Two date data pertaining to pre-monsoon and post monsoon was used to confirm the classes. Wetlands put to agriculture use in any of the two dates is not included as wetland class. Definitions of wetland categories used in the project is given in Annexure-I.

2.2.1 Spatial Framework and GIS Database

The National Spatial Framework) (NSF) has been used as the spatial framework to create the database (Anon. 2007) . The database design and creation standard suggested by NRDB/NNRMS guidelines is followed. Feature codification scheme for every input element has been worked out keeping in view the nationwide administrative as well as natural hierarchy (State-district- within the feature class for each of the theme. All data elements are given a unique name, which are self explanatory with short forms.

Following wetland layers are generated for each inland wetland:

- Wetland extent: As wetlands encompass open water, aquatic vegetation (submerged, floating and emergent), the wetland boundary should ideally include all these. Satellite image gives a clear signature of the wetland extends from the imprint of water spread over the years.
- Water spread: There are two layers representing post-monsoon and pre-monsoon water spread during the year of data acquisition.
- Aquatic vegetation spread: The presence of vegetation in wetlands provides information about its trophic condition. As is known, aquatic vegetation is of four types, viz. benthic, submerged, floating, and emergent. It is possible to delineate last two types of vegetation using optical remote sensing data.

A qualitative layer pertaining to presence of vegetation is generated for each season (as manifested on post-monsoon and post-monsoon imagery).

- Turbidity level of open water: A layer pertaining to a qualitative turbidity rating is generated. Three qualitative turbidity ratings (low, medium and high) is followed for pre and post-monsoon turbidity of lakes, reservoirs, barrages and other large wetlands.
- Small wetlands (smaller than minimum mappable unit) are mapped as point features.
- Base layers like major road network, railway, settlements, and surface drainage are created (either from the current image or taken from other project data base).

Table 1: Wetland Classification System and coding

Wettcode*	Level I	Level II	Level III
1000	Inland Wetlands		
1100		Natural	
1101			Lakes
1102			Ox-Bow Lakes/ Cut-Off Meanders
1103			High altitude Wetlands
1104			Riverine Wetlands
1105			Waterlogged
1106			River/stream
1200		Man-made	
1201			Reservoirs/ Barrages
1202			Tanks/Ponds
1203			Waterlogged
1204			Salt pans
2000	Coastal Wetlands		
2100		Natural	
2101			Lagoons
2102			Creeks
2103			Sand/Beach
2104			Intertidal mud flats
2105			Salt Marsh
2106			Mangroves
2107			Coral Reefs
2200		Man-made	
2201			Salt pans
2202			Aquaculture ponds

*: Wetland type code

3.0 STUDY AREA

Orissa is one of the eastern coastal states of India. It is located between the parallels of 17.49 N and 22.34 N latitudes and meridians of 81.27 E and 87.29 E longitudes. It is bounded by the Bay of Bengal on the east, Madhya Pradesh and Chhatisgarh on the west, Jharkhand and West Bengal on the north and Andhra Pradesh on the south (Figure 3). It has a coast line of about 480 km. It extends over an area of 155707 sq km comprising 4.74 % of the country's landmass. According to the 2001 census, it has a total population of 36 804 000, which accounts for 3.57 % of the total population of India. Administratively, it has 30 districts, 3 revenue divisions, 57 sub-divisions, 114 tahasils, 314 community development blocks, 51057 villages and 123 urban centres.

The state experiences four distinct seasons, namely winter (December to February), summer (March to May), Monsoon (June to September) and Post-monsoon (October and November).

About 80-83% of the annual rainfall (average about 1400mm) occurs during the monsoon period and the average number of rainy days is around 70. The rainfall is largely due to south-west monsoon. During post-monsoon period, the state receives an average rainfall of 22-25 cm. During this season intense low pressure system called Tropical Cyclonic storms are formed and strike the Orissa coast causing considerable loss of life and property. The state experiences either heavy flood or drought every alternate year due to disproportionate distribution of rainfall and failure of monsoon in some areas.

The mean monthly maximum temperature is about 37 °C and the minimum is 13 °C. The mean monthly morning relative humidity (RH) in the state varies from 63% in April-May to 84% in August. The afternoon mean monthly RH varies from 54% in January to 81% in August. During monsoon, the RH reaches 93% (SPCB, 2006).

On the basis of homogeneity, continuity and physiographical characteristics, Orissa has been divided into five major morphological regions : the Orissa Coastal Plain in the east, the Middle Mountainous and Highlands Region, the Central plateaus, the western rolling uplands and the major flood plains

The Orissa Coastal Plains are the depositional landforms of recent origin and geologically belong to the Post-Tertiary Period. The 75 m contour-line delimits their western boundary and differentiates them from the Middle Mountainous Region. This region stretches from the West Bengal border, i.e. from the River Subarnarekha in the north to the River Bahuda in the south.

This region is the combination of several deltas of varied sizes and shapes formed by the major rivers of Orissa, such as the Subarnarekha, the Budhabalanga, the Baitarani, the Brahmani, and the Mahanadi. It stretches along the coast of the Bay of Bengal having the maximum width in the Middle Coastal Plain (the Mahanadi Delta), narrow in the Northern Coastal Plain (Balasore Plain) and narrowest in the Southern Coastal Plain (Ganjam Plain). The North Coastal Plain comprises the deltas of the Subarnarekha and the Budhabalanga rivers and bears evidences of marine transgressions. The Middle Coastal Plain comprises the compound deltas of the Baitarani, Brahmani and Mahanadi rivers and bears evidences of past back bays and present lakes. The South Coastal Plain comprises the lacustrine plain of Chilika lake and the estuarine region of the Rushikulya River

The Middle Mountainous and Highlands Region

The region covers about three-fourth of the entire State. Geologically it is a part of the Indian Peninsula which as a part of the ancient landmass of the Gondwanaland. The major rivers of Orissa with their tributaries have cut deep and narrow valleys. This region mostly comprises the hills and mountains of the Eastern Ghats which rise abruptly and steeply in the east and slope gently to a dissected plateau in the west running from north-east (Mayurbhanj) to north-west (Malkangiri).

The Central Plateaus

The plateaus are mostly eroded plateaus forming the western slopes of the Eastern Ghats with elevation varying from 305-610 meters. There are two broad plateaus in Orissa : (i) the Panposh - Keonjhar -Pallahara plateau comprises the Upper Baitarani catchment basin, and (ii) the Nabrangpur - Jeypore plateau comprises the Sabari basin

The Western Rolling Uplands

These are lower in elevation than the plateaus having heights varying from 153 meters to 305 meters

Rivers of Orissa

Rivers in Orissa though not perennial, serve the basic requirement of the state. All the rivers of Puri district have a common characteristics . In the hot weather they are beds of sand with tiny streams or none at all , while in the rains they receive more water than they can carry. A brief description on the major river systems are given as follows:

Mahanadi : It is the major river of Orissa and the sixth largest river in India. It originates from the Amarkantak hills of the Bastar Plateau in Raipur district of Madhya Pradesh. It is about 857 km. Long (494 km in Orissa) and its catchment area spreads over 141,600 sq km (65,580 sq km in Orissa). The river carries on an average of about 92,600 million m of water

Brahmani: It is the second largest river in Orissa. It originates as two major rivers like the Sankh and the Koel from the Chhotanagpur Plateau of Bihar and both join at Veda Vyasa near Rourkela of Sundargarh district of Orissa forming the major River Brahmani. It flows through the Eastern Ghats in Sundargarh, Kendujhar, Dhenkanal, Cuttack and Jajpur districts into the Coastal Plains and enters into the Bay of Bengal along with a combined mouth with the Mahanadi known as the Dhamra. The Brahmani is 799 km long (541 km in Orissa) and its catchment area spreads over 39,033 sq km in Orissa.

Baitarani: It originates from the Gonasika hills of the Kendujhar district. It is 365 km long and its catchment area spreads over 12,790 sq km. It enters into the Bay of Bengal after joining of the Brahmani at Dharma mouth near Chandabali

Subarnarekha: It originates from the Chhotnagpur plateau of Bihar. It is 433 km (70 km in Orissa) and has a catchment area of 19,500 km (3,200 km in Orissa) with a mean annual flow of 7,900 million m.

Budhabalanga: It originates from the eastern slopes of the Similipal massif. It is about 175 km long having a total catchment area of 4840 sq km with an annual flow of 2177 million m. Its major tributaries are the Sone, the Gangadhar, the Catra etc.

Rushikuilya: It originates from the Rushyamala hills of the Eastern Ghats in Phulbani district. It is 165 km long with 8900 sq km of catchment area. Its tributaries are the Baghua ,the Dhanei Badanadi etc. It has no delta at its mouth

Bahuda: It originates from the Ramgiri hills of the Eastern Ghats in Gajapati district and joins the bay of Bengal near the border area of Orissa and Andhra Pradesh . Its length is 73 km having a catchment area of 1250 sq km.

Bansadhara: It originates from the Flanks of the Durgakangar hills (Lingaraj hills) of the Eastern Ghats in Kalahandi district. It is 230 km long, out of which only 150 km is in Orissa. It enters in to the Bay of Bengal at Kalingapatnam in Andhra Pradesh. It has a catchment area of 11500 sq km.

Nagabali: It originates from the Bijipur Hills of the Eastern Ghats near Lanji garah . It is 210 km long, out of which 100 km is in Orissa. It has a total catchment area of about 9410 sq km.

Salandi: It originates from the Meghasani Hills of the Similipal massif in Keonjhar district. It is 144 km long with a catchment areas of 1793 sq km.

The Indrabati: It originates from the Eastern Ghats in Kalahandi district. It is 530 km long with a catchment area of 41700 sq km as a tributary and flows into the Godavari river

The Kolab: It originates from the Sinkaran hills of the Eastern Ghats in Koraput district. It has catchment area of about 20400 sq km.

Lakes/Lagoon

The Chilika is a brackish water lagoon located in the southern part of the Orissa coastal plain. Its area varies from 780 sq km and 1144 sq km from winter to monsoon months having a length of 71 km and 32 km breadth. It is one of the Ramsar sites of India. Home to thousands of colourful birds throughout the year, it is particularly with the migratory birds who descend on it from as far off as Siberia in winter season. The white-bellied sea eagle, the grey legged geese the peach coloured flamingoes, purple moorhen, Jacana and Heron-all mingle in a flurry of crested feathers and grace.

The surrounding hills and sandy stretches abound in chitals, black bucks, monkeys, fishing cats, mongoose and porcupines and a Errawadi dolphin population cavorting joyfully near the channel meeting the sea. Snakes, turtles and lizards inhabit the surrounding beach area and wooded vegetation.

A number of islands dot the expanse of the lagoon. Nalbana Island, because of its varied flora and fauna form the core of Chilika sanctuary. Kalijai Island is home to the goddess Kalijai and offers a picturesque tourist spot.

Satpada is an ideal spot to enjoy Chilika lagoon. The thrilling sight of Errawadi dolphins round the year and abundance of migratory and resident birds in winter make Satpada a preferred place for a eco-tourism.

Bhitarakanika Sanctuary

Bhitarakanika Reserve forest declared as Wildlife Sanctuary area is the several largest contiguous mangrove forest in India. It is largest in the east coast of India. It lies between the latitude 20° 30' and 20° 50' N and the longitude 86° 45' and 87° 10' E in the northeast of the Mahanadi delta in Kendrapada district. In 1975 Bhitarakanika was declared as a sanctuary under the Wild Life protection act, 1972 and comprises Bhitarakanika, Kalibhanjadian and Gahirmatha mangrove area. Due to its biodiversity and uniqueness the sanctuary area is recently declared as a Ramsar site. The sanctuary is bounded by the Dhamara River in the north, the Hansua in the west and the Bay of Bengal in the east and south. Gahirmatha mangrove area comprises Sunirupi R.F, Habilikunti P.F and Gahirmatha P.F. The area is underlain by alluvial deposits which are brought down by the rivers. The average annual rain fall is 1300 mm and the main rainy months are from July to September. The area is also prone to severe cyclonic storms during April to June and October to November. The temperature varies between 10°C minimum in winter to 45°C maximum in summer. The humidity is high throughout the year varying between 75 to 95 %.

The northern portion of the Mahanadi Delta form the Bhitarakanika wildlife sanctuary, which comprises sandy beaches, mudflats and dense mangrove forest and is interrupted by a number of small creeks and streams. The entire coast has flats, sand spits with a number of small sand dunes of about 0.5 –1.0 m and covered with beach vegetation. As a result of high wind action some dunes have grown up to 20 m height at certain places.

Bhitarakanika region is covered with sediments of flood plain deposits. Due to regular inundation through tidal action the soil is mostly clayey loam and highly slushy. The surface soil is composed of silt loam and clayey loam and is about three to four meter in depth. The soil, though well aerated is saline in the elevated areas away from the creeks and channels the soil is more sandy and comparatively less moist and saline.

The mangroves of Bhitarakanika comprises 70 species, including mangrove and their associates with 4 species of *Brugeira*, 3 species of each *Avicennia*, *Sonneratia*, *Heritiera*, *Rhizophora* and *Xylocarpus*. The mangrove species are mostly concentrated along the network of creeks and channels and extend from the sheltered bay to the elevated banks of the upper riparian zone, where the composition of the mangrove community is due to the presence of non- mangles and transitory mangles. Pattnaik and Choudhury (1988) classified Bhitarakanika vegetation into mangal and salt bush formation.

Mangals: They are classified into three categories namely. Eumangals, semi- mangals & transitional mangals.

Eumangals: These typical mangroves are found in water logging area and adopted for high salinity variation. The dominant trees of this type are *Rhizophora apiculata*, *R. mucronata*, *Avicennia officinalis*, *Bruguiera gymnorrbiza*, *Ceriops decandra*, *Aegiceras corniculatum*, *Sonneratia apetala* and *S. caseolaris*. These are generally evergreen and show a high degree of morphological and reproductive a adaptation. A dominant grass *Portresia coarctata* are found along the banks which are submerged during high tide.

Semi-mangal: They grow close to riverine and creeks. The main species are *Heritiera formes*, *Cerberia mangals*, *Cynometra mimosoides*, *Xylocarpus granatum*, *Excoecaria agallocha* and *Tamarix indila*.

Transitional mangals: These plants are well adopted to more terrestrial habitat. Many of them are deciduous and few are evergreen. They are mostly found in less tidal action or low salinity. The common species found in transitional mangroves are *Hibiscus tiliacens*, *Excoecaria agallocha*, *Flagellaria indica*, *Ponga pinnata*, *Derris trifoliata* and *Salvadora persica*, and shrubs such as *Synstemous besiforme* and *Syzigum ruscolmu*.

The diversity in fauna is very high. The animals that are associated with mangroves have a wide range of invertebrate and vertebrate fauna. There are about 172 species of birds, 94 species of reptiles, 26 species of

mammals and 5 species of amphibians recorded in the Bhitarkanika. The important mammals are wild boar, monkey, spotted deer, sambar and fishing cat. The star attraction during monsoon is the “Baga Gahan” in Bhitarkanika which thronged thousands of nesting aquatic birds. It has been estimated that more than 80,000 birds nest together (community nesting) and majority of birds (approximately 60%) include open – billed storks. The forest department of Orissa established a salt water crocodile research and conservation center at Dangmal in 1975 for breeding of population of the endangered reptile using the grow and release technique. The longest Indian lizard, water monitor (*Varanus salivator*), the largest non-poisonous snake python (*Python molurus*) and deadly poisonous snake, king cobra (*Ophiophagus hannah*) are seen in Bhitarkanika. The amphibians like Indian toad, tree frog, skipping frog and other frogs are also seen in Bhitarkanika area. Fish and prawns spend most of their adult life at sea and return to the mangrove area for spawning. Some of the commercially important fishes are Hilsa (*Hilsa illisha*), Mullet (*Khaingot* sp), Bhekkti (*Lates calcarifer*), Kantia (*Myctus* sp), Anchovella sp etc. Prawns such as tiger prawn (*Penaous monodon*), *P. indicus*, *Metapenaus affinies* etc. and crabs (*Scylla serrata*) etc are available in Bhitarkanika wildlife sanctuary.

Anshupa Lake

Anshupa lake is a fresh water wetland situated along the river course of Mahanadi and is bounded by latitudes 20°26'06" to 20°28'03" N and longitudes 85°35'09" to 85°36'06' E. The lake is situated 8 km away from Athagarh sub-division of Cuttack district. The wetland receives water from the outflow of its catchments area which is mainly characterized by denudational hills and agricultural land. The water spread is about 2.12 sq km. The length of the lake is around 3 km. with an average width of 1.3 km. It is situated above 30 meters from Mean Sea Level.

Once famous for its natural beauty, an abode of avifauna and aesthetic sense, the lake is now subjected to siltation, infestation of weeds and chocking of the mouth. The southern part is mostly affected by eutrophication while the central part and northern part are mesotrophic to eutrophic in nature. More than 100 fishing families make their livelihood on the lake water. The area experiences a tropical rainy climate. The average annual rainfall is around 832 mm for last 10 years. May is the hottest month and January is the coldest month.

Other Lakes

Sara is another sweet water lake located near Puri. It is 5 km in length and 3 km in breadth. Kanjia is another sweet water lake with about 134 acres of area located in Nandankanan of Cuttack district near Bhubaneswar.

Tikarpara Sanctuary

The sight of one of the most fabulous vistas of river and forest, the Satakosia gorge where the great Mahanadi river crashes in with monumental force is a notable experience for the visitors.

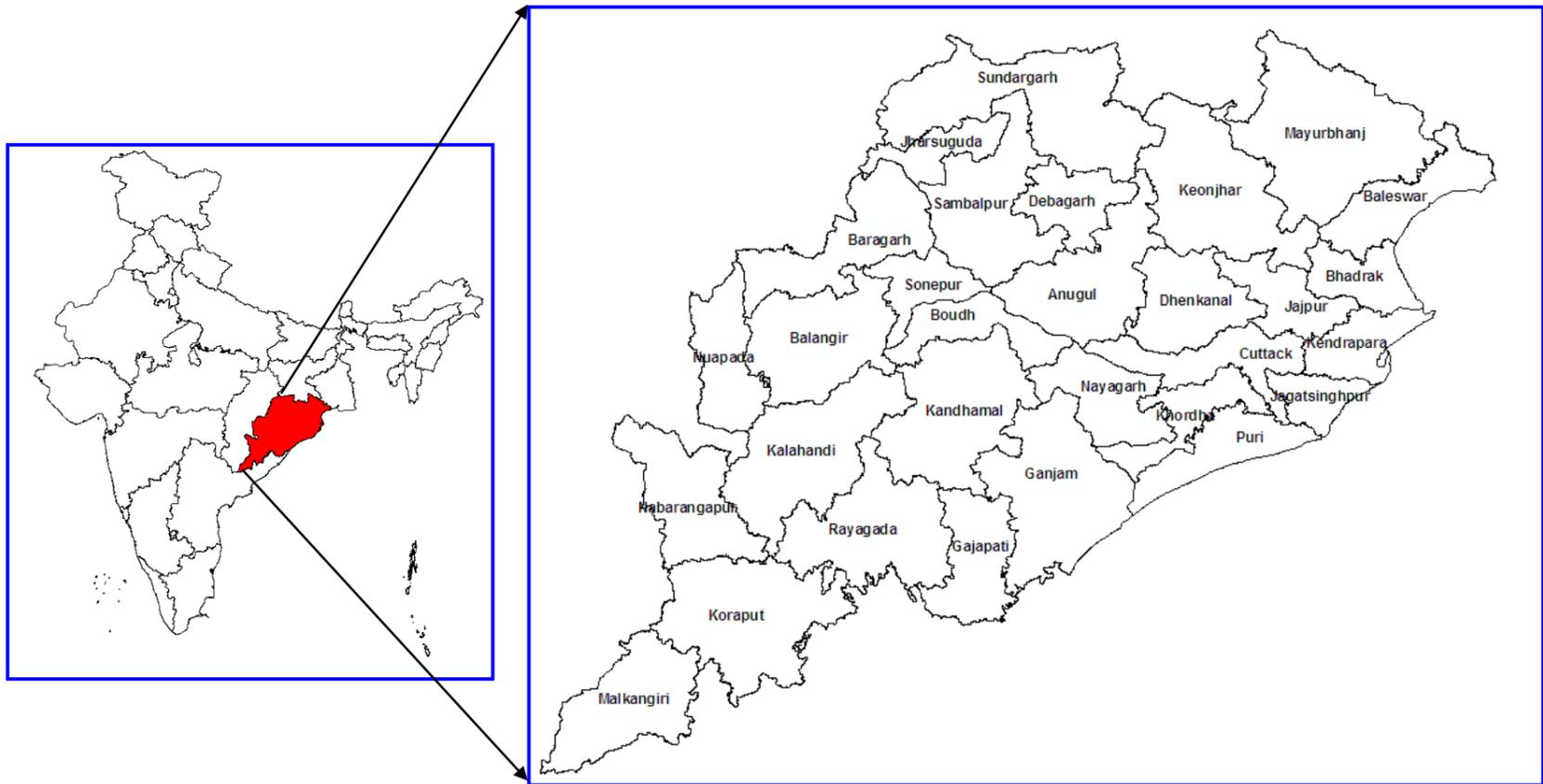


Figure 3: Location map

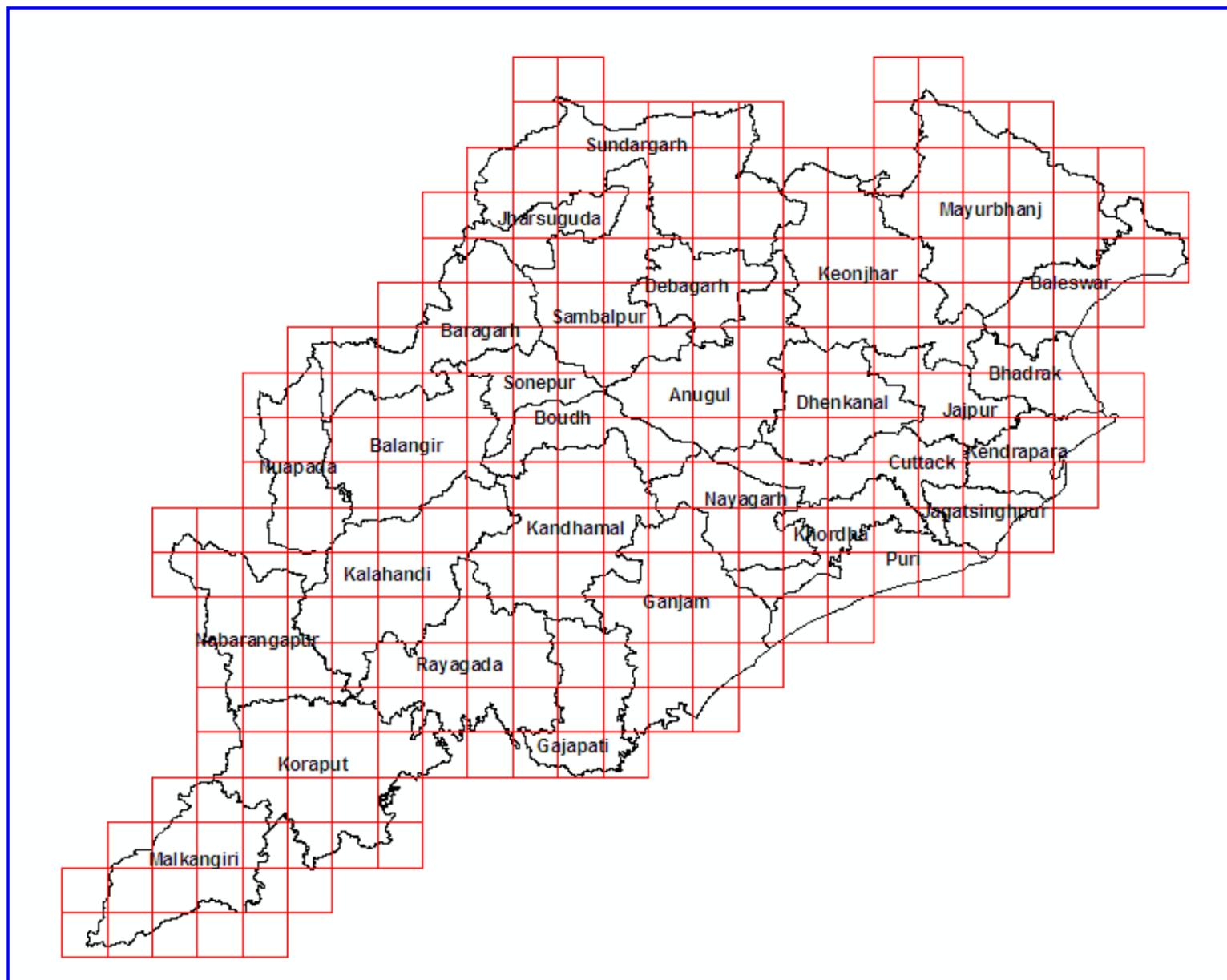


Figure 4: Spatial Framework of Orissa

4.0 DATA USED

Remote sensing data

IRS P6 LISS III data was used to map the wetlands. IRS P6 LISS III provide data in 4 spectral bands; green, red, Near Infra Red (NIR) and Short Wave Infra Red (SWIR), with 23 m spatial resolution and 24 day repeat cycle. The spatial resolution is suitable for 1:50,000 scale mapping. The state of Orissa is covered in 19 IRS LISS III scene (Figure 5). Two-date data, one acquired during March/May and another during October/November were used to capture the pre-monsoon and post-monsoon hydrological variability of the wetlands respectively (Table-2). Figure 6 shows the overview of the study area as seen in the LISS III FCC of post- monsoon pre-monsoon data respectively.

Ground truth data

Remote sensing techniques require certain amount of field observation called “ground truth” in order to convert into meaningful information. Such work involves visiting a number of test sites, usually taking the satellite images. The location of the features is recorded using the GPS. The standard proforma as per the NWIA manual was used to record the field data. Field photographs are also taken to record the water quality (subjective), status of aquatic vegetation and water spread. All field verification work has been done during October and November 2008.

Other data

Survey of India topographical maps (SOI) were used for reference purpose. Lineage data of National Wetland Maps at 1:250,000 scale was used for reference.

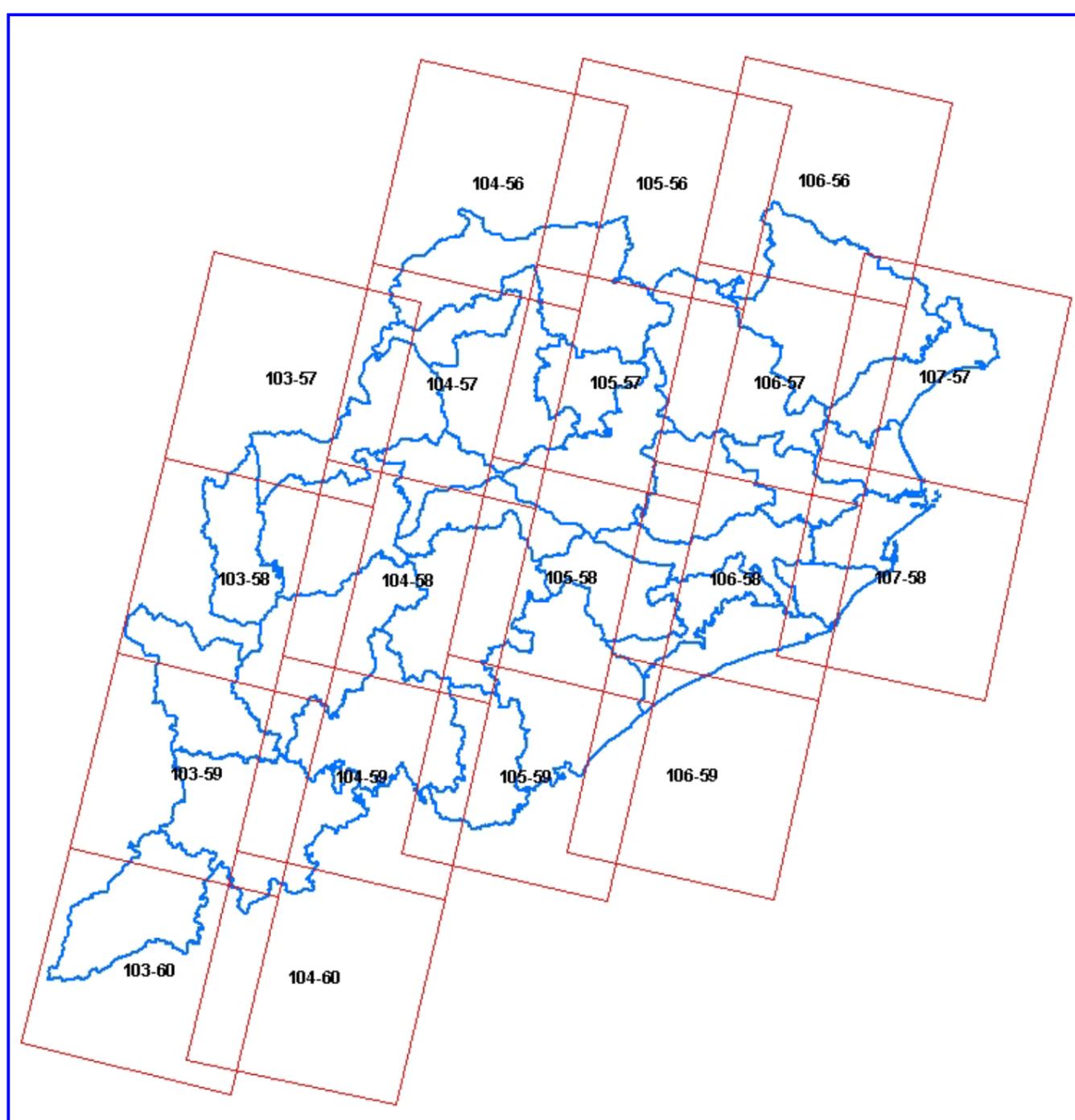


Figure 5: IRS P6 LISS-III coverage (path-row) of Orissa

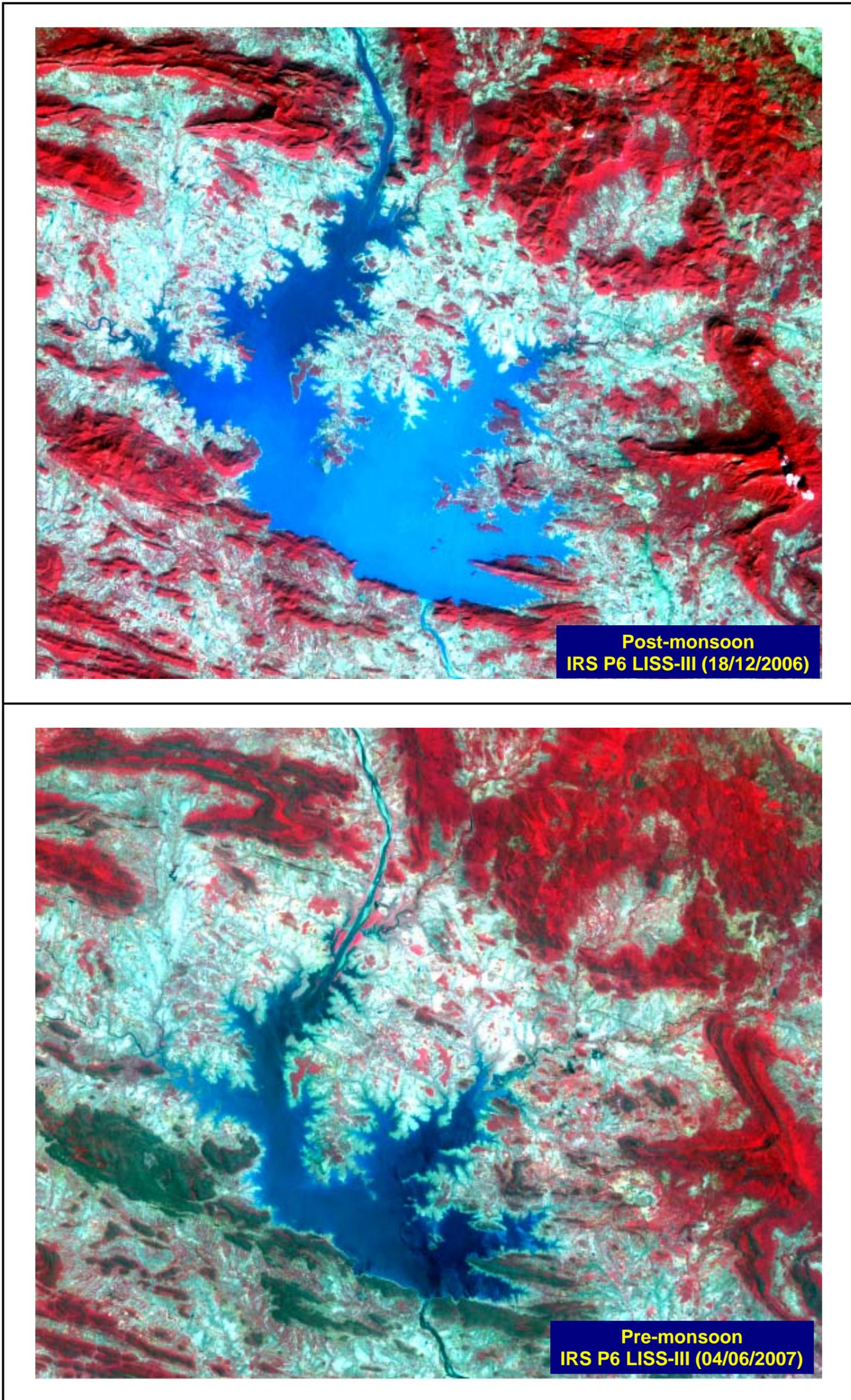


Figure 6 : IRS LISS-III FCC (Oct-Nov 2006-07 and Apr-May 2006-07)

Table-2: Satellite data used

Sr. No.	Sensor	Path-Row	Date of acquisition	
			Post-monsoon	Pre-monsoon
1	LISS-III	103-57	Nov 14, 2007	Apr 7, 2007
2	LISS-III	103-58	Dec 8, 2006	May 25, 2007
3	LISS-III	103-59	Dec 8, 2006	Apr 7, 2007
4	LISS-III	103-60	Dec 8, 2006	May 25, 2007
5	LISS-III	104-56	Nov 19, 2006	May 30, 2007
6	LISS-III	104-57	Nov 19, 2006	May 30, 2007
7	LISS-III	104-58	Nov 19, 2006	May 30, 2007
8	LISS-III	104-59	Nov 19, 2006	Apr 12, 2007
9	LISS-III	104-60	Nov 19, 2006	Apr 12, 2007
10	LISS-III	105-56	Dec 18, 2006	Apr 17, 2007
11	LISS-III	105-57	Dec 18, 2006	Jun 4, 2007
12	LISS-III	105-58	Dec 18, 2006	Feb 28, 2007
13	LISS-III	105-59	Dec 18, 2006	Apr 17, 2007
14	LISS-III	106-56	Oct 12, 2006	Mar 29, 2007
15	LISS-III	106-57	Oct 12, 2006	Apr 22, 2007
16	LISS-III	106-58	Oct 12, 2006	Apr 22, 2007
17	LISS-III	106-59	Oct 12, 2006	Apr 22, 2007
18	LISS-III	107-57	Dec 4, 2006	Apr 3, 2007
19	LISS-III	107-58	Dec 4, 2006	Apr 3, 2007

5.0 METHODOLOGY

The methodology to create the state level atlas of wetlands is adhered to NWIA technical guidelines and procedure manual (Garg and Patel, 2007). The overview of the steps used is shown in Figure 7. Salient features of methodology adopted are

- Generation of spatial framework in GIS environment for database creation and organisation.
- Geo-referencing of satellite data
- Identification of wetland classes as per the classification system given in NWIA Manual and mapping of the classes using a knowledge based digital classification and onscreen interpretation
- Generation of base layers (rail, road network, settlements, drainage, administrative boundaries) from satellite image and ancillary data.
- Mosaicing/edge matching to create district and state level database.
- Coding of the wetlands following the standard classification system and codification as per NWIA manual.
- Preparation of map compositions and generation of statistics
- Outputs on A3 size prints and charts for atlas.

Work was carried out using ERDAS Imagine, Arc/Info and Arcgis softwares.

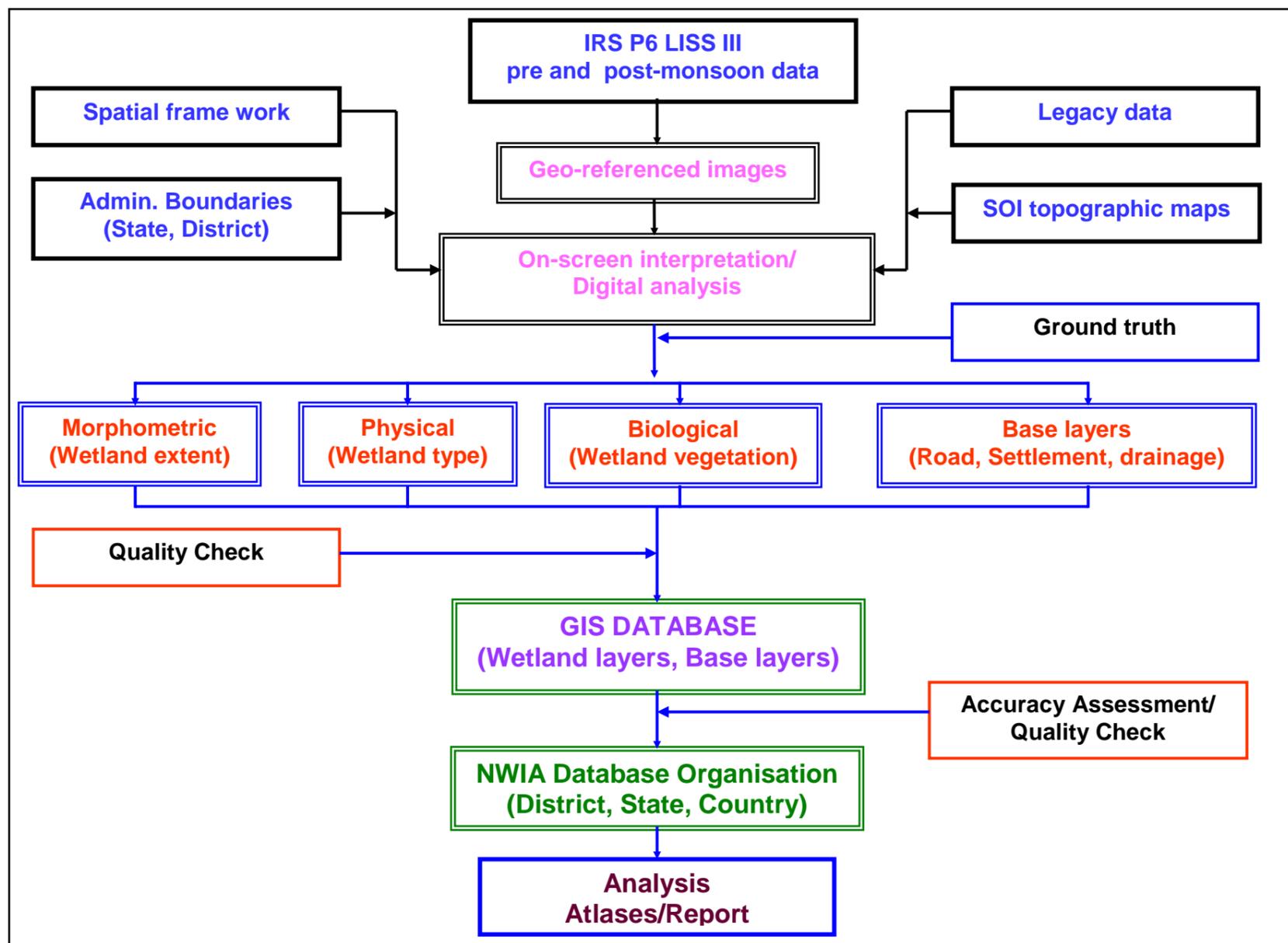


Figure 7: Flow chart of the methodology used

5.1 Creation of spatial framework

This is the most important task as the state forms a part of the national frame work and covered in multiple map sheets. To create NWIA database, NNRMS/NRDB standards is followed and four corners of the 1:50,000 (15' x 15') grid is taken as the tics or registration points to create each map taking master grid as the reference. Spatial framework details are given in NWIA manual (Patel and Garg, 2007). The spatial framework for Orissa state is shown in Figure 3.

5.2 Geo-referencing of satellite data

In this step the raw satellite images were converted to specific map projection using geometric correction. This is done using archive geometrically corrected LISS III data (ISRO-NRC-land use / land cover project). Standard image processing software was used for geo-referencing. First one date data was registered with the archive image. The second date data was then registered with the first date data.

5.3 Mapping of wetlands

The delineation of wetlands through image analysis forms the foundation for deriving all wetland classes and results. Consequently, a great deal of emphasis has been placed on the quality of the image Interpretation. In the present study, the mapping of wetlands was done following digital classification and onscreen visual interpretation. Wetlands were identified based on vegetation, visible hydrology and geography. There are various methods for extraction of water information from remote sensing imagery, which according to the number of bands used, are generally divided into two categories, i.e. Single-band and multi-band methods. Single-band method usually involves choosing a band from multi-spectral image to distinguish water from land by subjective threshold values. It may lead to over- or under-estimation of open water area. Multi-band method takes advantage of reflective differences of each band. In this project, five indices known in literature that enhances various wetland characteristics were used (McFeetres, 1986; Xu Hanqiu, 2006; Lacaux *et al*, 2007; Townshend and Justice, 1986; Tucker and Sellers, 1986) as given below:

- i). Normalised Difference Water Index (NDWI) = (Green-NIR) / (Green + NIR)
- ii). Modified Normalised Difference Water Index (MNDWI) = (Green-MIR) / (Green + MIR)
- iii). Normalised Difference Vegetation Index (NDVI) = (NIR - Red) / (NIR + Red)
- iv). Normalised Difference Pond Index (NDPI) = (MIR – Green / MIR + Green)
- v). Normalised Difference Turbidity Index (NDTI) = (Red – Green) / (Red + Green)

The indices were generated using standard image processing software, stacked as layers. (Figure 8). Various combinations of the indices/spectral bands were used to identify the wetland features as shown in Figure 9. The following indices were used for various layer extractions:

- Extraction of wetland extent :
MNDWI, NDPI and NDVI image was used to extract the wetland boundary through suitable hierarchical thresholds.
- Extraction of open water :
MNDWI was used with in the wetland mask to delineate the water and no-water areas.
- Extraction of wetland vegetation :
NDPI and NDVI image was used to generate the vegetation and no-vegetation areas within a wetland using a suitable threshold.
- Turbidity information extraction :
NDTI and MNDWI image was used to generate qualitative turbidity level (high, moderate and low) based on signature statistics and standard deviations. In the False Colour Composite (FCC) these generally appear in different hues as given in Table-3.

Table 3 : Qualitative turbidity ratings

Sr. No.	Qualitative Turbidity	Conditional criteria	Hue on FCC
1.	Low	> +1σ	Dark blue/blackish
2.	Moderate	> -1σ to <= +1σ	Medium blue
3.	High/Bottom reflectance	<= μ - 1σ	Light blue/whitish blue

5.4 Conversion of the conformation into a vector layer

The information on wetland extent, open water extent, vegetation extent and turbidity information was converted into vector layers using regional growing properties or on-screen digitisation.

5.5 Generation of reference layers

Base layers like major rail, road network, settlements, drainage are interpreted from the current image or taken from other project data base. The administrative boundaries (district, state) are taken from the known reference data.

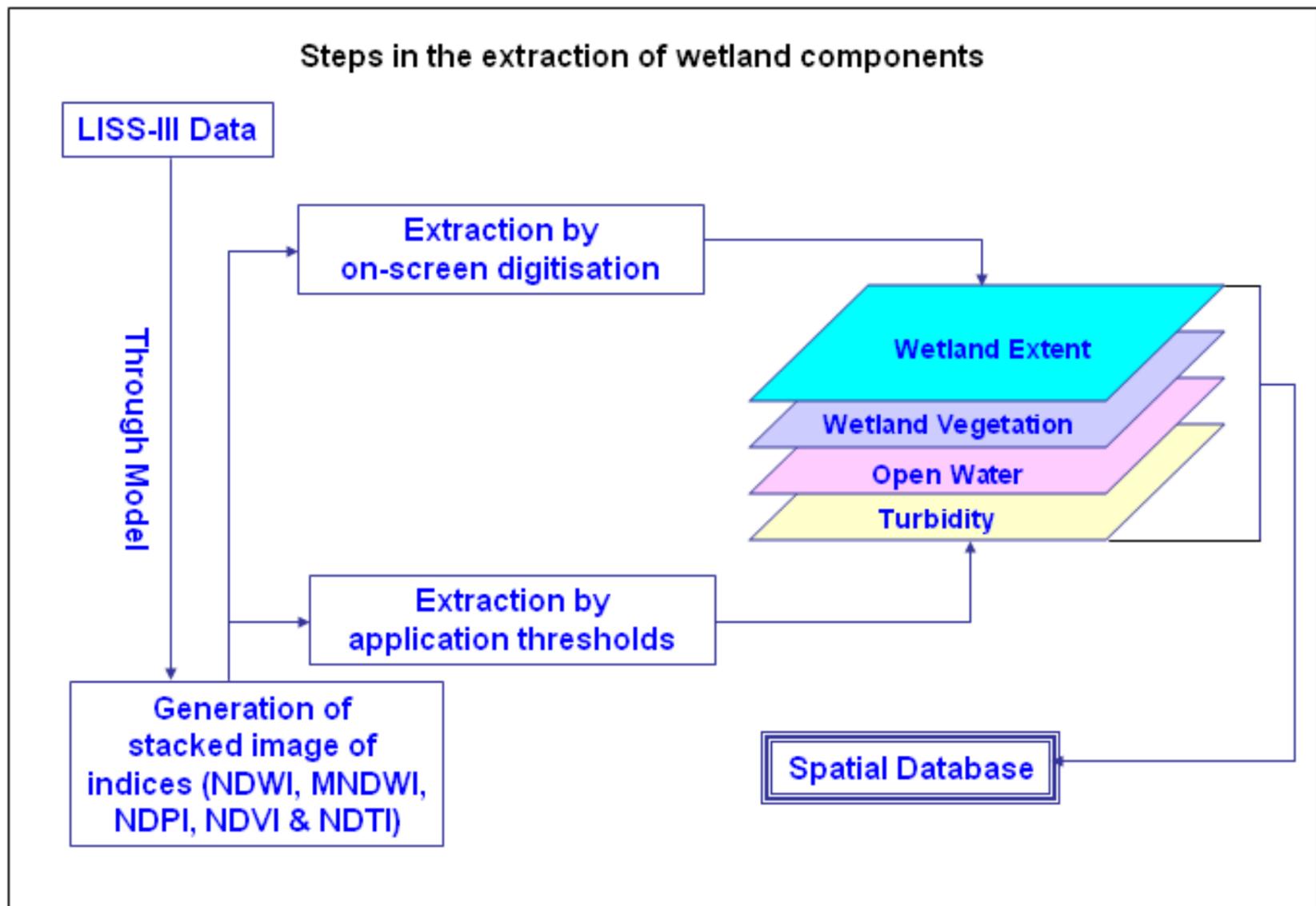


Figure 8: Steps in the extraction of wetland components

5.6 Coding and attribute scheme

Feature codification scheme for every input element has been worked out keeping in view the nationwide administrative as well as natural hierarchy (State-district-taluka) within the feature class for each of the theme. All data elements are given a unique name/code, which are self explanatory with short forms.

5.7 Map composition and output

Map composition for atlas has been done at district and state level. A standard color scheme has been used for the wetland classes and other layers. The digital files are made at 1:50,000 scale. The hard copy outputs are taken in A3 size.

6.0 ACCURACY ASSESSMENT

A comprehensive accuracy assessment protocol has been followed for determining the quality of information derived from remotely sensed data. Accuracy assessment involves determination of thematic (classification) as well as location accuracy. In addition GIS database(s) contents have been also evaluated for accuracy. To ensure the reliability of wetland status data, the project adhered to established quality assurance and quality control measures for data collection, analysis, verification and reporting.

This study used well established, time-tested, fully documented data collection conventions. It employed skilled and trained personnel for image interpretation, processing and digital database creation. All interpreted imagery was reviewed by technical expert team for accuracy and code. The reviewing analyst adhered to all standards, quality requirements and technical specifications and reviewed 100 percent of the work. The various stages of quality check include:

1. Image-Image Geo-referencing/Data generation
2. Reference layer preparation using NWIA post monsoon and pre-monsoon LISS-III data.
3. Wetland mapping using visual/digital interpretation techniques.
4. Geo-data base creation and organization
5. Output products.

6.1 *Data verification and quality assurance of output digital data files*

All digital data files were subjected to rigorous quality control inspections. Digital data verification included quality control checks that addressed the geospatial correctness, digital integrity and some cartographic aspects of the data. Implementation of quality checks ensured that the data conformed to the specified criteria, thus achieving the project objectives. There were tremendous advantages in using newer technologies to store and analyze the geographic data. The geospatial analysis capability built into this study provided a complete digital database to better assist analysis of wetland change information. All digital data files were subjected to rigorous quality control inspections. Automated checking modules incorporated in the geographic information system (Arc/GIS) were used to correct digital artifacts including polygon topology. Additional customized data inspections were made to ensure that the changes indicated at the image interpretation stage were properly executed.

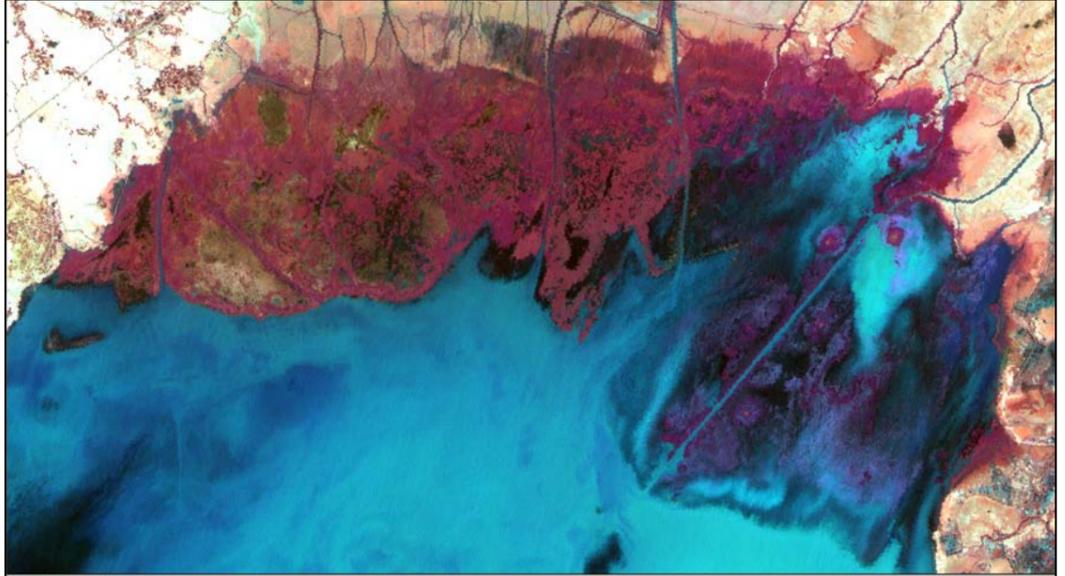
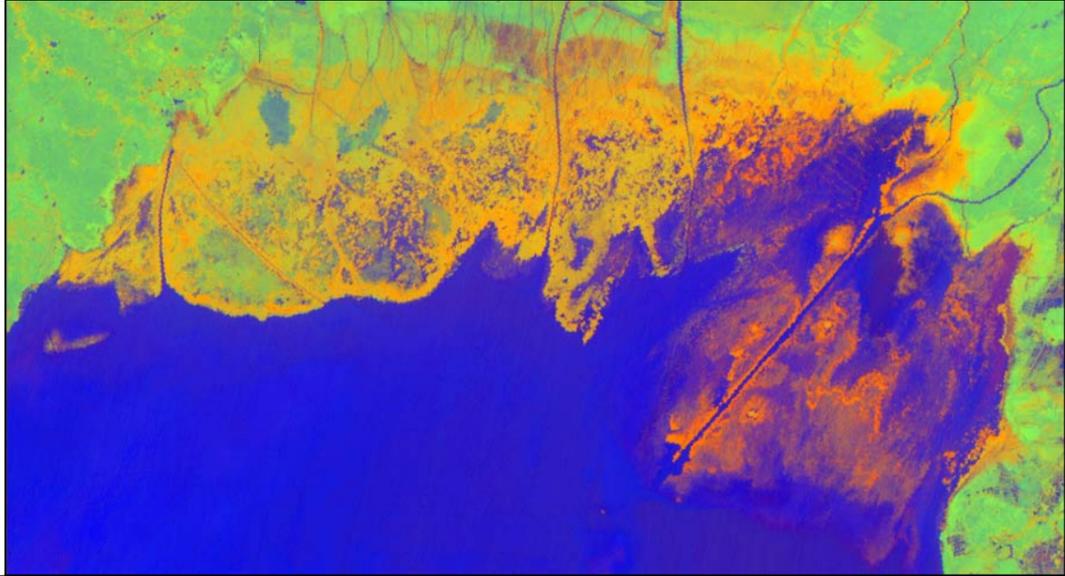
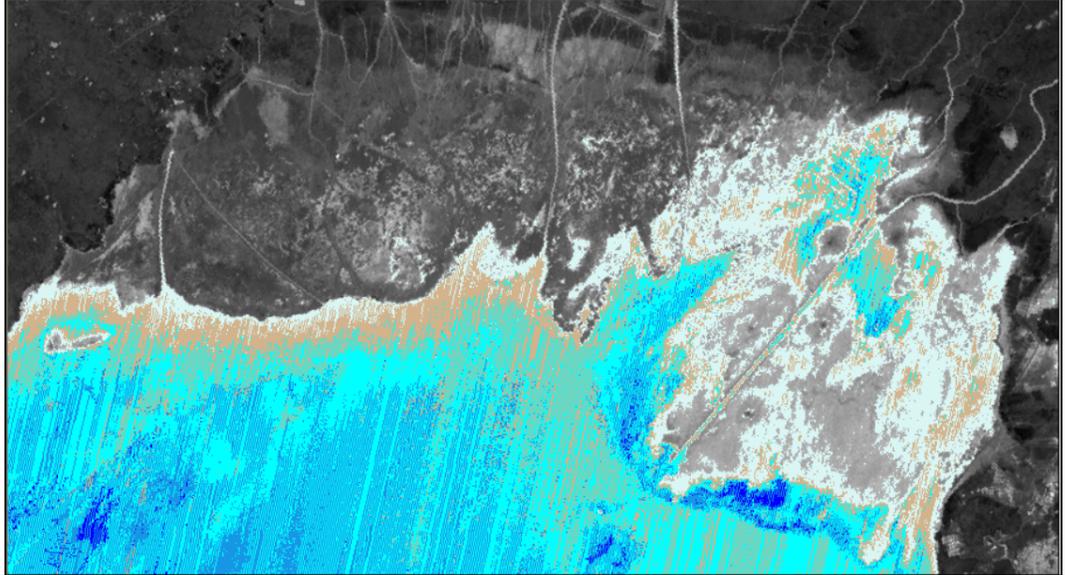
	<p>Part of Chilika lagoon</p> <p>IRS P6 LISS-III (pre-monsoon 2007)</p> <p>FCC: Green Red NIR</p>
	<p>FCC: Green Red SWIR</p>
	<p>FCC of Indices:</p> <p>MNDWI NDPI NDVI</p> <p>Useful for delineation of open water and aquatic vegetation</p>
	<p>σ-based classified MNDWI image useful in assigning qualitative turbidity ratings</p>

Figure 9: Various combinations of the indices/spectral bands used to identify wetland components

MAPS AND STATISTICS

7.0 WETLANDS OF ORISSA: MAPS AND STATISTICS

Area estimates of various wetland categories for Orissa have been carried out using GIS layers of wetland boundary, water-spread, aquatic vegetation and turbidity. In the state of Orissa 12266 wetlands have been delineated. In addition, 66174 small wetlands (< 2.25 ha) have also been discerned. Total wetland area is estimated to be 690904 ha. (Table 4). Inland wetlands dominated the extent of wetlands constituting about 66 per cent. Further, inland natural and man-made wetlands shared approximately similar extents with about 34 and 32 per cent of area under wetlands. Out of 24 per cent of coastal wetlands, the natural accounted for about 20 per cent and the rest 3 per cent is shared by man-made wetlands.

Table 4: Summary statistics of wetlands in Orissa

Sr. No.	Wettcode	Category	Number of wetlands	Total wetland area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon area	Pre-monsoon area
1	1100	Inland Wetlands - Natural	3111	238867	34.57	228701	218773
2	1200	Inland Wetlands - Man-made	7871	220207	31.87	197205	126476
		Total - Inland	10982	459074	66.45	425906	345249
3	2100	Coastal Wetlands - Natural	560	143978	20.84	60699	52384
4	2200	Coastal Wetlands - Man-made	724	21678	3.14	21677	21677
		Total - Coastal	1284	165656	23.98	82376	74061
		Sub-Total	12266	624730	90.42	508282	419310
5		Wetlands (<2.25 ha)	66174	66174	9.58	-	-
		Total	78440	690904	100	508282	419310

The major wetland types are River/Stream (223522 ha) comprising about 32 per cent of extent wetlands (Table 5) followed by Reservoir/Barrage (189972 ha), Tank/ Ponds (29301 ha), Lagoon (89023 ha), Intertidal mudflats (25514 ha) and Mangroves (23395 ha). There are large number of small wetlands (<2.25 ha) contributing about 10 per cent of the extent under wetlands in Orissa. The open water spread is 508282 ha in post-monsoon constituting about 81 per cent of the the wetland area. It has reduced to 419310 ha in pre-monsoon, which turns out to be about 14 per cent. The reduction in open water spread is visibly observed in case of Reservoir/Barrage, which was 180240 ha in post-monsoon has got reduced to 109975 ha in pre-monsoon season. The aquatic vegetation was observed to constituting about 10 per cent of wetland area in post-monsoon (62733 ha) has shown a significant increase during pre-monsoon (142584 ha) that turns out to be about 23 per cent. Open water exhibited dominantly moderate turbidity in both seasons followed by low and high turbidity levels. Graphical distribution of wetland type is shown in Figure 10.

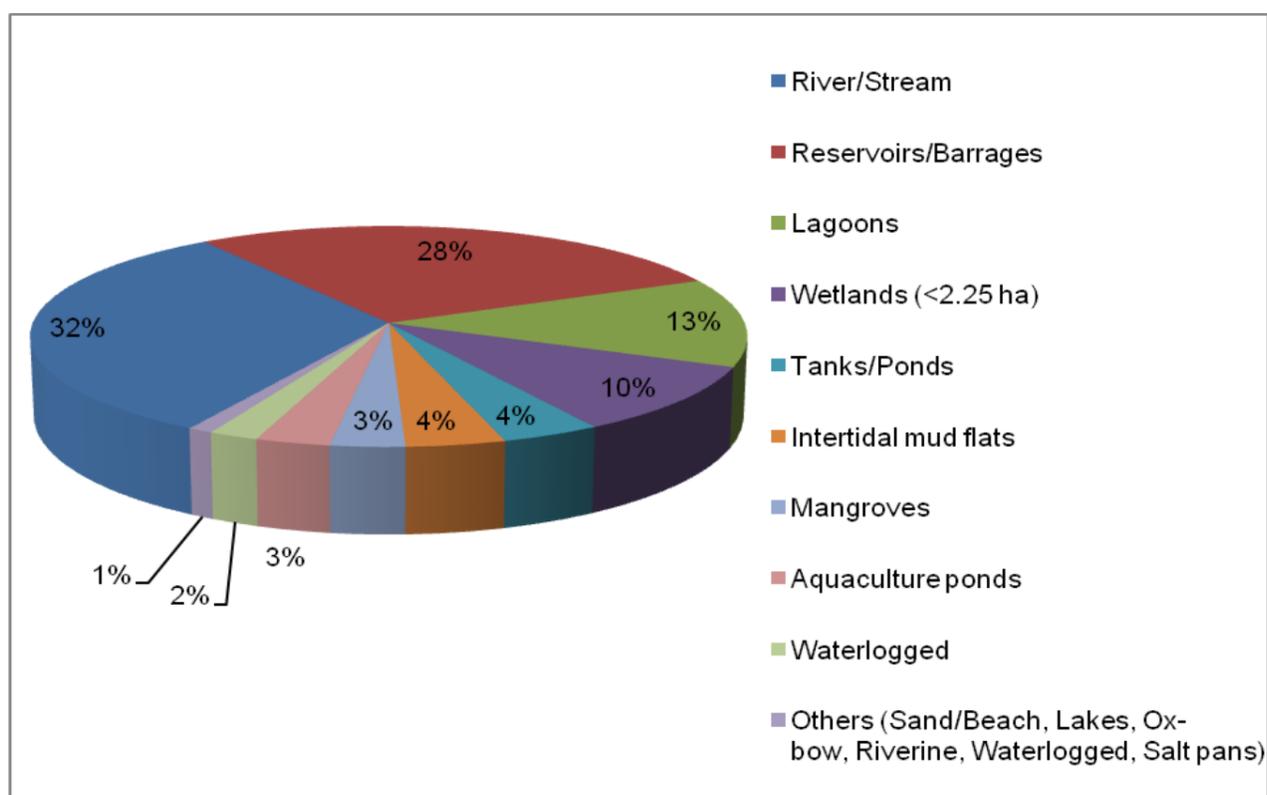


Figure 10: Type-wise wetland distribution in Orissa

Table 5: Type wise area estimates of wetlands in Orissa

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	4	712	0.10	344	225
2	1102	Ox-bow lakes/ Cut-off meanders	79	728	0.11	539	558
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	133	980	0.14	739	705
5	1105	Waterlogged	1158	12925	1.87	4487	4325
6	1106	River/Stream	1737	223522	32.35	222592	212960
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	1379	189972	27.50	180240	109975
8	1202	Tanks/Ponds	6441	29301	4.24	16293	15829
9	1203	Waterlogged	51	934	0.14	672	672
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	10982	459074	66.45	425906	345249
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	7	89023	12.89	60699	52384
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	72	6046	0.88	-	-
14	2104	Intertidal mud flats	318	25514	3.69	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	163	23395	3.39	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	2	1726	0.25	1726	1726
19	2202	Aquaculture ponds	722	19952	2.89	19951	19951
		Total - Coastal	1284	165656	23.98	82376	74061
		Sub-Total	12266	624730	90.42	508282	419310
		Wetlands (<2.25 ha)	66174	66174	9.58	-	-
		Total	78440	690904	100.00	508282	419310

Area under Aquatic Vegetation	62733	142584
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Area under turbidity levels		
Low	116369	138906
Moderate	378117	264017
High	13796	16387

7.1 DISTRICT-WISE WETLAND MAPS AND STATISTICS

The state has thirty districts. Overall, the wetlands account for about 4.5 per cent of geographical area of the state. Perusal of table 6 reveals that Puri district ranked first in terms of extent of total wetlands (Figure 11) and open water comprising 14.2 per cent of total area under wetlands in the state. This district comprises 98096 ha of area under wetlands with open water spread of 65593 ha in post-monsoon and 59427 ha in pre-monsoon showing a reduction of about 9 per cent in open water spread.

On the other hand Gajapati district has shown least area (Figure 11) comprising 3569 ha of wetlands with 2642 ha in post-monsoon and 1398 ha in pre-monsoon, which turns out to be about 47 per cent in terms of seasonal reduction in the extent of open water. Detailed account of wetland distribution along with their assessment in terms of their seasonal open water spread, aquatic vegetation and turbidity status is described in the subsequent account. The wetland maps based on the analysis of IRS P6 LISS-III data of post-monsoon as well as pre-monsoon, and corresponding satellite image are depicted in the following account for the appreciation of the users.

Table-6: District-wise statistics of distribution of wetlands

Sr. No.	Name	Geographic area (km ²)	Wetland area (ha)	% of wetland area	% of district geographic area	Open water (ha)		Seasonal reduction in open water extent (%)
						Post-monsoon	Pre-monsoon	
1	Bargarh	5832	29925	4.3	5.1	23672	17412	26
2	Jharsuguda	2202	42297	6.1	19.2	39393	18376	53
3	Sambalpur	6702	26511	3.8	4.0	23786	17261	27
4	Debagarh	2781	25025	3.6	9.0	23900	15343	36
5	Sundargarh	9942	20725	3.0	2.1	17336	14989	14
6	Kendujhar	8336	21089	3.1	2.5	16143	12451	23
7	Mayurbhanj	10418	19650	2.8	1.9	12876	11100	14
8	Baleshwar	3706	19061	2.8	5.1	10387	10104	3
9	Bhadrak	2788	19017	2.8	6.8	9886	9713	2
10	Kendrapara	2546	49284	7.1	19.4	21516	21413	0
11	Jagatsinghapur	1759	20386	3.0	11.6	14760	14428	2
12	Cuttack	3915	26738	3.9	6.8	21996	19598	11
13	Jajpur	2885	15714	2.3	5.4	10759	10132	6
14	Dhenkanal	4597	13663	2.0	3.0	9736	8472	13
15	Anugul	6347	28616	4.1	4.5	25507	20112	21
16	Nayagarh	3954	9185	1.3	2.3	6631	6194	7
17	Khordha	2888	14407	2.1	5.0	6030	5144	15
18	Puri	3055	98096	14.2	32.1	65593	59427	9
19	Ganjam	8033	29920	4.3	3.7	18883	16099	15
20	Gajapati	3056	3569	0.5	1.2	2642	1398	47
21	Khandhamal	6004	5865	0.8	1.0	5052	4802	5
22	Baudh	4289	11011	1.6	2.6	9203	8950	3
23	Sonapur	2284	12576	1.8	5.5	10899	10333	5
24	Balangir	6552	20276	2.9	3.1	13407	12503	7
25	Nuapada	3408	9792	1.4	2.9	6842	4961	27
26	Kalahandi	8197	23227	3.4	2.8	17408	16015	8
27	Rayagada	7585	8672	1.3	1.1	7048	6517	8
28	Nabarangpur	5135	12503	1.8	2.4	8588	7921	8
29	Koraput	8534	26307	3.8	3.1	24124	19007	21
30	Malkangiri	6115	27796	4.0	4.5	24275	19130	21
Total		153845	690904	100.0	4.5	4.5	419310	18

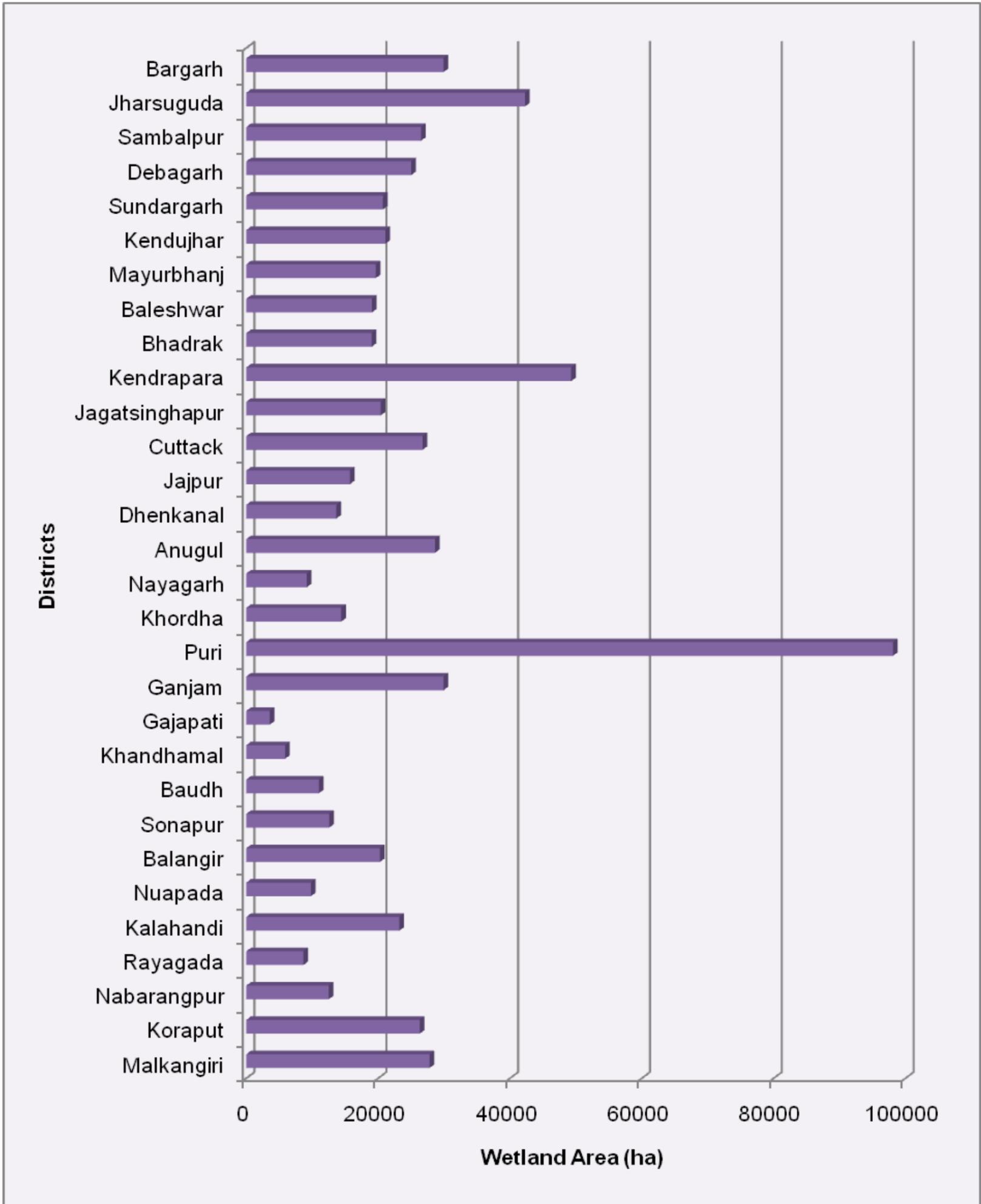
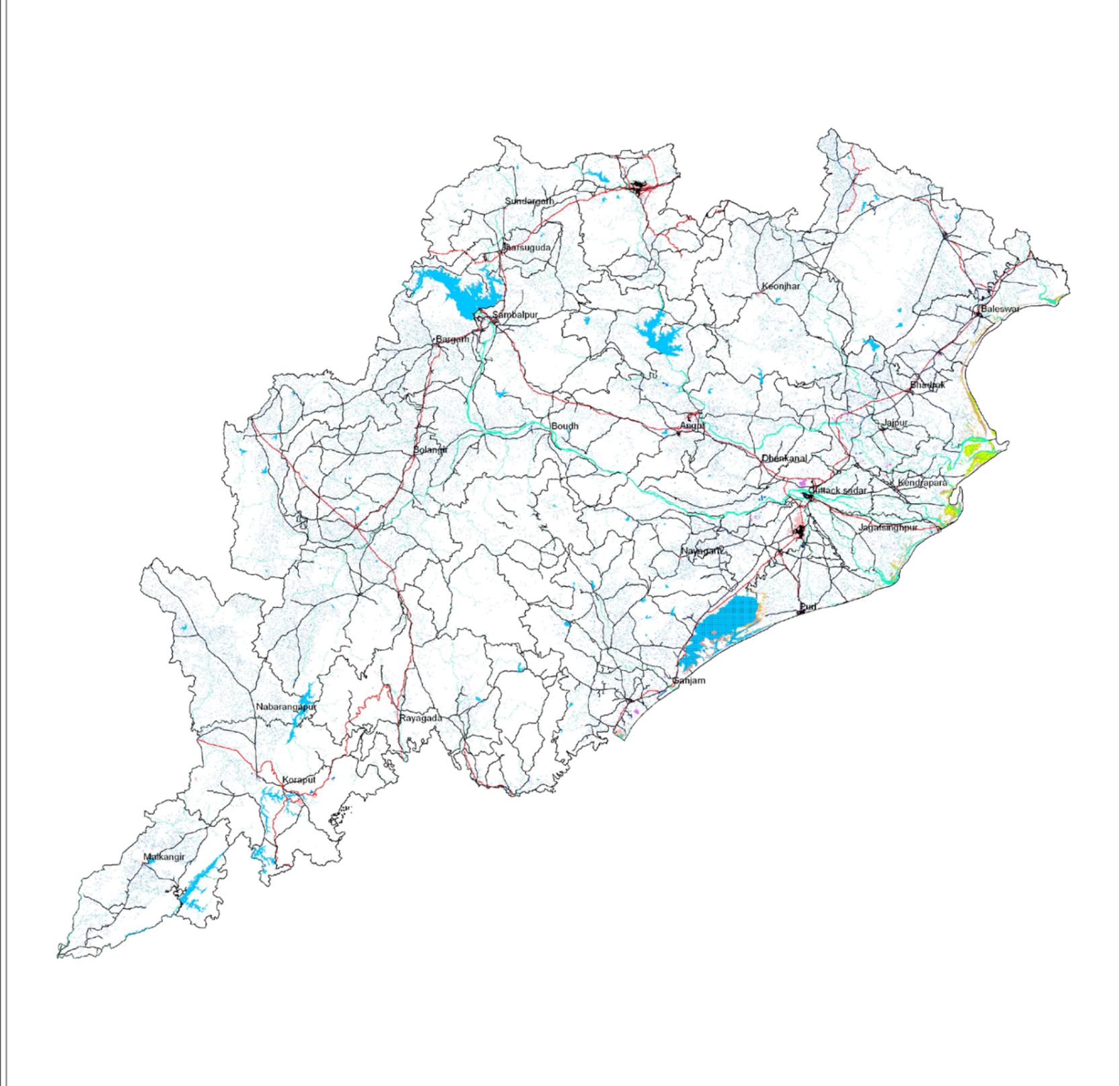
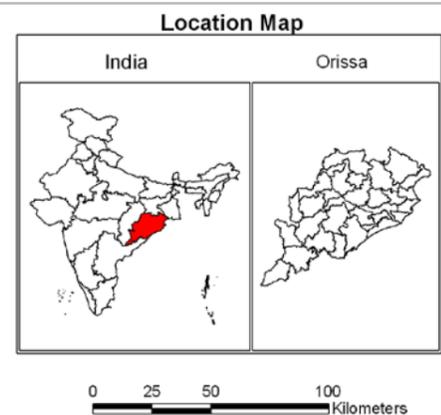


Figure 11: District-wise wetland distribution in Orissa



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

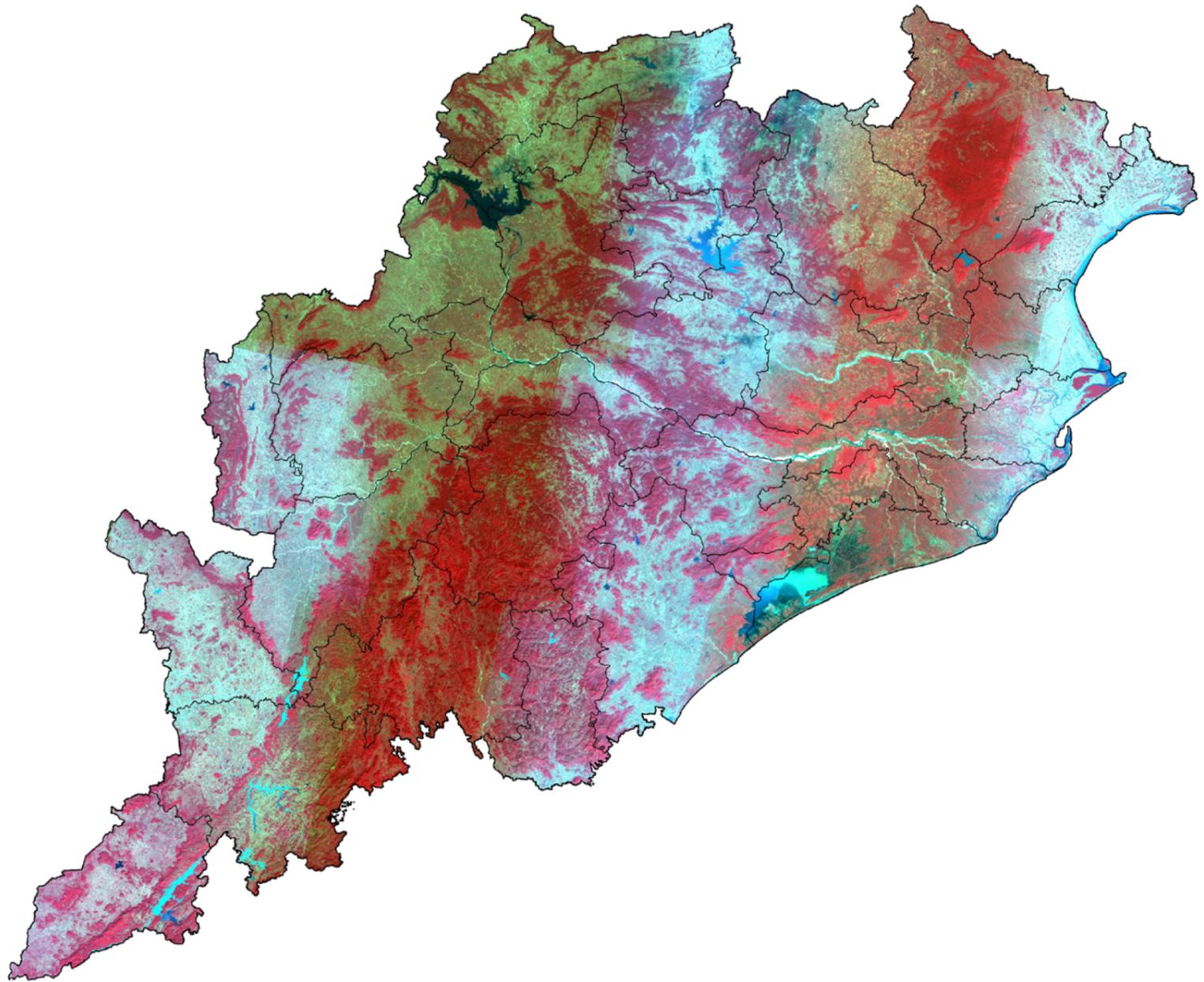


Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
 Space Applications Centre (ISRO), Ahmedabad
 and
 Orissa Space Applications Centre, Bhubaneswar

Sponsored By :
 Ministry of Environment and Forests
 Government of India

State : Orissa



IRS P6 LISS-III Post-monsoon data (2006)

7.1.1 Baragarh

The total geographical area of the district is 5832 sq km. Baragarh comprises 960 wetlands accounting for 26407 ha (Table 7). This includes the small wetlands (<2.25 ha), which are 3518. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (12 %) assuming that each wetland would be on an average 1 ha in extent. The Reservoir/Barrage category ranked first in terms of extent (about 58 %) comprising 17238 ha of area followed by River/Stream (5953 ha) and Tank/Pond (2694 ha). Other categories like natural waterlogged areas (35 ha) and Riverine wetlands (419 ha) are represented but together accounts for less than 2 per cent of wetland extent. The seasonal reduction in open water spread is about 26 per cent, which is observed to be 23672 ha in post-monsoon got reduced to 17412 ha in pre-monsoon. The reduction is pronounced in Reservoir/Barrage category with 16283 ha and 10195 ha in post- and pre-monsoon seasons respectively (Table 7). Aquatic vegetation has shown about 3 fold increase from 2777 ha in post-monsoon to 8879 ha in pre-monsoon. Moderate turbidity is dominated the open water spread in both the seasons, which was observed to be 21641 ha and 10532 ha in post- and pre-monsoon followed by high and low turbidity ratings.

Table 7: Area estimates of wetlands in Baragarh District

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	4	35	0.12	21	6
5	1105	Waterlogged	86	419	1.40	71	78
6	1106	River/Stream	44	5953	19.89	5929	5778
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	169	17238	57.60	16283	10195
8	1202	Tanks/Ponds	642	2694	9.00	1334	1321
9	1203	Waterlogged	15	68	0.23	34	34
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	960	26407	88.24	23672	17412
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
16	2201	Salt pans	-	-	-	-	-
17	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	960	26407	88.24	23672	17412
		Wetlands (<2.25 ha)	3518	3518	11.76	-	-
		Total	4478	29925	100.00	23672	17412

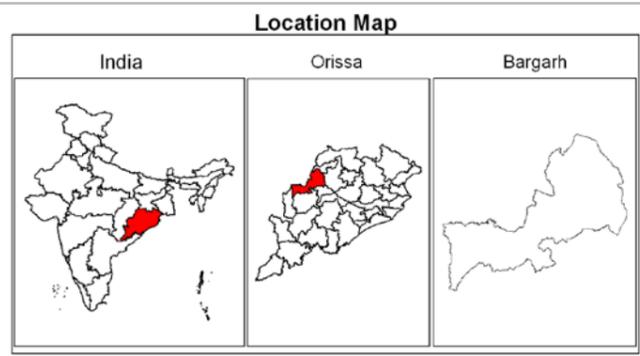
Area under Aquatic Vegetation	2777	8879
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Area under turbidity levels		
Low	167	2057
Moderate	21641	10532
High	1864	4823



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

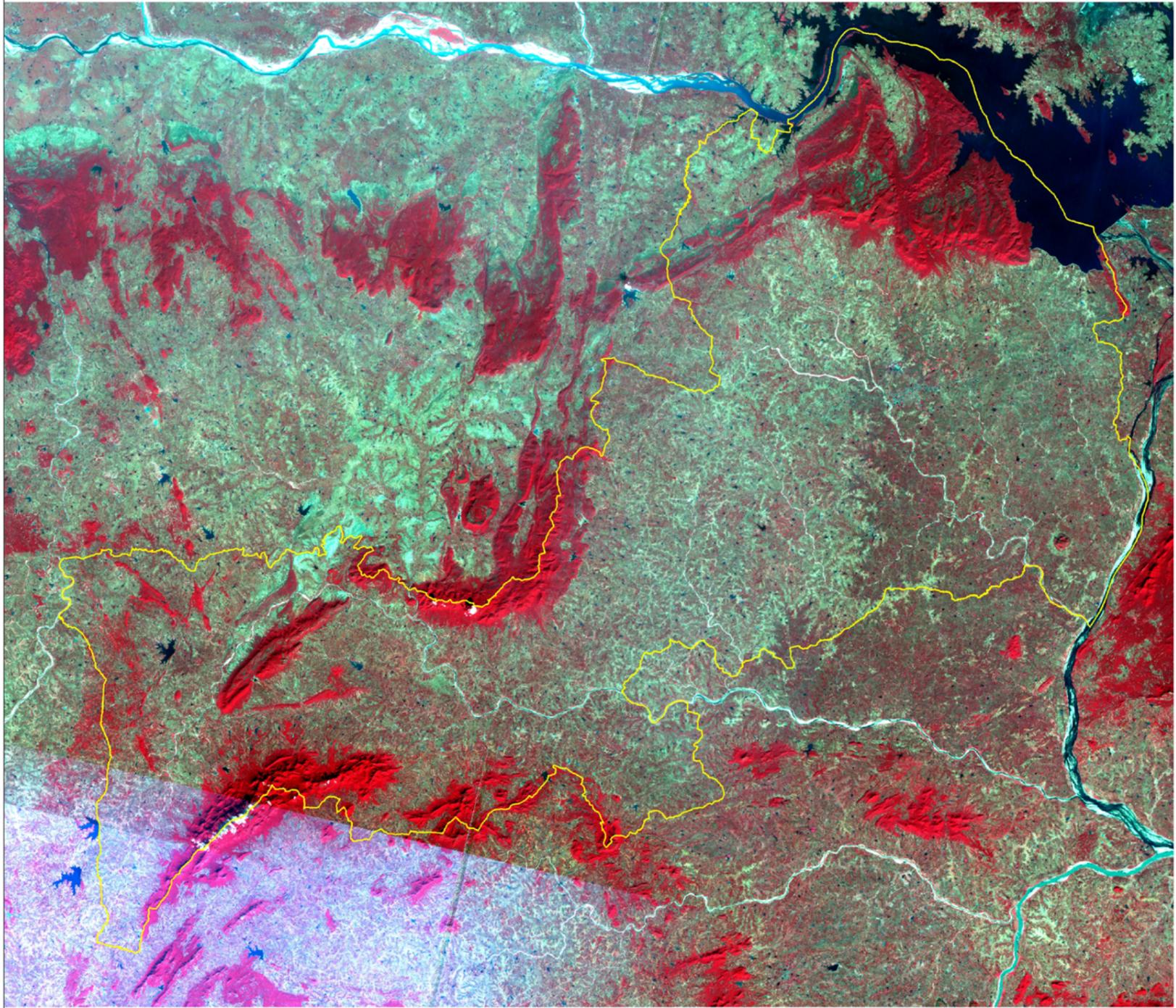
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

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Sponsored By :
 Ministry of Environment and Forests
 Government of India



7.1.2 Jharsuguda

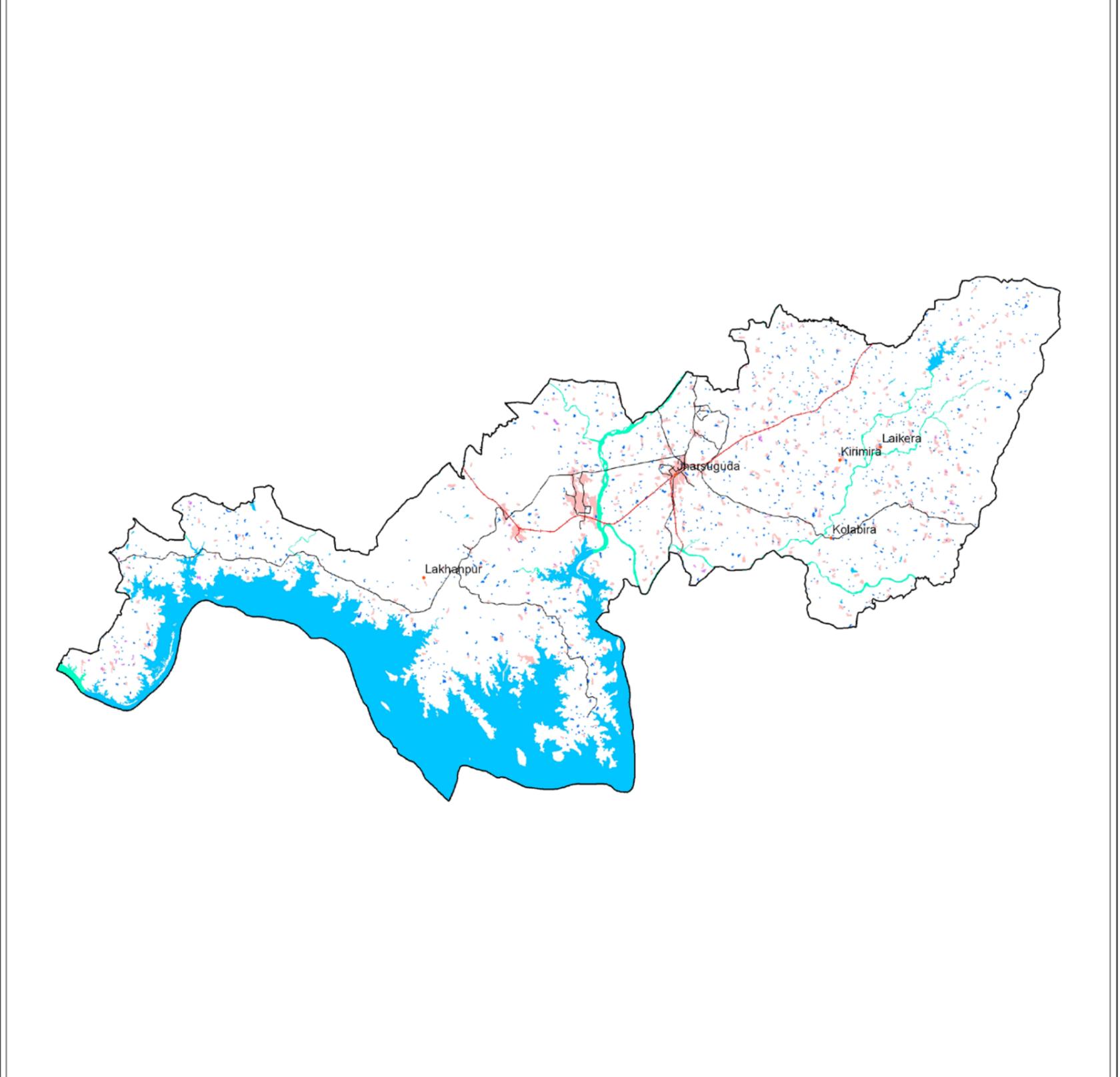
The total geographical area of Jharsuguda district is 2202 sq km with about 0.3 per cent under wetlands. Jharsuguda district comprises of 1323 wetland including 964 wetlands smaller than 2.25 ha. The wetland area is estimated to be 42297 ha (Table 8). Reservoir/Barrage category is singularly dominant wetland type constituting about 89 per cent of area (37620 ha) under wetlands in the district. River/Stream accounts for about 6 per cent of wetland extent occupying 2407 ha followed by Tank/Pond (1123 ha). Waterlogged (natural as well as man-made) areas and Riverine wetlands are represented in the district but are found to insignificant in terms of extent. Open water spread has shown a drastic reduction (47 %) from post-monsoon (39393 ha) to pre-monsoon (18376 ha). It is pronouncedly seen in Reservoir/Barrage, where in the post-monsoon spread was observed to be 36193 ha has got reduced to 15548 ha in pre-monsoon. Aquatic vegetation has shown an eleven times increase from 2050 ha in post-monsoon to 22729 ha in pre-monsoon (Table 8). Open water is dominated by moderate turbidity in both the seasons (38636 ha and 15398 ha). Extent under both low (13 ha) and high (744 ha) turbidity under open water has significantly increased in pre-monsoon season (1851 ha and 1127 ha).

Table 8: Area estimates of wetlands in Jharsuguda district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	1	3	0.01	-	-
5	1105	Waterlogged	36	176	0.42	86	86
6	1106	River/Stream	25	2407	5.69	2407	2053
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	23	37620	88.94	36193	15548
8	1202	Tanks/Ponds	273	1123	2.66	704	686
9	1203	Waterlogged	1	4	0.01	3	3
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	359	41333	97.72	39393	18376
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	359	41333	97.72	39393	18376
		Wetlands (<2.25 ha)	964	964	2.28	-	-
		Total	1323	42297	100.00	39393	18376

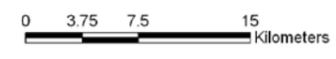
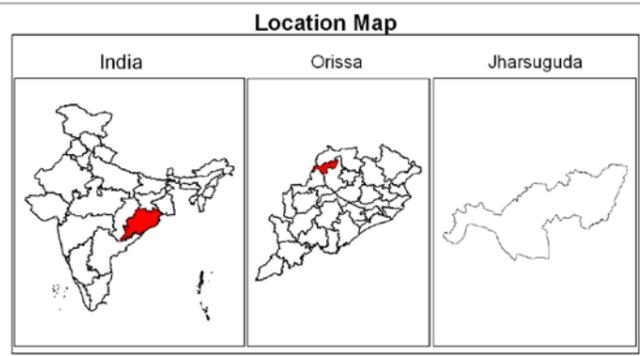
Area under Aquatic Vegetation	2050	22729
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Area under turbidity levels		
Low	13	1851
Moderate	38636	15398
High	744	1127



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

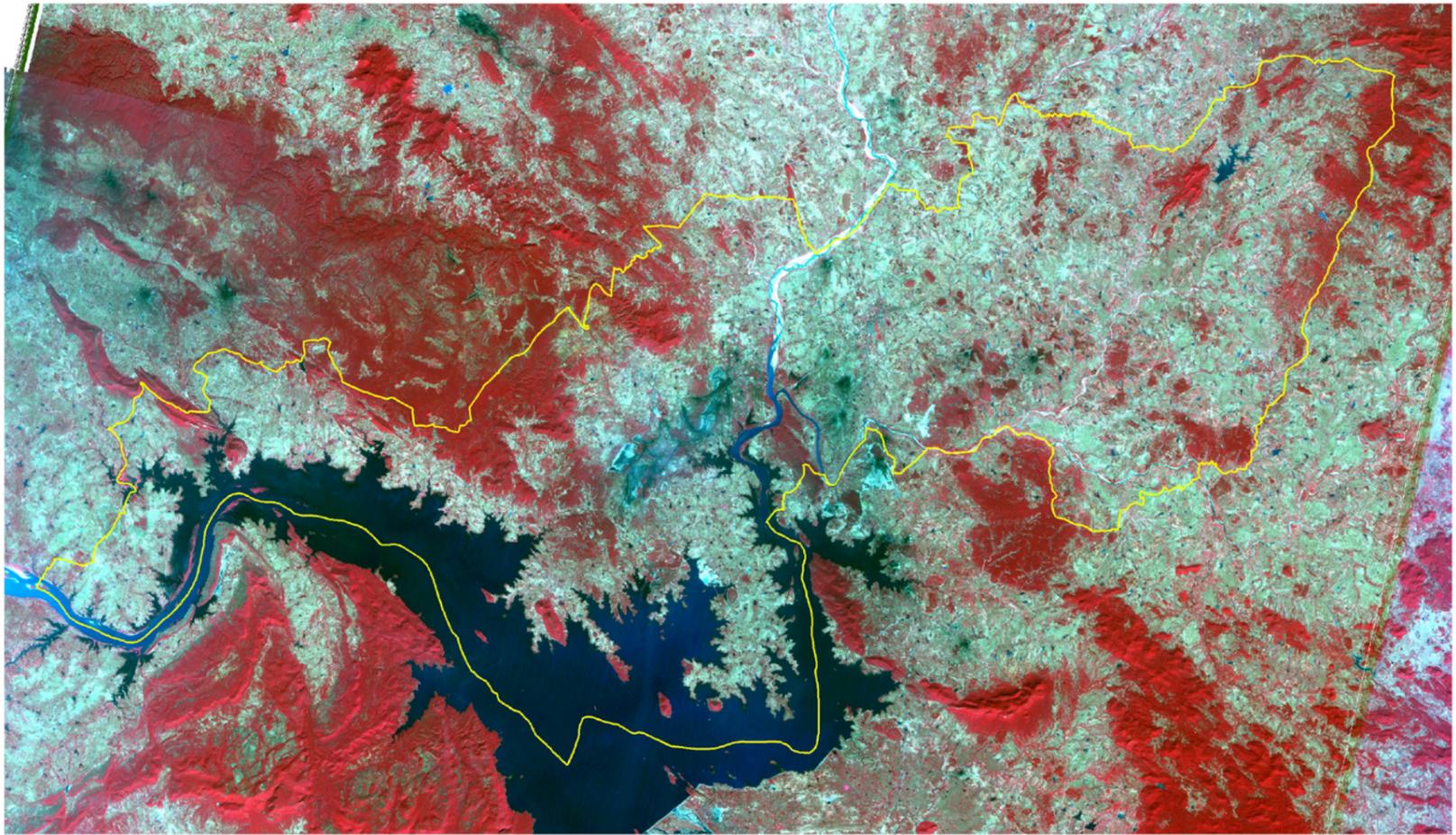
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Sponsored By :
Ministry of Environment and Forests
Government of India



7.1.3 Sambalpur

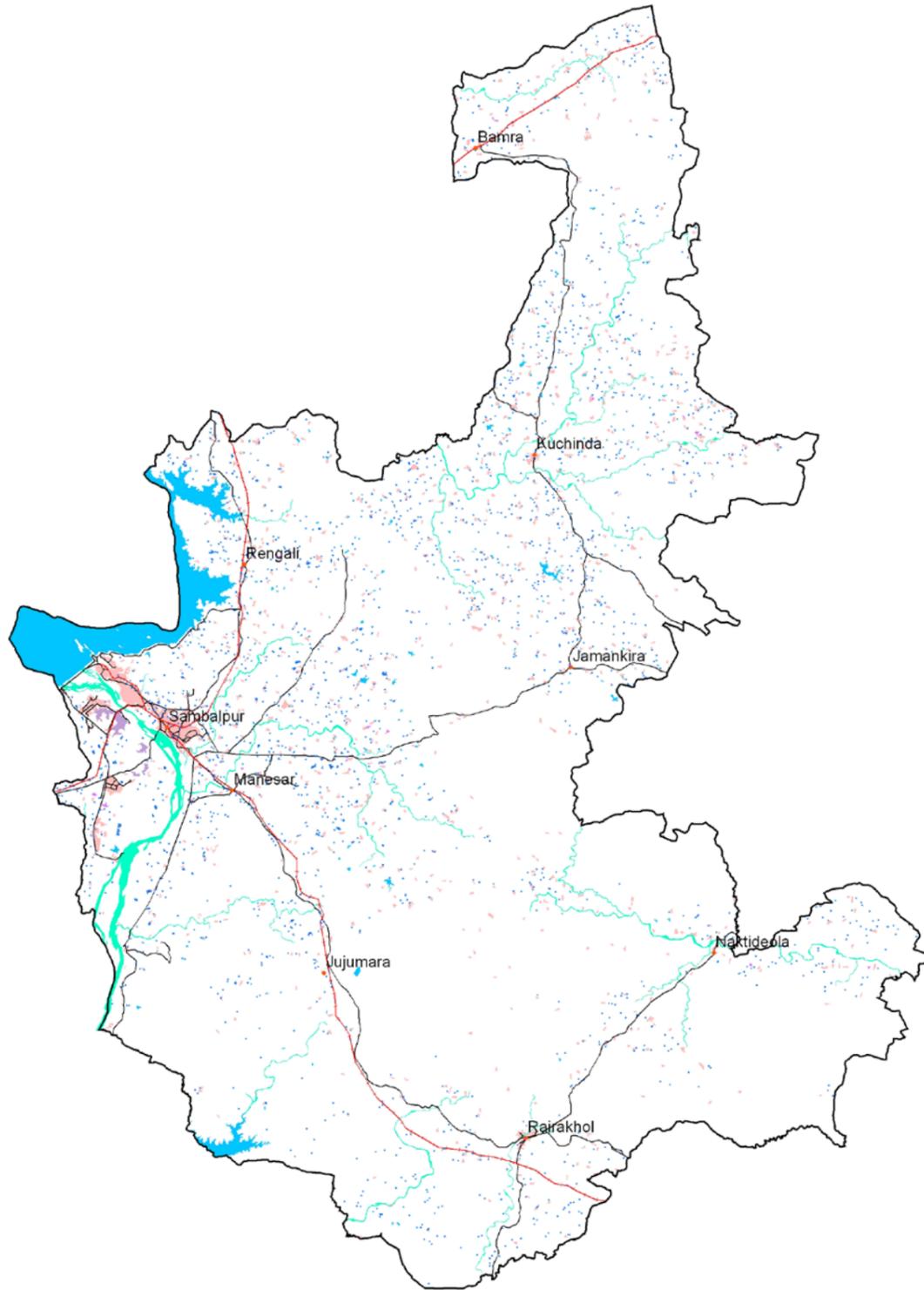
The total geographical area of Sambalpur district is 6702 sq km with an estimated . The wetland area is estimated to be 26511 ha (Table 9). The number of wetlands mapped are 556 and in addition, 1789 wetlands smaller than 2.25 ha have also been detected totalling to 2345. The major wetland types are Reservoir/Barrage (14566 ha) constituting about 55 per cent of wetland area followed by River/Stream (8066 ha) and Tank/Pond (1384 ha). Assuming that the small wetlands (<2.25 ha) are on average of 1 ha each, the area (about 7 %) accounted by them becomes significant in the district. A 27 per cent reduction on open water spread is observed in the district from post-monsoon (23786 ha) to pre-monsoon (17261 ha). Aquatic vegetation has shown about 7 fold increase from post-monsoon (954 ha) to pre-monsoon (6842 ha). Open water is dominantly moderate occupying 21912 ha out of 23789 ha of open water in post-monsoon. Low turbidity has not been observed in post-monsoon but 1874 ha of open water was observed to be highly turbid. Moderate turbidity (13676 ha) continued to dominate the open water in pre-monsoon also followed by high (2602 ha) and low (983 ha).

Table 9: Area estimates of wetlands in Sambalpur district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	25	156	0.59	42	42
6	1106	River/Stream	58	8066	30.43	8048	7411
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	136	14566	54.94	14203	8330
8	1202	Tanks/Ponds	332	1384	5.22	943	928
9	1203	Waterlogged	5	550	2.07	550	550
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	556	24722	93.25	23786	17261
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	556	24722	93.25	23786	17261
		Wetlands (<2.25 ha)	1789	1789	6.75	-	-
		Total	2345	26511	100.00	23786	17261

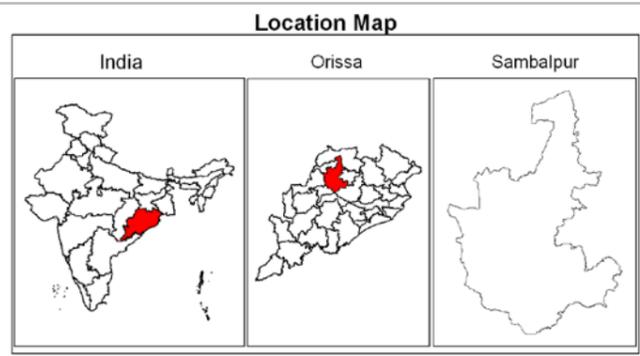
Area under Aquatic Vegetation	954	6842
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Area under turbidity levels		
Low	-	983
Moderate	21912	13676
High	1874	2602



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

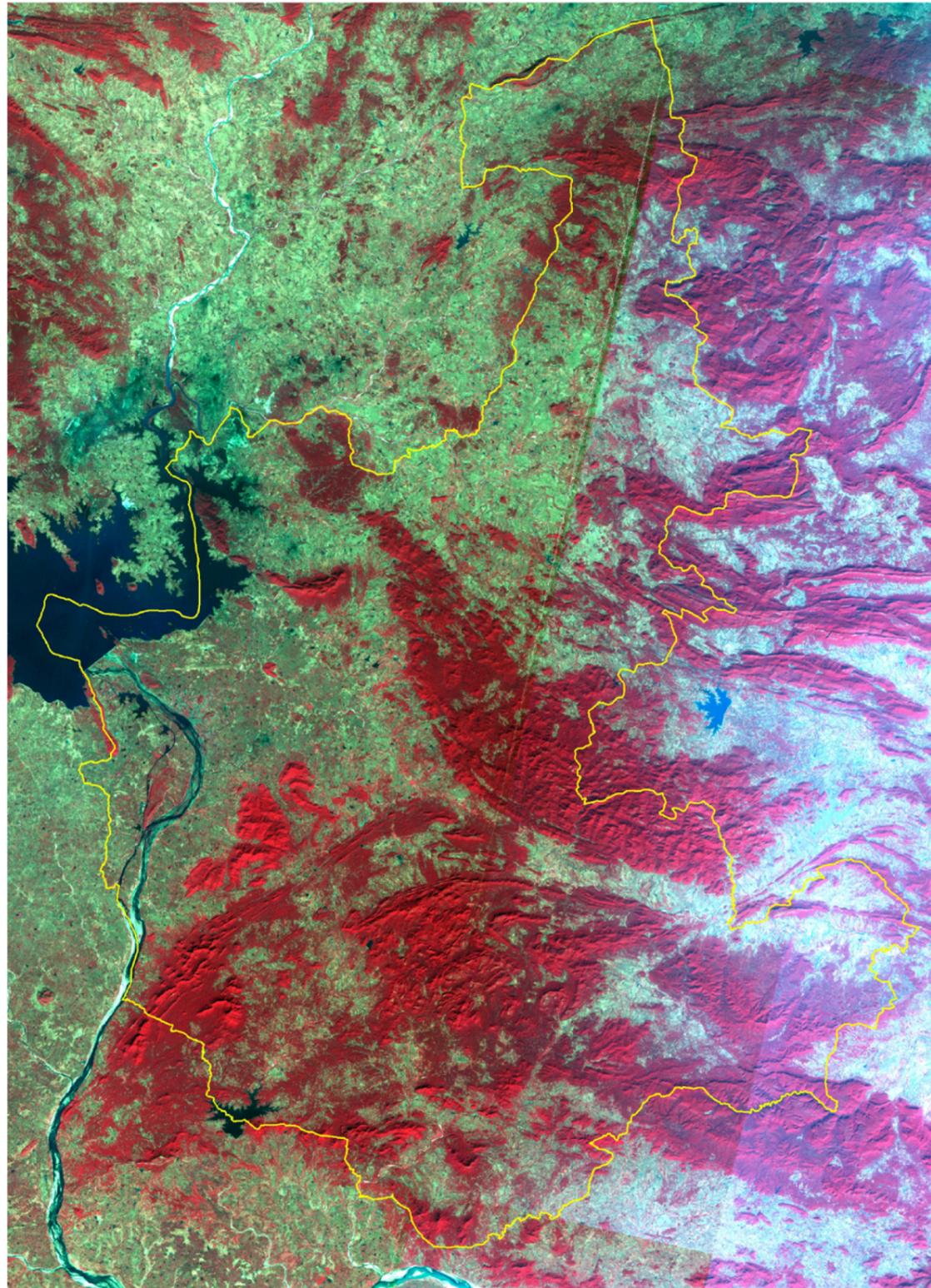
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
 Space Applications Centre (ISRO), Ahmedabad
 and
 Orissa Space Applications Centre, Bhubaneswar

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 Ministry of Environment and Forests
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7.1.4 Debagarh

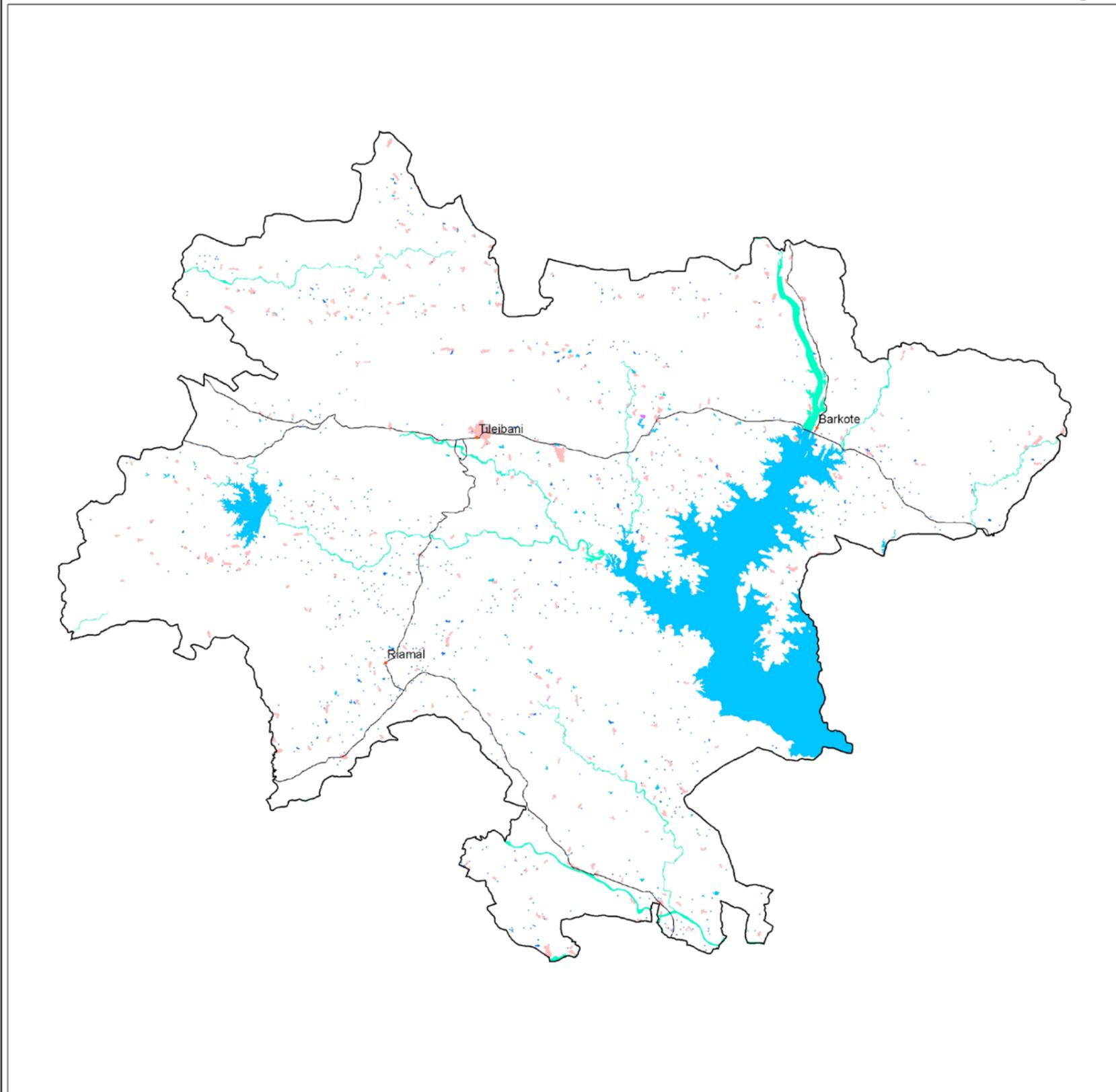
The total geographical area of Debagarh district is 2781 sq km with about 0.2 per cent under wetlands. The district comprises 1031 wetlands including 869 <2.25 ha shown as point features. The wetland area is estimated to be 25025 ha (Table 10). The major wetland types are Reservoir/Barrage that accounts for about 85 per cent of wetland extent followed by River/Stream (2681 ha), which constitutes about 11 per cent of area under wetlands. Open water extent of wetlands in the district has shown a steep reduction of about 37 per cent from 23900 ha to 15343 ha in post- and pre-monsoon seasons. This reduction is mainly because of Reservoir/Barrage category as revealed in the Table 11. Turbidity assessment carried out for open water is observed to be dominated by moderate level (19449 ha) in post-monsoon followed by low and high. However, it has shown a reduction to 6355 ha in pre-monsoon followed by low and high.

Table 10: Area estimates of wetlands in Debagarh district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	0	0	0.00	0	0
2	1102	Ox-bow lakes/ Cut-off meanders	0	0	0.00	0	0
3	1103	High altitude wetlands	0	0	0.00	0	0
4	1104	Riverine wetlands	0	0	0.00	0	0
5	1105	Waterlogged	4	20	0.08	6	6
6	1106	River/Stream	42	2681	10.71	2679	2083
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	62	21264	84.97	21114	13153
8	1202	Tanks/Ponds	51	182	0.73	92	92
9	1203	Waterlogged	3	9	0.04	9	9
10	1204	Salt pans	0	0	0.00	0	0
		Total - Inland	162	24156	96.53	23900	15343
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	0	0	0.00	0	0
12	2102	Creeks	0	0	0.00	0	0
13	2103	Sand/Beach	0	0	0.00	0	0
14	2104	Intertidal mud flats	0	0	0.00	0	0
15	2105	Salt Marsh	0	0	0.00	0	0
16	2106	Mangroves	0	0	0.00	0	0
17	2107	Coral Reefs	0	0	0.00	0	0
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	0	0	0.00	0	0
19	2202	Aquaculture ponds	0	0	0.00	0	0
		Total - Coastal	0	0	0.00	0	0
		Sub-Total	162	24156	96.53	23900	15343
		Wetlands (<2.25 ha)	869	869	3.47	0	0
		Total	1031	25025	100.00	23900	15343

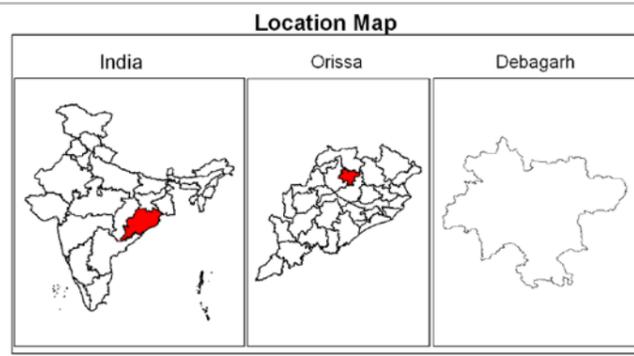
Area under Aquatic Vegetation	289	8250
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Area under turbidity levels		
Low	3612	8784
Moderate	19449	6355
High	839	204



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

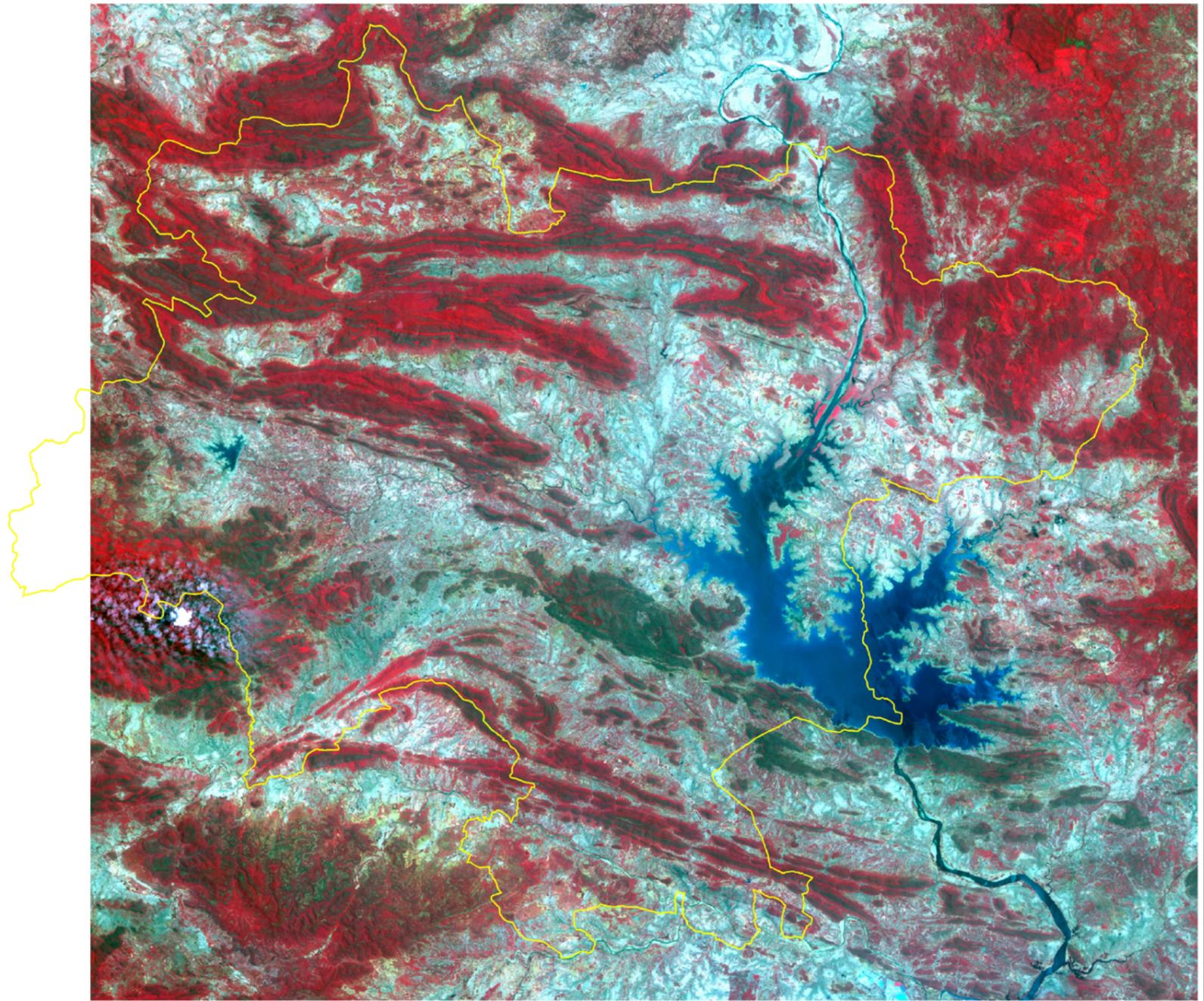
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
 Space Applications Centre (ISRO), Ahmedabad
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 Orissa Space Applications Centre, Bhubaneswar

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7.1.5 Sundargarh

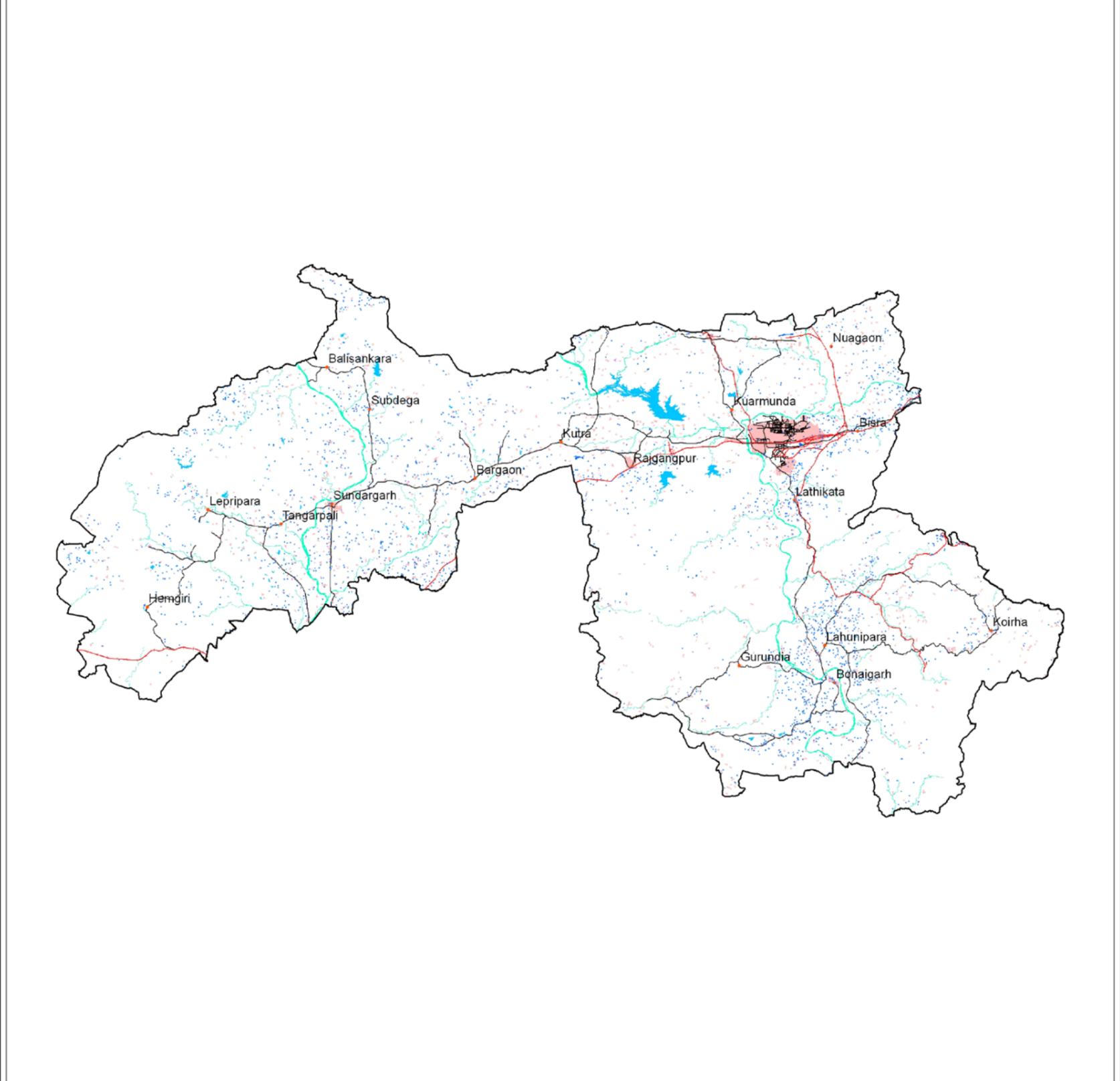
The total geographical area of Sundargarh district is 9942 sq km. The wetland area is estimated to be 20725 ha (Table 11), which constitutes about 3 per cent of wetland extent in the state. Inventory estimates the number of wetlands to 2922, which includes a major number (2439) wetlands smaller than 2.25 ha. The major wetland types are River/Stream (11165 ha) comprising of about 54 per cent of wetland extent followed by Reservoir/Barrage (5854 ha), Tank/Ponds (1114 ha). The small wetlands occupy significant area (about 12 %). Compared to the preceding districts, Sundargarh has shown lower seasonal reduction (14 %) in open water extent. It was estimated to be 17336 ha in post-monsoon and found to have reduced to 14989 ha in pre-monsoon. Aquatic vegetation has shown almost 2.5 times increase from post-monsoon (1005 ha) to 2495 ha in pre-monsoon. Turbidity was dominated by moderate level followed by low and high in both the seasons.

Table 11: Area estimates of wetlands in Sundargarh district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	3	15	0.07	-	-
5	1105	Waterlogged	34	138	0.67	35	35
6	1106	River/Stream	56	11165	53.87	11160	10303
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	144	5854	28.25	5398	3910
8	1202	Tanks/Ponds	246	1114	5.38	743	741
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	483	18286	88.23	17336	14989
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	483	18286	88.23	17336	14989
		Wetlands (<2.25 ha)	2439	2439	11.77	-	-
		Total	2922	20725	100.00	17336	14989

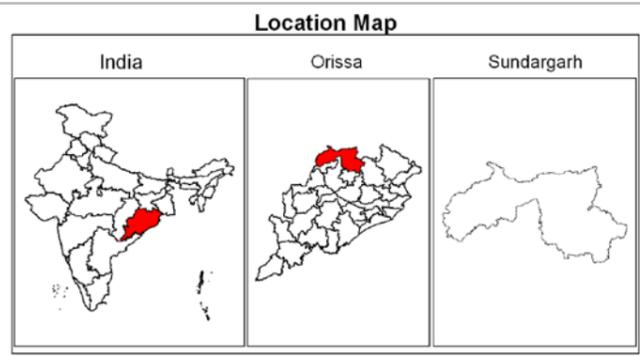
Area under Aquatic Vegetation	1005	2495
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Area under turbidity levels		
Low	5574	3475
Moderate	11268	9754
High	494	1760



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

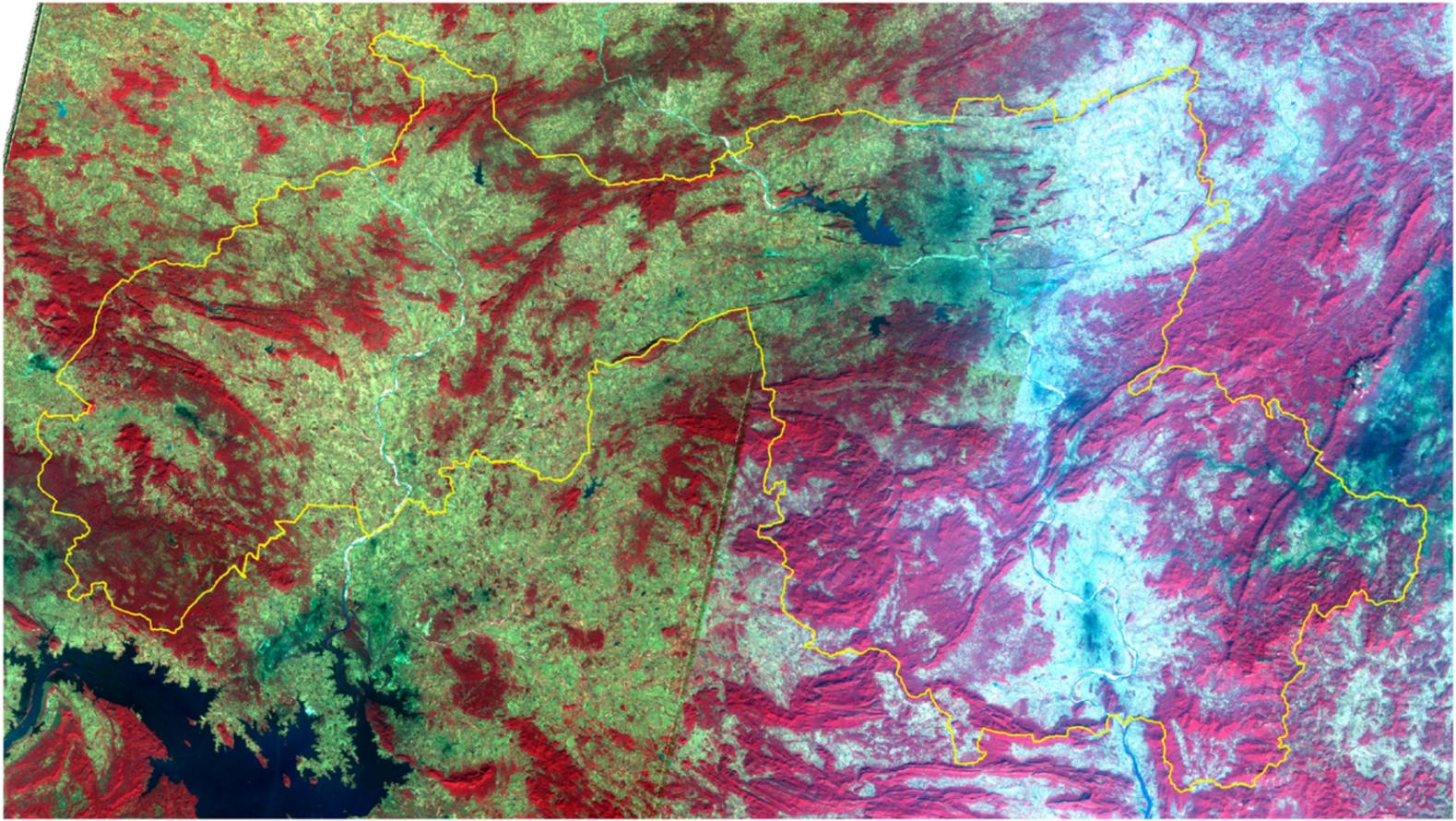
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
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7.1.6 Kendujhar

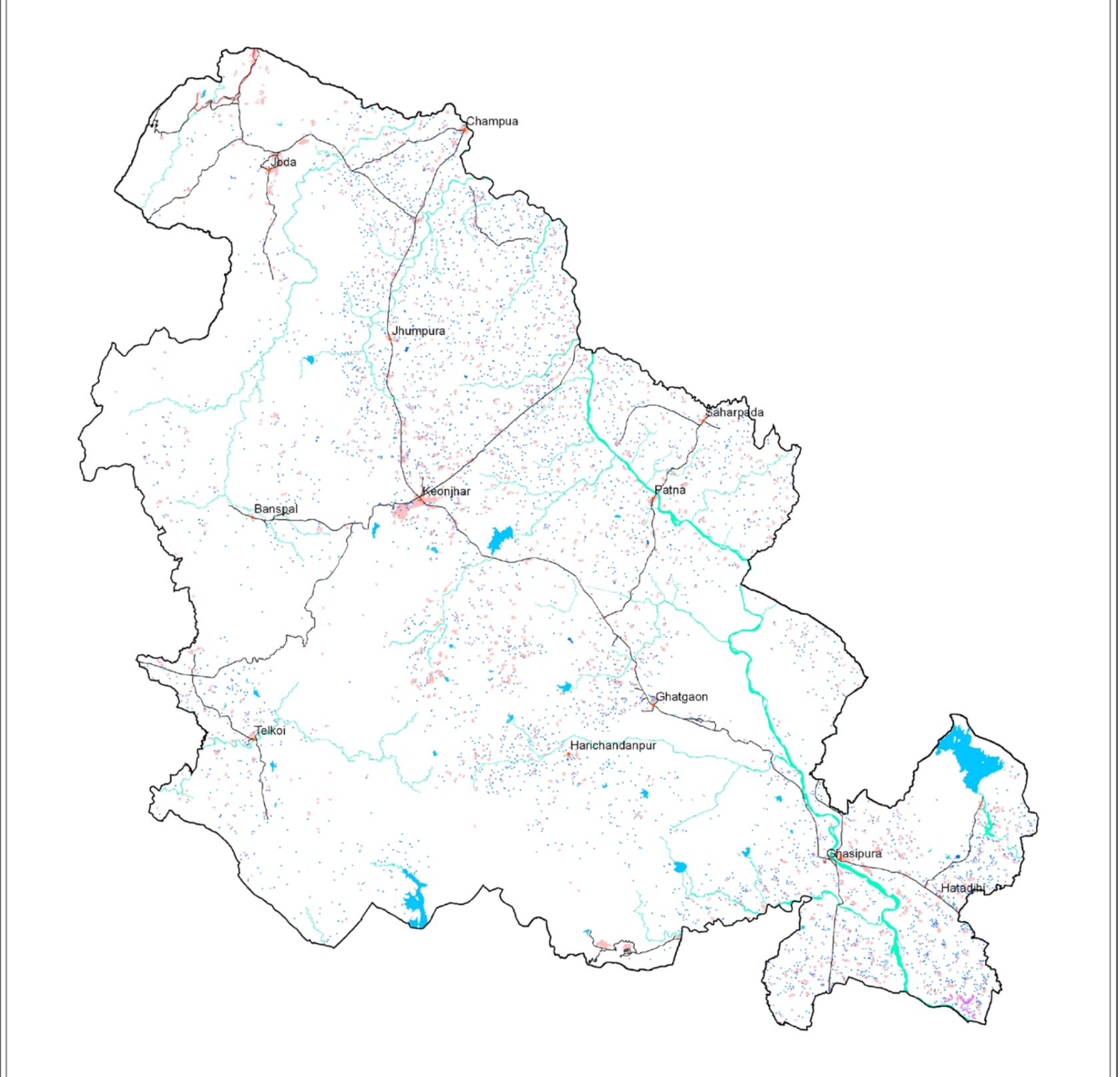
The total geographical area of Kendujhar district is 8336 sq km. The district comprises of 4676 wetlands occupying an estimated area of 21089 ha. This includes 4390 wetlands smaller than 2.25 ha (Table 12). Wetlands of the district constitute about 3 per cent of total wetland area in the state. The major wetland types are River/Stream (about 49 %) comprising 10200 ha of area followed by Reservoir/Barrage (5649 ha). The small wetlands constitutes about 21 per cent, which is very significant. Open water extent has shown a reduction of about 23 per cent from post-monsoon (16143 ha) to 12451 ha in pre-monsoon season. Aquatic vegetation has shown a seven-fold increase from 421 ha to 3143 ha in post-monsoon and pre-monsoon. Overall turbidity of open water is observed to be of moderate in both the seasons followed by low and high. However, high turbidity has not been observed in pre-monsoon.

Table 12: Area estimates of wetlands in Kendujhar District Orissa

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	5	70	0.33	70	70
5	1105	Waterlogged	23	244	1.16	161	161
6	1106	River/Stream	62	10200	48.37	10037	9068
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	58	5649	26.79	5425	2709
8	1202	Tanks/Ponds	138	536	2.54	450	443
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	286	16699	79.18	16143	12451
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	286	16699	79.18	16143	12451
		Wetlands (<2.25 ha)	4390	4390	20.82	-	-
		Total	4676	21089	100.00	16143	12451

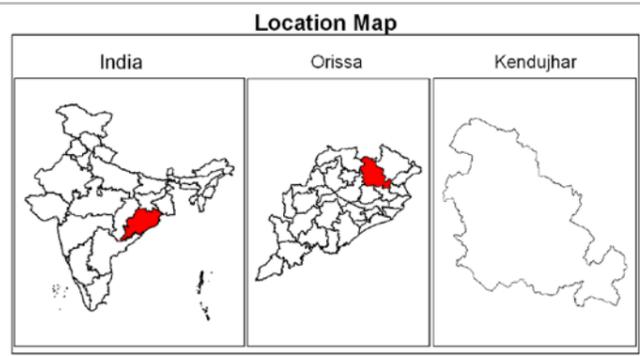
Area under Aquatic Vegetation	421	3143
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Area under turbidity levels		
Low	3516	2428
Moderate	11899	10023
High	728	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

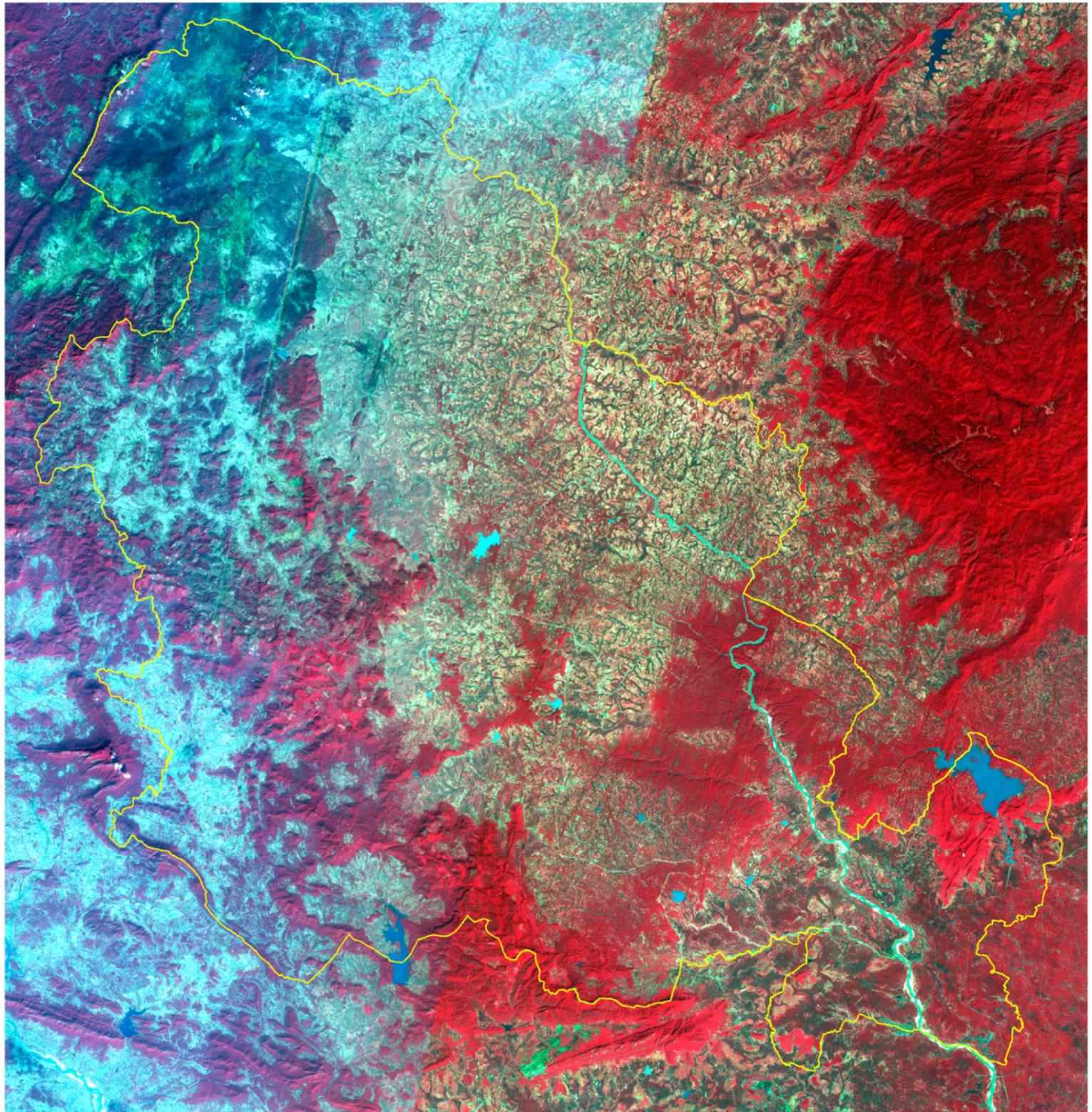
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
 Space Applications Centre (ISRO), Ahmedabad
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 Orissa Space Applications Centre, Bhubaneswar

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7.1.7 Mayurbhanj

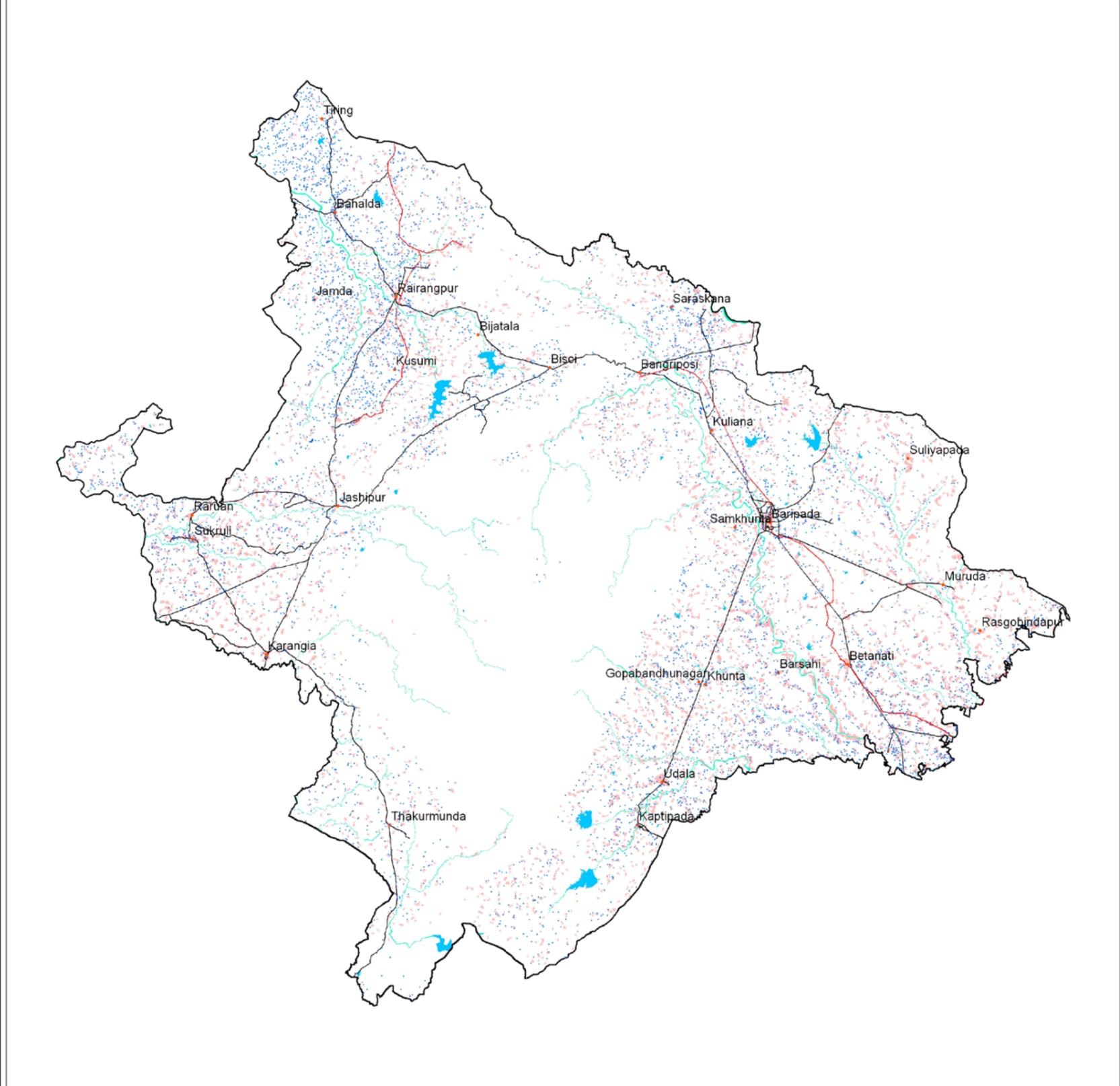
The total geographical area of Mayurbhanj district is 10418 sq km with an estimated area under wetland of 19650 ha accounting for about 3 per cent of the geographical area of the district (Table 6). The district comprises 6548 wetlands (Table 13), which include 6196 small wetlands of < 2.25 ha. These small wetlands account for a significant area under wetlands (about 32 %) assuming that each one would be one of hectare area. The major wetland types are River/Stream (7812 ha) and Reservoir/Barrage (4811 ha) comprising about 40 and 25 per cent respectively of the total wetland in the district. Even though Tank/Pond are largest in number (156 out 352) accounts for about only 3 per cent in terms of area (5936 ha). Area under open water (12876 ha) remained at 96 per cent of the wetland extent in the post-monsoon, which had reduced to 11100 ha in pre-monsoon with a seasonal change of about 13 per cent. Aquatic vegetation has shown more than a four-fold increase from post-monsoon (603 ha) to pre-monsoon (2323 ha). Open water is predominantly moderate in turbidity followed by low in both the seasons. High turbidity is conspicuously absent in both the seasons.

Table 13: Area estimates of wetlands in Mayurbhanj district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Area in ha	
						Open Water Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	4	55	0.28	55	55
3	1103	High altitude wetlands	-	-	0.00	-	-
4	1104	Riverine wetlands	3	10	0.05	6	6
5	1105	Waterlogged	35	169	0.86	152	152
6	1106	River/Stream	76	7812	39.76	7808	7753
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	77	4811	24.48	4352	2631
8	1202	Tanks/Ponds	156	593	3.02	499	499
9	1203	Waterlogged	1	4	0.02	4	4
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	352	13454	68.47	12876	11100
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	352	13454	68.47	12876	11100
		Wetlands (<2.25 ha)	6196	6196	31.53	-	-
		Total	6548	19650	100.00	12876	11100

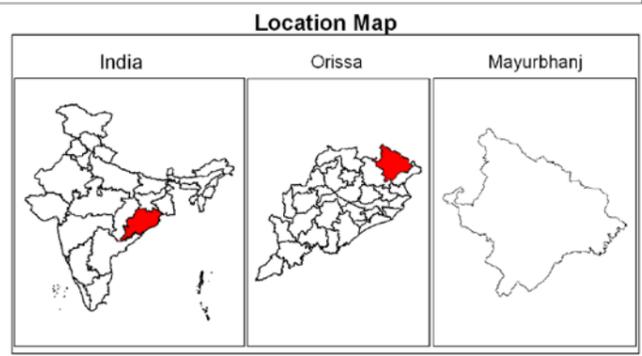
Area under Aquatic Vegetation	603	2323
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Area under turbidity levels		
Low	3273	2383
Moderate	9603	8717
High	-	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

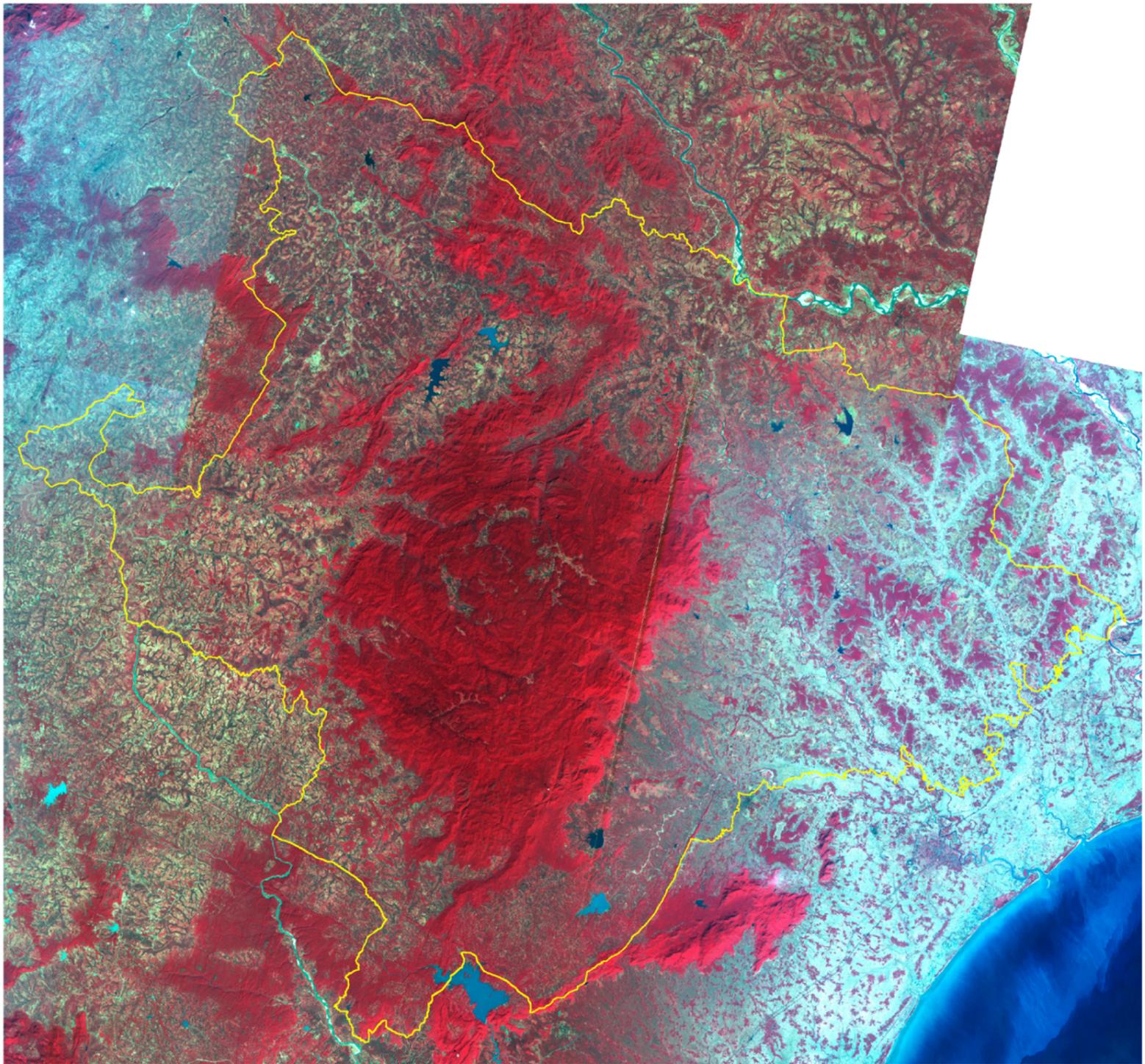


0 5 10 20 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Orissa Space Applications Centre, Bhubaneswar

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7.1.8 Baleswar

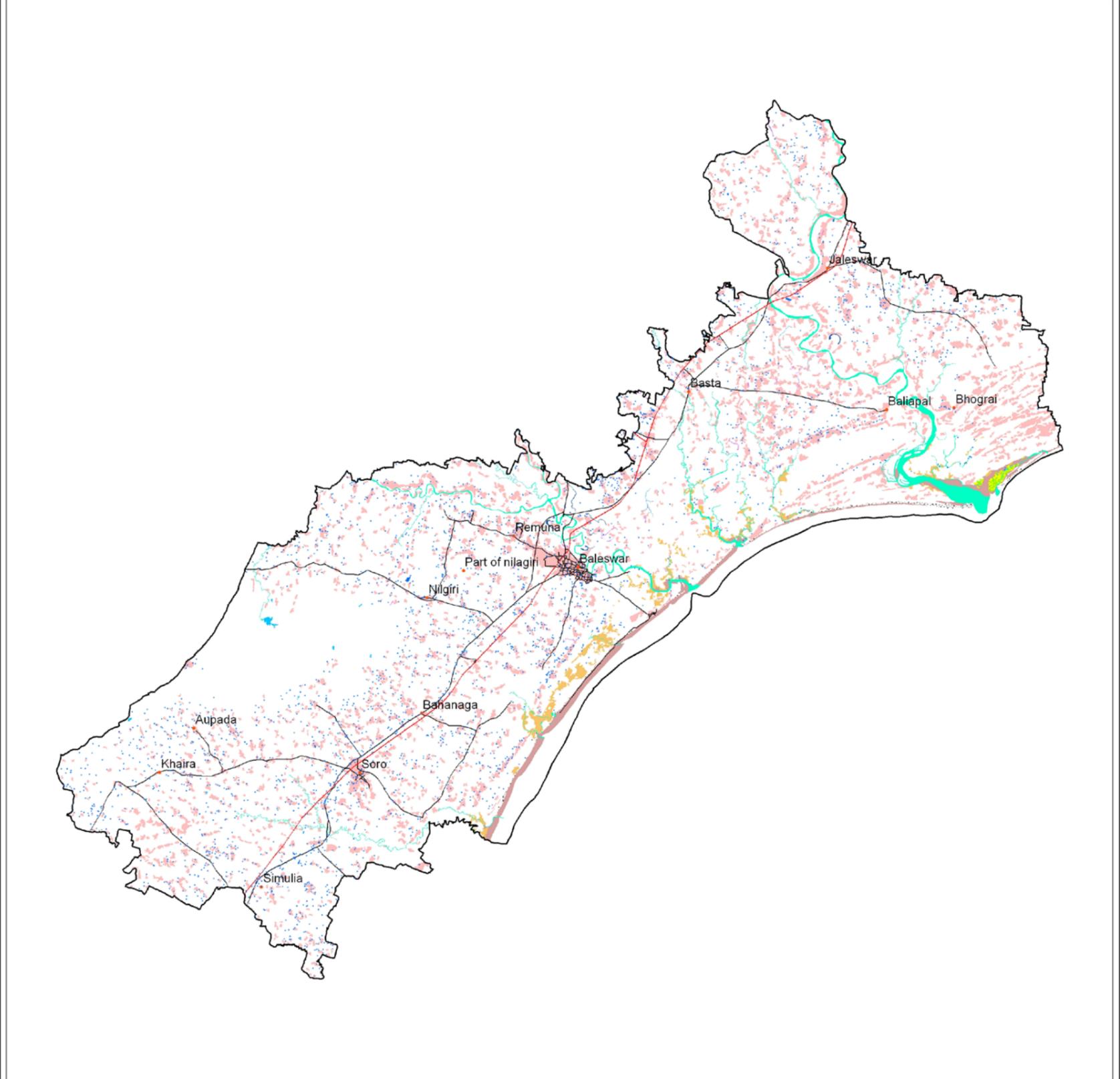
Baleswar district has a geographical area of 3806 sq km with about 3 per cent under wetlands. The wetland area is estimated to be 15923 ha (Table 14). District comprises of 3536 wetlands including 3138 wetlands smaller than 2.25 ha. Major wetland categories are River/Stream (6375 ha) and Intertidal Mudflats (4126 ha) accounting for about 33 and 22 per cent of wetlands of the district. Aquaculture ponds constitute a significant extent (3396 ha) along with small wetlands of <2.25ha (about 16 %). Area under aquatic vegetation is insignificant, which constitute 113 ha and 141 ha in post- and pre-monsoon seasons. Open water constituted about 65 per cent of wetland area in post-monsoon (10387 ha) and has shown a marginal seasonal reduction in pre-monsoon (10104 ha). Moderated turbidity is prevalent in open water in both the seasons followed by low turbidity. High turbidity has not been exhibited by the open water in both the seasons.

Table 14: Area estimates of wetlands in Baleswar district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	6	110	0.58	110	110
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	13	147	0.77	147	137
5	1105	Waterlogged	19	134	0.70	130	130
6	1106	River/Stream	76	6375	33.45	6361	6116
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	9	124	0.65	80	57
8	1202	Tanks/Ponds	34	148	0.78	132	127
9	1203	Waterlogged	1	31	0.16	31	31
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	158	7069	37.09	6991	6708
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	12	943	4.95	-	-
14	2104	Intertidal mud flats	39	4126	21.65	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	8	389	2.04	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	181	3396	17.82	3396	3396
		Total - Coastal	240	8854	46.45	3396	3396
		Sub-Total	398	15923	83.54	10387	10104
		Wetlands (<2.25 ha)	3138	3138	16.46	-	-
		Total	3536	19061	100.00	10387	10104

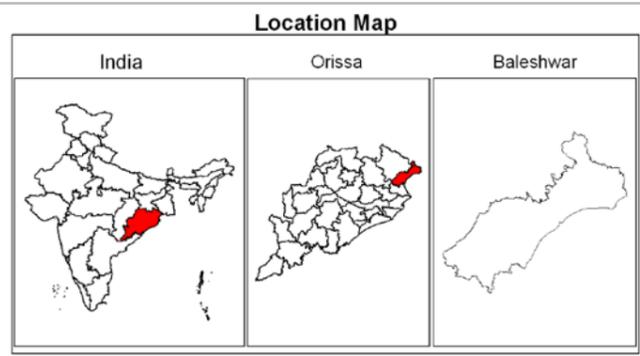
Area under Aquatic Vegetation	113	141
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Area under turbidity levels		
Low	82	2194
Moderate	10305	7910
High	-	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

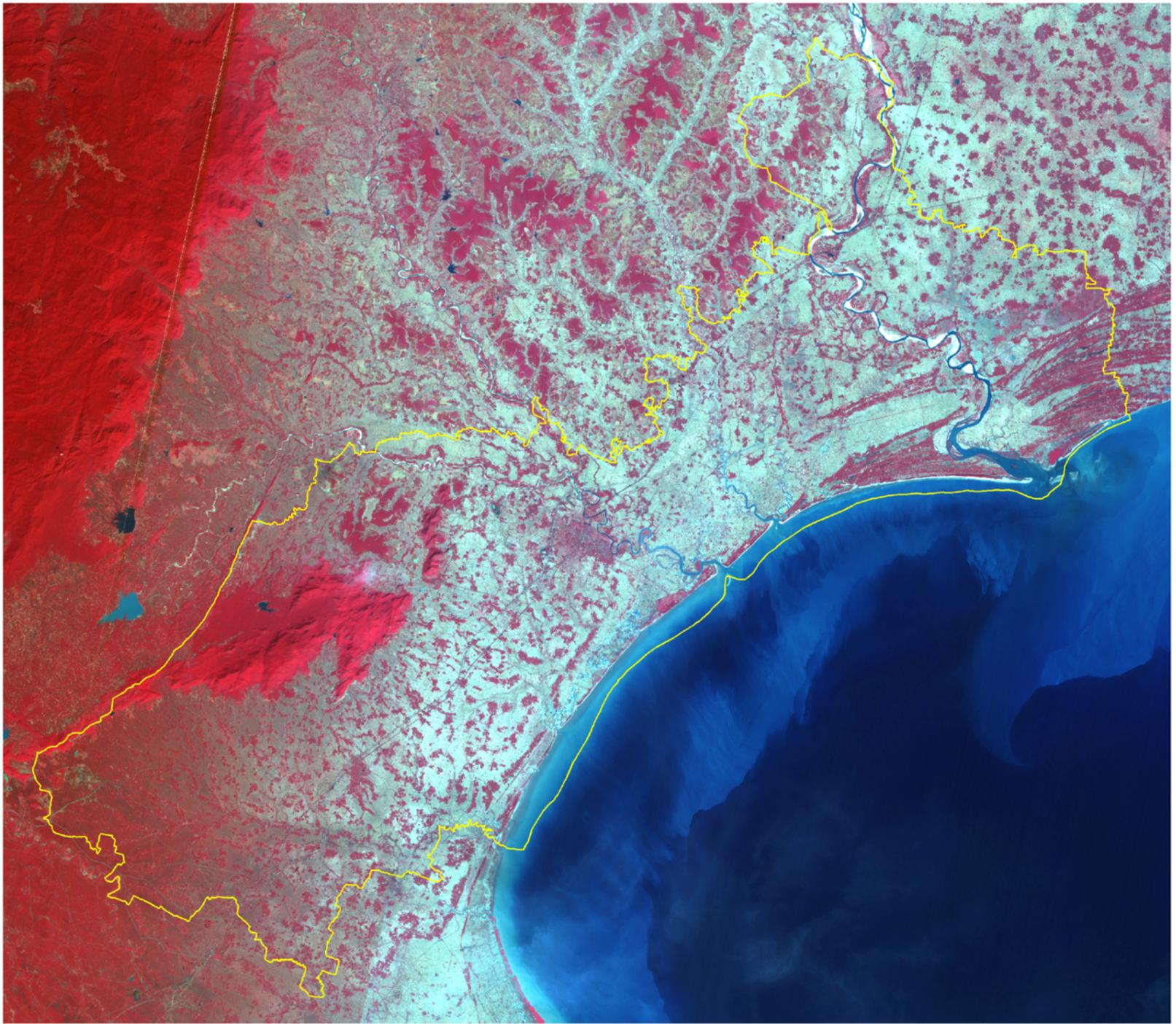
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

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7.1.9 Bhadrak

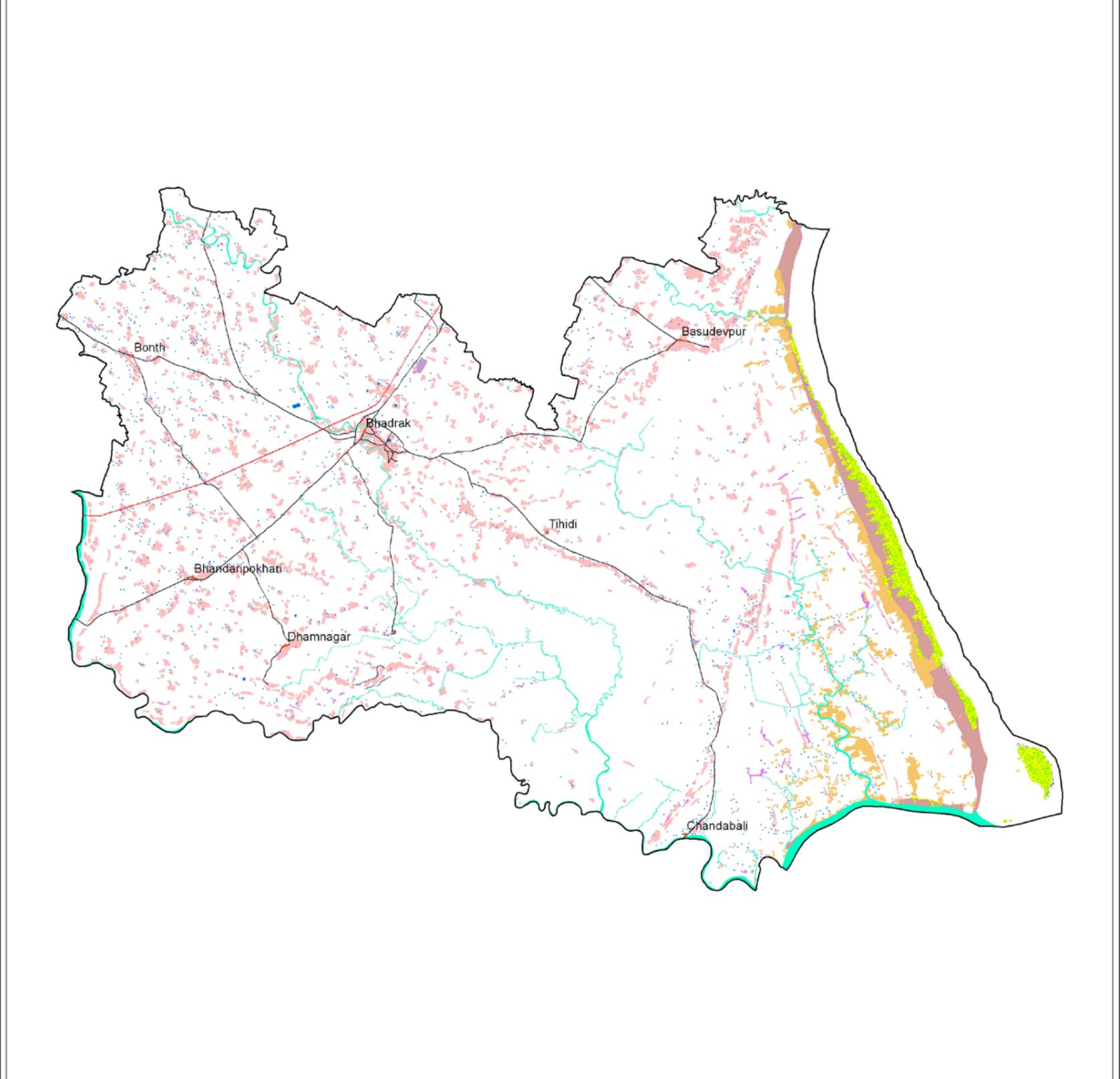
The total geographical area of Bhadrak district is 2788 sq km with about 3 per cent area under wetlands. The wetland area is estimated to be 2788 ha (Table 15). The mapped wetlands include 370 of the size > 2.25 ha and 2038 that are < 2.25 ha, which have been shown as point features. Major wetland categories are River/Stream (4989 ha) comprising of about 26 per cent followed by Aquaculture Ponds (~ 24 %), Intertidal Mudflats (~ 20 %) and Mangroves (~ 15 %). The small wetland (<2.25 ha) have significant contribution in terms their extent (~ 11 %). The extent of open water was estimated to be 9886 ha in post-monsoon and has not shown any significant seasonal reduction. Aquatic vegetation accounted for a small per cent (~1 %) of the wetland area and remained unchanged in both the seasons. Turbidity predominantly moderate in post-monsoon (9859 ha) as well as in pre-monsoon (8124 ha). Marginal extent (27 ha) was observed under high turbidity in post-monsoon without any low turbidity rating. On the other hand pre-monsoon season has not shown high turbidity and instead comprised low turbid area of 1589 ha.

Table 15: Area estimates of wetlands in Bhadrak district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Area in ha	
						Open Water Post-monsoon area	Open Water Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	3	30	0.16	30	30
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	2	22	0.12	22	22
5	1105	Waterlogged	35	278	1.46	195	195
6	1106	River/Stream	48	4989	26.23	4989	4816
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	11	51	0.27	51	51
9	1203	Waterlogged	1	72	0.38	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	100	5442	28.62	5287	5114
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	3	114	0.60	-	-
14	2104	Intertidal mud flats	11	3879	20.40	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	19	2945	15.49	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	237	4599	24.18	4599	4599
		Total - Coastal	270	11537	60.67	4599	4599
		Sub-Total	370	16979	89.28	9886	9713
		Wetlands (<2.25 ha)	2038	2038	10.72	-	-
		Total	2408	19017	100.00	9886	9713

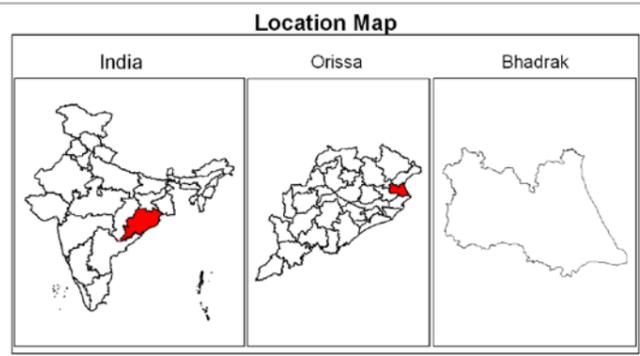
Area under Aquatic Vegetation	239	239
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Area under turbidity levels		
Low	-	1589
Moderate	9859	8124
High	27	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

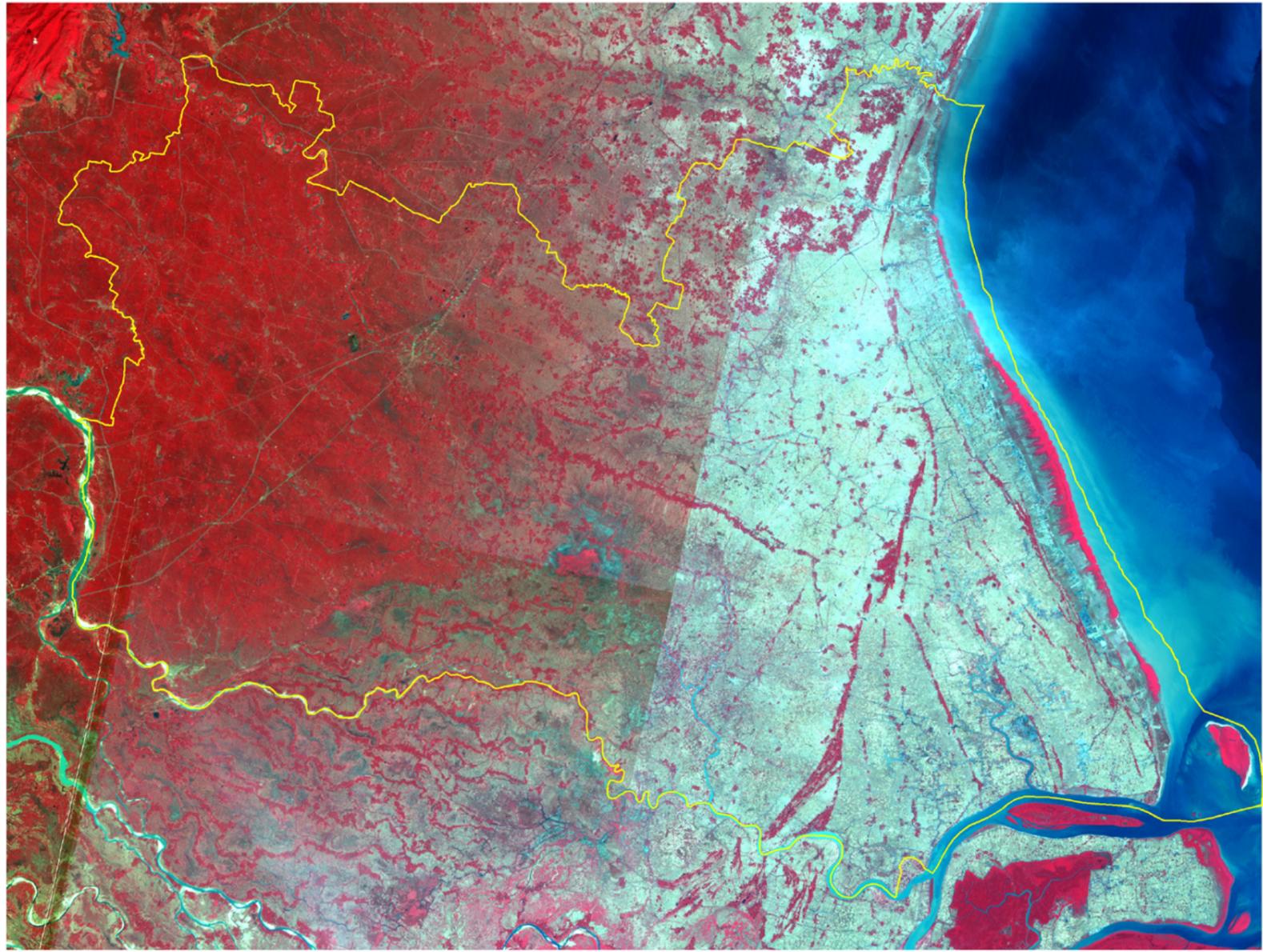
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
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 - International Boundary



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7.1.10 Kendrapara

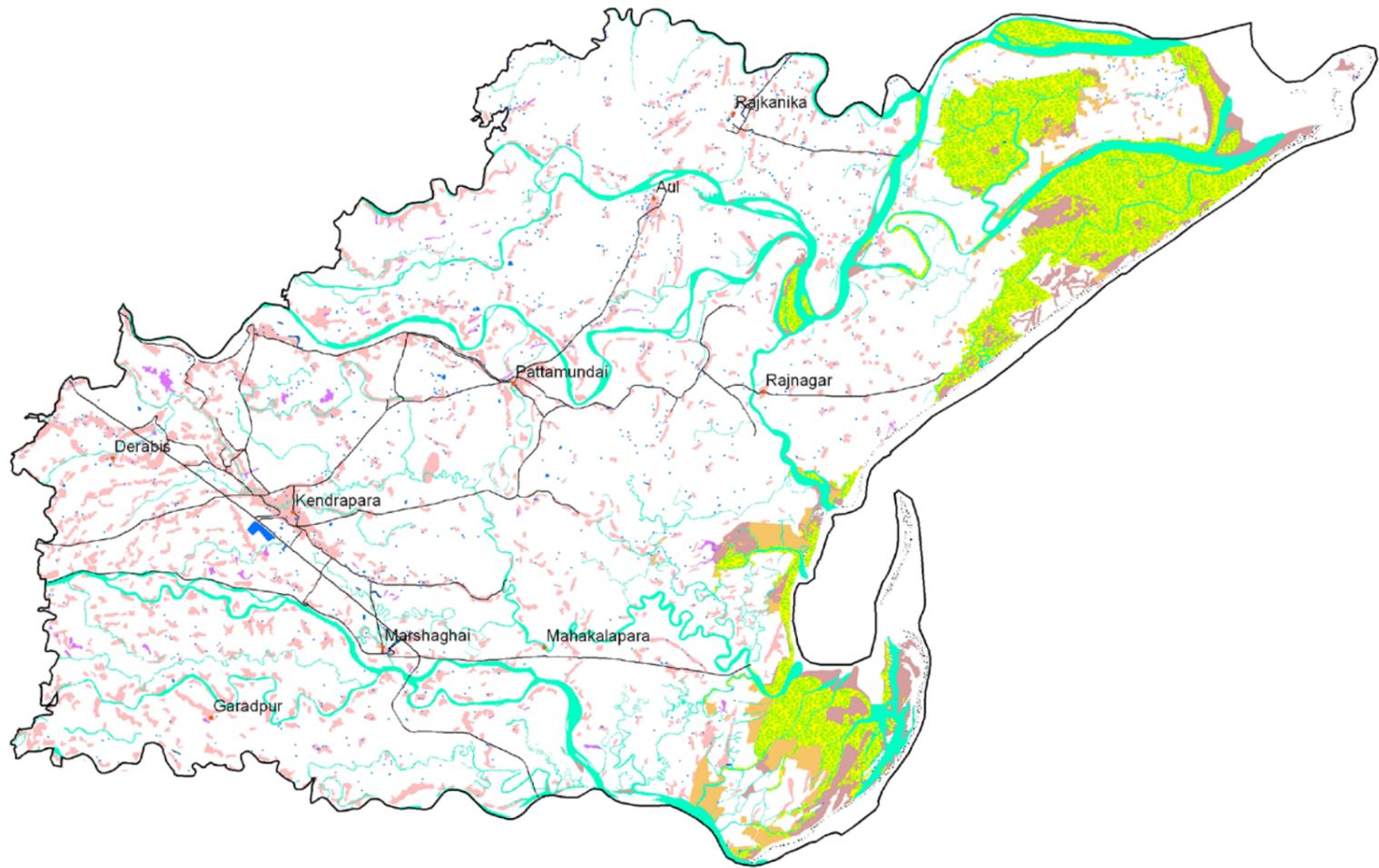
The total geographic area of Kendrapara district is 2546 sq km. The wetland area estimated is 49284 ha (Table 16), which is about 7 per cent of the area under wetlands for this district. In addition to 526 wetlands mapped in the district, 1074 wetlands of < 2.25 ha have also been discerned as point feature. The major wetland types are Mangrove (19277 ha) followed by River/stream (17934 ha) intertidal Mudflats (5249 ha). Open water has shown a marginal decrease in the extent from 21516 ha in post-monsoon to 21413 ha in pre-monsoon. While the extent of aquatic vegetation remained unchanged in both the seasons (791 ha). Open water was observed to be dominated by moderate turbidity in both the seasons followed by low. However, pre-monsoon open water extent has not exhibited high turbidity.

Table 16: Area estimates of wetlands in Kendrapara district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	8	47	0.10	7	6
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	2	6	0.01	6	6
5	1105	Waterlogged	62	589	1.20	215	215
6	1106	River/Stream	102	17934	36.39	17770	17668
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	32	198	0.40	170	170
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	206	18774	38.09	18168	18065
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	20	1562	3.17	-	-
14	2104	Intertidal mud flats	103	5249	10.65	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	103	19277	39.11	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	94	3348	6.79	3348	3348
		Total - Coastal	320	29436	59.73	3348	3348
		Sub-Total	526	48210	97.82	21516	21413
		Wetlands (<2.25 ha)	1074	1074	2.18	-	-
		Total	1600	49284	100.00	21516	21413

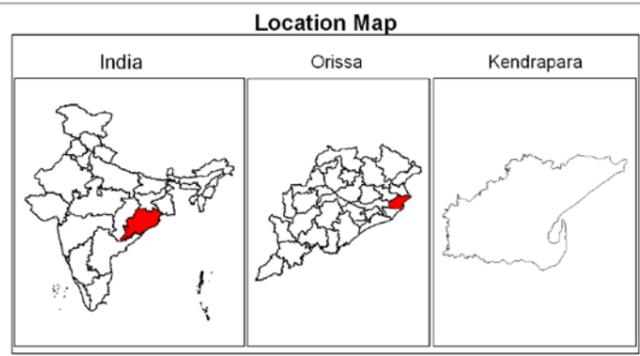
Area under Aquatic Vegetation	791	791
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Area under turbidity levels		
Low	5988	6257
Moderate	15506	15156
High	22	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
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 - International Boundary



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7.1.11 Jagatsinghpur

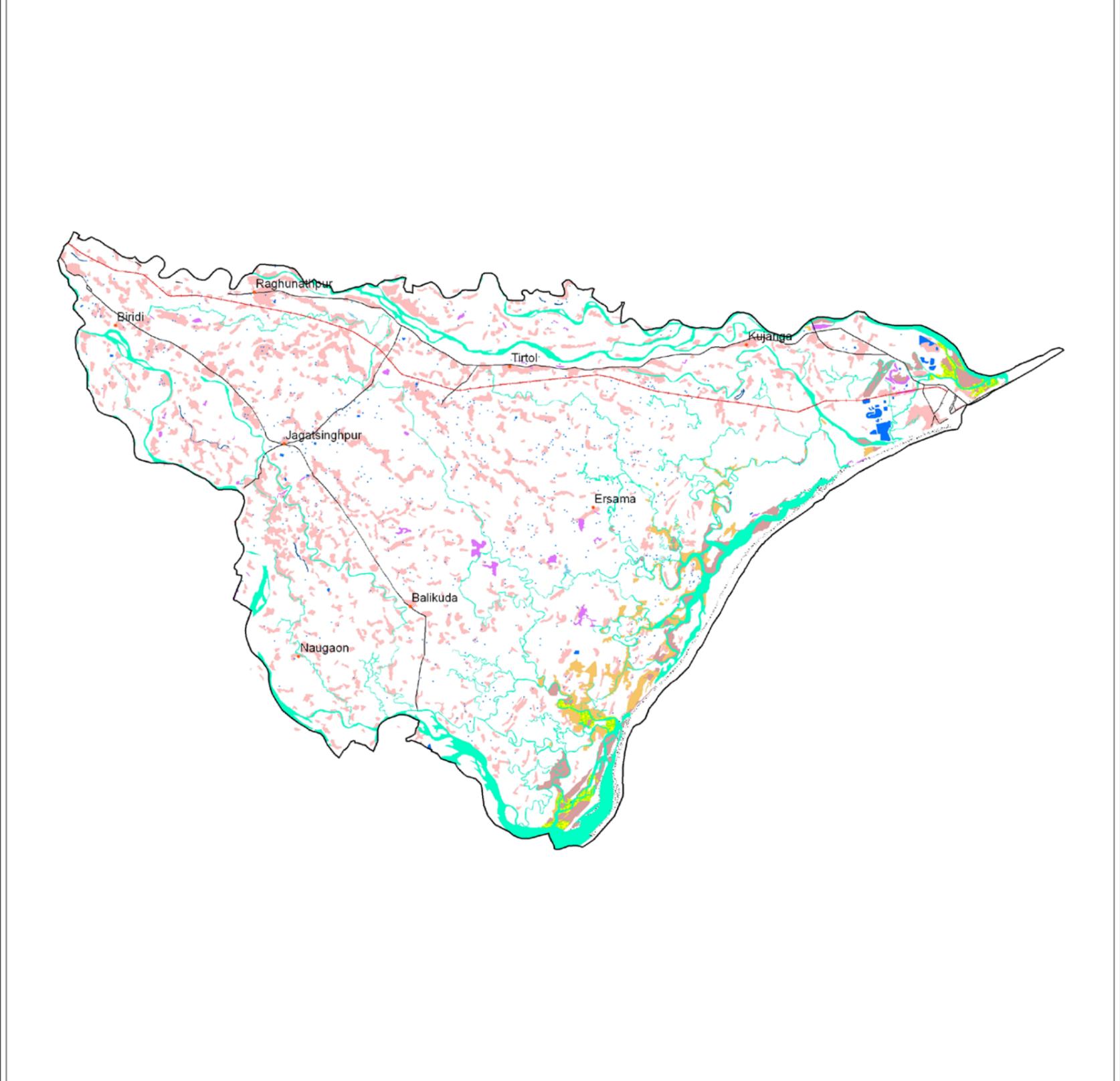
The total geographical area of Jagatsinghpur district is 1759 sq km. The wetland area is estimated to be 19691 ha. In spite of the presence of coastal wetlands like Intertidal Mudflats, Mangrove and Aquaculture Ponds the inland wetlands dominated in terms of extent accounting for about 65 per cent. Major wetland types are River/Stream (12153 ha), Intertidal Mudflats (2348 ha) and Aquaculture Ponds (2250 ha), which account for about 60 %,12 % and 11 % respectively. In addition to 360 wetlands larger than 2.25 ha, there are 695 wetlands those smaller than 2.25 ha. Open water extent of wetlands has shown a marginal decrease of 332 ha from post-monsoon (14760 ha) to pre-monsoon (14428 ha). Aquatic vegetation remained unchanged in its extent (801 ha) from post-monsoon to pre-monsoon. Moderate turbidity dominated the open water of the wetlands in this district in both seasons followed by low and high. However, high turbidity is not exhibited by the open water of the wetlands.

Table 17: Area estimates of wetlands in Jagatsinghpur district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	0	0	0.00	0	0
2	1102	Ox-bow lakes/ Cut-off meanders	8	83	0.41	63	63
3	1103	High altitude wetlands	0	0	0.00	0	0
4	1104	Riverine wetlands	3	37	0.18	14	14
5	1105	Waterlogged	38	638	3.13	286	286
6	1106	River/Stream	67	12153	59.61	12005	11673
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	0	0	0.00	0	0
8	1202	Tanks/Ponds	37	427	2.09	142	142
9	1203	Waterlogged	0	0	0.00	0	0
10	1204	Salt pans	0	0	0.00	0	0
		Total - Inland	153	13338	65.43	12510	12178
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	0	0	0.00	0	0
12	2102	Creeks	0	0	0.00	0	0
13	2103	Sand/Beach	11	971	4.76	0	0
14	2104	Intertidal mud flats	73	2348	11.52	0	0
15	2105	Salt Marsh	0	0	0.00	0	0
16	2106	Mangroves	33	784	3.85	0	0
17	2107	Coral Reefs	0	0	0.00	0	0
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	0	0	0.00	0	0
19	2202	Aquaculture ponds	90	2250	11.04	2250	2250
		Total - Coastal	207	6353	31.16	2250	2250
		Sub-Total	360	19691	96.59	14760	14428
		Wetlands (<2.25 ha)	695	695	3.41	0	0
		Total	1055	20386	100.00	14760	14428

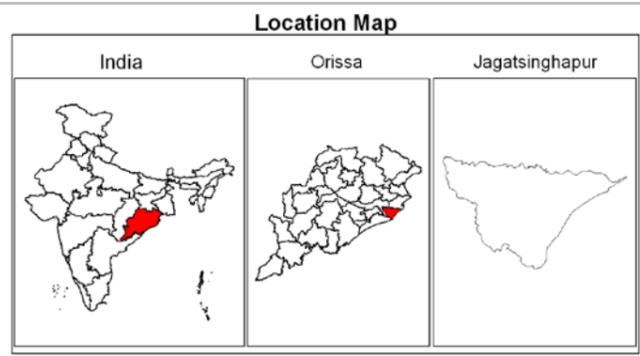
Area under Aquatic Vegetation	801	801
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Area under turbidity levels		
Low	2129	3948
Moderate	12624	10480
High	7	0



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
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7.1.12 Cuttack

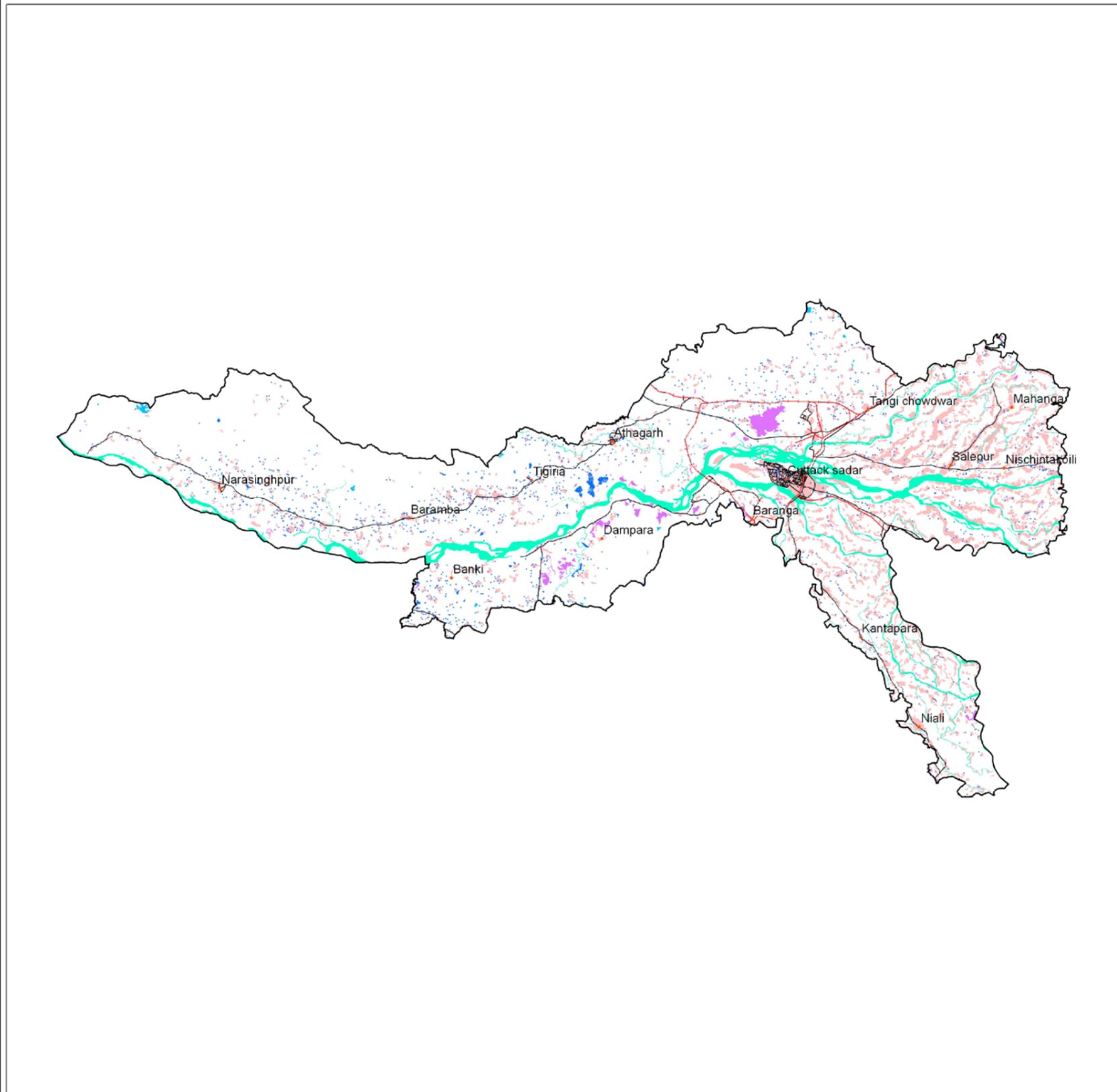
The total geographical area of Cuttack district is 3915 sq km with about 4 per cent of area under wetlands. The wetland area is estimated to be 26738 ha (Table 18). In addition, 1489 wetlands smaller than 2.25 ha have also been discerned. River/Stream singularly dominated the extent of wetlands in the district with about 77 per cent. Other major types are natural waterlogged areas (11 %) and Tank/Pond (3 %). The small wetlands are significant, which comprise about 6 per cent. Open water has shown about 11 per cent seasonal decrease while aquatic vegetation has increased marginally by about one per cent. Moderate turbidity pronouncedly dominated the open water of the wetlands in this district in the post-monsoon season followed by low and high. The low turbid open water is largest in pre-monsoon (10870 ha). However, high turbidity is not exhibited by the open water of the wetlands.

Table 18: Area estimates of wetlands in Cuttack district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	3	411	1.54	144	21
2	1102	Ox-bow lakes/ Cut-off meanders	11	91	0.34	81	81
3	1103	High altitude wetlands	0	0	0.00	0	0
4	1104	Riverine wetlands	7	35	0.13	25	25
5	1105	Waterlogged	90	2958	11.06	582	464
6	1106	River/Stream	75	20557	76.88	20557	18540
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	17	377	1.41	230	103
8	1202	Tanks/Ponds	148	820	3.07	377	364
9	1203	Waterlogged	0	0	0.00	0	0
10	1204	Salt pans	0	0	0.00	0	0
		Total - Inland	351	25249	94.43	21996	19598
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	0	0	0.00	0	0
12	2102	Creeks	0	0	0.00	0	0
13	2103	Sand/Beach	0	0	0.00	0	0
14	2104	Intertidal mud flats	0	0	0.00	0	0
15	2105	Salt Marsh	0	0	0.00	0	0
16	2106	Mangroves	0	0	0.00	0	0
17	2107	Coral Reefs	0	0	0.00	0	0
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	0	0	0.00	0	0
19	2202	Aquaculture ponds	0	0	0.00	0	0
		Total - Coastal	0	0	0.00	0	0
		Sub-Total	351	25249	94.43	21996	19598
		Wetlands (<2.25 ha)	1489	1489	5.57	0	0
		Total	1840	26738	100.00	21996	19598

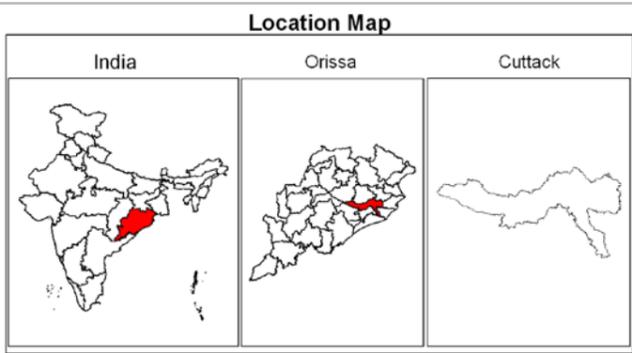
Area under Aquatic Vegetation	3258	3641
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Area under turbidity levels		
Low	680	10870
Moderate	21306	8728
High	10	0



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

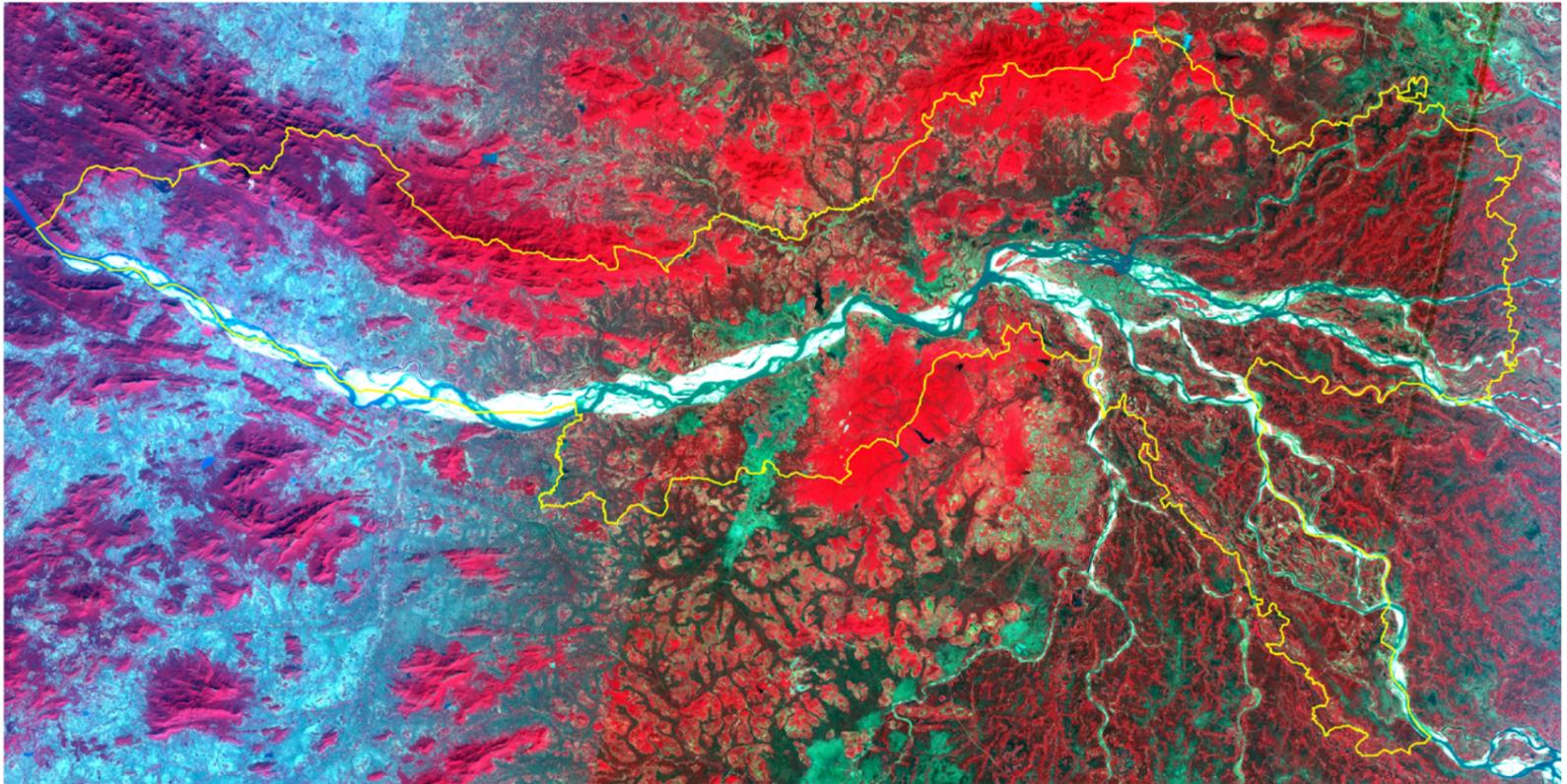
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
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 - Town/Settlements
 - District Boundary
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7.1.13 Jajpur

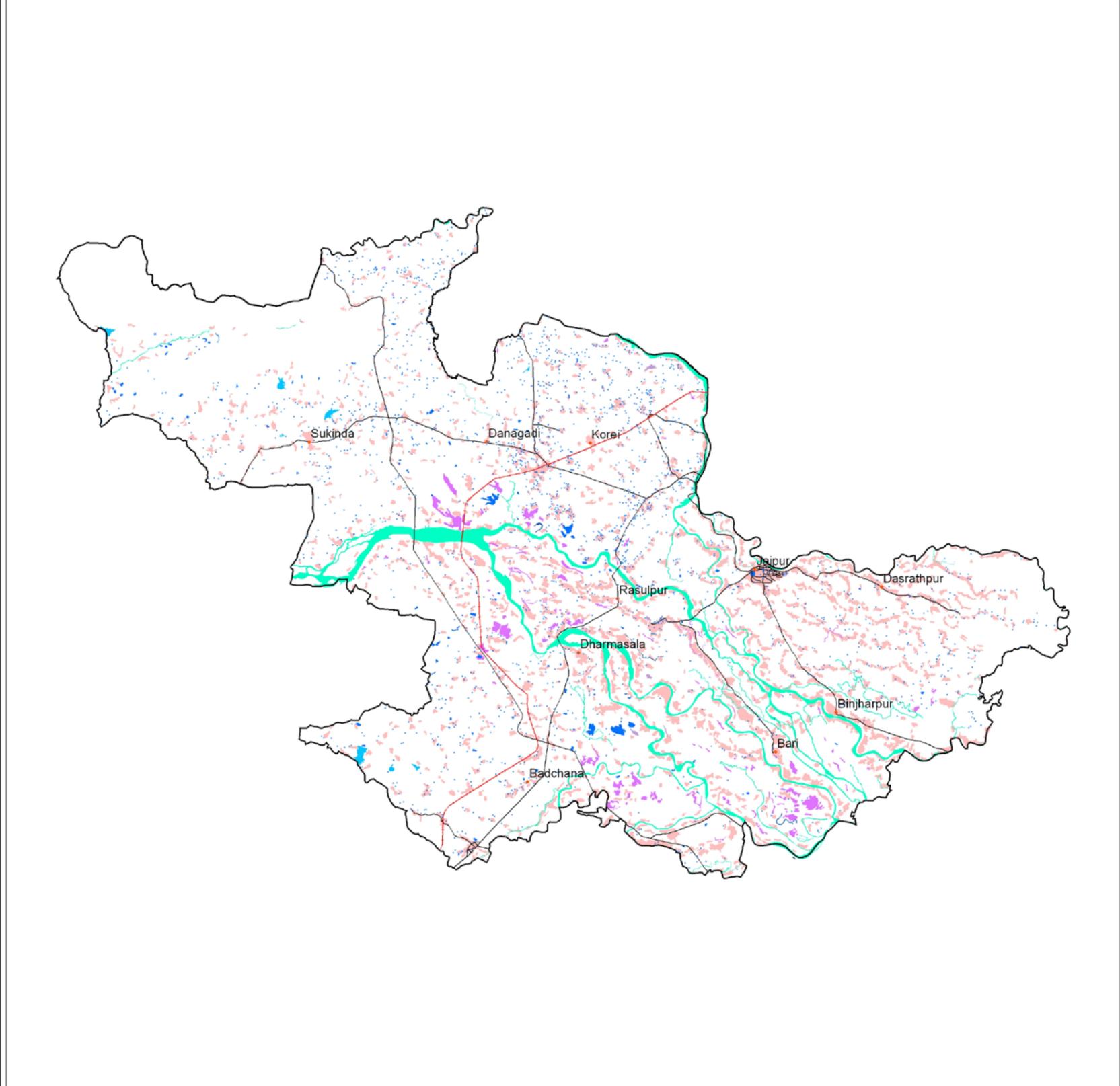
The total geographical area of Jajpur district is 2885 sq km with an estimated wetland area of 15714 ha (Table 19). The wetland area comprises of 380 wetlands (>2.25ha) and in addition 2169 wetlands smaller than 2.25 ha. The major wetland types are River/Stream (9720 ha) and natural waterlogged areas (2412 ha). The small wetlands constitute a significant per cent (about 14 %) of wetlands in the district. Open water extent has shown a seasonal reduction of 627 ha from 10759 ha in post-monsoon to 10132 ha in pre-monsoon. About 3 per cent increase is observed in the extent of aquatic vegetation from post-monsoon (2607 ha) to 2900 ha in pre-monsoon. Moderate turbidity prevailed in open water in post-monsoon with 6754 ha out 10759 ha followed by low (3830 ha) and high (175 ha). While in pre-monsoon the moderated turbidity (9878 ha t of 10132 ha of open water) is predominant and low turbidity being 254 ha. However, high turbidity is not observed in pre-monsoon.

Table 19: Area estimates of wetlands in Jajpur district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	5	66	0.42	61	61
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	127	2412	15.35	338	321
6	1106	River/Stream	100	9720	61.86	9541	9207
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	8	354	2.25	272	162
8	1202	Tanks/Ponds	132	896	5.70	529	363
9	1203	Waterlogged	7	97	0.62	18	18
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	379	13545	86.20	10759	10132
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	380	13545	86.20	10759	10132
		Wetlands (<2.25 ha)	2169	2169	13.80	-	-
		Total	2549	15714	100.00	10759	10132

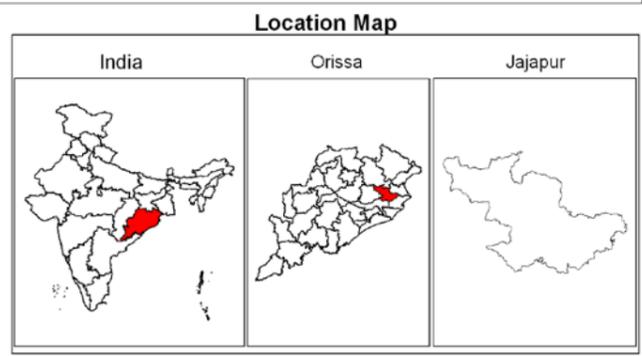
Area under Aquatic Vegetation	2607	2900
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Area under turbidity levels		
Low	3830	254
Moderate	6754	9878
High	175	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

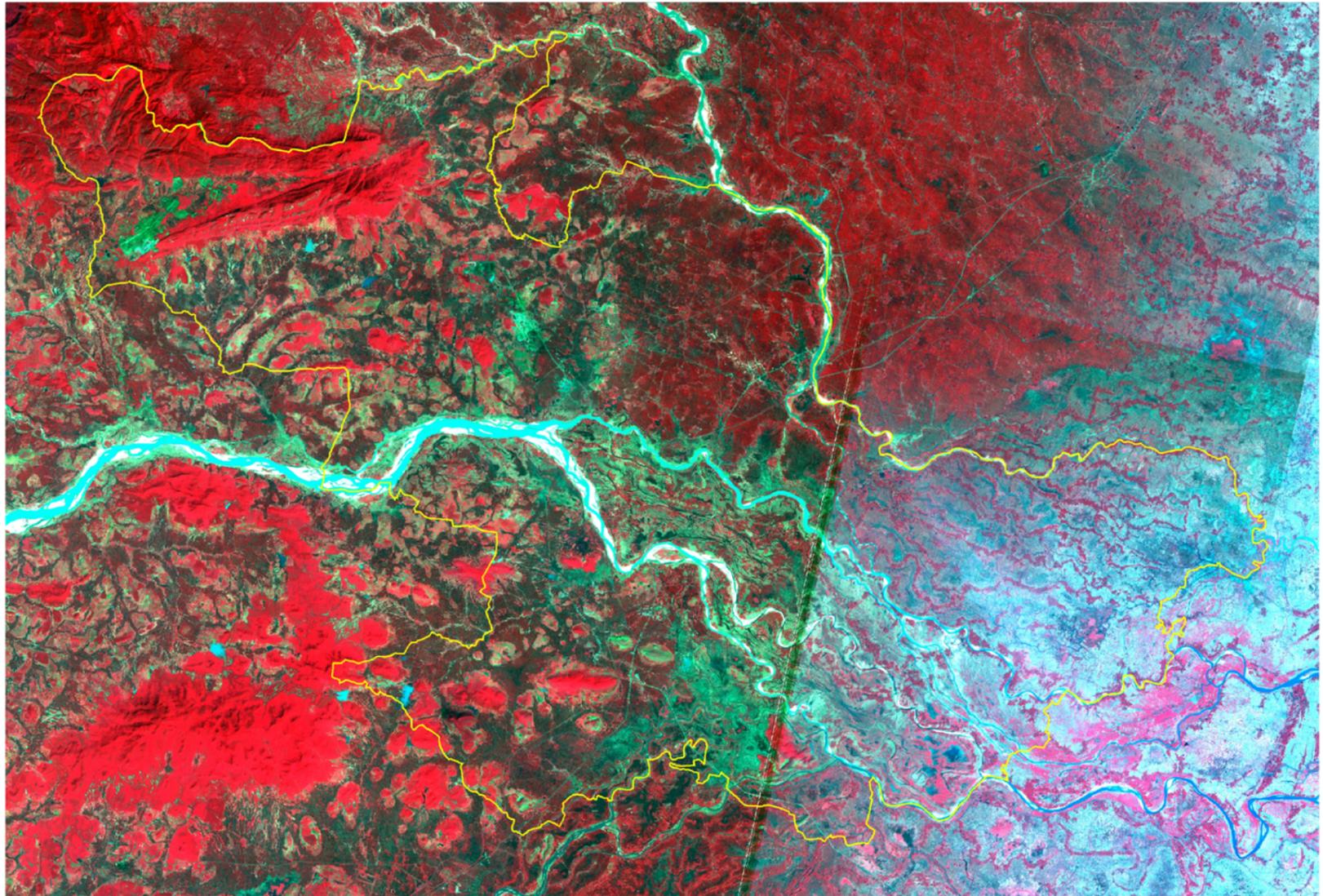


0 3.75 7.5 15 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Orissa Space Applications Centre, Bhubaneswar

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7.1.14 Dhenkanal

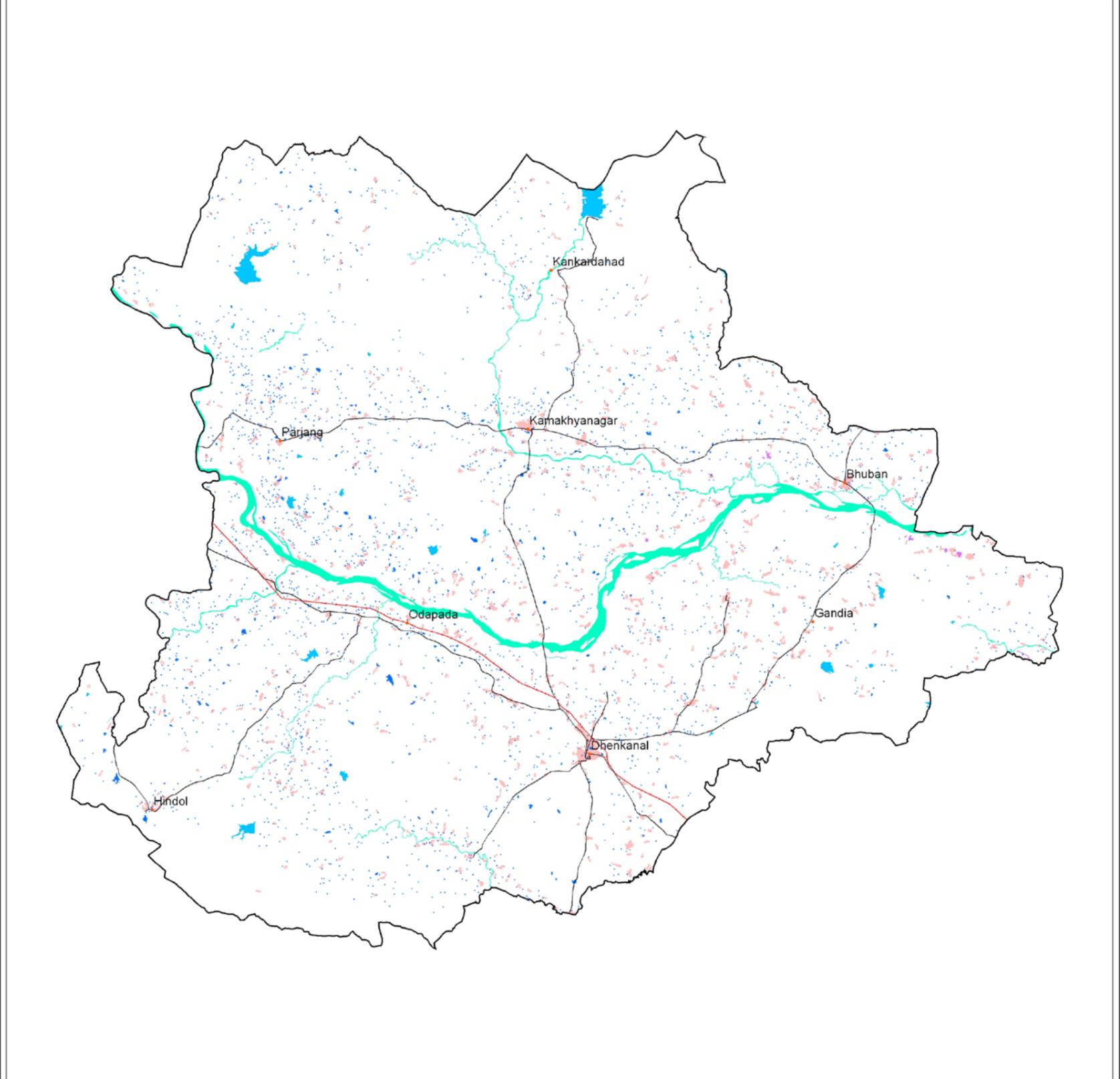
The total geographical area of Dhenkanal district is 4597 sq km with an estimated area under wetlands of 13663 ha (Table 20). The area is segregated in 3364 wetlands with 288 being > 2.25 ha while 3076 being <2.25 ha shown as point features. The major wetland types are River/Stream (7756 ha) comprising about 57 per cent followed by Reservoir/Barrage (1736 ha). The small wetlands (<2.25 ha) account for a significant per cent of wetlands (about 23). Open water has shown a decrease of 1264 ha from 9736 ha in post-monsoon to 8472 ha in pre-monsoon. Aquatic vegetation doubled from post-monsoon (853 ha) to pre-monsoon (1870 ha). Turbidity was largely low (5206 ha) followed by moderate (3038 ha) and high (1492 ha). In case of pre-monsoon, moderate turbidity singularly dominated the open water with 7976 ha followed by low (496 ha). High turbidity was not observed in pre-monsoon.

Table 20: Area estimates of wetlands in Dhenkanal district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	1	10	0.07	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	3	26	0.19	-	-
5	1105	Waterlogged	8	81	0.59	6	-
6	1106	River/Stream	26	7756	56.77	7756	7509
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	25	1736	12.71	1585	610
8	1202	Tanks/Ponds	225	978	7.16	389	353
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	288	10587	77.49	9736	8472
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	288	10587	77.49	9736	8472
		Wetlands (<2.25 ha)	3076	3076	22.51	-	-
		Total	3364	13663	100.00	9736	8472

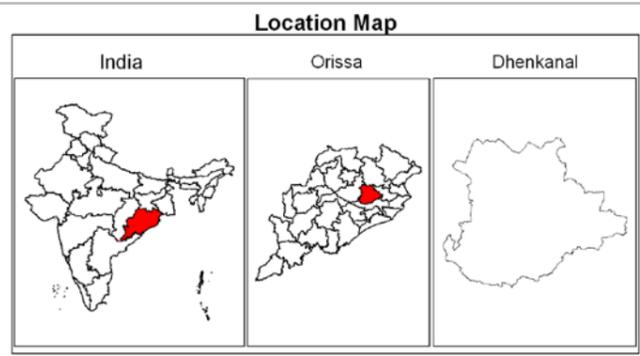
Area under Aquatic Vegetation	853	1870
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Area under turbidity levels		
Low	5206	496
Moderate	3038	7976
High	1492	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

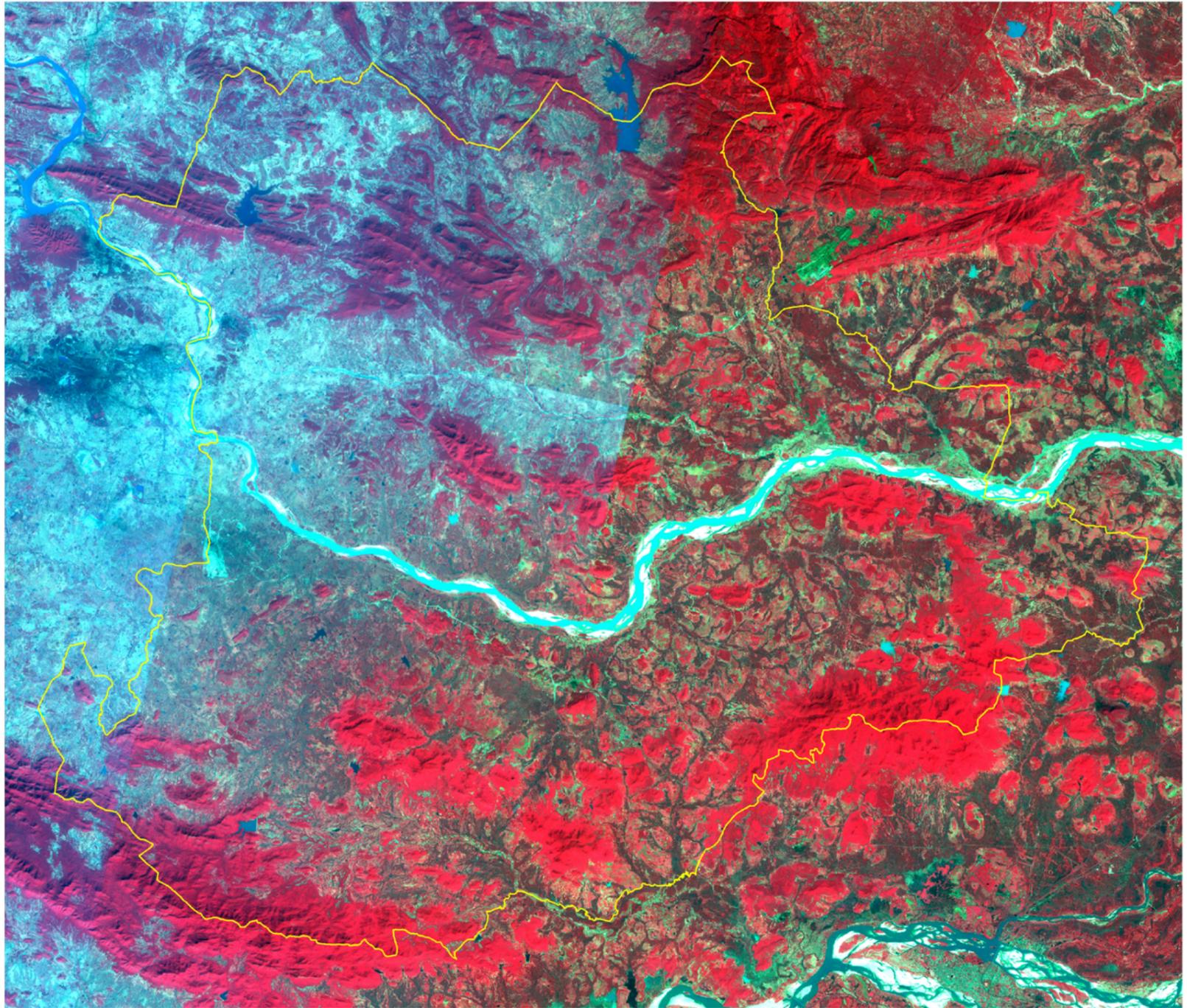
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Orissa Space Applications Centre, Bhubaneswar

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7.1.15 Anugul

The total geographical area of Anugul district is 6347 sq km with an estimated area under wetlands to be about 4 per cent. The wetland area is estimated to be 28616 ha (Table 21). The district comprises of 421 wetlands in addition to 2440 wetlands that <2.25 ha. The major wetland categories are Reservoir/Barrage (13864 ha) followed by River/Stream (10170 ha) and tank/Pond (1875 ha). The small wetlands constitute about 9 per cent of wetlands in the district. Open water has shown about 20 per cent seasonal reduction from 25507 ha (post-monsoon) to 20112 ha in pre-monsoon. An approximately eight-fold increase in aquatic vegetation is observed from post-monsoon (720 ha) to pre-monsoon (5645 ha). Turbidity of open water was observed to dominated by moderate level followed by low and high in both the seasons.

Table 21: Area estimates of wetlands in Anugul district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	6	76	0.27	72	72
5	1105	Waterlogged	28	191	0.67	95	105
6	1106	River/Stream	86	10170	35.54	10148	9679
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	29	13864	48.45	13806	8637
8	1202	Tanks/Ponds	272	1875	6.55	1386	1619
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	421	26176	91.47	25507	20112
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	421	26176	91.47	25507	20112
		Wetlands (<2.25 ha)	2440	2440	8.53	-	-
		Total	2861	28616	100.00	25507	20112

Area under Aquatic Vegetation	720	5645
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Area under turbidity levels		
Low	7108	8052
Moderate	15664	11753
High	2735	307

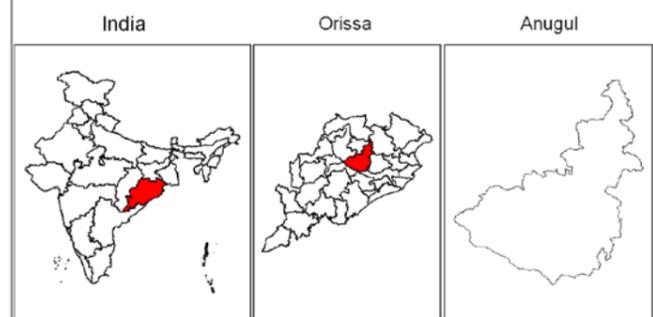


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

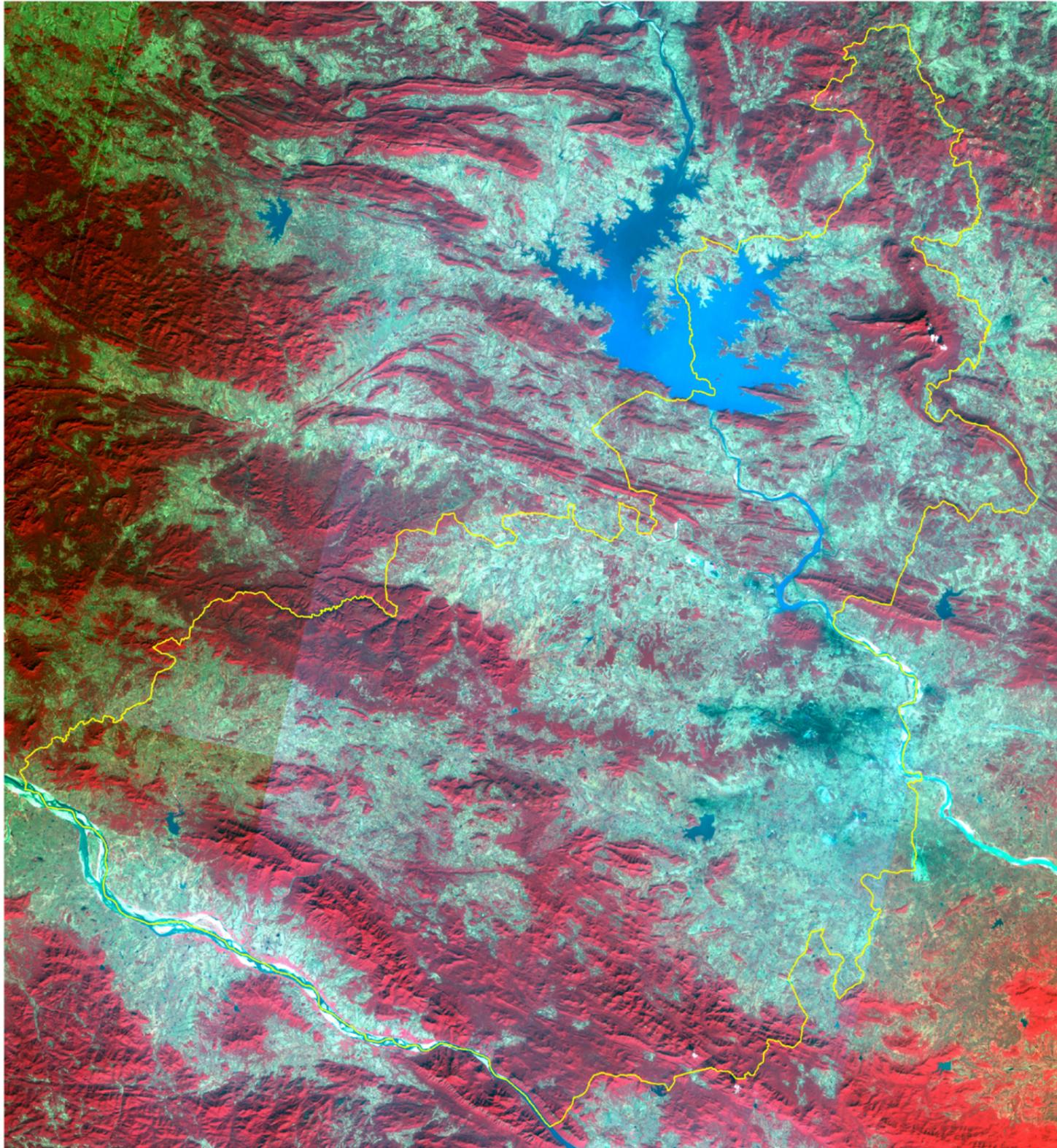


0 5 10 20 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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7.1.16 Nayagarh

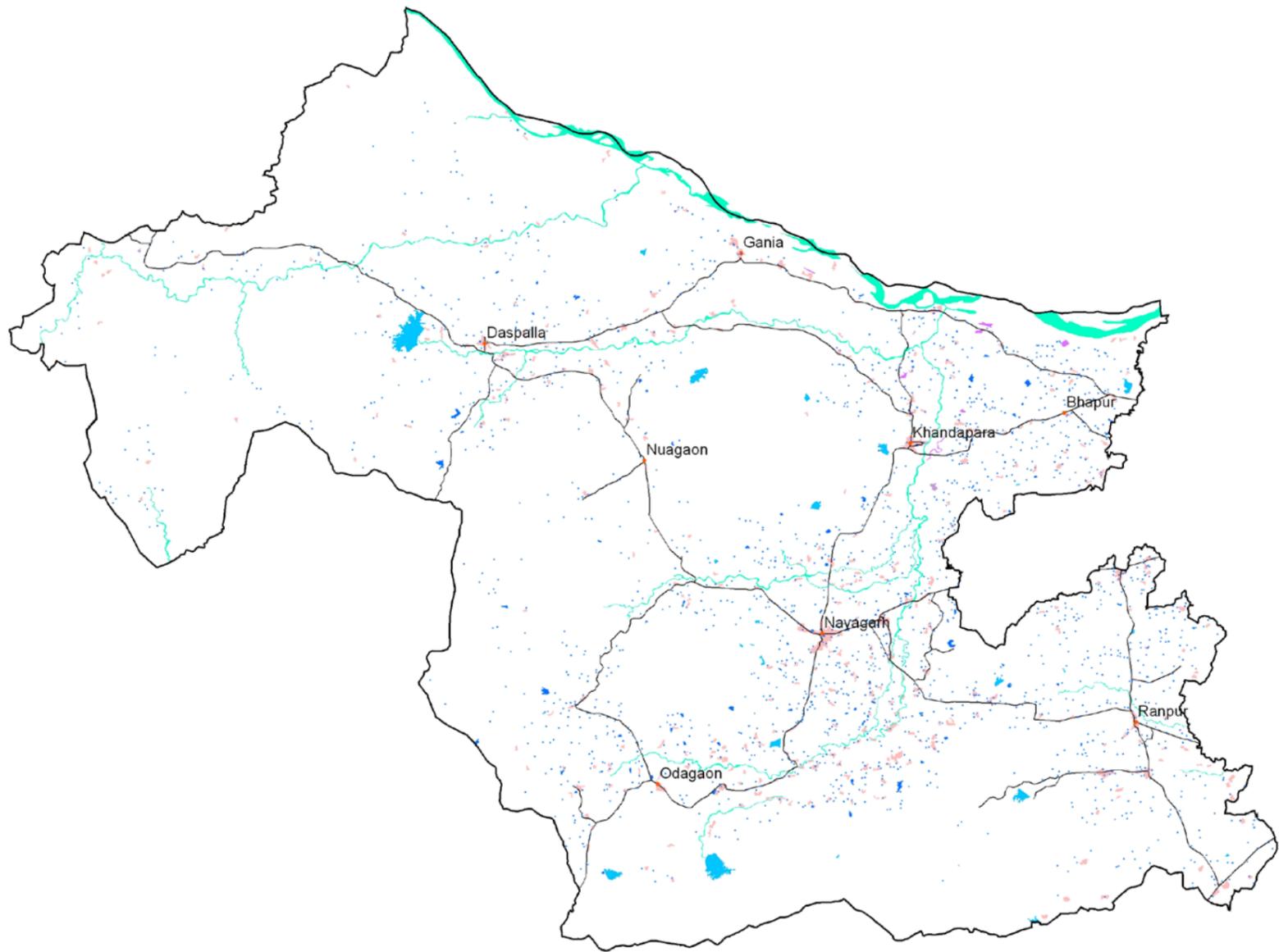
The total geographical area of Nayagarh district is 3954 sq km. The district comprises of 2105 wetlands including 1919, which are <2.25ha. The wetland area is estimated to be 9185 ha (Table 22). The major wetland types are River/Stream (5301 ha) and Reservoir/Barrage (1241 ha). The small wetlands constitute a significant per cent of the wetlands (about 21). Open water has shown a marginal seasonal reduction from 6631 ha in post-monsoon to 6194 ha in pre-monsoon, while aquatic vegetation has marginally increased from 636 ha 893 ha. Open water is observed to be dominated with moderate turbidity followed by low. High turbidity is exhibited in both the seasons.

Table 22: Area estimates of wetlands in Nayagarh district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	8	115	1.25	35	35
6	1106	River/Stream	29	5301	57.71	5301	5123
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	26	1241	13.51	949	788
8	1202	Tanks/Ponds	121	582	6.34	346	248
9	1203	Waterlogged	2	27	0.29	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	186	7266	79.11	6631	6194
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	186	7266	79.11	6631	6194
		Wetlands (<2.25 ha)	1919	1919	20.89	0	0
		Total	2105	9185	100.00	6631	6194

Area under Aquatic Vegetation	636	893
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Area under turbidity levels		
Low	1265	2730
Moderate	5366	3464
High	-	-

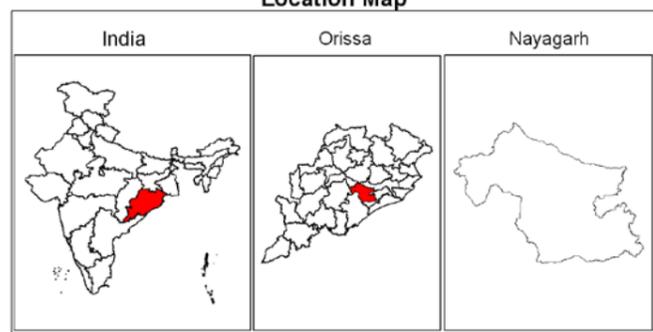


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

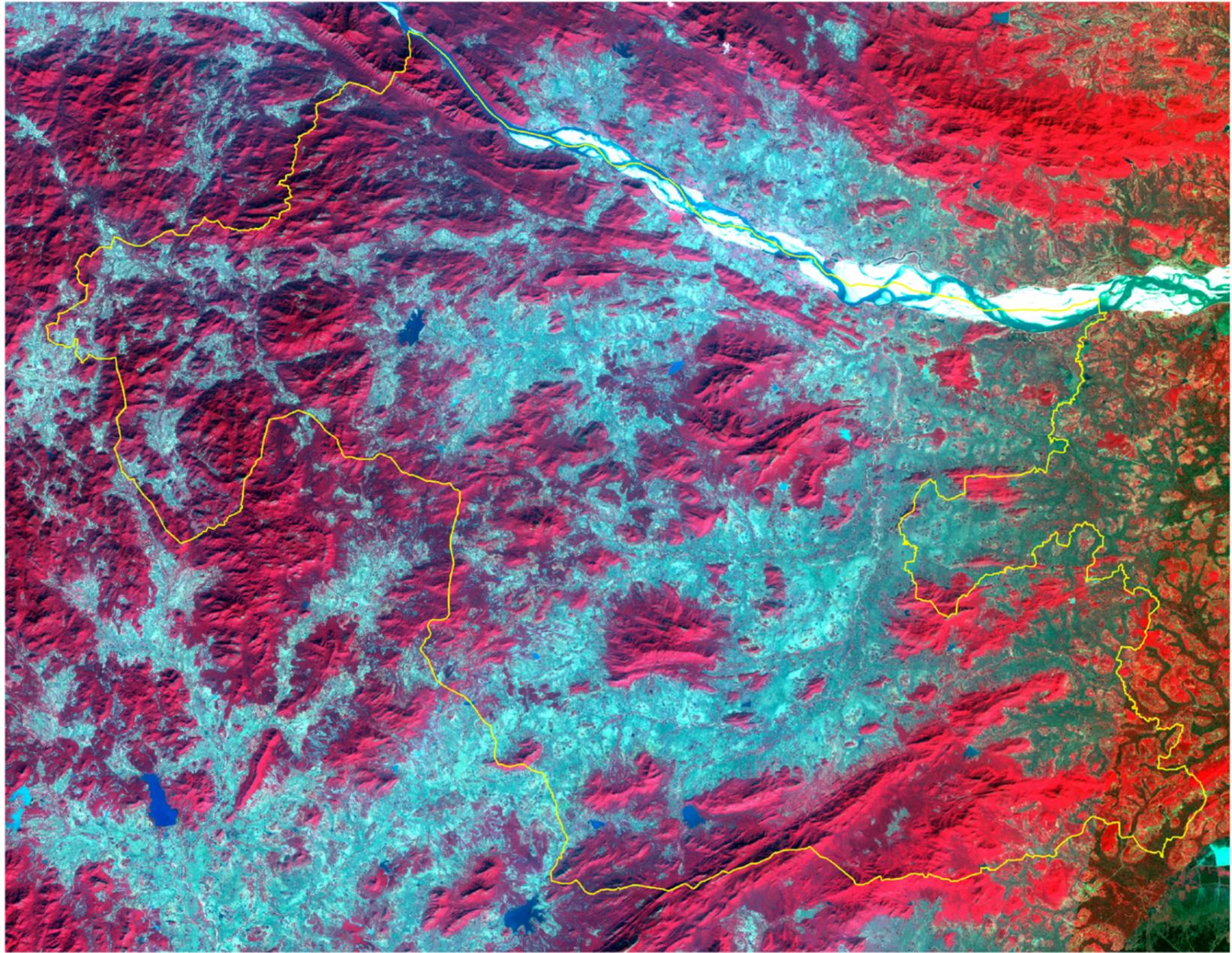
Location Map



Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
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7.1.17 Khordha

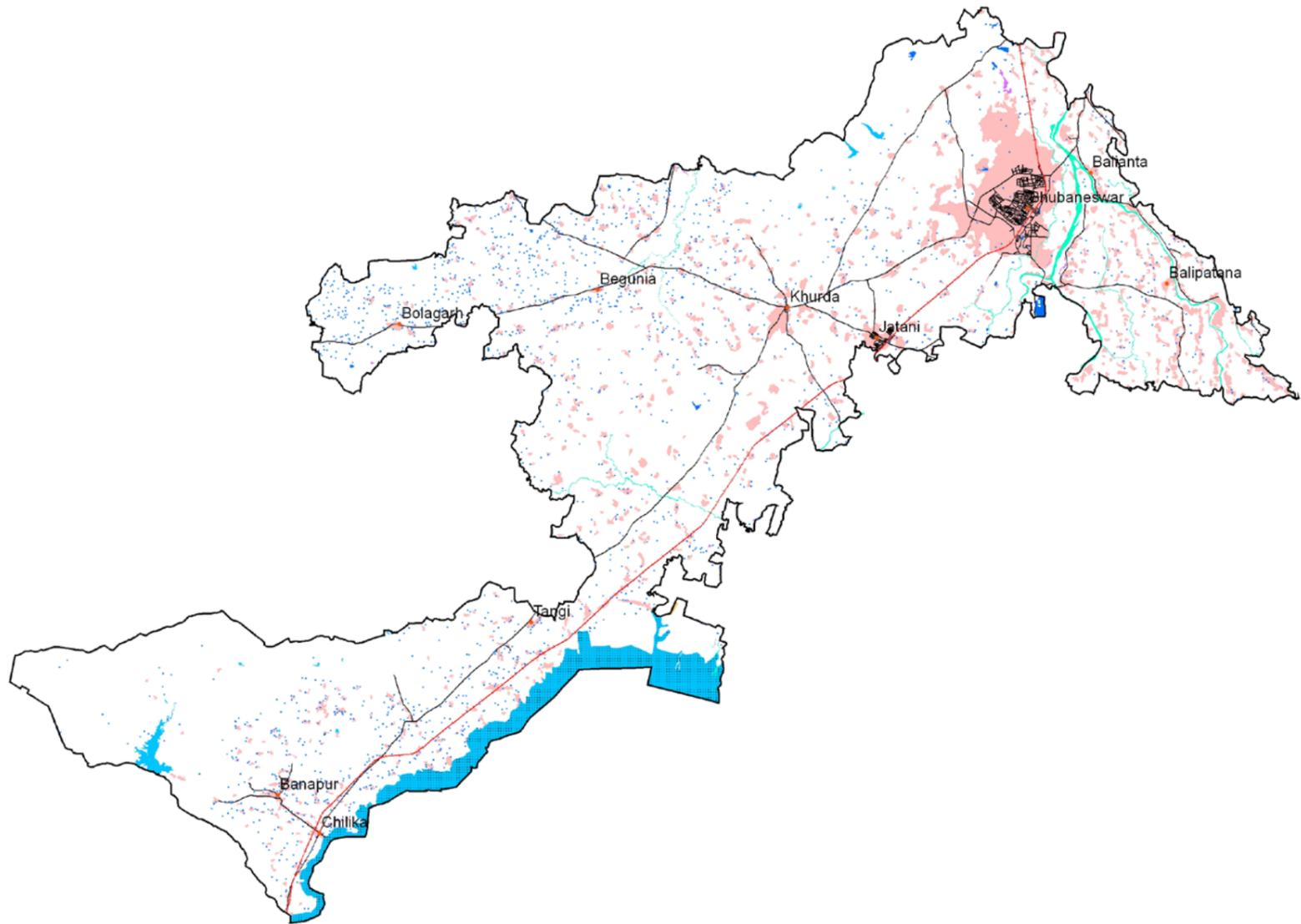
The total geographical area of Khordha district is 2888 sq km. The wetland area is estimated to be 14407 ha (Table 23). An additional 1795 wetlands smaller than 2.25 ha have been discerned besides 147 wetlands, which are >2.25 ha. The major wetland types are Lagoon (9266 ha), which is part of Chilika accounts for about 64 per cent of area. The other major types are River/Stream (1929 ha) and Reservoir/Barrage (839 ha). The small wetlands constitute a significant per cent (about 12) of wetlands in the district. Open water constituent of wetlands has shown a seasonal reduction of 886 ha from 6030 ha in post-monsoon to 5144 ha in pre-monsoon. Aquatic vegetation has shown an increase of 704 ha from post-monsoon (6586 ha) to 7290 ha in pre-monsoon. Moderate turbidity (3885 ha) is observed to be of larger extent of open water in post-monsoon followed by low (2145 ha). While in case of pre-monsoon the low turbidity accounted for larger area (3140 ha) followed by moderate (2004 ha). High turbidity was not observed in both the seasons.

Table 23: Area estimates of wetlands in Khordha district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	1	2	0.01	2	2
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	1	4	0.03	4	4
5	1105	Waterlogged	16	115	0.80	46	46
6	1106	River/Stream	57	1929	13.39	1929	1747
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	15	839	5.82	633	549
8	1202	Tanks/Ponds	53	422	2.93	71	71
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	143	3311	22.98	2685	2419
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	2	9266	64.32	3310	2690
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	2	35	0.24	35	35
		Total - Coastal	4	9301	64.56	3345	2725
		Sub-Total	147	12612	87.54	6030	5144
		Wetlands (<2.25 ha)	1795	1795	12.46	-	-
		Total	1942	14407	100.00	6030	5144

Area under Aquatic Vegetation	6586	7290
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Area under turbidity levels		
Low	2145	3140
Moderate	3885	2004
High	-	-

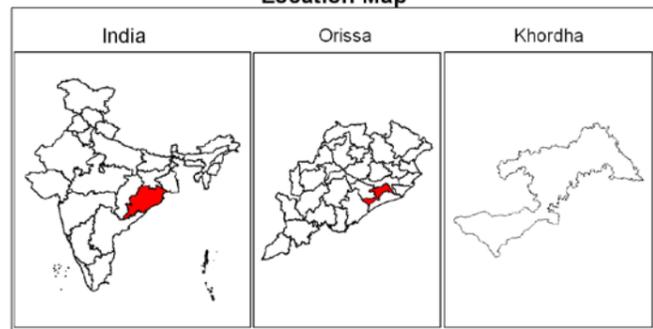


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

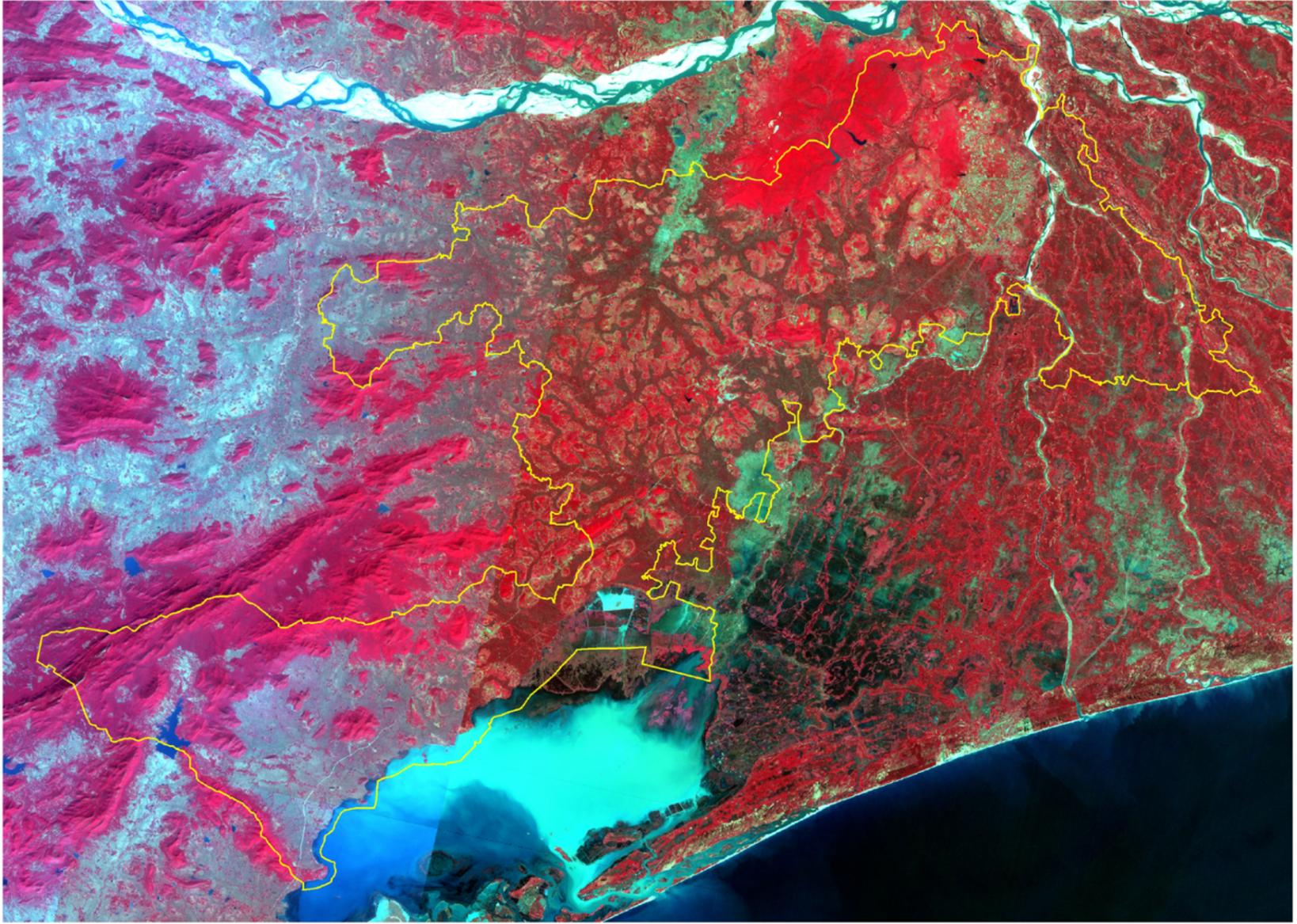


0 5 10 20 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

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Orissa Space Applications Centre, Bhubaneswar

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7.1.18 Puri

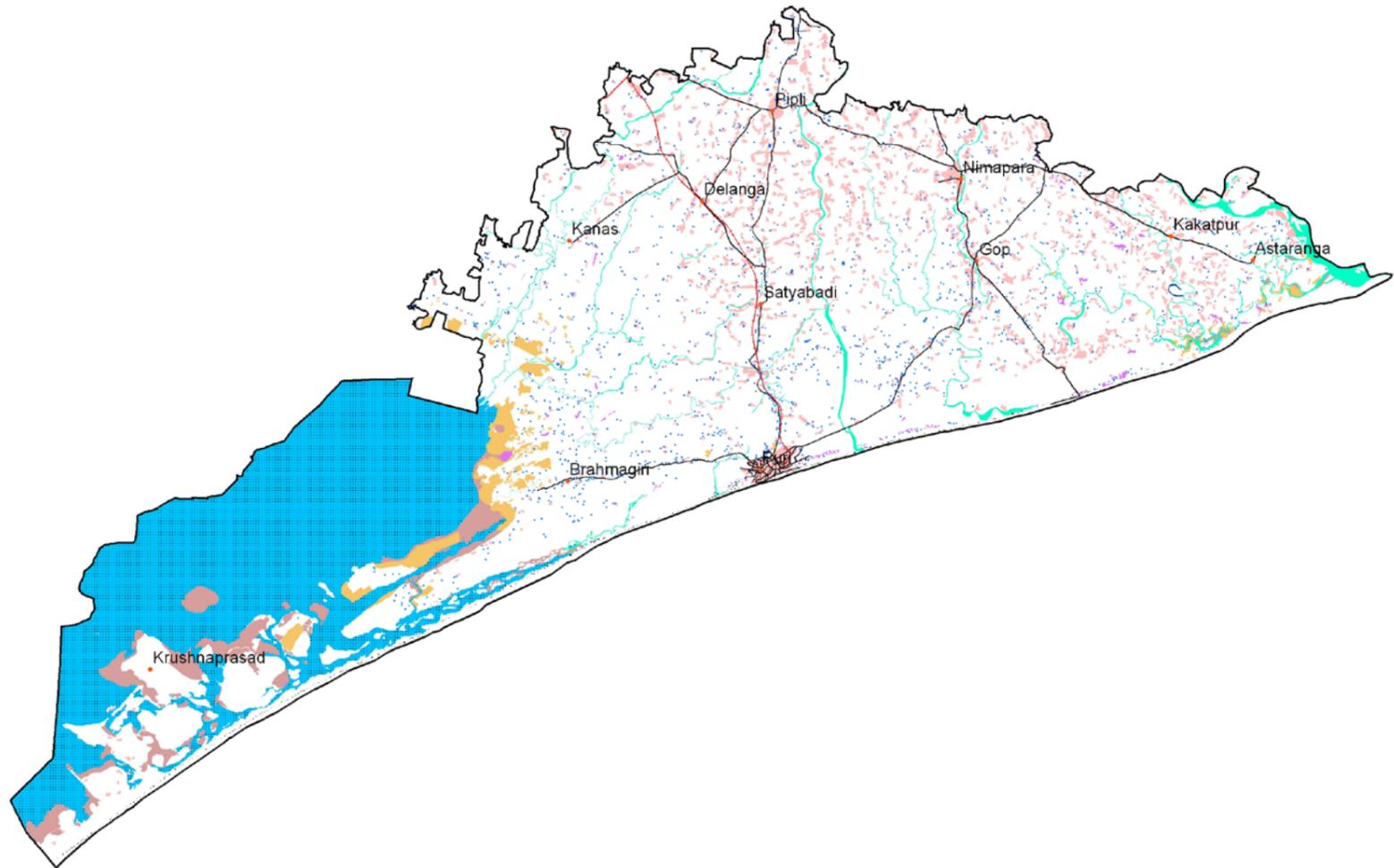
The total geographic area of Puri district is 3055 sq km. Wetlands constitute largest extent in state that forms about 14 per cent of the geographical area of the district. The wetland area estimated is 98096 ha (Table 24). An additional 1489 wetlands smaller than 2.25 ha have been discerned besides mapping of 382 wetlands greater than 2.25 ha. The major wetland type is Lagoon (72759 ha) accounting for about 74 per cent of wetland extent due to the presence of Chilika Lagoon, a Ramsar site. Other major wetland types are Intertidal Mudflats covering 8565 ha of area followed by River/Stream 96637 ha0 and Aquaculture Ponds (5974 ha). Open water component formed about 68 per cent of wetland extent in post-monsoon has reduced to 59427 ha in pre-monsoon from 65593 ha. Aquatic vegetation has shown an increase from post-monsoon (21573 ha) to pre-monsoon (28255 ha). Low turbidity is observed to be dominant of the open water followed by moderate in both the seasons. High turbidity has not been observed in both the seasons.

Table 24: Area estimates of wetlands in Puri district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	6	69	0.07	57	57
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	4	36	0.04	36	36
5	1105	Waterlogged	71	659	0.67	449	449
6	1106	River/Stream	40	6637	6.77	6627	6465
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	62	259	0.26	175	175
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	183	7660	7.81	7344	7182
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	4	72759	74.17	52275	46271
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	18	1649	1.68	-	-
14	2104	Intertidal mud flats	70	8565	8.73	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	107	5974	6.09	5974	5974
		Total - Coastal	199	88947	90.67	58249	52245
		Sub-Total	382	96607	98.48	65593	59427
		Wetlands (<2.25 ha)	1489	1489	1.52	-	-
		Total	1871	98096	100.00	65593	59427

Area under Aquatic Vegetation	21573	28255
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Area under turbidity levels		
Low	41778	46869
Moderate	23815	12558
High	-	-

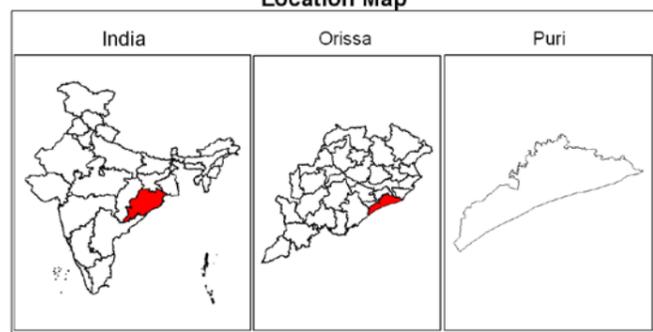


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
■	1101			Ox-bow lakes/ Cut-off meanders
■	1102			High altitude wetlands
■	1103			Riverine wetlands
■	1104			Waterlogged
■	1105			River/Stream
■	1106			
			Man-made	
■	1201			Reservoirs/Barrages
■	1202			Tanks/Ponds
■	1203			Waterlogged
■	1204			Salt pans
		Coastal Wetlands		
			Natural	
■	2101			Lagoons
■	2102			Creeks
■	2103			Sand/Beach
■	2104			Intertidal mud flats
■	2105			Salt marsh
■	2106			Mangroves
■	2107			Coral reefs
			Man-made	
■	2201			Salt pans
■	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



0 5 10 20 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Orissa Space Applications Centre, Bhubaneswar

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7.1.19 Ganjam

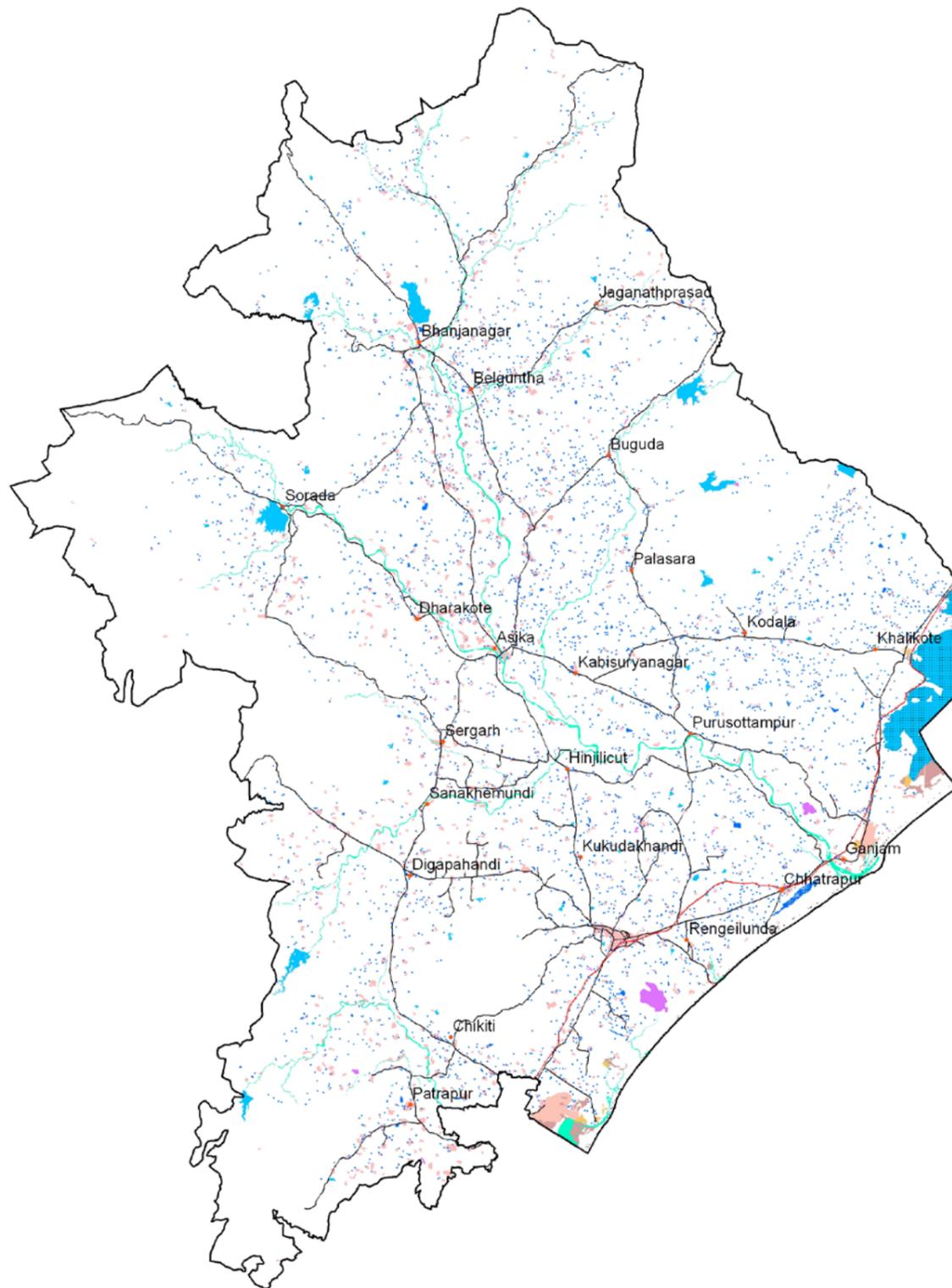
The total geographical area of Ganjam district is 8033 sq km. The district comprises of 4783 wetlands including 4088 that are smaller than 2.25 ha. Together they account for 29920ha of area (Table 25). The major wetland types are Lagoon (6998 ha) followed by River/Stream (6131 ha) and Reservoir/Barrage (4689 ha). The small wetlands contribute a significant area (about 14 %) towards the aerial extent of wetlands in the district. Open water component of wetlands has shown about 15 per cent reduction as seasonal change from post-monsoon (18883 ha) to pre-monsoon (16099 ha). Aquatic vegetation has shown an increase of about one and half times from post-monsoon (4894 ha) to 7167 ha in pre-monsoon. Open water has exhibited larger area under moderate turbidity followed by low without the presence of high turbidity in both the seasons.

Table 25: Area estimates of wetlands in Ganjam district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	1	301	1.01	200	204
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	1	12	0.04	-	-
5	1105	Waterlogged	39	1051	3.51	745	738
6	1106	River/Stream	17	6131	20.49	6131	5578
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	73	4689	15.67	3503	3007
8	1202	Tanks/Ponds	515	2397	8.01	1107	1066
9	1203	Waterlogged	5	23	0.08	7	7
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	651	14604	48.81	11693	10600
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	1	6998	23.39	5114	3423
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	8	807	2.70	-	-
14	2104	Intertidal mud flats	22	1347	4.50	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	2	1726	5.77	1726	1726
19	2202	Aquaculture ponds	11	350	1.17	350	350
		Total - Coastal	44	11228	37.53	7190	5499
		Sub-Total	695	25832	86.34	18883	16099
		Wetlands (<2.25 ha)	4088	4088	13.66	-	-
		Total	4783	29920	100.00	18883	16099

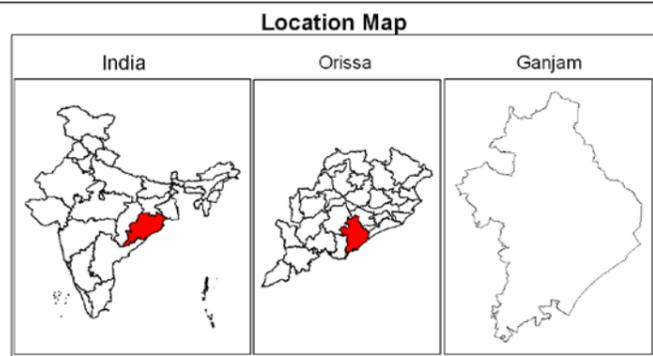
Area under Aquatic Vegetation	4894	7167
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Area under turbidity levels		
Low	8485	6737
Moderate	10398	9362
High	-	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1102			High altitude wetlands
	1103			Riverine wetlands
	1104			Waterlogged
	1105			River/Stream
	1106			
			Man-made	
				Reservoirs/Barrages
	1201			Tanks/Ponds
	1202			Waterlogged
	1203			Salt pans
	1204			
		Coastal Wetlands		
			Natural	
				Lagoons
	2101			Creeks
	2102			Sand/Beach
	2103			Intertidal mud flats
	2104			Salt marsh
	2105			Mangroves
	2106			Coral reefs
	2107			
			Man-made	
				Salt pans
	2201			Aquaculture ponds
	2202			

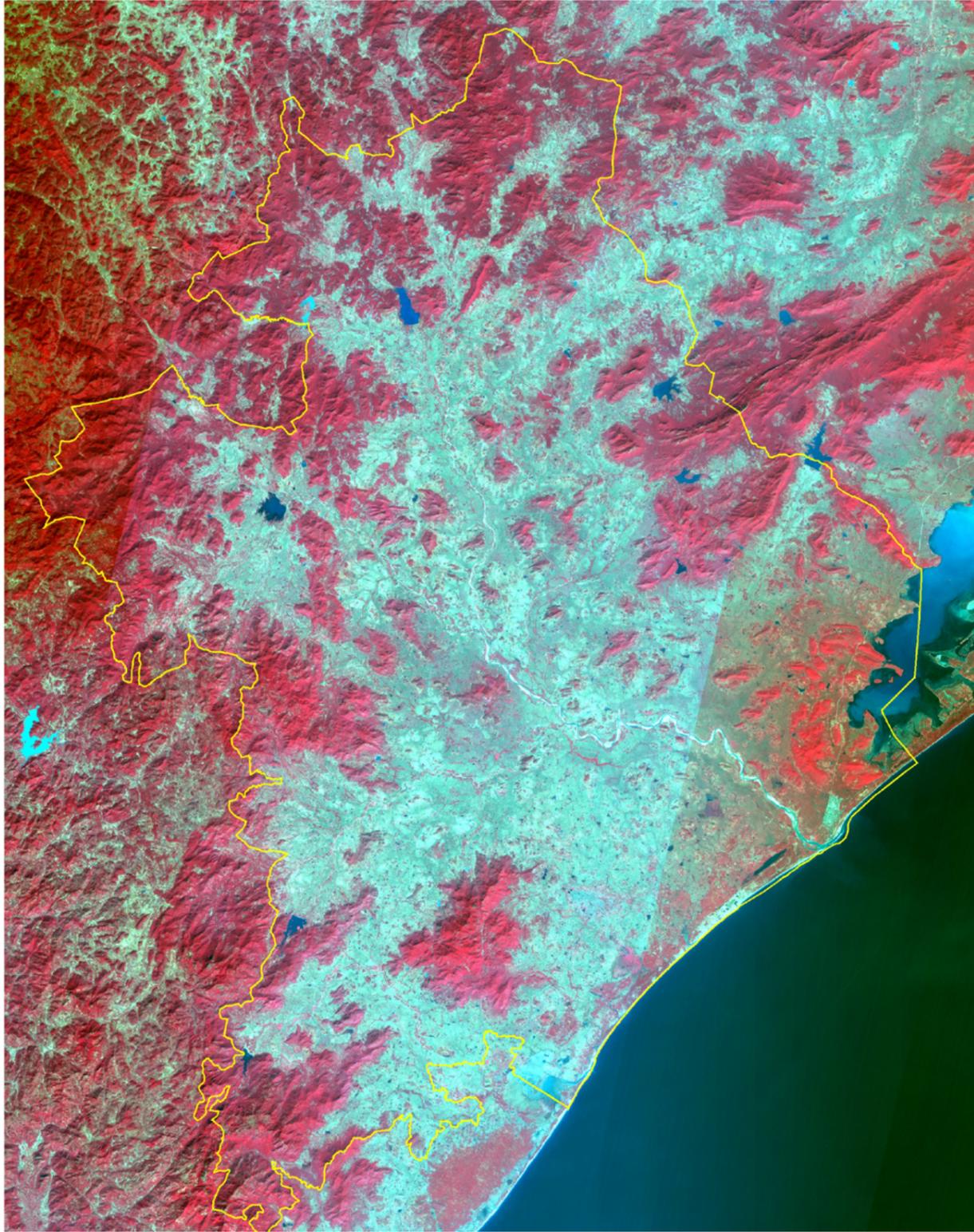
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
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Orissa Space Applications Centre, Bhubaneswar

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7.1.20 Gajapati

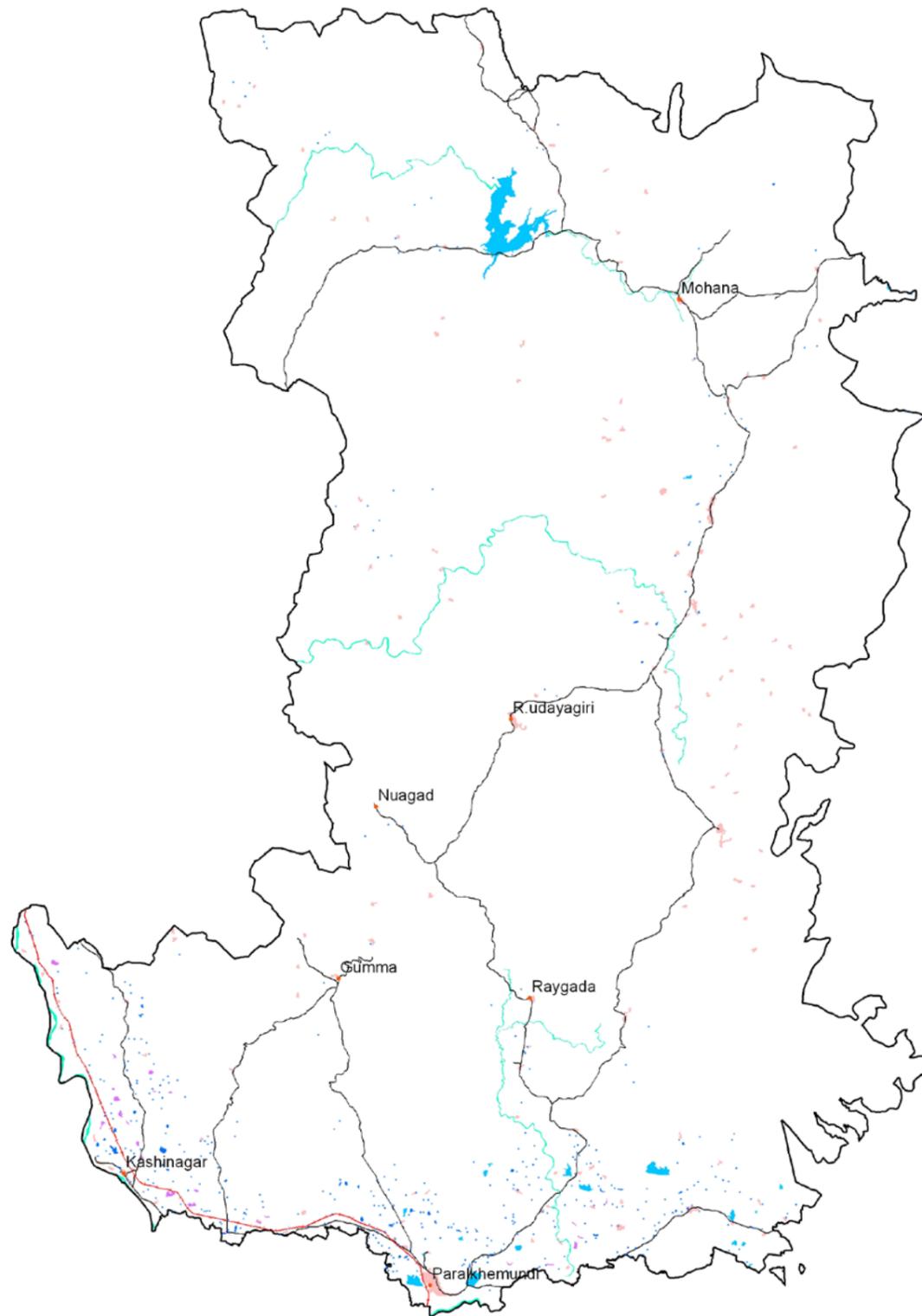
The total geographical area of Gajapati district is 3056 sq km. The wetland area is estimated to be 3569 ha (Table 26), which is a fraction of one per cent of total wetland extent of the state. Total number wetlands are fewer (521) including the small ones of <2.25 ha (398) compared to the preceding districts. The major wetland types are Reservoir/Barrage (1558 ha) and River/Stream (1275 ha). Small wetlands constitute about 11 per cent of wetland extent in the district. Seasonal reduction in the extent of open water has been observed to be very large (about 47 %) from 2642 ha in post-monsoon to 1398 ha in pre-monsoon. Extent of aquatic vegetation has registered more than three-fold increase from post-monsoon (536 ha) to pre-monsoon (1768 ha). Moderate turbidity is observed to dominated the open water in post-monsoon (1918 ha) as well as pre-monsoon (1372 ha) followed by low turbidity. High turbidity is not observed in both the seasons.

Table 26: Area estimates of wetlands in Gajapati district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	25	144	4.03	7	7
6	1106	River/Stream	29	1275	35.72	1275	1263
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	21	1558	43.65	1282	50
8	1202	Tanks/Ponds	48	194	5.44	78	78
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	123	3171	88.85	2642	1398
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	123	3171	88.85	2642	1398
		Wetlands (<2.25 ha)	398	398	11.15	-	-
		Total	521	3569	100.00	2642	1398

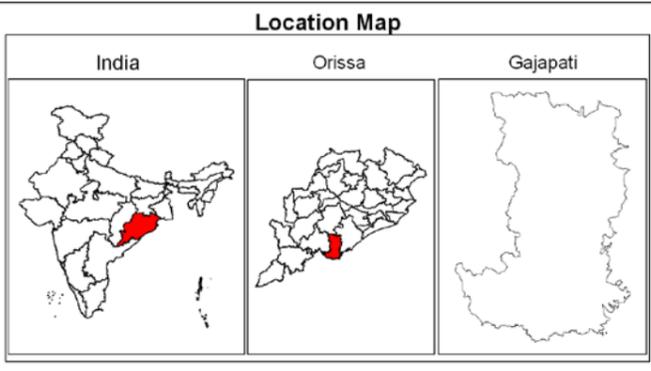
Area under Aquatic Vegetation	536	1768
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Area under turbidity levels		
Low	724	26
Moderate	1918	1372
High	-	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1102			High altitude wetlands
	1103			Riverine wetlands
	1104			Waterlogged
	1105			River/Stream
	1106			
			Man-made	
				Reservoirs/Barrages
	1201			Tanks/Ponds
	1202			Waterlogged
	1203			Salt pans
	1204			
		Coastal Wetlands		
			Natural	
				Lagoons
	2101			Creeks
	2102			Sand/Beach
	2103			Intertidal mud flats
	2104			Salt marsh
	2105			Mangroves
	2106			Coral reefs
	2107			
			Man-made	
				Salt pans
	2201			Aquaculture ponds
	2202			

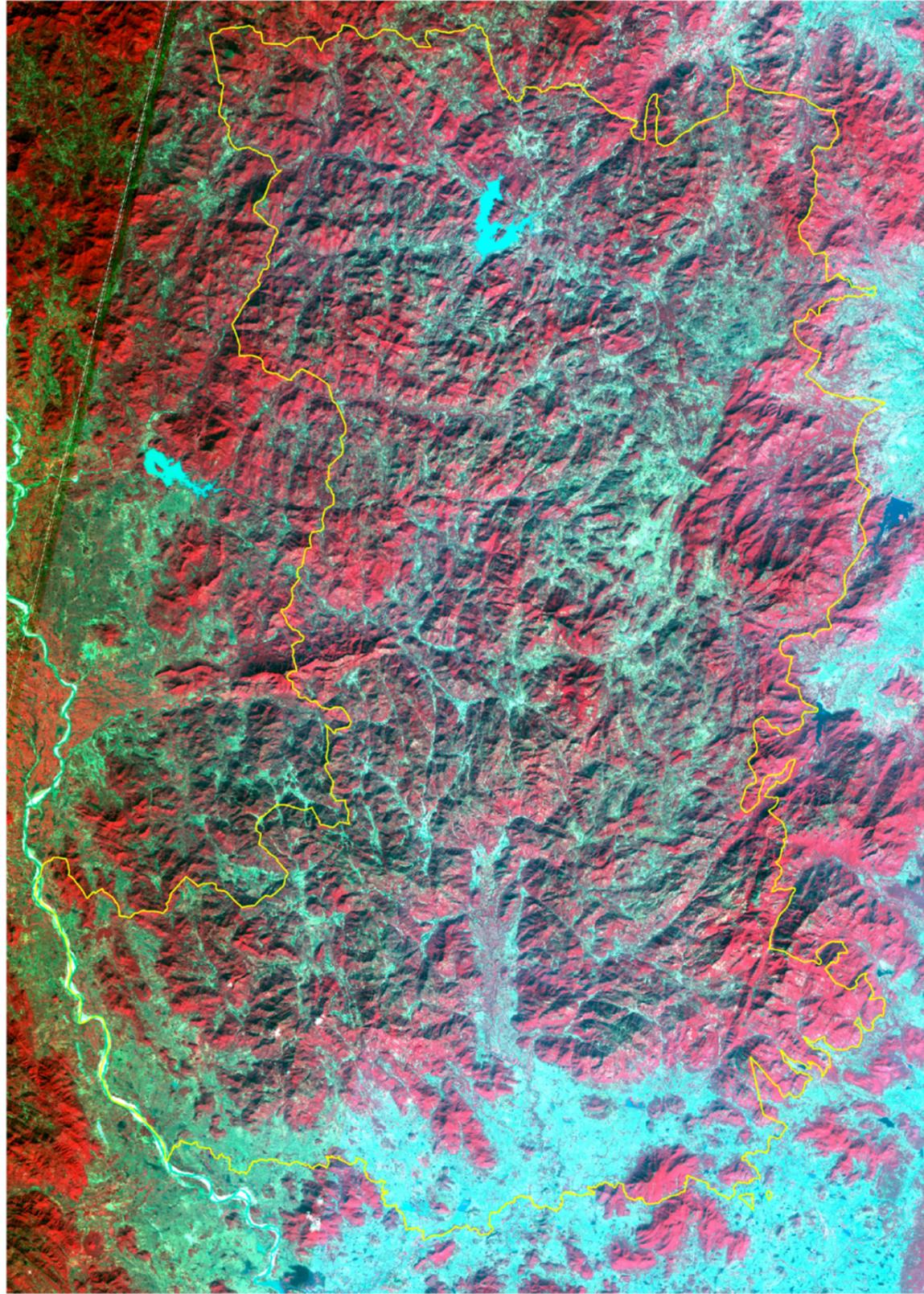
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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7.1.21 Kandhamal

The total geographical area of Kandhamal district is 6004 sq km. The wetland area is estimated to be 5865 ha (Table 27). An additional 726 wetlands smaller than 2.25 ha have also been discerned besides mapping of 113 wetlands >2.25 ha. The major wetland types are River/Stream (4455 ha) and Reservoir/Barrage (620 ha). The seasonal reduction in the extent of open water is observed to marginal (about 5 %) from post-monsoon to pre-monsoon. A four-fold increase is observed in aquatic vegetation from 87 ha in post-monsoon to 337 ha in pre-monsoon. Open water is dominated by moderate level of turbidity in both seasons (4662 ha and 4616 ha) followed by low turbidity. However, high turbidity is not observed in both the seasons.

Table 27: Area estimates of wetlands in Kandhamal district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	65	4455	75.96	4455	4455
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	33	620	10.57	543	293
8	1202	Tanks/Ponds	14	61	1.04	51	51
9	1203	Waterlogged	1	3	0.05	3	3
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	113	5139	87.62	5052	4802
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	113	5139	87.62	5052	4802
		Wetlands (<2.25 ha)	726	726	12.38	-	-
		Total	839	5865	100.00	5052	4802

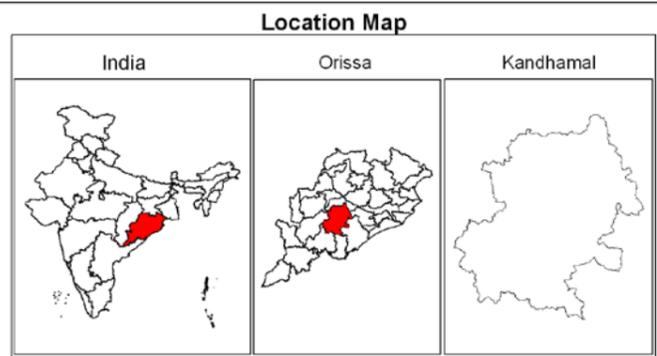
Area under Aquatic Vegetation	87	337
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Area under turbidity levels		
Low	390	186
Moderate	4662	4616
High	-	-



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1102			High altitude wetlands
	1103			Riverine wetlands
	1104			Waterlogged
	1105			River/Stream
	1106			
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

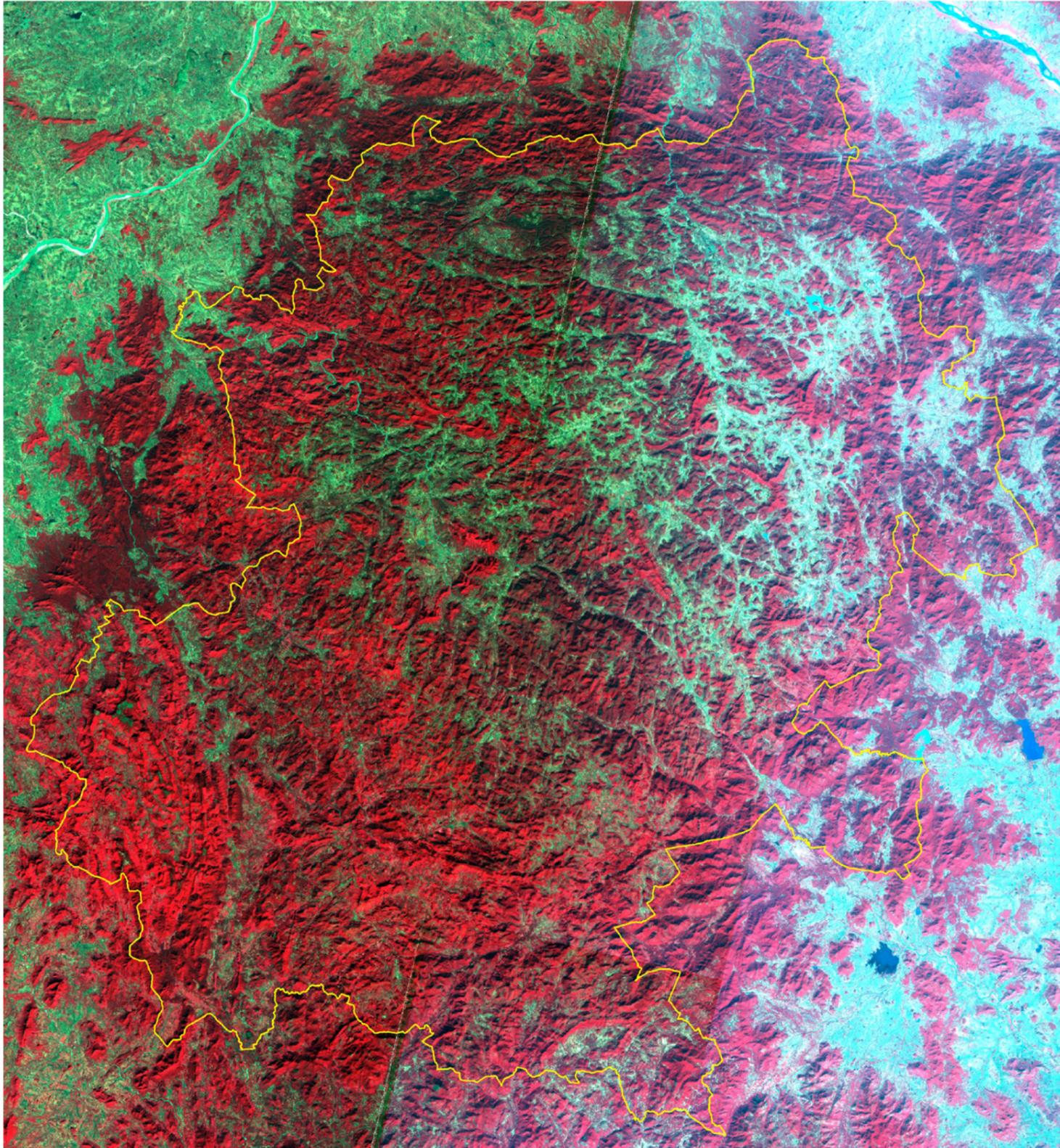


0 4.5 9 18 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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7.1.22 Boudh

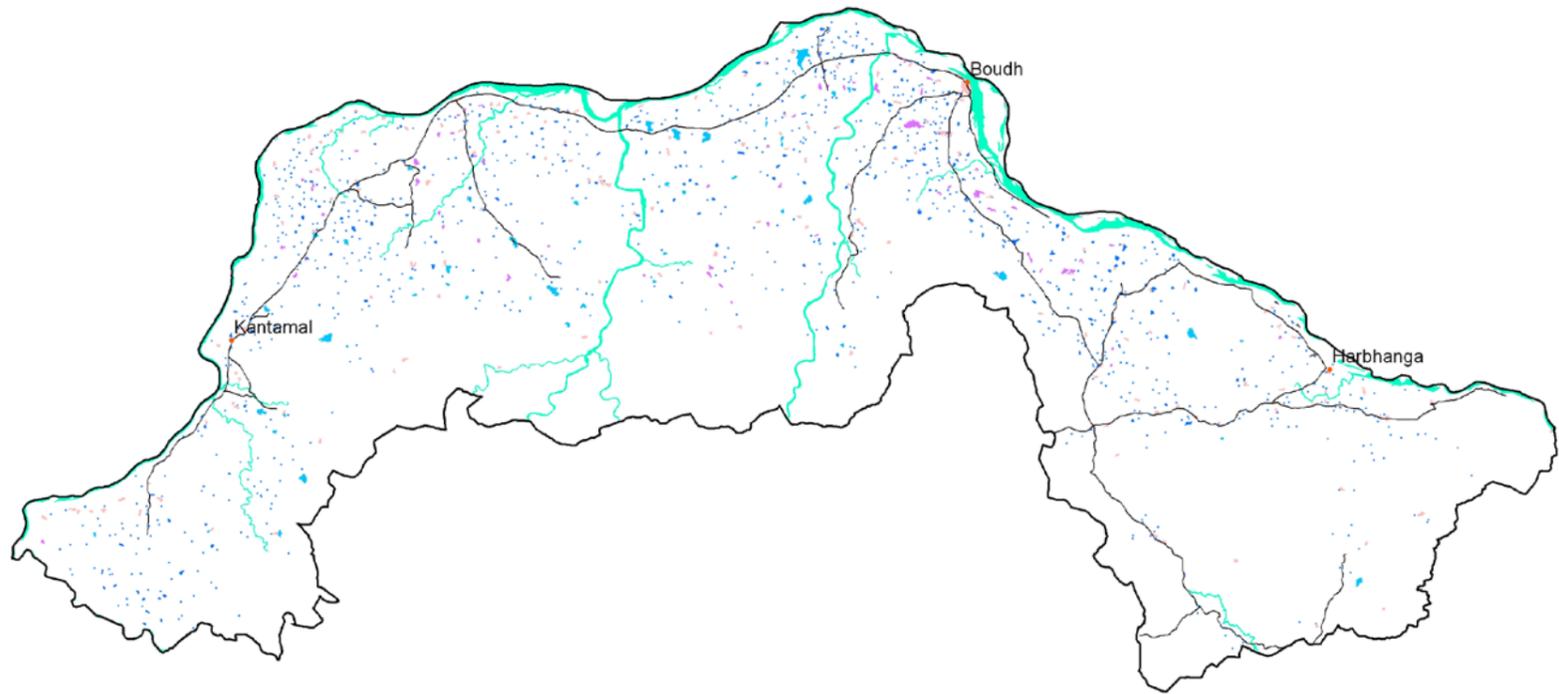
The total geographical area of Boudh district is 4289 sq km with an estimated area under wetlands to be is 11011 ha (Table 28). Besides mapping of 309 (> 2.25 ha) an additional, 958 wetlands < 2.25 ha have also been discerned. River/Stream singularly comprised the majority (about 77 %) of extent of wetlands. The other major wetland types in terms of area are Reservoir/barrage (657 ha) and Tank/Ponds (569 ha). On the other hand small wetlands (<2.25 ha) accounted for about 9 per cent of the wetland area in the district. Aquatic vegetation has shown a marginal increase of about 2 per cent from post-monsoon (842 ha) to pre-monsoon (981 ha). Open water is dominated by moderate turbidity followed by low in both the seasons. High turbidity is not observed in post-monsoon. However, a small area (52 ha) was observed in pre-monsoon season.

Table 28: Area estimates of wetlands in Boudh district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	58	354	3.21	112	101
6	1106	River/Stream	37	8458	76.81	8453	8339
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	52	657	5.97	305	177
8	1202	Tanks/Ponds	158	569	5.17	333	333
9	1203	Waterlogged	1	4	0.04	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	309	10053	91.30	9203	8950
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	309	10053	91.30	9203	8950
		Wetlands (<2.25 ha)	958	958	8.70	-	-
		Total	1267	11011	100.00	9203	8950

Area under Aquatic Vegetation	842	981
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Area under turbidity levels		
Low	2348	3949
Moderate	6855	4949
High	-	52

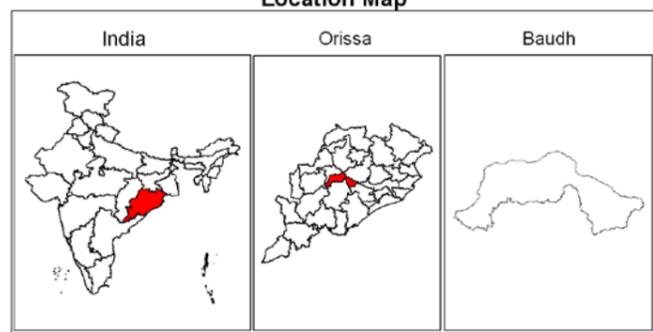


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1102			High altitude wetlands
	1103			Riverine wetlands
	1104			Waterlogged
	1105			River/Stream
	1106			
			Man-made	
				Reservoirs/Barrages
	1201			Tanks/Ponds
	1202			Waterlogged
	1203			Salt pans
	1204			
		Coastal Wetlands		
			Natural	
				Lagoons
	2101			Creeks
	2102			Sand/Beach
	2103			Intertidal mud flats
	2104			Salt marsh
	2105			Mangroves
	2106			Coral reefs
	2107			
			Man-made	
				Salt pans
	2201			Aquaculture ponds
	2202			

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

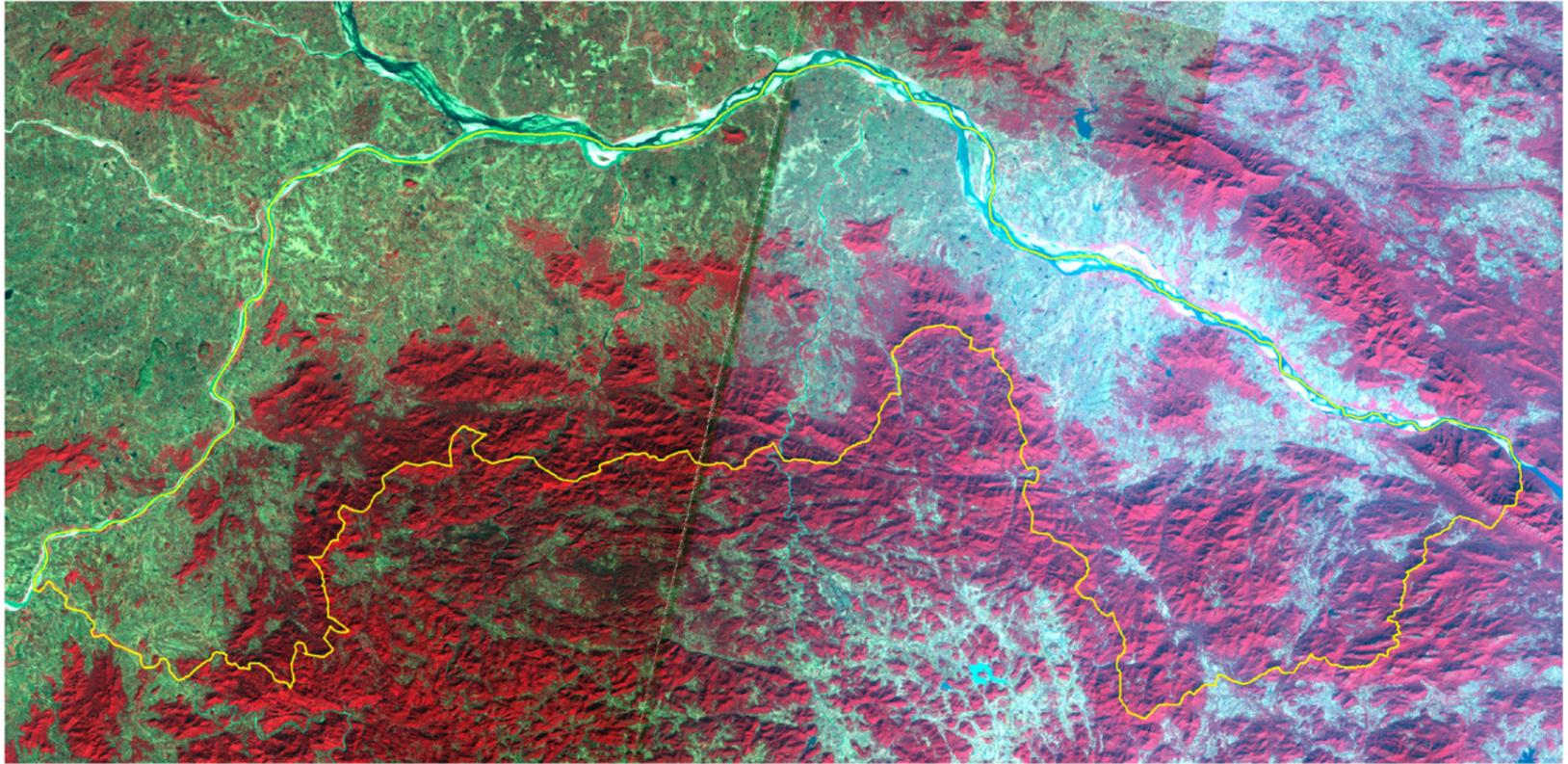


0 5 10 20 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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7.1.23 Sonapur

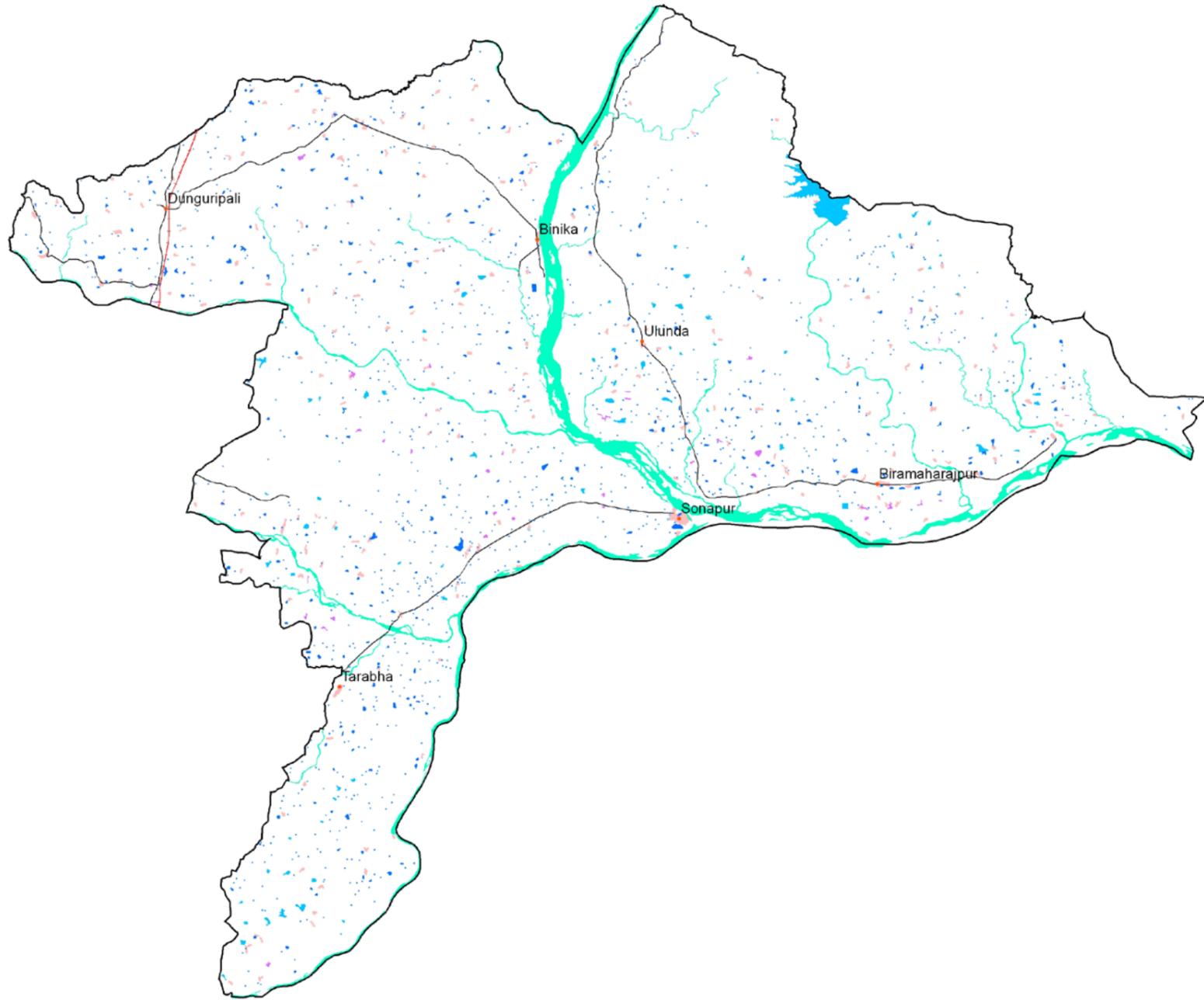
The total geographic area of Sonapur district is 2337 sq km. The wetland area estimated is 12576 ha (Table 29). An additional 1071 wetlands smaller than 2.25 ha have been discerned as point features besides mapping of 447 wetlands >2.25 ha. River/Stream (8881 ha) constituting about 71 per cent has dominated the area under wetlands. The other major types are Reservoir/Barrage (1248 ha) and Tank/Pond (1152 ha). A marginal seasonal decrease of about 5 per cent has been observed in the extent of open water from post-monsoon (10899 ha) to pre-monsoon (10333 ha). Aquatic vegetation has registered an increase of 358 ha from 611 ha in post-monsoon to 969 ha in pre-monsoon. Moderate turbidity accounted for major part of the open water in both post- and pre-monsoon (9534 ha and 6062 ha respectively) followed by low and high turbidity.

Table 29: Area estimates of wetlands in Sonapur district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	5	15	0.12	15	15
5	1105	Waterlogged	37	206	1.64	158	158
6	1106	River/Stream	43	8881	70.62	8886	8678
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	76	1248	9.92	1019	658
8	1202	Tanks/Ponds	285	1152	9.16	818	821
9	1203	Waterlogged	1	3	0.02	3	3
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	447	11505	91.48	10899	10333
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	447	11505	91.48	10899	10333
		Wetlands (<2.25 ha)	1071	1071	8.52	-	-
		Total	1518	12576	100.00	10899	10333

Area under Aquatic Vegetation	611	969
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Area under turbidity levels		
Low	1272	2773
Moderate	9534	6062
High	93	1498

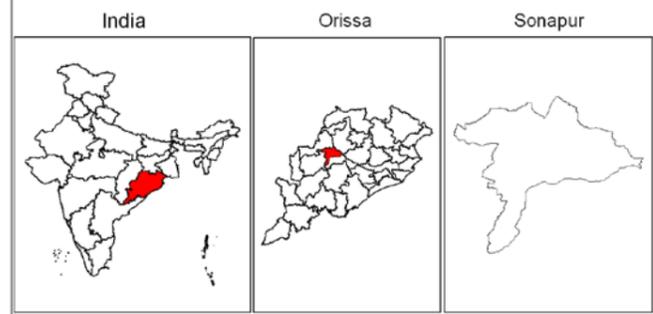


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
■	1101			Ox-bow lakes/ Cut-off meanders
■	1102			High altitude wetlands
■	1103			Riverine wetlands
■	1104			Waterlogged
■	1105			River/Stream
■	1106			
			Man-made	
■	1201			Reservoirs/Barrages
■	1202			Tanks/Ponds
■	1203			Waterlogged
■	1204			Salt pans
		Coastal Wetlands		
			Natural	
■	2101			Lagoons
■	2102			Creeks
■	2103			Sand/Beach
■	2104			Intertidal mud flats
■	2105			Salt marsh
■	2106			Mangroves
■	2107			Coral reefs
			Man-made	
■	2201			Salt pans
■	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

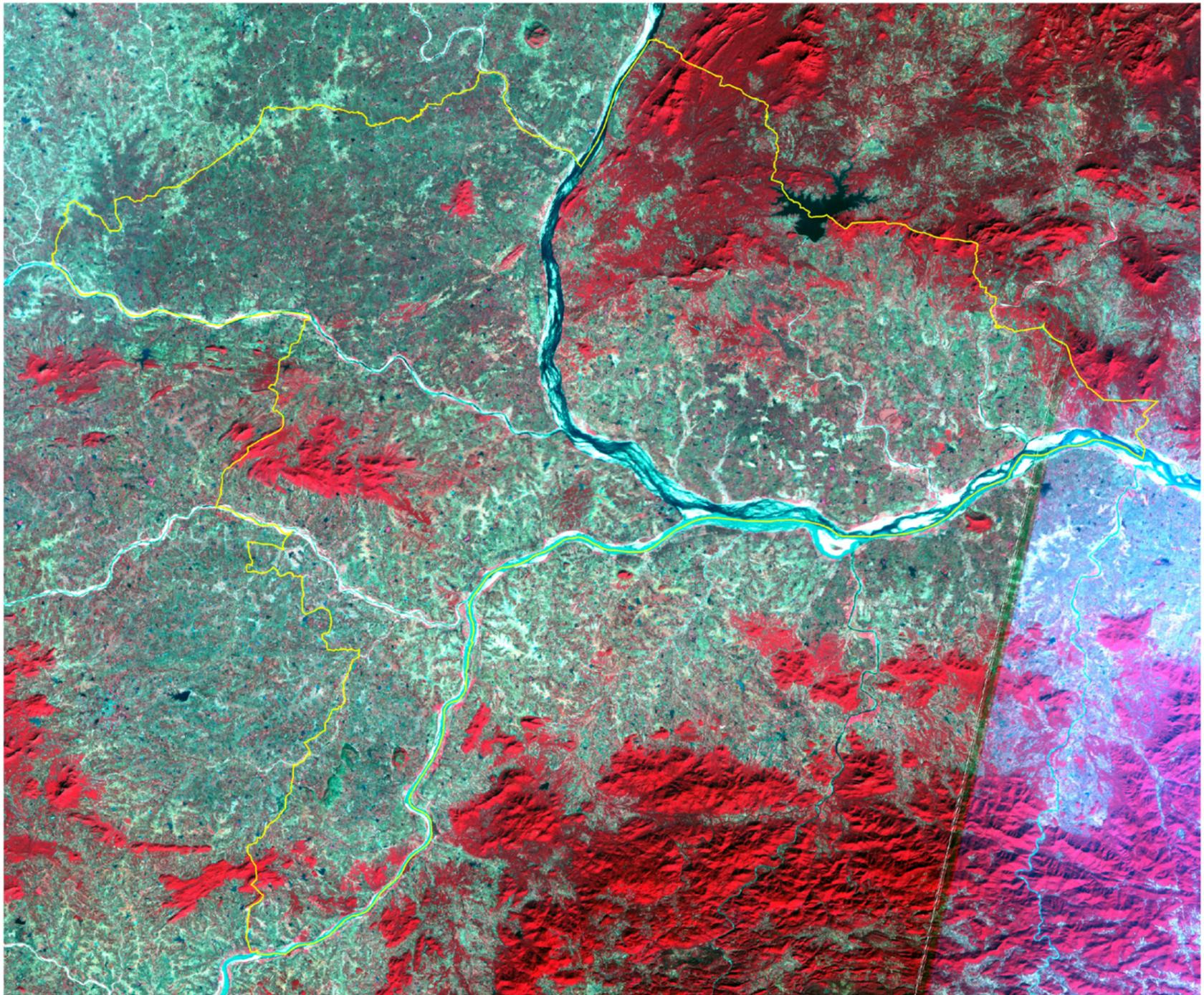


0 3 6 12 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Orissa Space Applications Centre, Bhubaneswar

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7.1.24 Balangir

The total geographical area of Balangir district is 6552 sq km. The district comprised of 5036 wetlands of which 3748 are <2.25 ha while 1288 are >2.25 ha. The wetland area is estimated to be 20276 ha (Table 30). The major wetland types are River/Stream (9040 ha) followed by Tank/Pond (4196 ha) and Reservoir/Barrage (2483 ha). In terms of per cent, small wetlands (<2.25 ha) constitute a major part (about 18 %) of wetland extent. Open water in post-monsoon constituted 13407 ha out 16528 ha of wetlands has shown a reduction to 12503 ha in pre-monsoon. Similarly, an increase of 924 ha is observed in aquatic vegetation from post-monsoon (3020 ha) to pre-monsoon. Moderate turbidity dominated major part of the open water followed by low in both seasons. High turbidity (494 ha) is observed only in pre-monsoon season.

Table 30: Area estimates of wetlands in Balangir district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	5	31	0.15	31	31
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	28	191	0.94	144	135
5	1105	Waterlogged	78	580	2.86	282	285
6	1106	River/Stream	85	9040	44.58	8972	8980
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	94	2483	12.25	1560	672
8	1202	Tanks/Ponds	996	4196	20.69	2414	2396
9	1203	Waterlogged	2	7	0.03	4	4
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	1288	16528	81.52	13407	12503
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	1288	16528	81.52	13407	12503
		Wetlands (<2.25 ha)	3748	3748	18.48	-	-
		Total	5036	20276	100.00	13407	12503

Area under Aquatic Vegetation	3020	3944
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Area under turbidity levels		
Low	2717	1126
Moderate	10695	10883
High	-	494

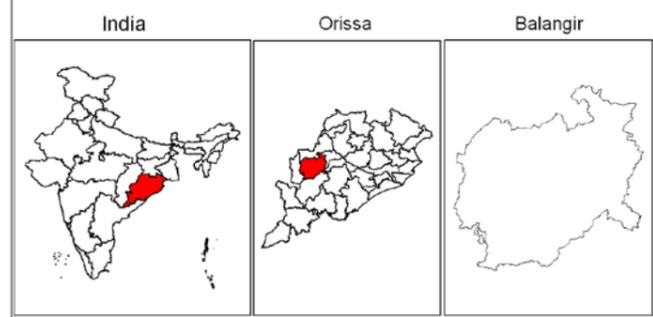


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

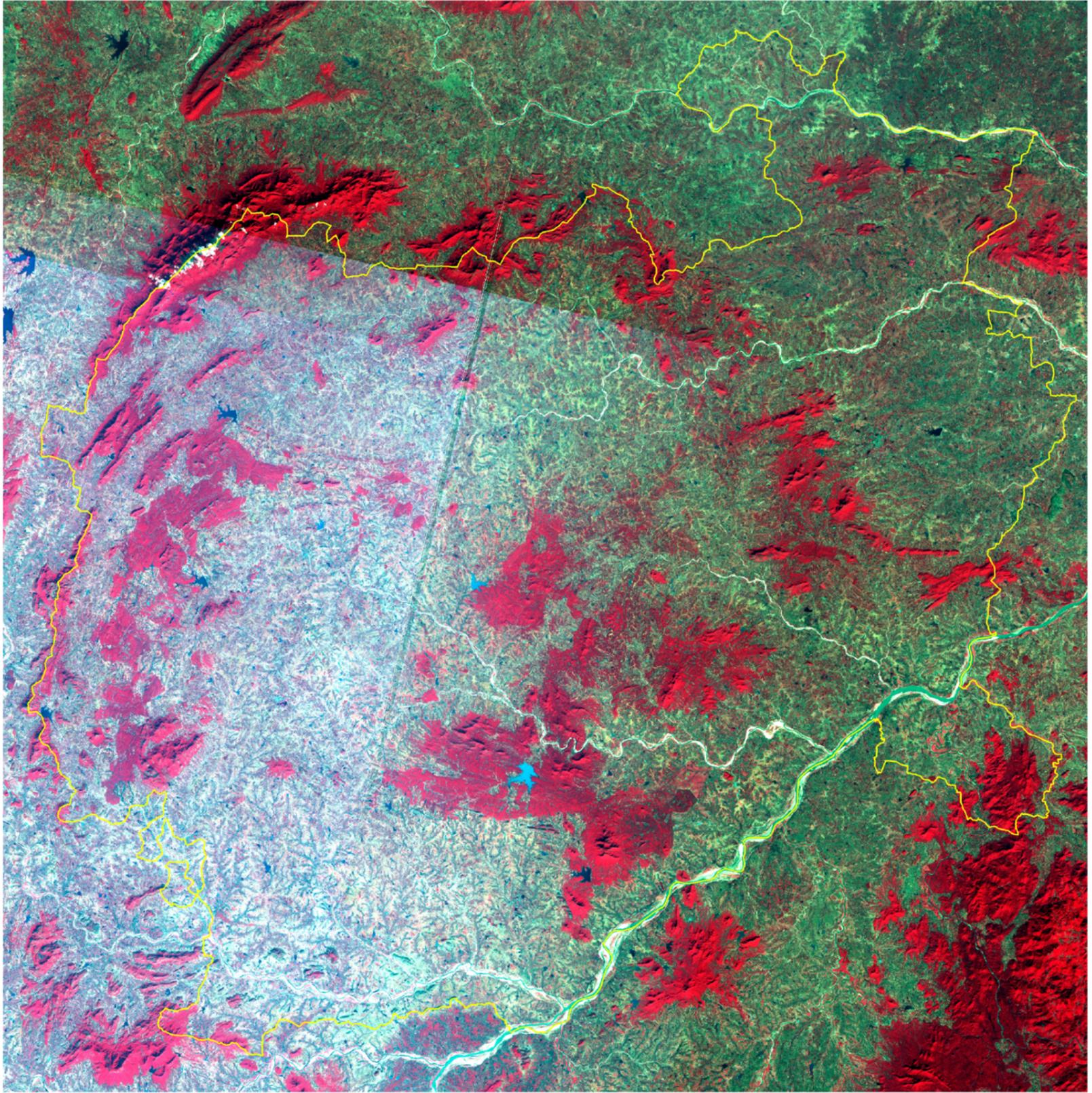


0 4 8 16 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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7.1.25 Nuapada

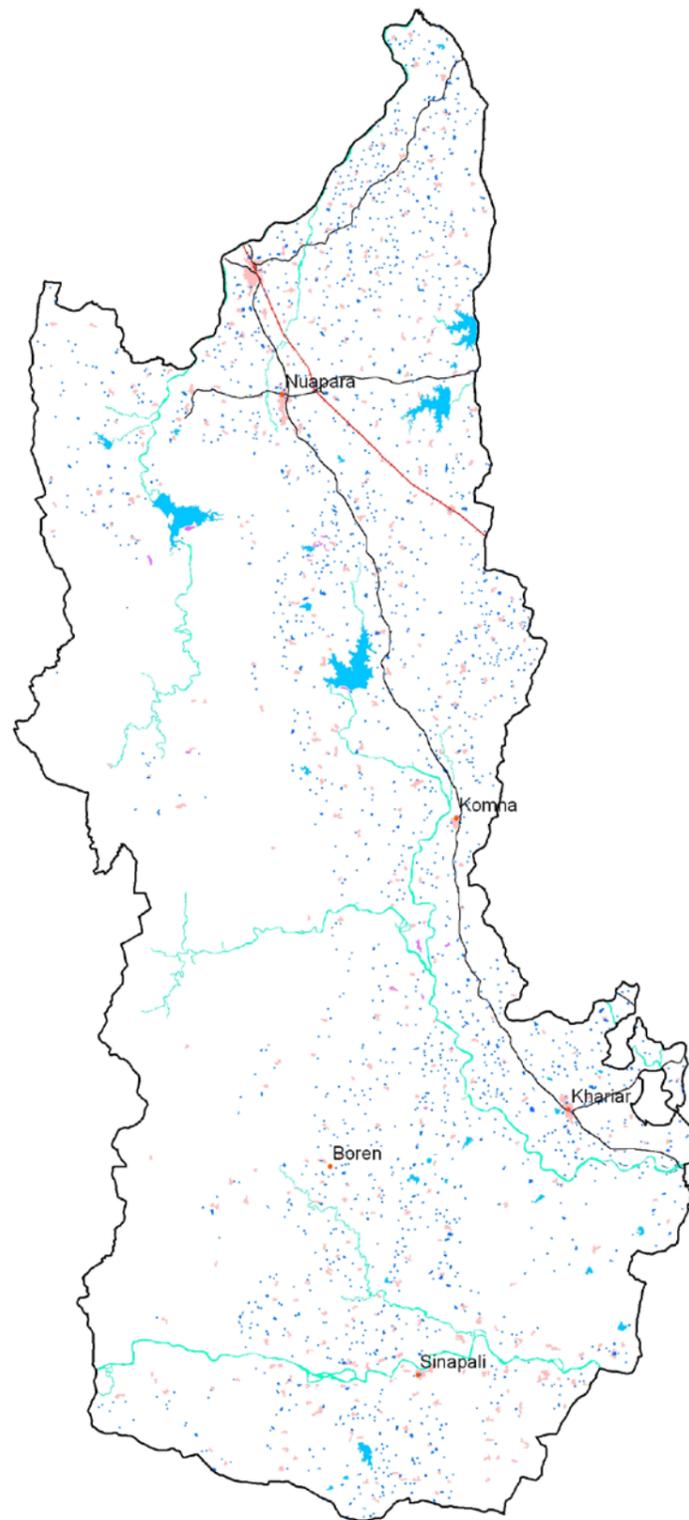
The total geographical area of Nuapada district is 3408 sq km with an estimated area of 9792 ha (Table 31) under wetlands. This area comprises of 2130 wetlands, which include 1653 small wetlands (<2.25 ha) that have been discerned as point features. The major wetland types are River/Stream (3431 ha) followed by Reservoir/Barrage (3026 ha) and Tank/Pond (1534 ha). Substantial seasonal reduction (about 27 %) is observed in the open water from post-monsoon (6842 ha) to 4961 ha in pre-monsoon. A two and half times increase in aquatic vegetation is observed from post-monsoon (1227 ha) to pre-monsoon (3070 ha). Open water exhibited moderate turbidity in a major extent in post-monsoon (4547 ha) as well as pre-monsoon (4332 ha) followed by low and high turbidity. However, low turbidity is not observed in post-monsoon.

Table 31: Area estimates of wetlands in Nuapada District

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	5	19	0.19	19	19
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	17	129	1.32	80	80
6	1106	River/Stream	35	3431	35.04	3362	3323
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	29	3026	30.90	2474	632
8	1202	Tanks/Ponds	391	1534	15.67	907	907
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	477	8139	83.12	6842	4961
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	477	8139	83.12	6842	4961
		Wetlands (<2.25 ha)	1653	1653	16.88	-	-
		Total	2130	9792	100.00	6842	4961

Area under Aquatic Vegetation	1227	3070
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Area under turbidity levels		
Low	2295	609
Moderate	4547	4332
High	-	20

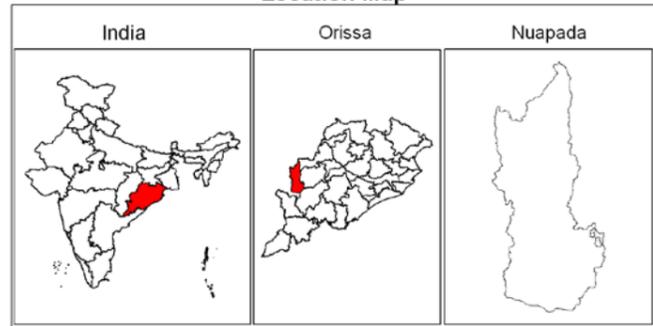


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1102			High altitude wetlands
	1103			Riverine wetlands
	1104			Waterlogged
	1105			River/Stream
	1106			
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

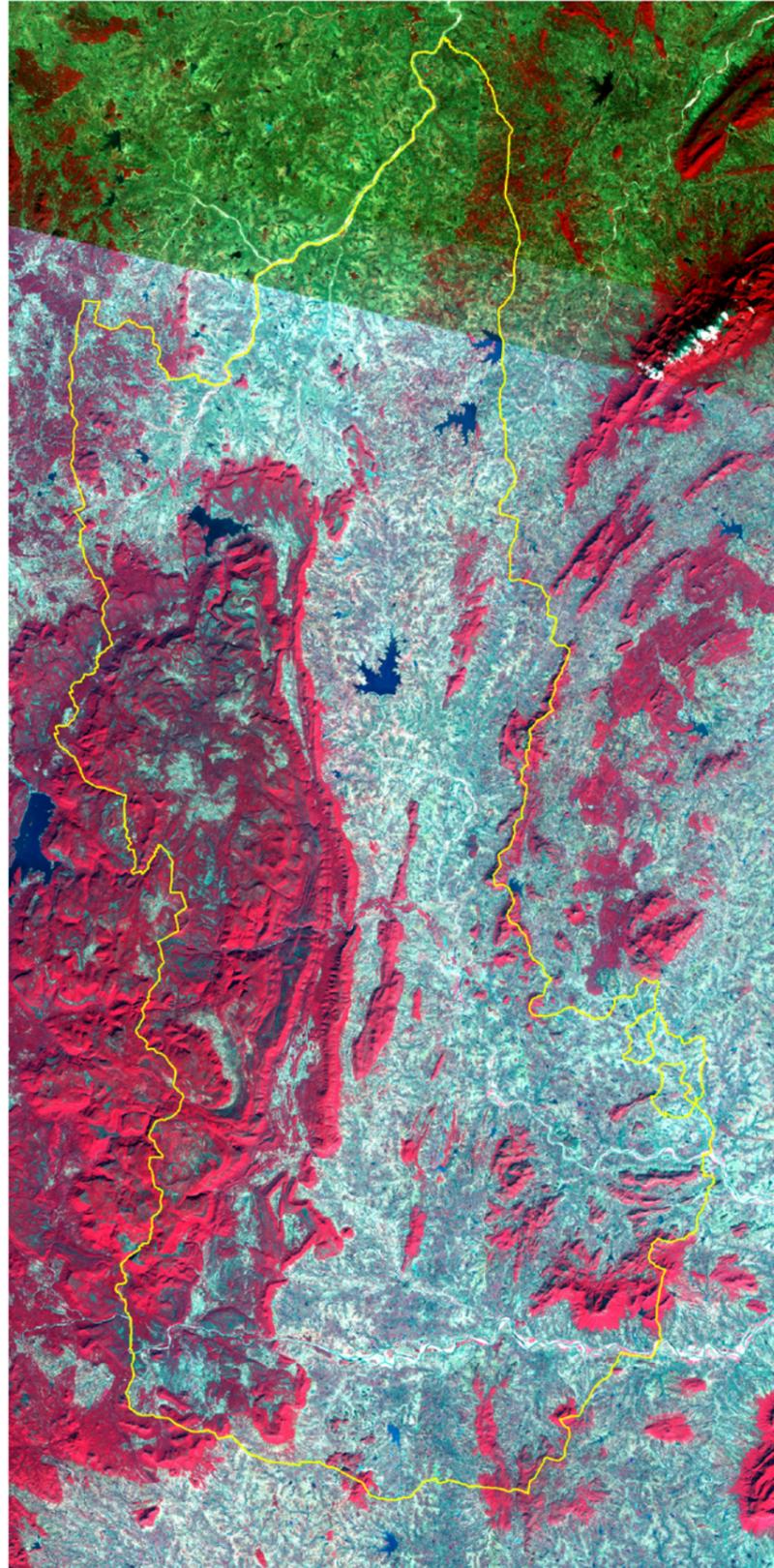


0 5 10 20 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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7.1.26 Kalahandi

The total geographic area of Kalahandi district is 8197 sq km with about 3.4 per cent area under wetlands. The wetland area is estimated to be 23227 ha (Table 32), which include mapped wetlands of 981 (>2.25 ha) and small wetlands (<2.25 ha) shown as point features. The major wetland types are River/Stream (8810 ha) followed by Reservoir/Barrage (7746 ha) and Tank/Pond (2826 ha). The small wetlands constitute a significant per cent (about 14 %) of wetlands in the district. About 8 per cent decrease has been observed in open water extent from post-monsoon (17408 ha) to pre-monsoon (16015 ha). Aquatic vegetation has shown about 1.5 per cent increase from 2779 ha in post-monsoon to 3943 ha in pre-monsoon. Moderate turbidity formed the majority level of turbidity prevailing in the open water in the sate followed by low and high in both the seasons. .

Table 32: Area estimates of wetlands in Kalahandi district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	0	0	0.00	0	0
2	1102	Ox-bow lakes/ Cut-off meanders	3	12	0.05	12	12
3	1103	High altitude wetlands	0	0	0.00	0	0
4	1104	Riverine wetlands	26	158	0.68	133	133
5	1105	Waterlogged	71	396	1.70	70	74
6	1106	River/Stream	80	8810	37.93	8771	8743
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	115	7746	33.35	7116	5788
8	1202	Tanks/Ponds	686	2826	12.17	1306	1265
9	1203	Waterlogged	0	0	0.00	0	0
10	1204	Salt pans	0	0	0.00	0	0
		Total - Inland	981	19948	85.88	17408	16015
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	0	0	0.00	0	0
12	2102	Creeks	0	0	0.00	0	0
13	2103	Sand/Beach	0	0	0.00	0	0
14	2104	Intertidal mud flats	0	0	0.00	0	0
15	2105	Salt Marsh	0	0	0.00	0	0
16	2106	Mangroves	0	0	0.00	0	0
17	2107	Coral Reefs	0	0	0.00	0	0
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	0	0	0.00	0	0
19	2202	Aquaculture ponds	0	0	0.00	0	0
		Total - Coastal	0	0	0.00	0	0
		Sub-Total	981	19948	85.88	17408	16015
		Wetlands (<2.25 ha)	3279	3279	14.12	0	0
		Total	4260	23227	100.00	17408	16015

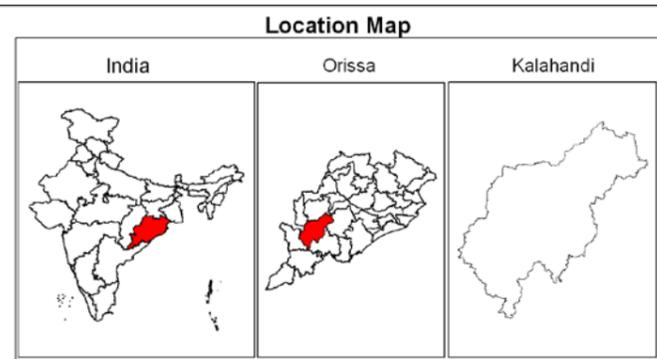
Area under Aquatic Vegetation	2779	3943
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Area under turbidity levels		
Low	5047	5091
Moderate	12136	10894
High	225	30



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1102			High altitude wetlands
	1103			Riverine wetlands
	1104			Waterlogged
	1105			River/Stream
	1106			
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
				Lagoons
	2101			Creeks
	2102			Sand/Beach
	2103			Intertidal mud flats
	2104			Salt marsh
	2105			Mangroves
	2106			Coral reefs
	2107			
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

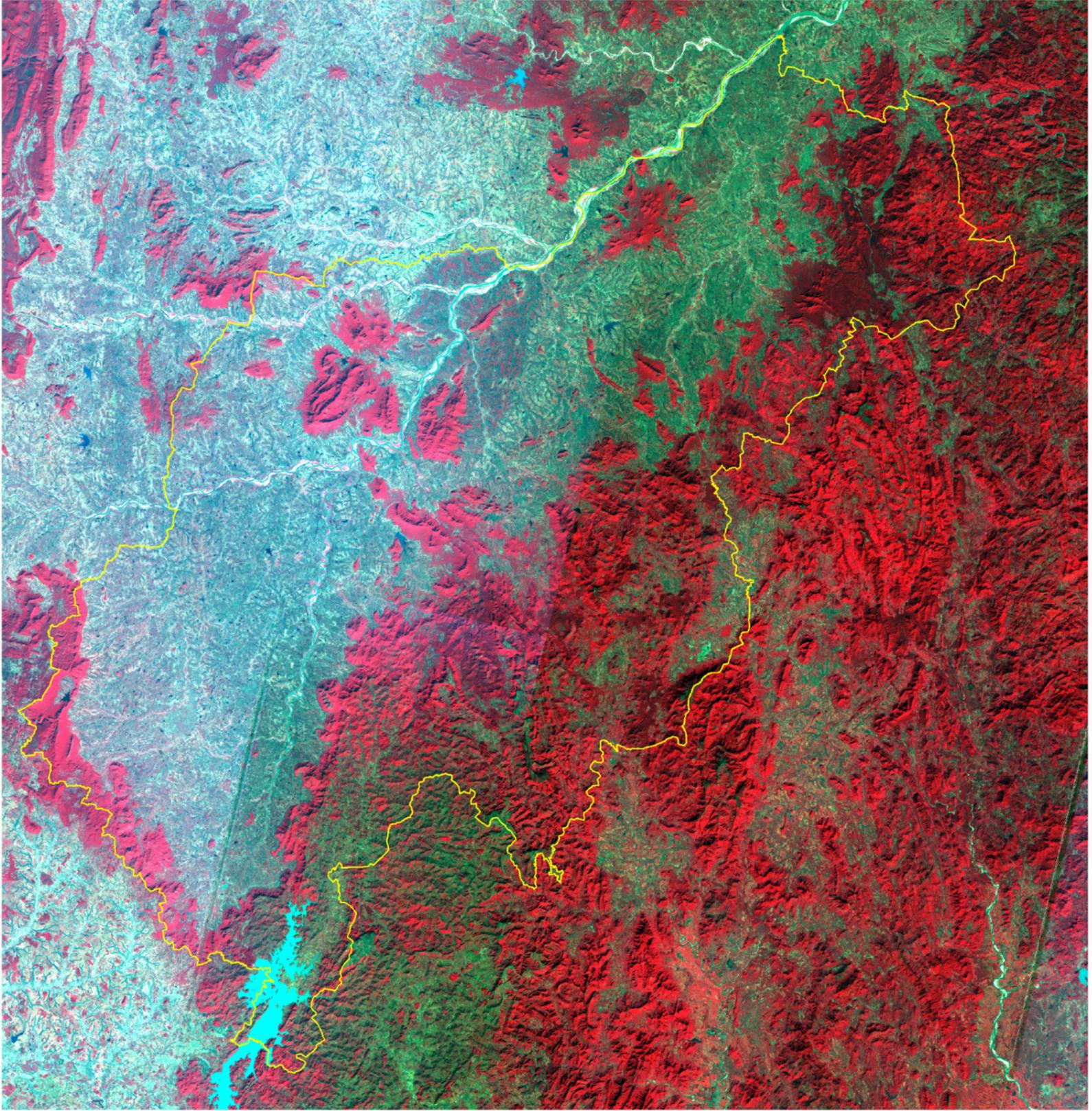
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

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7.1.27 Rayagada

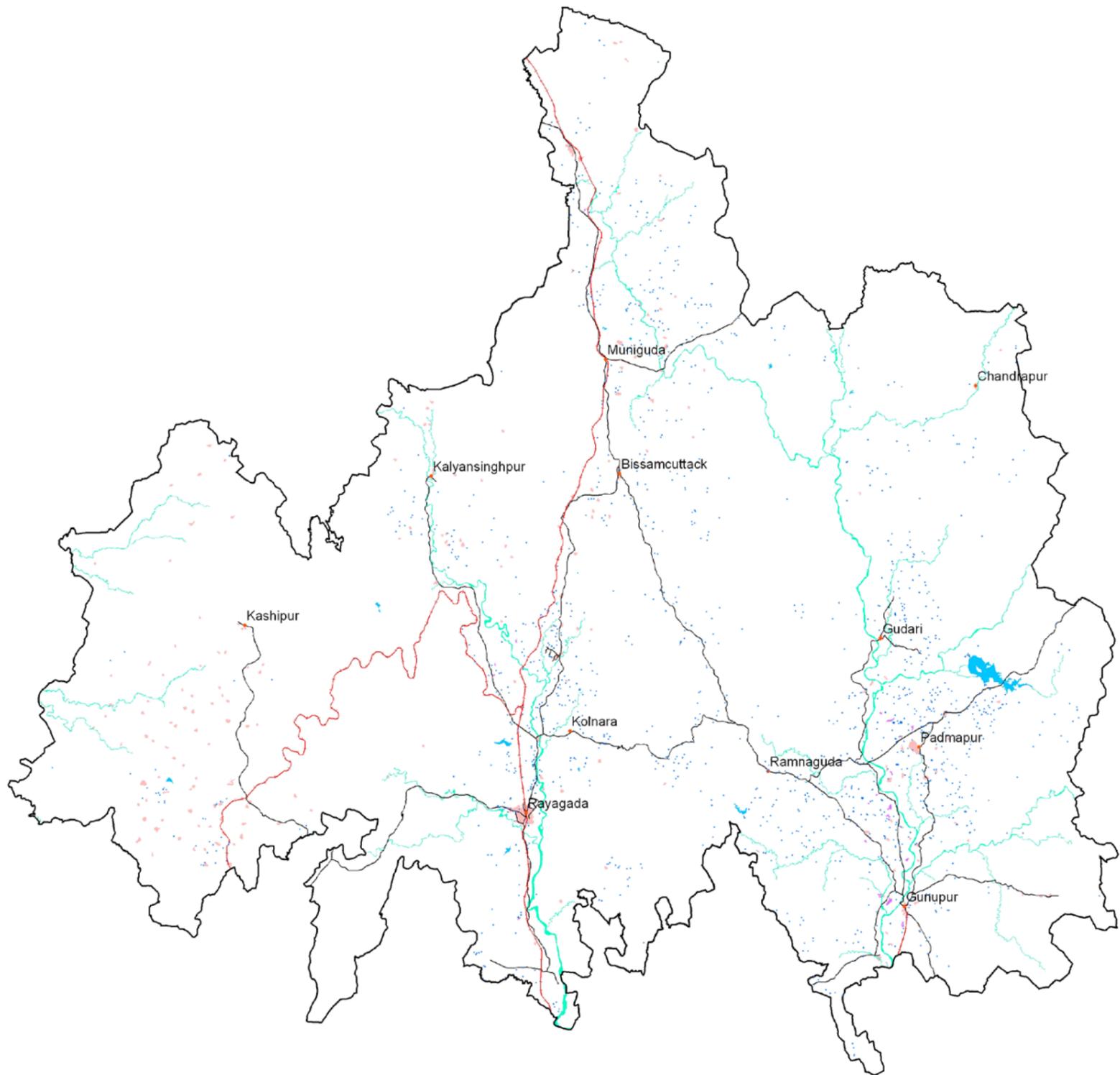
The total geographical area of Rayagada district is 7585 sq km with an estimated area of 8672 ha under wetlands (Table 33). There are 145 wetlands (>2.25 ha) and in addition, 1268 wetlands <2.25 ha have also been discerned as point features. About 70 per cent of wetland area is accounted by River/Stream (6082 ha) category. Other major category is Reservoir/Barrage (1028 ha). Nevertheless, the small wetlands (<2.25 ha) deserve a significance owing to their contribution of about 15 per cent of wetland area. The extent of open water has shown a seasonal decrease of 531 ha from post-monsoon (7048 ha) to pre-monsoon (6517 ha). Aquatic vegetation has registered an increase of 220 ha from post-monsoon to pre-monsoon. Open water is overwhelmingly moderate in turbidity in post-monsoon (6682 ha) as well as pre-monsoon (6282 ha) out of 7048 ha and 6517 ha of open water respectively.

Table 33: Area estimates of wetlands in Rayagada district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	2	10	0.12	10	10
5	1105	Waterlogged	18	147	1.70	4	4
6	1106	River/Stream	70	6082	70.13	6079	5769
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	17	1028	11.85	945	724
8	1202	Tanks/Ponds	37	134	1.55	10	10
9	1203	Waterlogged	1	3	0.03	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	145	7404	85.38	7048	6517
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	145	7404	85.38	7048	6517
		Wetlands (<2.25 ha)	1268	1268	14.62	-	-
		Total	1413	8672	100.00	7048	6517

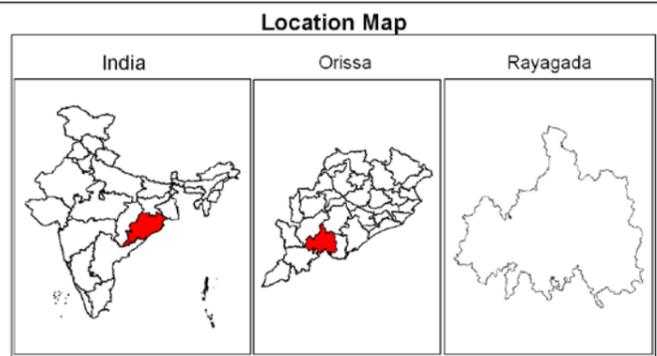
Area under Aquatic Vegetation	354	574
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Area under turbidity levels		
Low	366	142
Moderate	6682	6282
High	-	93



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1102			High altitude wetlands
	1103			Riverine wetlands
	1104			Waterlogged
	1105			River/Stream
	1106			
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

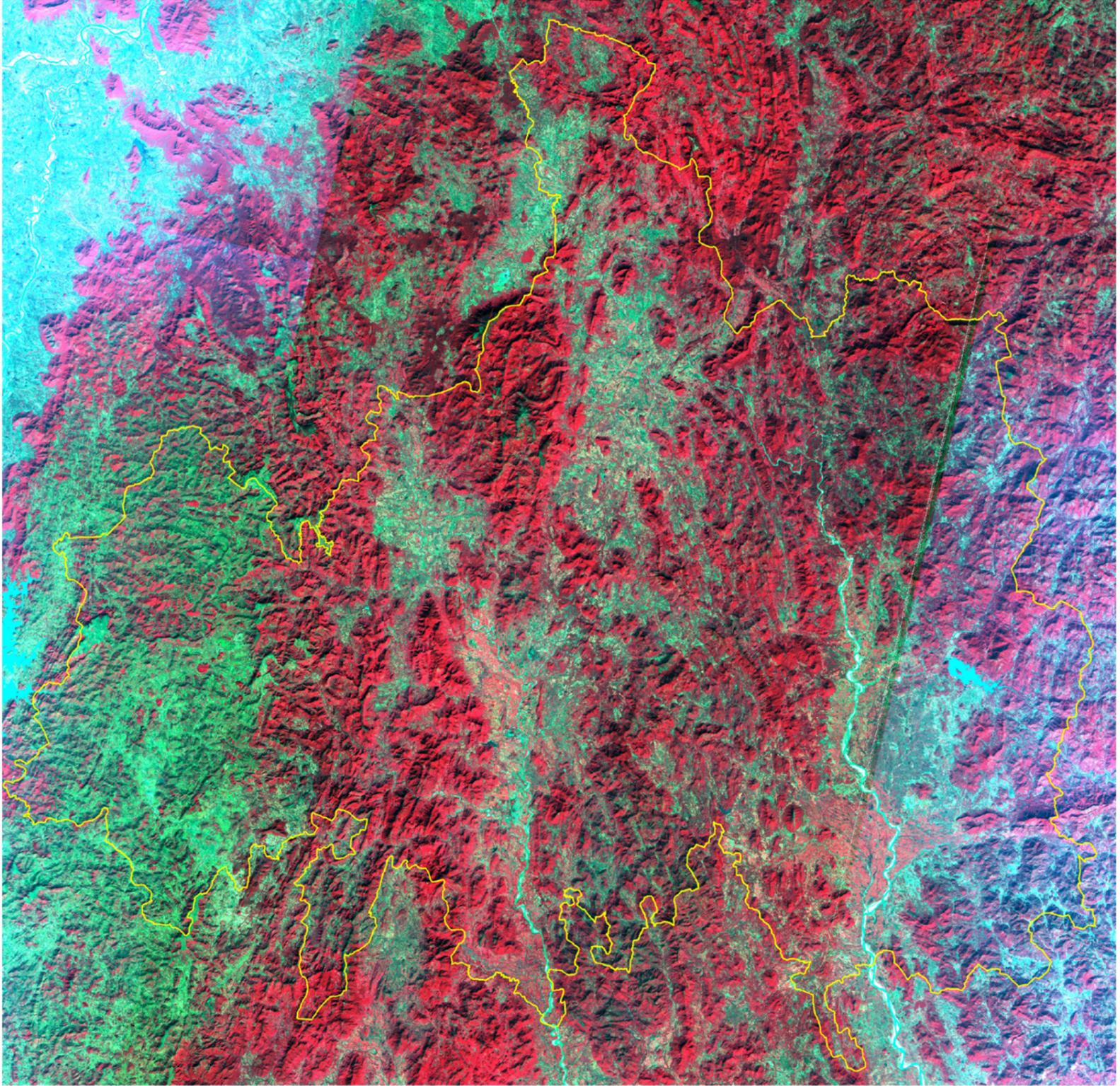
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary



Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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7.1.28 Nabarangapur

The total geographical area of Nabarangapur district is 5135 sq km. The wetland area is estimated to be 12503 ha (Table 34). An additional 3359 wetlands <2.25 ha have also been discerned as point features besides 295 wetlands (>2.25 ha), which could be mapped. The major wetland types are River/Stream (4496 ha) and Reservoir/Barrage (3858 ha). The district comprises a large number of small wetlands (3359), which assume importance in the light of the per cent (about 27) contribution towards the wetland area of the district. Open water has shown about 8 per cent seasonal reduction in area from 8588 ha in post-monsoon to pre-monsoon (7921 ha). On the other hand aquatic vegetation has registered a substantial increase of 414 ha in the overall extent from 570 ha in post-monsoon to pre-monsoon. Moderate turbidity dominated the open water in both the seasons followed by low and high turbidity.

Table 34: Area estimates of wetlands in Nabarangapur district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	2	20	0.16	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	2	8	0.06	8	8
5	1105	Waterlogged	12	119	0.95	40	3
6	1106	River/Stream	98	4496	35.96	4497	4245
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	14	3858	30.86	3808	3430
8	1202	Tanks/Ponds	165	632	5.05	232	232
9	1203	Waterlogged	2	11	0.09	3	3
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	295	9144	73.13	8588	7921
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	295	9144	73.13	8588	7921
		Wetlands (<2.25 ha)	3359	3359	26.87	-	-
		Total	3654	12503	100.00	8588	7921

Area under Aquatic Vegetation	570	984
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Area under turbidity levels		
Low	1789	2479
Moderate	5758	3734
High	1041	1708

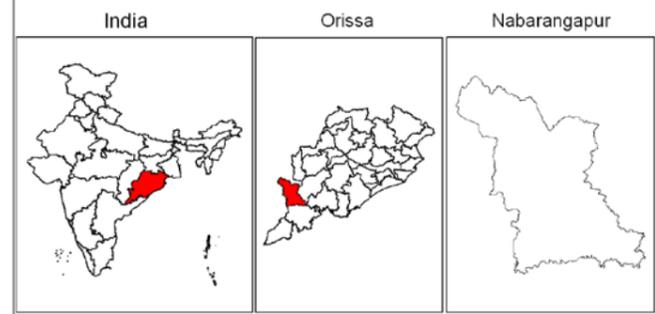


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

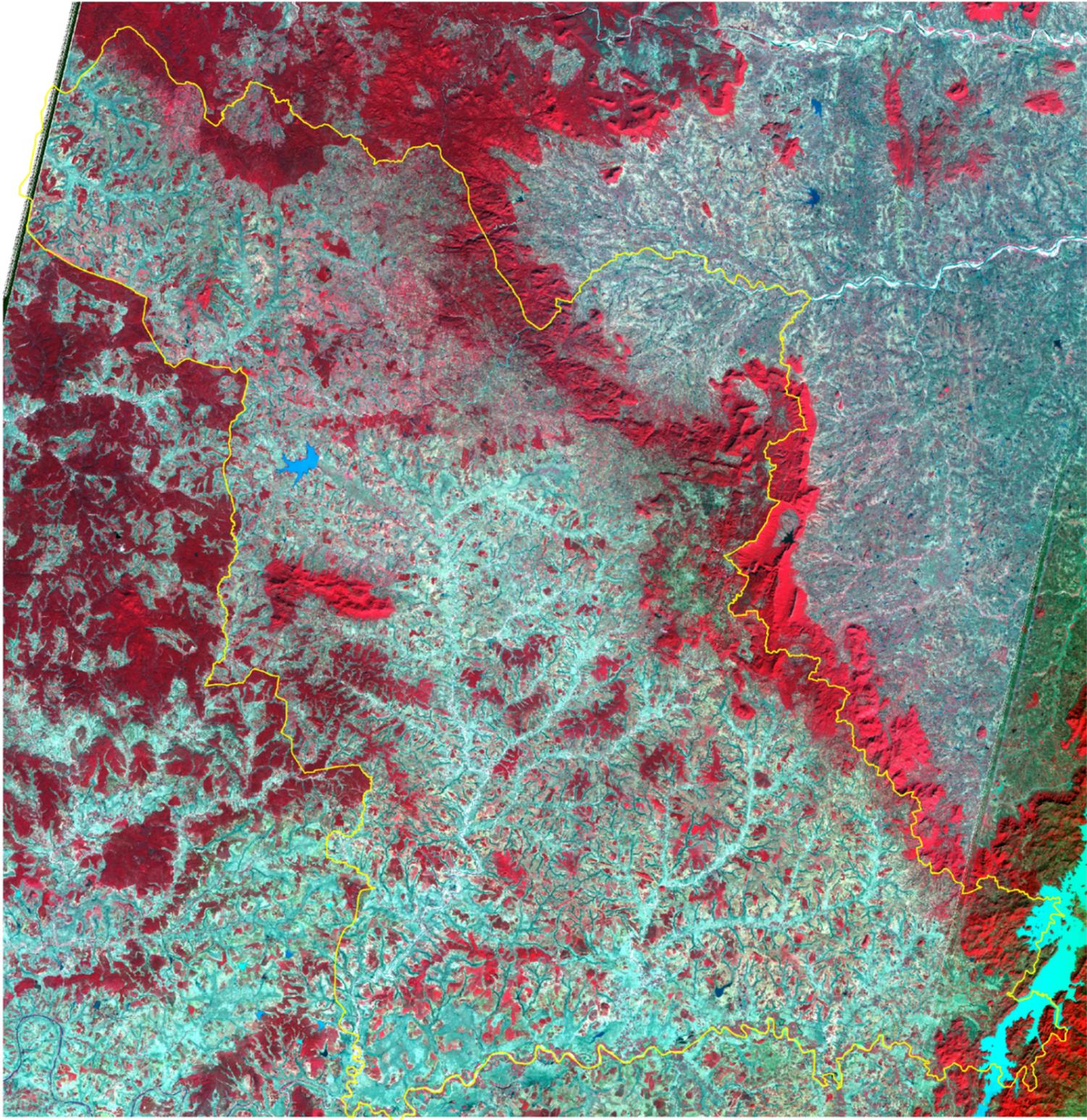


0 3.75 7.5 15 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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7.1.29 Koraput

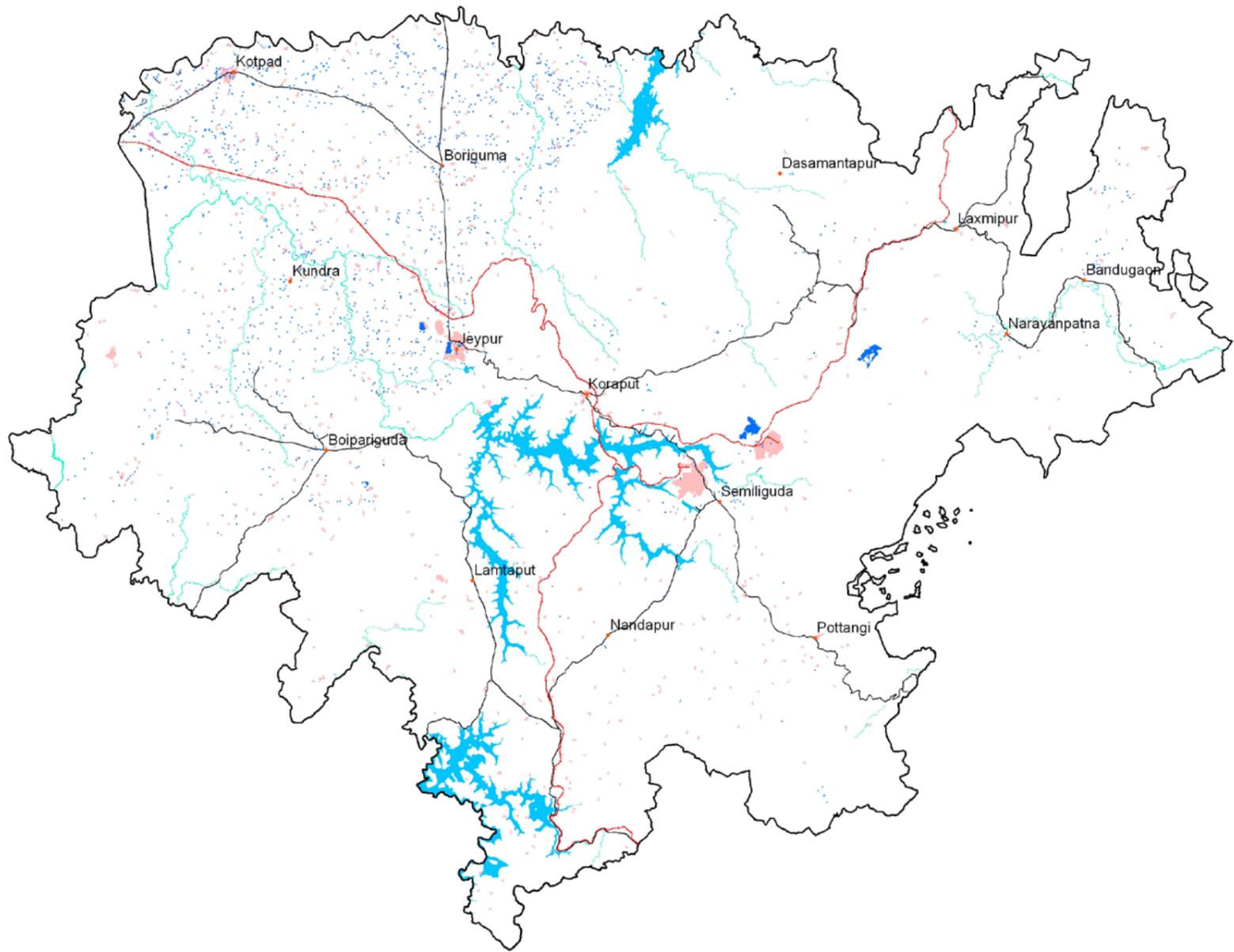
The total geographical area of Koraput district is 8534 sq km. The wetland area in the district is estimated to be 26307 ha (Table 35). This include 1404 wetlands <2.25 ha discerned as point features and 229 wetlands >2.25 ha that could be mapped. The major wetland types are Reservoir/Barrage (18833 ha) accounting for about 72 per cent of wetland extent and River/Stream (4908 ha). Open water registered about 21 per cent seasonal decline from post-monsoon (24124 ha) to pre-monsoon (19007 ha). On the other hand the aquatic vegetation has registered nearly ten-fold increase from post-monsoon (597 ha) to 5715 ha in pre-monsoon. Moderate turbidity accounted for majority extent of open water in both the seasons followed by low and high levels of turbidity.

Table 35: Area estimates of wetlands in Koraput district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	11	83	0.32	11	31
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	6	39	0.15	6	6
5	1105	Waterlogged	28	181	0.69	46	56
6	1106	River/Stream	101	4908	18.66	4908	4908
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	26	18833	71.59	18822	13901
8	1202	Tanks/Ponds	55	841	3.20	331	105
9	1203	Waterlogged	2	18	0.07	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	229	24903	94.66	24124	19007
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	229	24903	94.66	24124	19007
		Wetlands (<2.25 ha)	1404	1404	5.34	-	-
		Total	1633	26307	100.00	24124	19007

Area under Aquatic Vegetation	597	5715
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Area under turbidity levels		
Low	4574	3963
Moderate	19005	14256
High	545	788

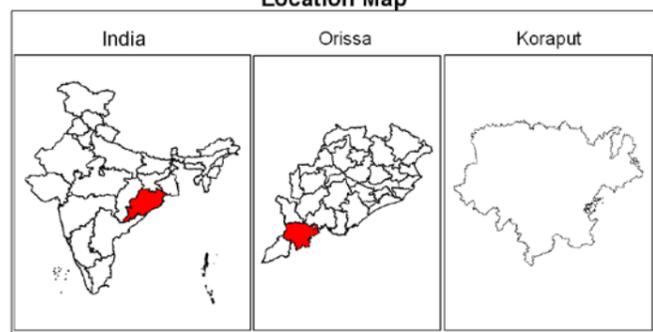


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

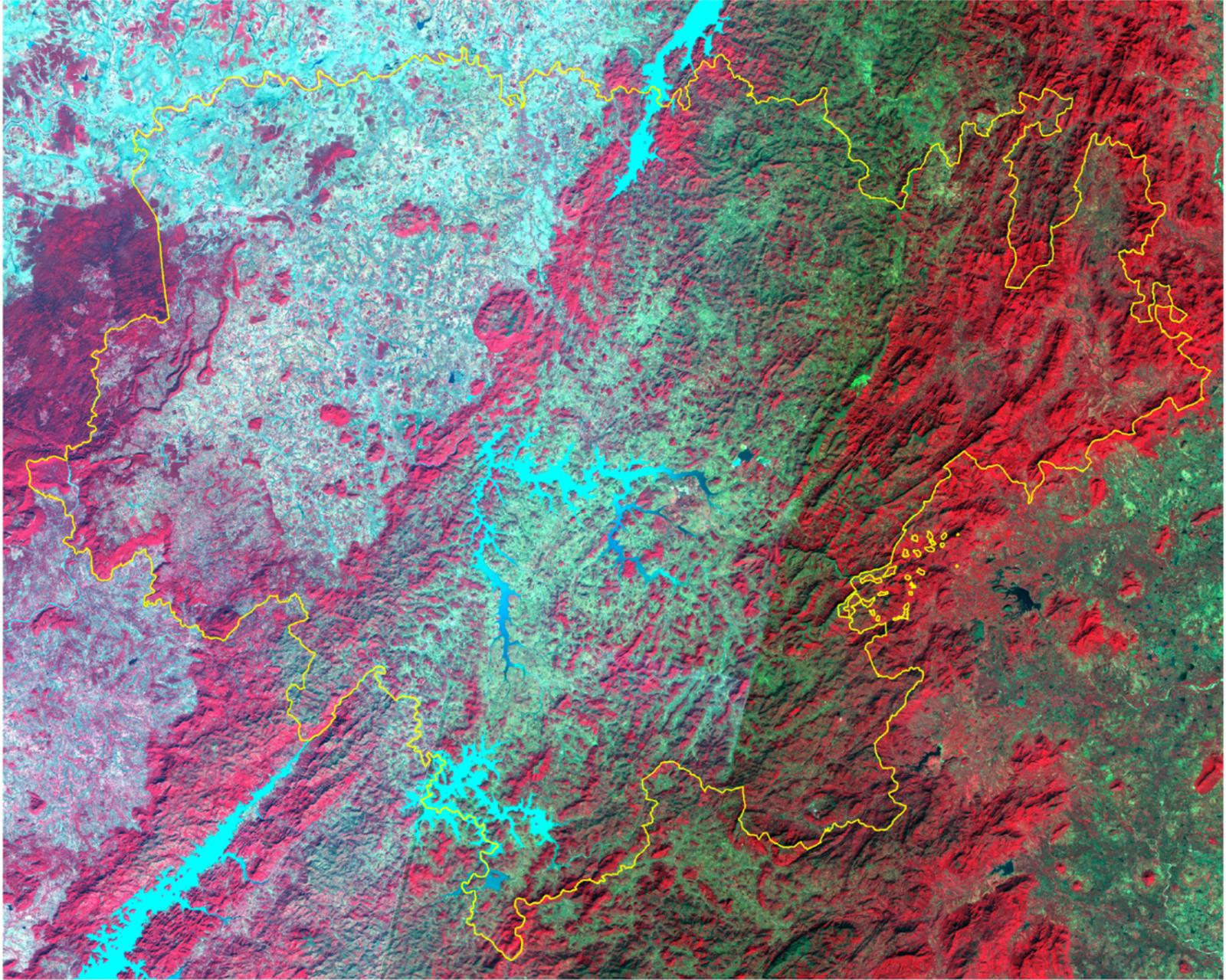


0 5 10 20 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
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7.1.30 Malkangiri

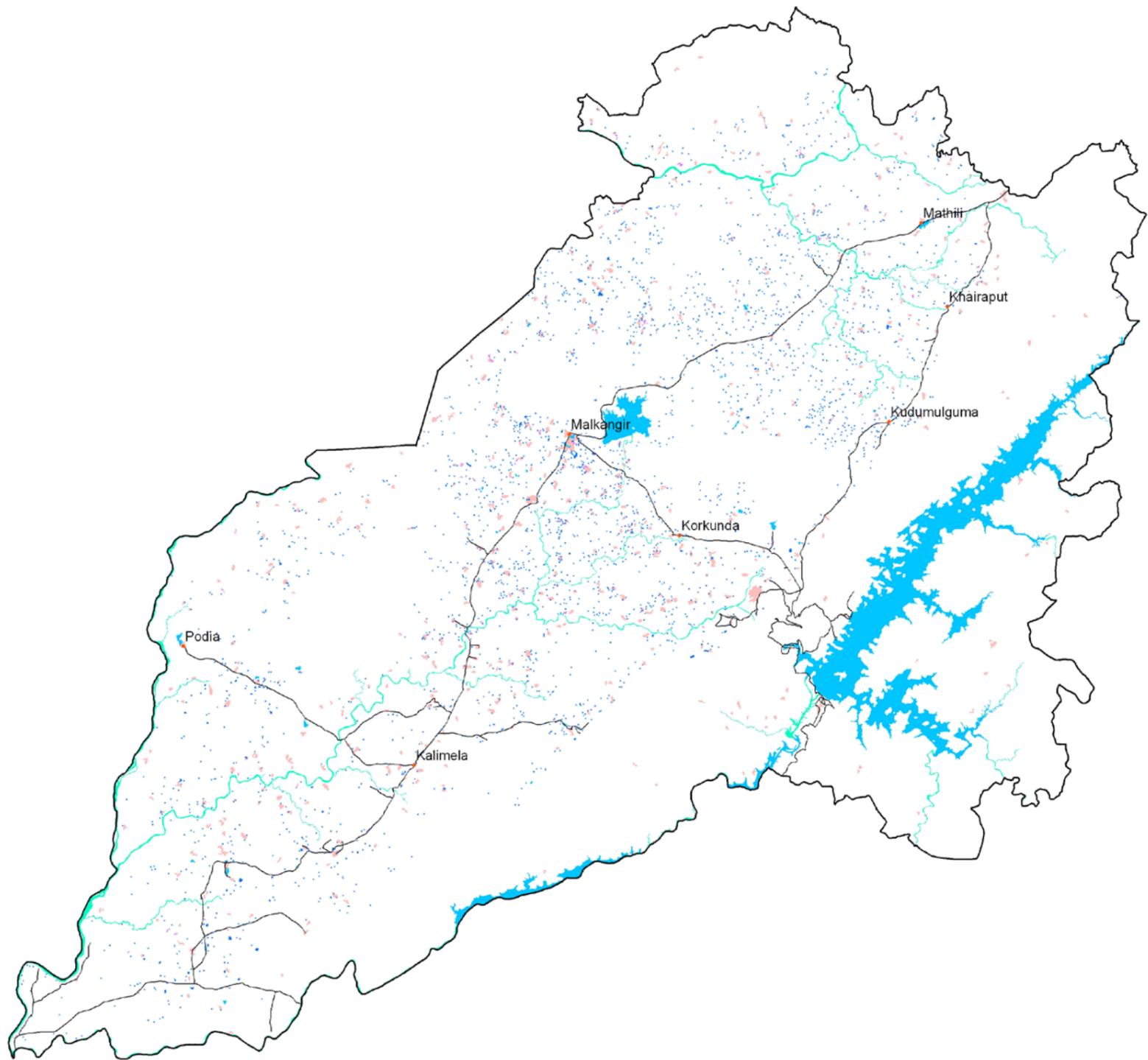
The total geographical area of Malkangiri district is 6115 sq km. The wetland area in this district is estimated to be 27796 ha (Table 36). An additional 2735 wetlands <2.25 ha have been discerned as pointy features besides 221 wetlands >2.25 ha that have been mapped. The major wetland types are Reservoir/Barrage (18689 ha) and River/Stream (5750 ha). The small wetlands constitute about 10 per cent of area under wetlands in the district. An extent of 5145 ha of open water was found declined as seasonal reduction from post-monsoon (24275 ha) to pre-monsoon (19130 ha). On the other hand the extent of aquatic vegetation has increased by 6 times from post-monsoon (940 ha) to 6005 ha in pre-monsoon. Low turbid extent was not observed in post-monsoon but moderate turbidity singularly dominated the open water in post-monsoon (23396 ha) followed by high (879 ha). Moderate turbidity continued to account for large extent (14789 ha) followed by low (3461 ha) and high (880 ha) in pre-monsoon season.

Table 36: Area estimates of wetlands in Malkangiri district

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	3	13	0.05	-	-
5	1105	Waterlogged	29	126	0.45	13	13
6	1106	River/Stream	32	5750	20.69	5750	5685
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	31	18689	67.24	18340	13260
8	1202	Tanks/Ponds	126	483	1.74	172	172
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	221	25061	90.16	24275	19130
	2100	Coastal Wetlands - Natural					
11	2101	Lagoons	-	-	-	-	-
12	2102	Creeks	-	-	-	-	-
13	2103	Sand/Beach	-	-	-	-	-
14	2104	Intertidal mud flats	-	-	-	-	-
15	2105	Salt Marsh	-	-	-	-	-
16	2106	Mangroves	-	-	-	-	-
17	2107	Coral Reefs	-	-	-	-	-
	2200	Coastal Wetlands - Man-made					
18	2201	Salt pans	-	-	-	-	-
19	2202	Aquaculture ponds	-	-	-	-	-
		Total - Coastal	-	-	-	-	-
		Sub-Total	221	25061	90.16	24275	19130
		Wetlands (<2.25 ha)	2735	2735	9.84	-	-
		Total	2956	27796	100.00	24275	19130

Area under Aquatic Vegetation	940	6005
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Area under turbidity levels		
Low	-	3461
Moderate	23396	14789
High	879	880

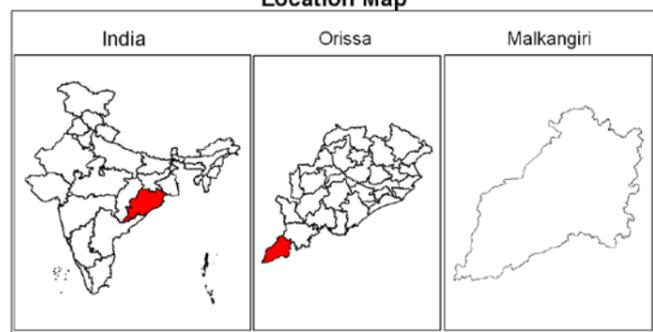


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
	1101			Ox-bow lakes/ Cut-off meanders
	1102			High altitude wetlands
	1103			Riverine wetlands
	1104			Waterlogged
	1105			River/Stream
	1106			
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
				Lagoons
	2101			Creeks
	2102			Sand/Beach
	2103			Intertidal mud flats
	2104			Salt marsh
	2105			Mangroves
	2106			Coral reefs
	2107			
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Canal
- Railway
- Drainage (line)
- Roads
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

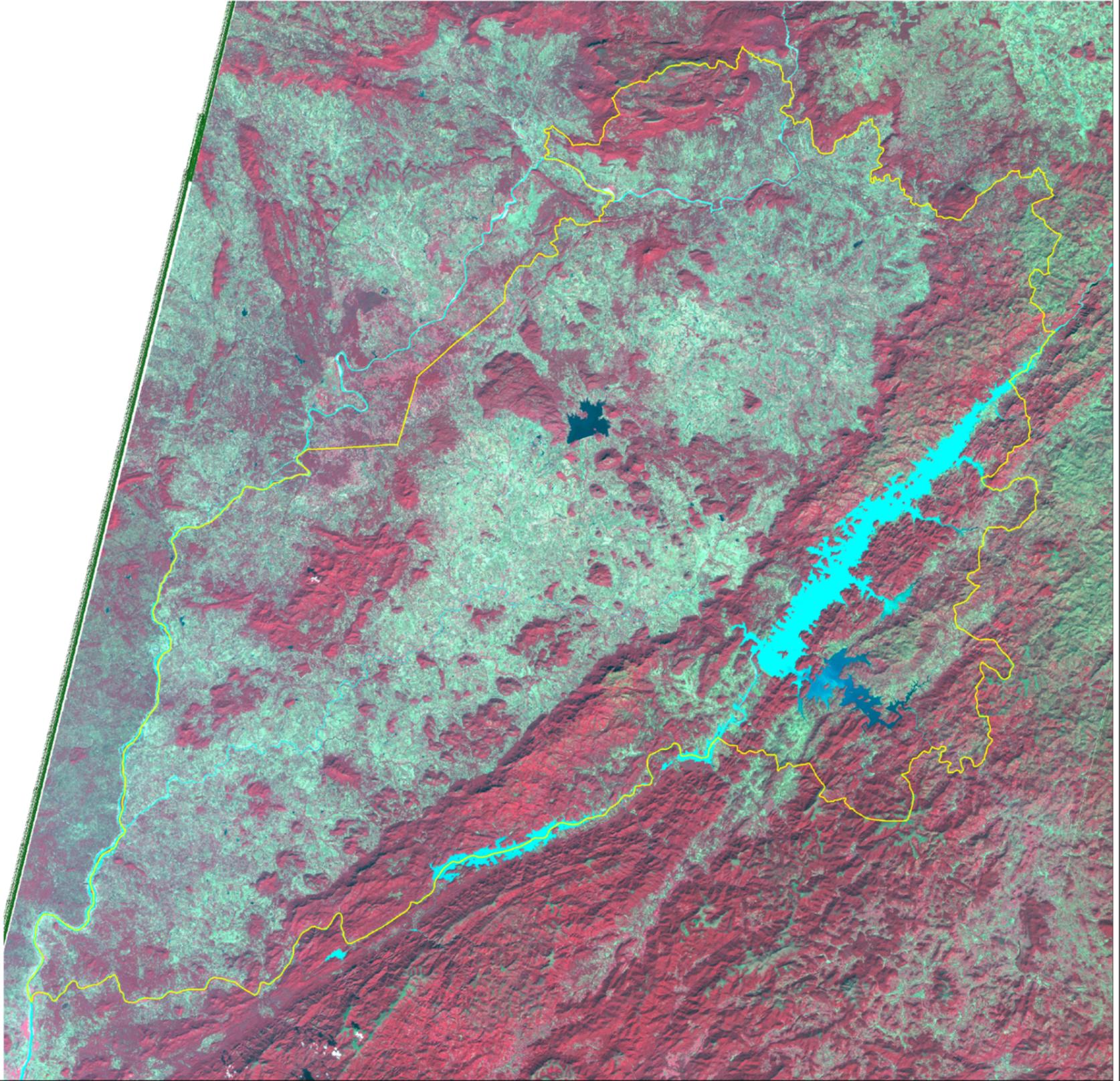


0 4 8 16 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Orissa Space Applications Centre, Bhubaneswar

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MAJOR WETLAND TYPES

8.0 MAJOR WETLAND TYPES OF ORISSA

Major wetland types observed in the state are lagoon, mangroves, inter-tidal mud flats, salt pans, beach, river, reservoirs, tanks and ponds. Details are given in Plate-1. Ground truth data was collected for selected wetland sites. The standard proforma was used to record the field data. Field photographs are also taken to record the water quality (subjective), status of aquatic vegetation and water spread. The location of the features was recorded using GPS. Field photographs and ground truth data of different wetland types are shown in Plates 2a,2b., 2c., 2d and 2e.

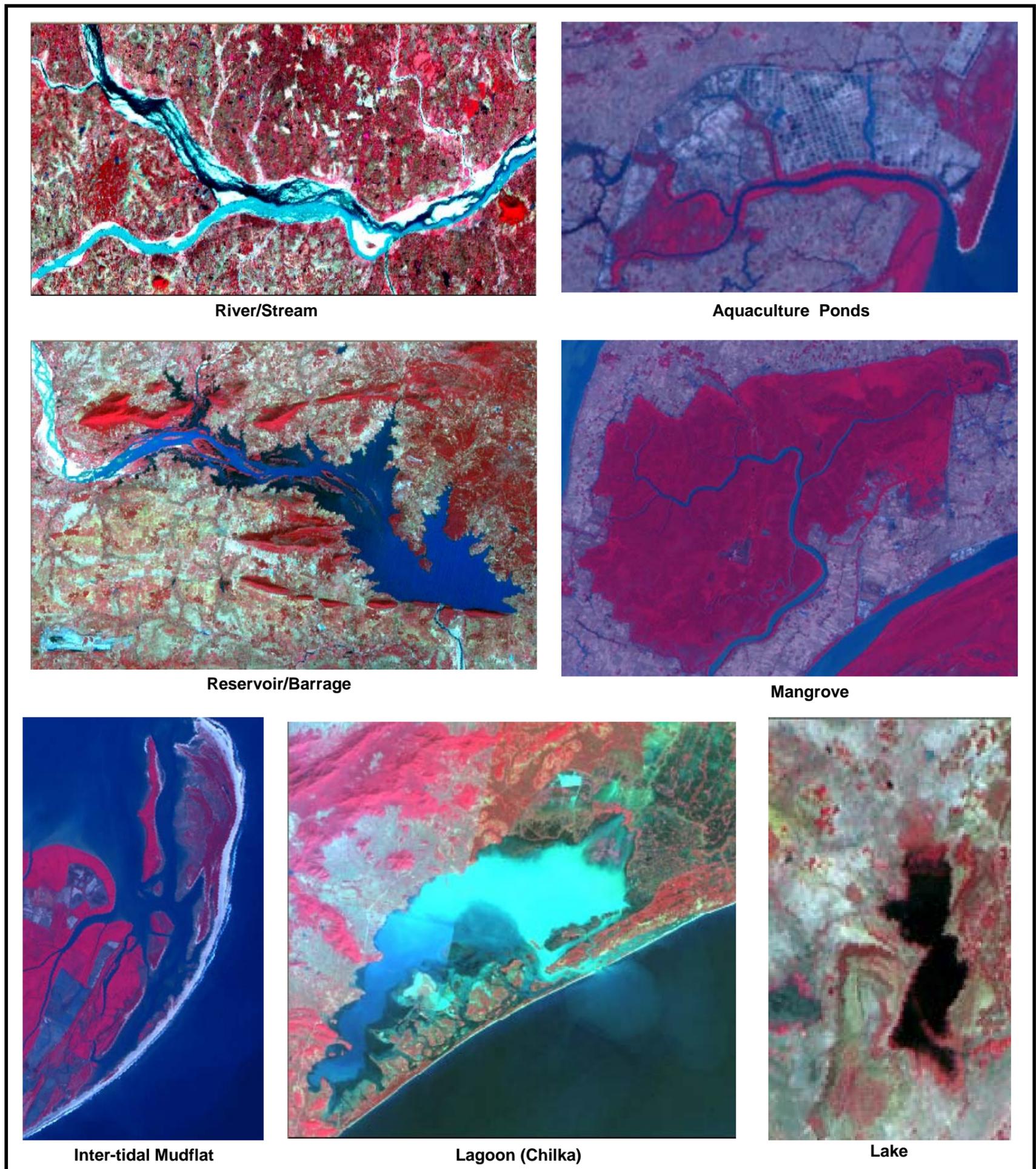


Plate - 1: Major wetland types of Orissa

Sr. No.	Description	Field Photograph
1	Wetland type: Sand/Beach Location: Balasore District Longitude: 87° 03' 20" E Latitude: 21° 27' 39" N	
2	Wetland type: Sand/Beach Location: Ganjam District Longitude: 84° 58' 40" E Latitude: 19° 18' 43" N	
3	Wetland type: River (Brahmini River) Location: Anugul District Longitude: 85° 02' 17" E Latitude: 21° 15' 27" N	
4	Wetland type: Salt Pans Location: Huma, Ganjam District Longitude: 85° 04' 26" E Latitude: 19° 24' 51" N	

Plate 2a: Field photographs and ground truth data of different wetland types in Orissa

<p>5</p>	<p>Wetland type: Reservoir Location: Boudh District Longitude: 83° 47' 53" E Latitude: 20° 32' 36" N</p>	
<p>6</p>	<p>Wetland type: Reservoir (Hadagarh) Location: Kendujhar District Longitude: 86° 17' 52" E Latitude: 21° 17' 14" N</p>	
<p>7</p>	<p>Wetland type: Man-made Tank (Abandoned mine) Location: Talcher District Longitude: 85° 08' 07" E Latitude: 20° 56' 03" N</p>	
<p>8</p>	<p>Wetland type: Lake/Pond Location: Puri District Longitude: 85° 49' 56" E Latitude: 20° 04' 58" N</p>	

Plate 2b: Field photographs and ground truth data of different wetland types in Orissa

<p>9</p>	<p>Wetland type: Natural Waterlogged Location: Jagatsinghpur District Longitude: 86° 50' 25" E Latitude: 20° 18' 09" N</p>	
<p>10</p>	<p>Wetland type: Natural Waterlogged (Vegetated) Location: Kendujhar District Longitude: 85° 51' 38" E Latitude: 20° 10' 53" N</p>	
<p>11</p>	<p>Wetland type: Lake (Anshupa) Location: Cuttack District Longitude: 85° 36' 10" E Latitude: 20° 26' 54" N</p>	
<p>12</p>	<p>Wetland type: Natural Waterlogged Location: Jagatsinghpur District Longitude: 86° 08' 31" E Latitude: 20° 08' 57" N</p>	

Plate 2c: Field photographs and ground truth data of different wetland types in Orissa

<p>13</p>	<p>Wetland type: Mangrove Location: Bhitarkarnika Sanctuary Longitude: 86° 05' 28" E Latitude: 20° 41' 03" N</p>	
<p>14</p>	<p>Wetland type: Mangrove (Showing respiratory roots) Location: Bhitarkarnika Sanctuary Longitude: 86° 52' 02" E Latitude: 20° 42' 55" N</p>	
<p>15</p>	<p>Wetland type: Mangrove (Gupti creek) Location: Kendrapara District Longitude: 86° 44' 22" E Latitude: 20° 22' 13" N</p>	
<p>16</p>	<p>Wetland type: Creek Longitude: 86° 46' 19" E Latitude: 20° 08' 18" N</p>	

Plate 2d: Field photographs and ground truth data of different wetland types in Orissa

<p>17</p>	<p>Wetland type: Lagoon Location: Chilika (Ramsar Site) Longitude: 85° 18' 08" E Latitude: 19° 46' 42" N</p>	
<p>18</p>	<p>Wetland type: Mudflat Location: Chilika (Ramsar Site) Longitude: 85° 19' 08" E Latitude: 19° 42' 12" N</p>	
<p>19</p>	<p>Wetland type: Mudflats Location: Balasore Coast Longitude: 86° 55' 14" E Latitude: 21° 20' 22" N</p>	
<p>20</p>	<p>Wetland type: Aquaculture Ponds Location: Bhadrak District Longitude: 86° 48' 52" E Latitude: 21° 08' 14" N</p>	

Plate 2e: Field photographs and ground truth data of different wetland types in Orissa

IMPORTANT WETLANDS OF ORISSA

9.0 IMPORTANT WETLANDS OF ORISSA

Anshupa lake, Satkoshia Gorge Sanctuary, Hirakud reservoir, Chilika lagoon and Bhitarkanika mangroves (wildlife sanctuary) are most important wetland areas of Orissa state. Extensive field work was carried out for these wetland areas. Wetland maps have been prepared for 5 km buffer area of each wetland sites. Details of each wetland and wetland map of 5 km buffer area are shown in plates 3-20.

9.1 Anshupa Lake

Name: Anshupa Lake

Location: 85° 34' 41" - 85° 37' 56" E
20° 26' 33" - 20° 28' 47" N

Wetland type: Inland lake

Average annual rainfall: 150 cm

Area: 230 ha

Located north of Mahanadi delta has association of two other lakes namely; Kantapanhara and Ostia. Morphometrically, it is about 3 km in length and width varying between 250m - 500 m. The average depth was supposed to be about 12 m, which due to siltation has reduced to about 3 m now. Water spread extent would gradually reduce by pre-monsoon and the vegetation would be pronouncedly observed on the imagery. The adjacent lakes nearly dry out during pre-monsoon. The combination of indices (MNDWI NDPI NDVI) aids in delineation of open water and vegetation specific to wetland.

Flora: Include 47 species. The fringes are occupied by *Polygonum glabrum*, *P. barbatum*, *Limnophila heterophylla*, *Cyperus plalystylis*, *Aeschynomene aspera*. *Hydrilla verticellata*, *Ceratophyllum demersum*, *Myriophyllum tetrandrus* are seen where shallow water is present. Free floating species like *Nymphoides*, *Trapa natans*, *Eichhornia crassipes* and rooted floating ones like *Euryale ferox*, *Nymphaea aquatica*, *Trapa natans Var. bisporosa* are seen at a depth of 2-3 m. The emergent species like *Sacciolepis interrupta*, *Eichhornia stagnina* are observed in the lake.

Fauna: *Pila globosa*, *Bellama bengalensis*, *Lymnaea accuminata* are seen abundantly. 20 species of avifauna are observed in the lake, of which the dominant ones are *Porphyrio porphyrio*, *Metopidius indicus*, *Halcyon smymensis*, *Egretta garretta* etc

Fish: 15 fishes are known to exist in the lake of which *Nandus nandus*, *Clarias baraches*, *Heteropneustes fossilis*, *Barbus chola* and *B. ticto* are dominant.

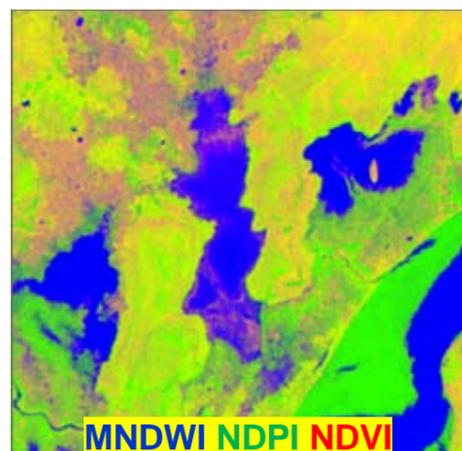
The lake is declared as an important wetland site and has tourists' attraction.

Legend

- 1 Aquatic vegetation
- 2 Open water



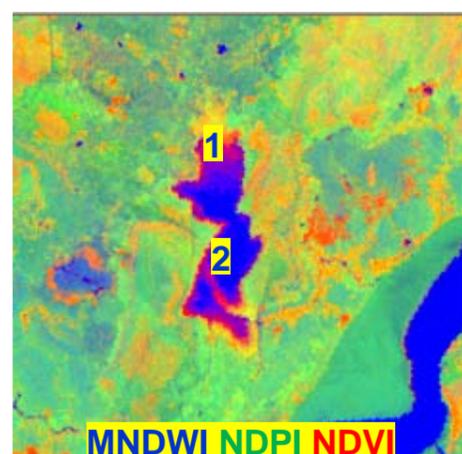
IRS P6 LISS-III FCC (12/10/2006)



FCC OF INDICES (12/10/2006)

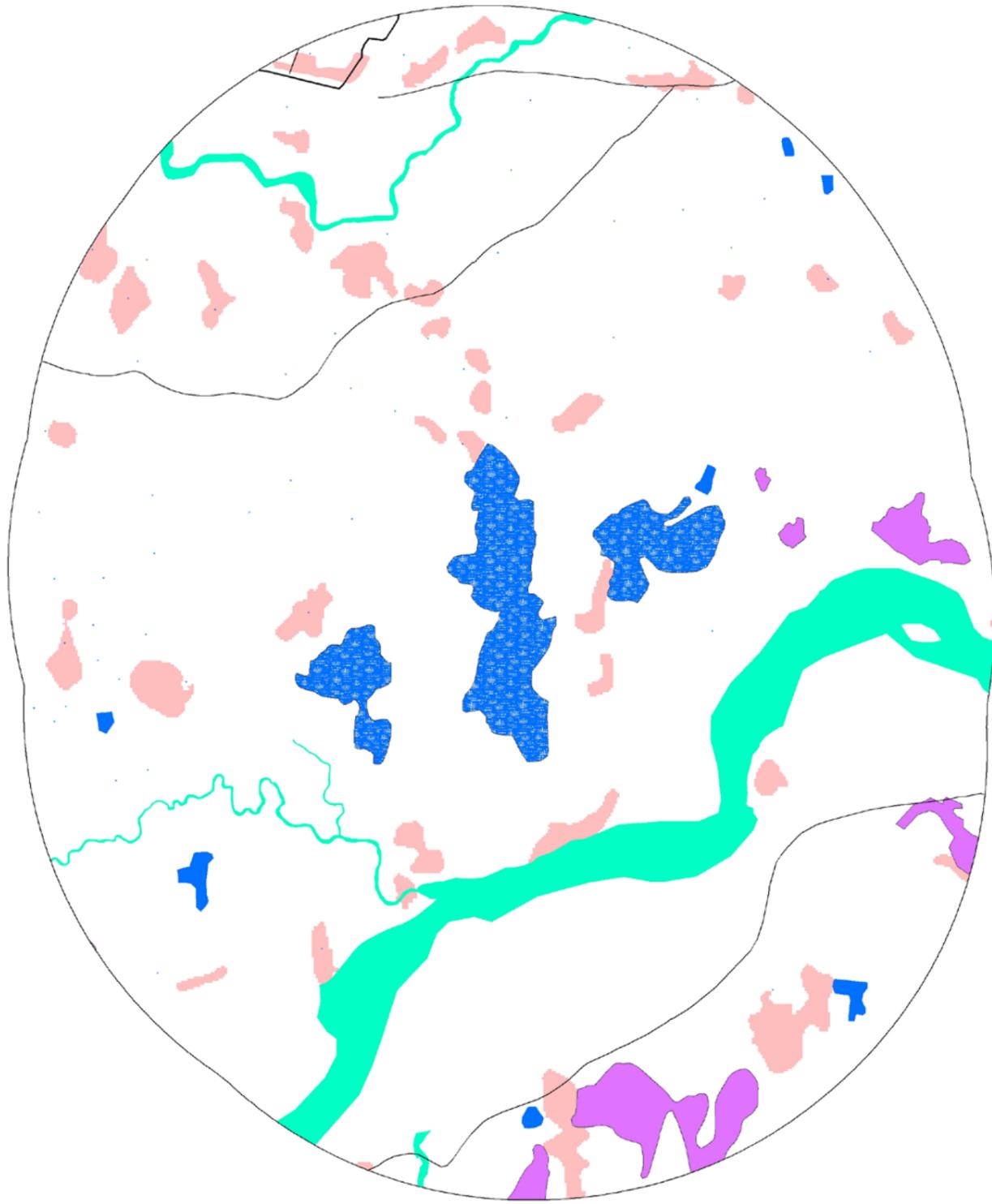


IRS P6 LISS-III FCC (22/04/2007)



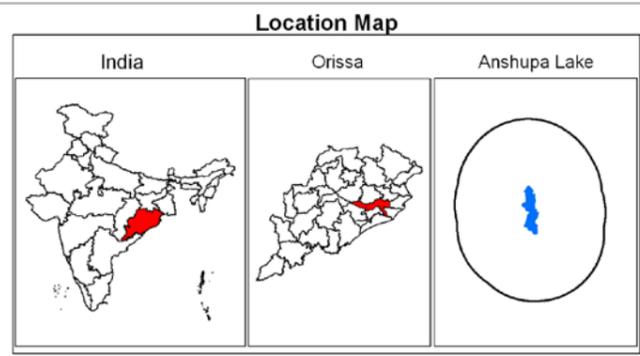
FCC OF INDICES (22/04/2007)

Plate – 3: Anshupa Lake



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

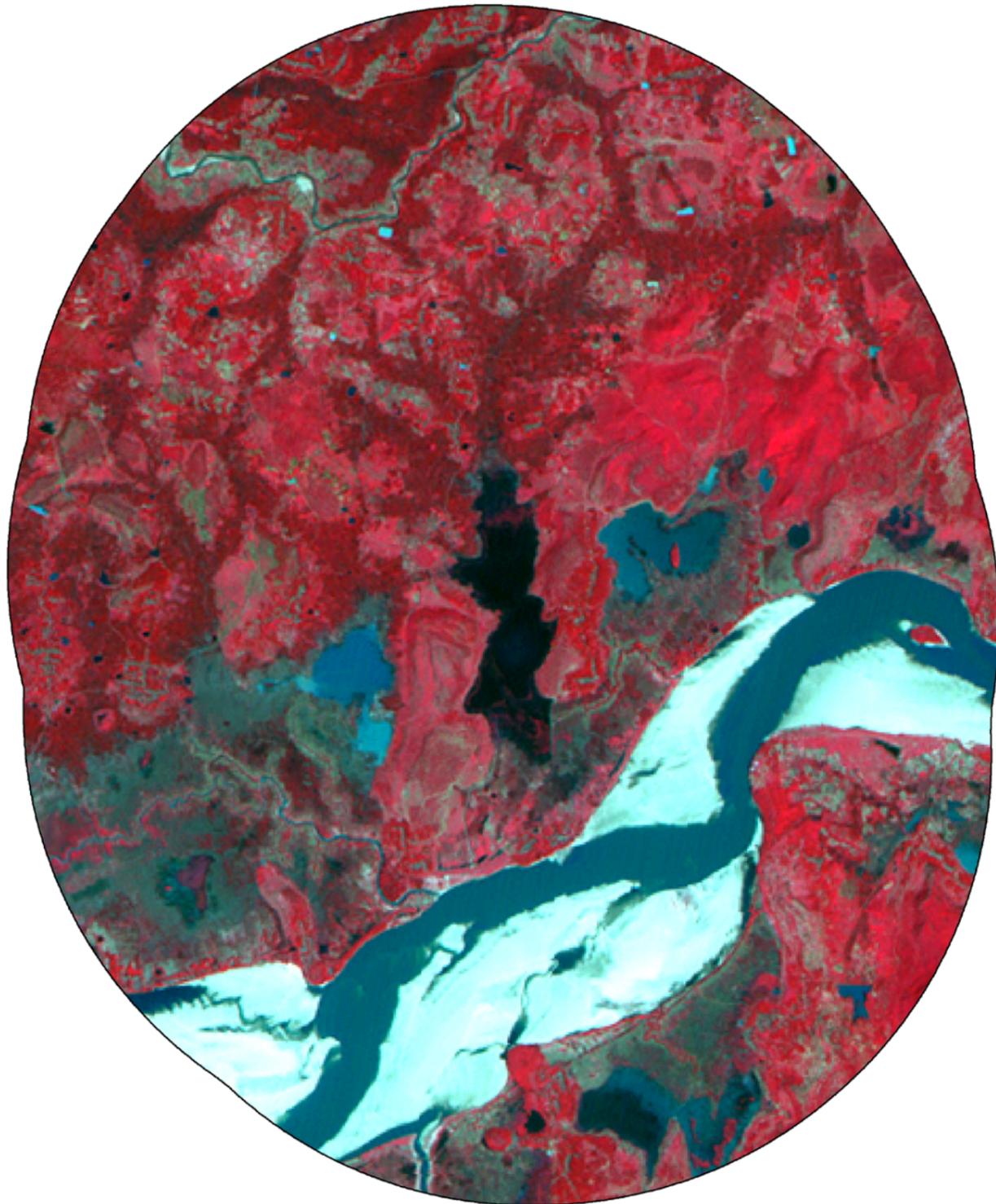


Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
 Space Applications Centre (ISRO), Ahmedabad
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 Orissa Space Applications Centre, Bhubaneswar

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Plate 4: Wetland map - 5 km buffer area of Anshupa Lake



IRS P6 LISS III post-monsoon data (2006)

Plate 5: IRS P6 LISS-III image - 5 km buffer area of Anshupa Lake

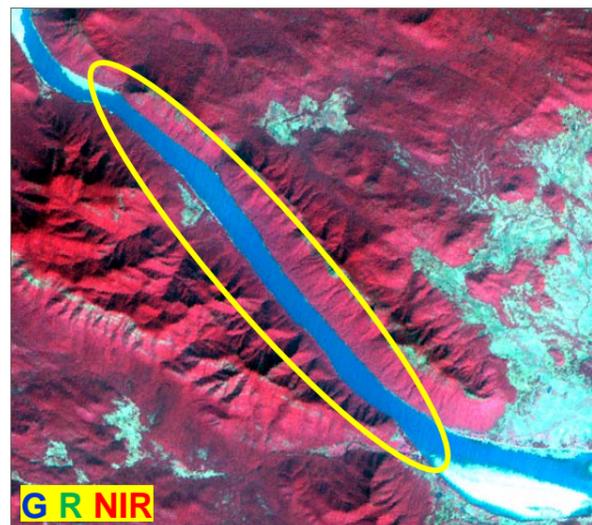
9.2 Satkoshia Gorge Sanctuary

Name: Satkoshia Gorge Sanctuary

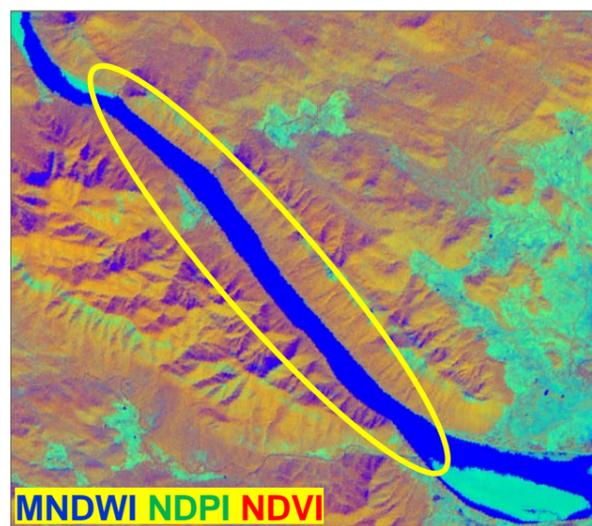
Location: 84°47'46" - 84°51'21"
20°30'12" - 20°35'22"

Wetland Type: River (Gorge) - Mahanadi

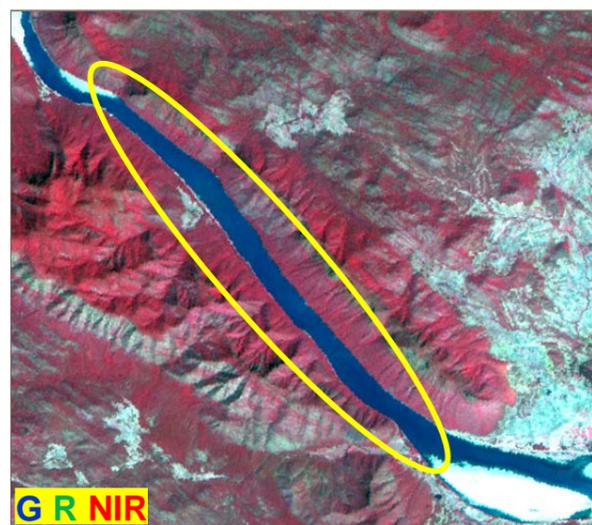
A stretch of 22 km of Mahanadi river in the Satkoshia Gorge between Tikerpara and Barmul has been declared as sanctuary in 1976 to protect and conserve the endangered Gharial (*Gavialis gangeticus*). The area of the sanctuary is estimated to be 79,552 ha. The river is very slow-flowing for much part of the year as evident from the satellite data of both post-monsoon as well as pre-monsoon. Several sand bars and gravel beds are exposed at low water levels, which form sites for the Gharial. The last wild hatchlings were observed in 1974. To restore the population, captive-reared individuals are being released to augment the vestigial population. About 107 were reported to have been released during 1977 to 1980. There has been a considerable amount of research centered around the Gharial project.



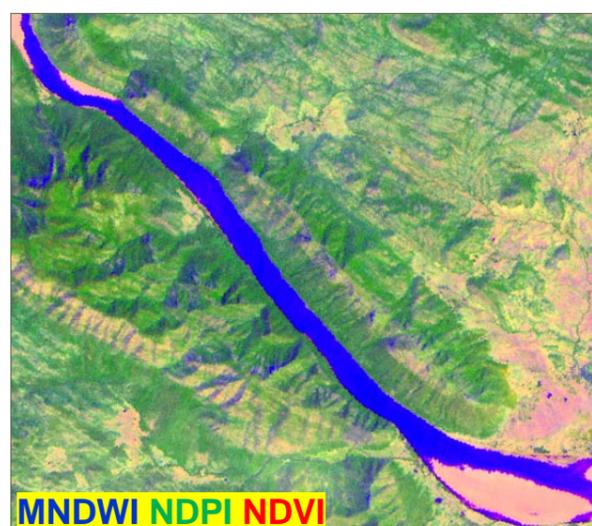
IRS P6 LISS-III FCC (18/12/2006)



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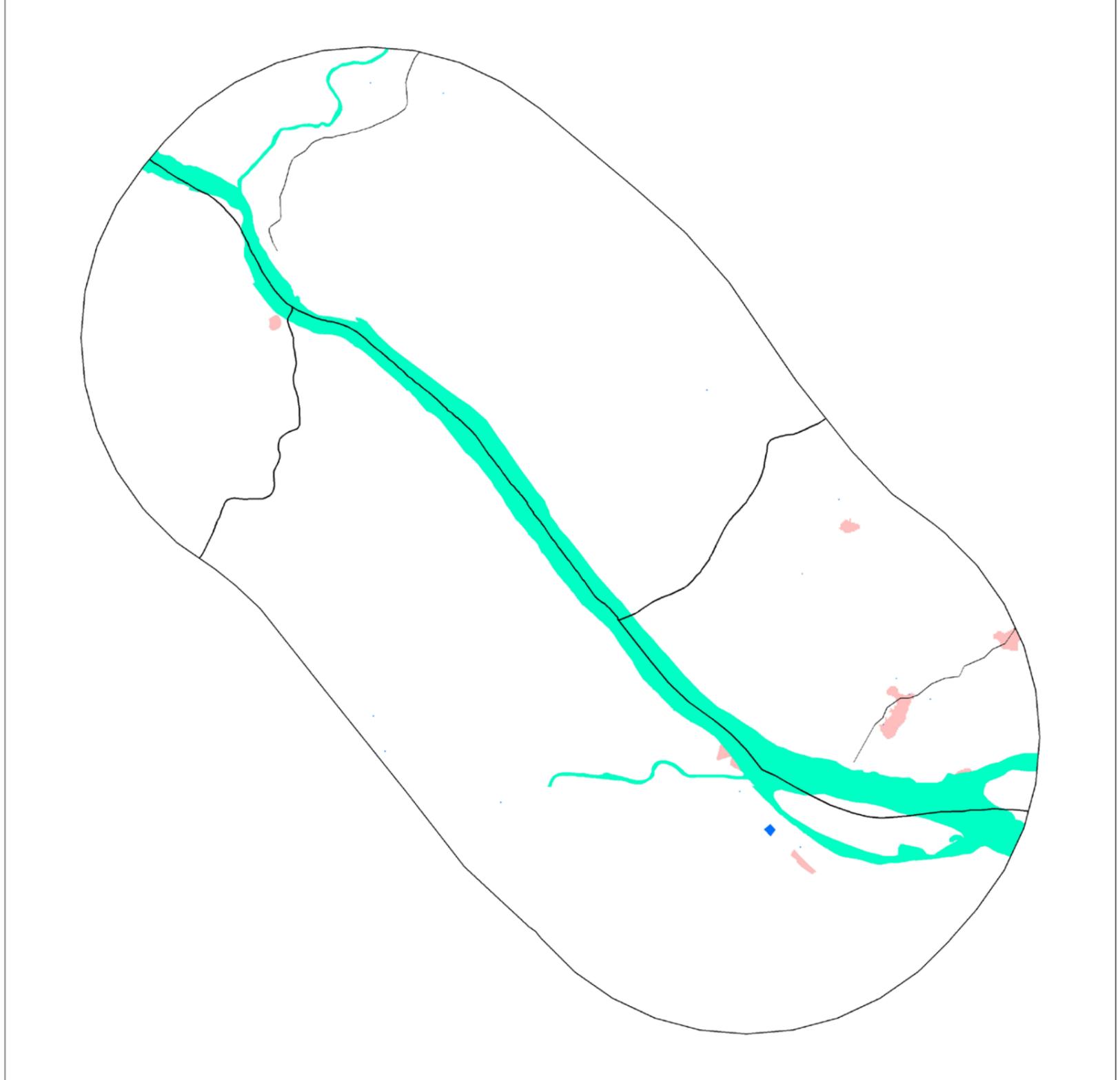


IRS P6 LISS-III FCC (28/02/2007)



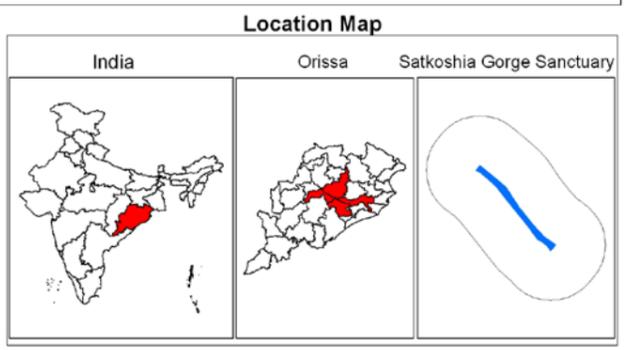
FCC OF INDICES (28/02/2007)

Plate 6: Satkoshia Gorge Sanctuary



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
■	1101			Ox-bow lakes/ Cut-off meanders
■	1102			High altitude wetlands
■	1103			Riverine wetlands
■	1104			Waterlogged
■	1105			River/Stream
■	1106			
			Man-made	
■	1201			Reservoirs/Barrages
■	1202			Tanks/Ponds
■	1203			Waterlogged
■	1204			Salt pans
		Coastal Wetlands		
			Natural	
■	2101			Lagoons
■	2102			Creeks
■	2103			Sand/Beach
■	2104			Intertidal mud flats
■	2105			Salt marsh
■	2106			Mangroves
■	2107			Coral reefs
			Man-made	
■	2201			Salt pans
■	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

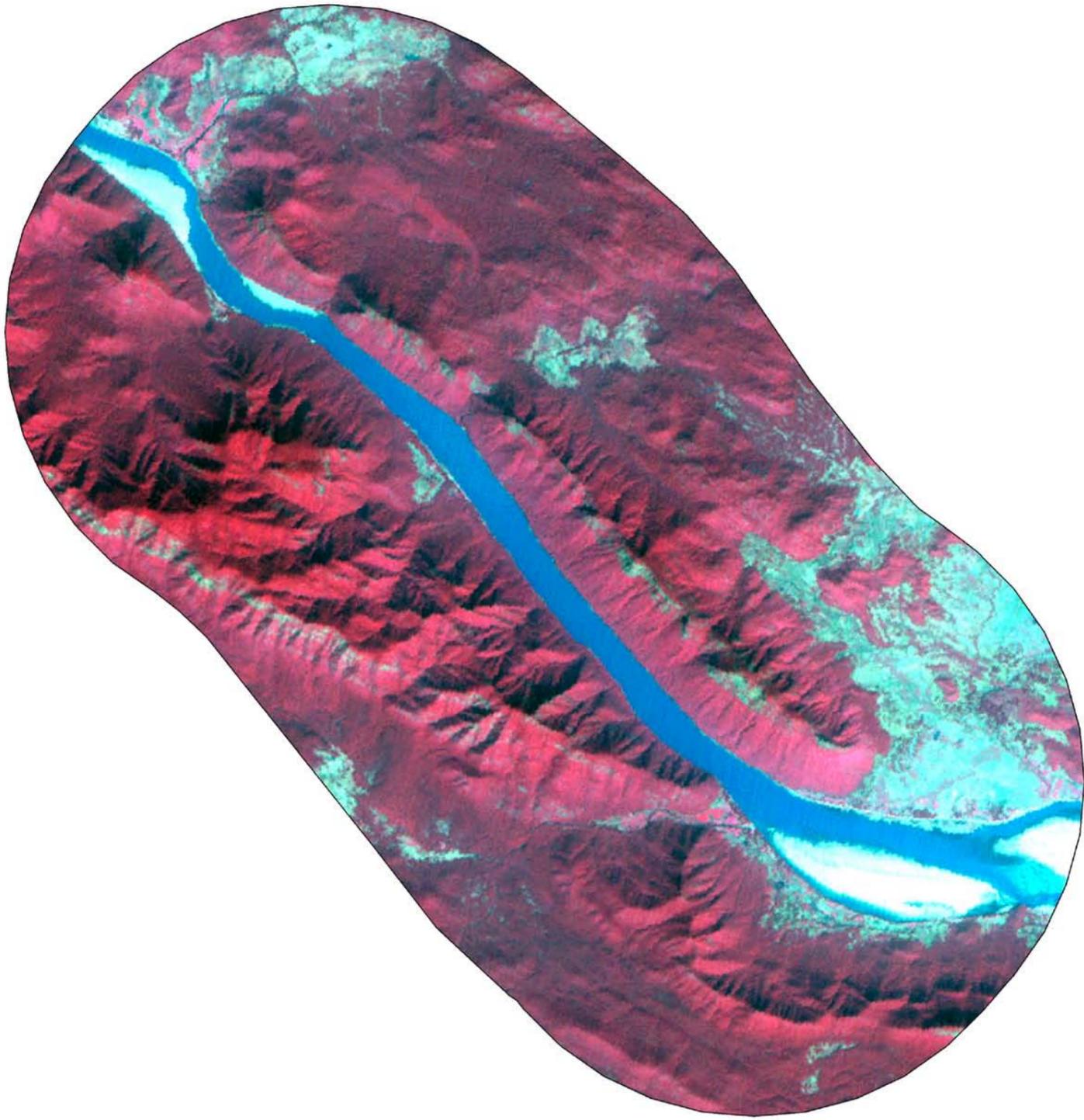


Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Orissa Space Applications Centre, Bhubaneswar

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Government of India

Plate 7: Wetland map - 5 km buffer area of Satkosha Gorge Sanctuary



IRS P6 LISS-III Post-monsoon data (2006)

Plate 8: IRS P6 LISS-III image - 5 km buffer area of Satkoshia Gorge Sanctuary

9.3 Hirakud Reservoir

Name: Hirakud Reservoir

Location: 83° 22' 45" - 83° 26' 16" E
21° 50' 10" - 21° 46' 54" N

Wetland type: Reservoir/Barrage

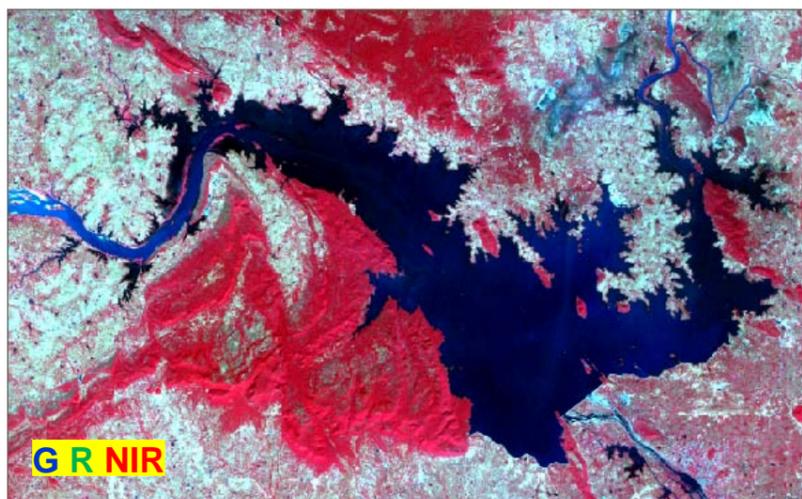
Average annual rainfall: 150 cm

Area: 65073 ha

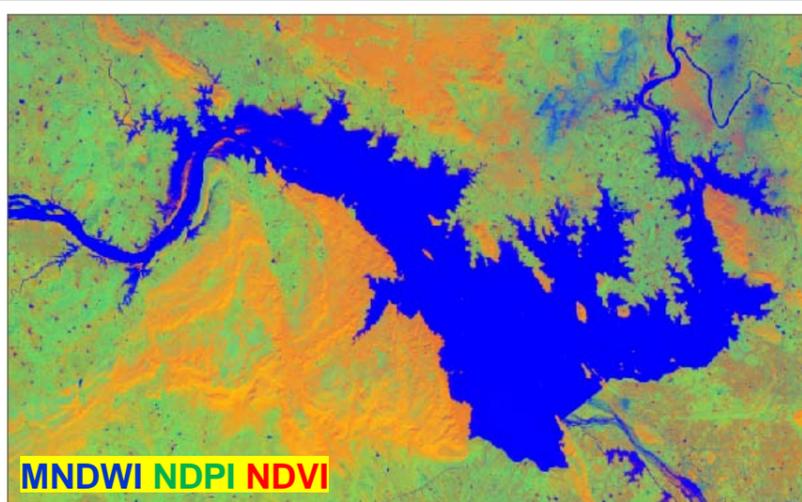
It is the world's longest main stream dam having a length of 4800 m. The live capacity at Full Reservoir Level (FRL) is 5.378 billion cubic meter. It drains an area of 141 600 sq km of which 46.5% lie in Orissa. It is a multi-purpose dam meant for irrigation, flood control and power generation. It irrigates around 264228 ha of land. The power installed is 270MW.

Water temperature varies from 21°C to 30°C and pH values range from 7.3 to 8.5.

Phytoplankton include 39 recorded species and zooplankton consists of 10 species belonging to Rotifera, Cladocera, Copepoda.



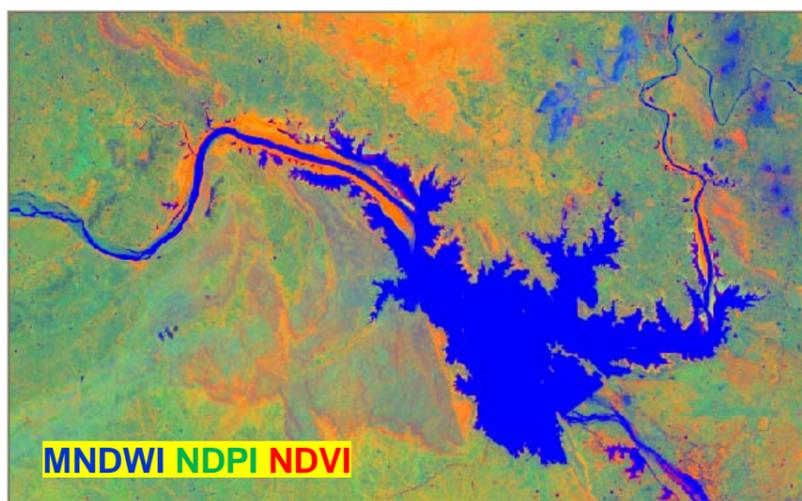
IRS P6 LISS-III FCC (19/11/2006)



FCC OF INDICES (19/11/2006)

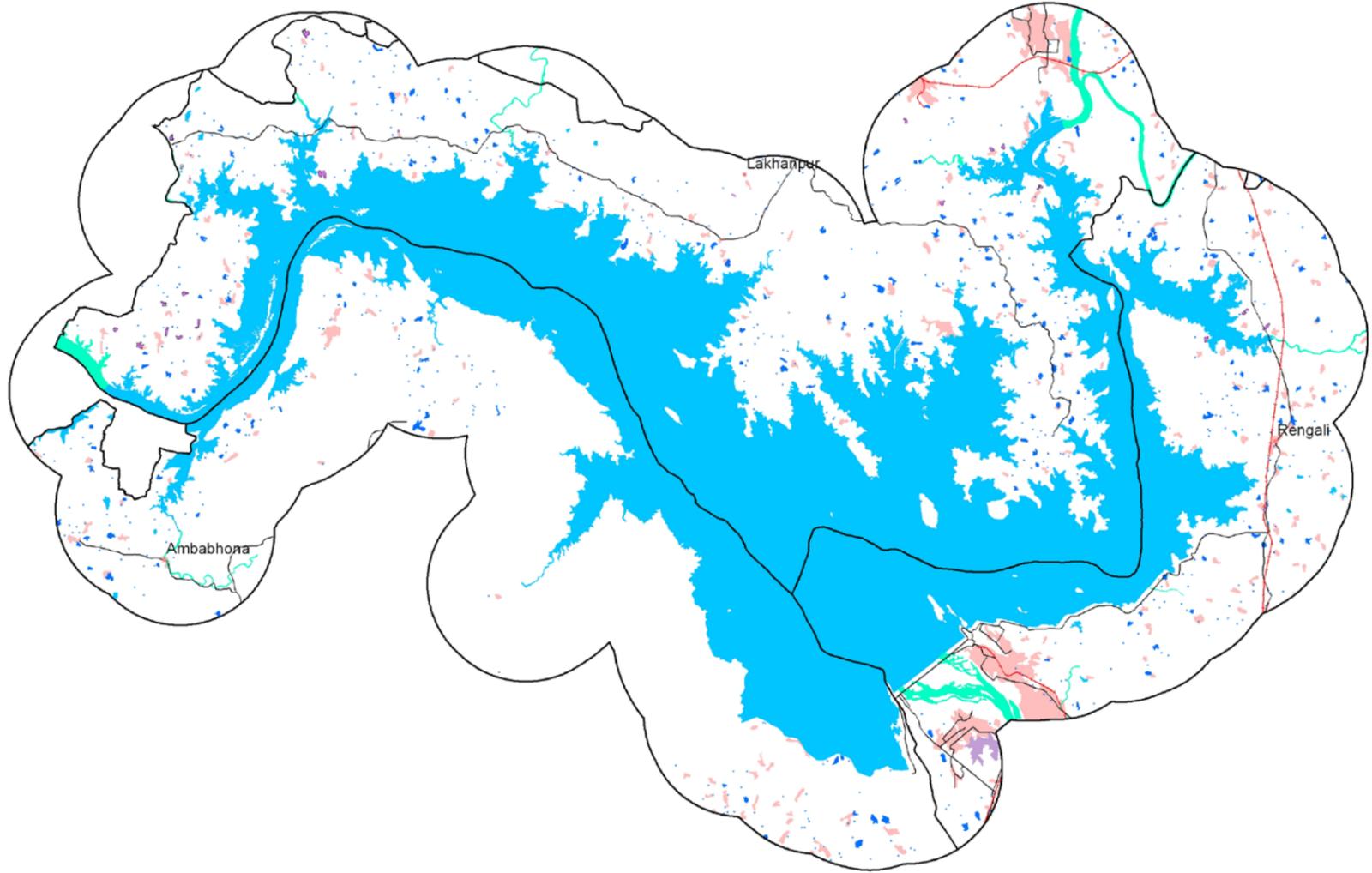


IRS P6 LISS-III FCC (30/05/2007)



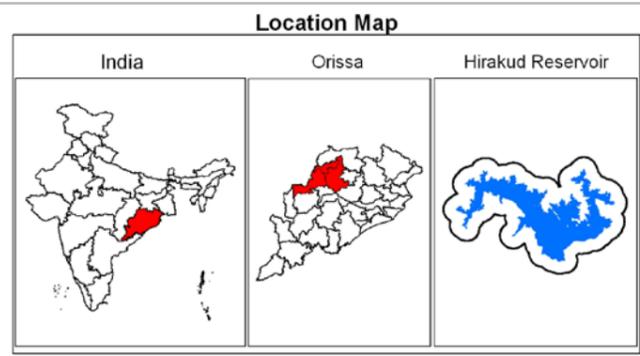
FCC OF INDICES (30/05/2007)

Plate – 9 : : Hirakud Reservoir



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

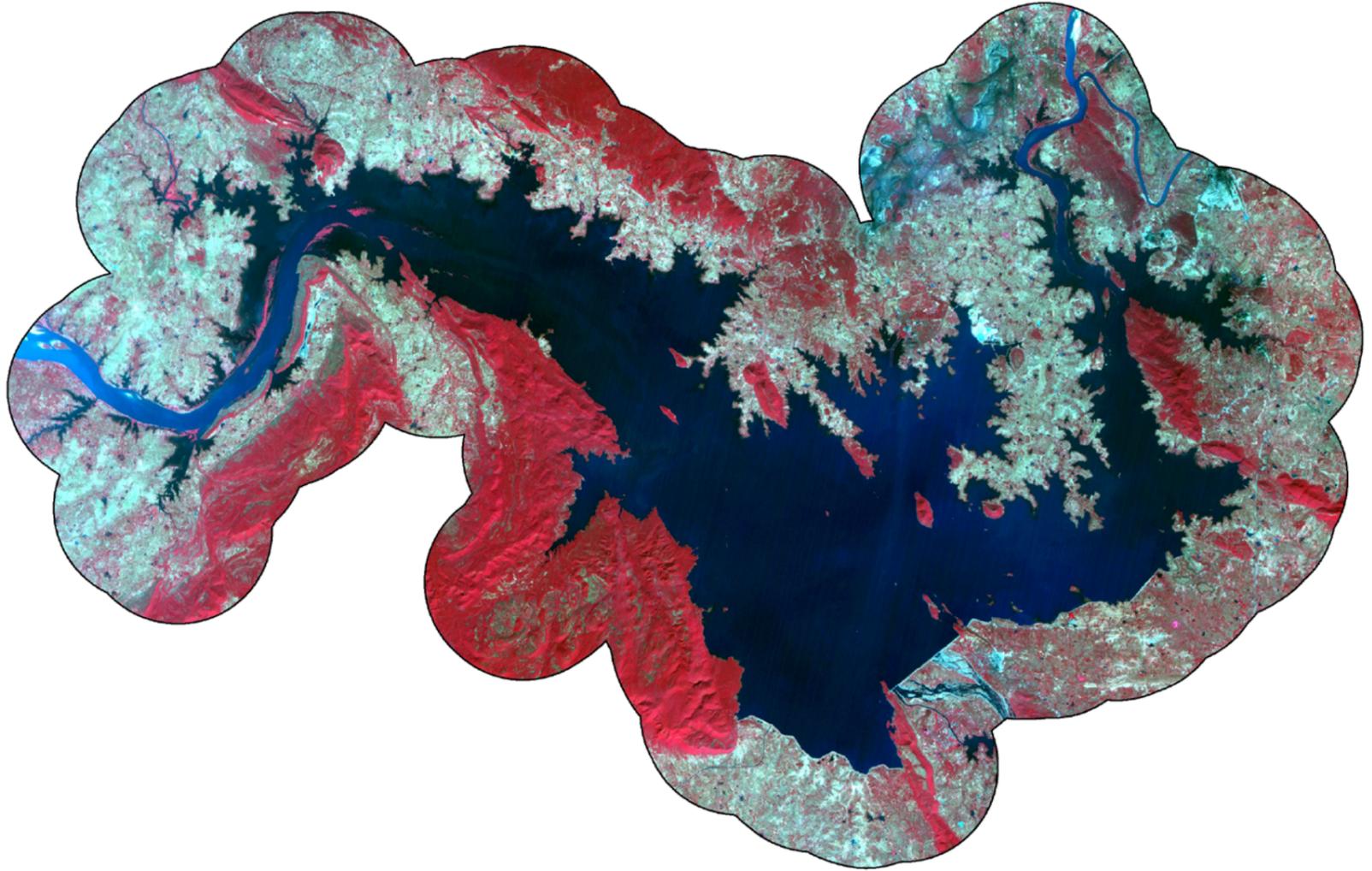


Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

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Government of India

Plate 10: Wetland map - 5 km buffer area of Hirakud Reservoir



IRS P6 LISS III post-monsoon data (2006)

Plate 11: IRS P6 LISS-III image - 5 km buffer area of Hirakud Reservoir

9.4 Chilika Lagoon

Name: Chilika

Location: 85°04'14" - 85°49'13" E
19°26'31" - 20°05'35" N

Wetland Type: Lagoon

Area: 89023 ha

Chilika lagoon is situated in Puri and Ganjam districts of Orissa on east coast. Chilika is the largest brackish-water lagoon in India and perhaps the second largest in the world. It was declared as a sanctuary in 1973 and latter designated as Wetland of International Importance under Ramsar Convention in 1981.

The lagoon experiences a typical tropical monsoon climate with temperatures ranging from 17.5°C to 32.5°C. The variation in salinity between 0.1 to 36 ‰. The pH varies between 6.8 to 9.7. The Bhargavi and Daya rivers in the north are the main besides other eight rivers that bring in an estimated 375,000 cusecs of monsoon fresh water in to the lagoon. The annual sediment load due this inflow water is estimated to be about 13 Mmt. The lake is connected to the Bay of Bengal by channel through a sand ridge in the north-east.

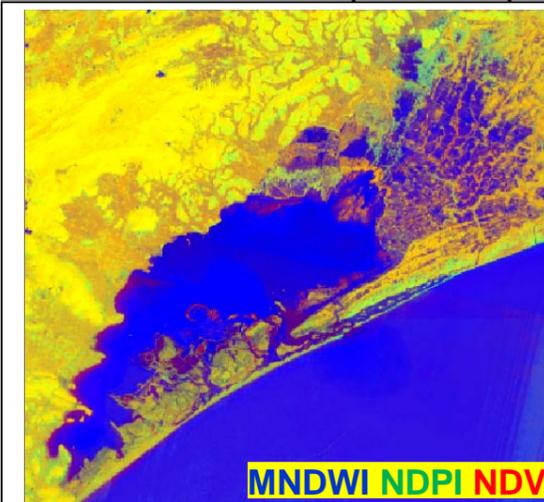
Flora: 22 species algae, 150 species of vascular plants are recorded in the lagoon. The dominant emergent plants are *Pragmites karka*, *Typha angustata*, *Cyperus sp.* and *Kailinga triceps*. Submerged vegetation is dominated by *Enteromorpha sp.*, *Gracillaria sp.*, *Cladophora sp.*, *Polysiphonia sp.*, *Najas sp.*, *Chara sp.*, *Hydrilla sp.* and *Potomageton sp.*

Fauna: It has 267 species of fishes, 35 species of crabs and 29 species of shrimp and prawns. Nearly 225 bird species in the peak winter season. The lagoon hosts over one million migratory birds with flocks of ducks (Anatinae), Geese (Anserinae), Flamingos (*Phoenicopterus sp.*), Pelican (*Pelecanus sp.*), Plover (*Charadrius sp.*), Gulls (*Larus sp.*) and Terns (*Sterna sp.*). It is home to seven species of amphibians mainly frogs and toads. It also forms a habitat to 24 species of reptiles comprising soft-shelled turtles, lizards, snakes. It shelters the largest population (158) of endangered Irrawaddy dolphin.

Threats: Sediment load, proliferation of emergent vegetation, pollution from domestic and industrial waste.

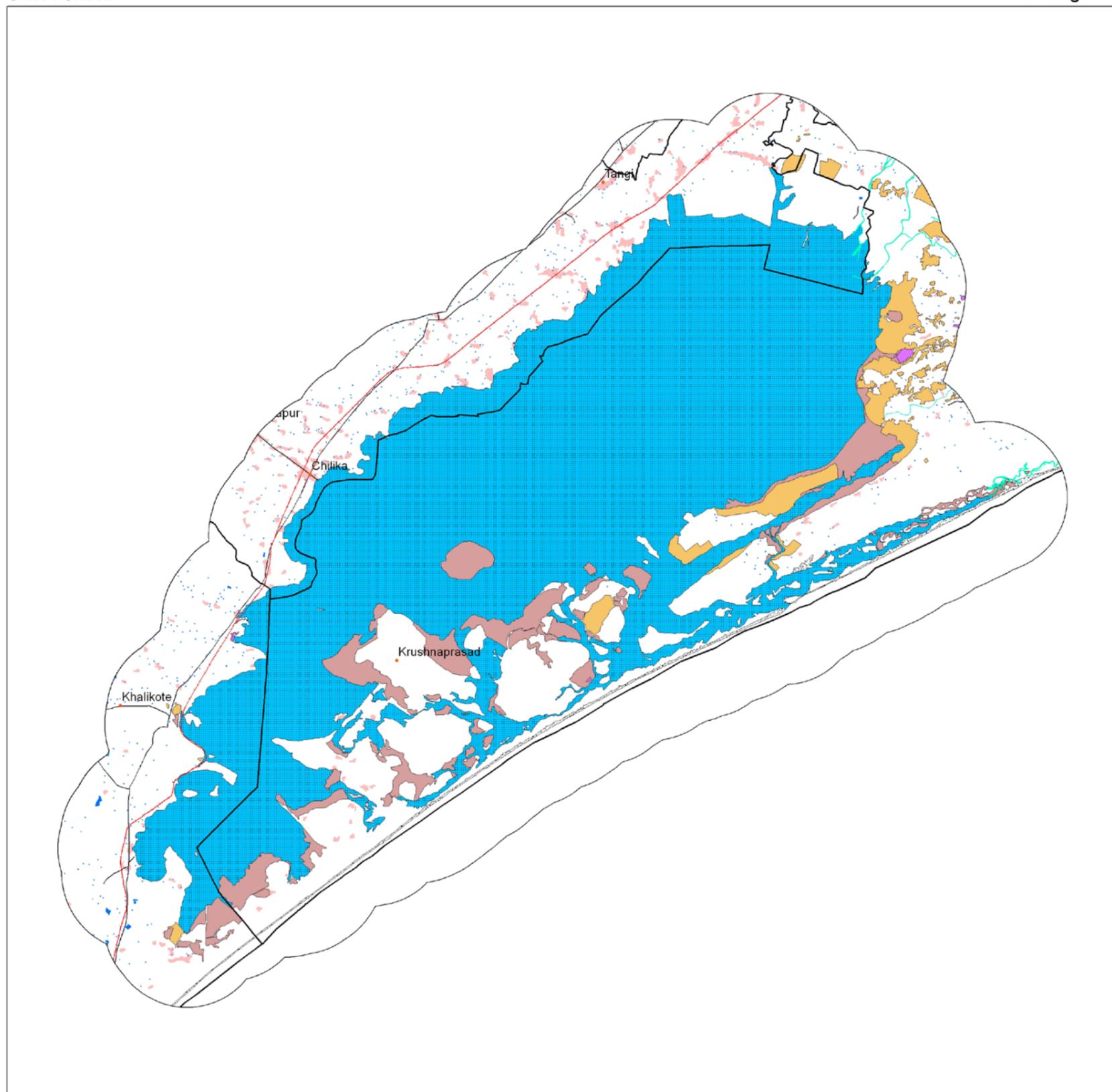


IRS P6 LISS-III FCC (12/10/2006)



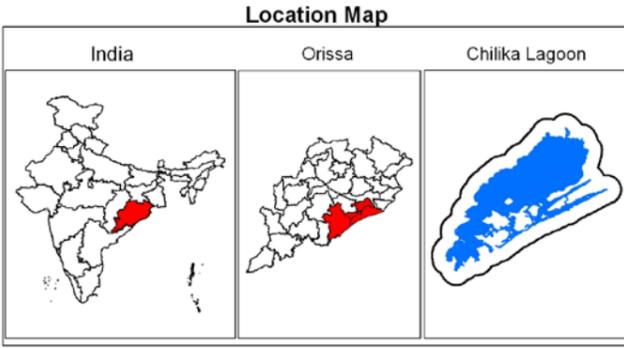
FCC OF INDICES (12/10/2006)





Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

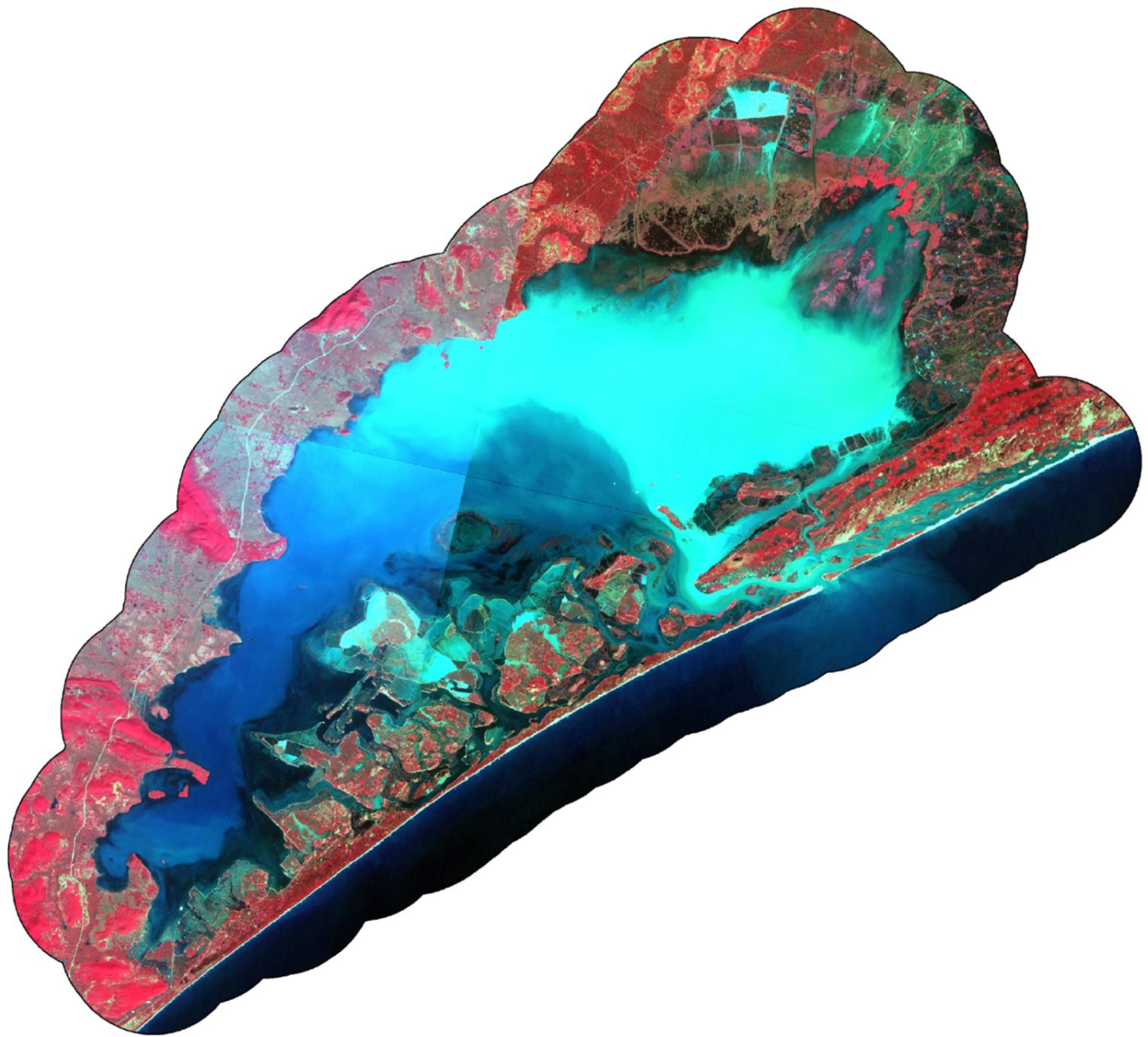


Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
 Space Applications Centre (ISRO), Ahmedabad
 and
 Orissa Space Applications Centre, Bhubaneswar

Sponsored By :
 Ministry of Environment and Forests
 Government of India

Plate 13: Wetland map - 5 km buffer area of Chilika lagoon



IRS P6 LISS III post-monsoon data (2006)

Plate 14: IRS P6 LISS-III image - 5 km buffer area of Chilika lagoon

9.5 Bhitarkanika Mangrove (Wildlife Sanctuary)

Name: Bhitarkanika Wildlife Sanctuary

Wetland Type: Mangrove (Estuarine Complex)

Location: 20°30'00" - 20°50'00" N
86°45'00" - 87°10'00" E

Kendrapara district

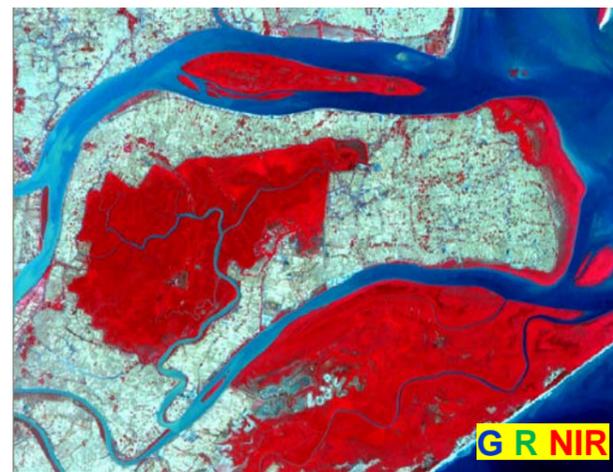
Area: 4396 ha

Area experiences a typical coastal tropical monsoon climate with temperature ranging from 21°C to 33°C and 1313 mm of rainfall. The area is prone to severe cyclonic storms almost every year during April/May and October/November. Bhitarkanika represents one of the finest patches of mangrove forest along the entire coast of India after Sunderabans and Andaman and Nicobar Islands. Bhitarkanika was declared as Wildlife Sanctuary in 1975 initially to protect saltwater crocodile and latter as National Park in 1998. Garhimata coast (eastern boundary of the sanctuary) to protect Olive ridley - sea turtle as Garhimata Marine Sanctuary in 1997. The whole area has been accorded International Importance by its designation as a Ramsar Site in 2002.

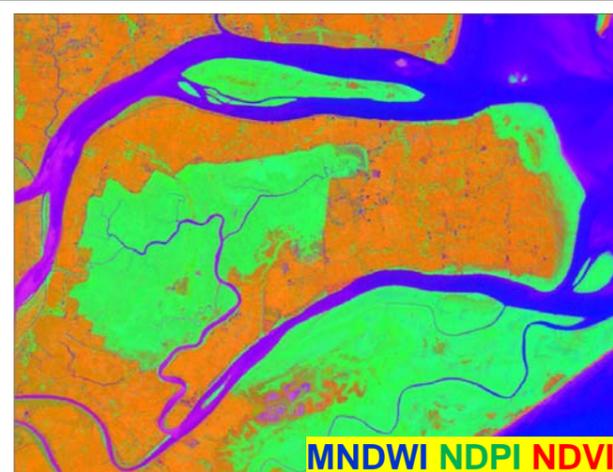
Flora: Compared to Sundarbans - India's largest tract of mangrove forest, Bhitarkanika represents a wider species diversity of mangrove flora, which comprise 55 species out of recorded 58 species in India. The *Heritiera* formation of Champion and Seth (Type 4B/TS-4, 1968) comprising brackishwater association of *Heritiera*, *Cynometra*, *Aglaia*, *Cerbera* and *Intsia* are well represented in Bhitarkanika. Dominant mangrove species are *Aegiceras corniculatum*, *Avicennia officinalis*, *Cerebra manghas*, *Excoecaria agallocha*, *Heritiera fomes*, *H. littoralis*, *Kandelia kandel*, *Merope angulata*, *Rhizophora apiculata*, *R. mucronata*, *Sonneratia apetala*, *Xylocarpus granatum*, *X. mekongensis* and *X. moulcensis*.

Fauna: Bhitarkanika harbours one of the largest populations (about 700) of endangered saltwater crocodile (*Crocodylus porosus*) in India. Eastern boundary of Bhitarkanika (Garhimata) supports nearly half million olive ridleys that nest every year is the single largest nesting ground in the world. The water monitor (*Varanus salvator*) is common here otherwise rare in most part of India. Two other monitors common here are *V. bengalensis* and *V. flavescens*. Notable among other reptiles are *Ophiophagus hannah*, *Python molurus bivittatus*, *Bungarus fasciatus*, *B. caeruleus* and *Chryopelia ornata*.

Extremely high congregations of migratory waterfowl are observed during December and January of which eleven species from Ciconiiformes are known to nest in the multispecies nesting colony. Five species of marine dolphins have been recorded from the area namely *Sousa chinensis*, *Orcaella brevirostris*, *Delphinus delphis* and Pantropical spotted dolphin.



IRS P6 LISS-III FCC (04/12/2006)



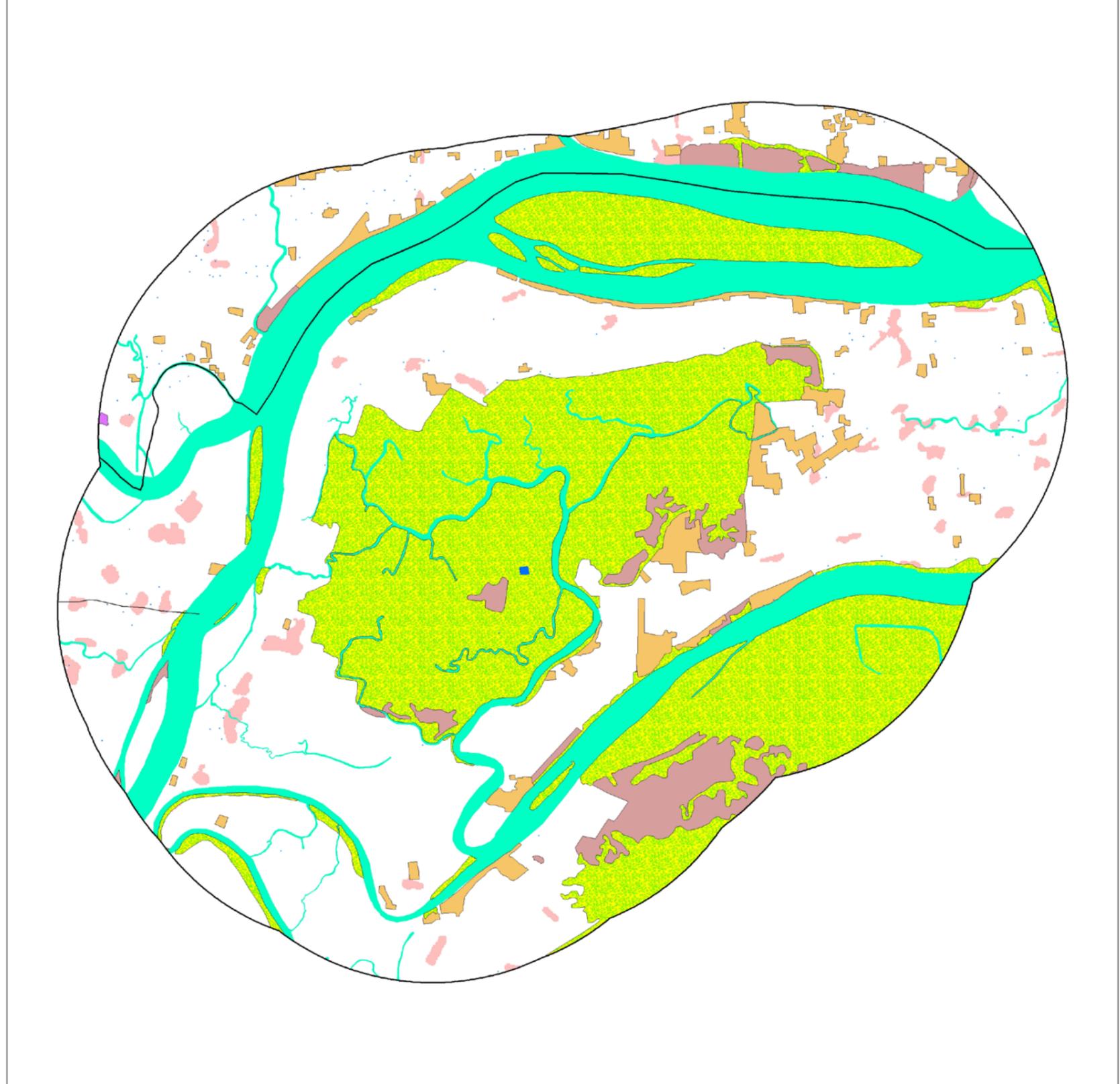
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Mangrove Forest

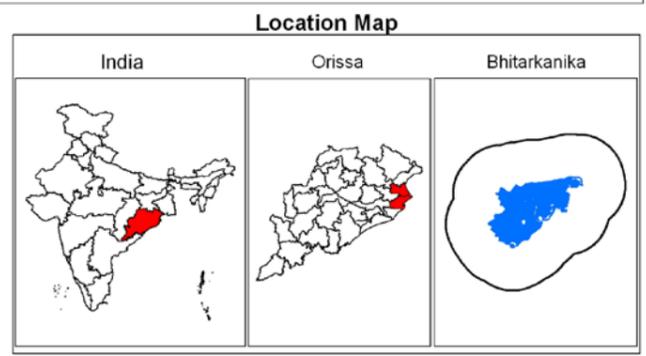


Olive Ridley - Turtles



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
 - Drainage (line)
 - Roads
 - Town/Settlements
 - District Boundary
 - State Boundary
 - International Boundary

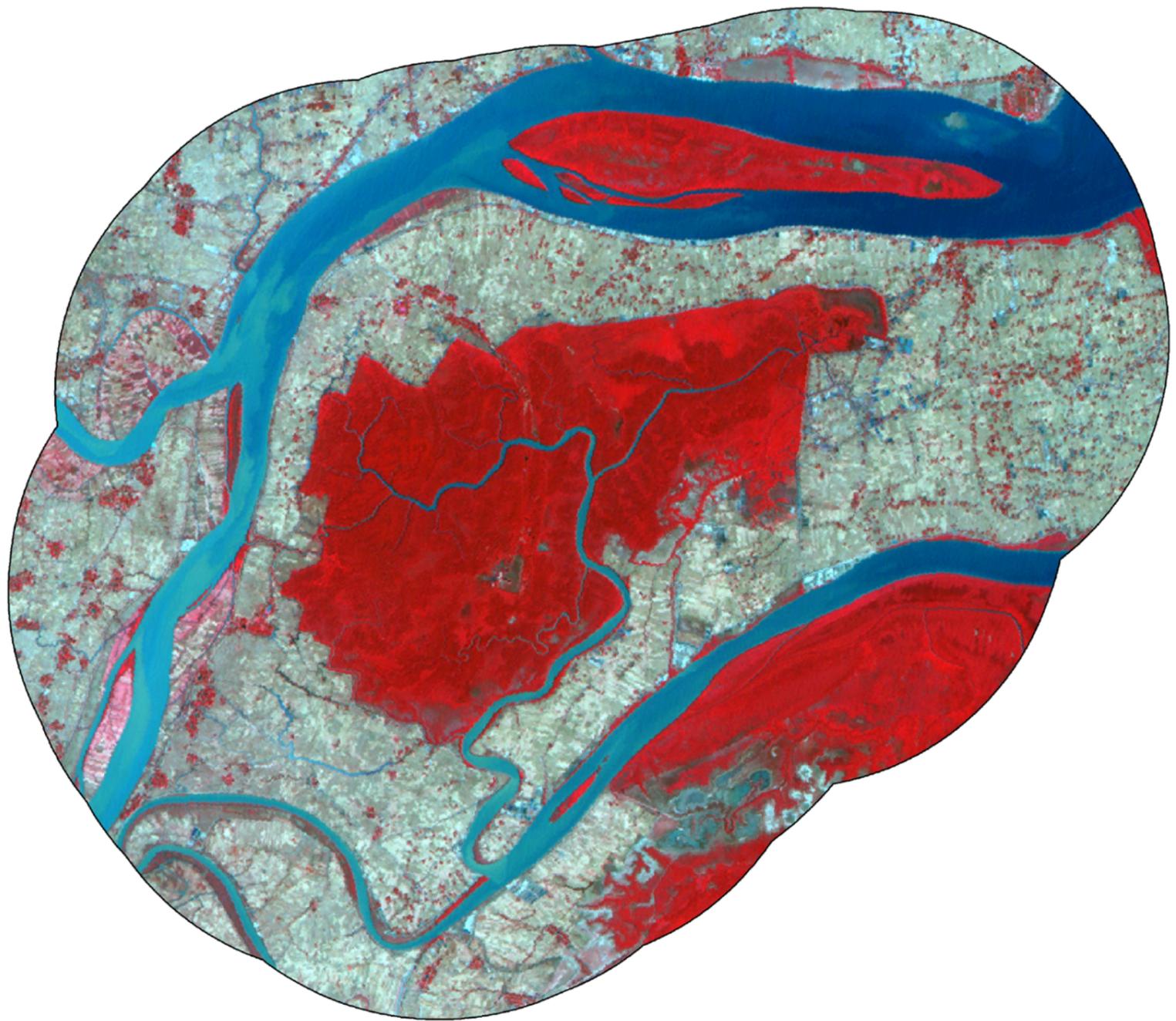


Data Source :
 IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
 Space Applications Centre (ISRO), Ahmedabad
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 Orissa Space Applications Centre, Bhubaneswar

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Plate 16: Wetland map - 5 km buffer area of Bhitarkanika



IRS P6 LISS III post-monsoon data (2006)

Plate 17: IRS P6 LISS-III image - 5 km buffer area of Bhitarkanika

9.6 Kanjia Wetland

Name: Kanjia Wetland

Wetland Type: Riverine wetland (Swmap)

Location: 80°48'44" - 80°49'46" E
20°23'44" - 20°24'33" N

Area: 105 ha

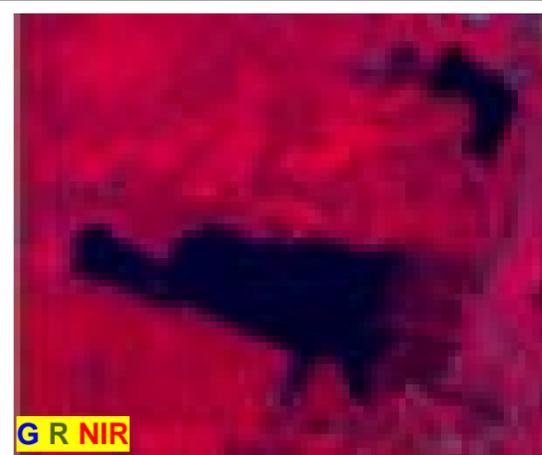
It is located inside the zoological and botanical park Nandankanan tiger reserve. The depth varies between 2.5 to 4 m. The wetland opens into flat deltaic plain of Prachi river which existed in the past.

Flora: The deep water habitat harbours few species like *Ceratophyllum demersum*, *Hydrilla verticellata*, *Najas foveolata* and *Potamogeton pectinatus*. While medium depth habitat records the presence of *Vallisneria natans*, *Aponogeton natans*, *Ottelia alismoides*, *Nymphoides hydrophylla*, *N. inida*, *Nymphae stellata*, *N. nouchali*, *Nelumbo nucifera*, *Trapa natans*. The free floating species are *Salvinia cucullata*, *Pistia stratiotes*, *Echhornia crassipes*. The emergent plants that are seen in shallow water are *Scirpus articulata*, *S. grossus*, *Typha angustata*, *Cyperus plastyllis*, *Panium repens*. The rooted submerged plants include *Utricularia inflexa*, *Myriophyllum tetradrum*, *Limnophyllia indica*. The shoreline is dominated by *Hygroryza aristata*. Marshland around the wetland has the presence of *Ludurigia adscendens*, *Adenostemma lavenia*, *Sesbania javanica*, *Typhya angustata*, *Aeschynomene aspera*.

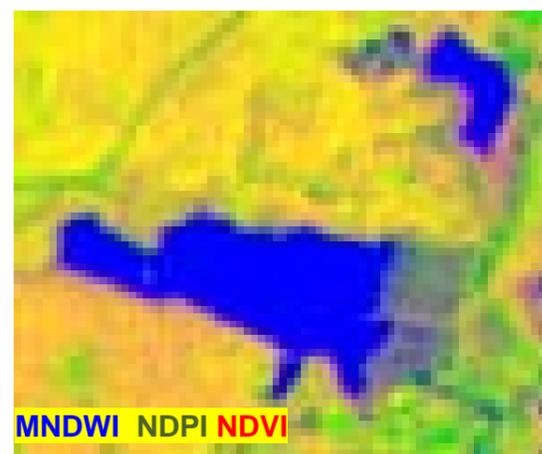
Fauna: Fauna include 40 species of riverine fish, 12 species of frog and 21 species of birds.

It attracts a very large number of tourists (about 1.7 million) annually due to its proximity to Nadankanan National Park.

Threats: *Salvinia cucullata* covers the entire wetland within very short time during the post-monsoon, which warrants regular deweeding.



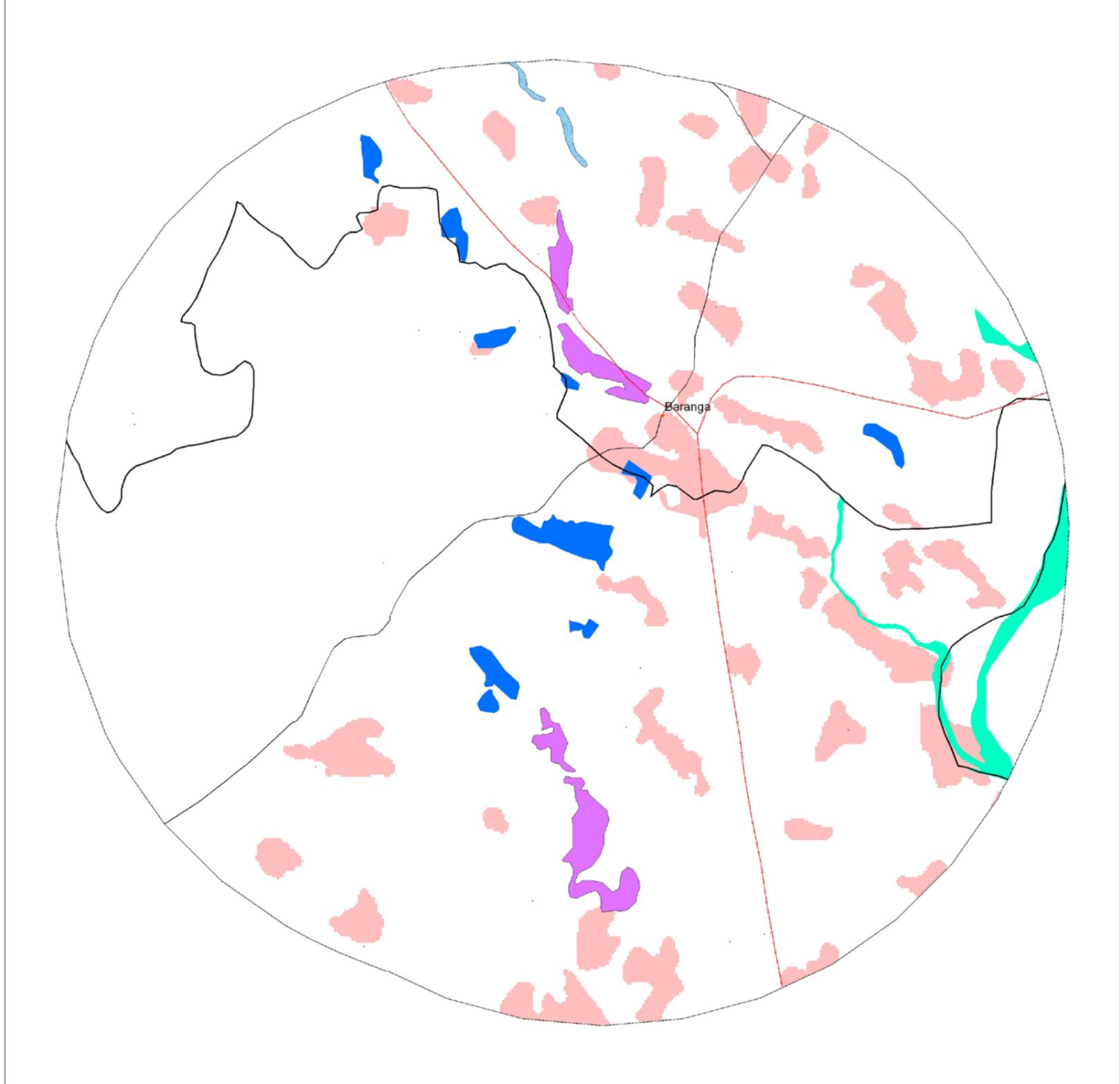
IRS P6 LISS-III (12/10/2006)



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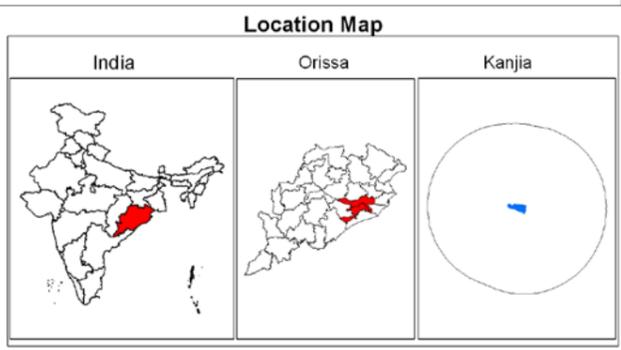


Plate 18: Kanjia Wetland



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
				Lakes/Ponds
				Ox-bow lakes/ Cut-off meanders
				High altitude wetlands
				Riverine wetlands
				Waterlogged
				River/Stream
			Man-made	
				Reservoirs/Barrages
				Tanks/Ponds
				Waterlogged
				Salt pans
		Coastal Wetlands		
			Natural	
				Lagoons
				Creeks
				Sand/Beach
				Intertidal mud flats
				Salt marsh
				Mangroves
				Coral reefs
			Man-made	
				Salt pans
				Aquaculture ponds

- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Canal
 - Railway
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 - Roads
 - Town/Settlements
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 - State Boundary
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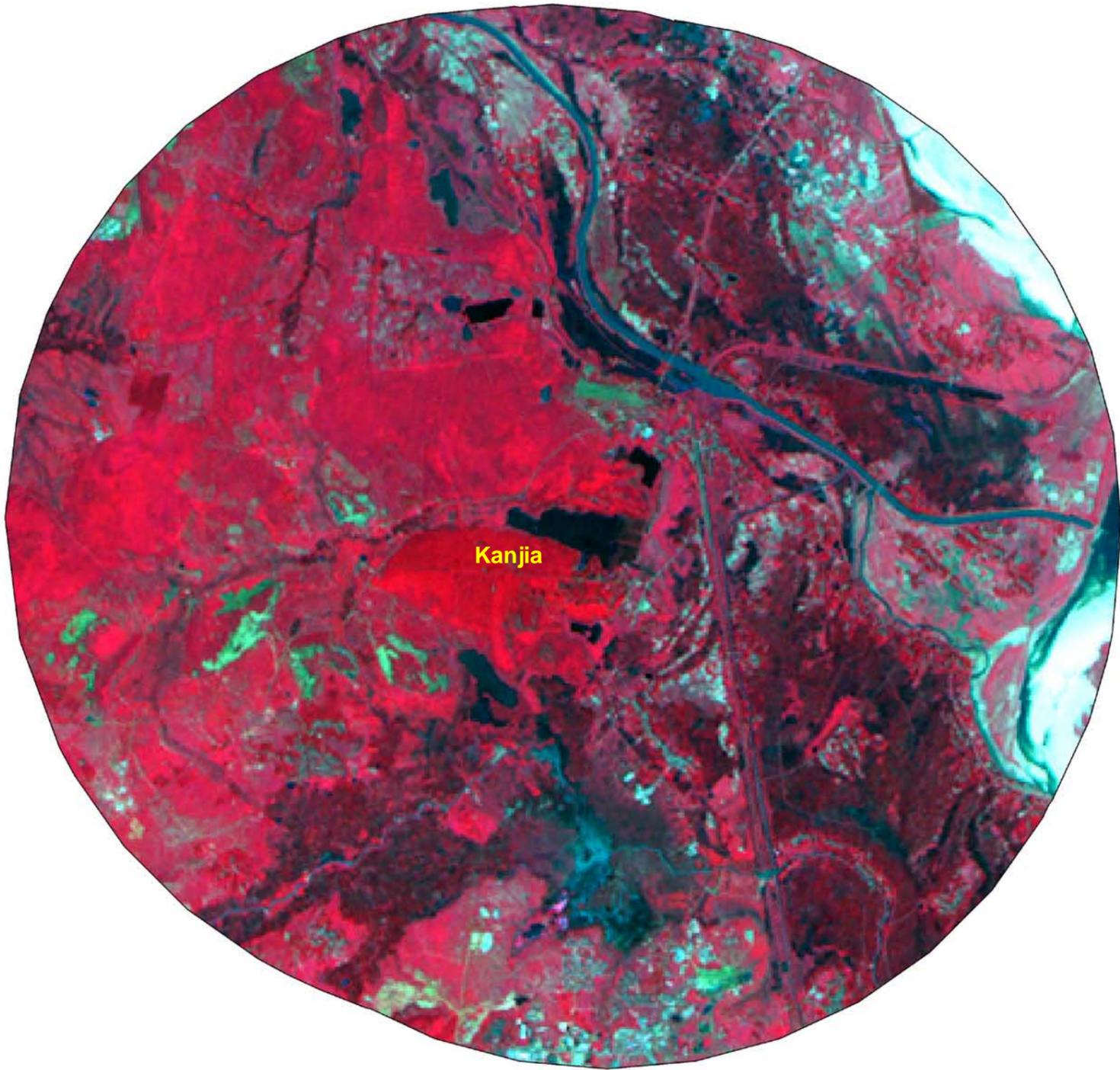


Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :
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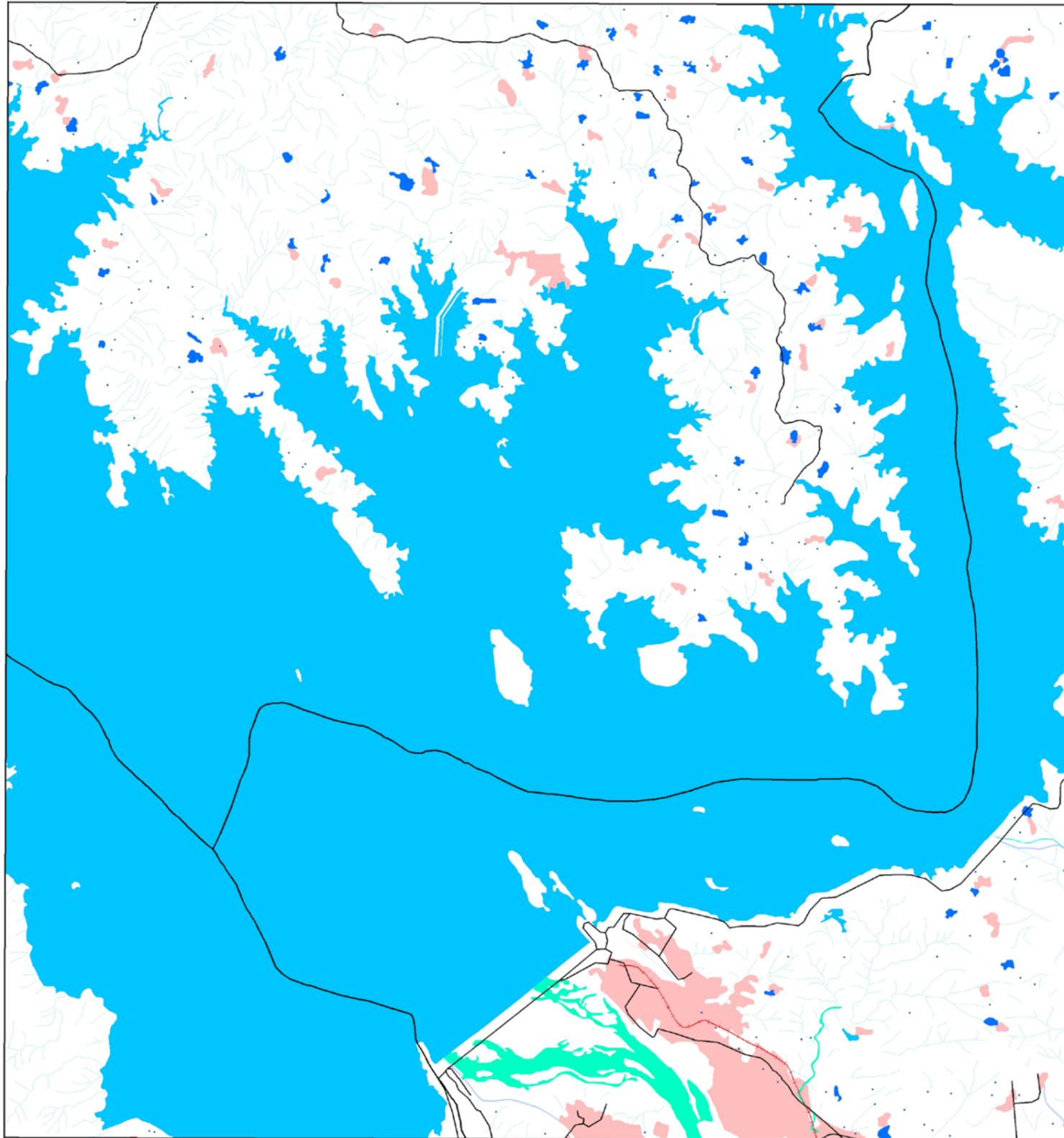
Plate 19: Wetland map - 5 km buffer area of Kanjia wetland



IRS P6 LISS-III Post-monsoon data (2006)

Plate 20: IRS P6 LISS-III image - 5 km buffer area of Kanjia wetland

**SOI MAP SHEET-WISE WETLAND MAPS
(Selected)**

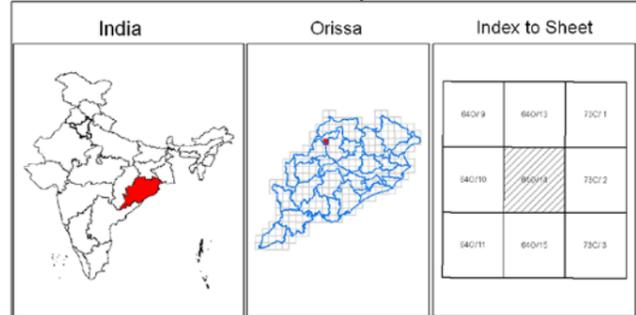


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
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	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Drainage (line)
- Canal
- Roads
- Railways
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

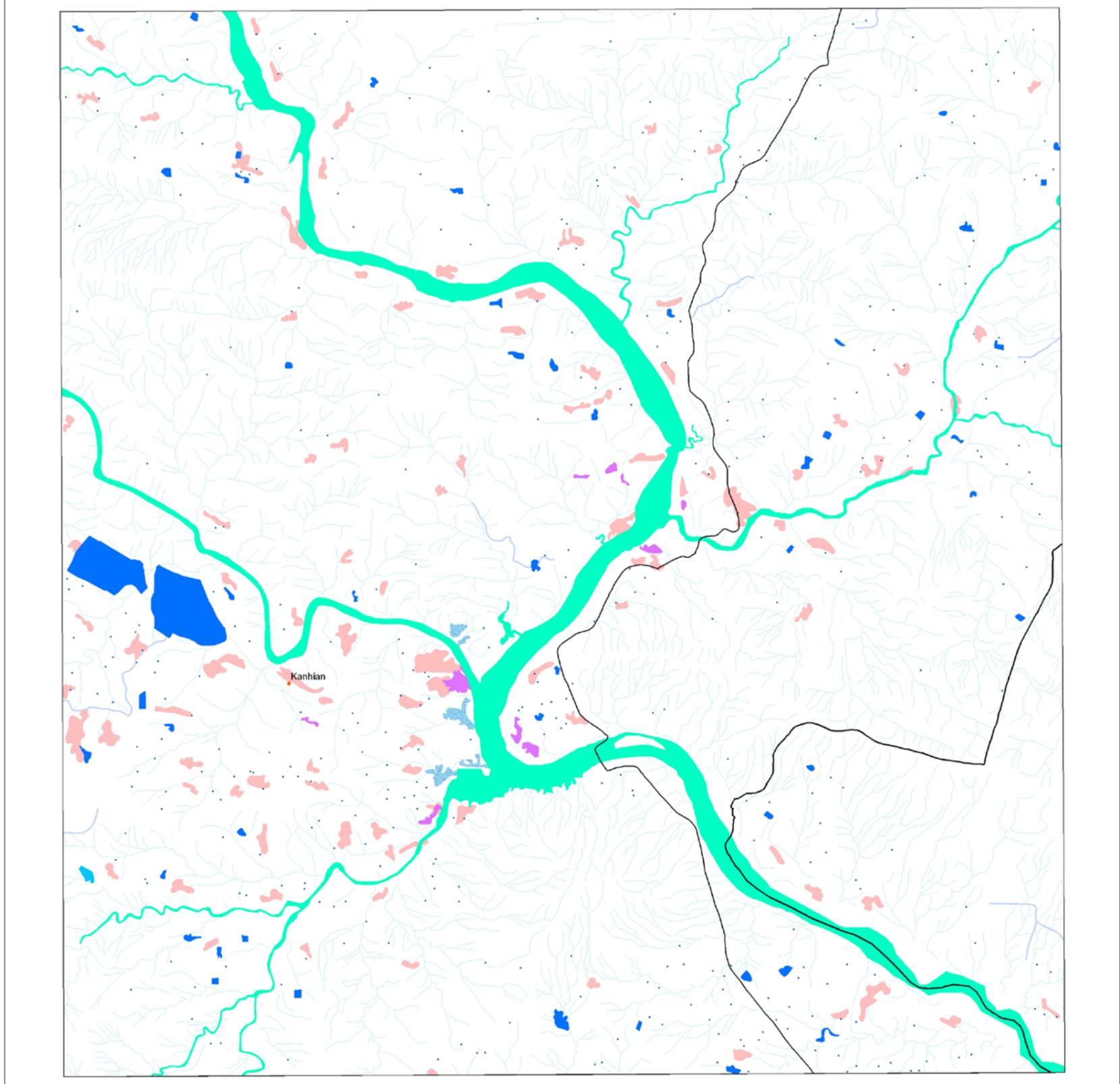


0 1 2 4 6 Kilometers

Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

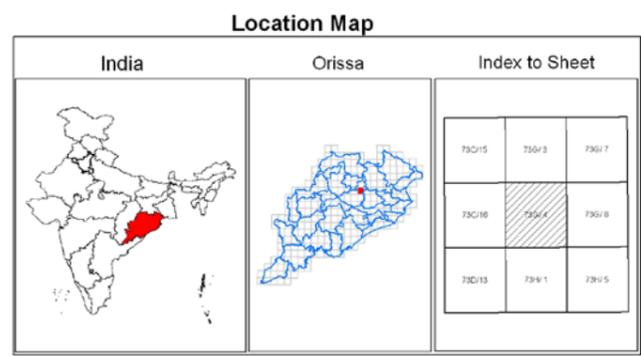
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Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

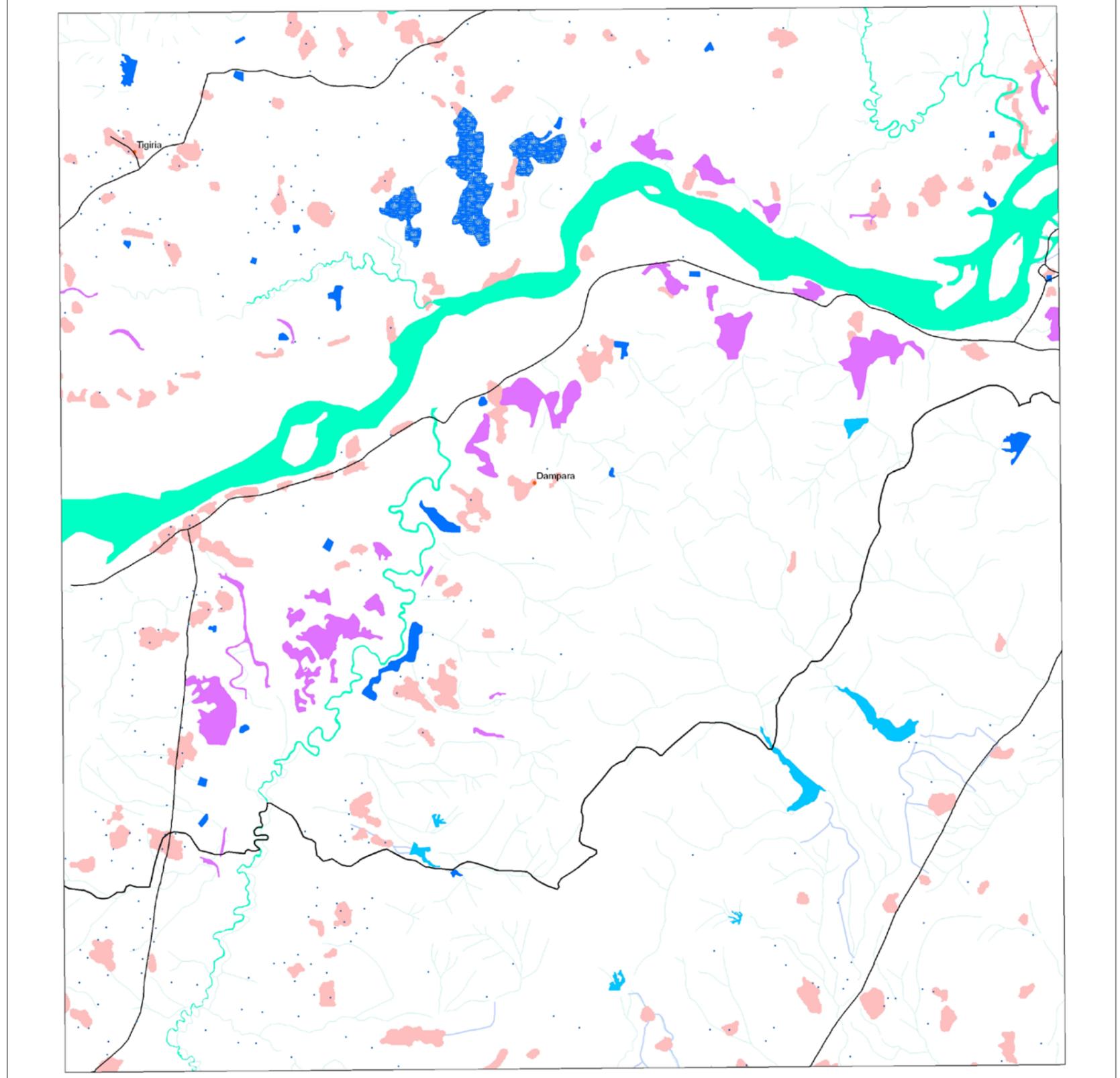
- Legend**
- Wetlands (<2.25 ha)
 - Settlements
 - Drainage (line)
 - Canal
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 - State Boundary
 - International Boundary



Data Source :
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

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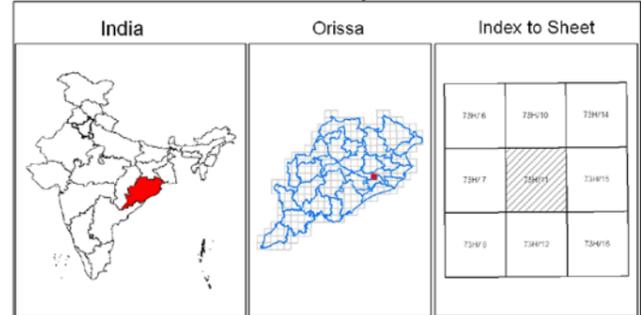


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Drainage (line)
- Canal
- Roads
- Railways
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map

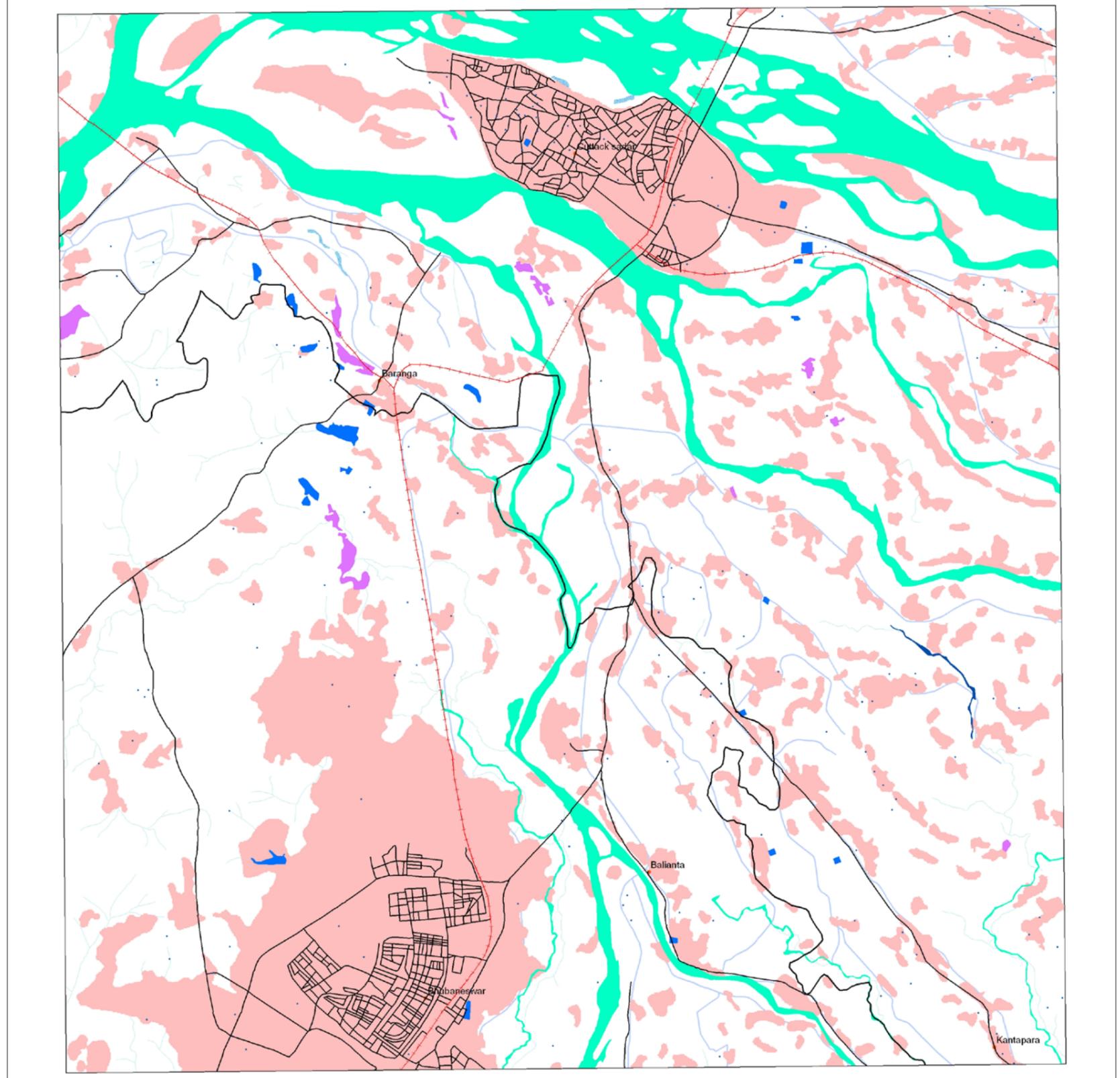


0 1 2 4 6 Kilometers

Data Source : IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By : Space Applications Centre (ISRO), Ahmedabad and Orissa Space Applications Centre, Bhubaneswar

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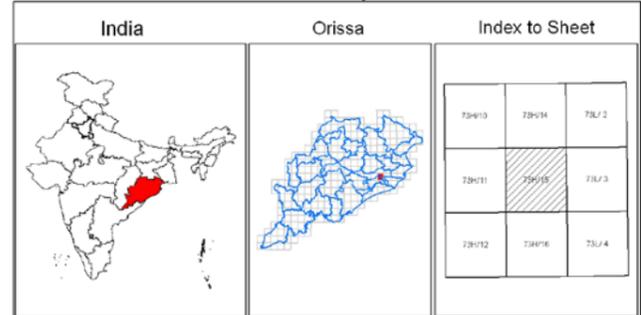


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		Inland Wetlands		
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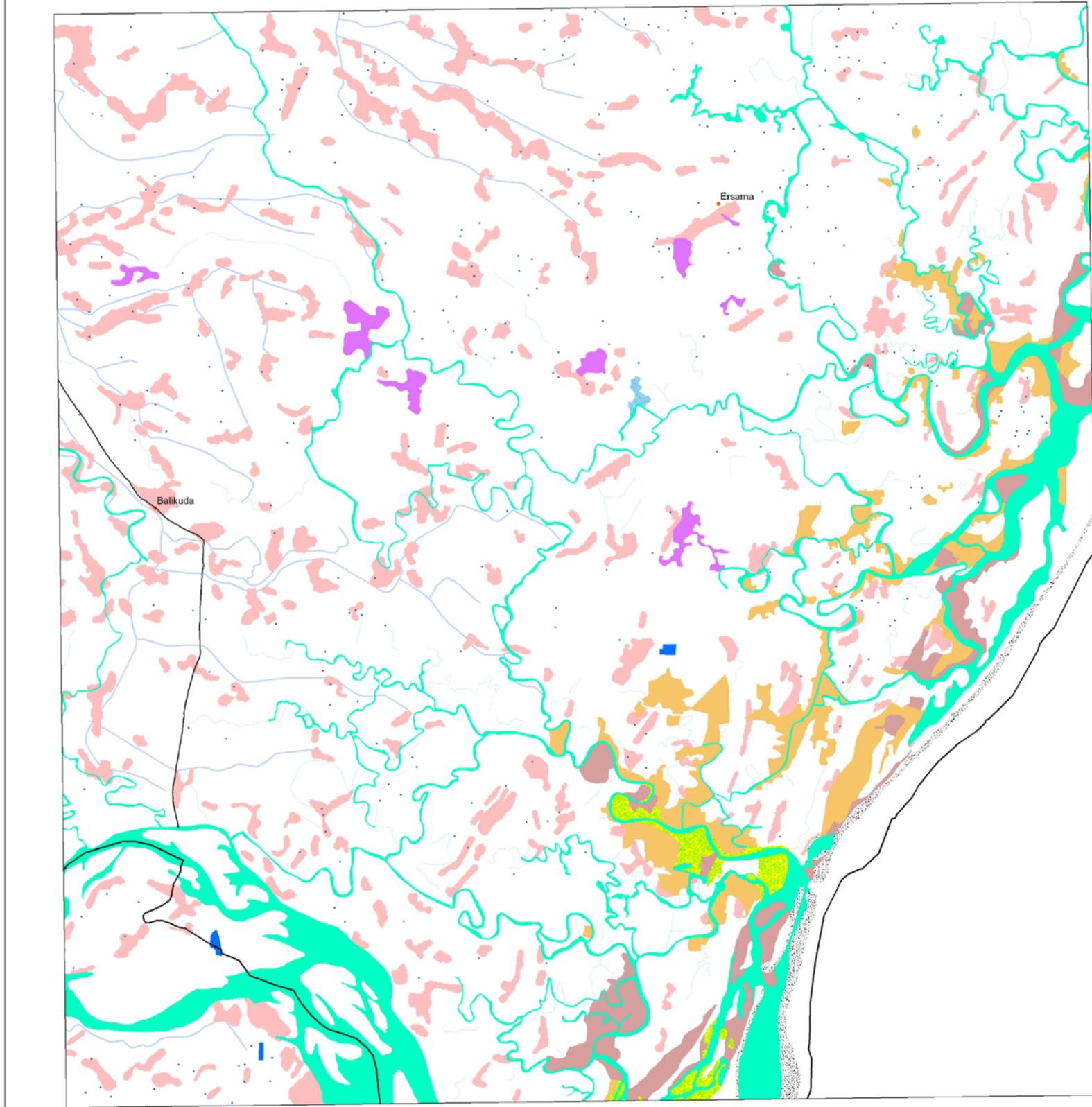


0 1 2 4 6 Kilometers

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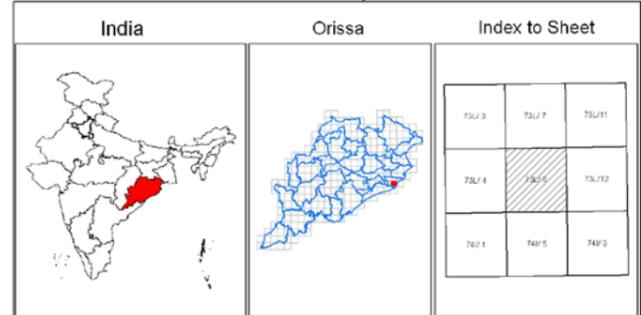


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
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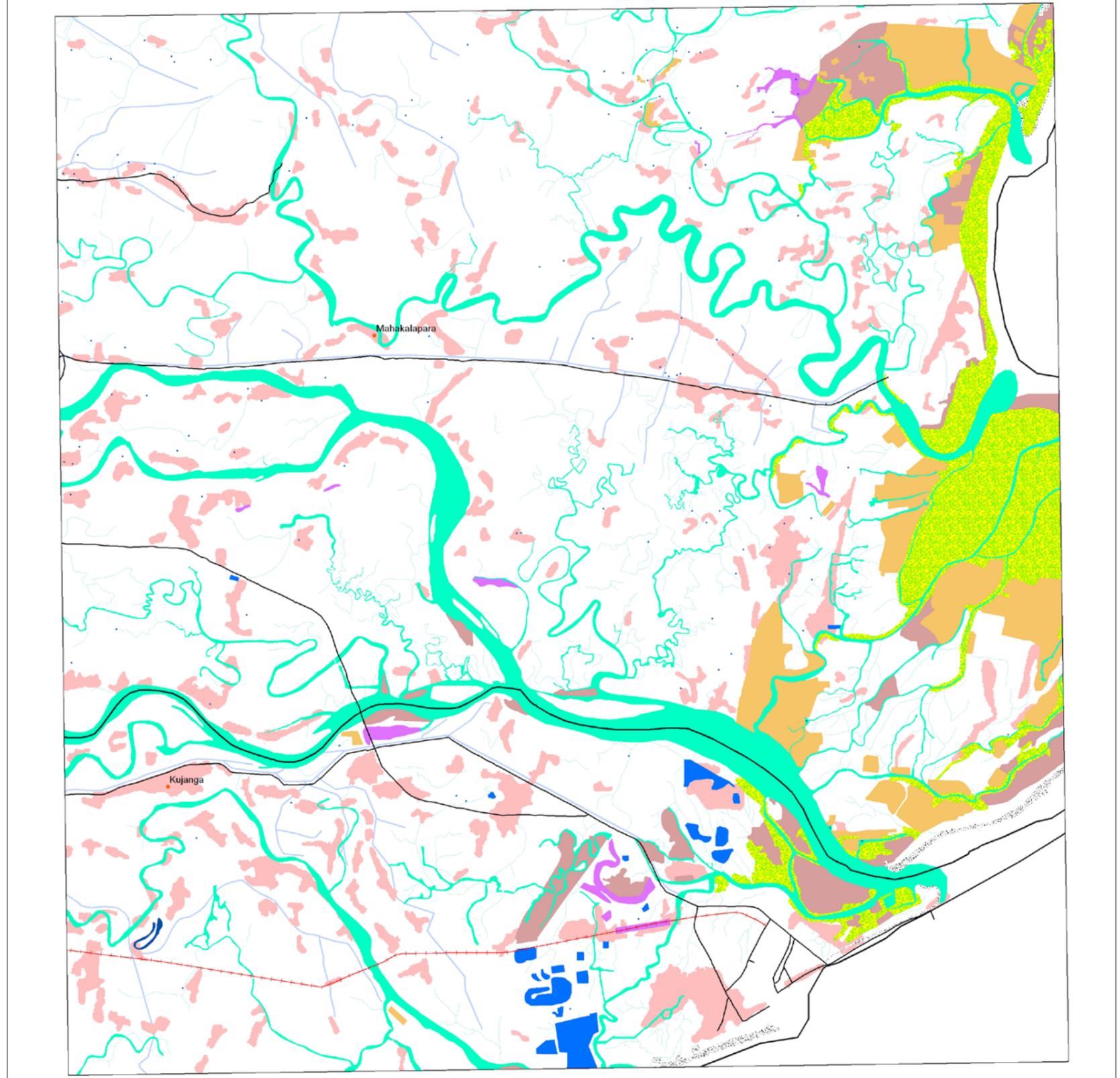


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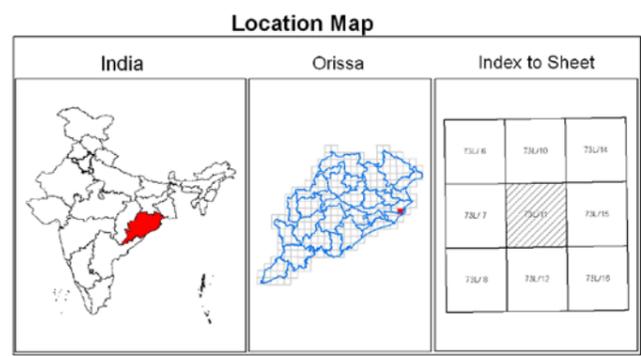
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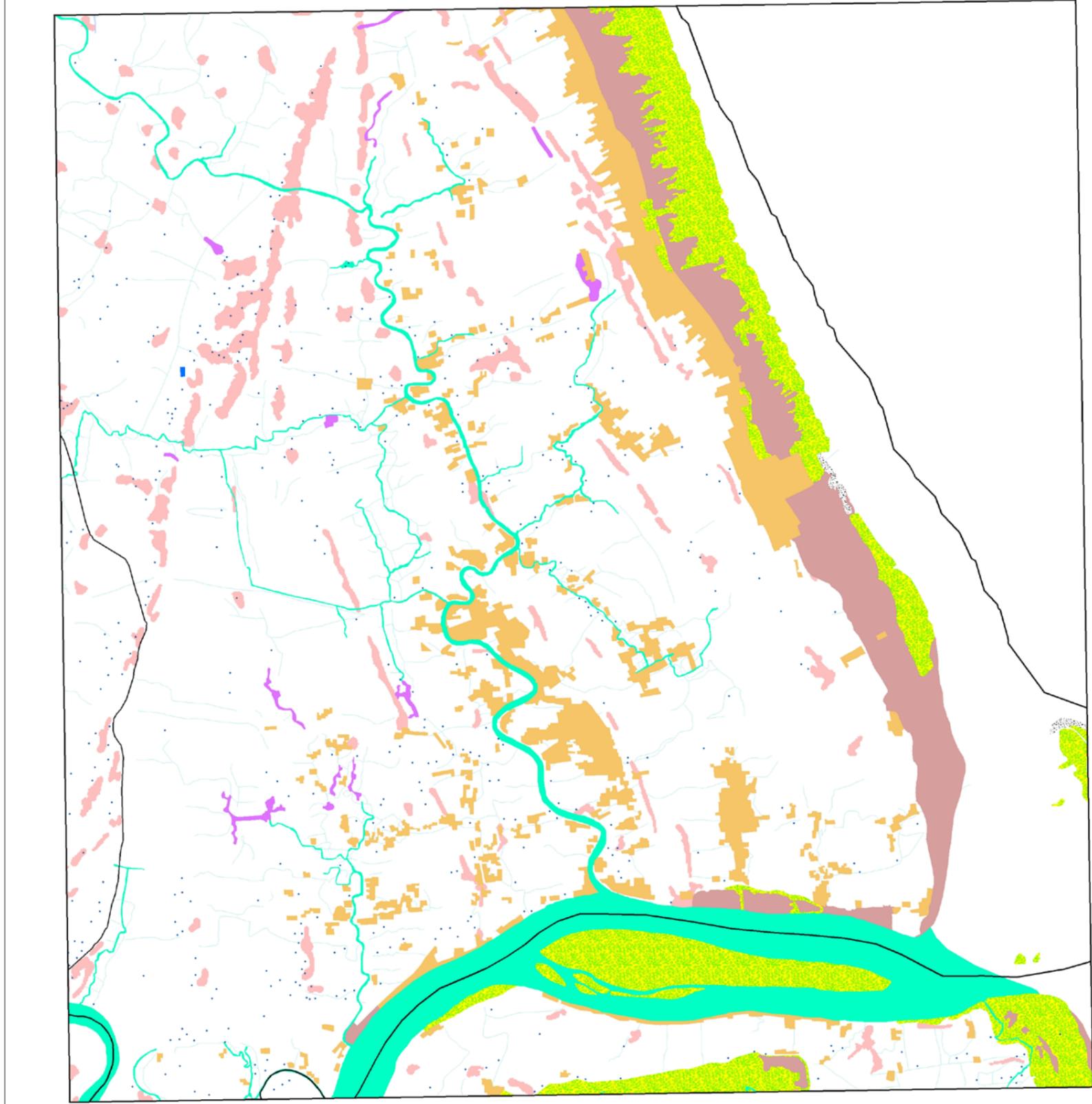
- Legend**
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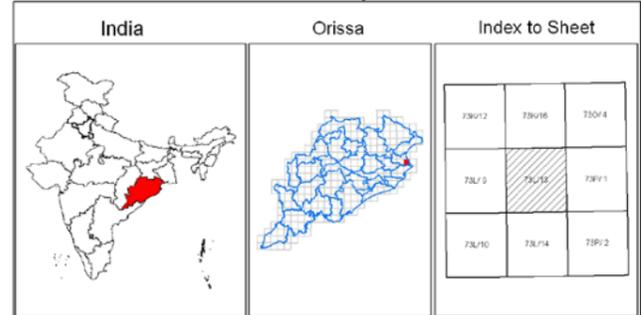


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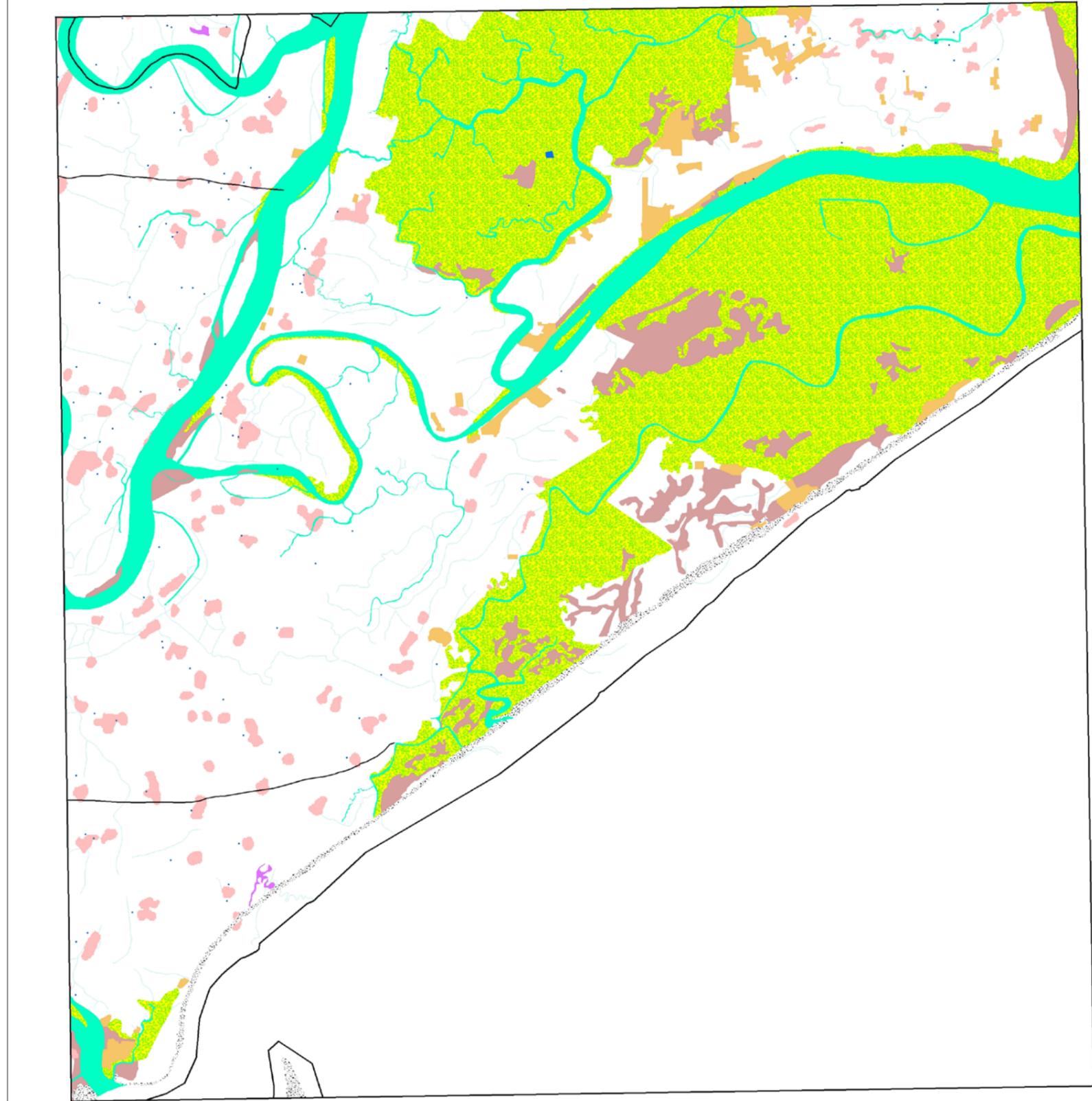


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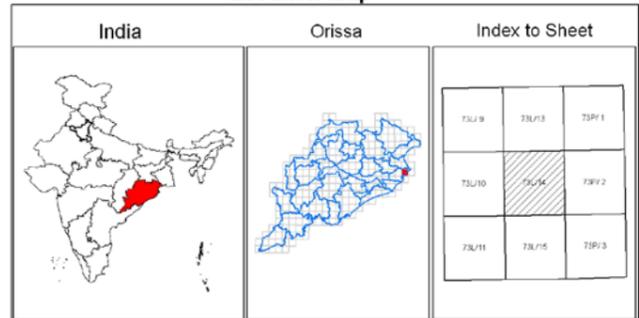


Symbol	Typecode	Level I	Level II	Level III
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			Natural	
	1101			Lakes/Ponds
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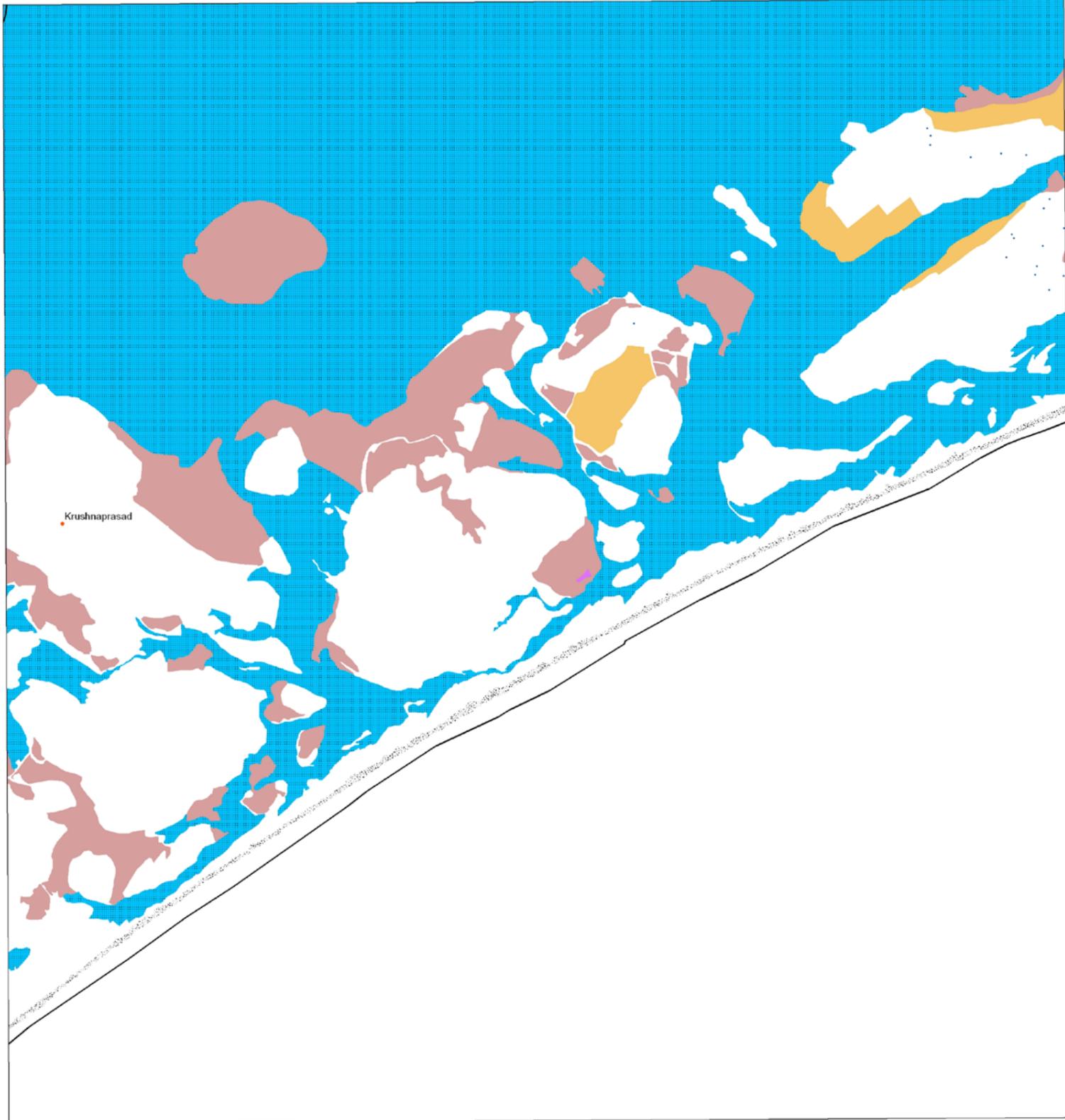


0 1 2 4 6 Kilometers

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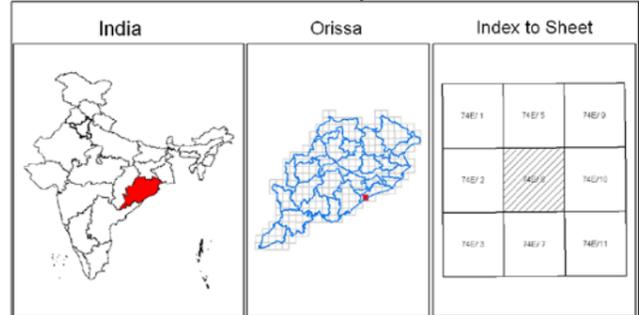


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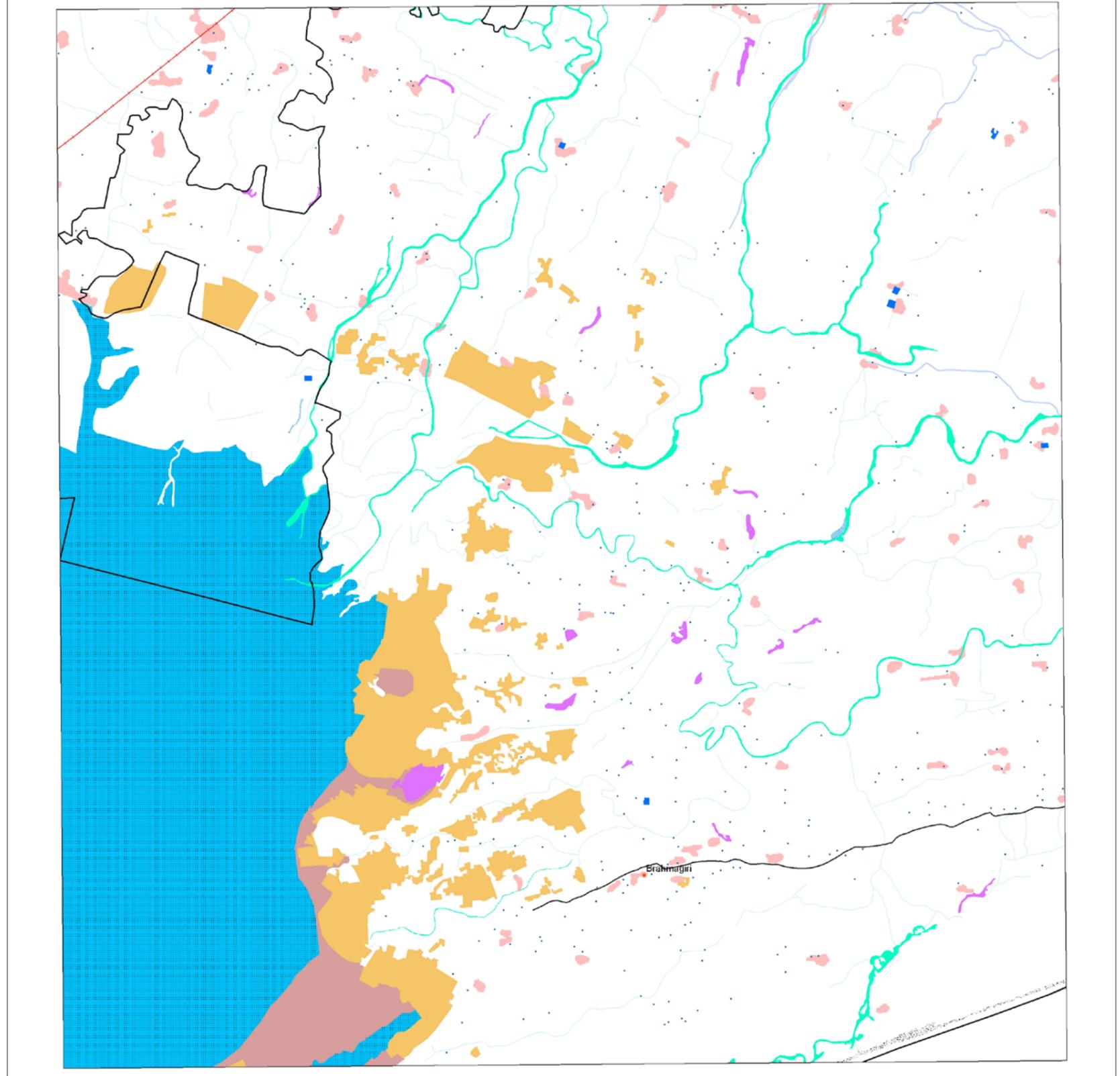


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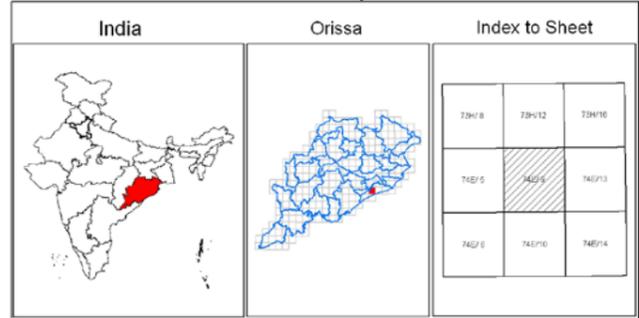


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Annexure I
Definitions of wetland categories used in the project

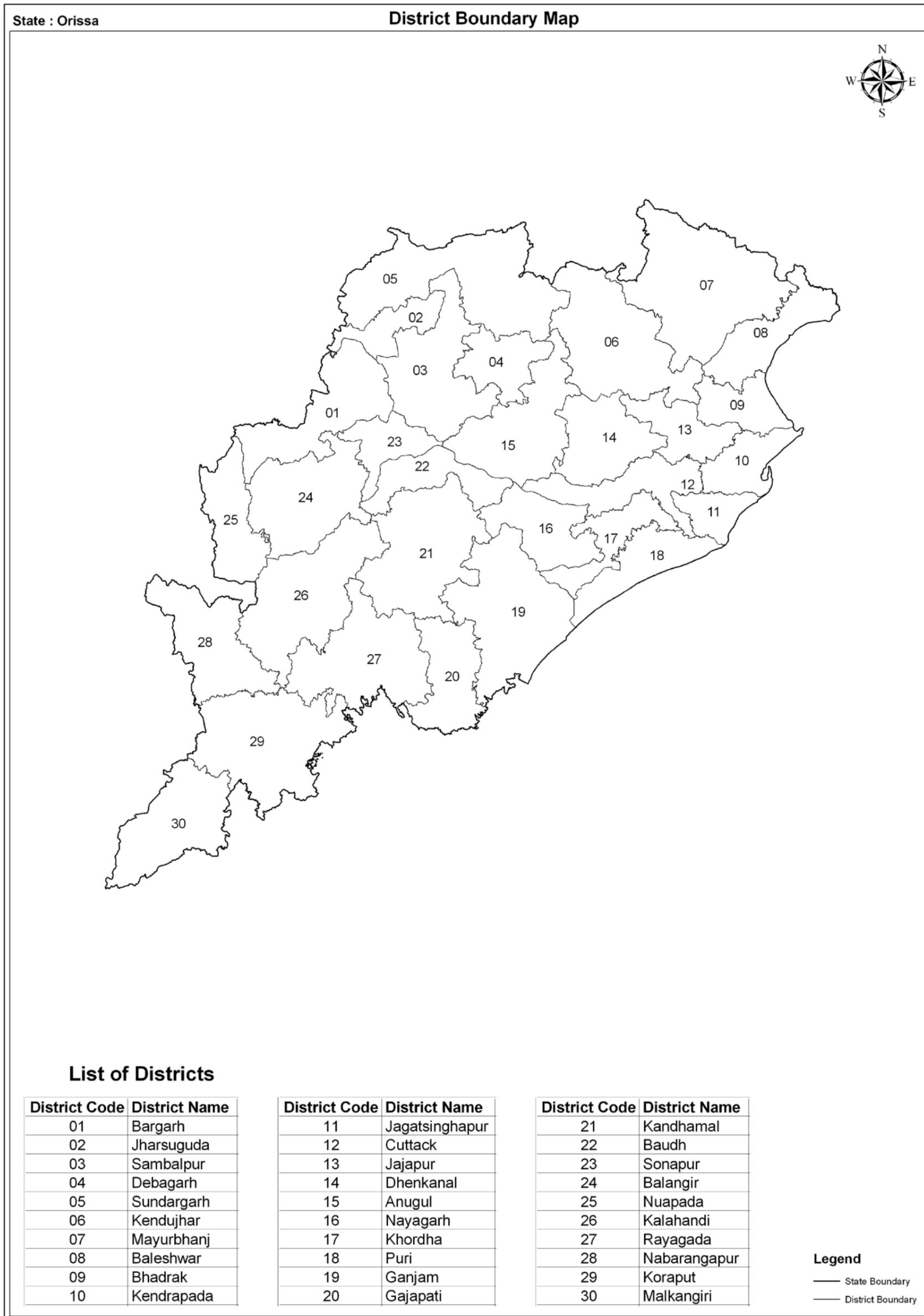
For ease of understanding, definitions of wetland categories and their typical appearance on satellite imagery is given below:

Wetland type code	Definition and description
1000	Inland Wetlands
1100	Natural
1101	Lakes: Larger bodies of standing water occupying distinct basins (Reid <i>et al</i> , 1976). These wetlands occur in natural depressions and normally fed by streams/rivers. On satellite images lakes appear in different hues of blue interspersed with pink (aquatic vegetation), islands (white if unvegetated, red in case of terrestrial vegetation). Vegetation if scattered make texture rough.
1102	Ox-bow lakes/ Cut off meanders: A meandering stream may erode the outside shores of its broad bends, and in time the loops may become cut-off, leaving basins. The resulting shallow crescent-shaped lakes are called oxbow lakes (Reid <i>et al</i> , 1976). On the satellite image Ox-bow lakes occur near the rivers in plain areas. Some part of the lake normally has aquatic vegetation (red/pink in colour) during pre-monsoon season.
1103	High Altitude lakes: These lakes occur in the Himalayan region. Landscapes around high lakes are characterized by hilly topography. Otherwise they resemble lakes in the plain areas. For keeping uniformity in the delineation of these lakes contour line of 3000 m above msl will be taken as reference and all lakes above this contour line will be classified as high altitude lakes.
1104	Riverine Wetlands: Along the major rivers, especially in plains water accumulates leading to formation of marshes and swamp. Swamps are 'Wetland dominated by trees or shrubs' (U.S. Definition). In Europe, a forested fen (a peat accumulating wetland that has no significant inflows or outflows and supports acidophilic mosses, particularly <i>Sphagnum</i>) could be called a swamp. In some areas reed grass - dominated wetlands are also called swamps). (Mitsch and Gosselink, 1986). Marsh: A frequently or continually inundated wetland characterised by emergent herbaceous vegetation adapted to saturated soil conditions. In European terminology a marsh has a mineral soil substrate and does not accumulate peat (Mitsch and Gosselink, 1986). Tone is grey blue and texture is smooth. Comment: Using satellite data it is difficult to differentiate between swamp and marsh. Hence, both have been clubbed together.
1105	Waterlogged: Said of an area in which water stands near, at, or above the land surface, so that the roots of all plants except hydrophytes are drowned and the plants die (Margarate <i>et al</i> , 1974). Floods or unlined canal seepage and other irrigation network may cause waterlogging. Spectrally, during the period when surface water exists, waterlogged areas appear more or less similar to lakes/ponds. However, during dry season large or all parts of such areas dry up and give the appearance of mud/salt flats (grey bluish).
1106	River/stream: Rivers are linear water features of the landscape. Rivers that are wider than the mapping unit will be mapped as polygons. Its importance arises from the fact that many stretches of the rivers in Indo-Gangetic Plains and peninsular India are declared important national and international wetlands (Ex. The river Ganga between Brajghat and Garh Mukteshwar, is a Ramsar site, Ranganthattu on the Cavery river is a bird sanctuary etc.). Wherever, rivers are wide and features like sand bars etc. are visible, they will be mapped.
1200	Man-made
1201	Reservoir: A pond or lake built for the storage of water, usually by the construction of a dam across a river (Margarate <i>et al</i> , 1974). On RS images, reservoirs have irregular boundary behind a prominent dyke. Wetland boundary in case of reservoir incorporates water, aquatic vegetation and footprint of water as well. In the accompanying images aquatic vegetation in the reservoir is seen in bright pink tone. Tone is dark blue in deep reservoirs while it is ink blue in case of shallow reservoirs or reservoirs with high silt load. These will be annotated as Reservoirs/Dam. Barrage: Dykes are constructed in the plain areas over rivers for creating Irrigation/water facilities. Such water storage areas develop into wetlands (Harike Barrage on Satluj – a Ramsar site, Okhla barrage on the Yamuna etc. – a bird sanctuary). Water appears in dark blue tone with a smooth texture. Aquatic vegetation appears in pink colour, which is scattered, or contiguous depending on the density. Reservoirs formed by barrages will be annotated as reservoir/barrage.

1202	<p>Tanks/Ponds: A term used in Ceylon and the drier parts of Peninsular India for an artificial pond, pool or lake formed by building a mud wall across the valley of a small stream to retain the monsoon (Margarate <i>et al</i>, 1974). Ponds Generally, suggest a small, quiet body of standing water, usually shallow enough to permit the growth of rooted plants from one shore to another (Reid <i>et al</i>, 1976). Tanks appear in light blue colour showing bottom reflectance.</p> <p>In this category Industrial ponds/mining pools mainly comprising Abandoned Quarries are also included (Quarry is defined as "An open or surface working or excavation for the extraction of stone, ore, coal, gravel or minerals." In such pits water accumulate (McGraw Hill Encyclopaedia of Environmental Sciences, 1974), Ash pond/Cooling pond (The water body created for discharging effluents in industry, especially in thermal power plants (Encyclopaedic Directory of Environment, 1988) and Cooling pond: An artificial lake used for the natural cooling of condenser-cooling water serving a conventional power station (Encyclopaedic Directory of Environment, 1988). These ponds can be of any shape and size. Texture is rough and tonal appearance light (quarry) to blue shade (cooling pond).</p>
1203	<p>Waterlogged : Man-made activities like canals cause waterlogging in adjacent areas due to seepage especially when canals are unlined. Such areas can be identified on the images along canal network. Tonal appearance is in various hues of blue. Sometimes, such waterlogged areas dry up and leave white scars on the land. Texture is smooth.</p>
1204	<p>Salt pans: Inland salt pans in India occur in Rajasthan (Sambhar lake). These are shallow rectangular man-made depressions in which saline water is accumulated for drying in the sun for making salt.</p>
2000	Coastal Wetlands
2100	Natural
2101	<p>Lagoons/Backwaters: Such coastal bodies of water, partly separated from the sea by barrier beaches or bass of marine origin, are more properly termed lagoons. As a rule, lagoons are elongate and lie parallel to the shoreline. They are usually characteristic of, but not restricted to, shores of emergence. Lagoons are generally shallower and more saline than typical estuaries (Reid <i>et al</i>, 1976). Backwater: A creek, arm of the sea or series of connected lagoons, usually parallel to the coast, separated from the sea by a narrow strip of land but communicating with it through barred outlets (Margarate <i>et al</i>, 1974).</p>
2102	<p>Creek: A notable physiographic feature of salt marshes, especially low marshes. These creeks develop as do rivers "with minor irregularities sooner or later causing the water to be deflected into definite channels" (Mitsch and Gosselink, 1986). Creeks will be delineated, however, their area will not be estimated.</p>
2103	<p>Sand/Beach: Beach is an unvegetated part of the shoreline formed of loose material, usually sand that extends from the upper berm (a ridge or ridges on the backshore of the beach, formed by the deposit of material by wave action, that marks the upper limit of ordinary high tides and wave wash to low water mark(Clark,1977).Beach comprising rocky material is called rocky beach.</p>
2104	<p>Intertidal mudflats: Most unvegetated areas that are alternately exposed and inundated by the falling and rising of the tide. They may be mudflats or sand flats depending on the coarseness of the material of which they are made (Clark, 1977).</p>
2105	<p>Salt Marsh: Natural or semi-natural halophytic grassland and dwarf brushwood on the alluvial sediments bordering saline water bodies whose water level fluctuates either tidally or non- tidally (Mitsch and Gosselink, 1986). Salt marshes look in grey blue shade when wet.</p>
2106	<p>Mangroves: The mangrove swamp is an association of halophytic trees, shrubs, and other plants growing in brackish to saline tidal waters of tropical and sub-tropical coastlines (Mitsch and Gosselink, 1986). On the satellite images mangroves occur in red colour if in contiguous patch. When mangrove associations are scattered or are degraded then instead of red colour, brick red colour may be seen.</p>
2107	<p>Coral reefs: Consolidated living colonies of microscopic organisms found in warm tropical waters. The term coral reef, or organic reef is applied to the rock- like reefs built-up of living things, principally corals. They consist of accumulations of calcareous deposits of corals and coralline algae with the intervening space connected with sand, which consists largely of shells of foraminifera. Present reefs are living associations growing on this accumulation of past (Clark, 1977). Reefs appear in light blue shade.</p>
2200	Man-made
2201	<p>Salt pans: An undrained usually small and shallow rectangular, man-made depression or hollow in which saline water accumulates and evaporates leaving a salt deposit (Margarate <i>et al</i>, 1974). Salt pans are square or rectangular in shape. When water is there appearance is blue while salt is formed tone is white.</p>
2202	<p>Aquaculture ponds: Aquaculture is defined as "The breeding and rearing of fresh-water or marine fish in captivity. Fish farming or ranching". The water bodies used for the above are called aquaculture ponds (Encyclopaedic Directory of Environment, 1988). Aquaculture ponds are geometrical in shape usually square or rectangular. Tone is blue.</p>

Annexure – II

Details of District information followed in the atlas



Source : Survey of India (Surveyed in 2004 and published in 2005)

Space Applications Centre (SAC) is one of the major centres of the Indian Space Research Organisation (ISRO). It is a unique centre dealing with a wide variety of disciplines comprising design and development of payloads, societal applications, capacity building and space sciences, thereby creating a synergy of technology, science and applications. The Centre is responsible for the development, realisation and qualification of communication, navigation, earth & planetary observation, meteorological payloads and related data processing and ground systems. Several national level application programmes in the area of natural resources, weather and environmental studies, disaster monitoring/mitigation, etc are also carried out. It is playing an important role in harnessing space technology for a wide variety of applications for societal benefits.

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