NATIONAL WETLAND ATLAS:

CHHATTISGARH

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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Ministry of Environment and Forests, Government of India

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

Space Applications Centre (ISRO), Ahmedabad

and

National Remote Sensing Centre (NRSC), Hyderabad

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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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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 complied 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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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. Pradeeep 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, Coimbtore 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.

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(Sushma Panigrahy)

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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 Chhattisgarh, 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. 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), lacustarine (lakes), riverine (along rivers and streams), palustarine ('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 throughout 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 are 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 techniques

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, and 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, 1986; 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 - a typical wetland located in Purba Champaran district. 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, IRS series data has been successfully used in various fields of natural resources (Navalgund *et al,* 2002).

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.

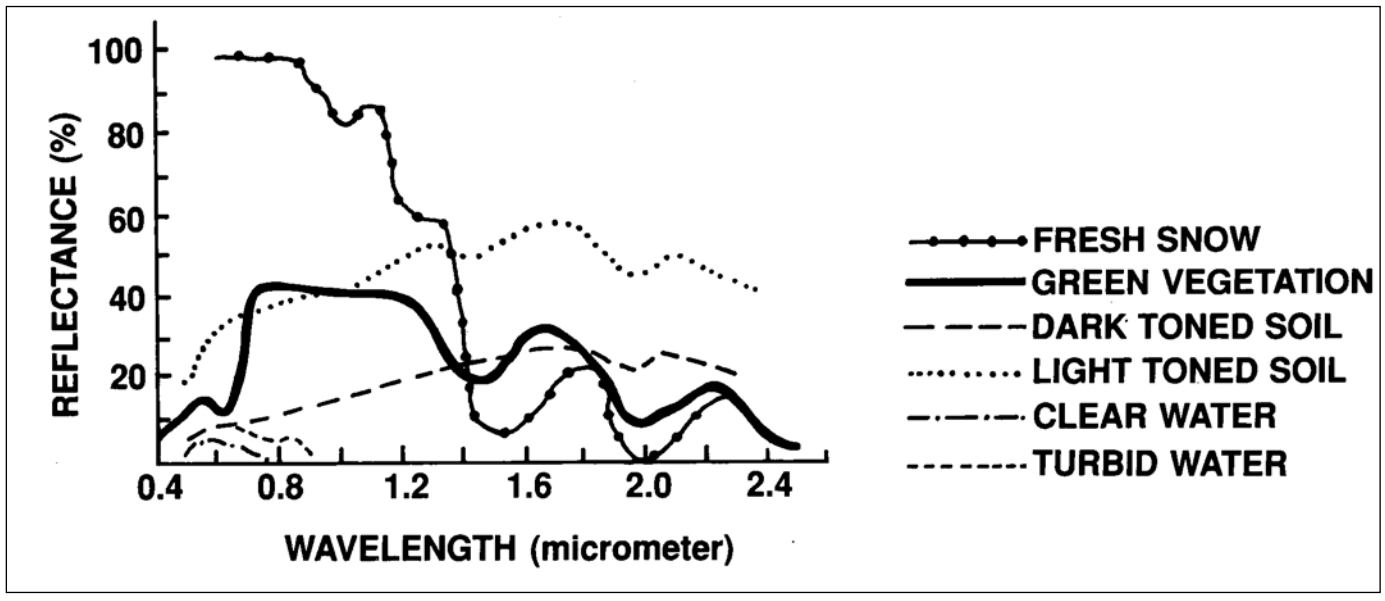
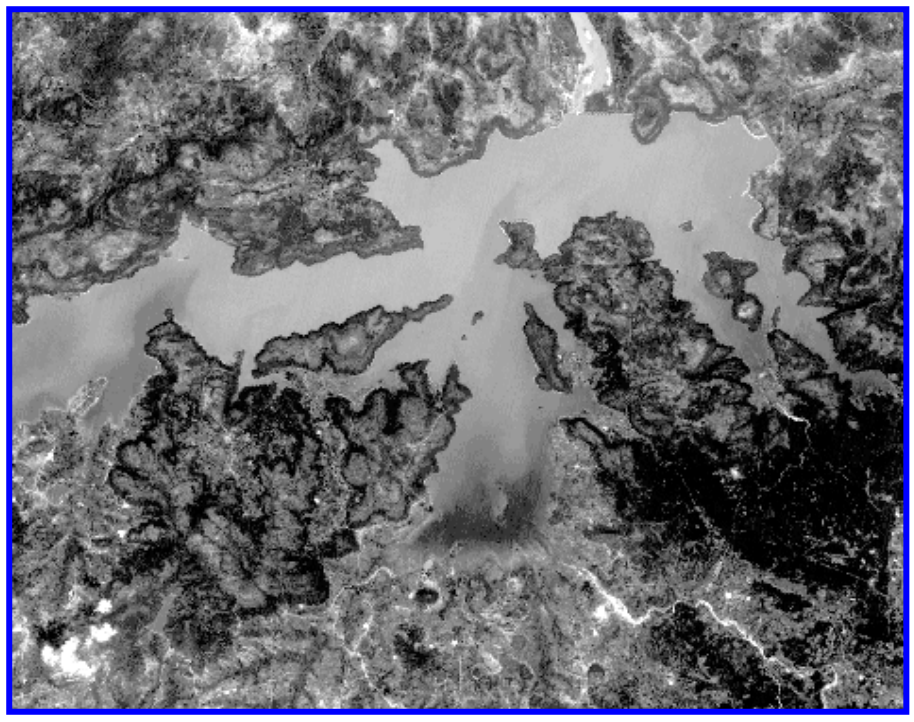
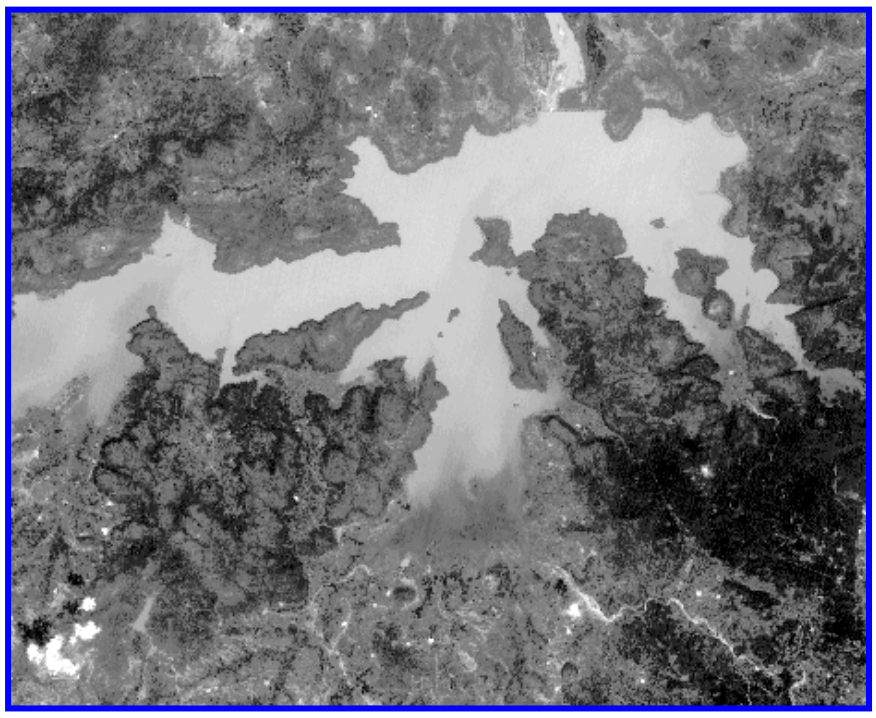


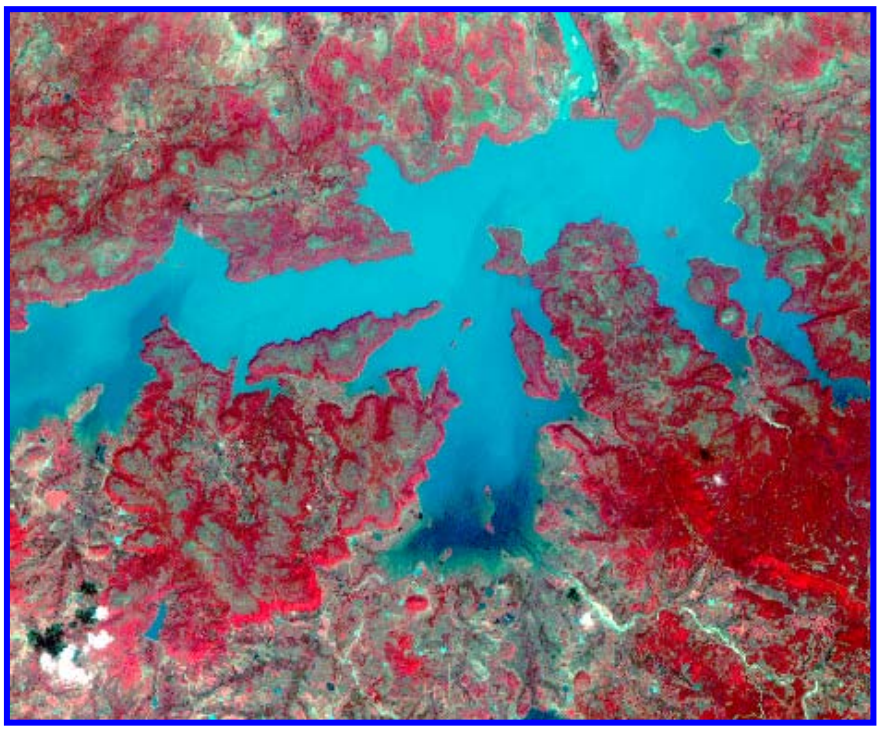
Figure 1: Spectral Signature of various targets



GREEN

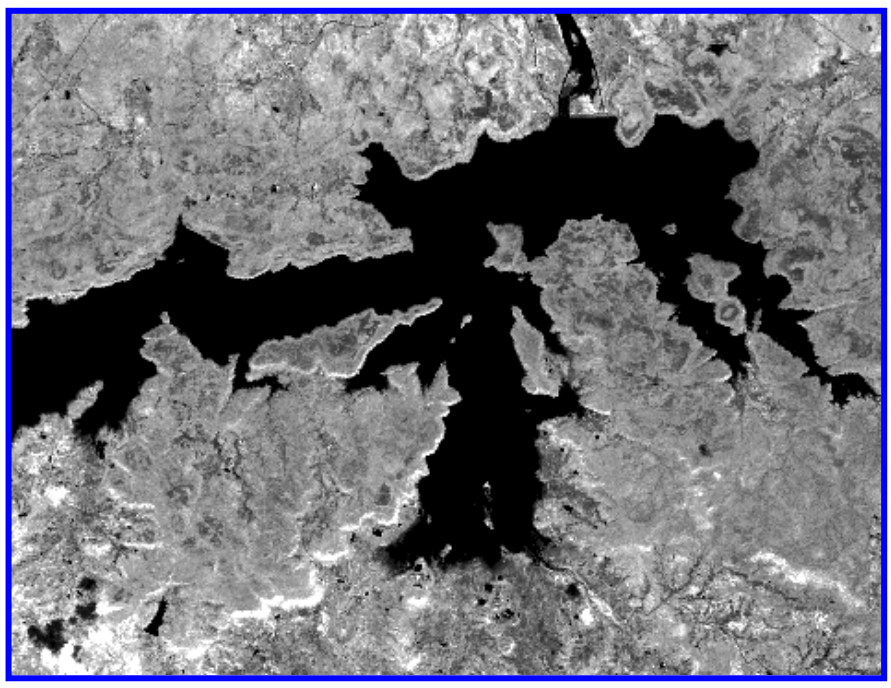


RED



IRS LISS-III FCC

NIR



SWIR

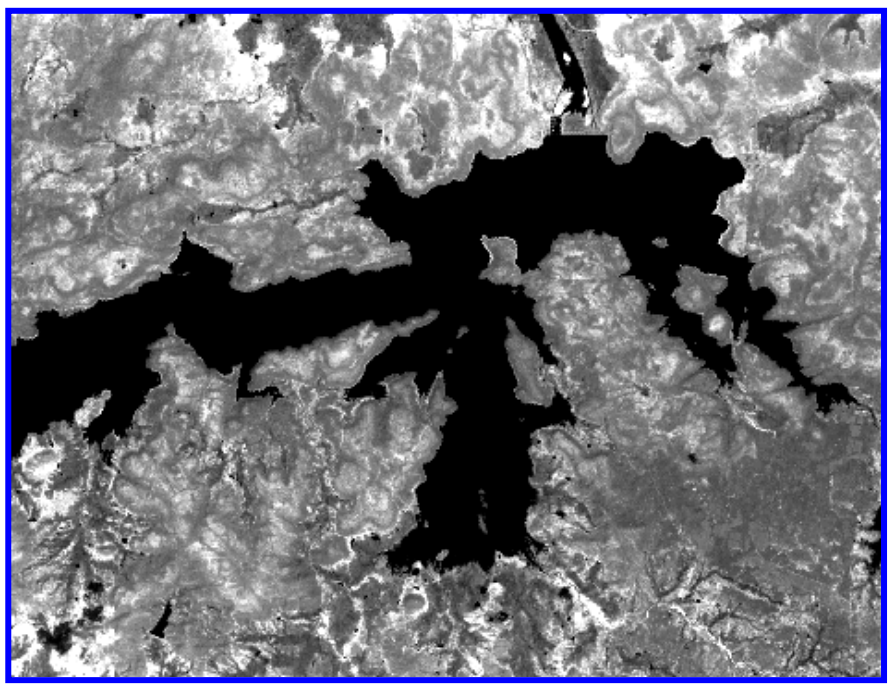


Figure 2: Various wetland features as they appear in four spectral bands and in a typical three band FCC

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 place 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 during1992-93 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 1:250000 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 scale 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 atlases

The project was initiated during 2007. The first task was to have a classification system that can be used by different types of 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 Chhattisgarh.

2.1 Wetland Classification System

In the present project, Modified National Wetland Classification system is used for wetland delineation and mapping comprising 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 are 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 extents 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 pre-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).

In the case of coastal wetlands only wetland extent is given.

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

Chhattisgarh situated in central India and lies between 80º15" to 84º20" longitude and between 17º46"N to 24º5".latitude. The capital city of this state is Raipur. The state is the 10th largest state of India and is spread across total area of 1,35,194 sq km. There are sixteen districts in the state. The state is bordered by Madhya Pradesh, Orissa, Maharashtra, Andhra Pradesh, Jharkhand and Uttar Pradesh. The state has a history of tanks built in villages since Kalchuri Kings and nearly every village has a small tank for daily needs. There are 4 Major, 33 Medium and 2199 Minor irrigation projects in the state. Location map is shown in Figure-3.

Climate

The climate of Chhattisgarh is mainly tropical. It is hot and humid because of its proximity to the Tropic of Cancer. It is dependent completely on the monsoons for rains. Summer in Chhattisgarh is from April to June, and can be uncomfortably hot, with the mercury hitting the high 40^{o} C. Monsoon season is from middle and late June to October and is a wonderful time to visit Chhattisgarh. Average rainfall in the state is around 1400 mm. and about 90% of the total rainfall is confined in the Monsoon season i.e. 15th June to September. The rainfall has erratic temporal and spatial distribution in the state. Winter season is from November to January. Winters are pleasant with low temperatures and less humidity.

Physiography and Drainage

The northern and southern part of Chhattisgarh is a hilly region. The northern portion lies on the edge of the Indo-Gangetic plain. A tributary of Ganges called the Rihand River drains this area. The southern part of this state is a constituent of the Deccan Plateau. The Godavari River and its tributaries is important river in the south. The central portion of the state is located in the upper basin of the Mahanadi River and its tributaries. This basin is an extremely fertile region and has ample scope for rice cultivation. The upper portion of the Mahanadi basin is separated from the upper Narmada basin to the west by the Maikal range, which is a part of the Satpuras. The Mahanadi River, geographically and economically, is the most important river of Chhattisgarh.

The state is mainly drained by three major river and their tributaries these are Mahanadi, Godavari in the south and Rihand river a tributary of Ganges in the north. The other main rivers of this state are Indravati, Jonk, Arpa and Hasdo (tributary of Mahanadi). Prominent reservoirs/tanks are noticed in Durg, Dhamtari, Korba and Raigarh, situated in the central, southern and north eastern part of the state. The prominent reservoirs are Minimata Bango, Ravi Shankar Sagar, Kurung, Kharkhara, Gondli Jalashay, Tendulat; Maramsilli, Dudhawa and Maniari form some important reservoirs. The reservoirs located in Durg and Dhamtari district are located in the southern part of the district. These are situated at elevated part almost forms semi-circular shape. The water of these reservoirs/ tanks caters to the irrigation requirements in the lower elevation in the nearby areas. Bango Reservoir on Hasdeo River, Korba forms important wetland in the northern part of Chhattisgarh state.

Geology

The Chhattisgarh basin is a crescent shaped basin within the Central Indian Craton formed due to thermal subsidence during Precambrian times, and comprises of a variety of rock types. The sedimentary infill of the basin is predominantly dominated by limestone, sandstone and shale formations of Middle to Upper Proterozoic (1600 – 900 Ma). The most litho units of Chhattisgarh super group are best developed in the Hirri sub-basin. The oldest litho unit i.e. Singhora group is best developed in small proto basin lying just south of Baradwar sub-basin. The Chhattisgarh basin in the Central Indian Craton is filled with stable sediments equivalent in age with Vindhyans. The Chhattisgarh basin is bordered by the Mahanadi Graben in the North east, Godavari Graben in the southwest, Satpura Belt in the northeast and the Eastern Ghats Mobile Belt in the east and southeast. The basement in the Chhattisgarh basin is composed of the Achaean granites and gneisses with associated Meta volcanic Meta sedimentary belts.

IRS P6 LISS-III data has been analyzed for delineating wetlands in the state. The state is covered in 244 Survey of India topographical maps on 1:50,000 scale that form the spatial frame work for mapping (Figure 4). The spatial framework was prepared using 15’ x 15’ grid.

A detail of district information followed in the atlas is given in Annexure-II.

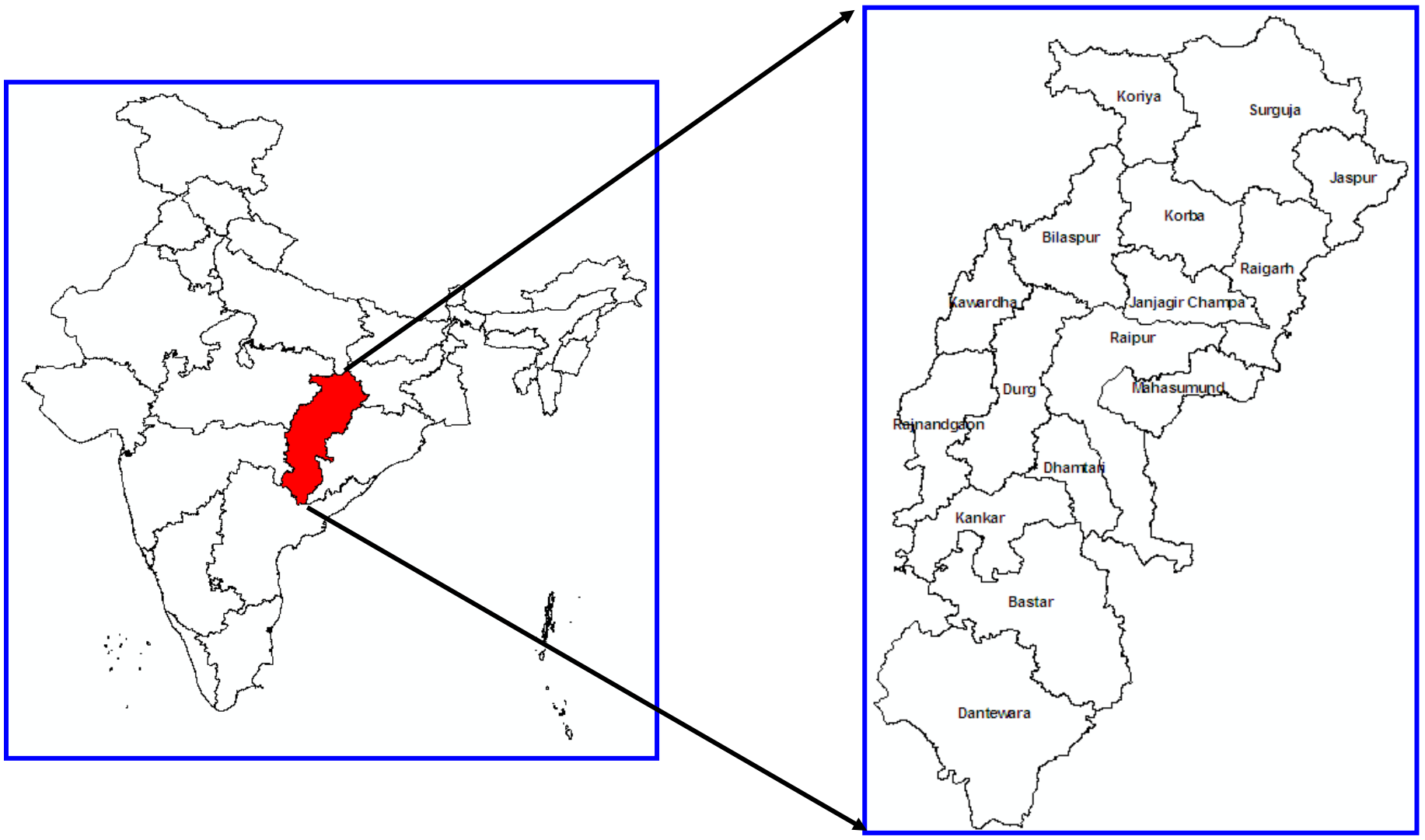


Figure 3: Location Map

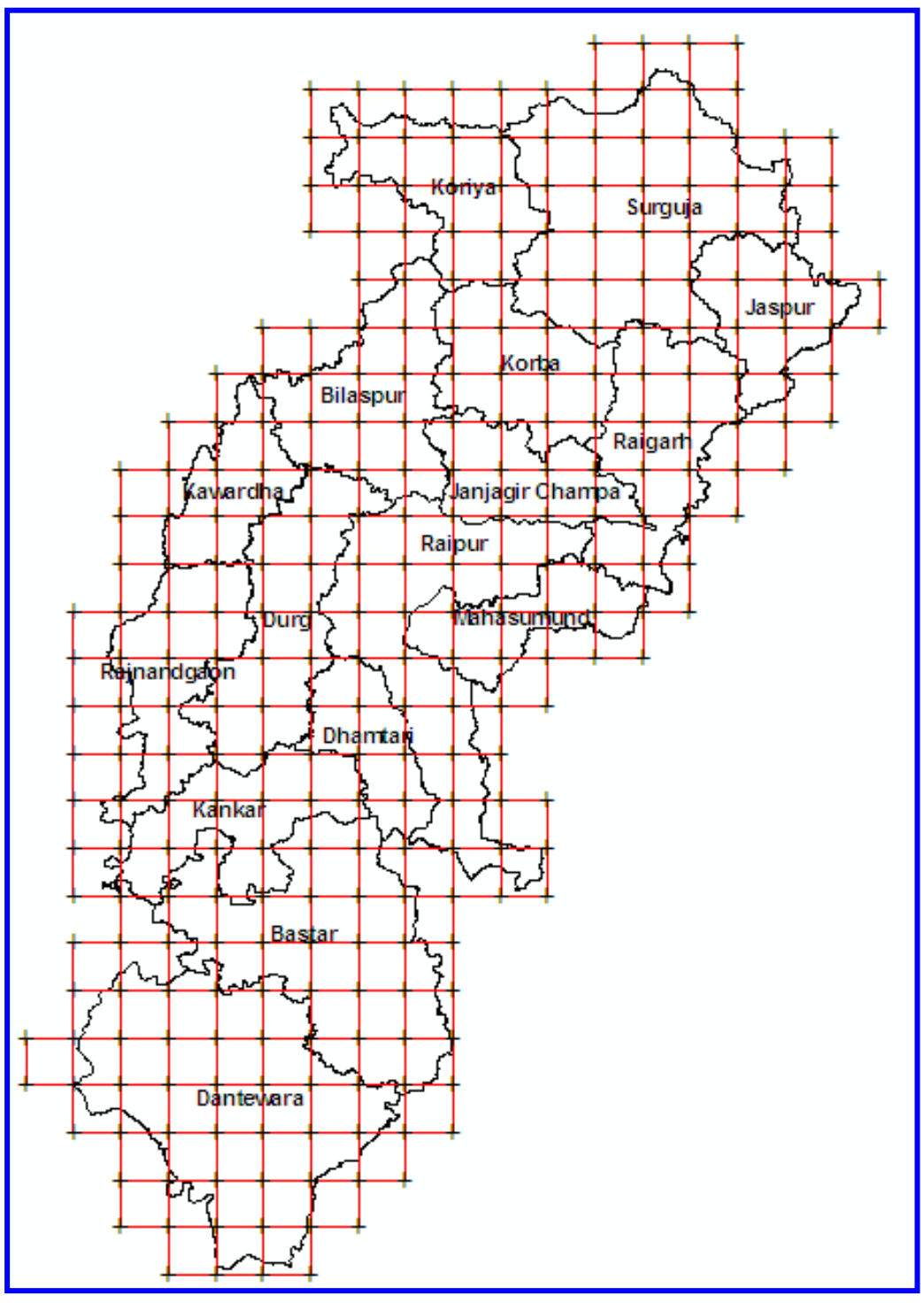


Figure 4: Spatial Framework of Chhattisgarh

4.0 DATA USED

Remote sensing data

IRS P6 LISS III data was used to map the wetlands. IRS P6 LISS III provides data in 4 spectral bands; green, red, Near Infra Red (NIR) and Short wave Infra Red (SWIR), with 23.5 m spatial resolution and 24 day repeat cycle. The spatial resolution is suitable for 1:50,000 scale mapping. The state of Chhattisgarh is covered in 17 IRS LISS III scene (Figure 5). Two date data, one set acquired during March to June and another during November to December 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 part of Chhattisgarh as seen in the LISS III FCC of post-monsoon and pre-monsoon data respectively.

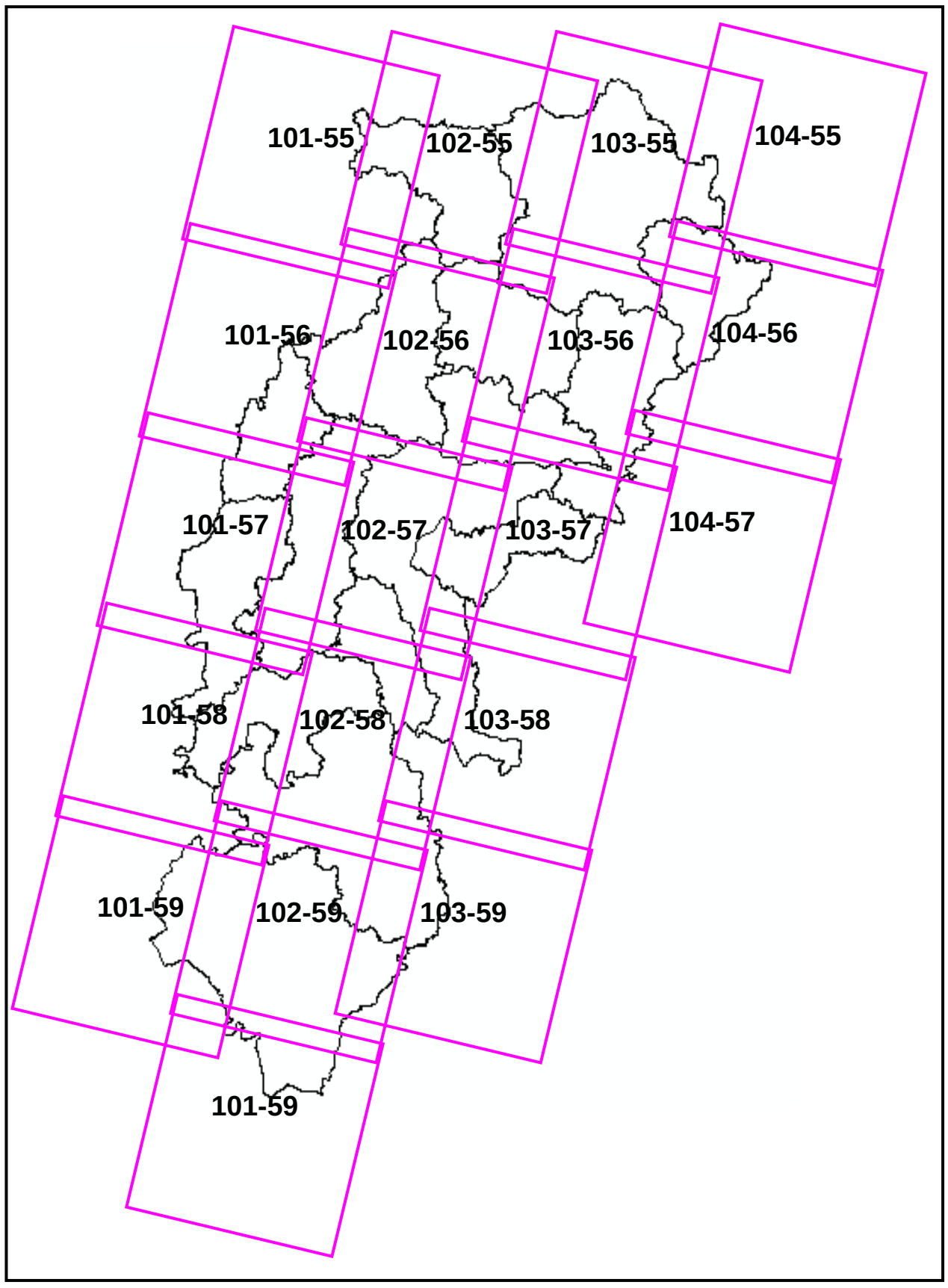


Figure 5: IRS P6 LISS-III coverage (path-row) of Chhattisgarh

Ground truth data

Remotely sensed data require certain amount of field observation called “ground truth” in order to convert it into meaningful information. Such work involves visiting a number of test sites, usually taking the satellite

data. 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.

Table-2: Satellite data used

Sr.No	Resourcesat LISS-III Path Row	Post-Monsoon (2006)	Pre-Monsoon (2007)
1	102-55	Oct 16, 2006	May 20, 2007
2	102-56	Oct 16, 2006	May 20, 2007
3	102-57	Oct 16, 2006	Apr 26, 2007
4	102-58	Oct 16, 2006	Apr 26, 2007
5	102-59	Dec 27, 2006	Apr 26, 2007
6	102-60	Dec 27, 2006	May 20, 2007
7	101-57	Nov 4, 2006	May 15, 2007
8	101-58	Nov 4, 2006	May 15, 2007
9	103-55	Nov 14, 2006	May 25, 2007
10	103-56	Nov 14, 2006	Apr 7, 2007
11	103-57	Nov 14, 2006	Apr 7, 2007
12	103-58	Dec 8, 2006	May 25, 2007
13	103-59	Dec 8, 2006	Apr 7, 2007
14	103-60	Dec 8, 2006	May 25, 2007
15	104-56	Nov 19, 2006	May 30, 2007
16	101-56	Nov 4, 2006	May 28, 2007
17	101-59	Nov 4, 2006	May 15, 2007

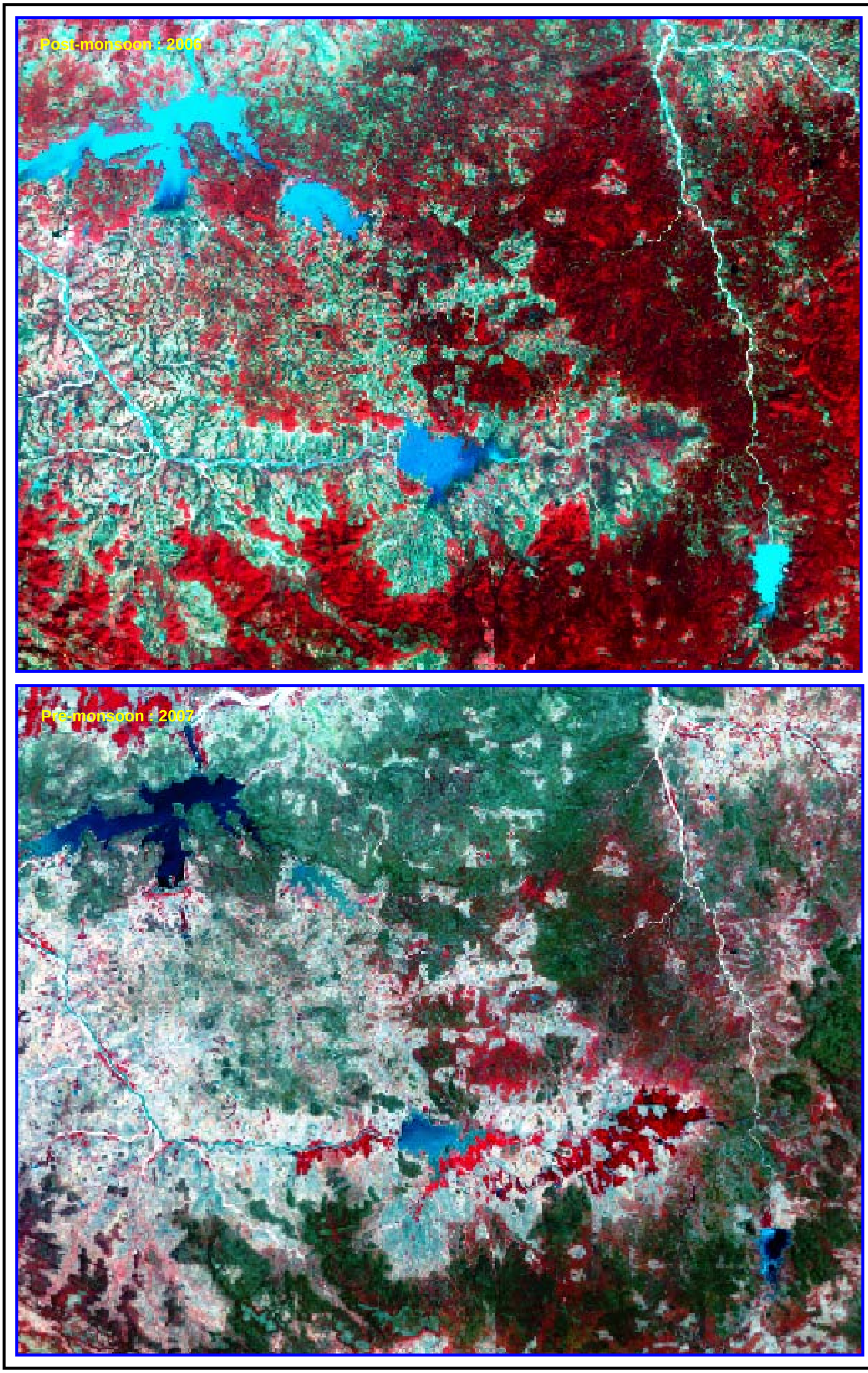


Figure 6: IRS LISS-III FCC (Post-monsoon and Pre-monsoon): Part of Chhattisgarh state

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.

5.1 Creation of spatial framework

This is the most important task as the state forms a part of the national frame work and is 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') grids 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 (Garg and Patel 2007). The spatial framework for Chhattisgarh state is shown in Figure 4.

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 archived 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 archived 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 within 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 :

  MNDWI image was used to generate qualitative turbidity level (high, moderate and low) based on signature statistics and standard deviations (Table-3). In the False Colour Composite (FCC) these generally appear in different hues from cyan (high) to blue/dark blue (low).

Table 3: Qualitative turbidity ratings

Sr. No.	Qualitative Turbidity	Conditional criteria	Hue on False Colour Composite (FCC)
1.	Low	> $+1\sigma$	Dark blue/blackish
2.	Moderate	> -1σ to <= $+1\sigma$	Medium blue
3.	High/Bottom reflectance	<= $\mu - 1\sigma$	Light blue/whitish blue

5.4 Conversion of the raster (indices) into a vector layer

The information on wetland extent, open water extent, vegetation extent and turbidity information was converted into vector layers using region 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 database. The administrative boundaries (district, state) are taken from the known reference data.

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 on A3 size.

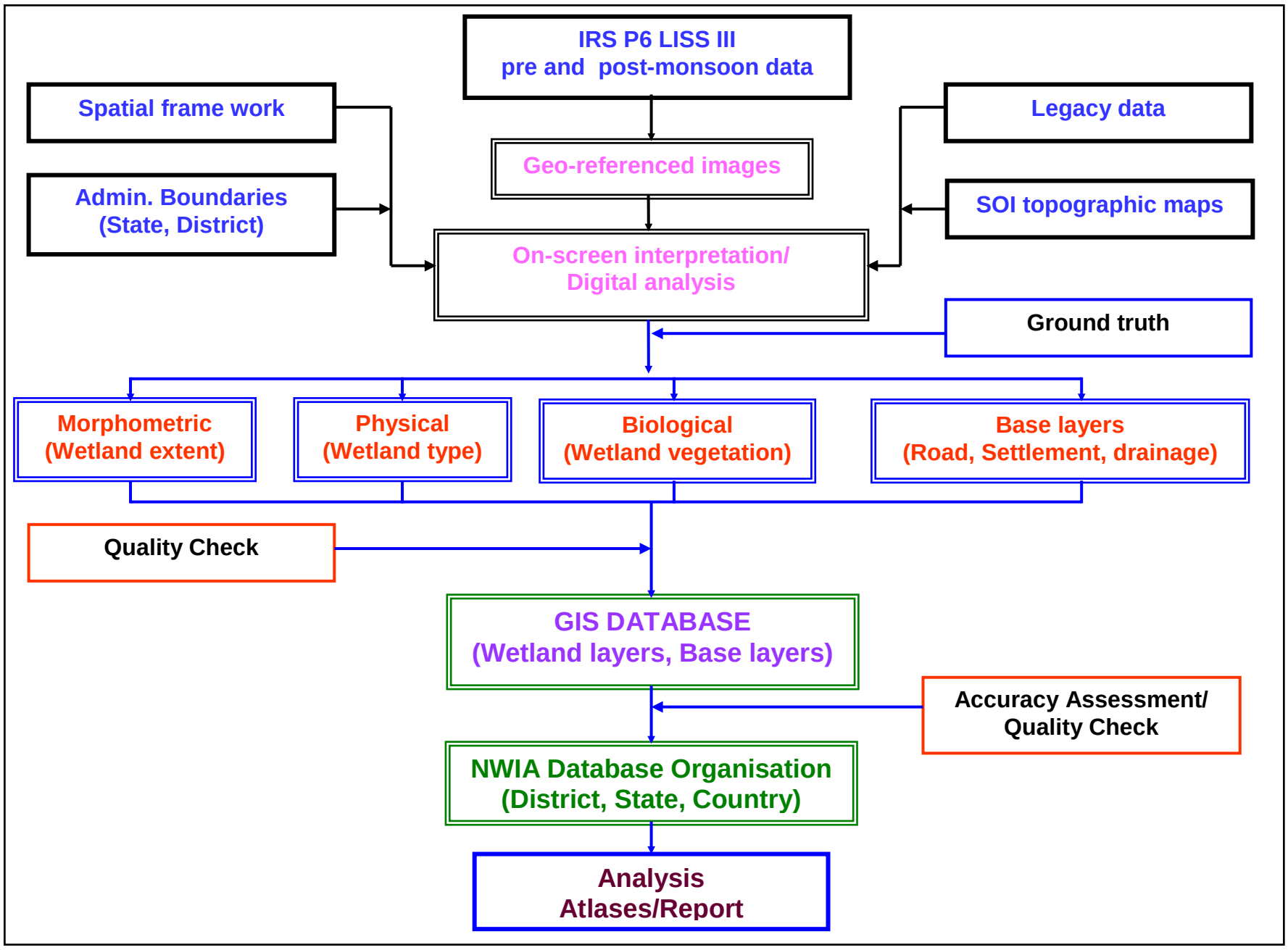


Figure 7: Flow chart of the methodology used

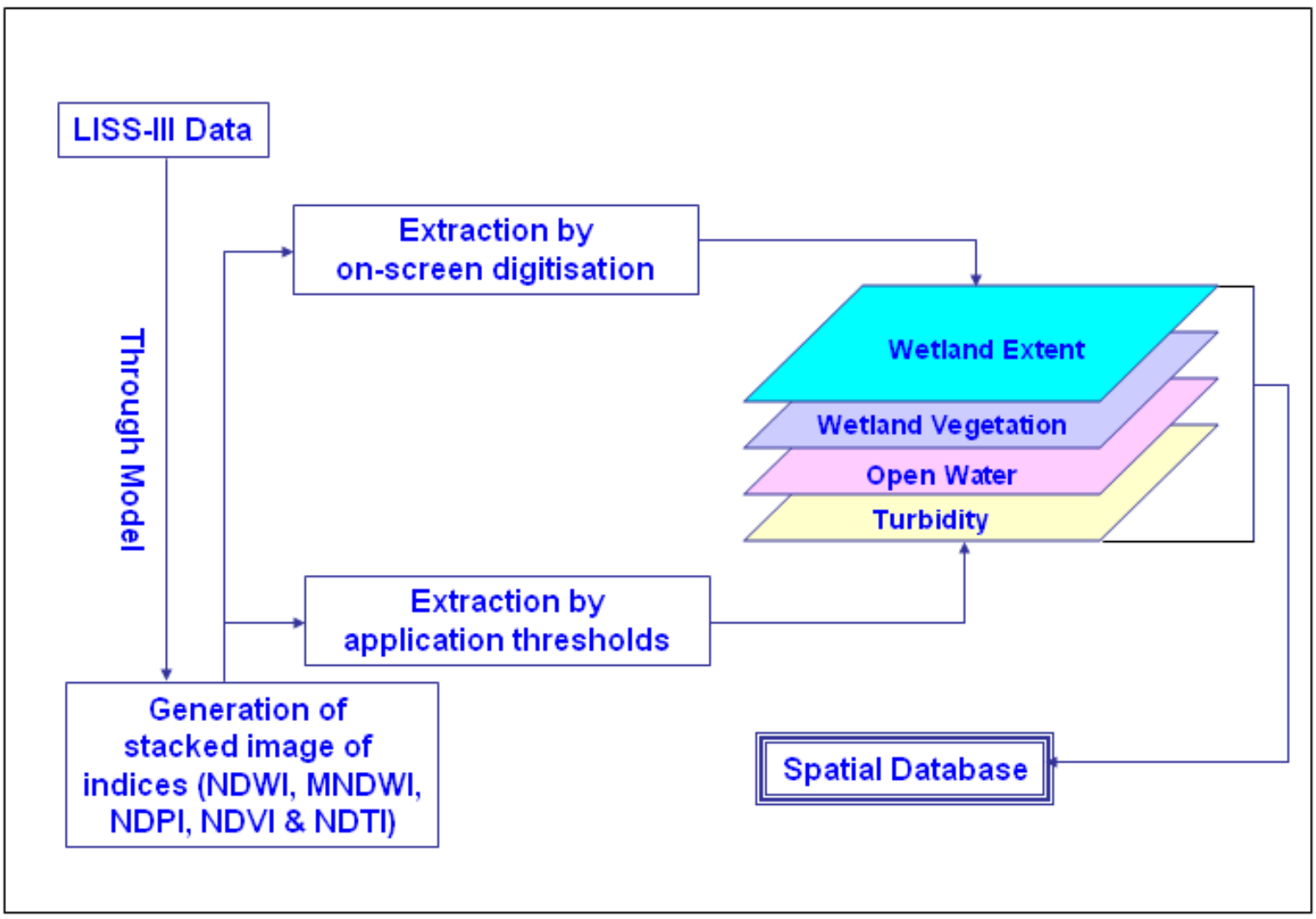


Figure 8: Steps in the extraction of wetland components

6.0 ACCURACY ASSESSMENT

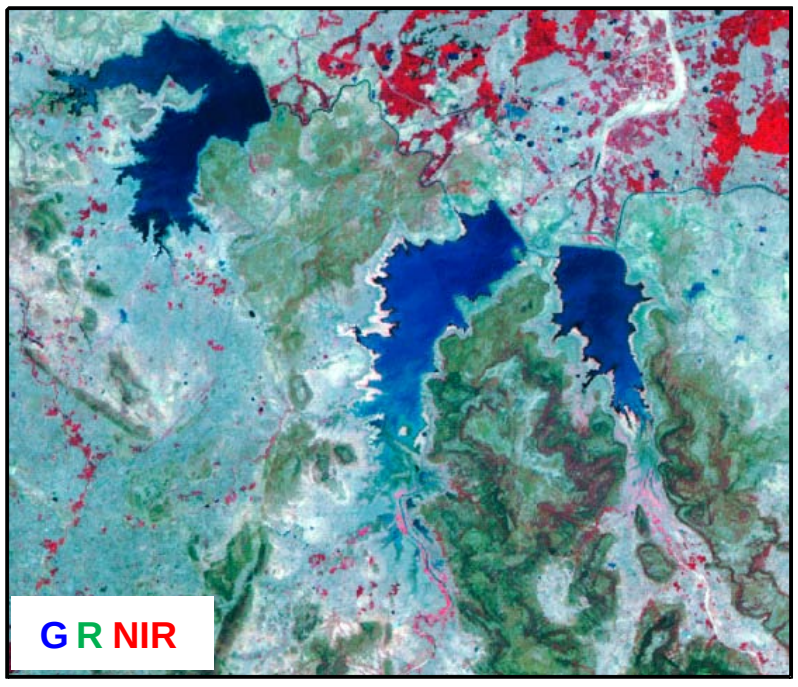
A comprehensive accuracy assessment protocol has been followed for determining the quality of information derived from remotely sensed data. Accuracy assessment involves determination of thematic (classification) as well as locational accuracy. In addition, GIS database(s) contents have been also evaluated 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.

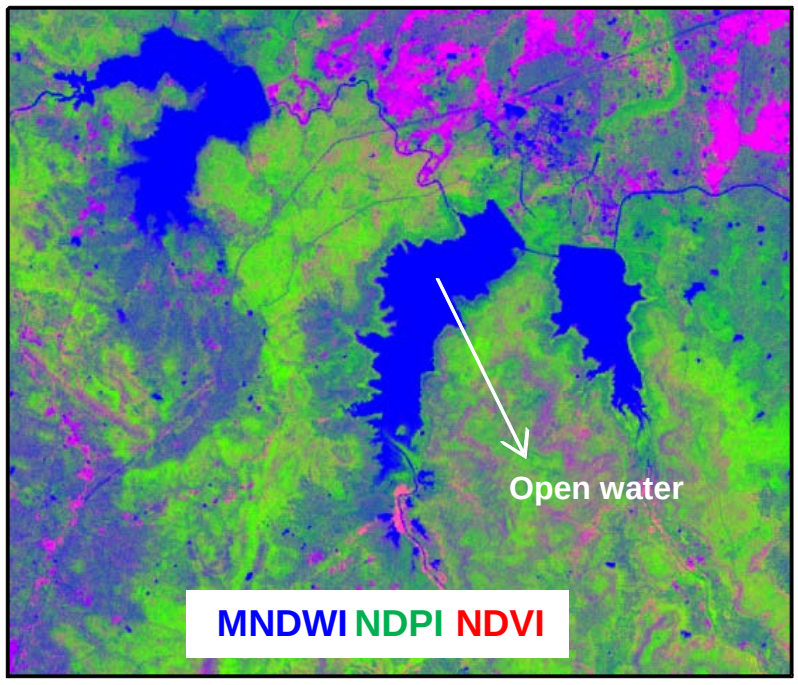
This study used well established, time-tested, fully documented data collection conventions. It employed skilled and trained personnel for image interpretation, processing and digital database creation. All interpreted imageries were reviewed by technical expert team for accuracy and code. The reviewing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

1. Image-to-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.

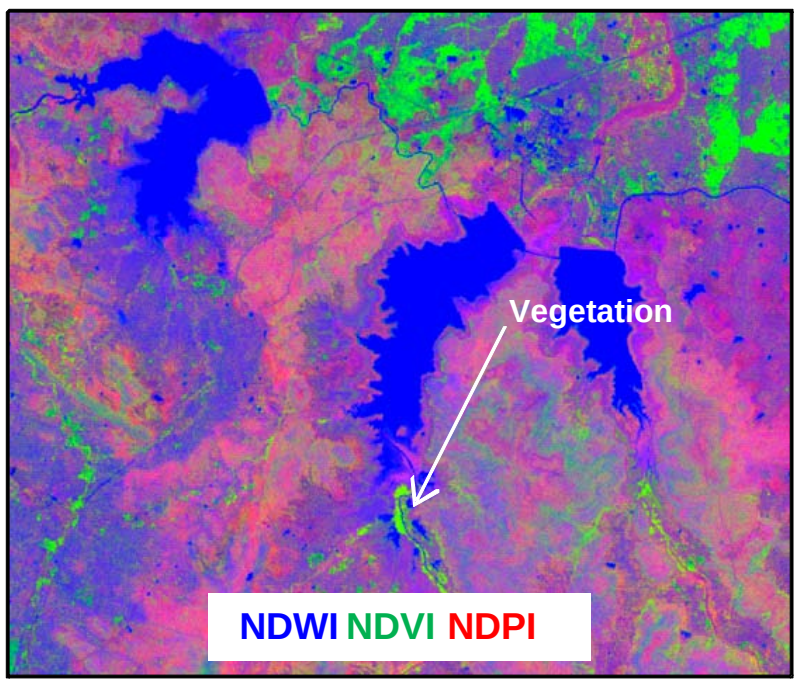
6.1 Data verification and quality assurance of output digital data files

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.

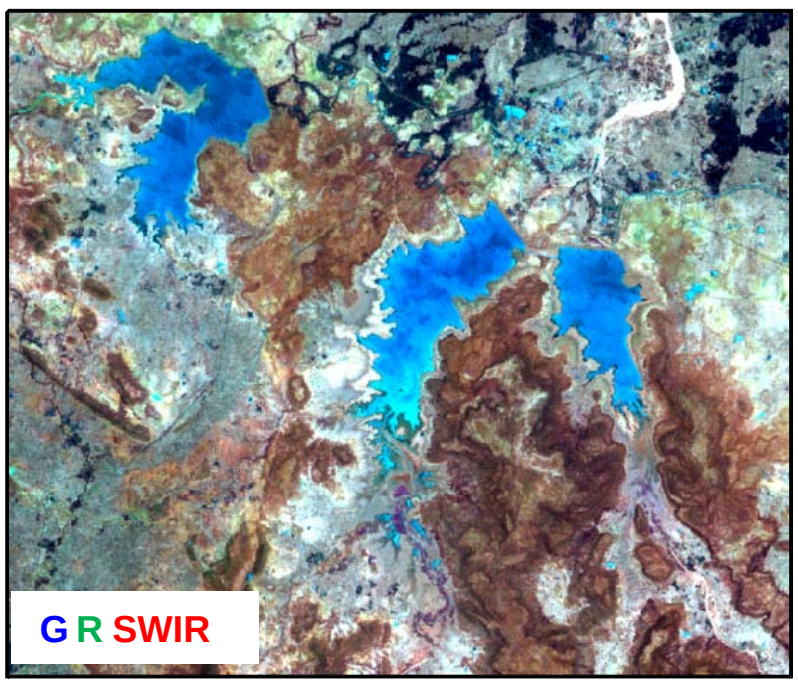


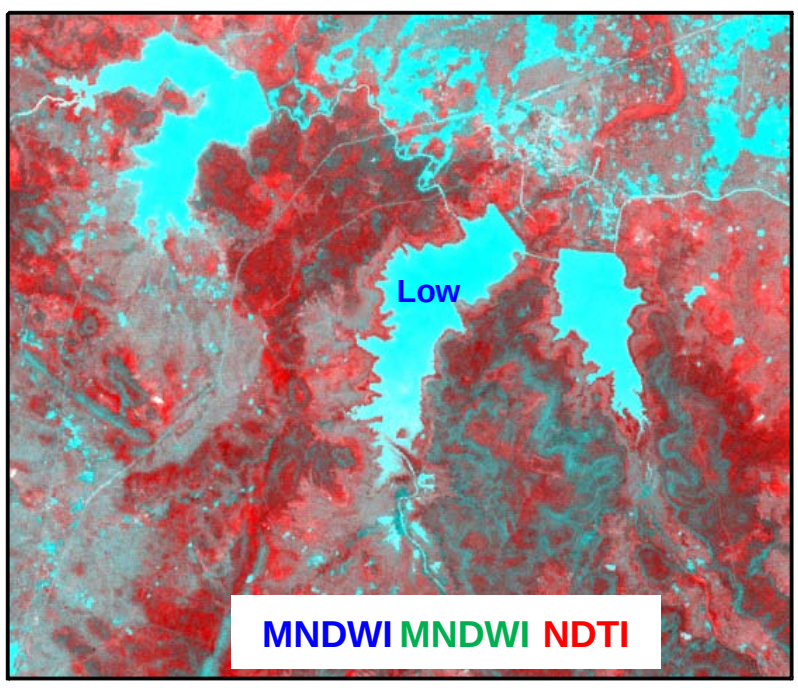


Useful for wetland boundary extraction/delineation



Useful for wetland vegetation &open water features





Useful for qualitative turbidity delineation

Tendulat Reservoir and surrounding area
IRS LISS-III data, 28 November, 2006.

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

MAPS AND STATISTICS

7.0 WETLANDS OF CHHATTISGARH: MAPS AND STATISTICS

Area estimates of various wetland categories for Chhattisgarh have been carried out using GIS layers of wetland boundary, water-spread, aquatic vegetation and turbidity. Total 7711 wetlands have been mapped at 1:50,000 scale in the state. In addition, 27823 wetlands (smaller than 2.25 ha) have also been identified and delineated as point feature. Total wetland area estimated is 337966 ha that is around 2.5 per cent of the geographic area. The major wetland types are River/Stream accounting for about 53 per cent of the wetlands (179088 ha), Reservoirs (90389 ha), and Tanks/Ponds (40226 ha). Graphical distribution of wetland type is shown in Figure 10. The small wetlands (< 2.25 ha) accounts for about 8.2 per cent assuming that each is of one ha.

Analysis of wetland status in terms of open water shows that out of the total wetland area the extent of open water is 243814 ha in post-monsoon and 173678 ha in pre-monsoon. There is a significant reduction in the extent of open water from post-monsoon to pre-monsoon. It is reflected in all the wetland types (Table 4). Turbidity is observed to be dominantly moderate in post-monsoon (183025 ha) out of 243814 ha of open water followed by high (31804 ha) and low turbidity (28985 ha).

The aquatic vegetation in Chhattisgarh accounts for about 0.6 and 5.8 per cent of total wetland area in post-monsoon (2123 ha) and Pre-monsoon (19600 ha) respectively.

Table 4: Area estimates of wetlands in Chhattisgarh

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	6	26	0.01	26	13
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	8	174	0.05	83	76
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	156	179088	52.99	124712	93095
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	604	90389	26.74	85148	54012
8	1202	Tanks/Ponds	6906	40226	11.90	33671	26366
9	1203	Waterlogged	31	240	0.07	174	116
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**7711**	**310143**	**91.77**	**243814**	**173678**
		Wetlands (<2.25 ha), mainly Tanks	27823	27823	8.23	-	-
		Total	**35534**	**337966**	**100.00**	**243814**	**173678**

Area under Aquatic Vegetation	2123	19600

Area under turbidity levels		
Low	28985	79103
Moderate	183025	85841
High	31804	8734

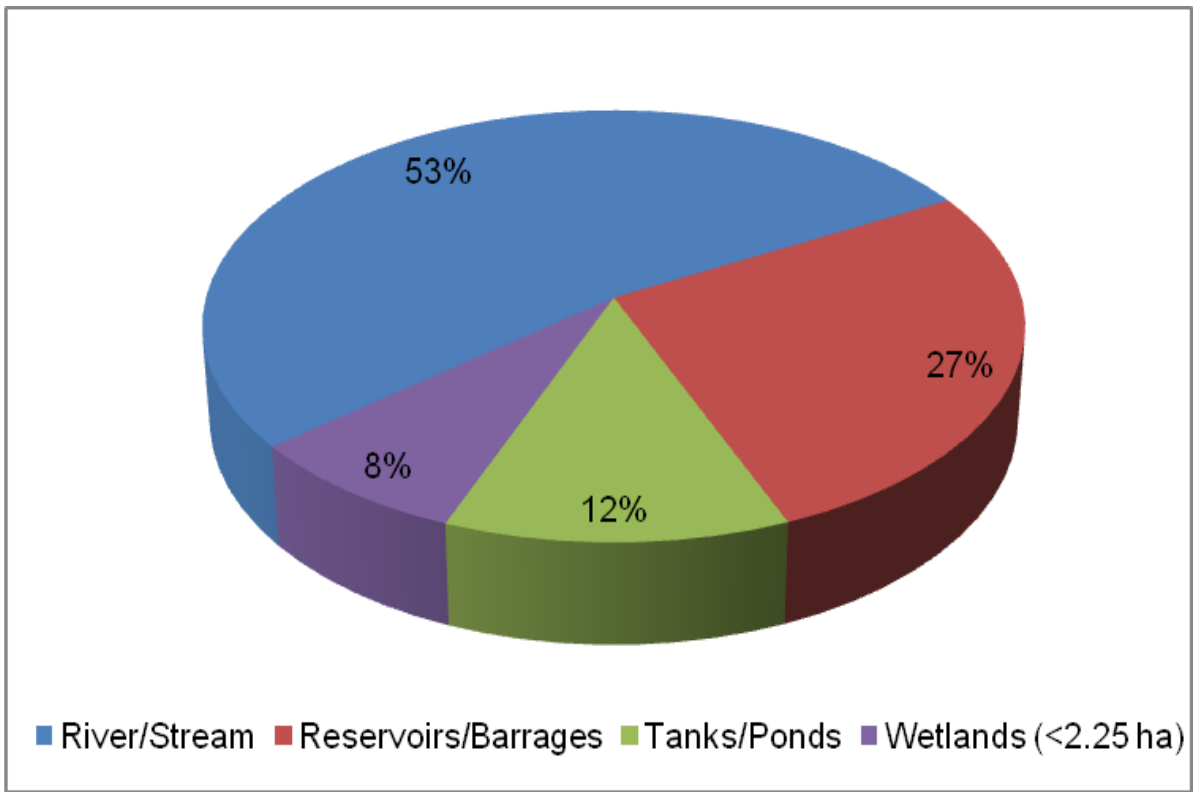


Figure 10: Type-wise wetland distribution in Chhattisgarh

7.1 DISTRICT-WISE WETLAND MAPS AND STATISTICS

The state has sixteen districts and district-wise distribution of wetlands showed that Janjgir-Champa (6.78%) followed by Dhamtari (6.65%) and Durg (3.55%), Raipur (3.53%) and Mahasamund (3.52) have the highest extent of wetlands (Table 5). The least extents (less than 1.5 per cent) of wetlands has been observed in Bastar (0.98%) Jashpur (1.3%) and Dantewada (1.45%) districts. The area statistics provided for each district has detailed tabular information on turbidity levels and aquatic vegetation status. Figure 11 shows graphical distribution of district-wise wetlands.

Wetland statistics followed by wetland map and corresponding satellite data for each district is given to have a fairly good idea about the distribution pattern and density of wetlands in the district.

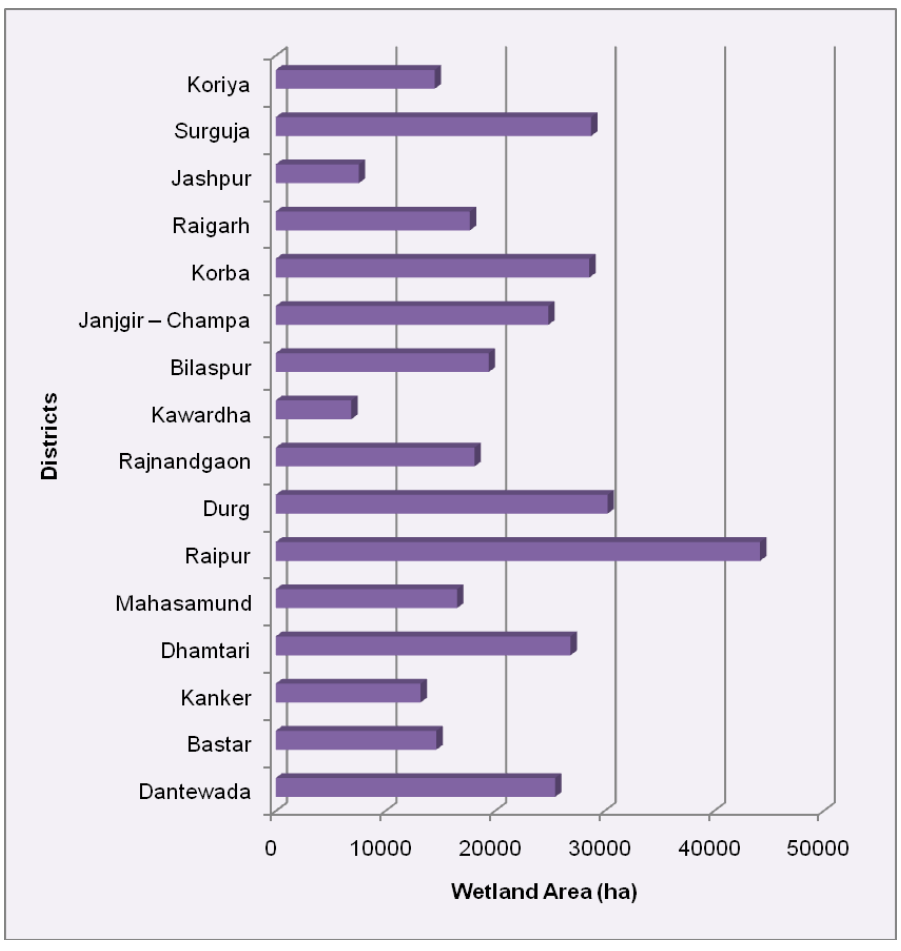


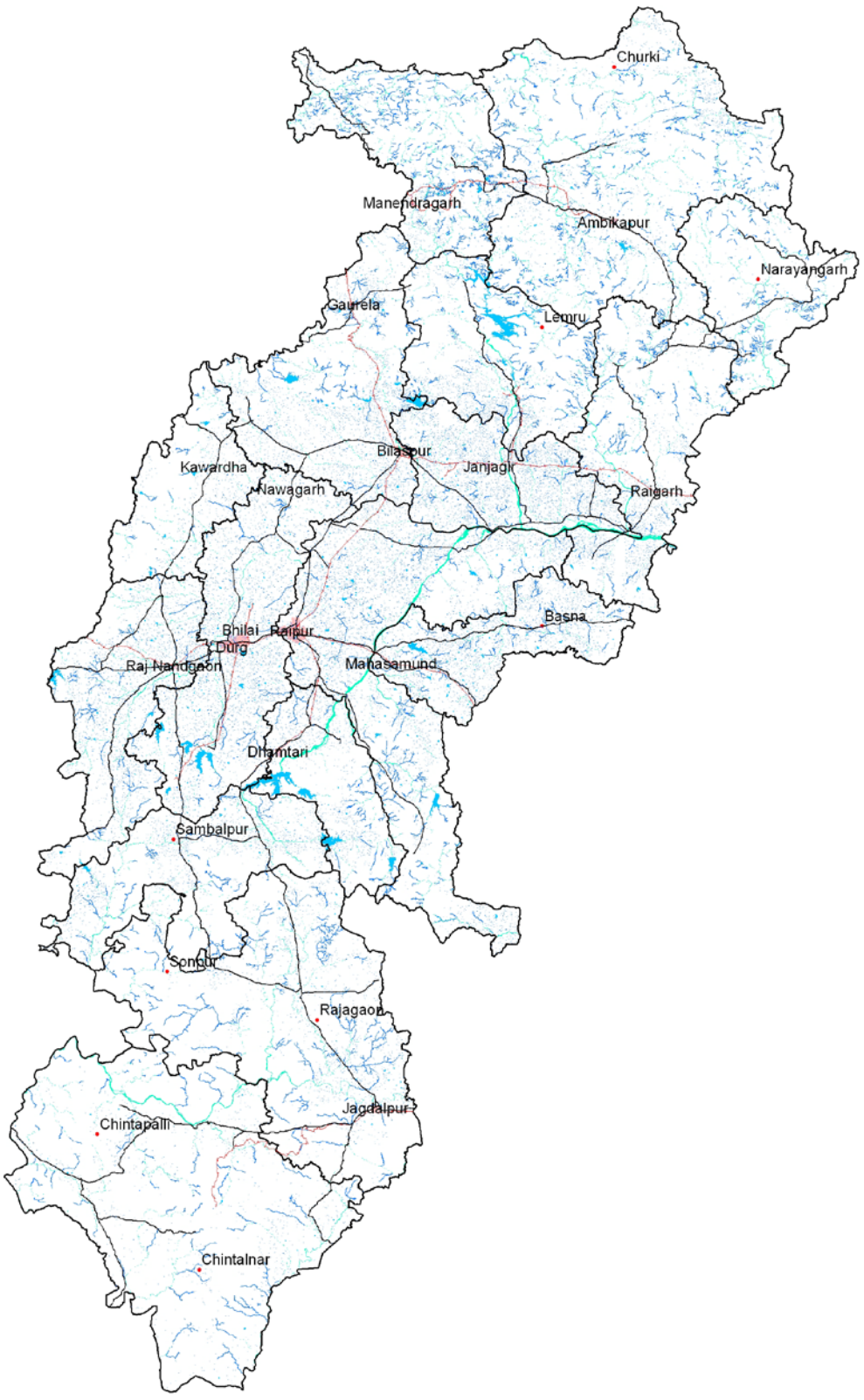
Figure 11: District-wise graphical distribution of wetlands

Table-5: District-wise wetland area

Sr. No.	District	Geographic Area (sq. km)	Wetland Area (ha)	% of total wetland area	% of district geographic area
1	Koriya	6604	14515	4.29	2.20
2	Surguja	15733	28794	8.52	1.83
3	Jashpur	5838	7585	2.24	1.30
4	Raigarh	7086	17719	5.24	2.50
5	Korba	9010	28624	8.47	3.18
6	Janjgir – Champa	3672	24886	7.36	6.78
7	Bilaspur	7215	19443	5.75	2.69
8	Kawardha	4223	6899	2.04	1.63
9	Rajnandgaon	6904	18149	5.37	2.63
10	Durg	8537	30291	8.96	3.55
11	Raipur	12507	44211	13.08	3.53
12	Mahasamund	4702	16557	4.90	3.52
13	Dhamtari	4049	26909	7.96	6.65
14	Kanker	6506	13219	3.91	2.03
15	Bastar	14974	14662	4.34	0.98
16	Dantewada	17634	25503	7.55	1.45
	Total	**135194**	**337966**	**100.00**	**2.50**

State : Chhatisgarh

WETLAND MAP



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

Location Map

40 20 0 40 80 Kilometers

Data Source :

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

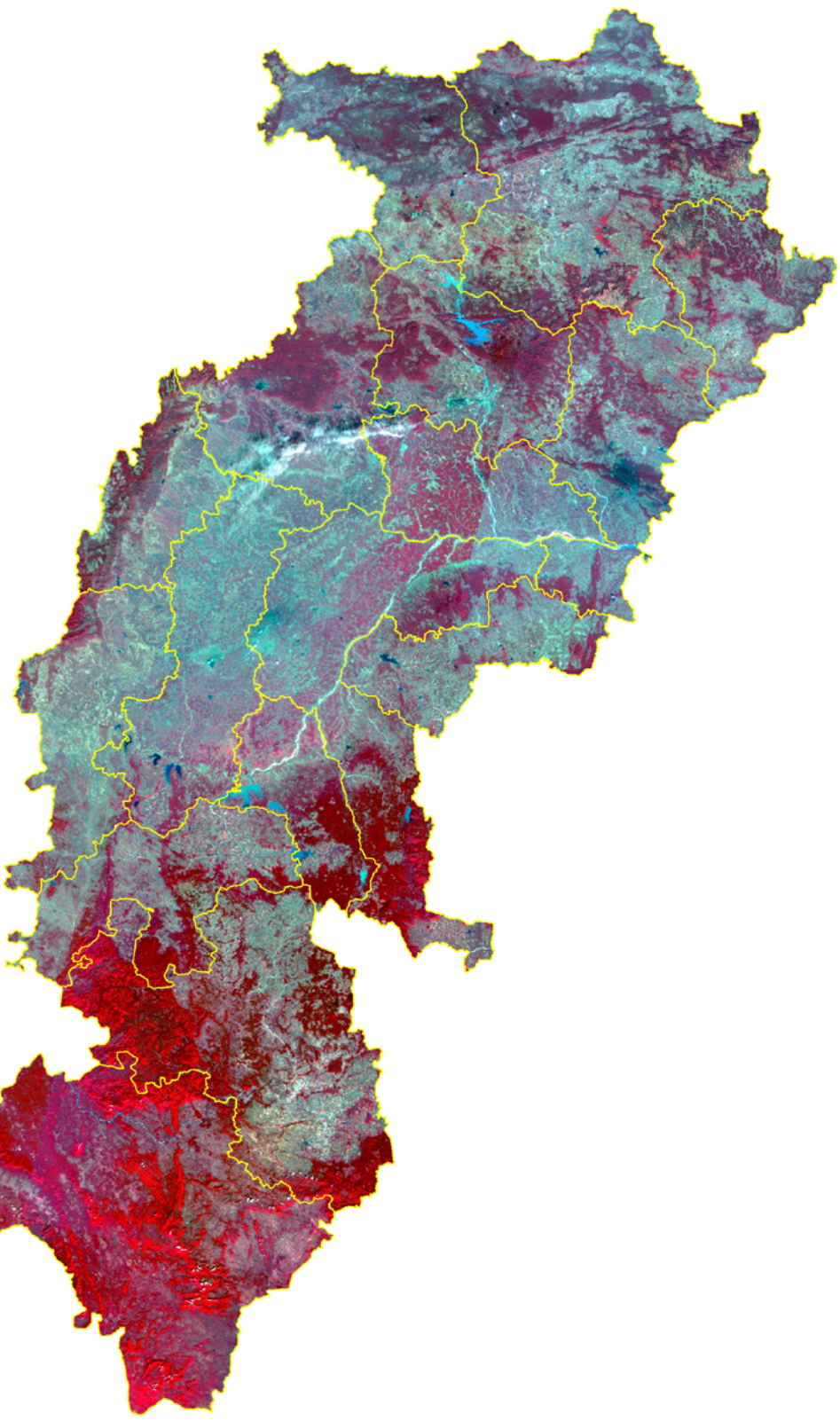
Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh



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

7.1.1 Koriya

Korea is one of the north-western districts of Chhattisgarh State. The district is bounded on the North by Shidhi district of Madhya Pradesh, on the south by Bilaspur district, on the east by its parent district Surguja and on the West by Shahdol district of Madhya Pradesh. The total geographical area of the district is 6604 sq km.

District comprises 103 wetlands accounting for 14515 ha. This includes the small wetlands (<2.25 ha), which are 690. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (4.75%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 80%) comprising 11594 ha of area followed by Reservoir/Barrage (1821 ha) and Tank/Pond (410 ha). The seasonal reduction in open water spread is observed to be 9666 ha in post-monsoon got reduced to 7486 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 60 ha during post-monsoon season and 155 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in both the seasons. Details of estimates of wetlands in Koriya are given in Table 6.

Table 6: Area estimates of wetlands in Koriya

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	27	11594	79.88	7574	6220
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	26	1821	12.55	1737	1059
8	1202	Tanks/Ponds	50	410	2.82	355	207
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**103**	**13825**	**95.25**	**9666**	**7486**
		Wetlands (<2.25 ha), mainly Tanks	690	690	4.75	**-**	-
		Total	**793**	**14515**	**100.00**	**9666**	**7486**

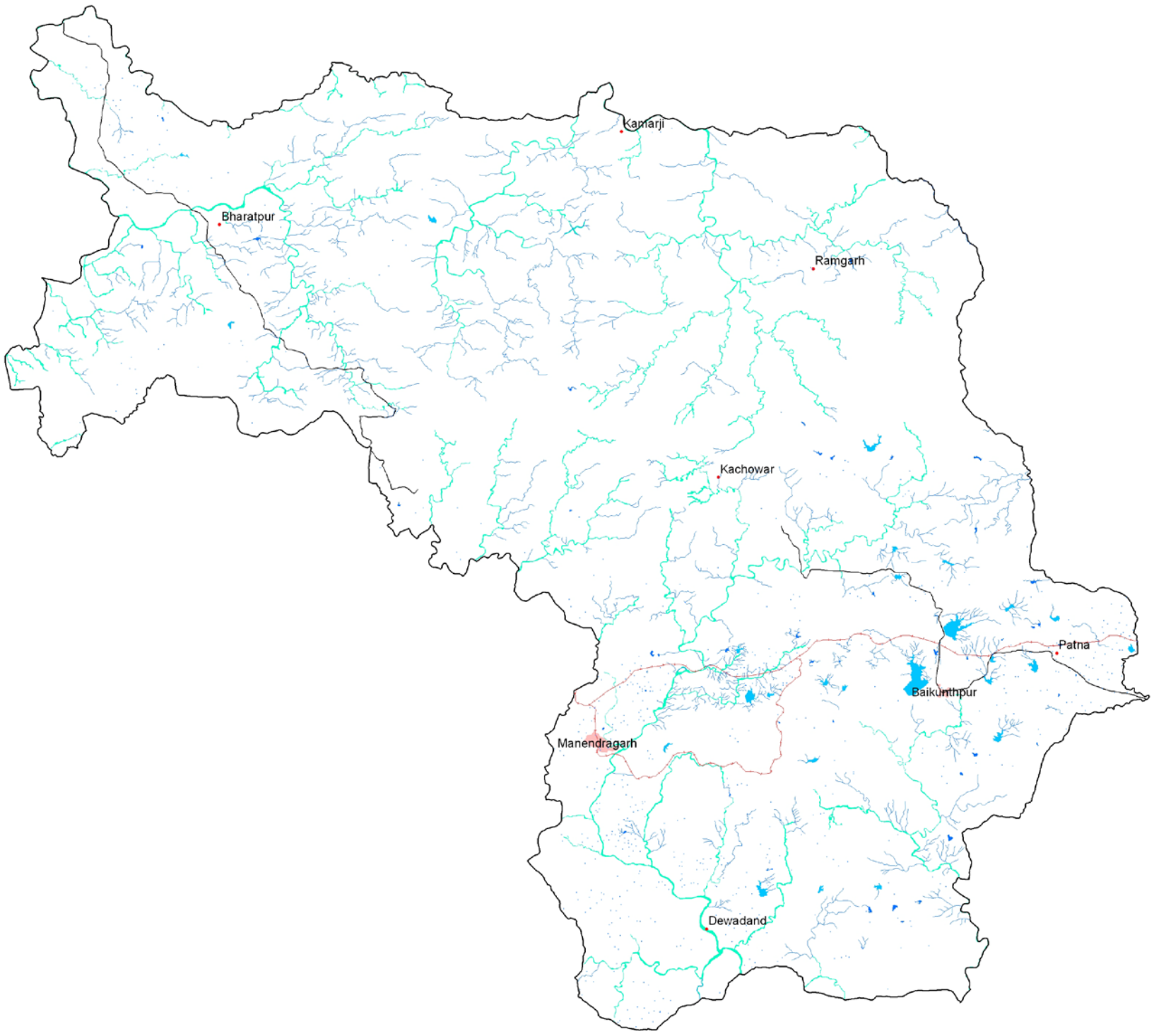
Area under Aquatic Vegetation	60	155

Area under turbidity levels		
Low	736	1053
Moderate	8064	6284
High	866	149

State : Chhatisgarh

WETLAND MAP

District : Koriya

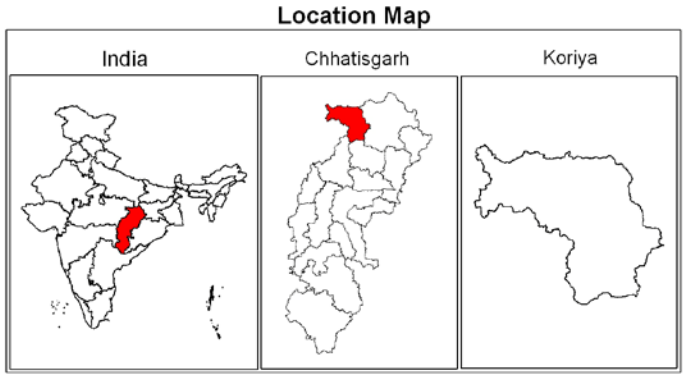


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

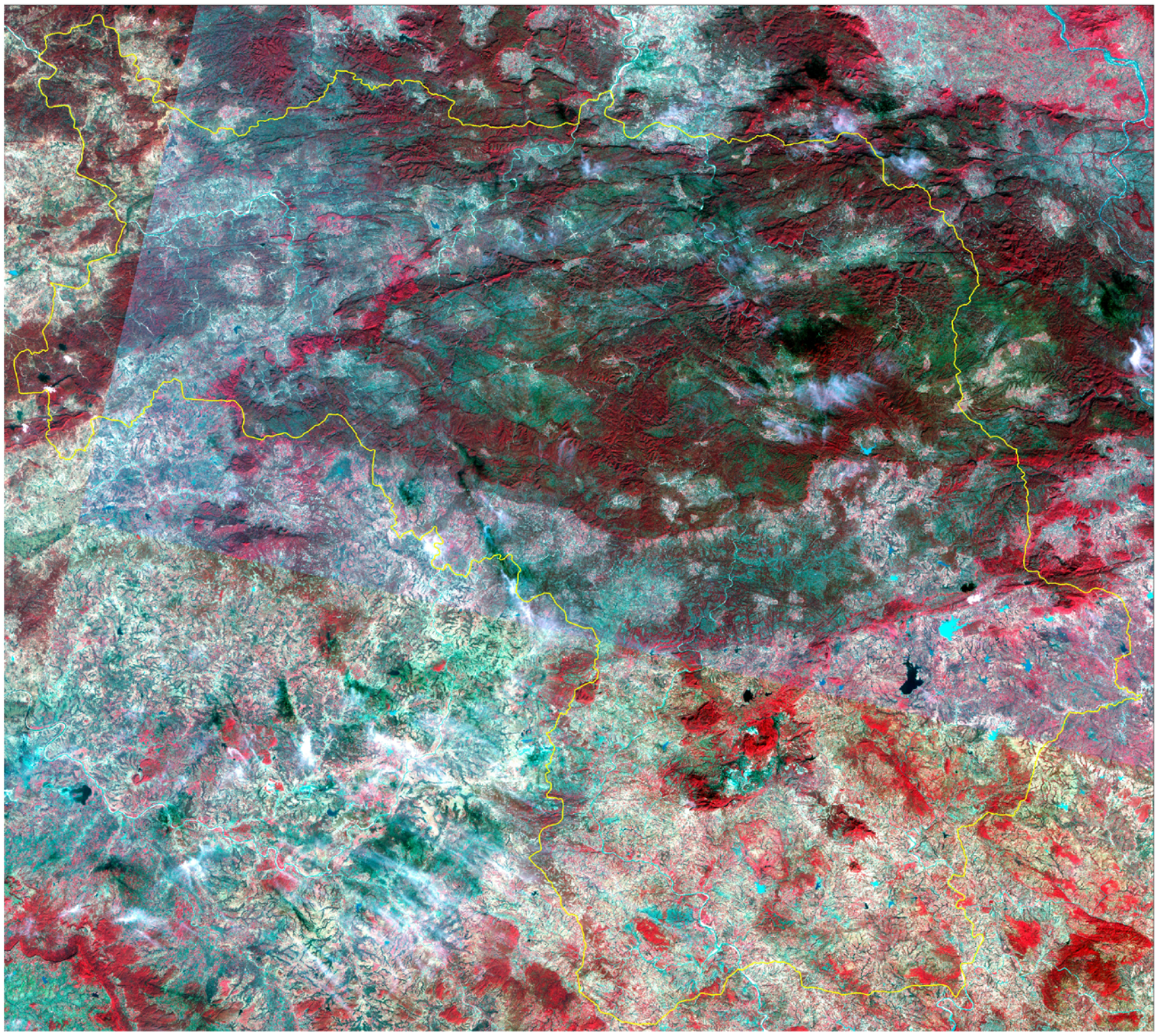
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Koriya



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

7.1.2 Surguja

Surguja district is located in the northern part of Chhattisgarh State of India. The district is surrounded by the borders of Uttar Pradesh, Jharkhand, Orissa and Madhya Pradesh States. This district has over extension between south-eastern parts of Vindhyachal-Baghelkhand region of peninsular India. The total geographical area of the district is 15733 sq km. Main rivers of the district are Kanhar, Moran, Rihand and Mahan.

District comprises 357 wetlands accounting for 28794 ha. This includes the small wetlands (<2.25 ha), which are 1523. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (5.3%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 71.8%) comprising 20689 ha of area followed by Reservoir/Barrage (4704 ha) and Tank/Pond (1843 ha). The seasonal reduction in open water spread is observed to be 20650 ha in post-monsoon got reduced to 16658 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 119 ha during post-monsoon season and 519 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in both the seasons. Details of estimates of wetlands in Surguja are given in Table 7.

Table 7: Area estimates of wetlands in Surguja

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	1	35	0.12	35	31
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	25	20689	71.85	14450	12642
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	53	4704	16.34	4526	3001
8	1202	Tanks/Ponds	278	1843	6.40	1639	984
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**357**	**27271**	**94.71**	**20650**	**16658**
		Wetlands (<2.25 ha), mainly Tanks	1523	1523	5.29	-	-
		Total	**1880**	**28794**	**100.00**	**20650**	**16658**

Area under Aquatic Vegetation	119	519

Area under turbidity levels		
Low	298	2418
Moderate	17953	12514
High	2399	1726

State : Chhatisgarh

WETLAND MAP

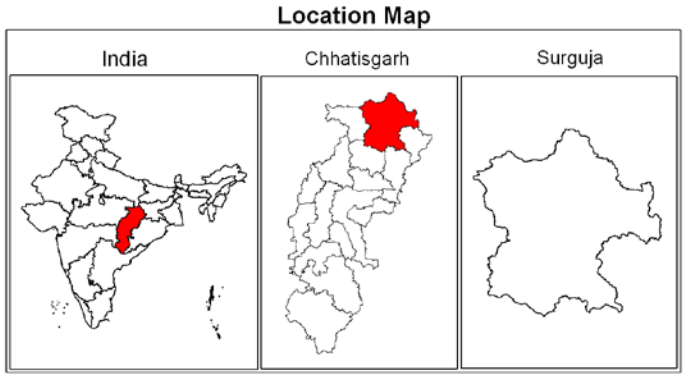
District : Surguja

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

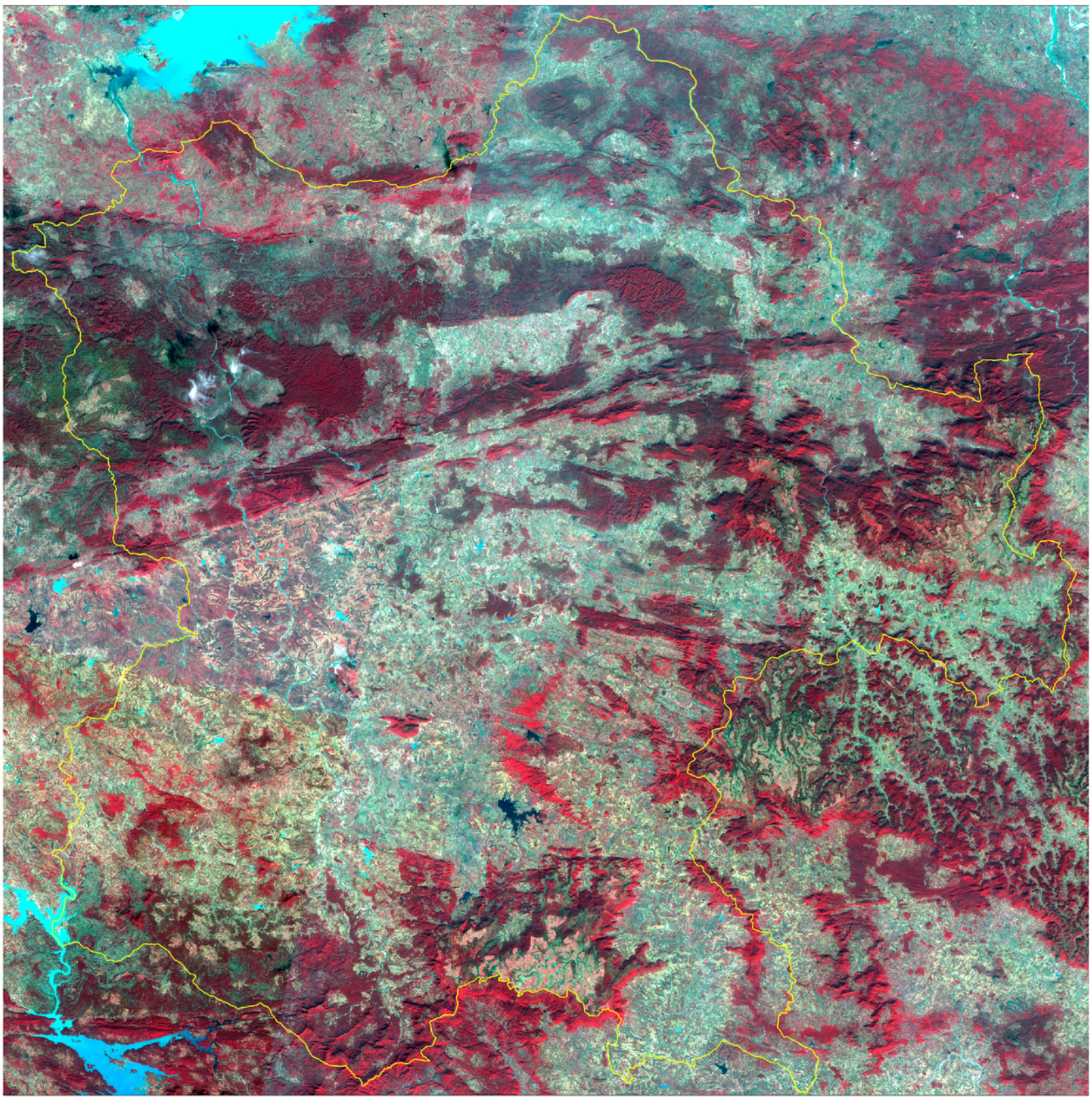
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Surguja



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

7.1.3 Jashpur

The district lies in the Northern corner of Chhattisgarh, adjoining the border of Bihar, Jharkhand and Orissa in the eastern side. Jashpur is divided in two parts the hilly belt and the upper Ghat. The total geographical area of the district is 5838 sq km.

District comprises 71 wetlands accounting for 7585 ha. This includes the small wetlands (<2.25 ha), which are 144. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (2%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 92.7%) comprising 7030 ha of area followed by Tank/Pond (337 ha). The seasonal reduction in open water spread is observed to be 6314 ha in post-monsoon got reduced to 4007 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 36 ha during post-monsoon season and 87 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in both the seasons. Details of estimates of wetlands in Jashpur are given in Table 8.

Table 8: Area estimates of wetlands in Jashpur

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	15	7030	92.68	6007	3734
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	4	74	0.98	74	64
8	1202	Tanks/Ponds	52	337	4.44	233	209
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**71**	**7441**	**98.10**	**6314**	**4007**
		Wetlands (<2.25 ha), mainly Tanks	144	144	1.90	-	-
		Total	**215**	**7585**	**100.00**	**6314**	**4007**

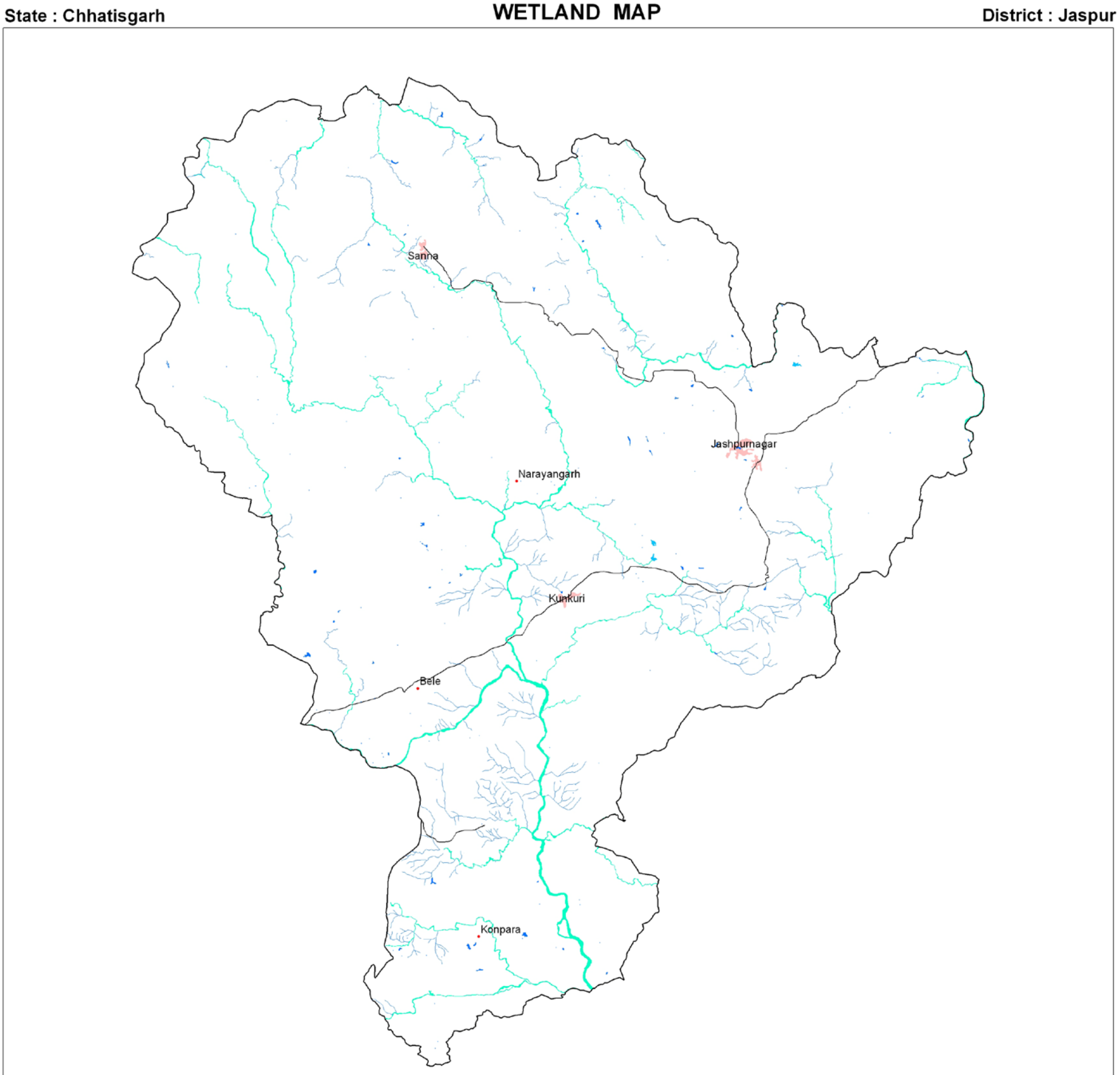
Area under Aquatic Vegetation	36	87

Area under turbidity levels		
Low	0	188
Moderate	6264	3753
High	50	66

State : Chhatisgarh

WETLAND MAP

District : Jaspur

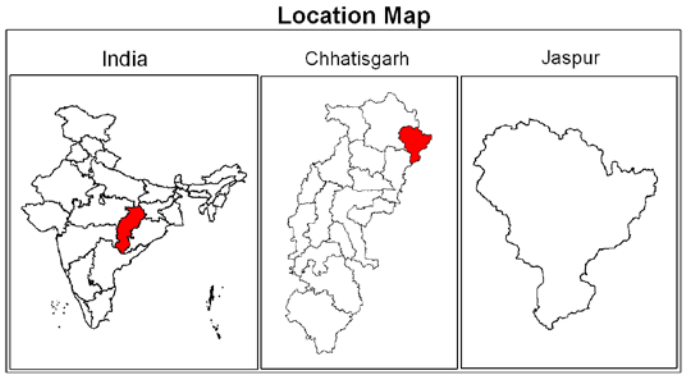


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



8 4 0 8 16 Kilometers

Data Source :

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

Prepared By :

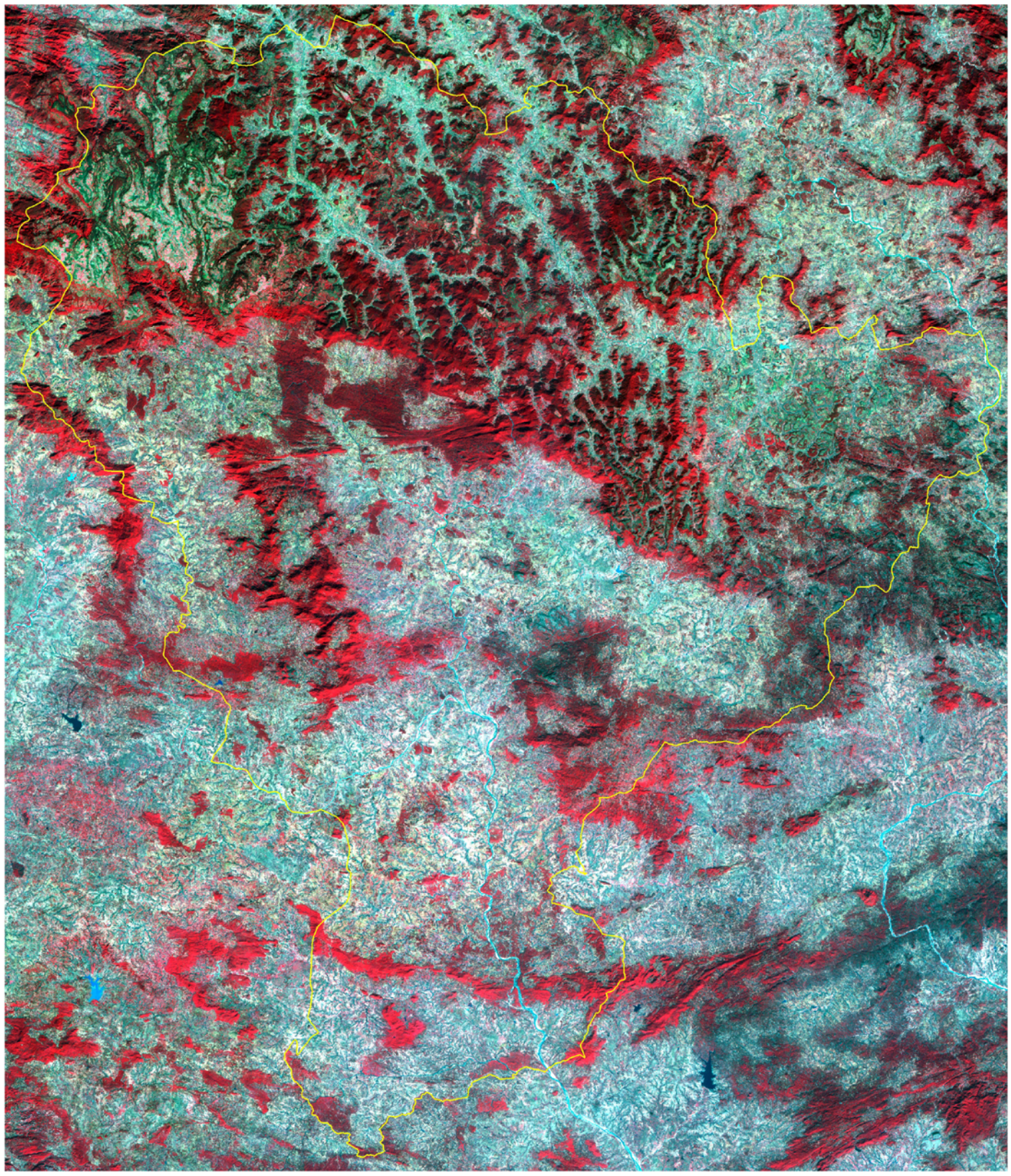
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Jaspur



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

7.1.4 Raigarh

Raigarh is situated on the eastern border of the Chhattisgarh state. The administrative head quarter of Raigarh is Raigarh town. The total geographical area of the district is 7086 sq km.

District comprises 384 wetlands accounting for 17719 ha. This includes the small wetlands (<2.25 ha), which are 1601. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (9%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 70%) comprising 12413 ha of area followed by Reservoir/Barrage (1866 ha) and Tank/Pond (1839 ha). The seasonal reduction in open water spread is observed to be 12951 ha in post-monsoon got reduced to 8236 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 113 ha during post-monsoon season and 457 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in post-monsoon and low in pre-monsoon season. Details of estimates of wetlands in Raigarh are given in Table 9.

Table 9: Area estimates of wetlands in Raigarh

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	28	12413	70.05	9729	6046
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	31	1866	10.53	1695	1085
8	1202	Tanks/Ponds	325	1839	10.38	1527	1105
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**384**	**16118**	**90.96**	**12951**	**8236**
		Wetlands (<2.25 ha), mainly Tanks	1601	1601	9.04	-	-
		Total	**1985**	**17719**	**100.00**	**12951**	**8236**

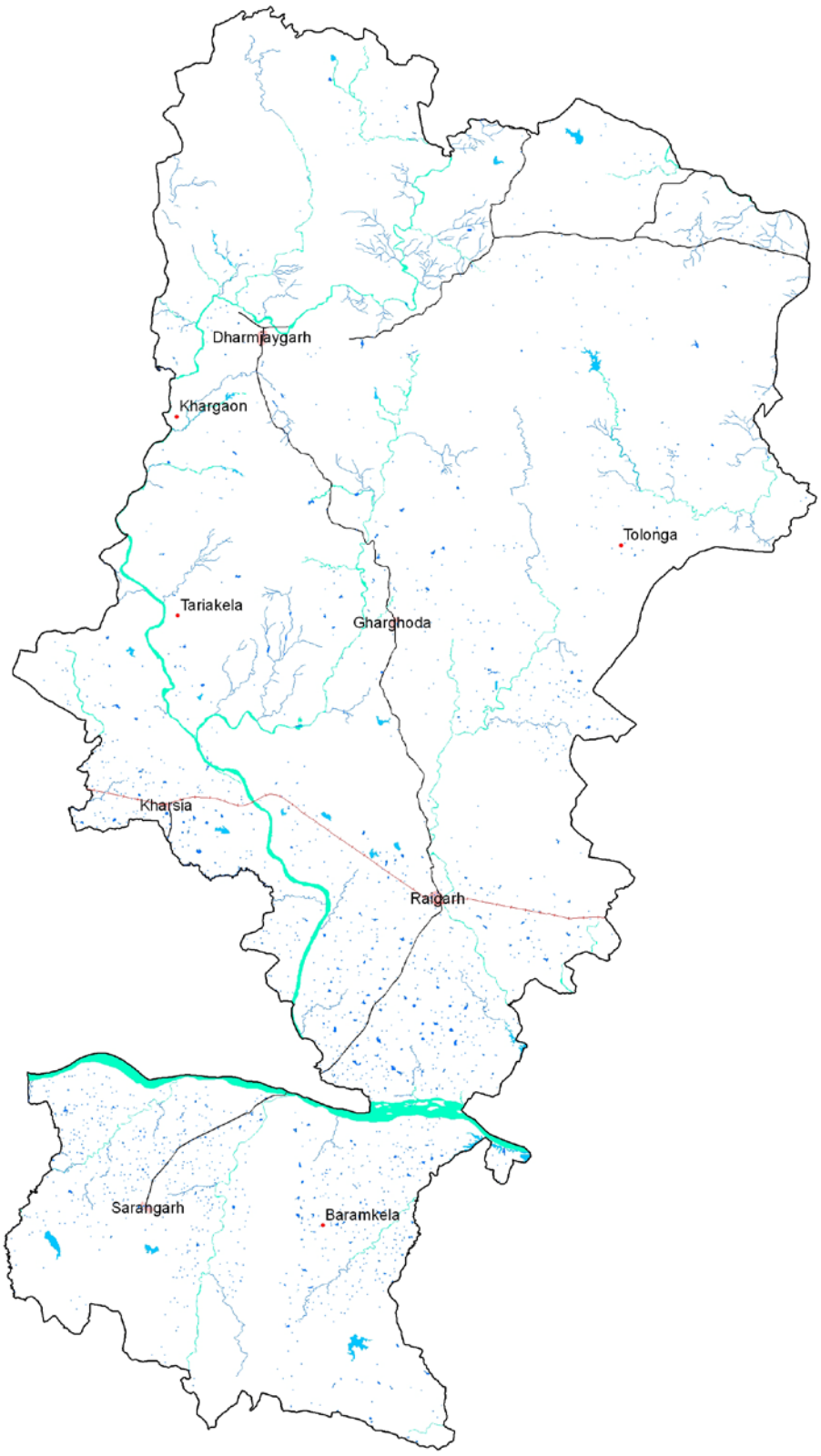
Area under Aquatic Vegetation	113	457

Area under turbidity levels		
Low	860	5258
Moderate	11422	2414
High	669	564

State : Chhatisgarh

WETLAND MAP

District : Raigarh

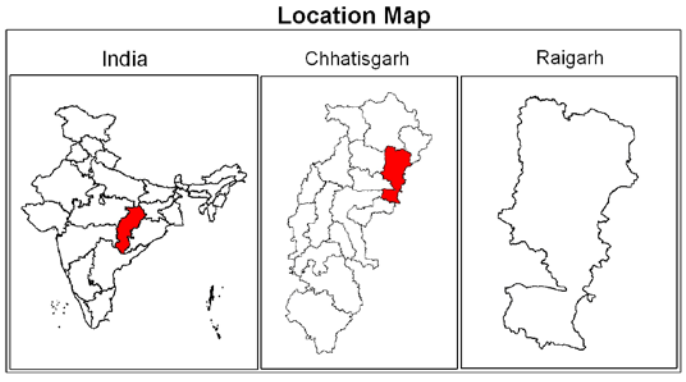


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

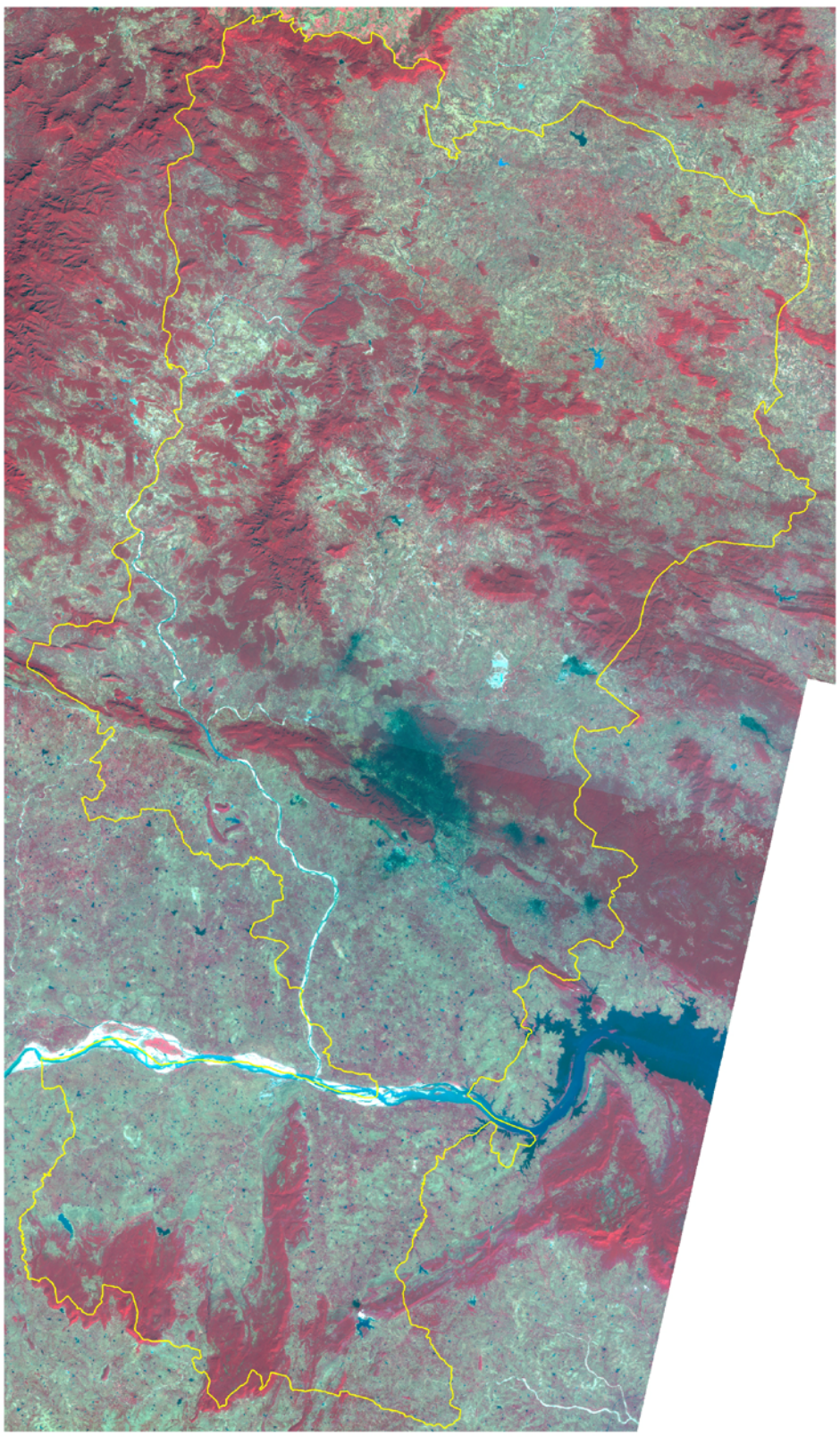
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Raigarh



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

7.1.5 Korba

Korba district is the power hub for Chhattisgarh and is also known as the power capital of the state. The district comes under Bilaspur division. The district headquarter is Korba city, which is situated on the banks of the confluence of rivers Hasdeo and Ahiran. Korba is situated in the northern half of the Chhattisgarh state and surrounded by the districts of Korea, Surguja, Bilaspur, Janjgir. Kobra is the land of black diamond, kosa silk and thermal power. The total geographical area of the district is 9010 sq km.

District comprises 273 wetlands accounting for 28624 ha. This includes the small wetlands (<2.25 ha), which are 1375. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (4.8%) assuming that each wetland would be on an average 1 ha in extent. The Reservoir category ranked first in term of extent (about 64%) comprising 18293 ha of area followed by River/stream (7645 ha) and Tank/Pond (1311 ha). The seasonal reduction in open water spread is observed to be 25026 ha in post-monsoon got reduced to 17708 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 70 ha during post-monsoon season and 705 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate to high in post-monsoon and low to moderate in pre-monsoon season. Details of estimates of wetlands in Korba are given in Table 10.

Table 10: Area estimates of wetlands in Korba

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	30	7645	26.71	6370	4401
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	35	18293	63.91	17482	12436
8	1202	Tanks/Ponds	208	1311	4.58	1174	871
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**273**	**27249**	**95.20**	**25026**	**17708**
		Wetlands (<2.25 ha), mainly Tanks	1375	1375	4.80	-	-
		Total	**1648**	**28624**	**100.00**	**25026**	**17708**

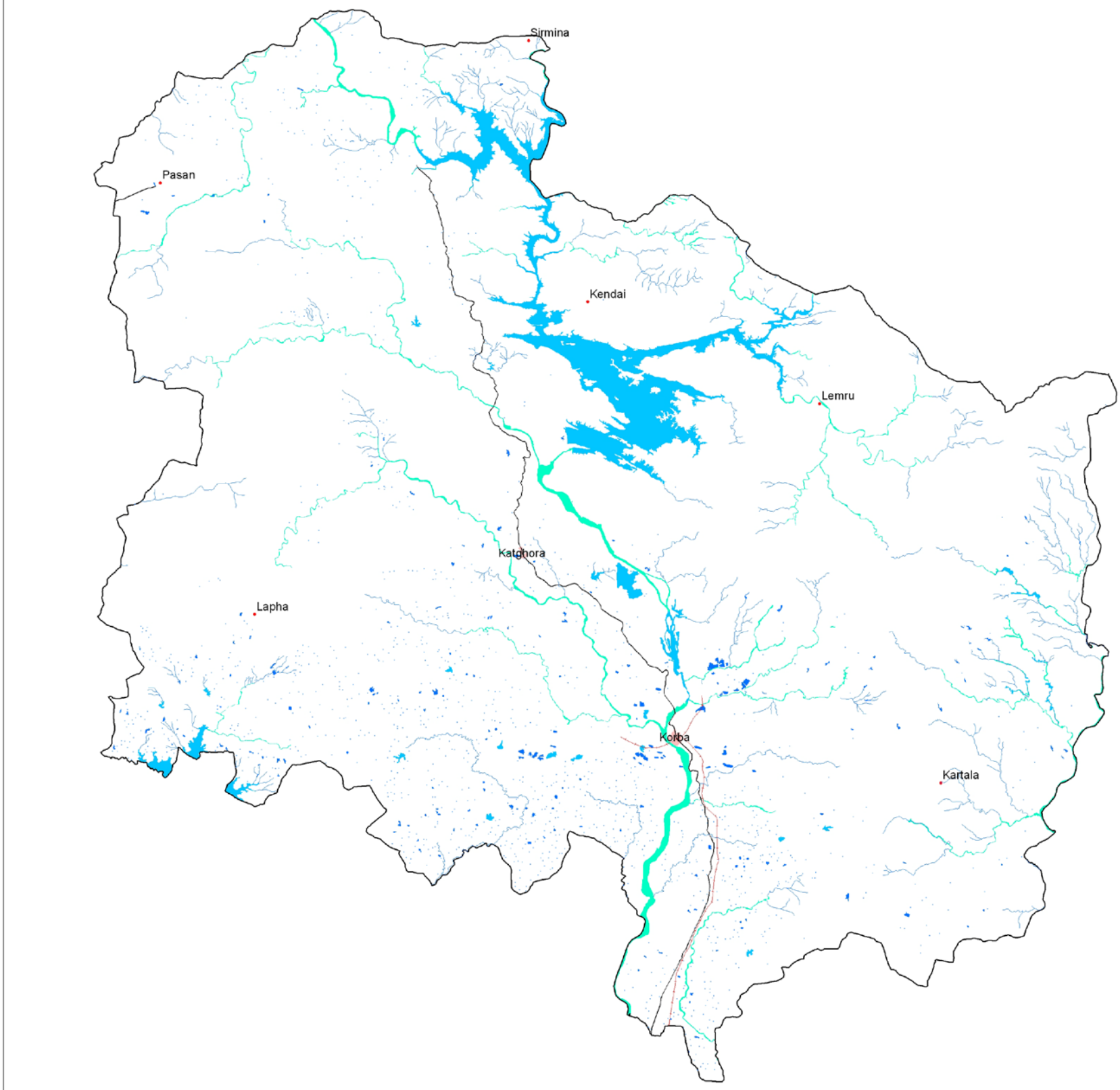
Area under Aquatic Vegetation	70	705

Area under turbidity levels		
Low	420	7743
Moderate	9781	9615
High	14825	350

State : Chhatisgarh

WETLAND MAP

District : Korba

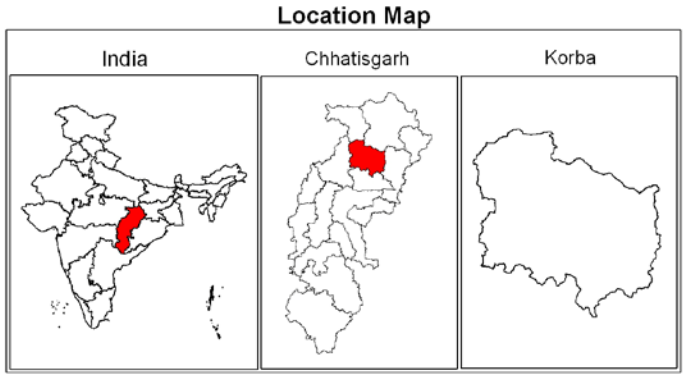


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



8 4 0 8 16 Kilometers

Data Source :

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

Prepared By :

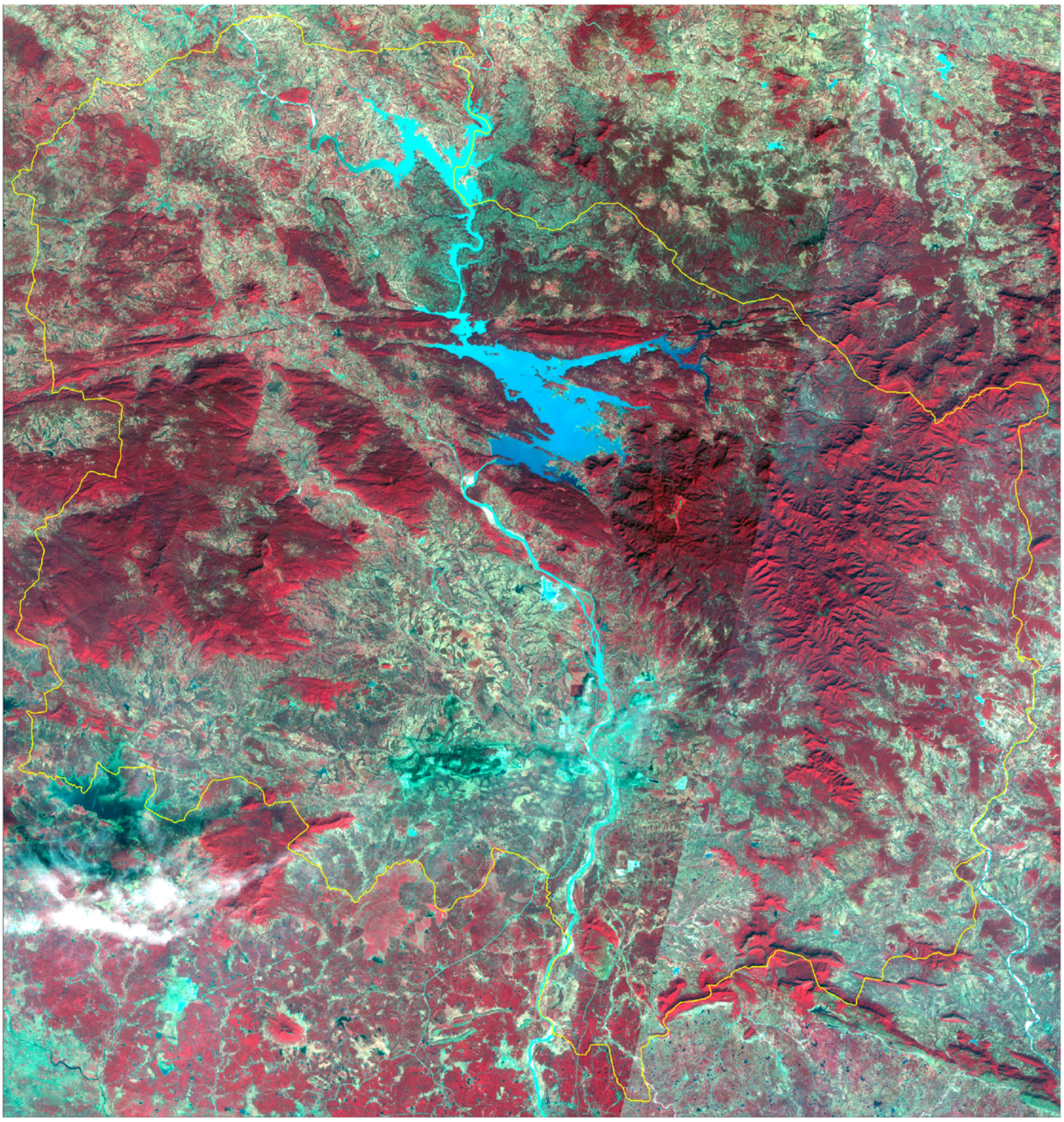
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Korba



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

7.1.6 Janjgir-Champa

The district is considered as heart of Chhattisgarh as it is situated in the centre of the Chhattisgarh state. Janjgir city is a district head quarter. The district is a major producer of food grains in the state of Chhattisgarh. The district is surrounded by the Raigarh district on the east, Bilaspur on the west and on the North by Korba and Bilaspur district. The total geographical area of the district is 3672 sq km.

District comprises 1007 wetlands accounting for 24886 ha. This includes the small wetlands (<2.25 ha), which are 3326. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (13.4%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 59.7%) comprising 14869 ha of area followed by Tank/pond (4980 ha) and Reservoir/Barrage (1605 ha). The seasonal reduction in open water spread is observed to be 13452 ha in post-monsoon got reduced to 11035 ha in pre-monsoon.

Area under aquatic vegetation is less, around 218 ha during post-monsoon season and 1206 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in post-monsoon and low to moderate in pre-monsoon season. Details of estimates of wetlands in Janjgir-Champa are given in Table 11.

Table 11: Area estimates of wetlands in Janjgir – Champa

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	3	14869	59.75	8508	6481
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	39	1605	6.45	1125	935
8	1202	Tanks/Ponds	950	4980	20.01	3751	3571
9	1203	Waterlogged	15	106	0.43	68	48
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**1007**	**21560**	**86.64**	**13452**	**11035**
		Wetlands (<2.25 ha), mainly Tanks	3326	3326	13.36	-	-
		Total	**4333**	**24886**	**100.00**	**13452**	**11035**

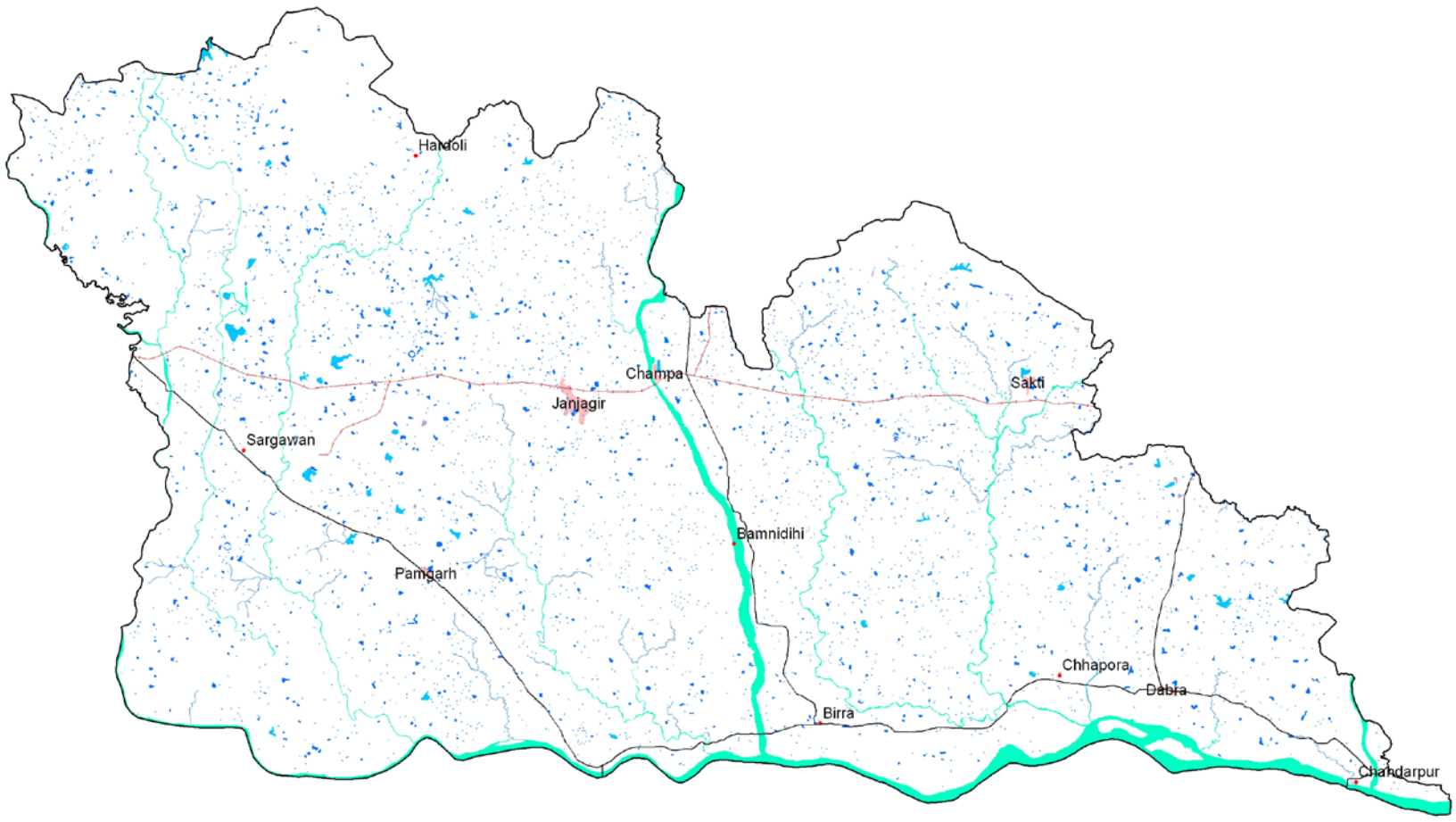
Area under Aquatic Vegetation	218	1206

Area under turbidity levels		
Low	855	5399
Moderate	10718	5004
High	1879	632

State : Chhatisgarh

WETLAND MAP

District : Janjgir Champa

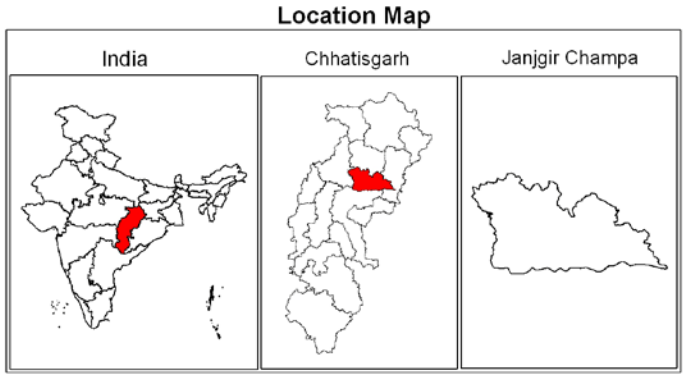


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

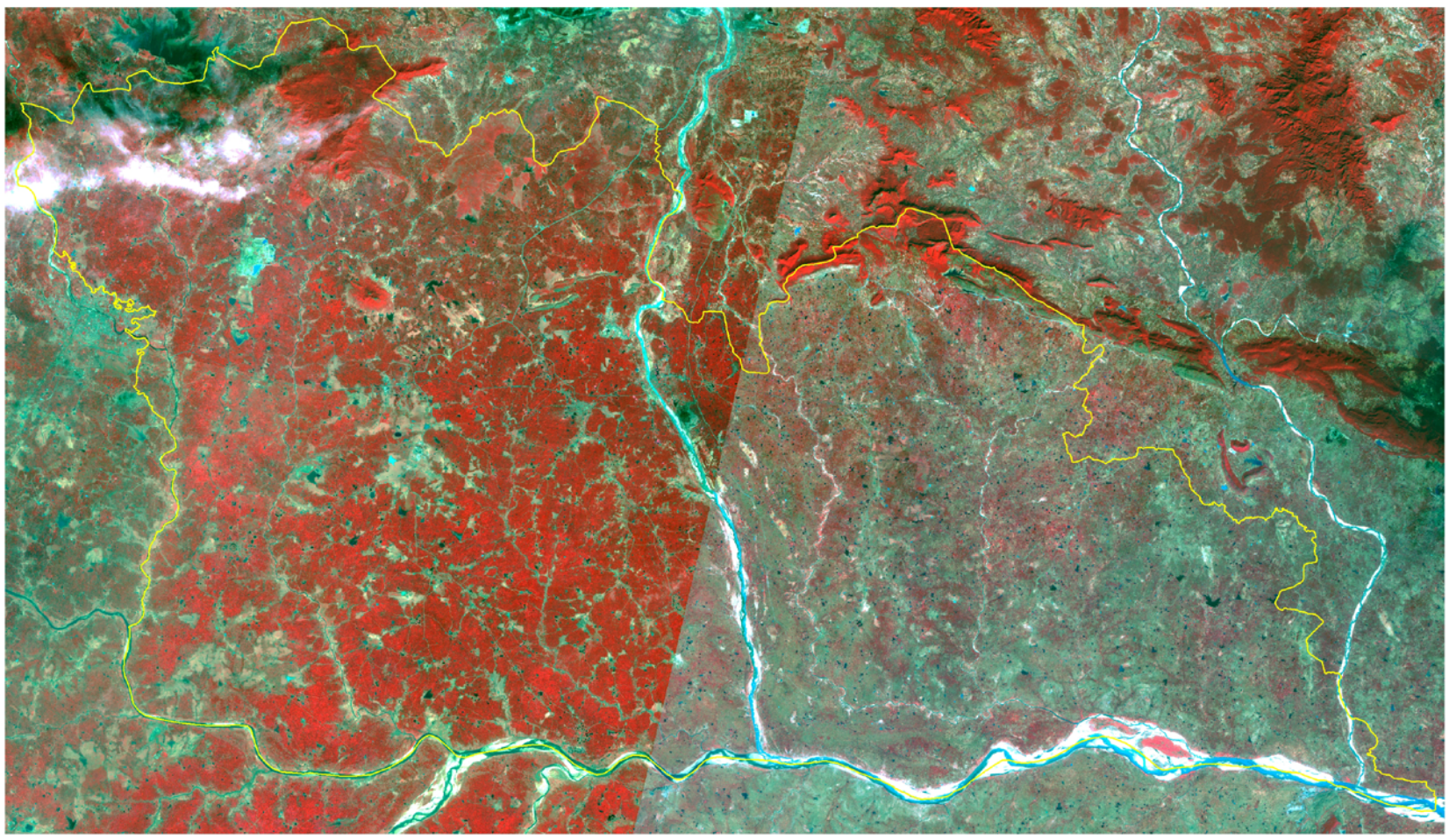
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Janjgir Champa



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

7.1.7 Bilaspur

Bilaspur district is situated in eastern part of Chhattisgarh and fall within the latitude 21'47" to 23'8" and longitude 81'14" to 83'15". Bilaspur district is surrounded by Koriya district in north, Shahdol district of Madhya Pradesh in south, Raipur district in east and Korba, Janjgir -Champa district in the west. Bilaspur district is not only famous in Chhattisgarh but in India due to its unique characteristics like rice quality, Kosa industry and its cultural background. Major rivers which surrounds Bilaspur district are Agaar, Maniyaar and Arpa. The total geographical area of the district is 7215 sq km.

District comprises 606 wetlands accounting for 19443 ha. This includes the small wetlands (<2.25 ha), which are 2497. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (12.8%) assuming that each wetland would be on an average 1 ha in extent. The Reservoir category ranked first in term of extent (about 39.5%) comprising 7685 ha of area followed by River/stream (6036 ha) and Tank/Pond (3127 ha). The seasonal reduction in open water spread is observed to be 15069 ha in post-monsoon got reduced to 8838 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 50 ha during post-monsoon season and 730 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in post-monsoon and low to moderate in pre-monsoon season. Details of estimates of wetlands in Bilaspur are given in Table 12.

Table 12: Area estimates of wetlands in Bilaspur

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	1	64	0.33	4	3
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	13	6036	31.04	5769	3389
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	43	7685	39.53	6239	3587
8	1202	Tanks/Ponds	547	3127	16.08	3033	1844
9	1203	Waterlogged	2	34	0.17	24	15
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**606**	**16946**	**87.16**	**15069**	**8838**
		Wetlands (<2.25 ha), mainly Tanks	2497	2497	12.84	-	-
		Total	**3103**	**19443**	**100.00**	**15069**	**8838**

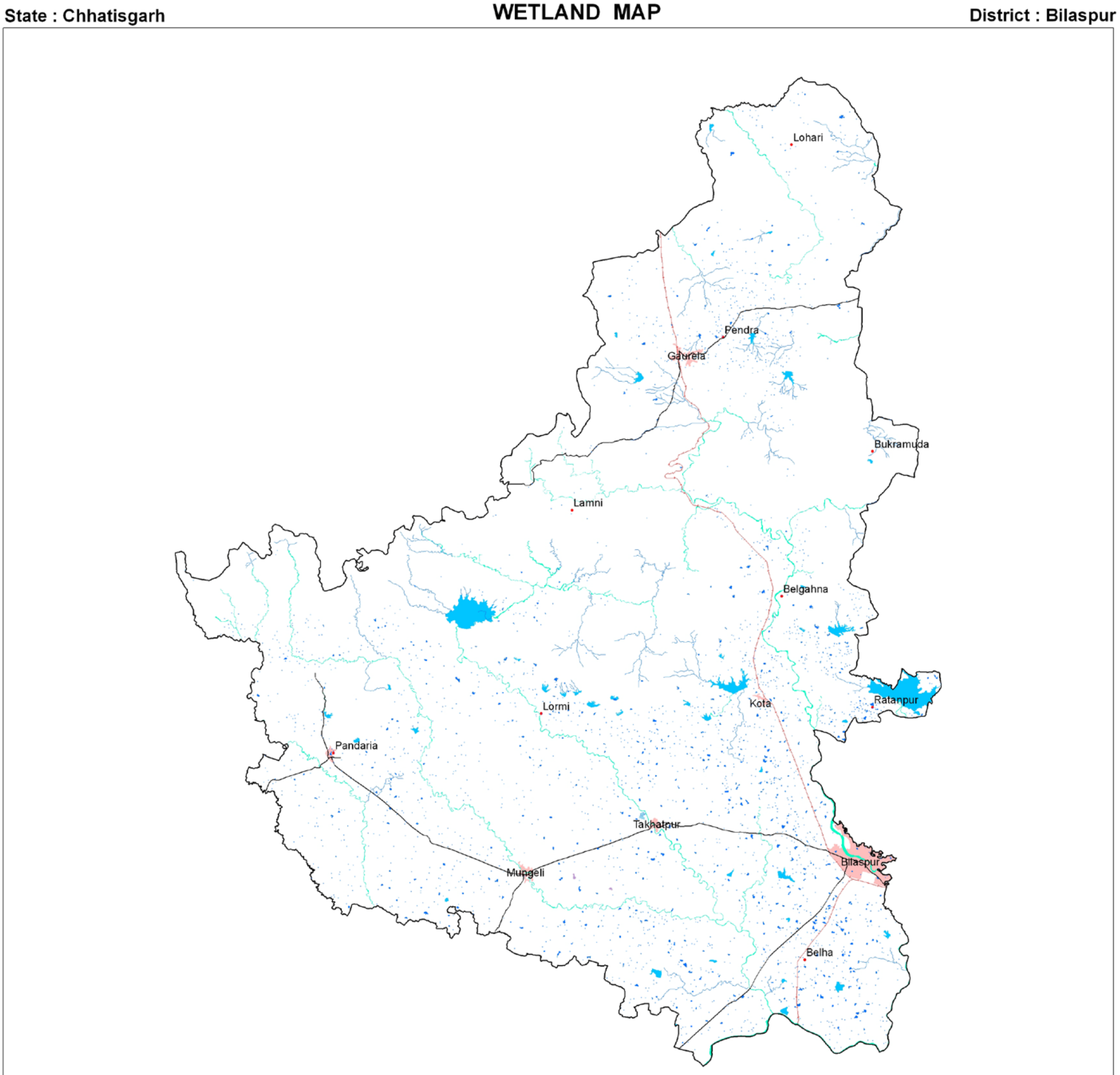
Area under Aquatic Vegetation	50	730

Area under turbidity levels		
Low	1441	4051
Moderate	13551	4321
High	77	466

State : Chhatisgarh

WETLAND MAP

District : Bilaspur

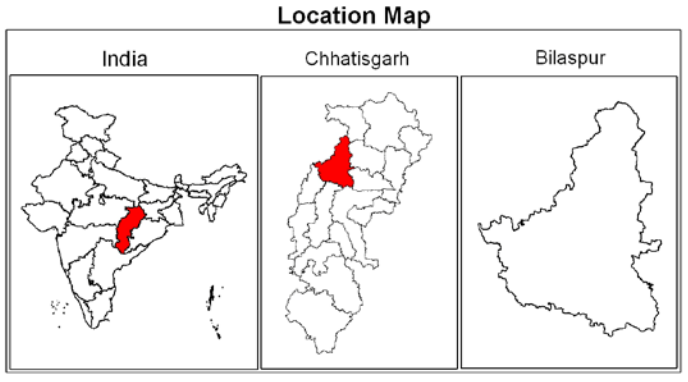


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



8 4 0 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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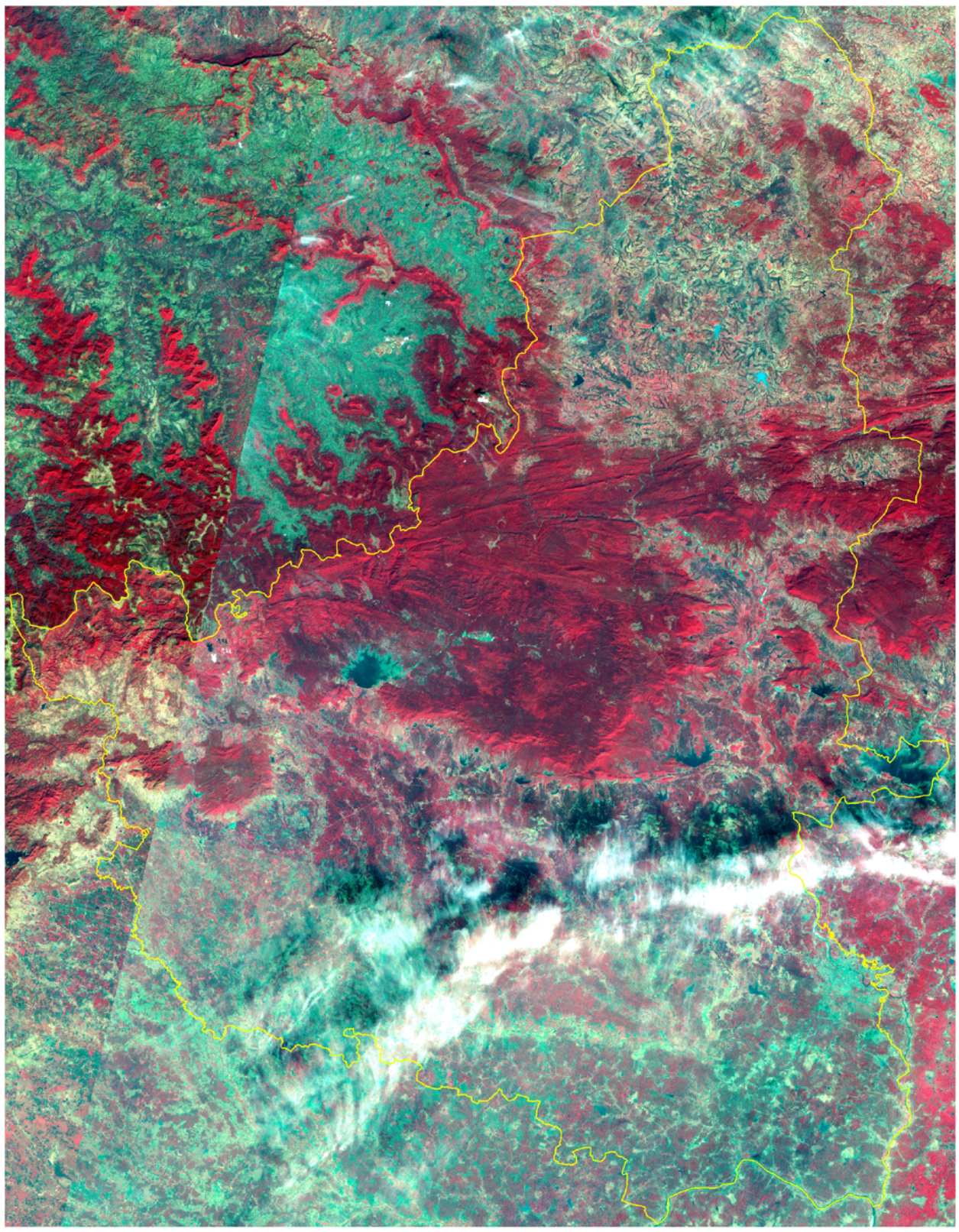
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Bilaspur



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

7.1.8 Kawardha

The district Kawardha is also known as Kabirdham. Kawardha is a peaceful and attractive place located on the southern bank of river Sakri. The district is surrounded by the Dindori district in north, Bilaspur and Durg in east, Rajnandgaon in South, and Balaghat in the west. Northern and western parts are surrounded by Maikal mountain ranges of Satpura. The main rivers of the district are Haf, Phok Sakri Phen, Halon, Banjar and Jamunia. The total geographical area of the district is 4223 sq km.

District comprises 255 wetlands accounting for 6899 ha. This includes the small wetlands (<2.25 ha), which are 505. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (7.3%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 49%) comprising 3372 ha of area followed by Reservoir/Barrage (1871 ha) and Tank/Pond (1151 ha). The seasonal reduction in open water spread is observed to be 4623 ha in post-monsoon got reduced to 2959 ha in pre-monsoon.

Area under aquatic vegetation is less, around 111 ha during post-monsoon season and 321 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in both the seasons. Details of estimates of wetlands in Kawardha are given in Table 13.

Table 13: Area estimates of wetlands in Kawardha

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	17	3372	48.88	2143	858
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	12	1871	27.12	1686	1468
8	1202	Tanks/Ponds	226	1151	16.68	794	633
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**255**	**6394**	**92.68**	**4623**	**2959**
		Wetlands (<2.25 ha), mainly Tanks	505	505	7.32	-	-
		Total	**760**	**6899**	**100.00**	**4623**	**2959**

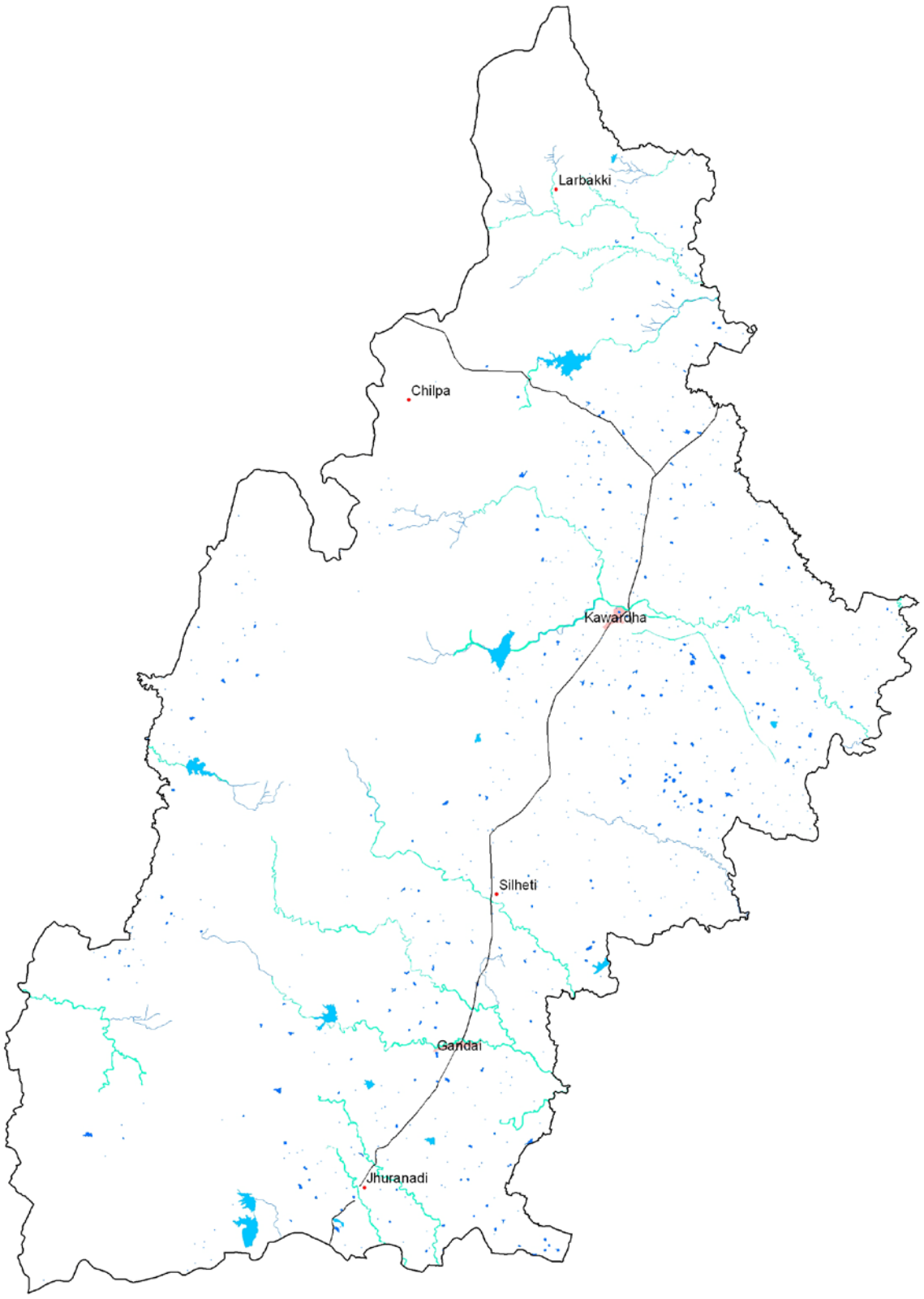
Area under Aquatic Vegetation	111	321

Area under turbidity levels		
Low	696	995
Moderate	3635	1736
High	292	228

State : Chhatisgarh

WETLAND MAP

District : Kawardha

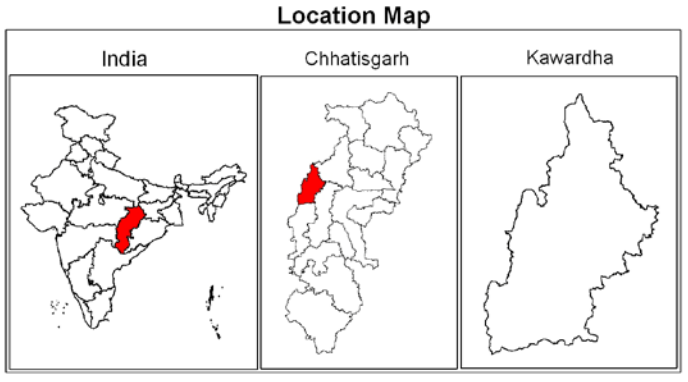


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



8 4 0 8 16 Kilometers

Data Source :

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

Prepared By :

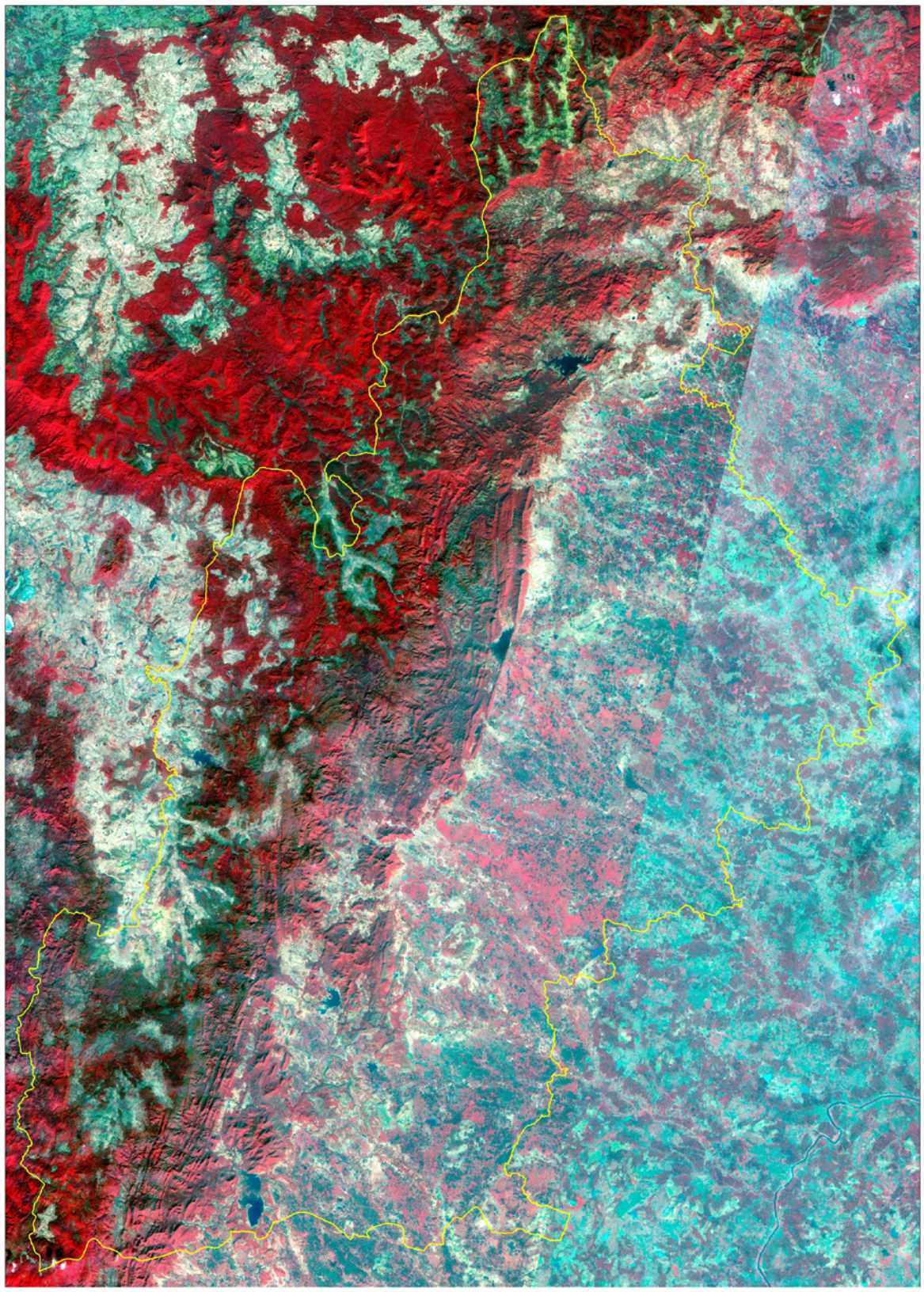
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Kawardha



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

7.1.9 Rajnandgaon

The district of Rajnandgaon was earlier a part of Durg and came into existence in the year 1973. The district was originally named as Nandgram. The principal river of the District is Sheonath, which is a tributary of Mahanadi. The total geographical area of the district is 6904 sq km.

District comprises 705 wetlands accounting for 18149 ha. This includes the small wetlands (<2.25 ha), which are 1901. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (10.5%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 40%) comprising 7345 ha of area followed by Reservoir/Barrage (5364 ha) and Tank/Pond (3505 ha). The seasonal reduction in open water spread is observed to be 13272 ha in post-monsoon got reduced to 10054 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 116 ha during post-monsoon season and 2195 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in post-monsoon and low to moderate in pre-monsoon season. Details of estimates of wetlands in Rajnandgaon are given in Table 14.

Table 14: Area estimates of wetlands in Rajnandgaon

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	17	7345	40.47	5233	4583
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	59	5364	29.56	4859	2715
8	1202	Tanks/Ponds	623	3505	19.31	3150	2730
9	1203	Waterlogged	6	34	0.19	30	26
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**705**	**16248**	**89.53**	**13272**	**10054**
		Wetlands (<2.25 ha), mainly Tanks	1901	1901	10.47	-	-
		Total	**2606**	**18149**	**100.00**	**13272**	**10054**

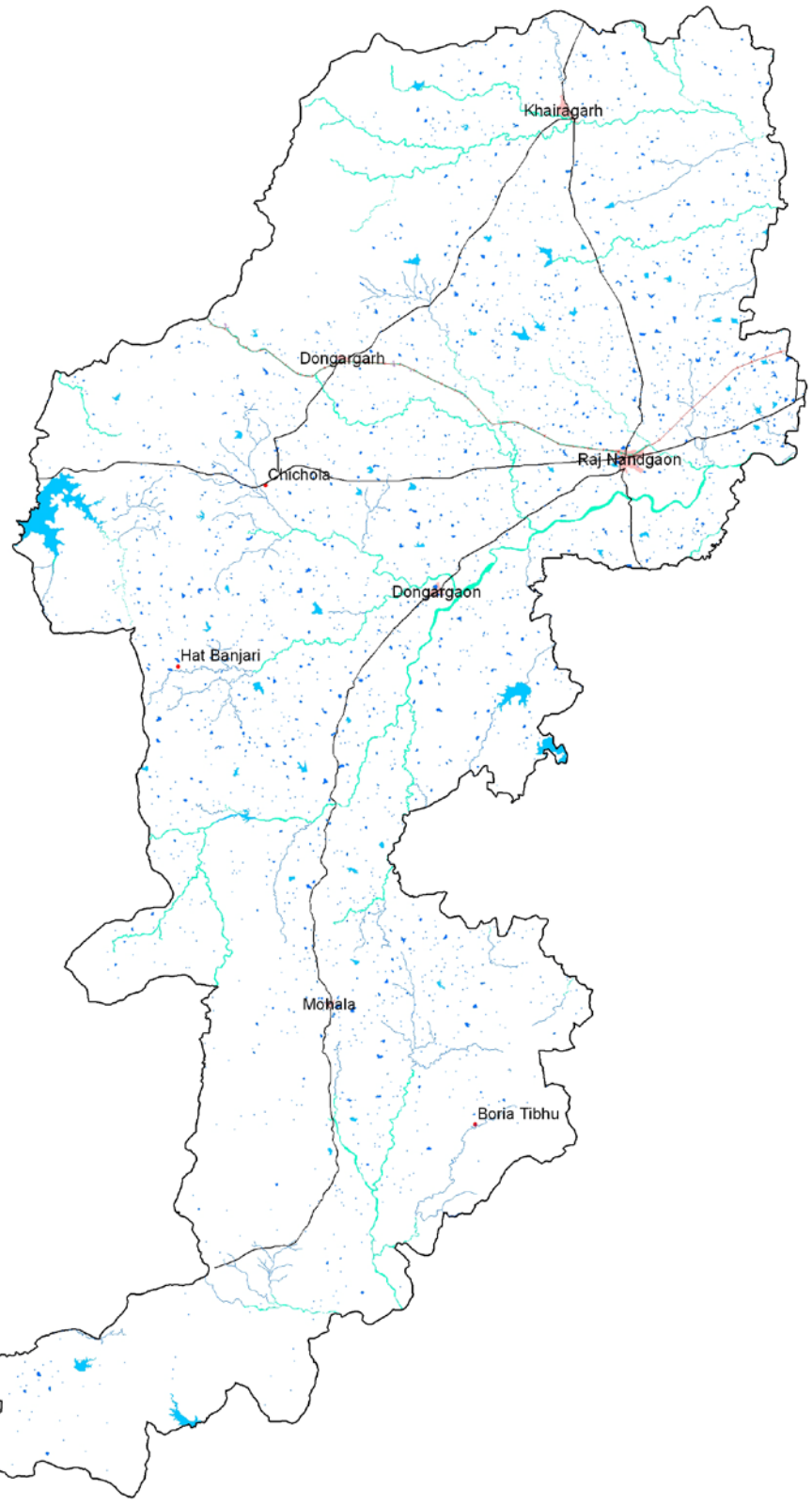
Area under Aquatic Vegetation	116	2195

Area under turbidity levels		
Low	330	4122
Moderate	11222	4706
High	1720	1226

State : Chhatisgarh

WETLAND MAP

District : Rajnandgaon

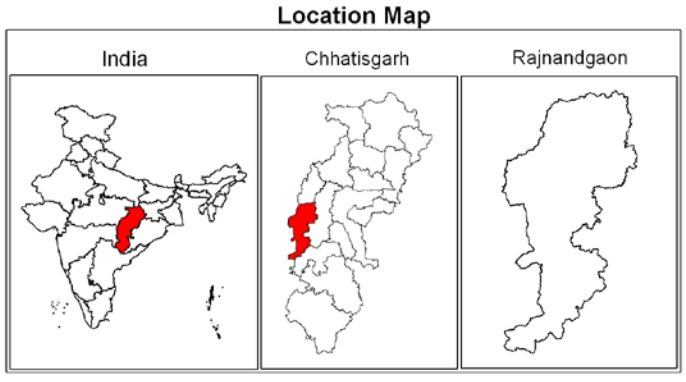


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



10 5 0 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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Sponsored By:

Ministry of Environment and Forests
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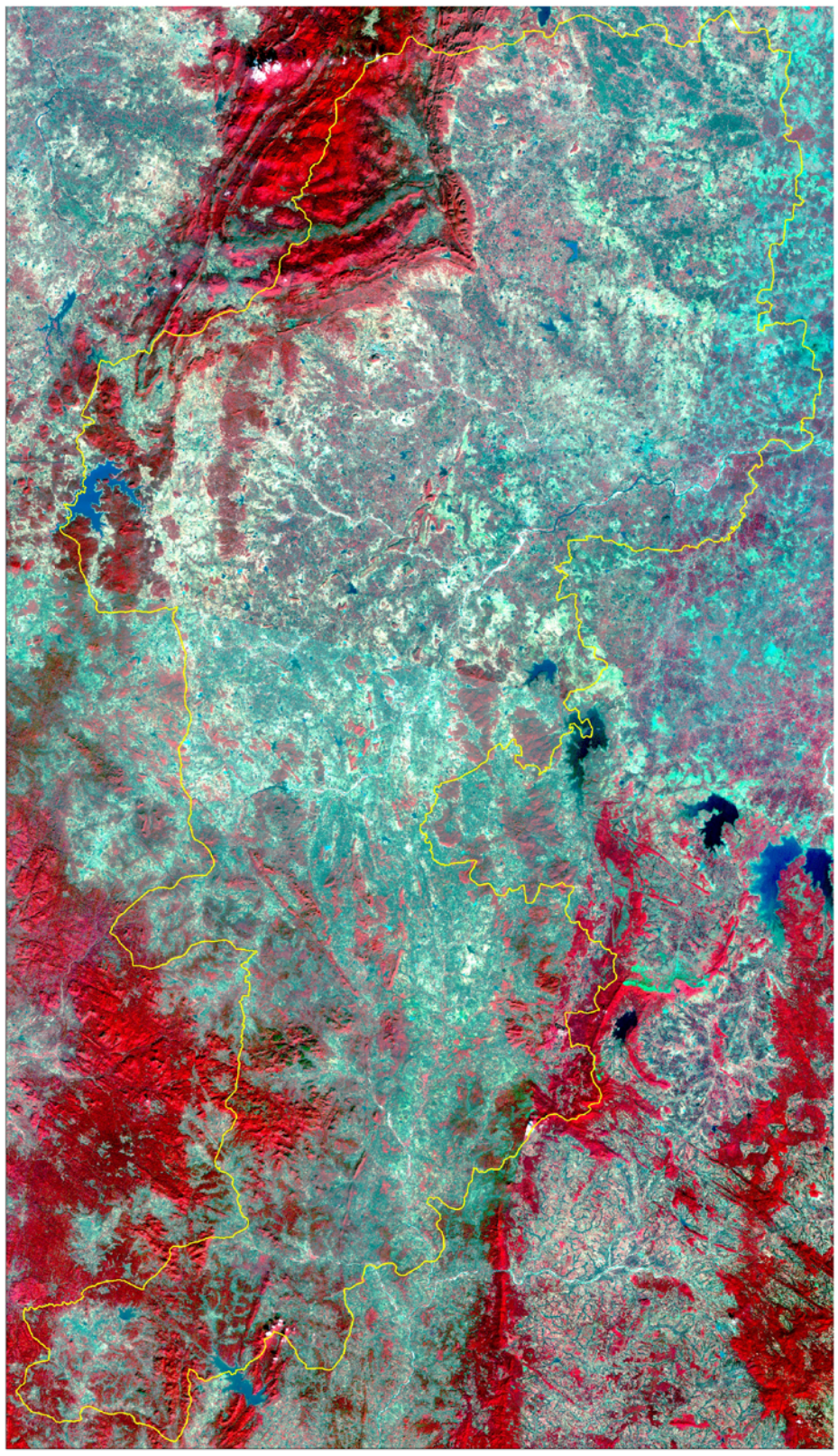
State : Chhatisgarh

District : Rajnandgaon



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

7.1.10 Durg

The Durg District is a populous district of Chhattisgarh. It occupies the southwestern part of the Chhattisgarh plain and possesses belts of hilly country in the south, southwest and northwest, and bestowed with mineral resources and forests. Sheonath and Kharun rivers contribute the most in the drainage system of the district. The total geographical area of the district is 8537 sq km.

District comprises 1347 wetlands accounting for 30291 ha. This includes the small wetlands (<2.25 ha), which are 3001. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (9.9%) assuming that each wetland would be on an average 1 ha in extent. The Reservoir category ranked first in term of extent (about 46.8%) comprising 14175 ha of area followed by Tank/pond (6820 ha) and River/stream (6295 ha). The seasonal reduction in open water spread is observed to be 925958 ha in post-monsoon got reduced to 18187 ha in pre-monsoon.

Area under aquatic vegetation is around 358 ha during post-monsoon season and 3772 ha during pre-monsoon. Qualitative turbidity of water is mainly low to moderate in both the seasons. Details of estimates of wetlands in Durg are given in Table 15.

Table 15: Area estimates of wetlands in Durg

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	11	6295	20.78	5791	4671
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	102	14175	46.80	13958	8788
8	1202	Tanks/Ponds	1234	6820	22.51	6209	4728
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**1347**	**27290**	**90.09**	**25958**	**18187**
		Wetlands (<2.25 ha), mainly Tanks	3001	3001	9.91	-	-
		Total	**4348**	**30291**	**100.00**	**25958**	**18187**

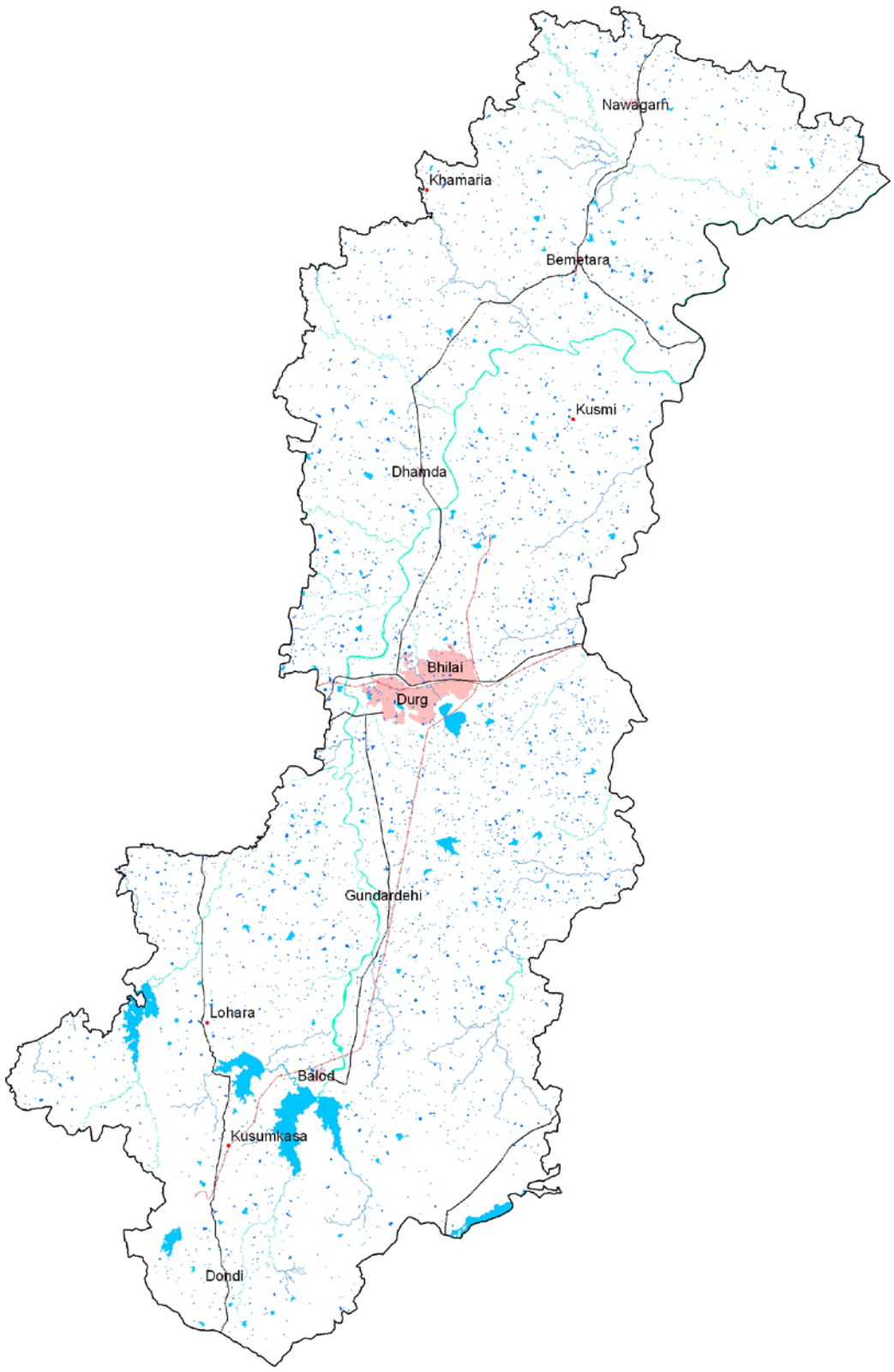
Area under Aquatic Vegetation	358	3772

Area under turbidity levels		
Low	9553	11475
Moderate	15753	6193
High	652	519

State : Chhatisgarh

WETLAND MAP

District : Durg

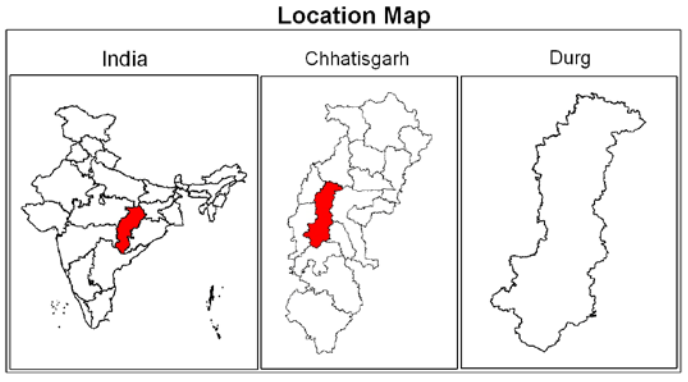


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

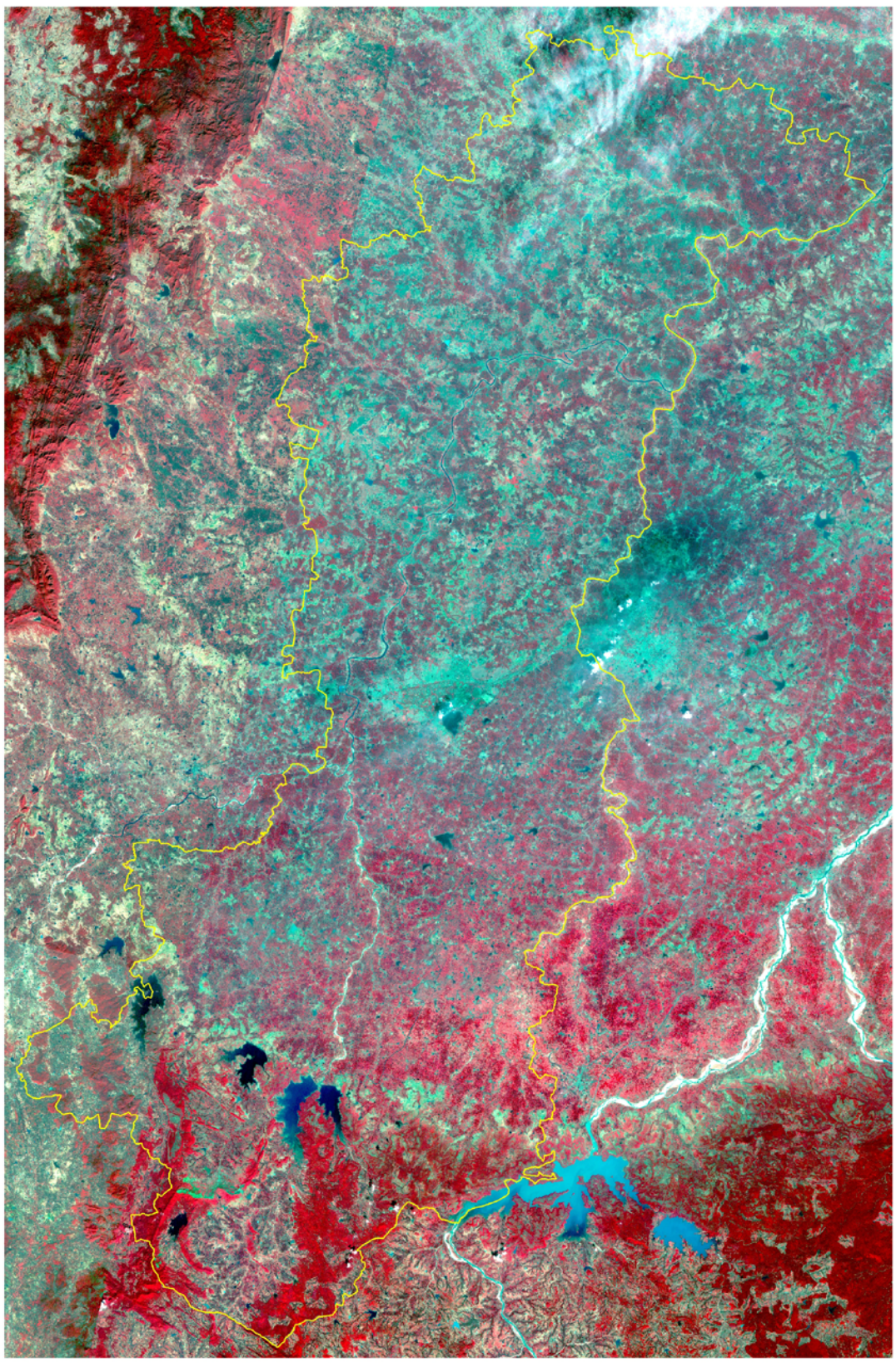
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Durg



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

7.1.11 Raipur

Raipur district is situated on the fertile plains of Chhattisgarh Region. The district headquarter is located at Raipur. The district is surrounded by t Bilaspur in north, Bastar and part of Orissa state in the south, Raigarh and part of Orissa state in the east and Durg in the West. The district occupies the south eastern part of the upper Mahanadi valley and the bordering hills in the south and the east. Thus, the district is divided into two major physical divisions, namely the Chattisgarh plain and the hilly areas. The chief crop of this region is paddy. Raipur is the biggest city of the region and a fast developing important industrial centre. Mahanadi is the principal river of this district. The total geographical area of the district is 12507 sq km.

District comprises 1201 wetlands accounting for 44211 ha. This includes the small wetlands (<2.25 ha), which are 4567. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (10.3%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 57%) comprising 25231 ha of area followed by Reservoir/Barrage (7527 ha) and Tank/Pond (6768 ha). The seasonal reduction in open water spread is observed to be 26783 ha in post-monsoon got reduced to 18739 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 181 ha during post-monsoon season and 2130 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in post-monsoon and low in pre-monsoon season. Details of estimates of wetlands in Raipur are given in Table 16.

Table 16: Area estimates of wetlands in Raipur

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	4	61	0.14	34	31
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	13	25231	57.07	14412	10947
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	82	7527	17.03	6971	3696
8	1202	Tanks/Ponds	1104	6768	15.31	5323	4043
9	1203	Waterlogged	7	57	0.13	43	22
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**1210**	**39644**	**89.67**	**26783**	**18739**
		Wetlands (<2.25 ha), mainly Tanks	4567	4567	10.33	-	-
		Total	**5777**	**44211**	**100.00**	**26783**	**18739**

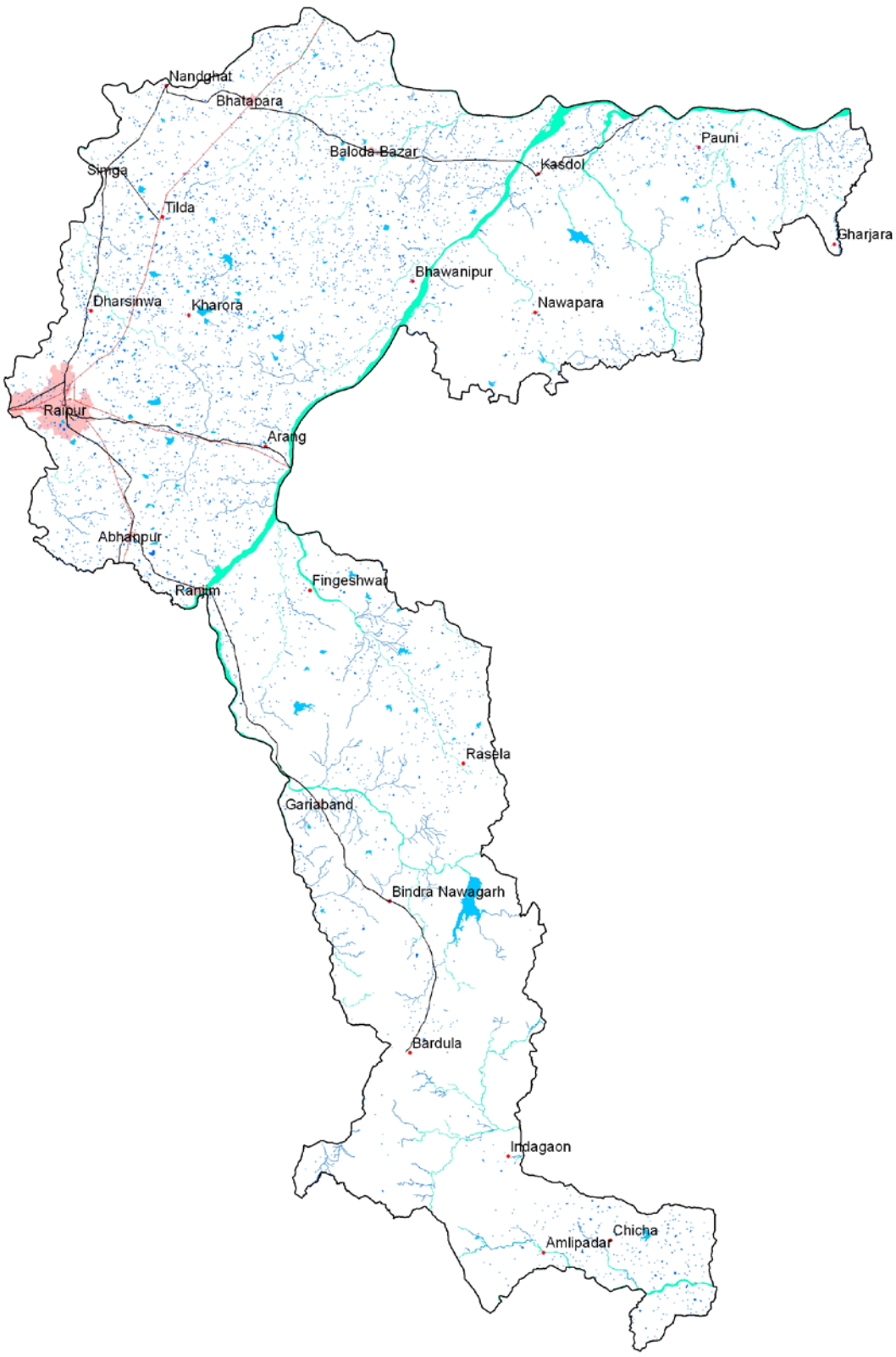
Area under Aquatic Vegetation	181	2130

Area under turbidity levels		
Low	3649	10899
Moderate	20524	6743
High	2610	1097

State : Chhatisgarh

WETLAND MAP

District : Raipur

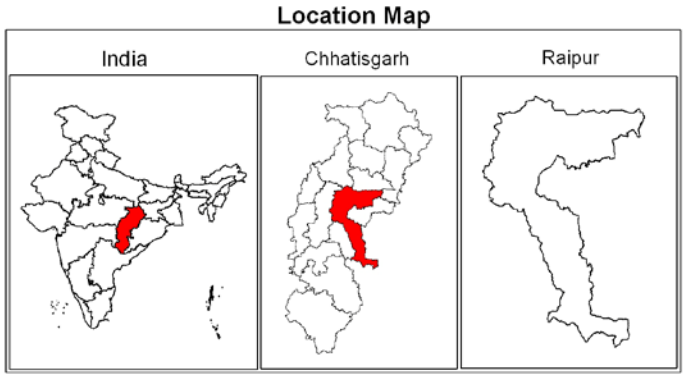


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

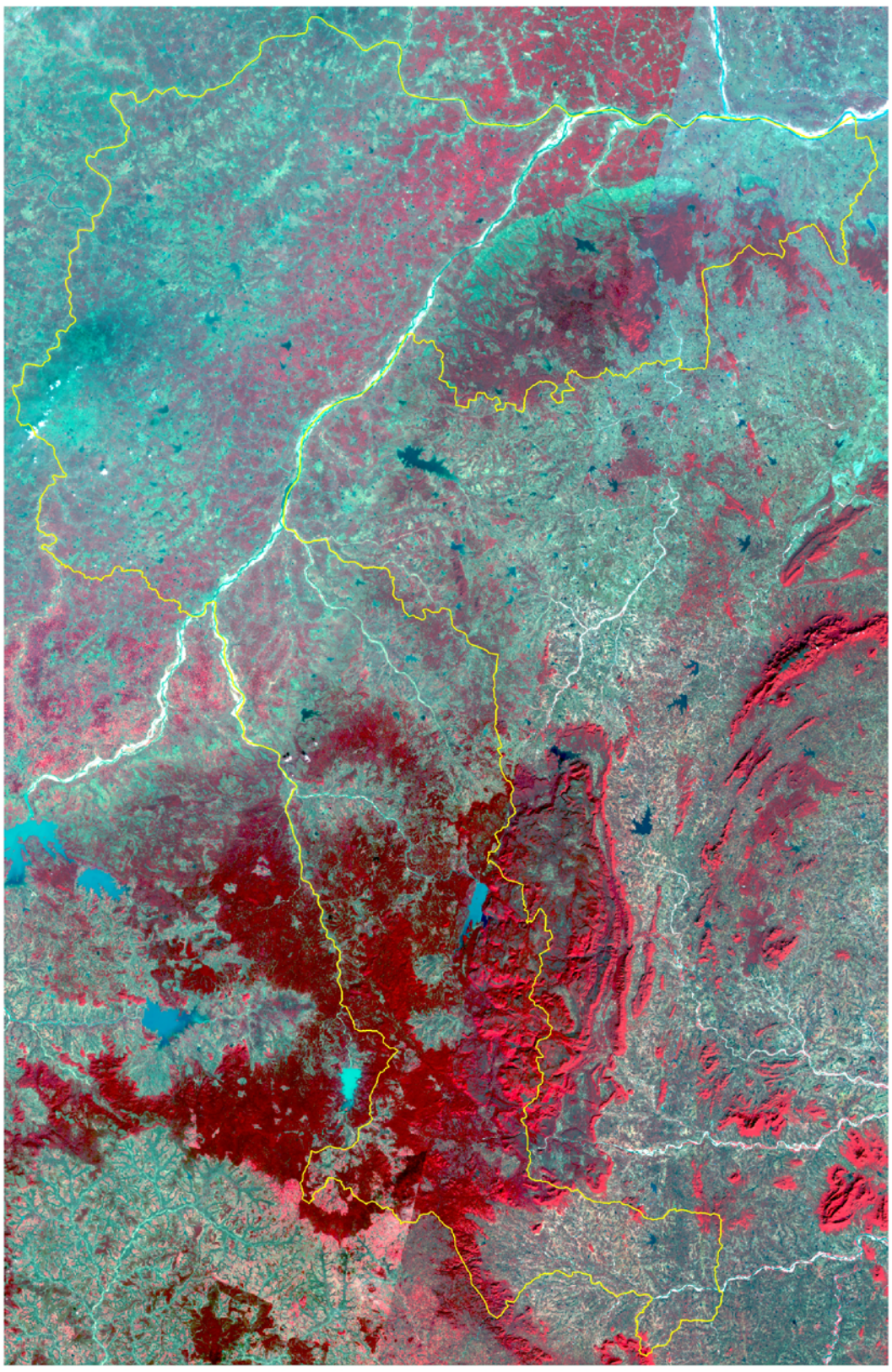
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Raipur



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

7.1.12 Mahasamund

Mahasamund district is spread out in an area of 4702 sq. kms in the Central-East of Chhattisgarh State. The district lies between 20°47' to 21°31'30'' latitude and 82°00' to 83°15'45'' longitude, surrounded by districts of Raigarh and Raipur of Chhattisgarh State and Nawapara and Bargarh of Orissa. Granite rocks can be found in the Bagbahra, Basna and Pithora region. Limestone rocks of Chhattisgarh group contemporary to Cuddapah group of Upper Pre-Cambrian age and comprising of limestone layers, shale, sandstone, or quartzite can be predominantly found. Neo-granite, dolerite, and quartz in intrusive forms are also found in the district. Hence there is a great scope of intense mining activity.

District comprises 732 wetlands accounting for 16557 ha. This includes the small wetlands (<2.25 ha), which are 1743. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (10.53%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 37%) comprising 6136 ha of area followed by Reservoir/Barrage (4829 ha) and Tank/Pond (3835 ha). The seasonal reduction in open water spread is observed to be 11468 ha in post-monsoon got reduced to 6857 ha in pre-monsoon.

Area under aquatic vegetation is less, around 508 ha during post-monsoon season and 2312 ha during pre-monsoon. Details of estimates of wetlands in Mahasamund are given in Table 17.

Table 17: Area estimates of wetlands in Mahasamund

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	2	14	0.08	10	11
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	8	6136	37.06	3916	1643
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	51	4829	29.17	4598	2585
8	1202	Tanks/Ponds	671	3835	23.16	2944	2618
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**732**	**14814**	**89.47**	**11468**	**6857**
		Wetlands (<2.25 ha), mainly Tanks	1743	1743	10.53	-	-
		Total	**2475**	**16557**	**100.00**	**11468**	**6857**

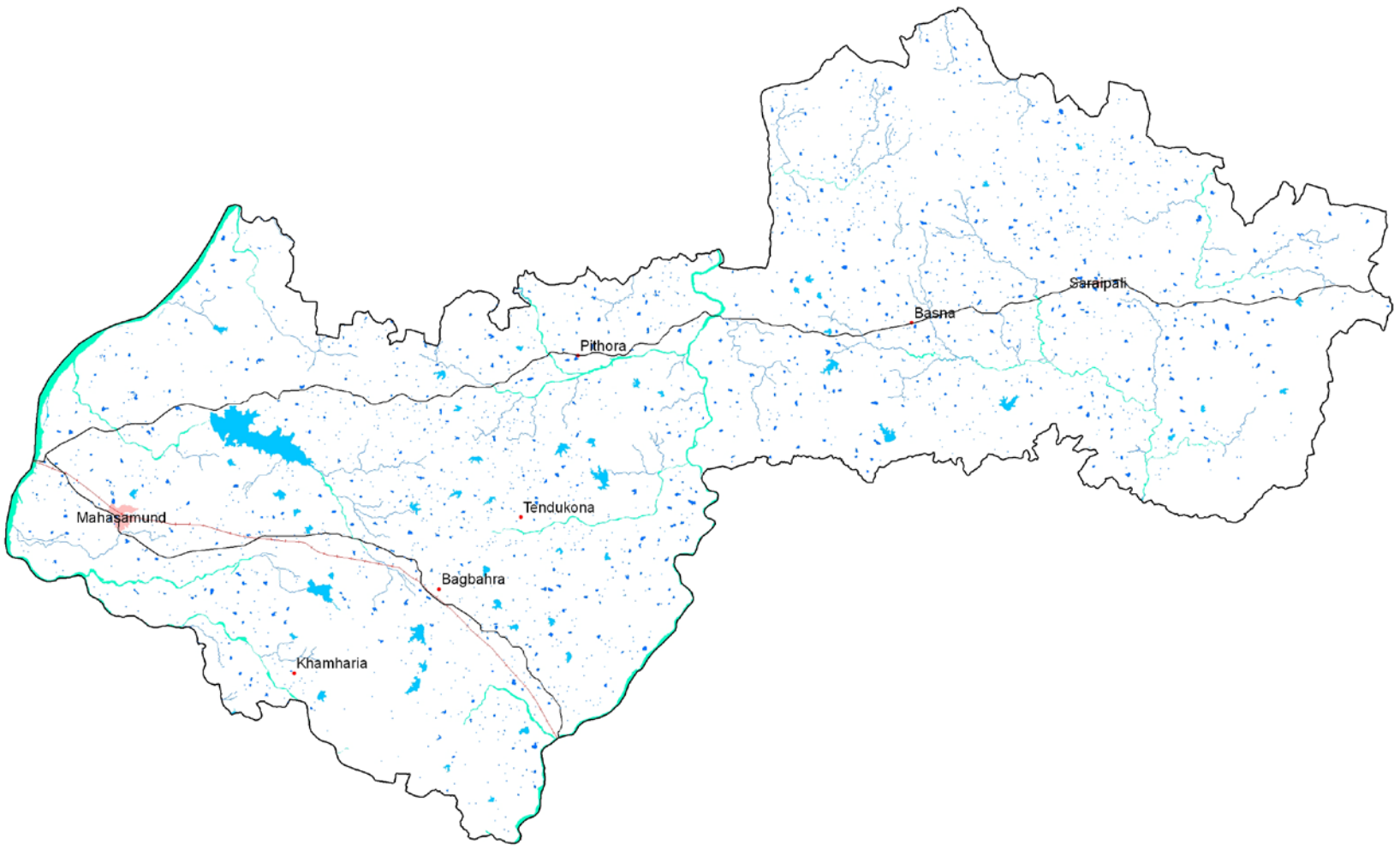
Area under Aquatic Vegetation	508	2312

Area under turbidity levels		
Low	3096	4161
Moderate	7216	1801
High	1156	895

State : Chhatisgarh

WETLAND MAP

District : Mahasamund

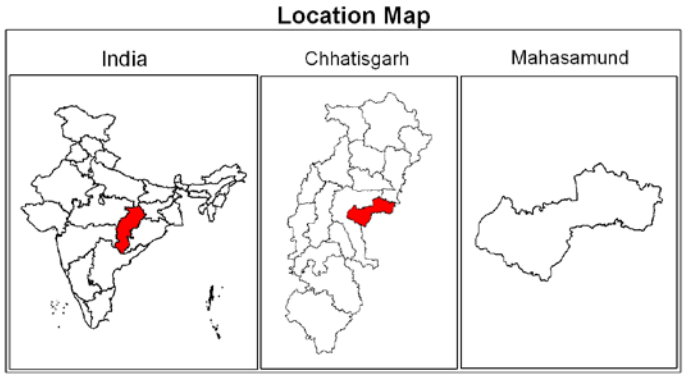


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



8 4 0 8 16 Kilometers

Data Source :

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

Prepared By :

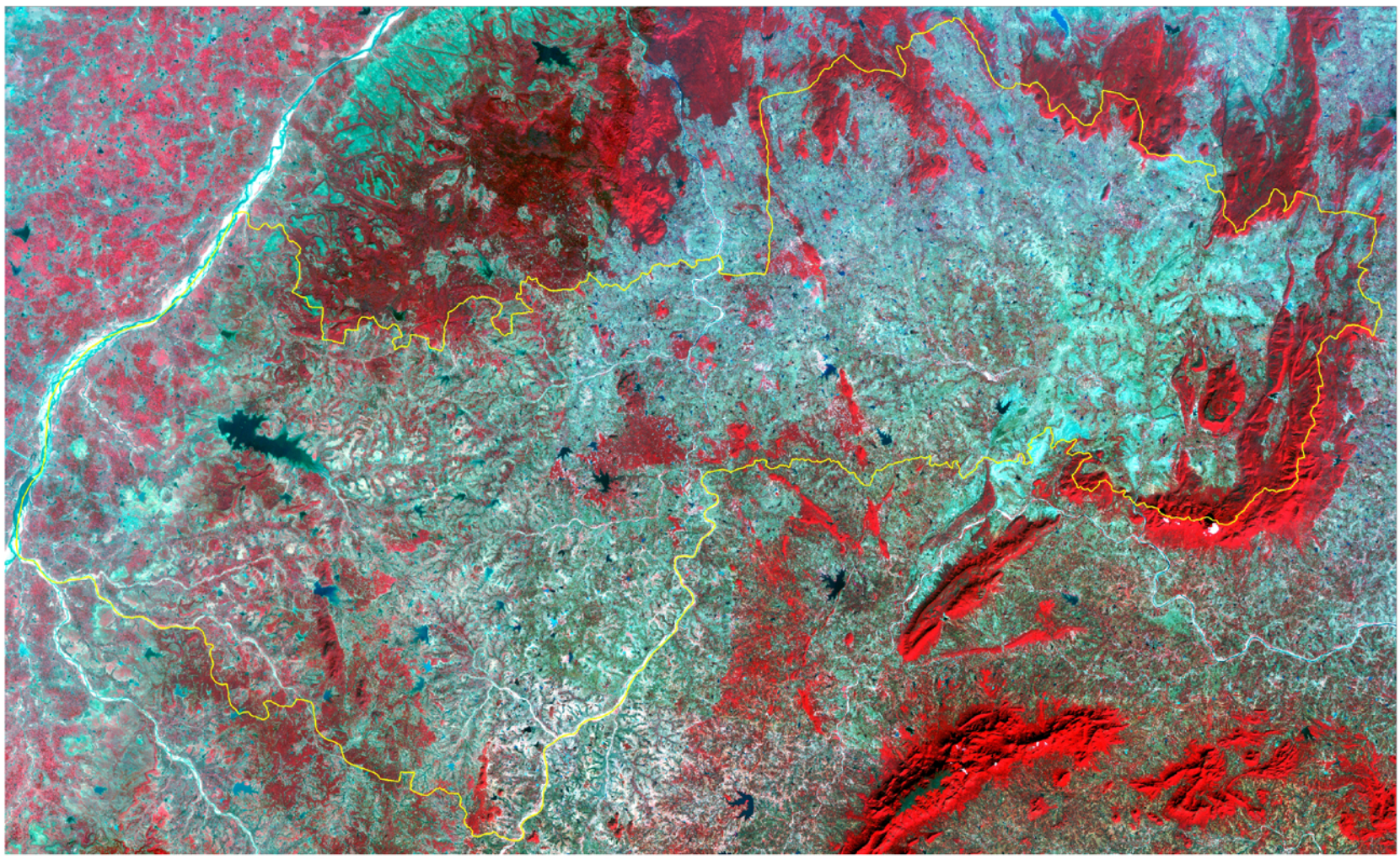
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Mahasamund



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

7.1.13 Dhamtari

The district is surrounded in the east, by Satpura range which is popularly known as Sihawa pahad, West district of Kanker. In North by Raipur, the heart and capital city of Chhattisgarh and in South by the boundary of Orissa state. Mahanadi is the principal river of this district. The total geographical area of the district is 4049 sq km.

District comprises 191 wetlands accounting for 26909 ha. This includes the small wetlands (<2.25 ha), which are 1134. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (4.21%) assuming that each wetland would be on an average 1 ha in extent. The Reservoirs category ranked first in term of extent (about 57.6%) comprising 15506 ha of area followed by River/stream (9429 ha) and Tank/Pond (840 ha). The seasonal reduction in open water spread is observed to be 19676 ha in post-monsoon got reduced to 11891 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 52 ha during post-monsoon season and 2981 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in post-monsoon and low in pre-monsoon season. Details of estimates of wetlands in Dhamtari are given in Table 18.

Table 18: Area estimates of wetlands in Dhamtari

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	15	9429	35.04	3584	1398
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	14	15506	57.62	15388	9886
8	1202	Tanks/Ponds	162	840	3.12	704	607
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**191**	**25775**	**95.79**	**19676**	**11891**
		Wetlands (<2.25 ha), mainly Tanks	1134	1134	4.21	-	-
		Total	**1325**	**26909**	**100.00**	**19676**	**11891**

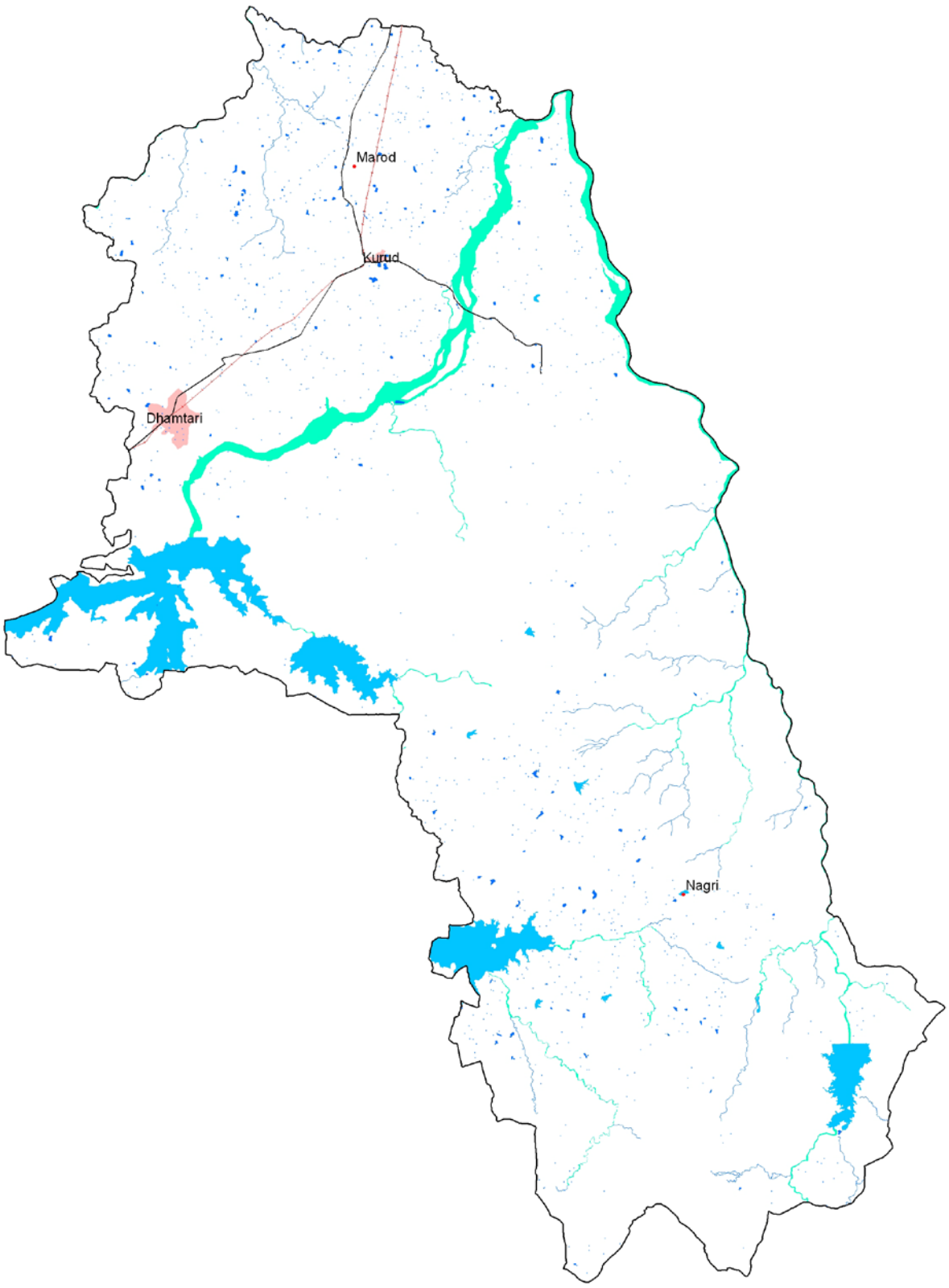
Area under Aquatic Vegetation	52	2981

Area under turbidity levels		
Low	4778	9174
Moderate	14210	2670
High	688	47

State : Chhatisgarh

WETLAND MAP

District : Dhamtari

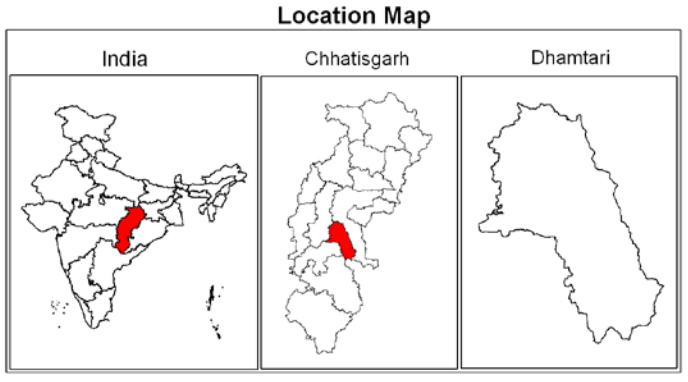


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



8 4 0 8 16 Kilometers

Data Source :

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

Prepared By :

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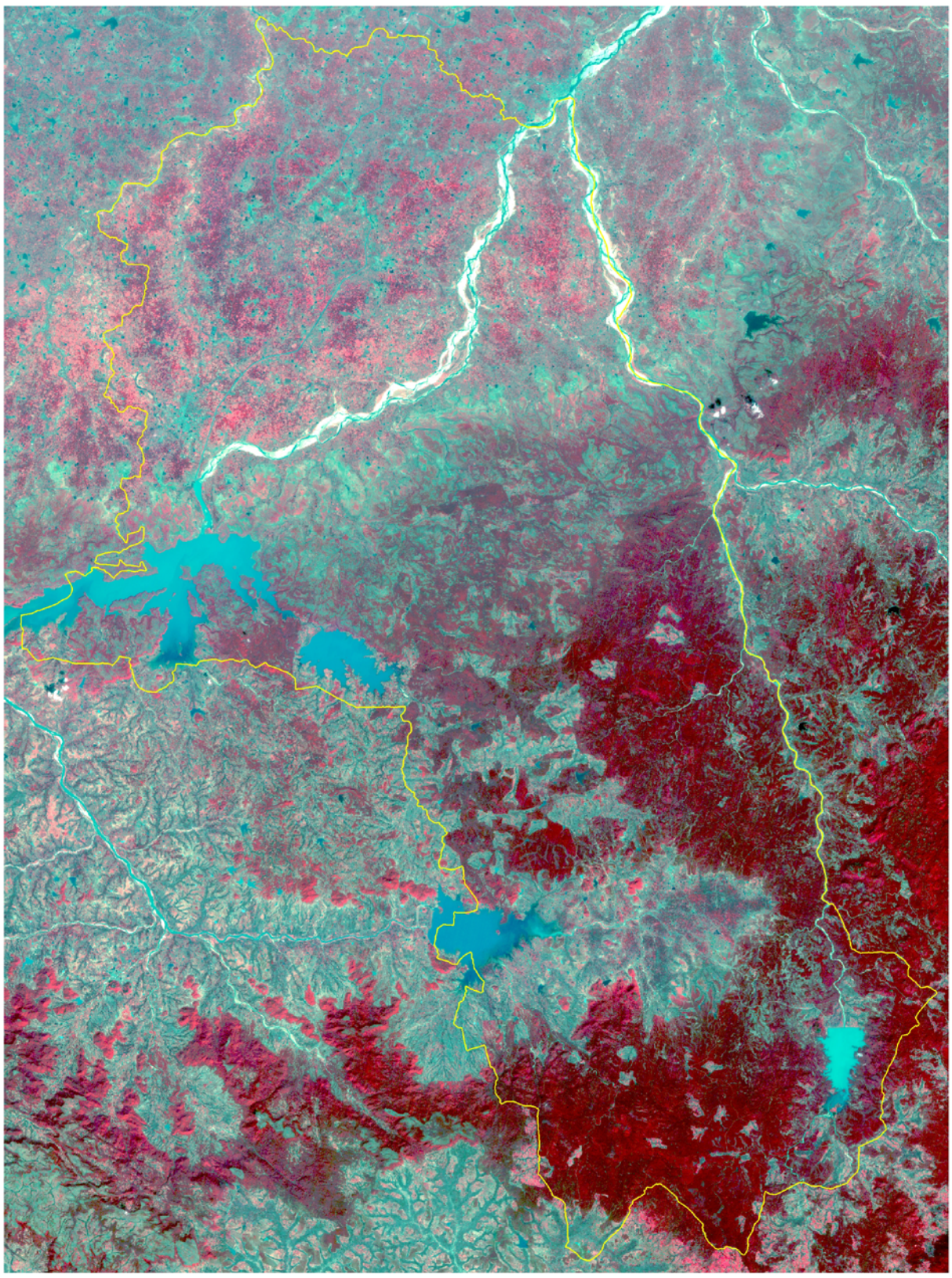
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Dhamtari



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

7.1.14 Kanker

The Kanker district is situated in the southern region of the state of Chhattisgarh. The district is surrounded by four districts of Chhattisgarh state, namely Bastar, Dhamtari, Durg and Rajnandgaon. Small hilly pockets are seen throughout the area. Five rivers flow through the district namely- Doodh, Mahanadi, Hatkul, Sindur and Turu river. The total geographical area of the district is 6506 sq km.

District comprises 220 wetlands accounting for 13219 ha. This includes the small wetlands (<2.25 ha), which are 1503. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (11.37%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 57%) comprising 7535 ha of area followed by Reservoir/Barrage (3192 ha) and Tank/Pond (980 ha). The seasonal reduction in open water spread is observed to be 9854 ha in post-monsoon got reduced to 6833 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 15 ha during post-monsoon season and 1061 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in both the seasons. Details of estimates of wetlands in Kanker are given in Table 19.

Table 19: Area estimates of wetlands in Kanker

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	19	7535	57.00	5798	4352
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	45	3192	24.15	3174	1772
8	1202	Tanks/Ponds	155	980	7.41	873	704
9	1203	Waterlogged	1	9	0.07	9	5
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**220**	**11716**	**88.63**	**9854**	**6833**
		Wetlands (<2.25 ha), mainly Tanks	1503	1503	11.37	-	-
		Total	**1723**	**13219**	**100.00**	**9854**	**6833**

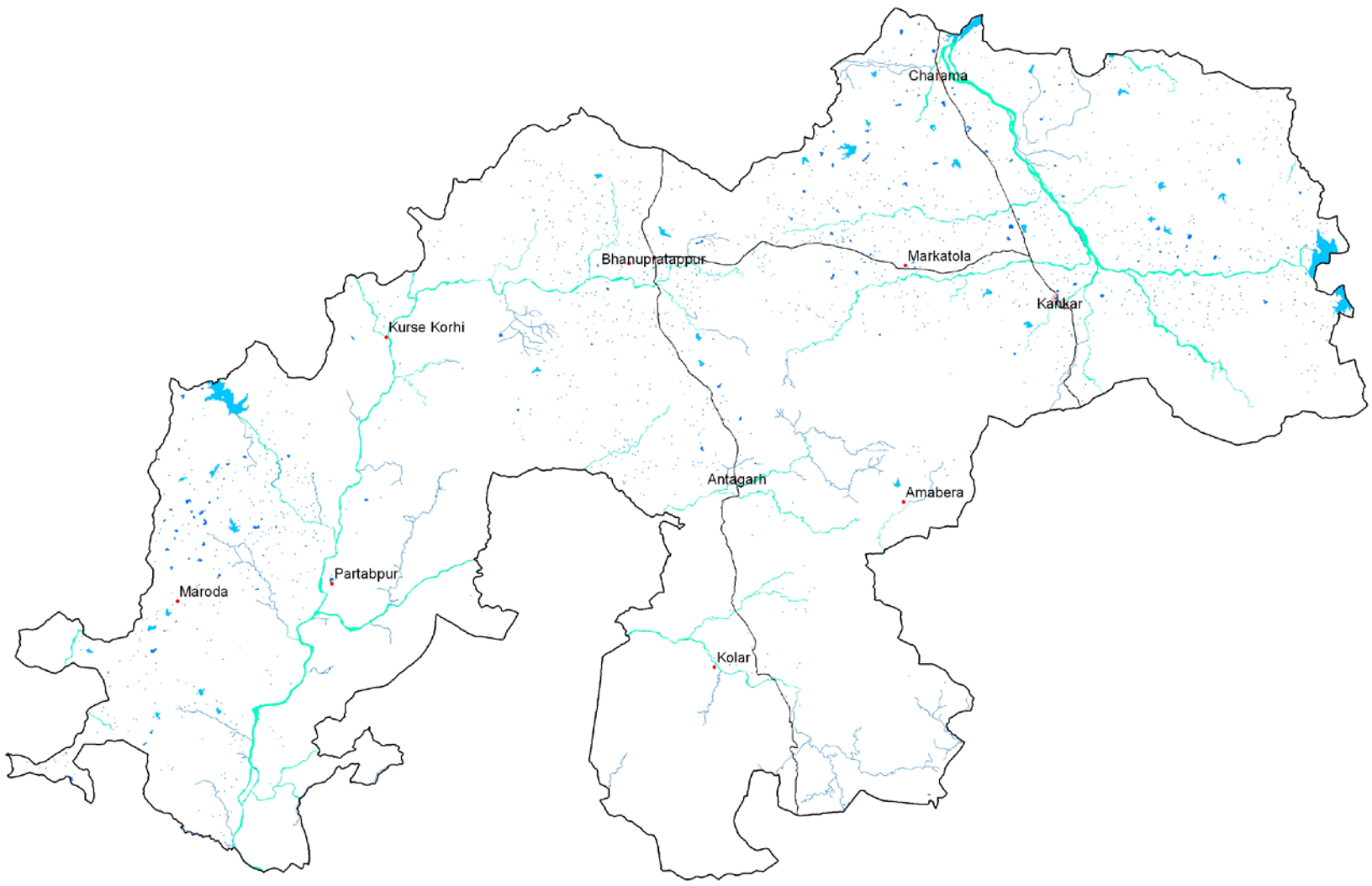
Area under Aquatic Vegetation	15	1061

Area under turbidity levels		
Low	1751	1380
Moderate	6505	5200
High	1598	253

State : Chhatisgarh

WETLAND MAP

District : Kankar

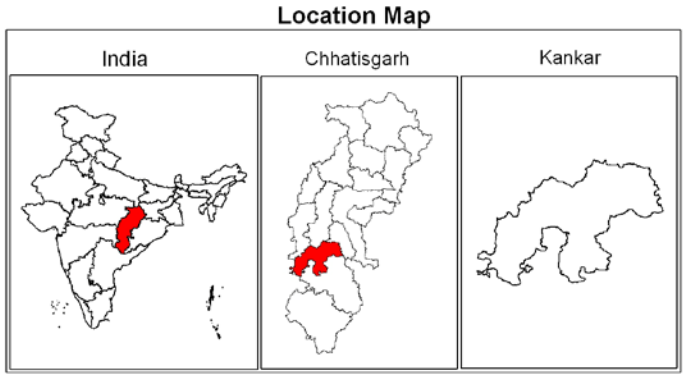


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



10 5 0 10 20 Kilometers

Data Source :

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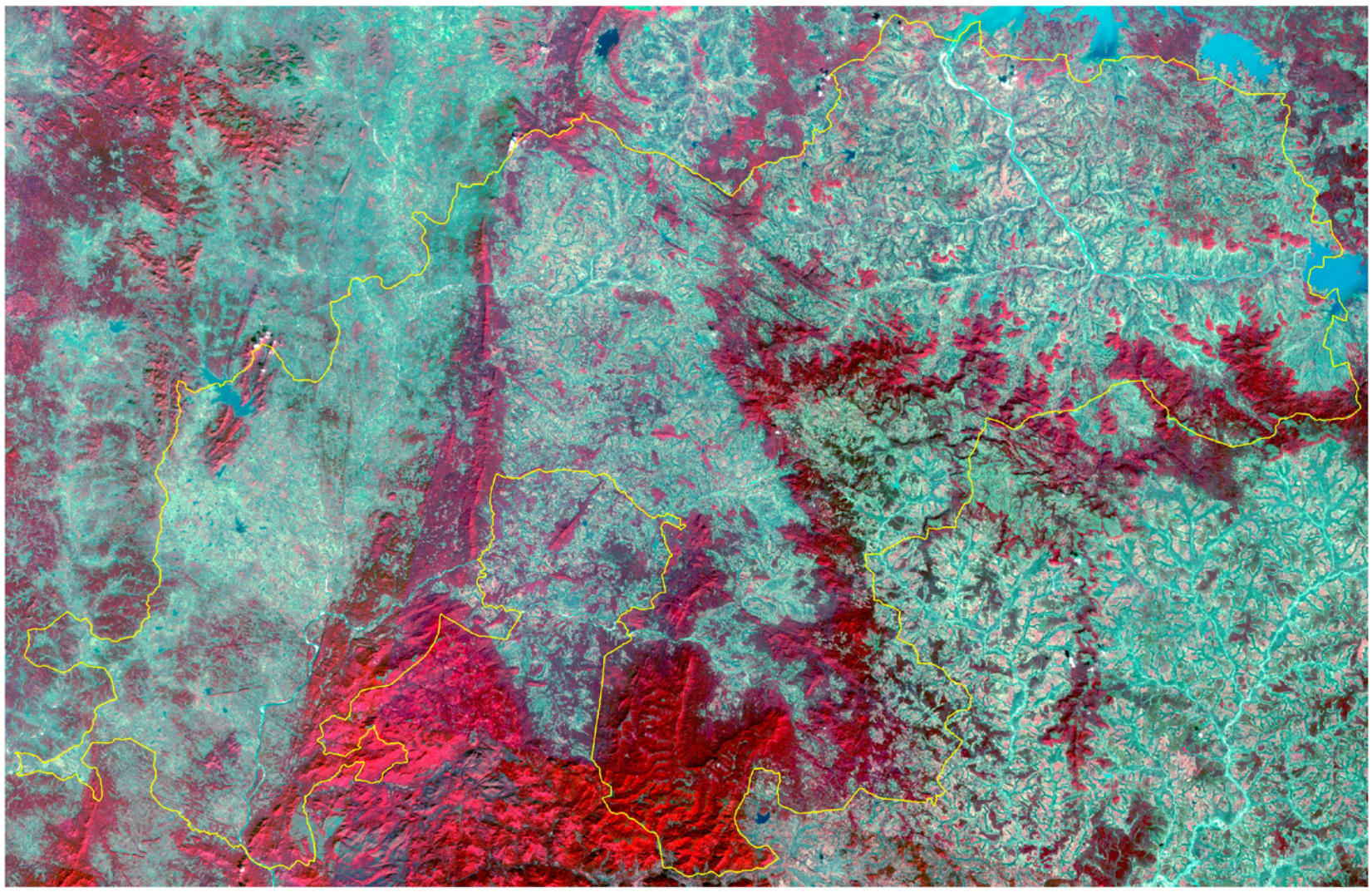
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Kankar



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

7.1.15 Bastar

Bastar is known as tribal district of India, the district headquarters being at Jagdalpur. Bastar is located in the southern part of Chhattisgarh and situated at a height of 2000 ft above sea level. The borders of Bastar district are Kanker district in the north, Maharashtra State in the west, Dantewada district in the south and Orissa State in the east. The District head quarter Jagdalpur is situated at a distance of 300 km from Raipur, which is the capital of Chhattisgarh state. The largest and the most important river in Bastar district is the Indravati. The total geographical area of the district is 14974 sq km.

District comprises 184 wetlands accounting for 14662 ha. This includes the small wetlands (<2.25 ha), which are 1519. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (10.36%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 75%) comprising 11025 ha of area followed by Reservoir/Barrage (1207 ha) and Tank/Pond (885 ha). The seasonal reduction in open water spread is observed to be 10732 ha in post-monsoon got reduced to 9976 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 4 ha during post-monsoon season and 460 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in both the seasons. Details of estimates of wetlands in Bastar are given in Table 20.

Table 20: Area estimates of wetlands in Bastar

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	6	26	0.18	26	13
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	25	11025	75.19	8830	8746
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	33	1207	8.23	1095	610
8	1202	Tanks/Ponds	120	885	6.04	781	607
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**184**	**13143**	**89.64**	**10732**	**9976**
		Wetlands (<2.25 ha), mainly Tanks	1519	1519	10.36	-	-
		Total	**1703**	**14662**	**100.00**	**10732**	**9976**

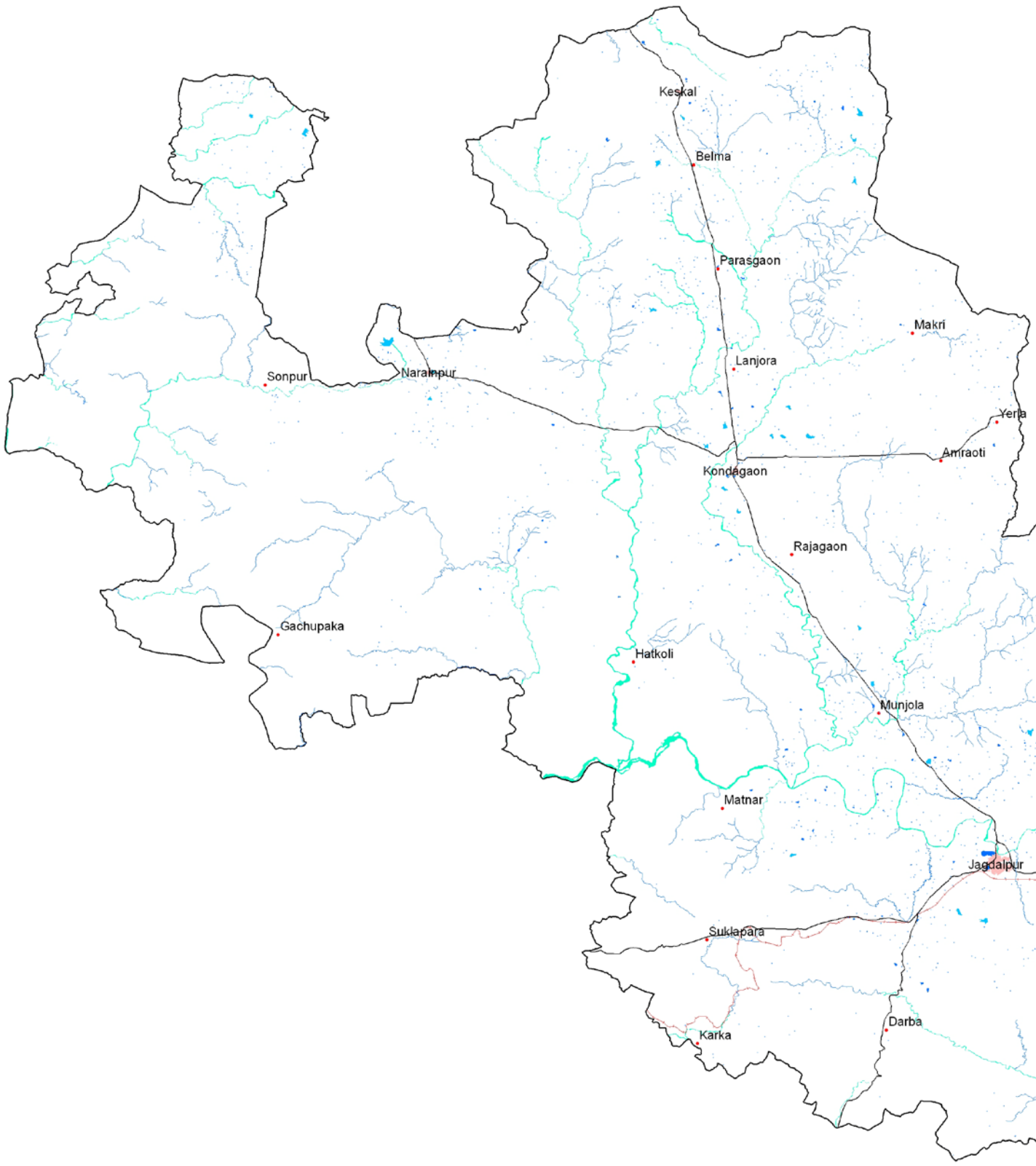
Area under Aquatic Vegetation	4	460

Area under turbidity levels		
Low	315	1533
Moderate	9216	8111
High	1201	332

State : Chhatisgarh

WETLAND MAP

District : Bastar

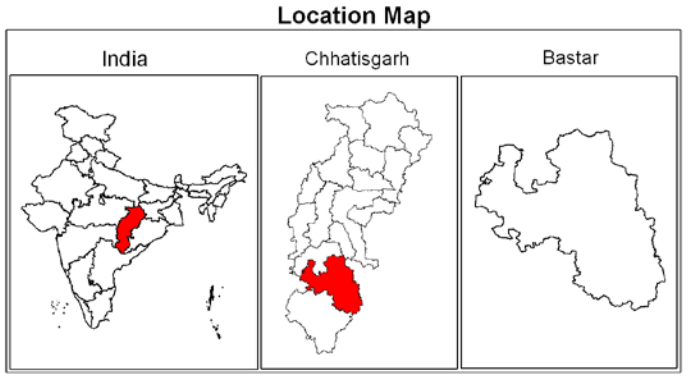


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

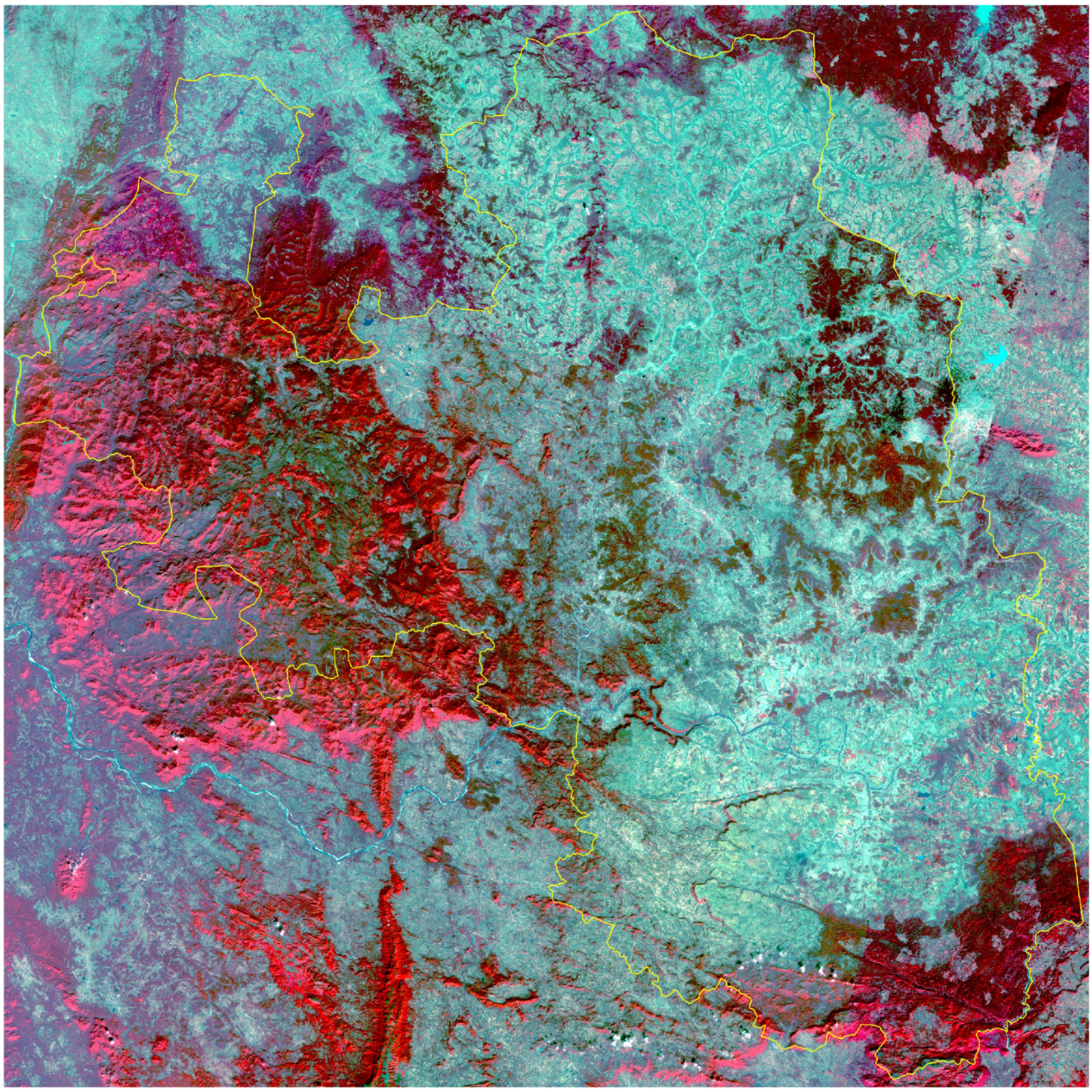
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Bastar



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

7.1.16 Dantewada

Dantewada district is also known as south Bastar. Dantewada is believed to be one among the 52 sacred Shakti pithas of the Hindu Mythology. The district is surrounded by three different states with different cultures and traditions. It is bordered by Maharashtra in the west, Orissa to the East and Andhra Pradesh to the south. The district had acquired a very rare blend of legacy in culture. Surrounded by hilly tracks, and valleys, numerous brooks and rivers, lush green and virgin forests, Dantewada is a paradise to the lovers of nature. Dantewada is also home to different species of wild life such as the Tiger, Leopard, Deer, and Bison. Two species, which give Dantewada a cut above the rest, are the Pahadi Maina and the Wild Buffalo (Bubalus bubalis). The total geographical area of the district is 17634 sq km.

District comprises 247 wetlands accounting for 25503 ha. This includes the small wetlands (<2.25 ha), which are 794. In terms of area, these small wetlands constitute a significant fraction of the wetland extent (3.11%) assuming that each wetland would be on an average 1 ha in extent. The River/Stream category ranked first in term of extent (about 88%) comprising 22444 ha of area followed by Tanks/ponds (1595 ha) and Reservoir/Barrage (670 ha). The seasonal reduction in open water spread is observed to be 18320 ha in post-monsoon got reduced to 14214 ha in pre-monsoon.

Area under aquatic vegetation is very less, around 112 ha during post-monsoon season and 509 ha during pre-monsoon. Qualitative turbidity of water is mainly moderate in post-monsoon and low to moderate in pre-monsoon season. Details of estimates of wetlands in Dantewada are given in Table 21.

Table 21: Area estimates of wetlands in Dantewada

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	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	10	22444	88.01	16598	12984
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	12	670	2.63	541	325
8	1202	Tanks/Ponds	225	1595	6.25	1181	905
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**247**	**24709**	**96.89**	**18320**	**14214**
		Wetlands (<2.25 ha), mainly Tanks	794	794	3.11	-	-
		Total	**1041**	**25503**	**100.00**	**18320**	**14214**

Area under Aquatic Vegetation	112	509

Area under turbidity levels		
Low	207	9254
Moderate	16991	4776
High	1122	184

State : Chhatisgarh

WETLAND MAP

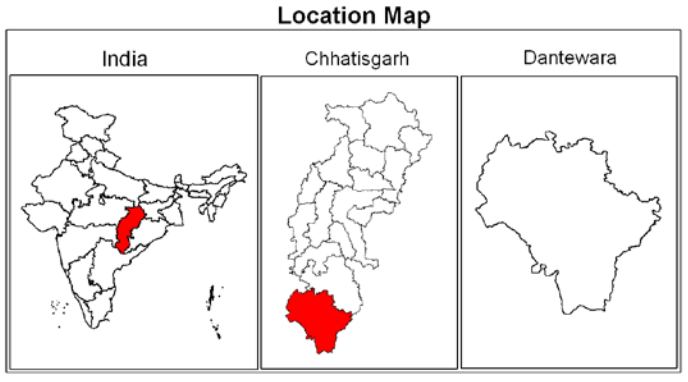
District : Dantewara

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

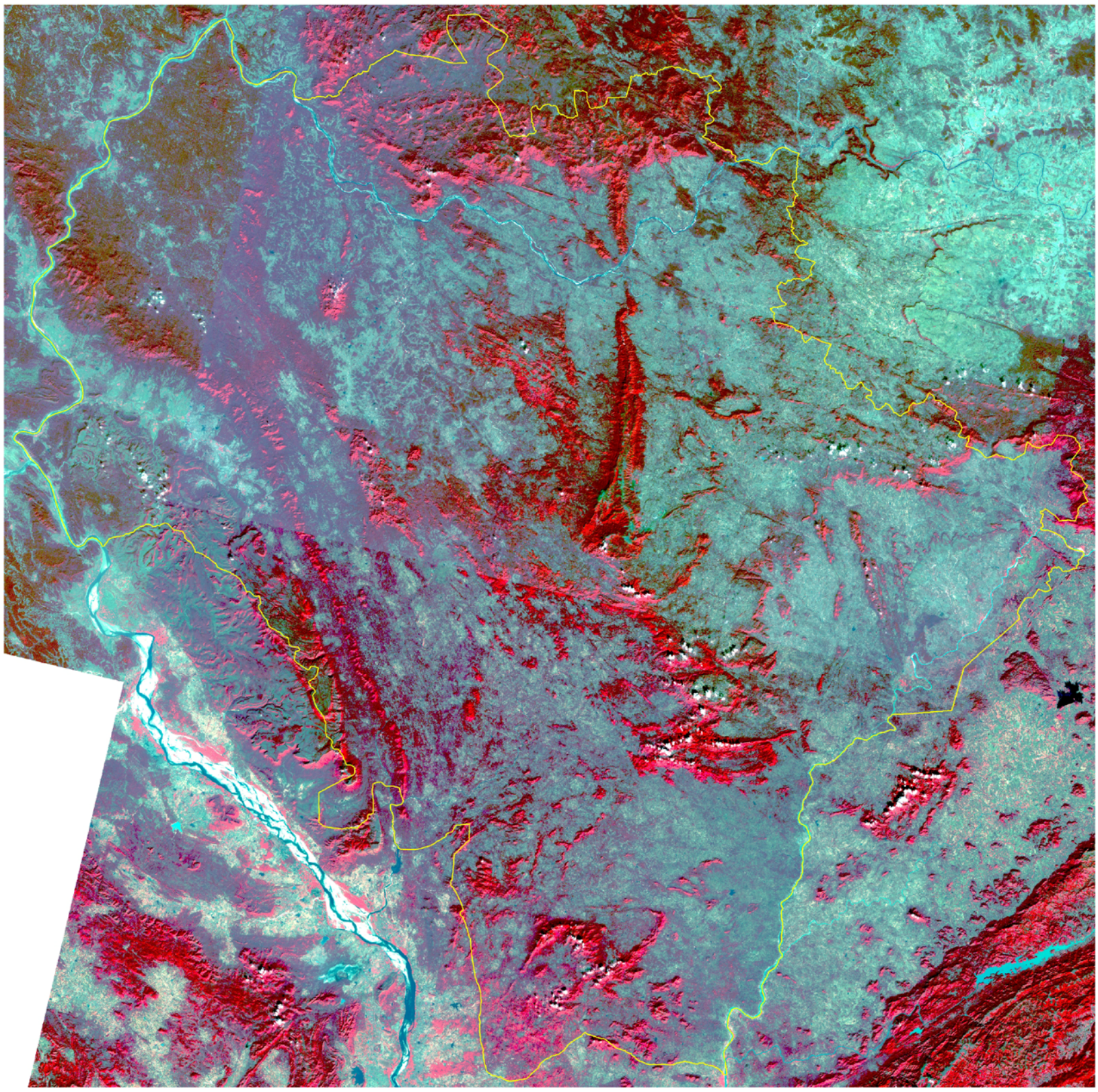
Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

District : Dantewara



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

MAJOR WETLAND TYPES

8.0 MAJOR WETLAND TYPES OF CHHATTISGARH

Major wetland types observed in the state are Rivers/Streams, Reservoir/Barrages, Tanks/Ponds and Waterlogged areas. Representative of some of these wetlands as seen on LISS-III imagery are given in Plates 1a and 1b. Ground truth data was collected for selected wetland sites. Field photographs are also taken to record the water quality (qualitative), aquatic vegetation. The location of the features was recorded using GPS. Field photographs of different wetland types are shown in Plates 2a and 2b.

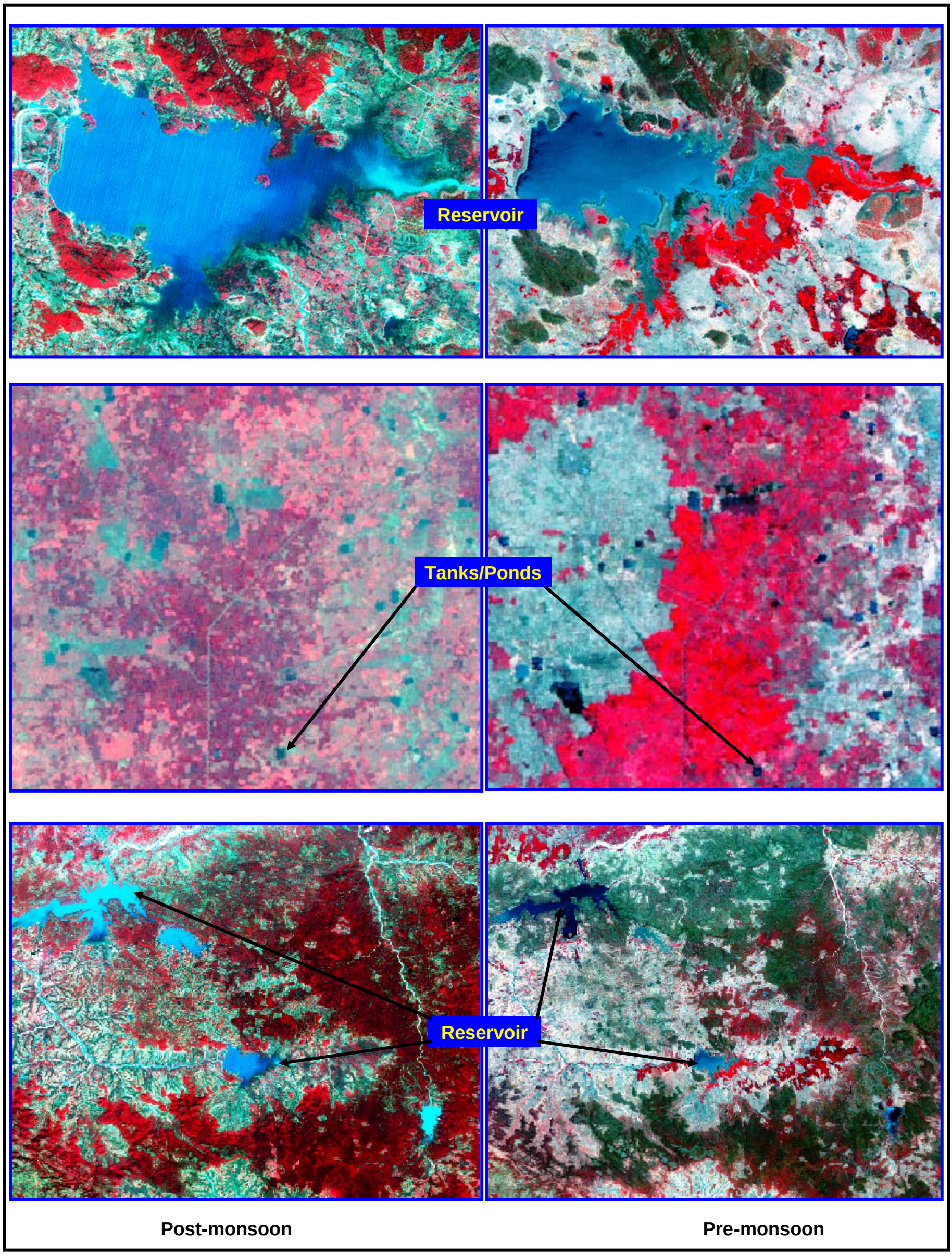


Plate – 1a: Wetland types of Chhattisgarh

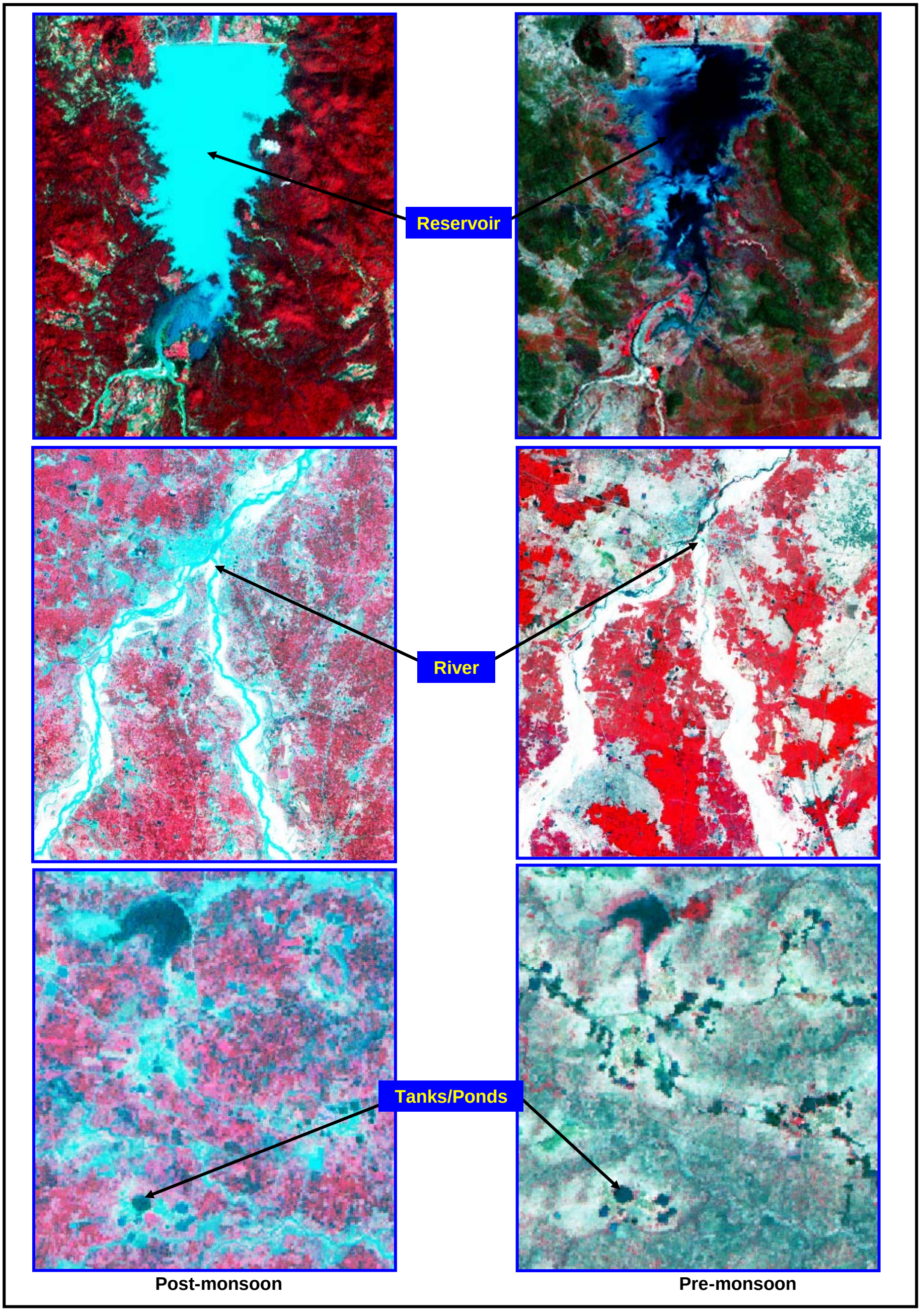


Plate – 1b: Wetland types of Chhattisgarh

Nehru Nagar Pond, Durg

Talpuri Lake, Durg

ACC Cements, Jamul and Environs

Mahasagar / Thagda lake, Durg (21.18N, 81.30E)

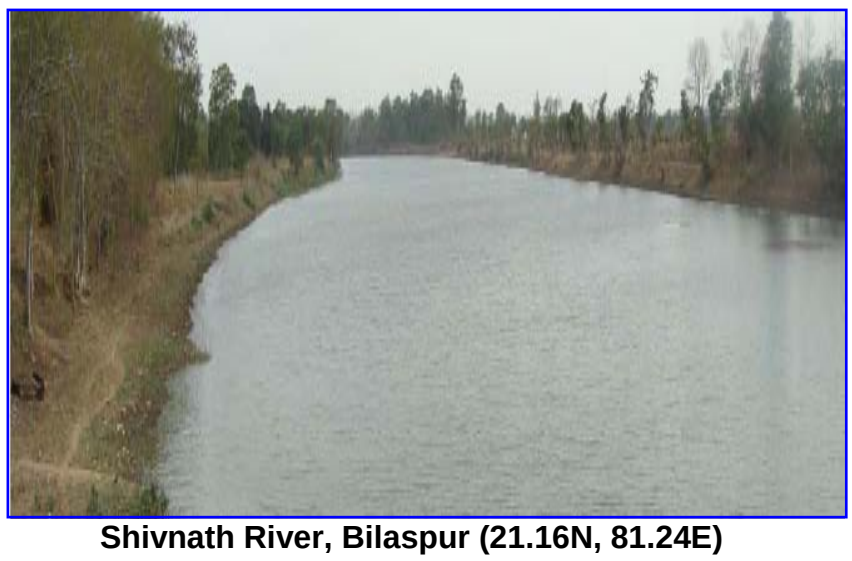
Plate 2a: Field photographs and ground truth data of different wetland types in Chhattisgarh

Borsi Road Pond, Durg (21.16N, 81.30E)

Maroda Tank, Durg (21.15N, 81.37E)

Talpuri Tank, Durg (21.17N, 81.30E)

Reclaimed mine ACC cements,(21 15 20N, 81 22 33E)



Shivnath River, Bilaspur (21.16N, 81.24E)

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

IMPORTANT WETLANDS OF CHHATTISGARH

9.0 IMPORTANT WETLANDS OF CHHATTISGARH

Ravishankar Sagar, Dudhawa Reservoir, Sondur Reservoir, Minimata Bango Reservoir and Tendulat Reservoir are some of the important Wetland areas of the Chhattisgarh state. Extensive field work was carried out for important wetland sites. Wetland maps have been prepared for 5km buffer area of each wetland sites. Details of each wetland and wetland map of 5 km buffer area are shown in Plates 3-12.

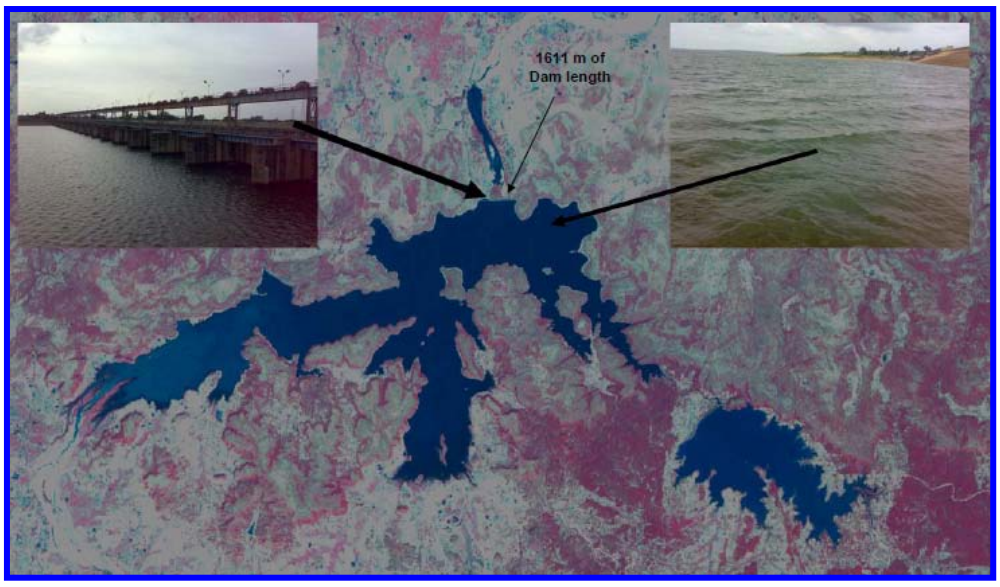
9.1 Ravishankar Sagar

Wetland Type: Reservoir

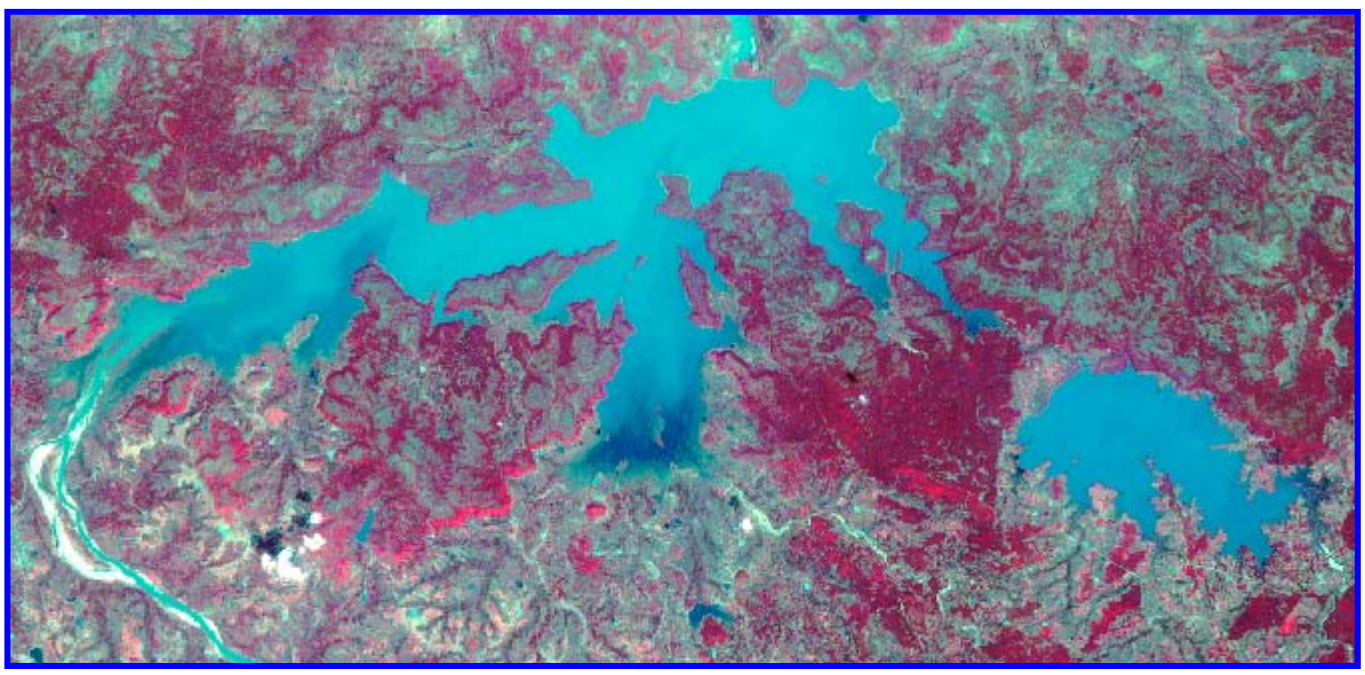
Name: Ravishankar Sagar

Location: 20° 38' N, 81° 34' E (central coordinates)

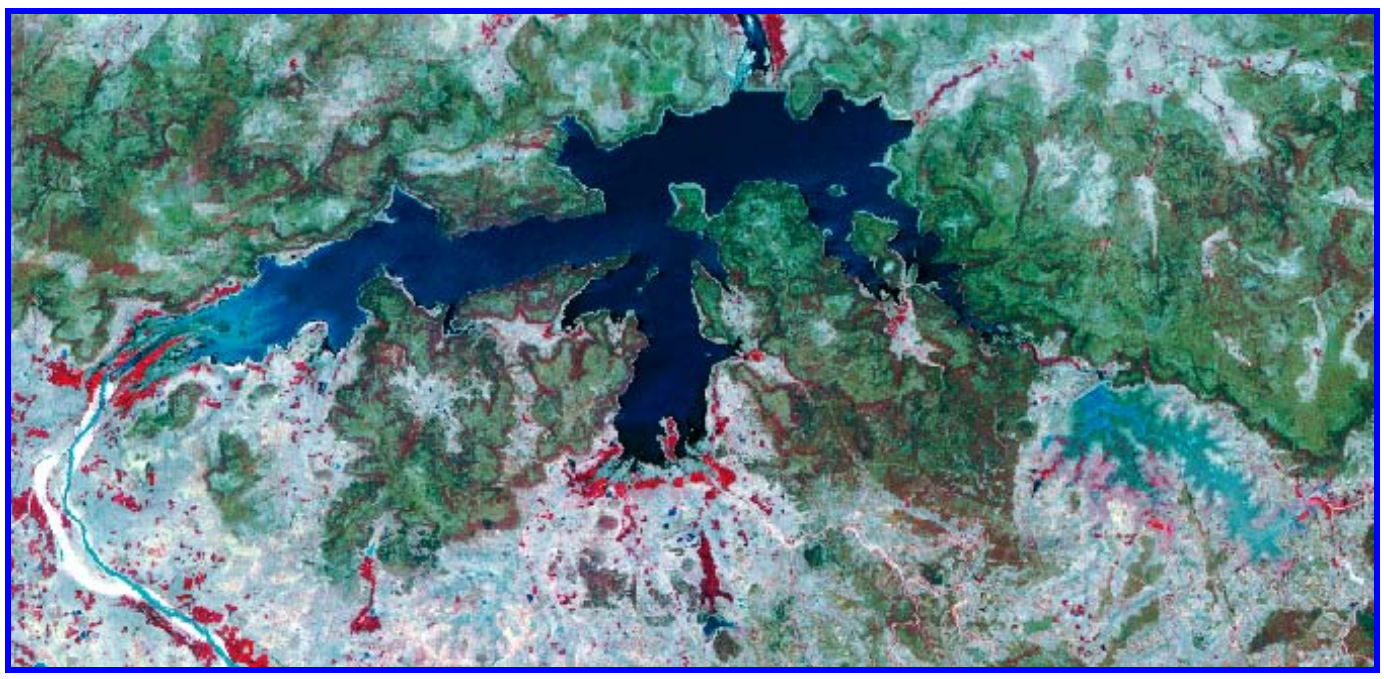
The Ravishankar Sagar project (RSP) dam was constructed in 1978 on the Mahanadi River. RSP is about 92 km south of the city of Raipur. It is a multi-purpose reservoir which serves irrigation, hydro-electric power-generation and the industrial requirements of the Bhilai Steel Plant. At the FRL of 348.7 m, the reservoir surface area is 95.40 km^2. The total catchment area is estimated at 3,620 km^2, of which 625 km^2 is intercepted by the upstream dam, Dudhawa and 486 km^2 by Murumsilli reservoir. At full level, the reservoir storage capacity is 909 Mm^3. The maximum depth of the reservoir is about 32 m. The off-taking channels carry water in the order of 11,000 to 30,000 cumec in the peak season. However, the outlets are rarely completely closed. Water level fluctuates by 3 to 5 m in a year. The sediments of Ravishankar Sagar are poor in nutrients and organic matter.



Ravishankar Sagar and surrounding area as seen in IRS LISS-III FCC



Post-monsoon (2006)

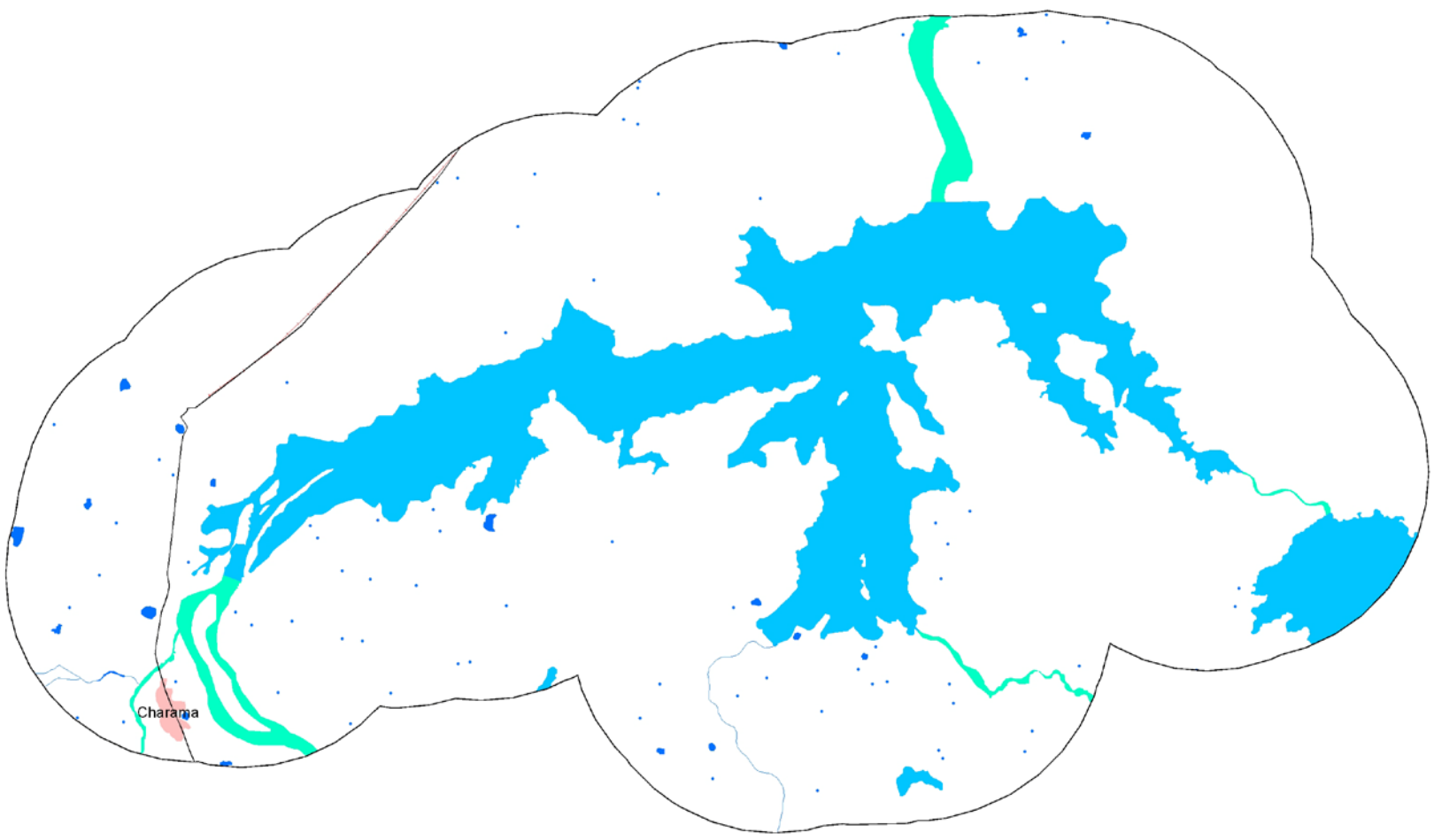


Pre-monsoon(2007)

State : Chhatisgarh

WETLAND MAP

Ravishankar Sagar

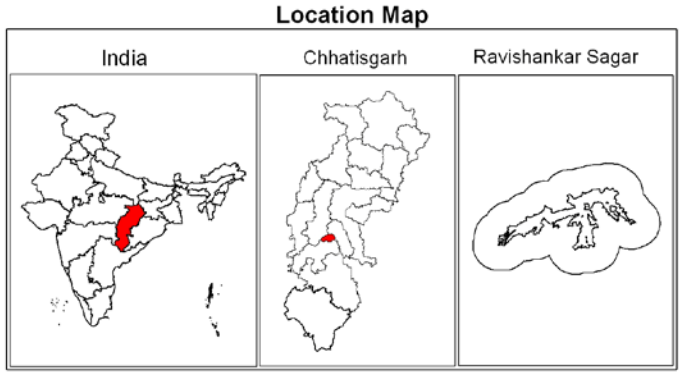


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- 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 :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

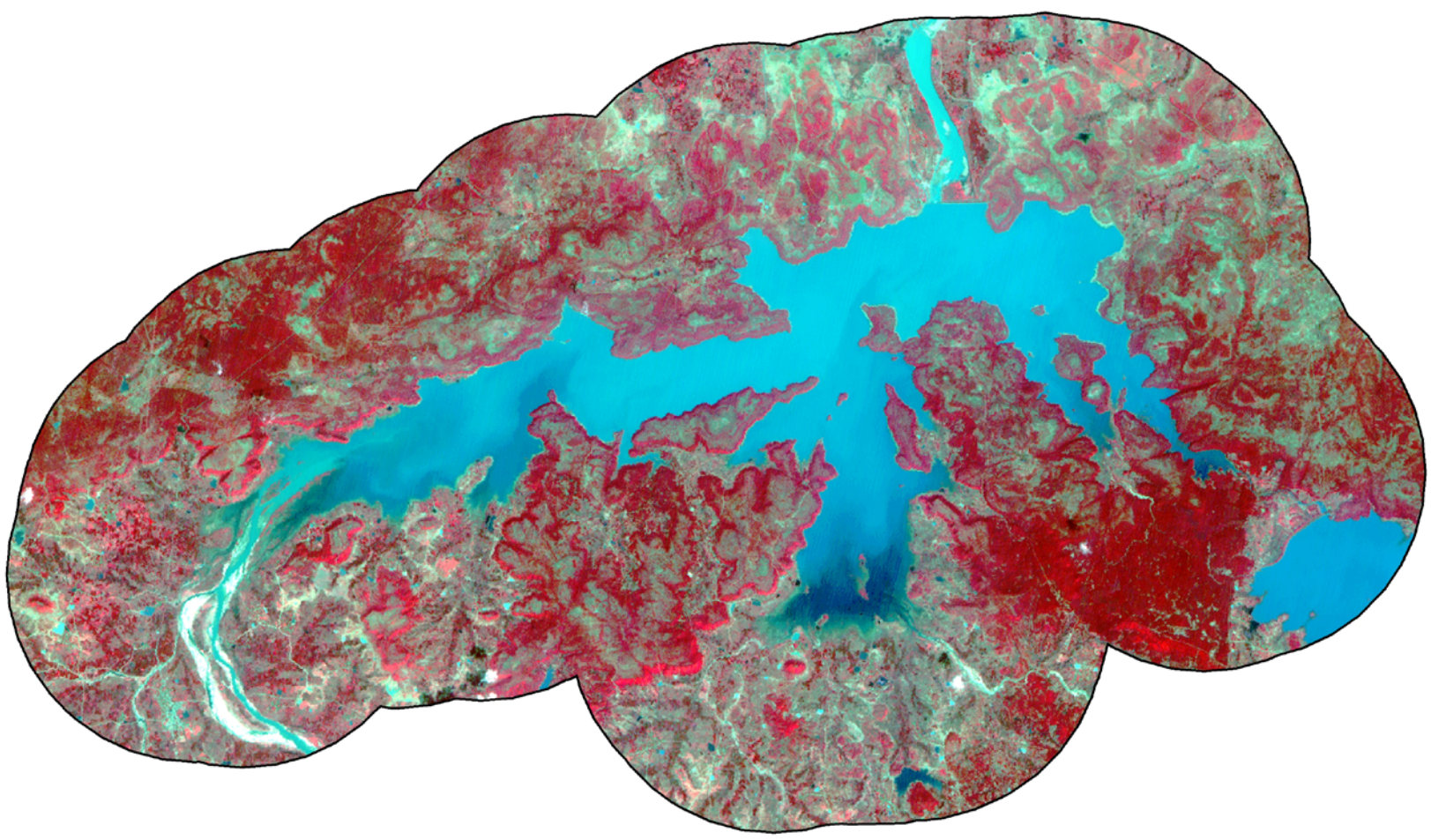
Sponsored By:

Ministry of Environment and Forests
Government of India

Plate 3 : Wetland map of 5 km buffer area of Ravishankar Sagar

State : Chhatisgarh

Ravishankar Sagar



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

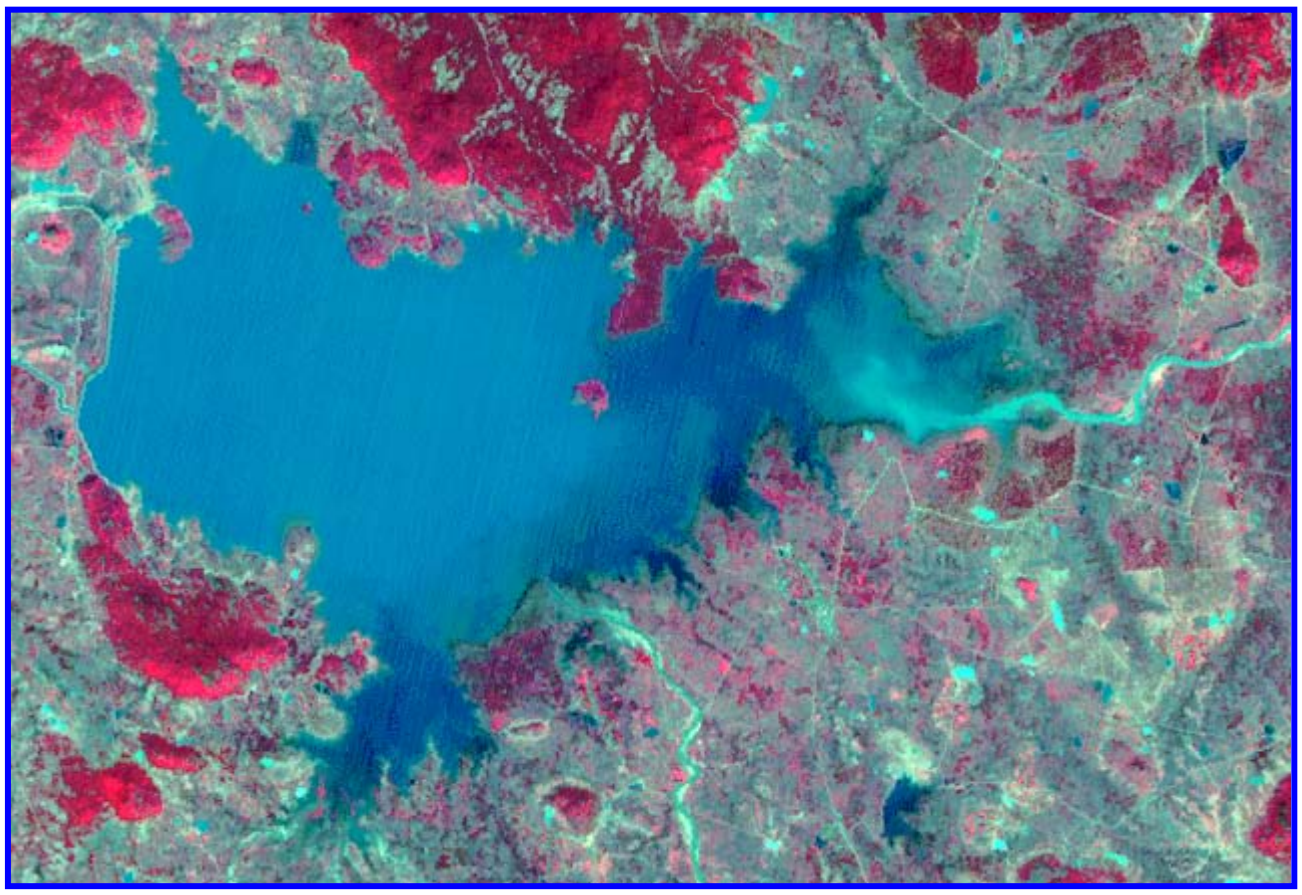
Plate 4 : IRS LISS III FCC - 5 km buffer area of Ravishankar Sagar

9.2 Dudhawa Reservoir

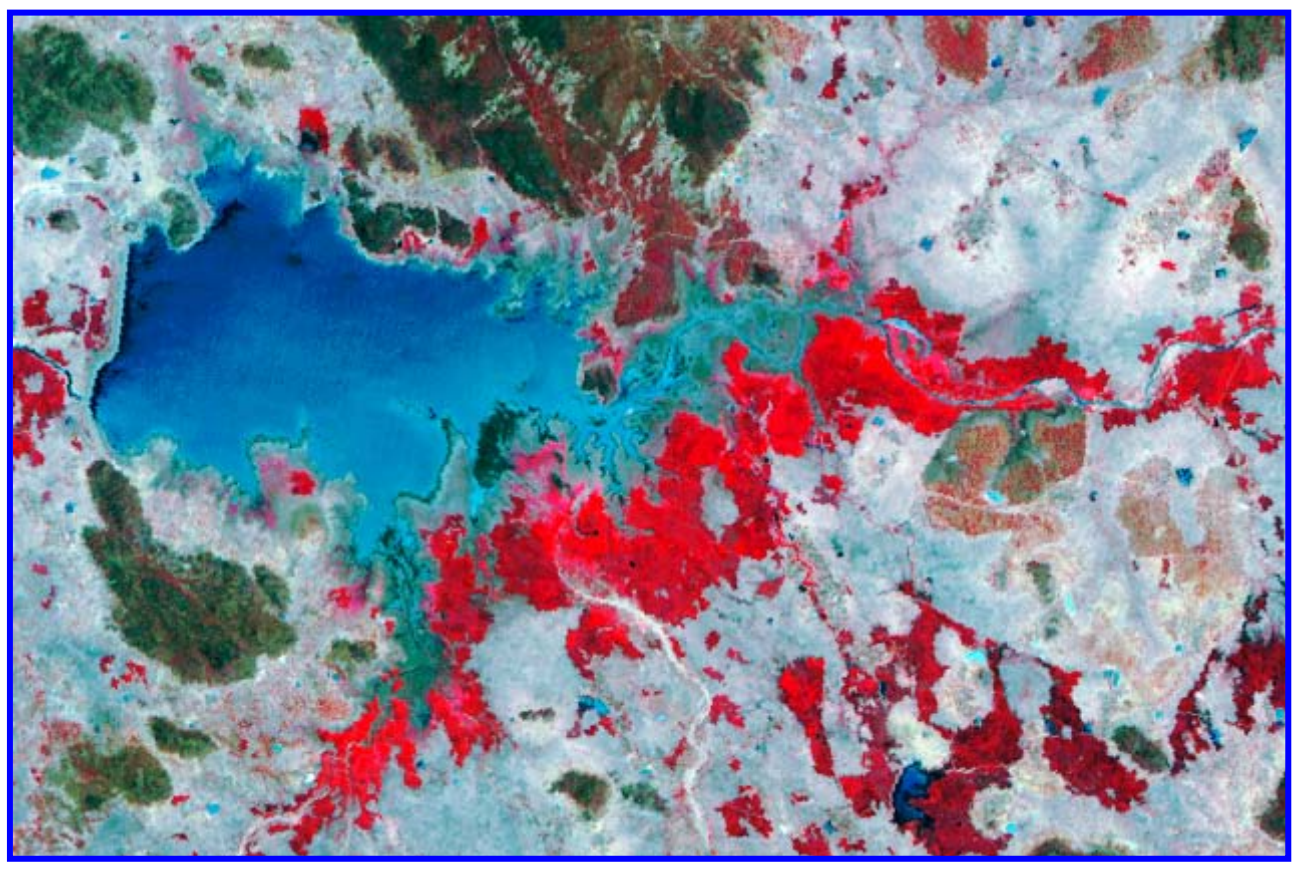
Wetland Type: Reservoir

Location: 81° 45' 21" E longitude and 20° 18' 1" N latitude

The Dudhawa reservoir is situated at 81° 45' 21" E longitude and 20° 18' 1" N latitude across Mahanadi River near Dudhawa village about 21 km west of Sihawa near the origin of Mahanadi river and 29 km east of Kanker. The reservoir is in Dhamtari district of Chhattisgarh state. The construction of the project started in 1953-54 and it was commissioned in 1963-64. This reservoir is designed to supply water to Ravishankar Sagar Project complex thereby increasing its irrigation potential. Water will also be provided to additional culturable areas under the command of the existing Mahanadi Tandula canal system. The maximum height of this earthen dam is 24.53 m and length is 2,906.43 m. Two subsidiary bunds of the dam have heights of 6.61 m and 2.83 m and lengths 568.42 and 426.70 m, respectively. The catchment area of the reservoir is 625.27 km^2 and gross command area is 566.80 km^2. At the Full Reservoir Level (FRL), the submergence area of the reservoir is 44.80 km^2.



Dudhawa Reservoir as seen in IRS LISS-III FCC of Post-monsoon (2006)

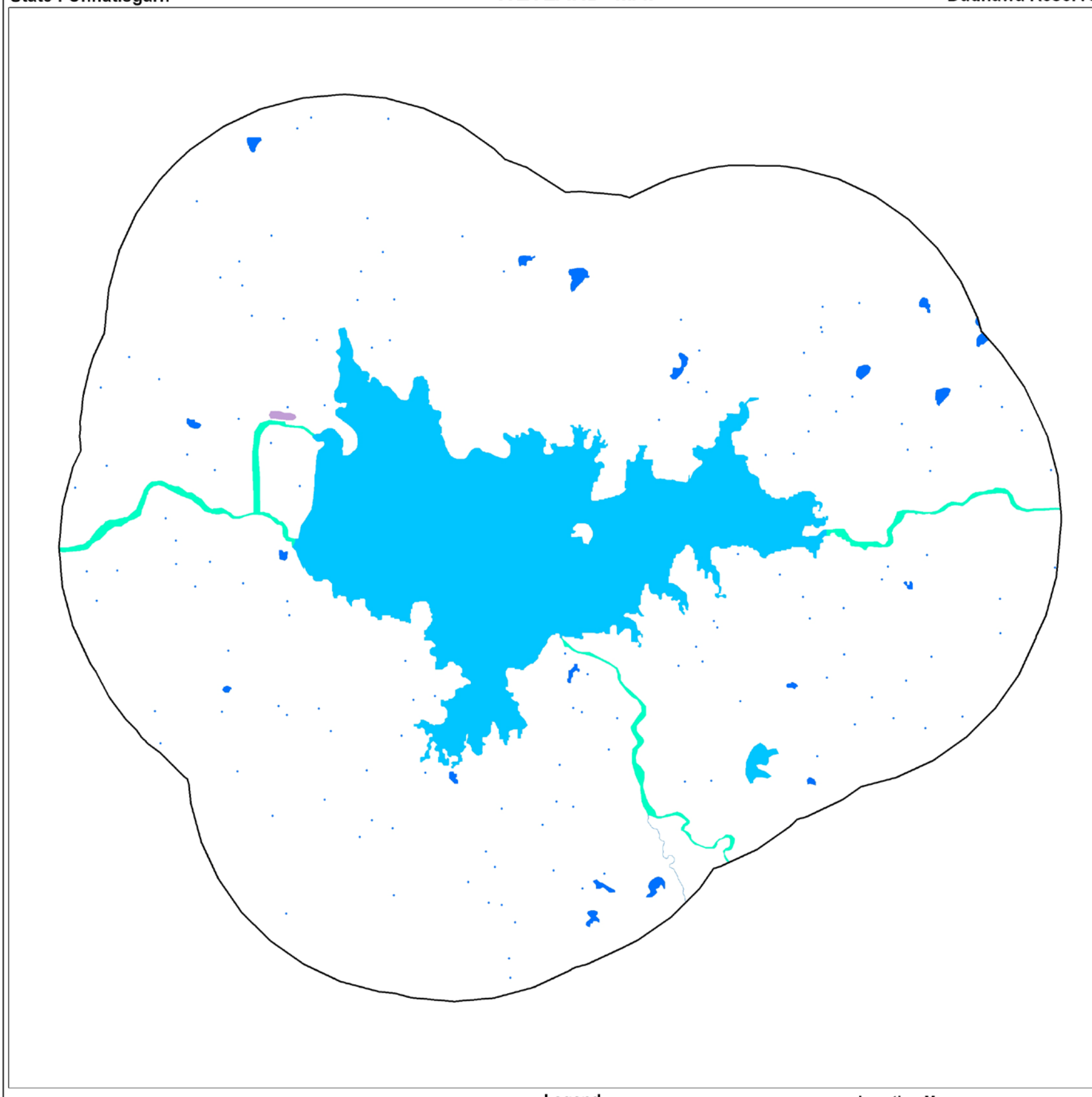


Dudhawa Reservoir as seen in IRS LISS-III FCC of Pre-monsoon (2007)

State : Chhatisgarh

WETLAND MAP

Dudhawa Reservoir

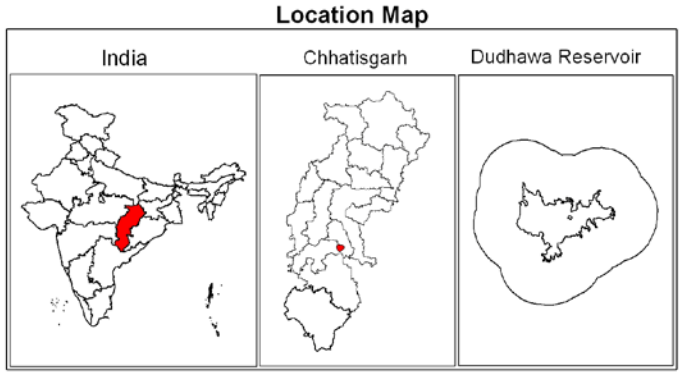


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- 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 :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

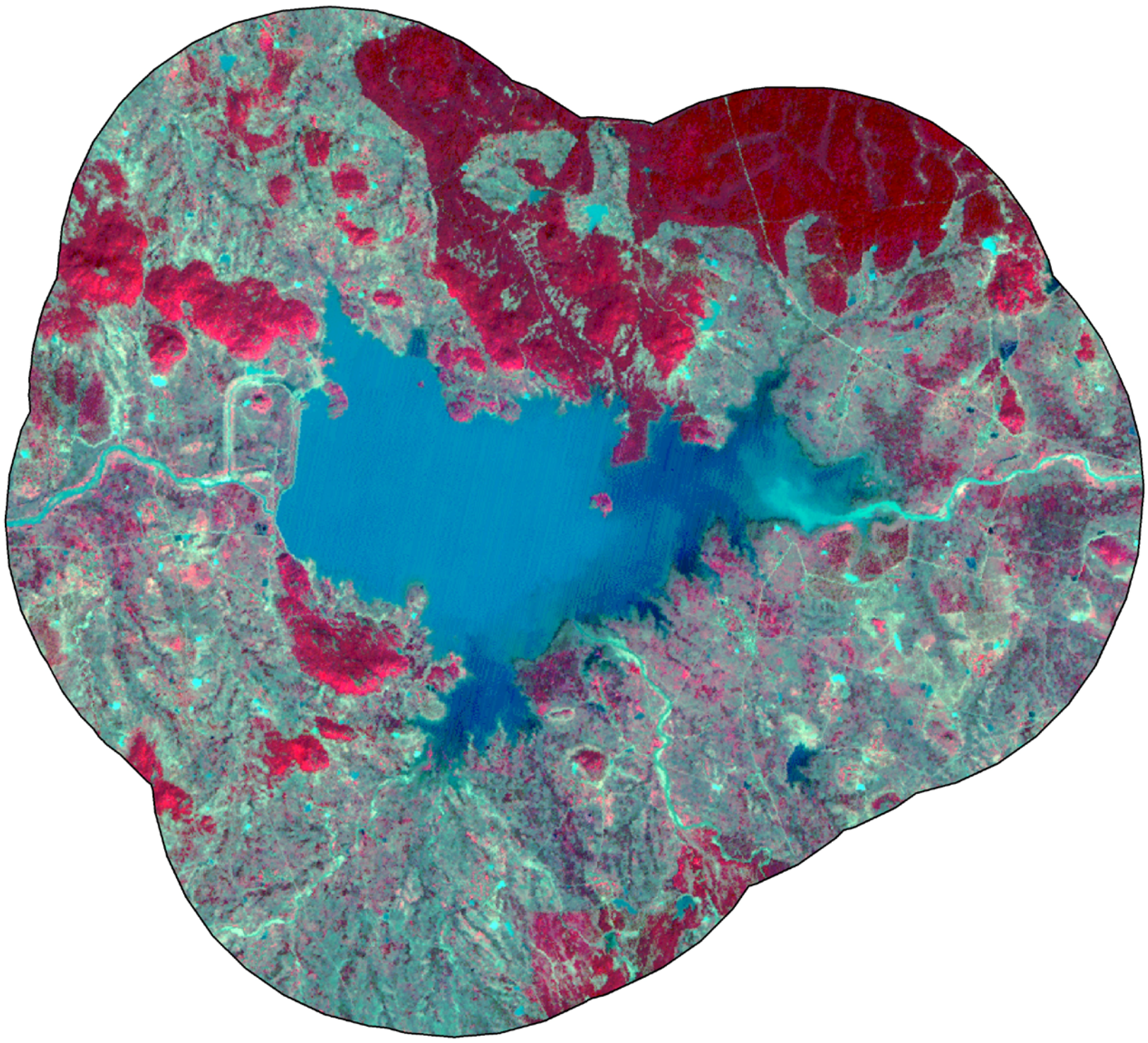
Sponsored By:

Ministry of Environment and Forests
Government of India

Plate 5 : Wetland map of 5 km buffer area of Dudhawa Reservoir

State : Chhatisgarh

Dudhawa Reservoir



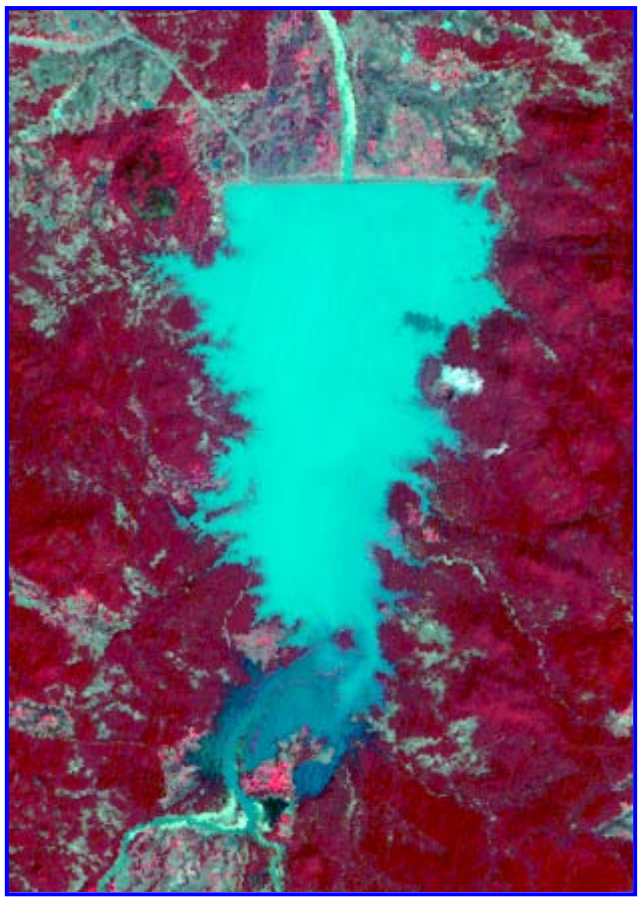
IRS P6 LISS-III Post-monsoon data (2006).

Plate 6 : IRS LISS III FCC - 5 km buffer area of Dudhawa Reservoir

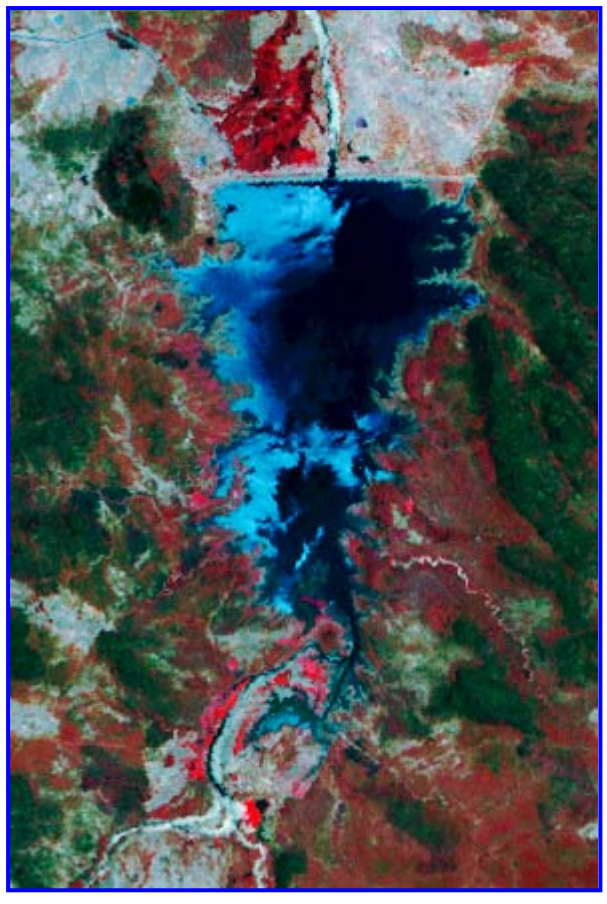
9.3 Sondur Reservoir

Wetland Type: Reservoir
Location: 82° 6' E longitude and 20° 14' N latitude

The Sondur reservoir is constructed at 82° 6' E longitude and 20° 14' N latitude across Sondur River a tributary of Mahanadi. Located near Gram Machka, Nagri block, Dhamtari district of Chhattisgarh state, the dam was constructed in the year 1988. The catchment area of Sondur River up to the dam site is 518 km^2. Major portion of the catchment lies in Dhamtari district of Chhattisgarh and Koraput district of Orissa state. Sondur project comprises of a 3.33 km long composite dam. This consists of a 191.25m long masonry dam at the center which includes overflow and non overflow portions; the rest is earthen dam at both the flanks. Irrigation sluice is provided at the left flank.



Post-monsoon(2006)



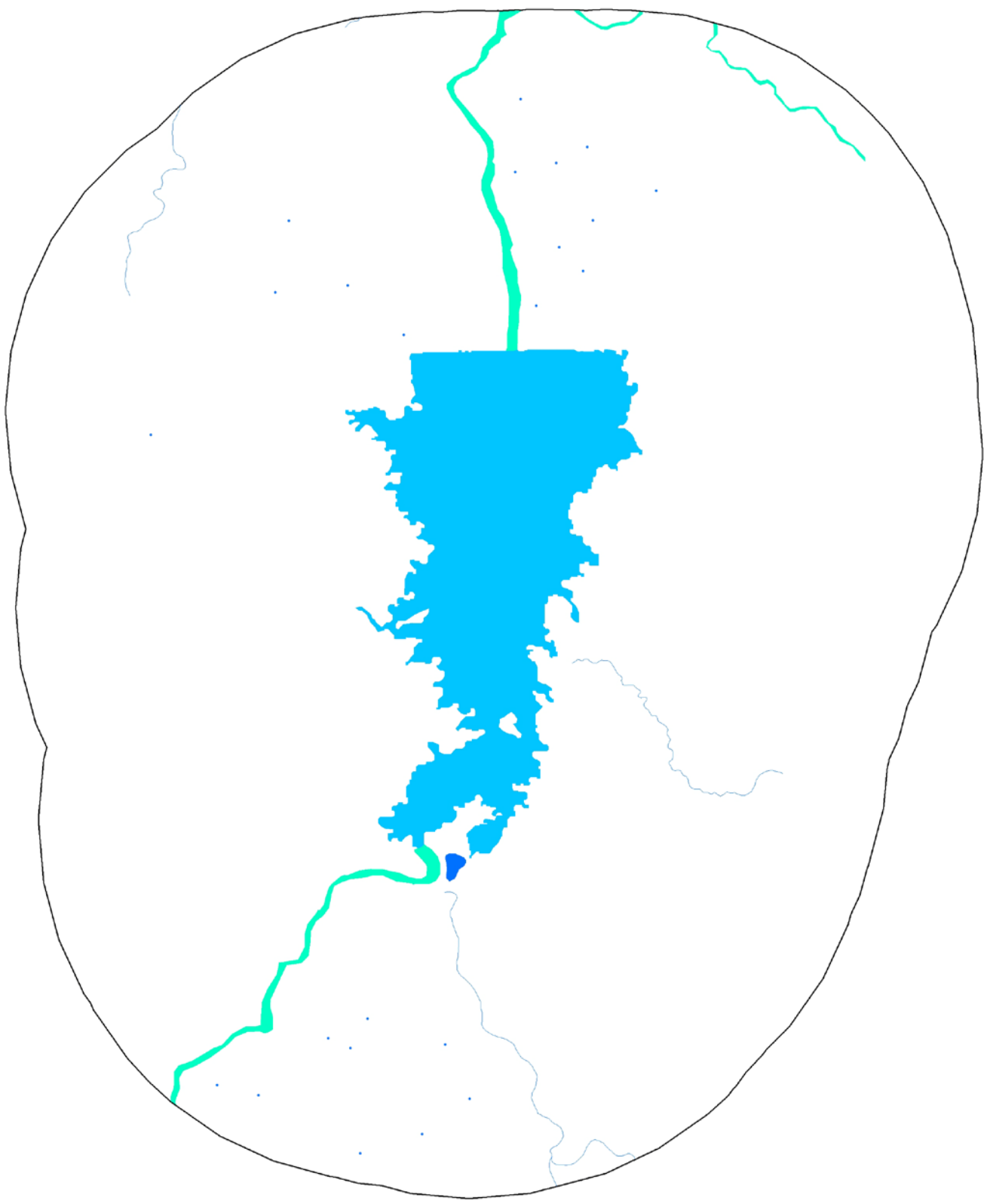
Pre-monsoon (2007)

Sondur Reservoir

State : Chhatisgarh

WETLAND MAP

Sondur Reservoir

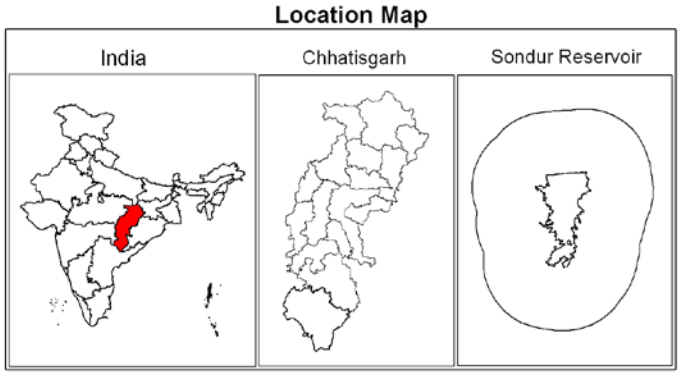


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



2 1 0 2 4 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

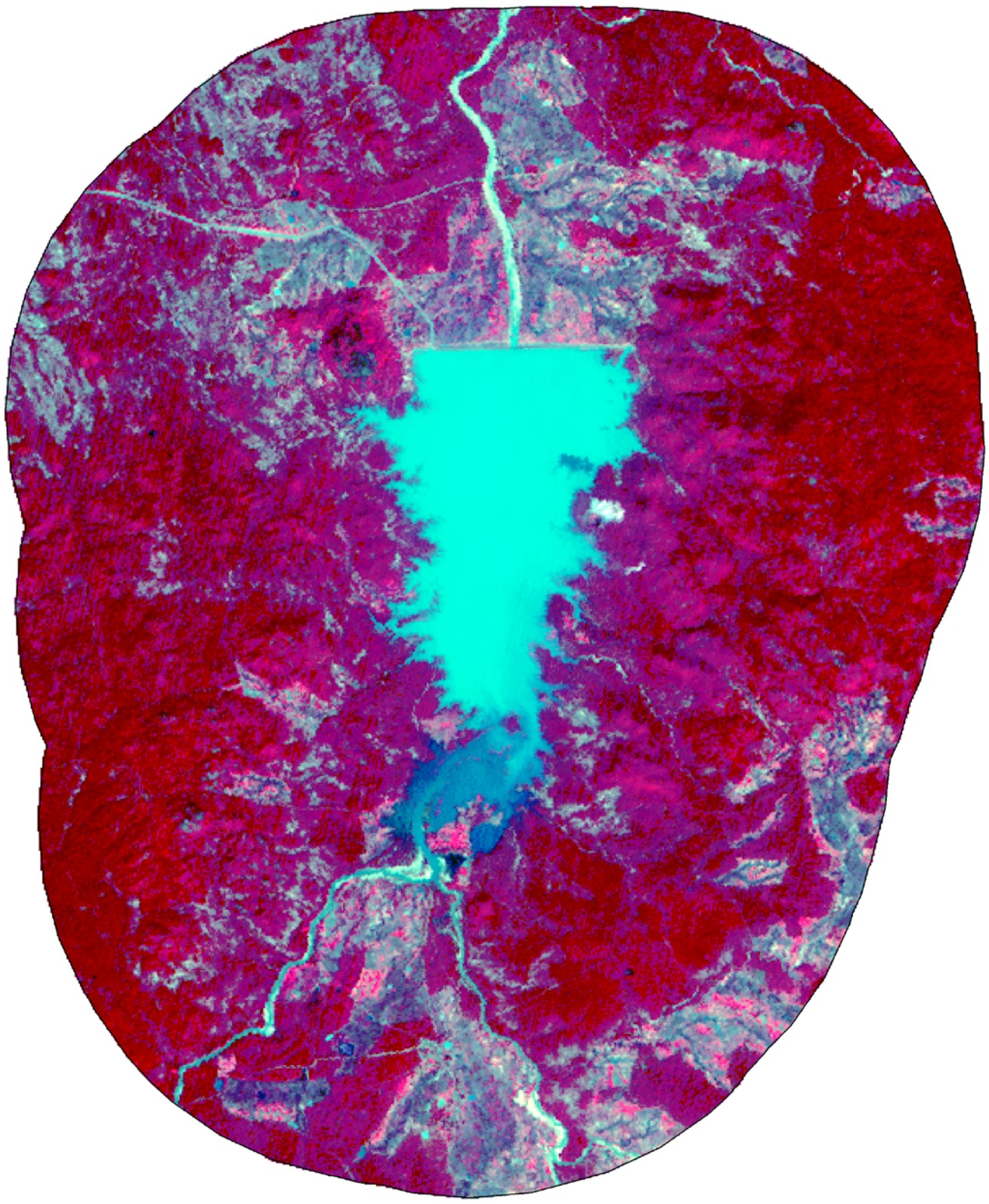
Sponsored By:

Ministry of Environment and Forests
Government of India

Plate 7 : Wetland map of 5 km buffer area of Sondur Reservoir

State : Chhatisgarh

Sondur Reservoir



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

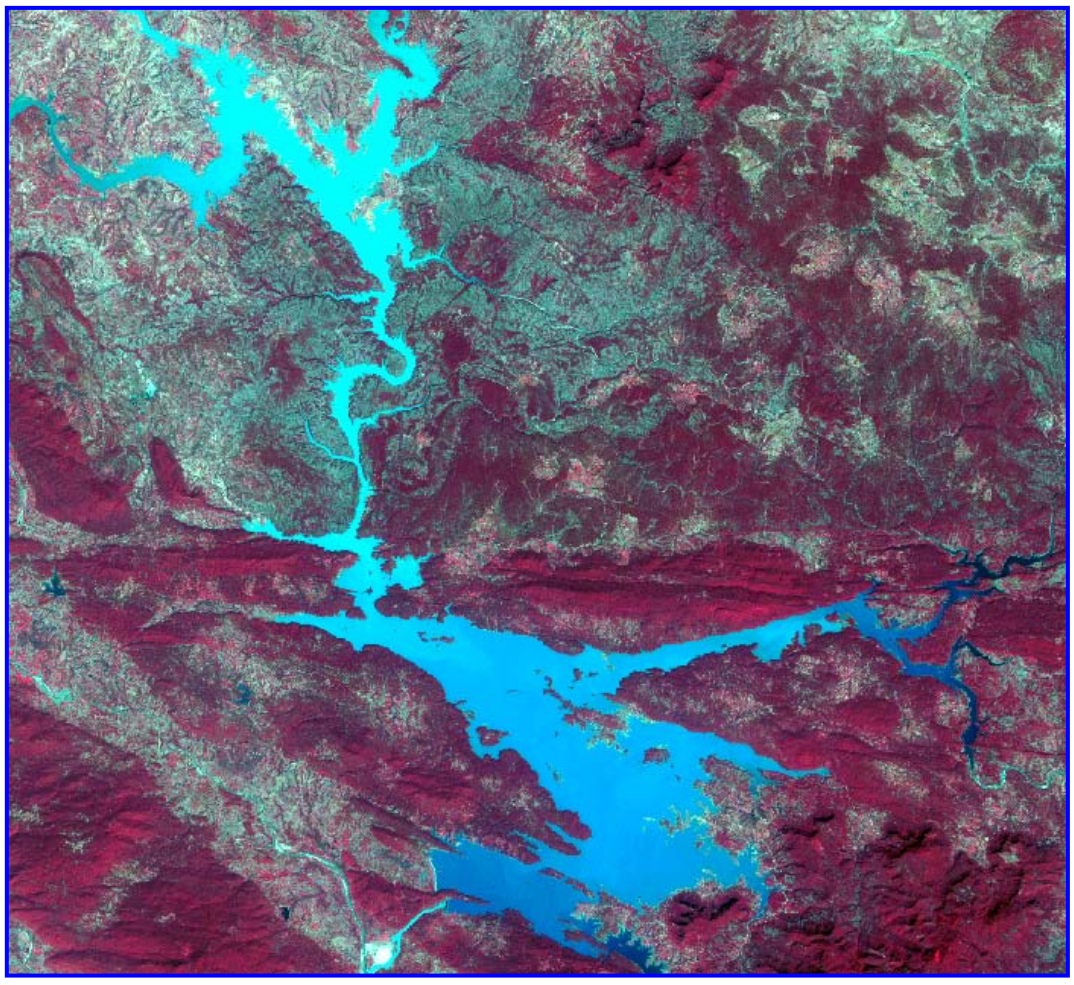
Plate 8 : IRS LISS III FCC - 5 km buffer area of Sondur Reservoir

9.4 Minimata Bango Reservoir

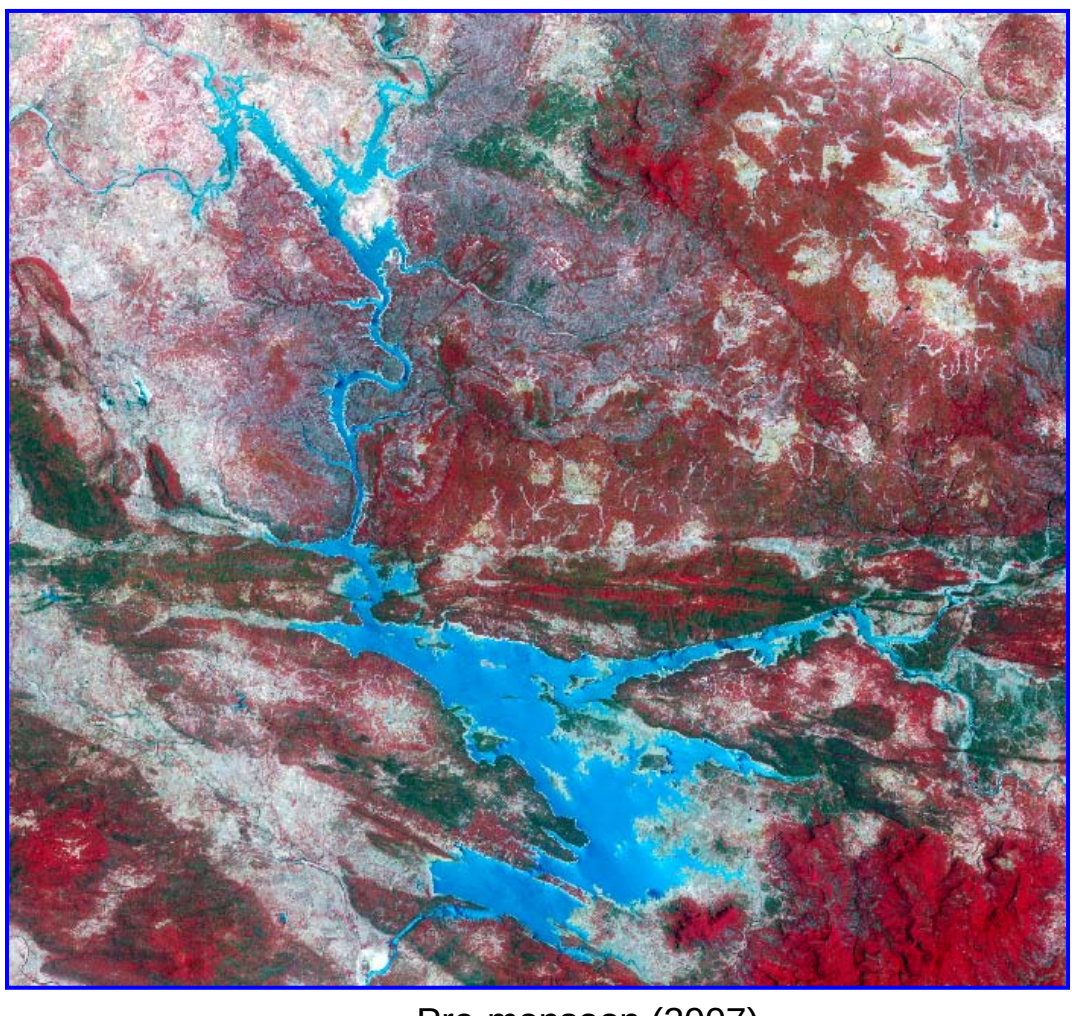
Wetland Type: Reservoir

Location: 82° 37' 7" E 22° 41' 00" N (central coordinates)

Minimata Bango is a multipurpose storage reservoir on Hasdeo River, tributary of Mahanadi River, 70 km from Korba, in Korba District, Chhattisgarh. The catchment area at the dam is 6,730 km^2. The masonry gravity dam is 87 m high. The FRL and the MDDL of the reservoir are 359.66 m and 329.79 m and it has a live storage capacity of 3,040 MCM. Mean annual inflow to the reservoir is 3,540 MCM. The power house has 3 units of 40 MW each and a firm power of 20 MW.



Post-monsoon (2006)



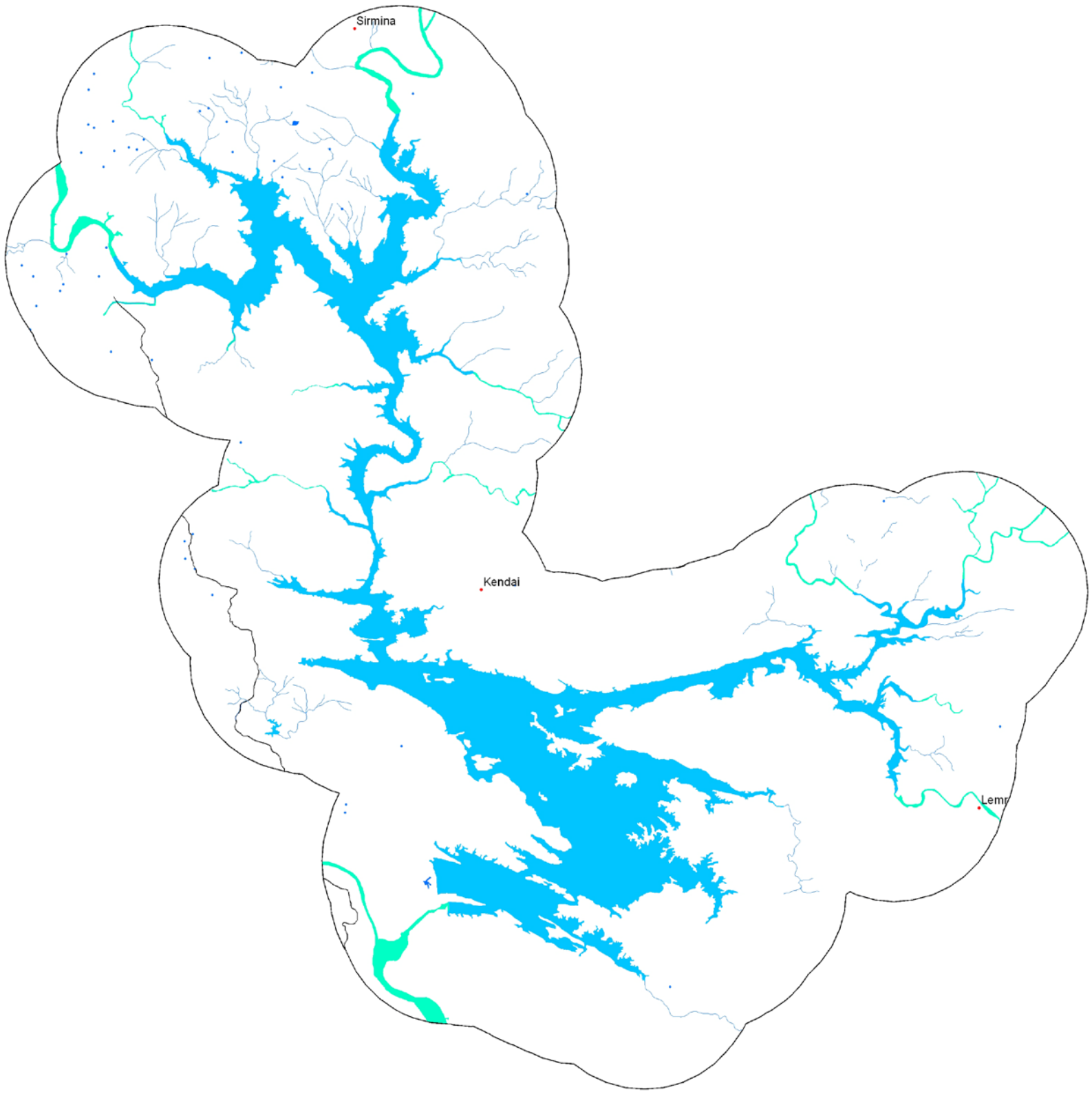
Pre-monsoon (2007)

Minimata Bango Reservoir as seen in IRS LISS-III FCC

State : Chhatisgarh

WETLAND MAP

Minimata Bango Reservoir

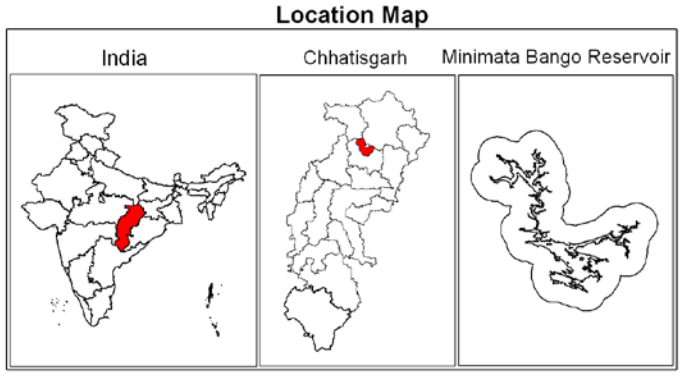


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- 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 :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

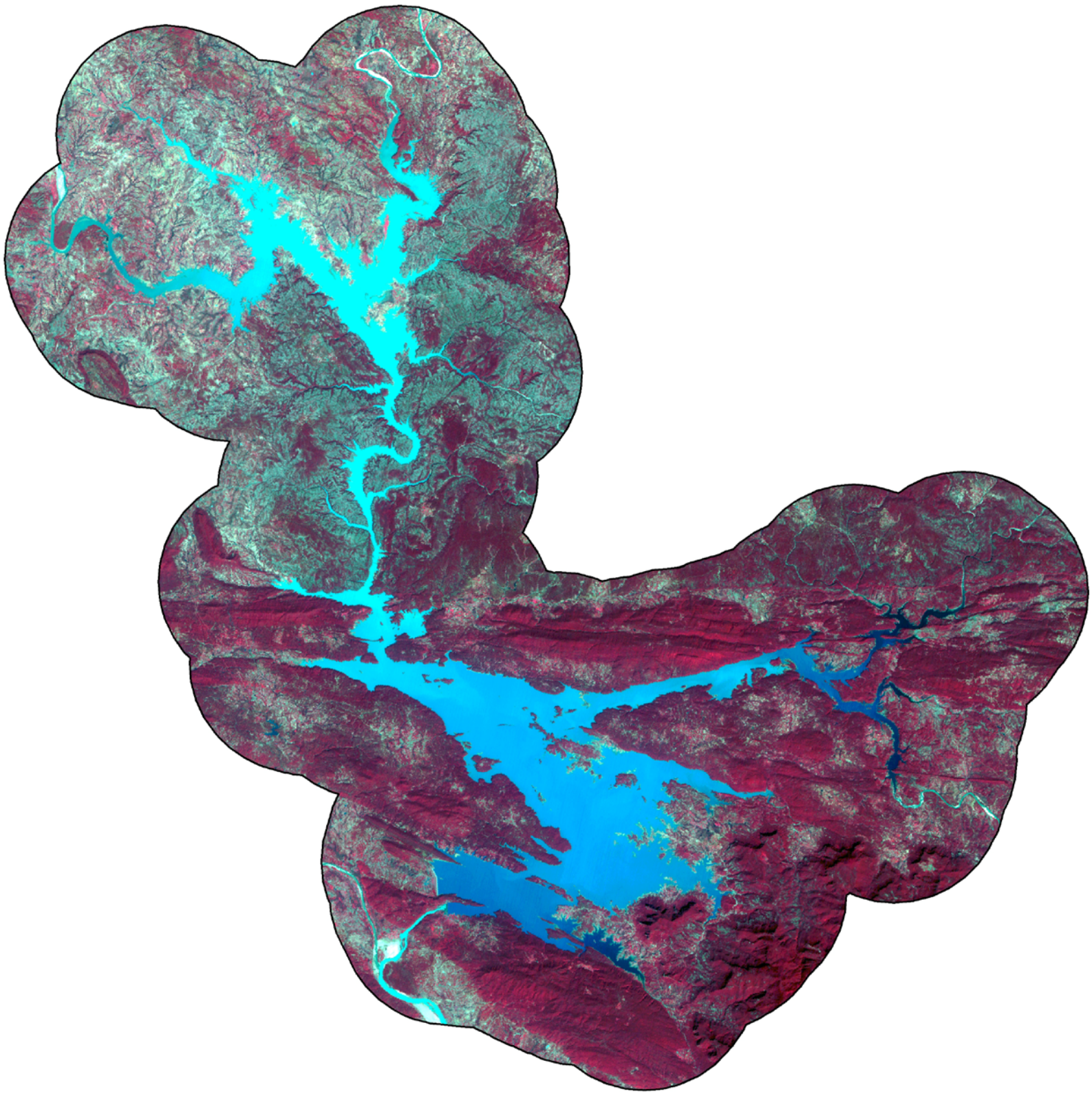
Sponsored By:

Ministry of Environment and Forests
Government of India

Plate 9 : Wetland map of 5 km buffer area of Minimata Bango Reservoir

State : Chhatisgarh

Minimata Bango Reservoir



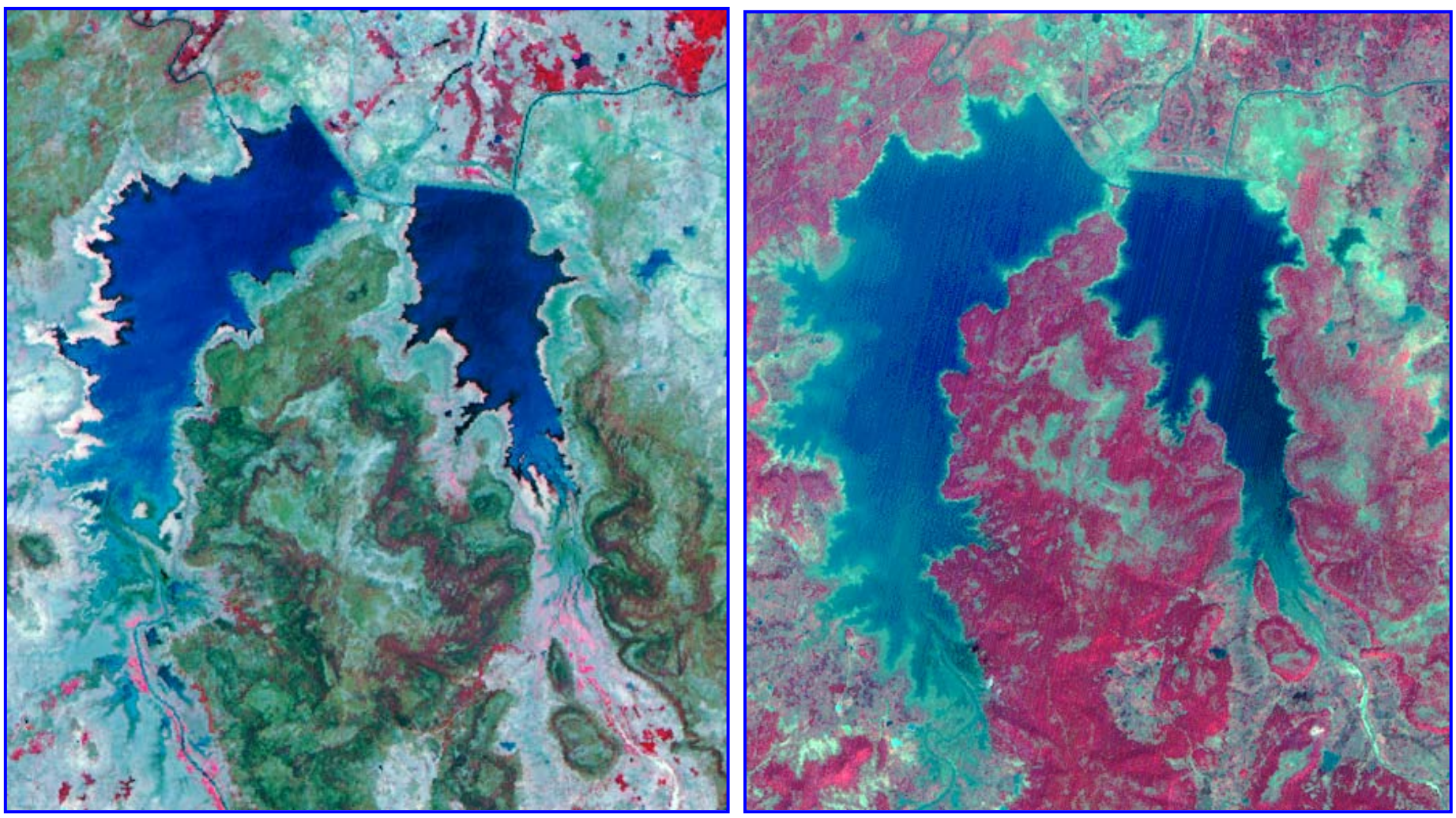
IRS P6 LISS-III Post-monsoon data (2006).

Plate 10 : IRS LISS III FCC - 5 km buffer area of Minimat Bango Reservoir

9.5 Tendulat Reservoir

Wetland Type: Reservoir
Location: 20º 41’ 24” N, 81º 10’ 26”E (central coordinates)

This is an important project of Chhattisgarh state. The dam is located in Balod tehsil of Durg district at about 5 km from the Balod city. A dam was completed on the confluence of Sukha Nala and Tandula River in 1921, with a catchment area of 827.2 sq. km. The gross, live, and dead storage capacities of the reservoir are 312.25 MCM, 302.28 MCM and 99.67 MCM respectively. For the reservoir, the highest flood level, the FRL, and MDDL are 333.415 m, 332.19 m, and 320.445 m. A canal takes off from the dam to provide irrigation to 68,219 ha of Kharif crop. Main canal and distributaries run for about 110 km and the length of minors is 880 km. The monsoon rainfall in the command is about 1,293 mm. In the 1950s, it was realized that the Tandula reservoir is unable to meet the demands of the command and hence a reservoir, named Gondali reservoir, was created on Jujhara Nala in 1957 and a supplementary canal of 9 km length was constructed to supply water from Gondali reservoir to Tandula reservoir. After construction of Bhilai Steel Plant in 1956, water is being supplied to this plant from the Gondali reservoir and supply for irrigation has been stopped.



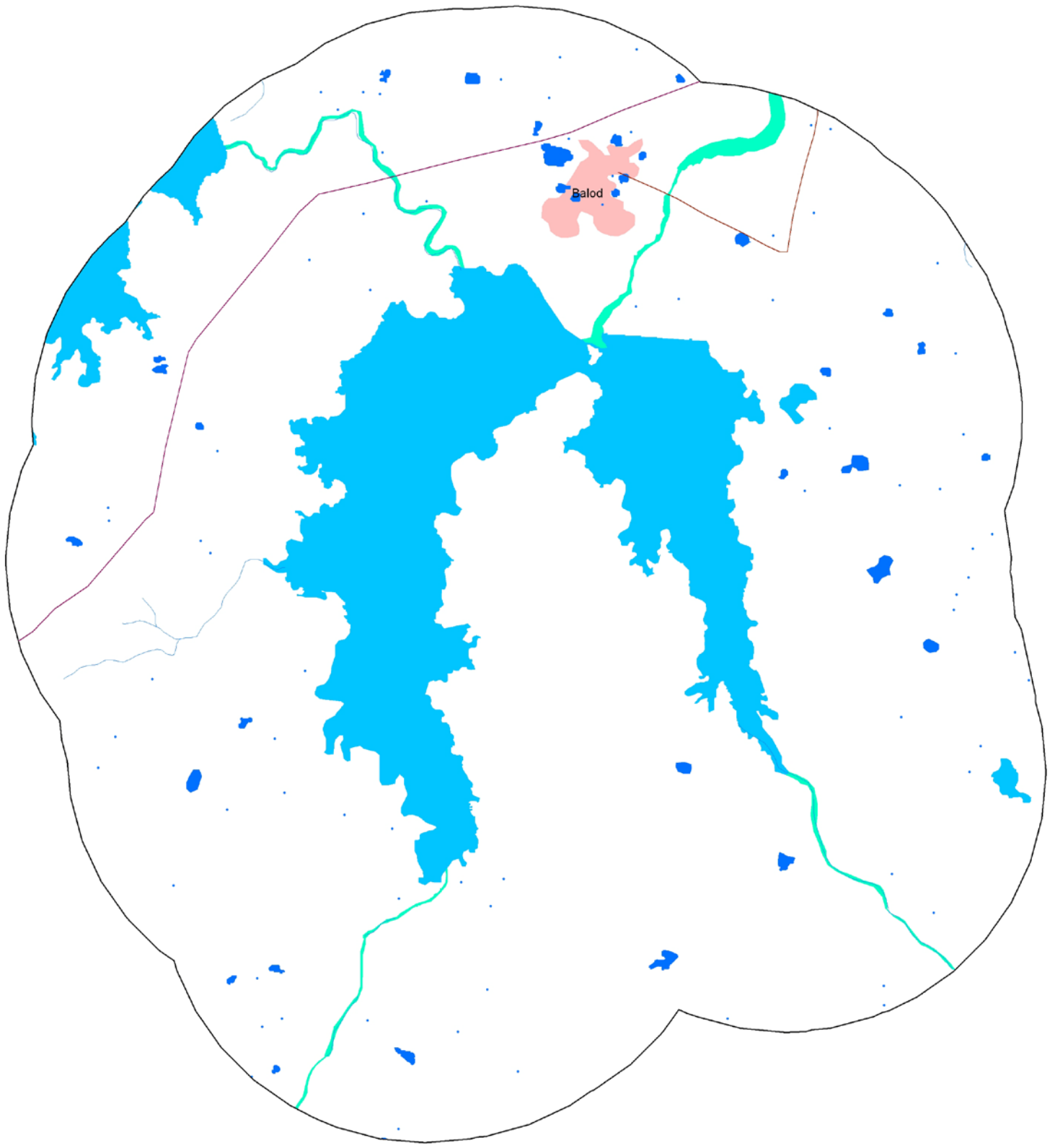
Post-monsoon (2006) Pre-monsoon(2007)

Tendulat Reservoir as seen in IRS LISS-III FCC

State : Chhatisgarh

WETLAND MAP

Tendulat Reservoir

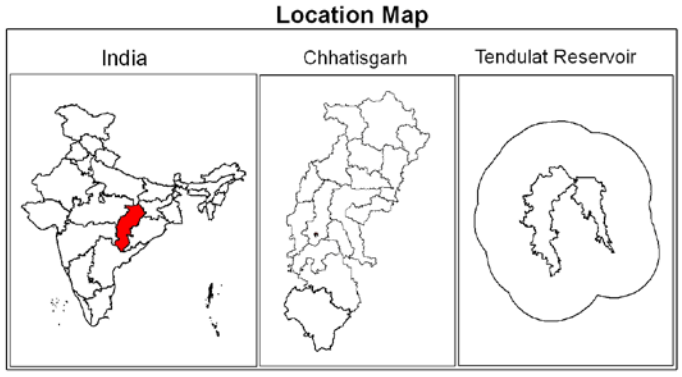


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 (<2.25ha)
- Drainage (line)
- Major Roads
- Railway
- Settlements
- 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 :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

Plate 11 : Wetland map of 5 km buffer area of Tendulat Reservoir

State : Chhatisgarh

Tendulat Reservoir

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

Plate 12 : IRS LISS III FCC - 5 km buffer area of Tendulat Reservoir

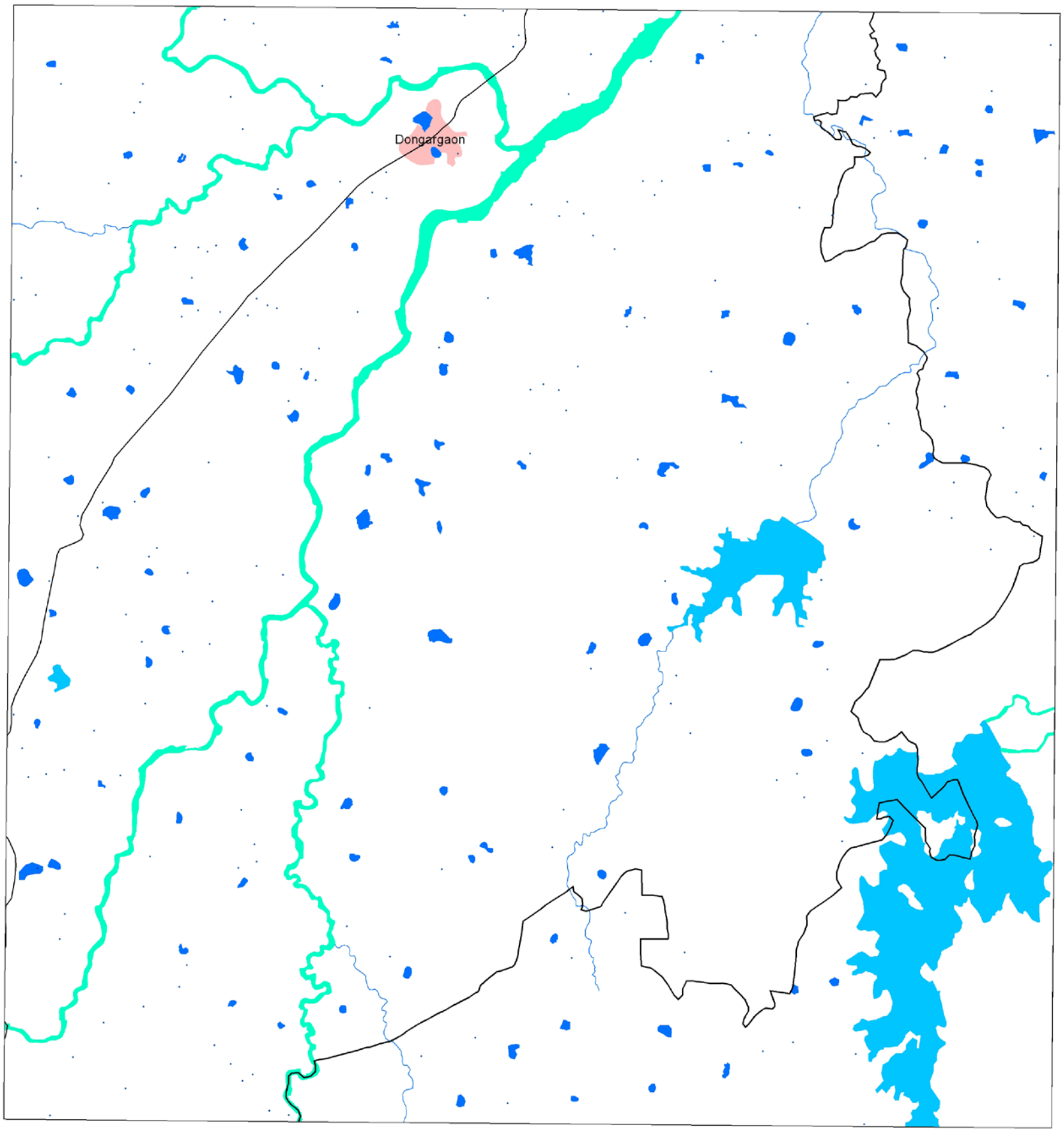
SOI MAP SHEET-WISE WETLAND MAPS

(Selected)

State : Chhatisgarh

WETLAND MAP

Map No. : 64D/13

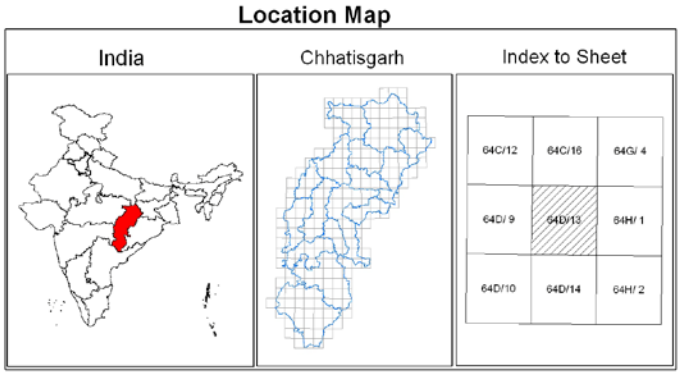


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

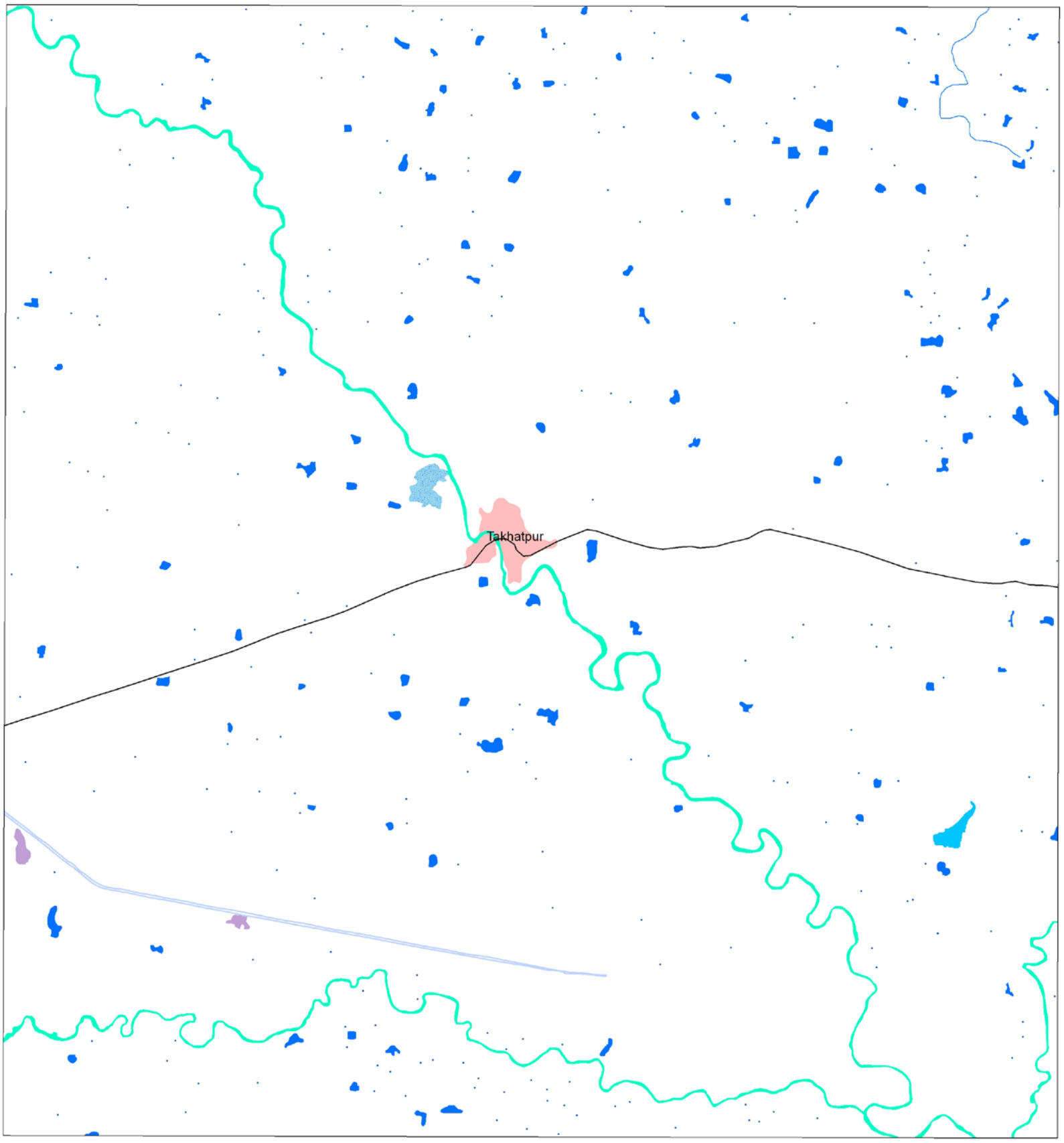
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64F/16

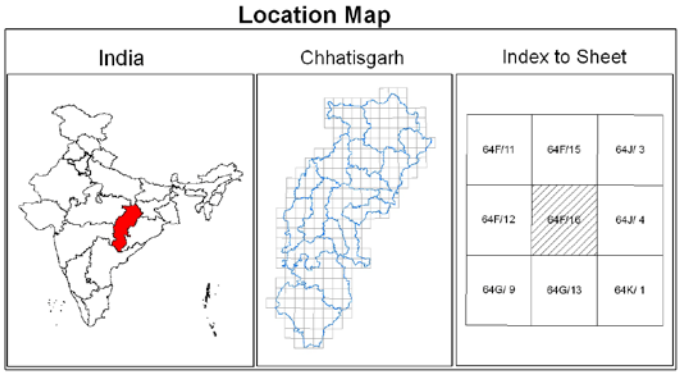


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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



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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National Remote Sensing Centre, Hyderabad

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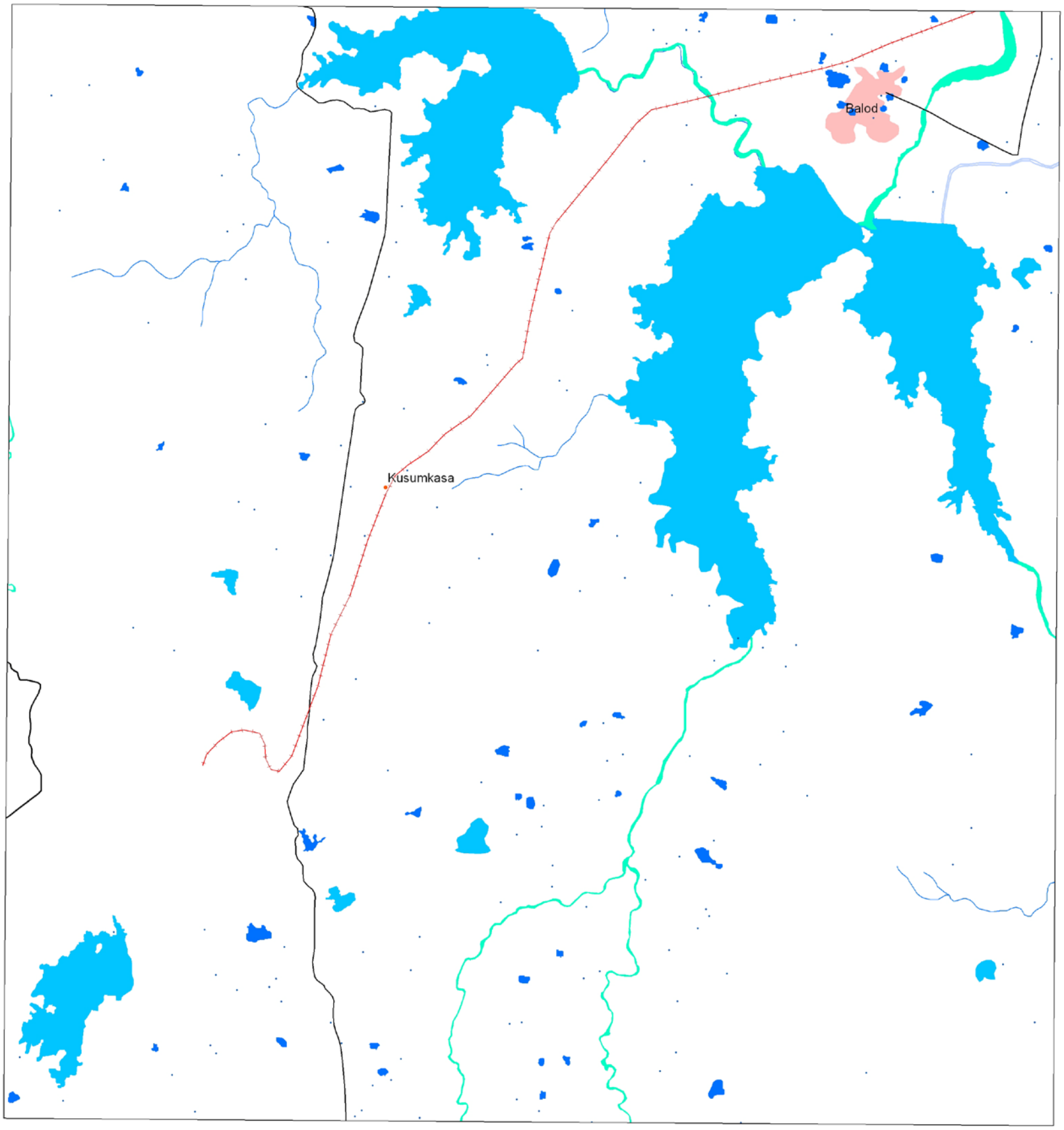
Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64H/02



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
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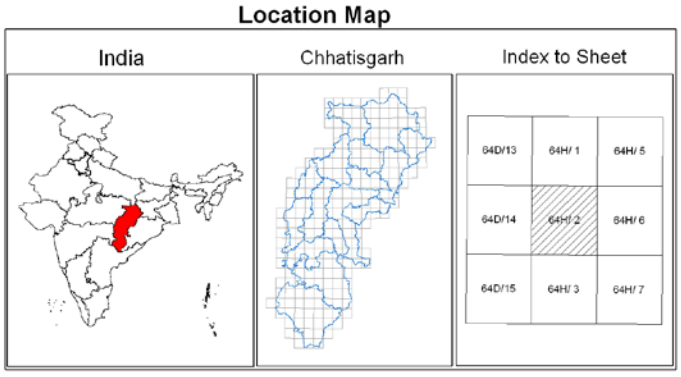
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

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

Location Map



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

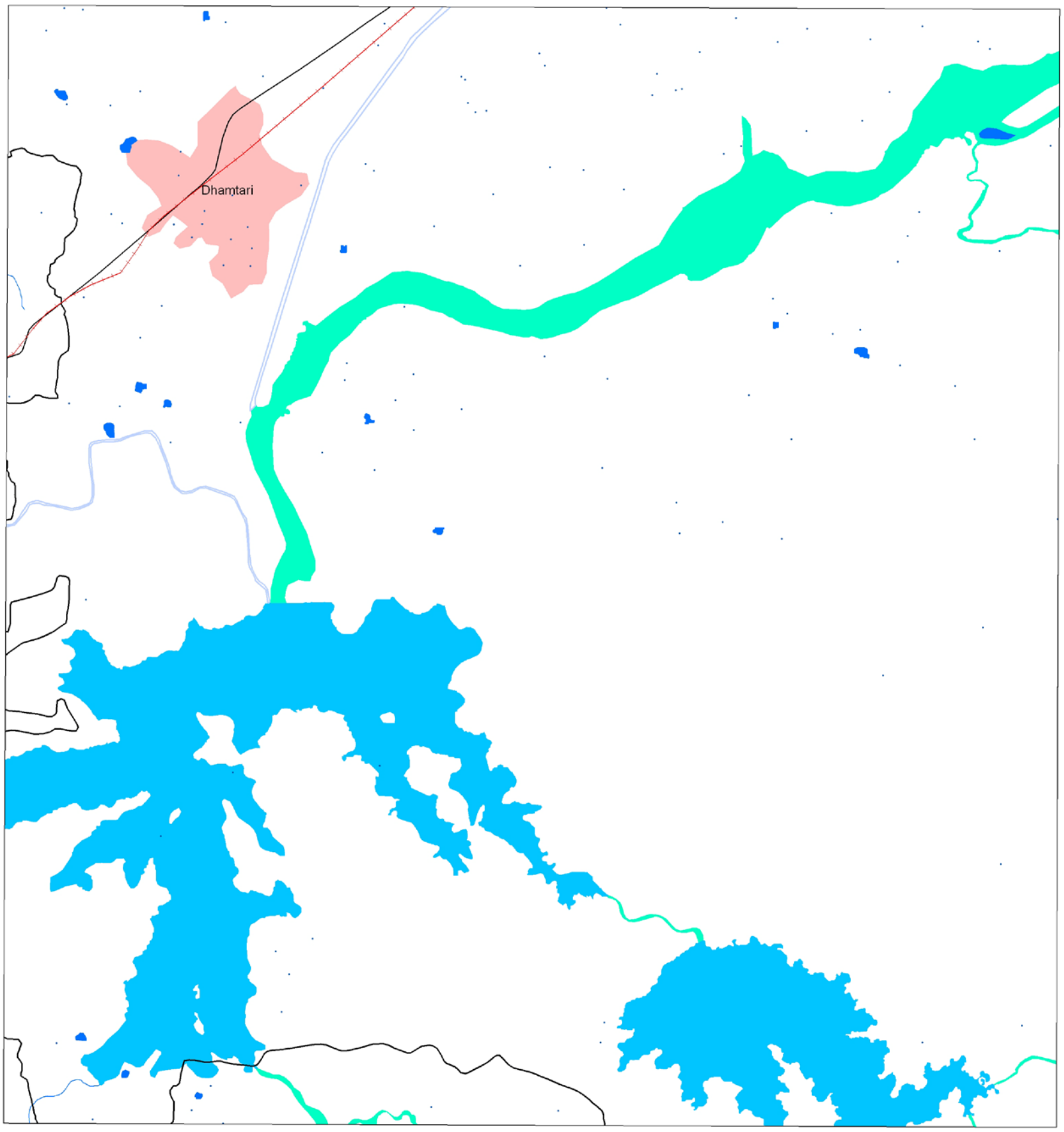
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64H/10



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
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		Coastal Wetlands		
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	2101			Lagoons
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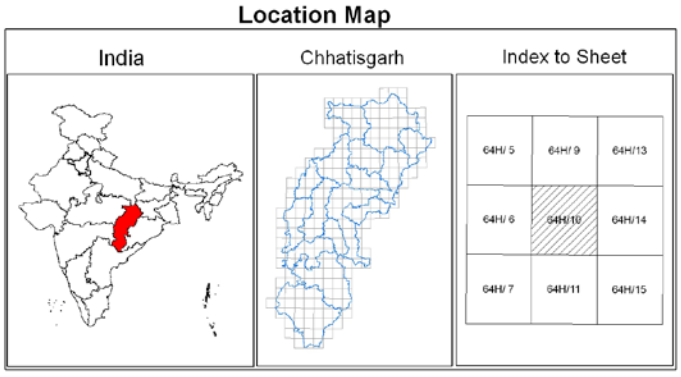
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

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

Location Map



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

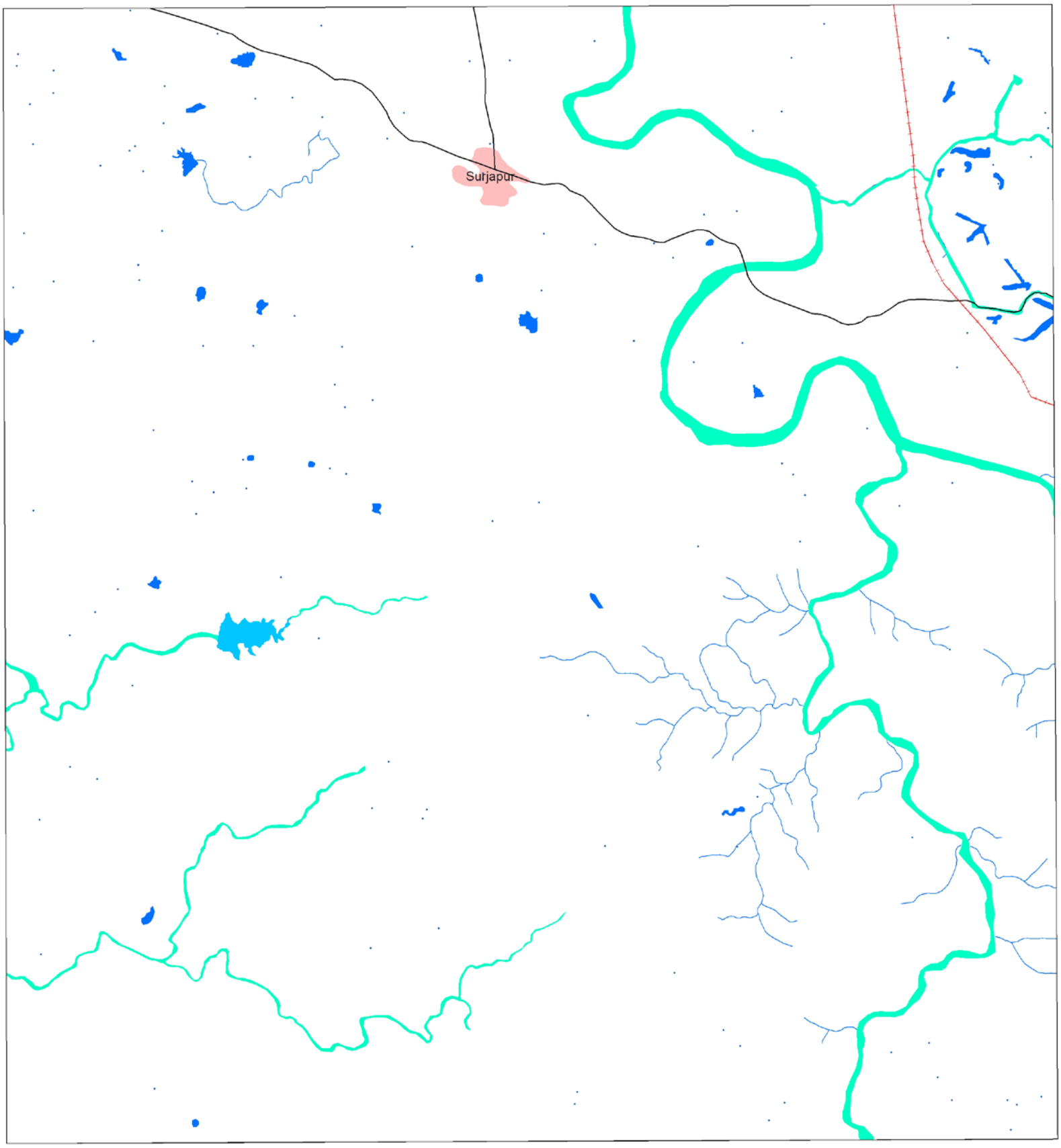
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64I/16



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
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	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
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			Natural	
	2101			Lagoons
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	2103			Sand/Beach
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	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

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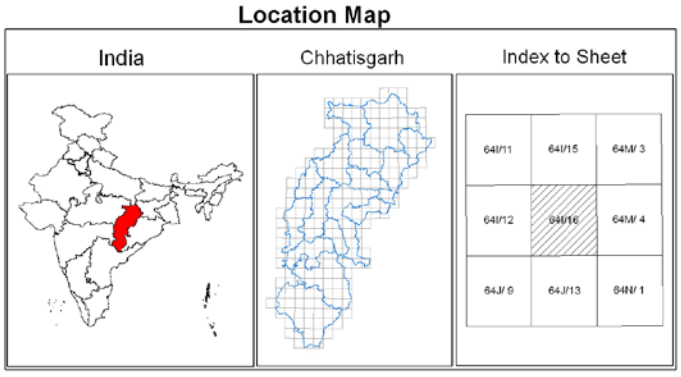
- Railways
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

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
National Remote Sensing Centre, Hyderabad

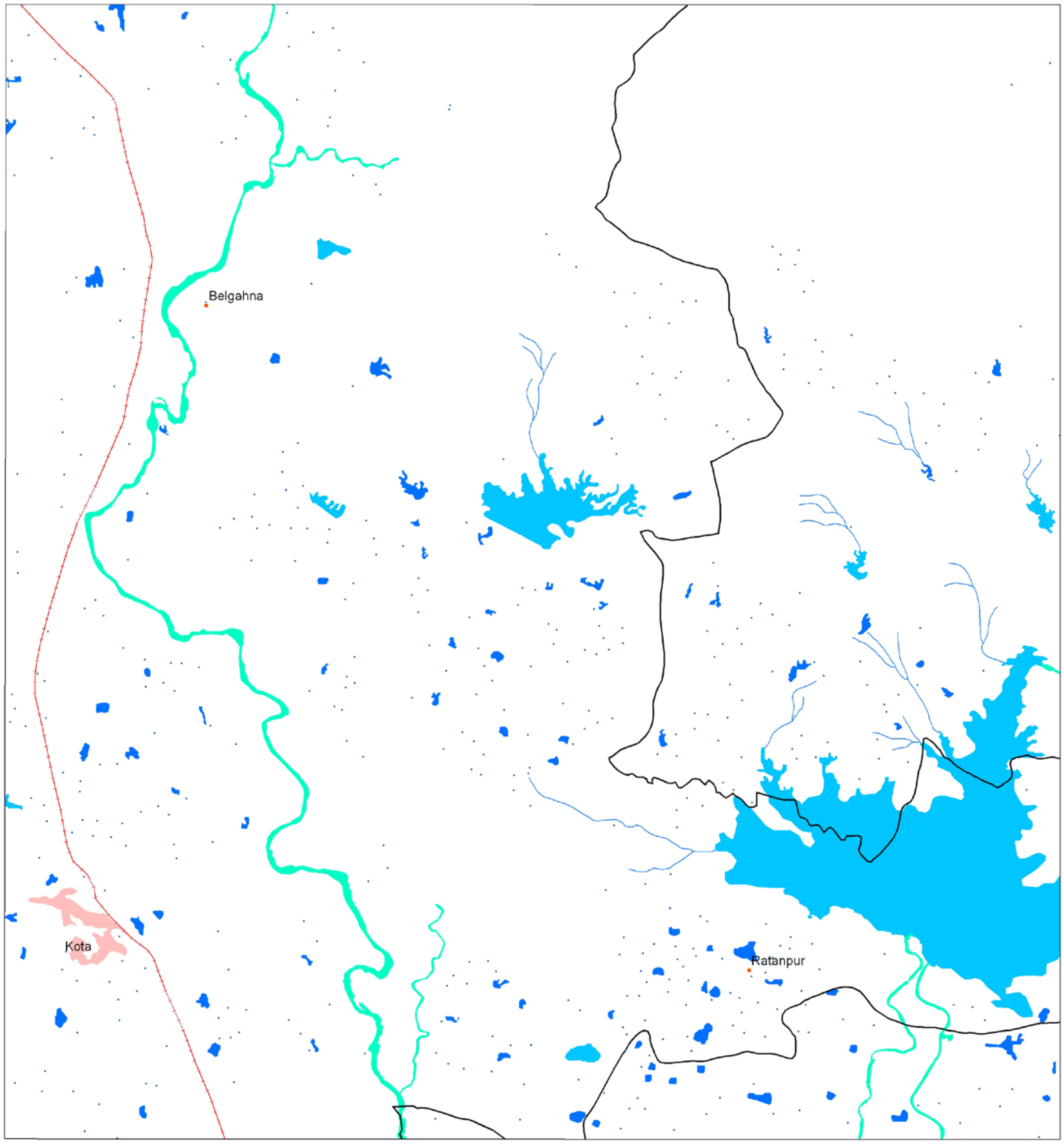
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64J/03



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
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	1106			River/Stream
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	2101			Lagoons
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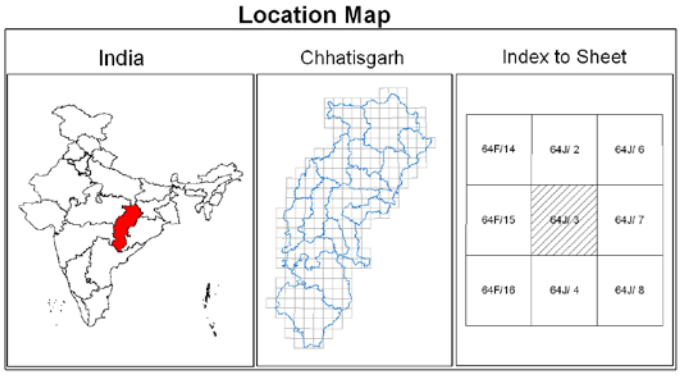
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

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

Location Map



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

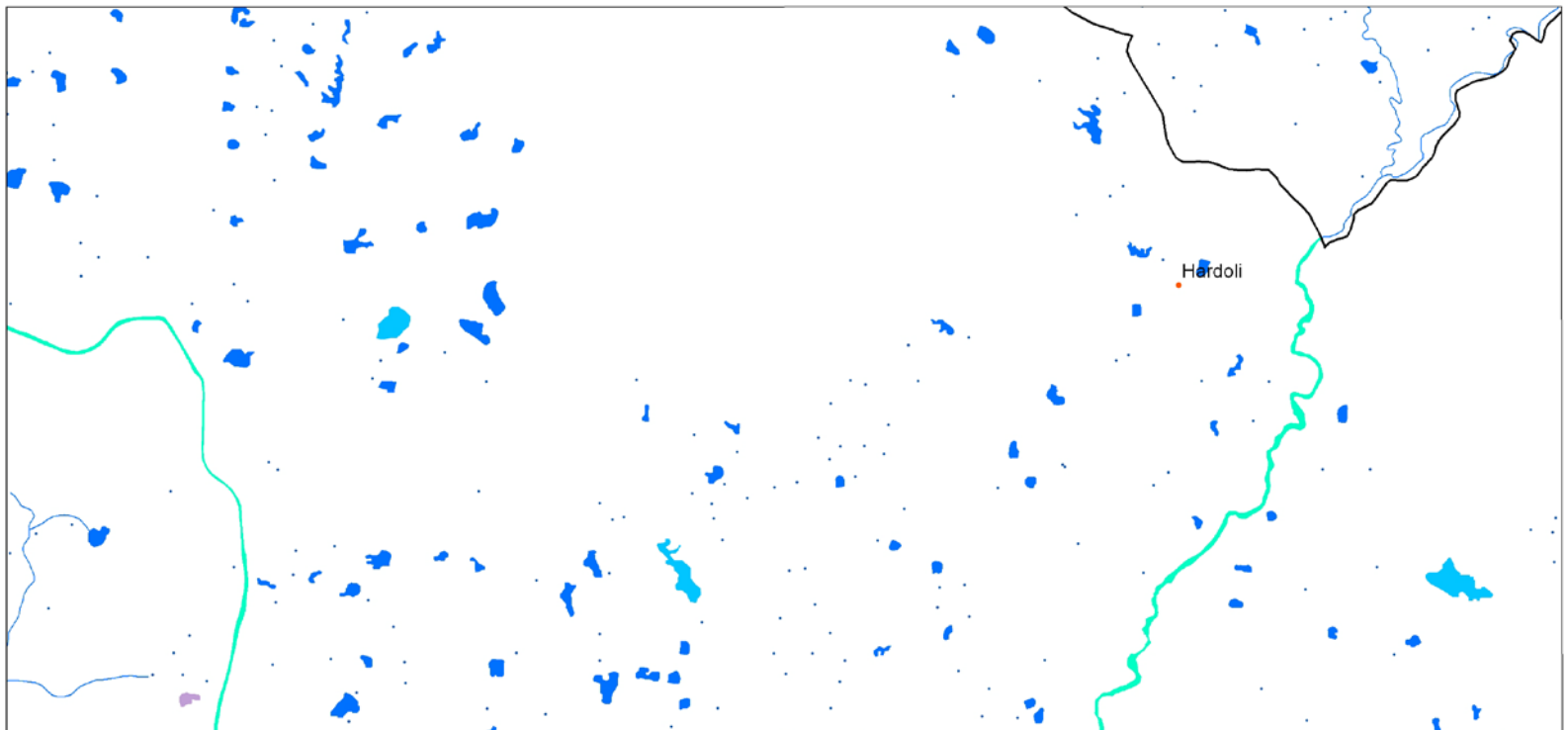
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64J/08



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
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	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

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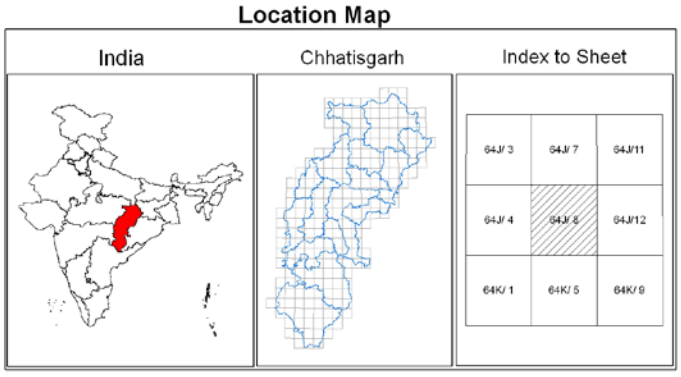
- Canal
- Roads
- Railways
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

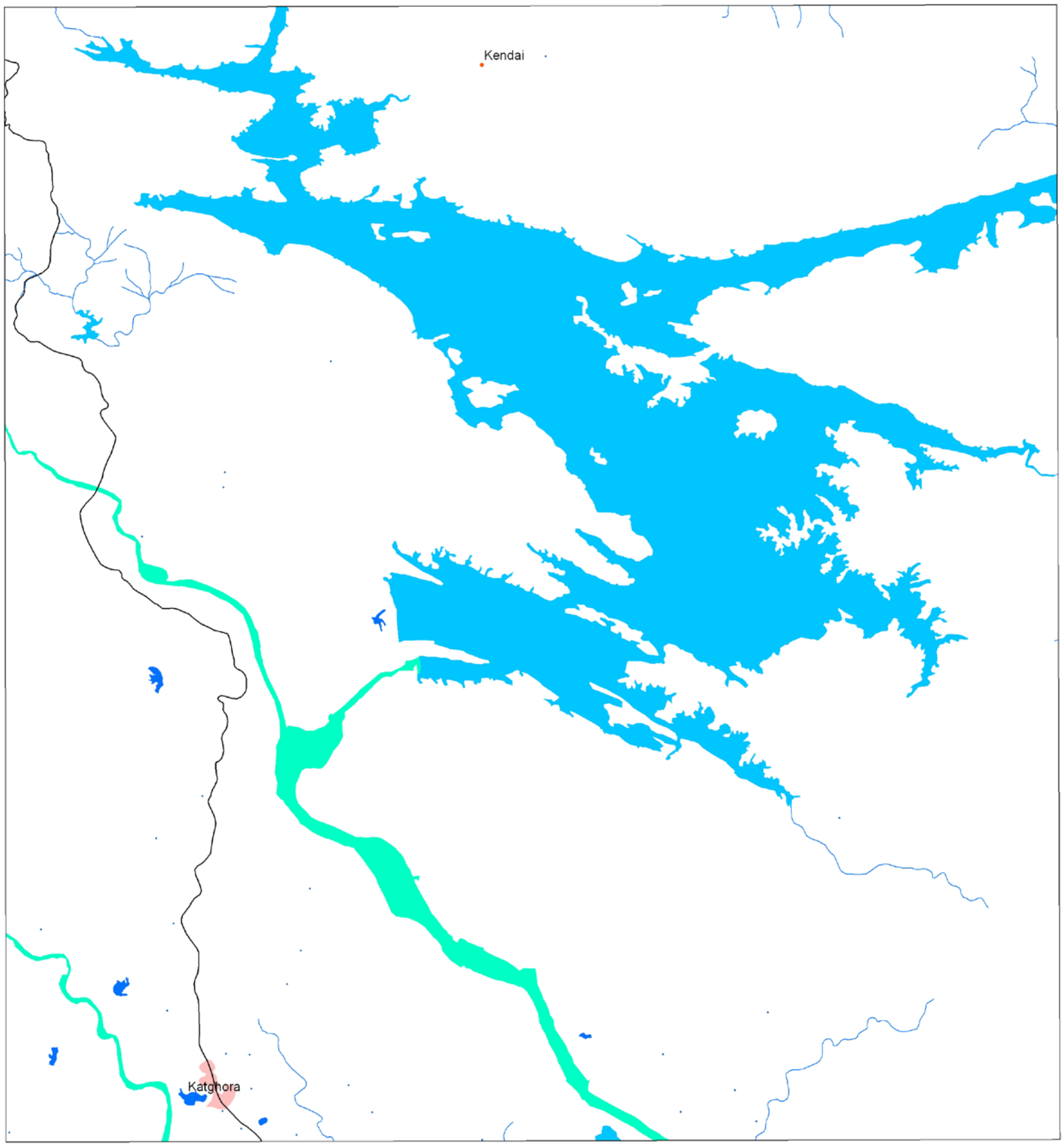
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64J/10



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
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			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
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			Natural	
	2101			Lagoons
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	2105			Salt marsh
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	2202			Aquaculture ponds

Legend

- Wetlands (<2.25 ha)
- Settlements
- Drainage (line)
- Canal
- Roads
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- District Boundary
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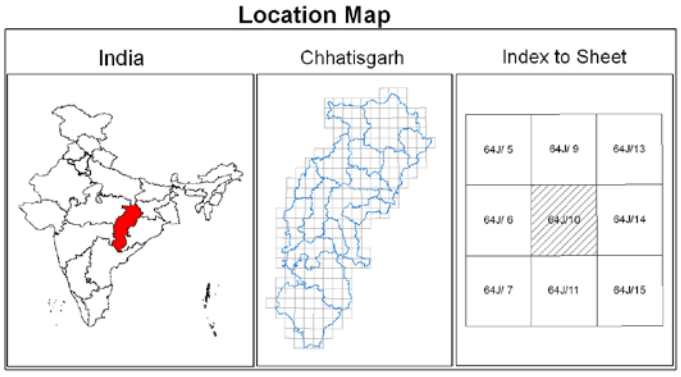
- International Boundary

Location Map



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

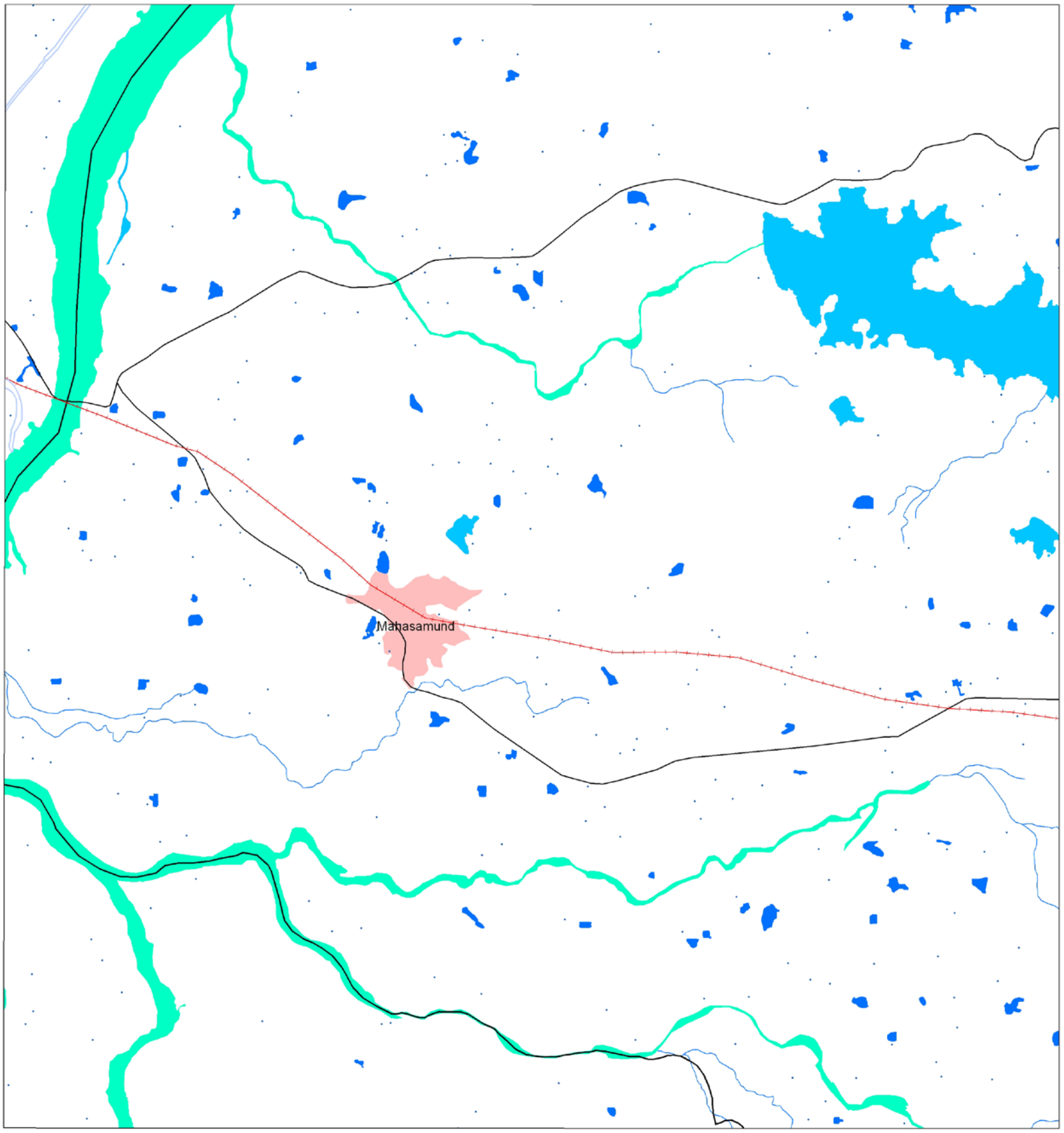
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64K/04

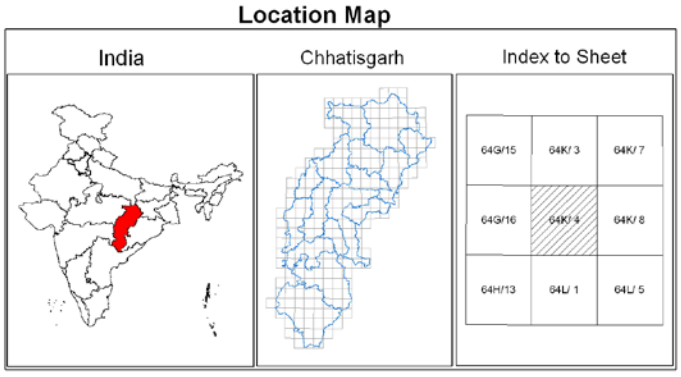


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
National Remote Sensing Centre, Hyderabad

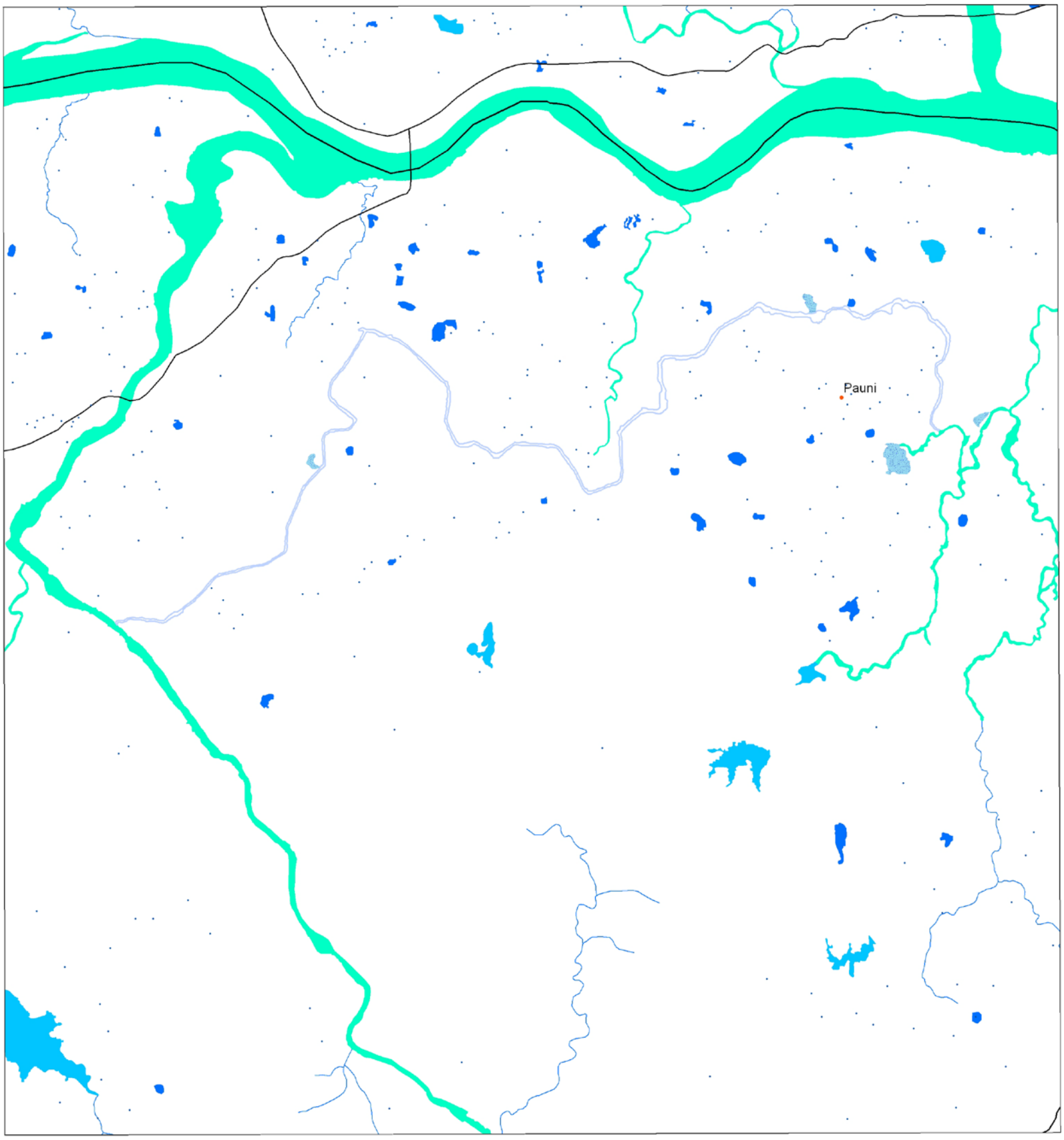
Sponsored By:

Ministry of Environment and Forests
Government of India

State : Chhatisgarh

WETLAND MAP

Map No. : 64K/10

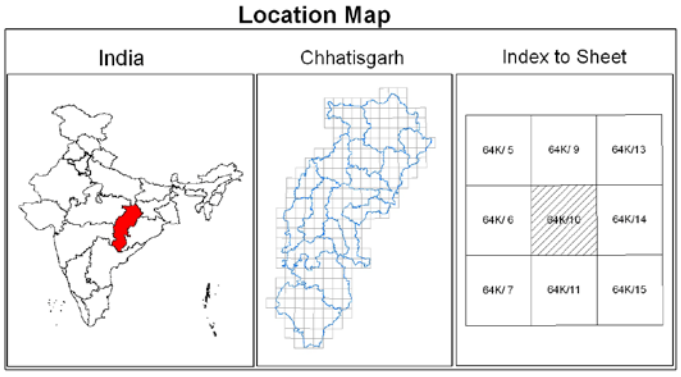


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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



Data Source :

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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:

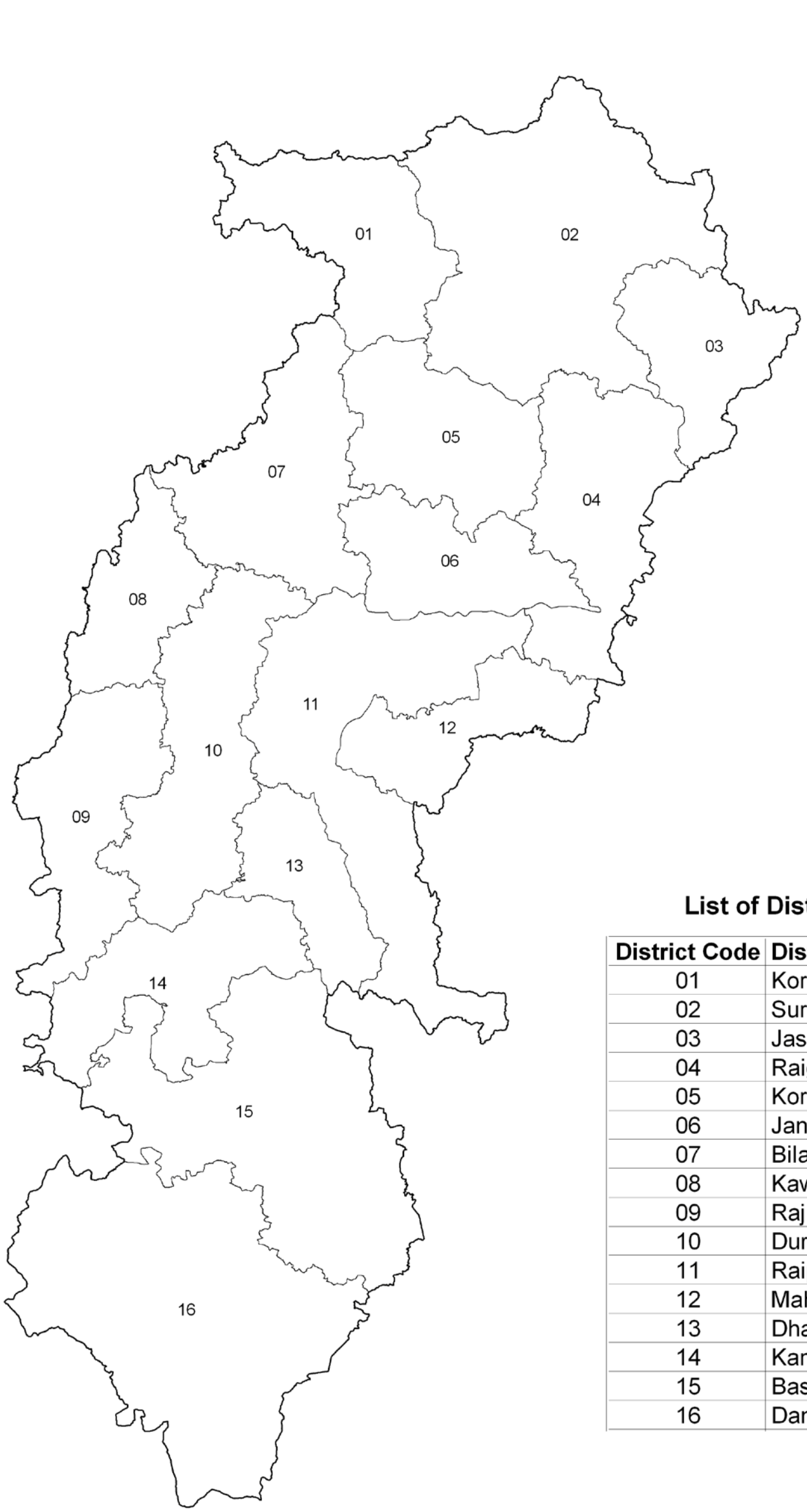
Wetland type code	Definition and description
1000	**Inland Wetlands**
1100	**Natural**
1101	**Lakes**: Larger bodies of standing water occupying distinct basins (Reid *et al*, 1976). These wetlands occur in natural depressions and normally fed by streams/rivers. On satellite images lakes appear in different 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 *et al*, 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 *Sphagnum*) 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 *et al*, 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 et al, 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	**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 *et al*, 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 *et al*, 1976). Tanks appear in light blue colour showing bottom reflectance. 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).
1203	**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.
1204	**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.
2000	**Coastal Wetlands**
2100	**Natural**
2101	**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 *et al*, 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 *et al*, 1974).
2102	**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.
2103	**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.
2104	**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).
2105	**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.
2106	**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.
2107	**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 corraline algae with the intervening space connected with sand, which consists largely of shells of foraminefera. Present reefs are living associations growing on this accumulation of past (Clark, 1977). Reefs appear in light blue shade.
2200	**Man-made**
2201	**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 *et al*, 1974). Salt pans are square or rectangular in shape. When water is there appearance is blue while salt is formed tone is white.
2202	**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.

Annexure – II
Details of District information followed in the atlas

State : Chhatisgarh

District Boundary Map



List of Districts

District Code	District Name
01	Koriya
02	Surguja
03	Jashpur
04	Raigarh
05	Korba
06	Janjgir Champa
07	Bilaspur
08	Kawardha
09	Rajnandgaon
10	Durg
11	Raipur
12	Mahasamund
13	Dhamtari
14	Kanker
15	Bastar
16	Dantewada

Legend

State Boundary

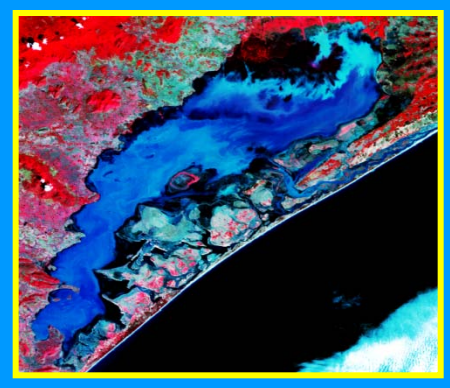
District Boundary

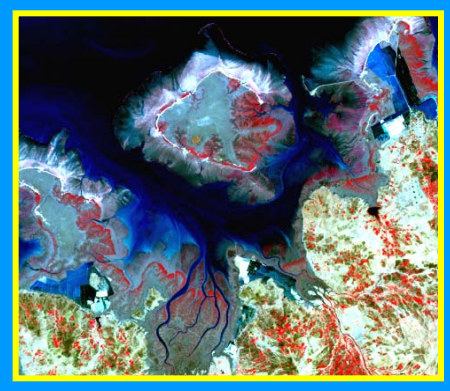
Source : Survey of India (Surveyed in 2004 and published in 2005)

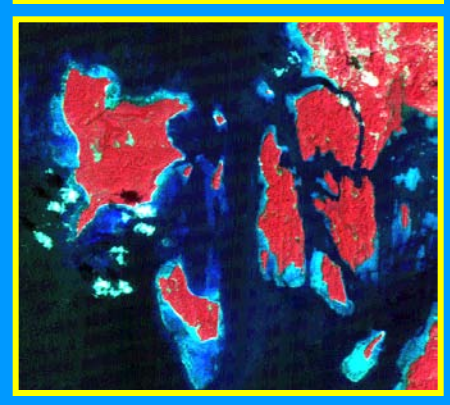
Space Applications Centre (SAC) is one of the major centres of the Indian Space Research Organisation (ISRO). It is a unique centre dealing with a wide variety of disciplines comprising design and development of payloads, societal applications, capacity building and space sciences, thereby creating a 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.

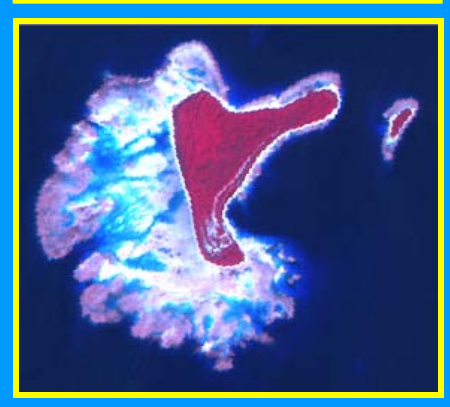
SAC is a host institution for the training programmes related to Satellite Communication, Satellite Meteorology and global change under the Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP) affiliated to the United Nations (UN).

http://www.isro.org









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