



NATIONAL WETLAND ATLAS: *ASSAM*



Sponsored by
Ministry of Environment and Forests
Government of India



Space Applications centre
Indian Space Research Organisation
Ahmedabad – 380 015



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

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

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

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NATIONAL WETLAND ATLAS

ASSAM

**Sponsored by
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
Assam Remote Sensing Applications Centre, Guwahati**

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जयराम रमेश
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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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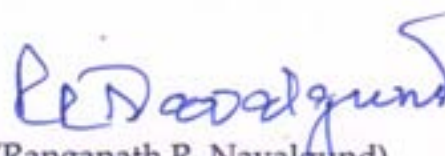
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FOREWORD

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

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

January 25, 2010


(Ranganath R. Navalgund)

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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 constraints most frequently faced for decision making is lack of scientific data of our natural resources. Often the data are sparse or unauthentic, rarely in the form of geospatial database (map), thus open to challenges. Hence, the current emphasis of every country is to have an appropriate geospatial database of natural resources based on unambiguous scientific methods. The wetland atlas of Assam, 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), lacustrine (lakes), riverine (along rivers and streams), palustrine ('marshy'- marshes, swamps and bogs). Given these characteristics, wetlands support a large variety of plant and animal species adapted to fluctuating water levels, making the wetlands of critical ecological significance. Utility wise, wetlands directly and indirectly support millions of people in providing services such as food, fiber and raw materials, storm and flood control, clean water supply, scenic beauty and educational and recreational benefits. The Millennium Ecosystem Assessment estimates conservatively that wetlands cover seven percent of the earth's surface and deliver 45% of the world's natural productivity and ecosystem services of which the benefits are estimated at \$20 trillion a year (Source: www.MAweb.org). The Millennium Assessment (MA) uses the following typology to categorise ecosystem services:

- Provisioning services: The resources or products provided by ecosystems, such as food, raw materials (wood), genetic resources, medicinal resources, ornamental resources (skin, shells, flowers).
- Regulating services: Ecosystems maintain the essential ecological processes and life support systems, like gas and climate regulation, water supply and regulation, waste treatment, pollination, etc.
- Cultural and Amenity services: Ecosystems are a source of inspiration to human culture and education 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 wetland area is estimated to already have disappeared over the last hundred years through conversion to industrial, agricultural and residential developments. Even in current scenario, when the ecosystem services provided by wetlands are better understood - degradation and conversion of wetlands continues. This is largely due to the fact that the 'full value' of ecosystem functions is often ignored in policy-making, plans and corporate evaluations of development projects.

1.2 Mapping and Geospatial Technique

To conserve and manage wetland resources, it is important to have inventory of wetlands and their catchments. The ability to store and analyse the data is essential. Digital maps are very powerful tools to achieve this. Maps relate the feature to any given geographical location has a strong visual impact. Maps are thus essential for monitoring and quantifying change over time scale, assist in decision making. The technique used in the preparation of map started with ground survey. The Survey of India (SOI) topographical 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 recognised 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, satellite remote sensing can be defined as the use of satellite borne sensors to observe, measure, and record the electromagnetic radiation (EMR) reflected or emitted by the earth and its environment for subsequent analysis and extraction of information. EMR sensors includes visible light, near-, mid- and far-infrared (thermal), microwave, and long-wave radio energy. The capability of multiple sources of information is unique to remote sensing. Of specific advantage is the spectral, temporal, and spatial resolution. Spectral resolution refers to the width or range of each spectral band being recorded. Since each target affects different wavelengths of incident energy differently, they are absorbed, reflected or transmitted in different proportions. Currently, there are many land resource remote sensing satellites that have sensors operating in the green, red, near infrared and short wave Infra red regions of the electromagnetic spectrum giving a definite spectral signature of various targets due to difference in radiation absorption and reflectance of targets. These sensors are of common use for land cover studies, including wetlands. Figure 1 shows typical spectral signature of few targets from green to SWIR region. Converted to image, in a typical false colour composite (FCC) created using NIR, red and green bands assigned as red, green and blue colour, the features become very distinct as shown in Figure 2. In FCC, the vegetation thus appears invariably red (due to high reflection in NIR from green leaves).

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

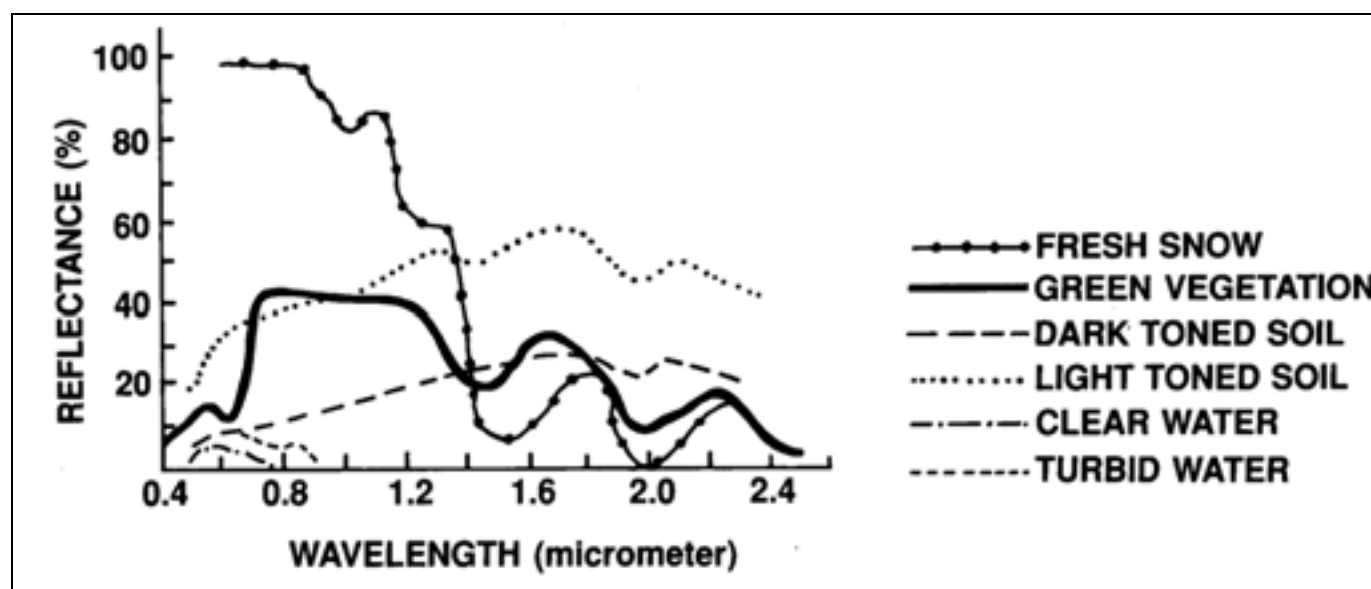
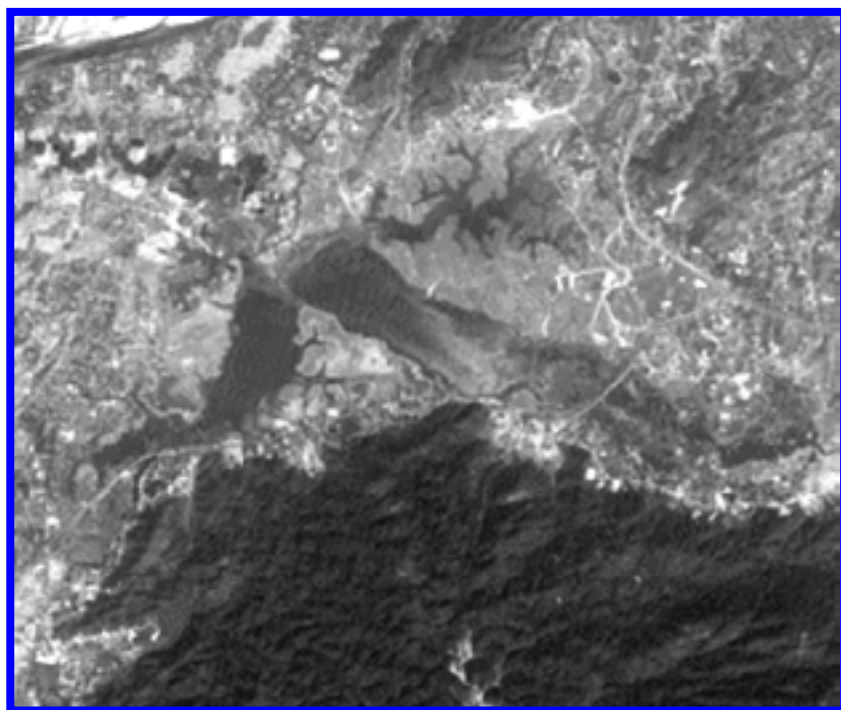
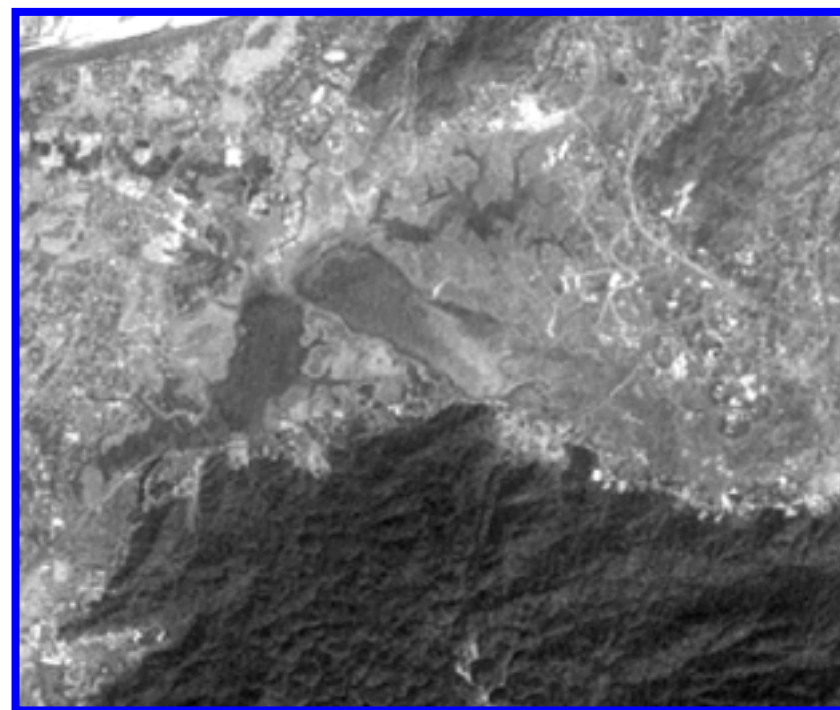


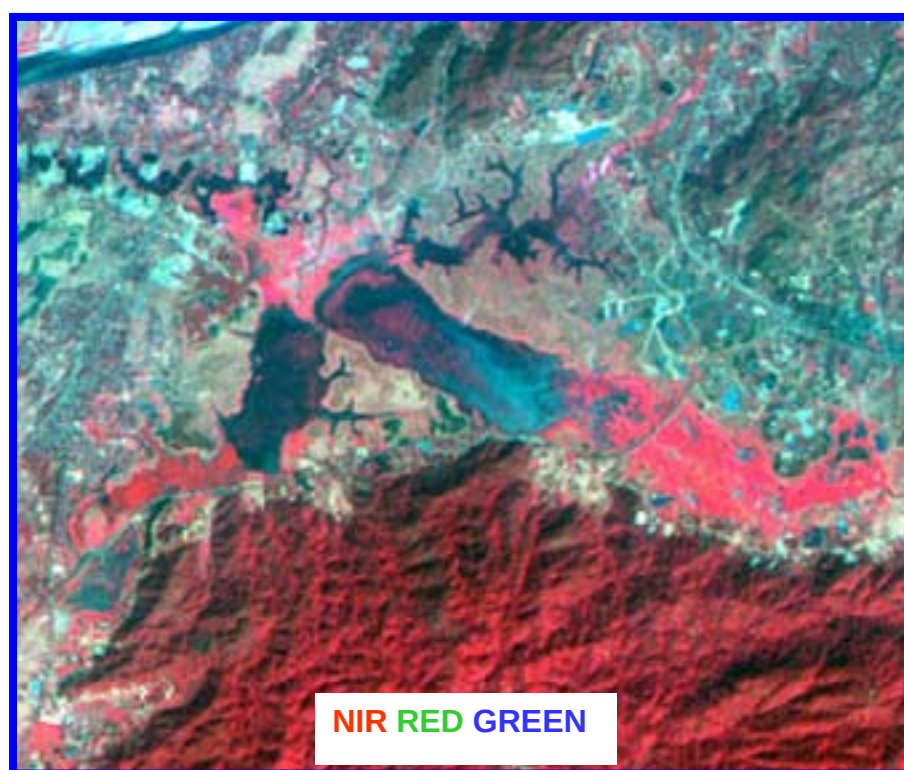
Figure 1: Spectral Signature of various targets



Red



Green



NIR

SWIR

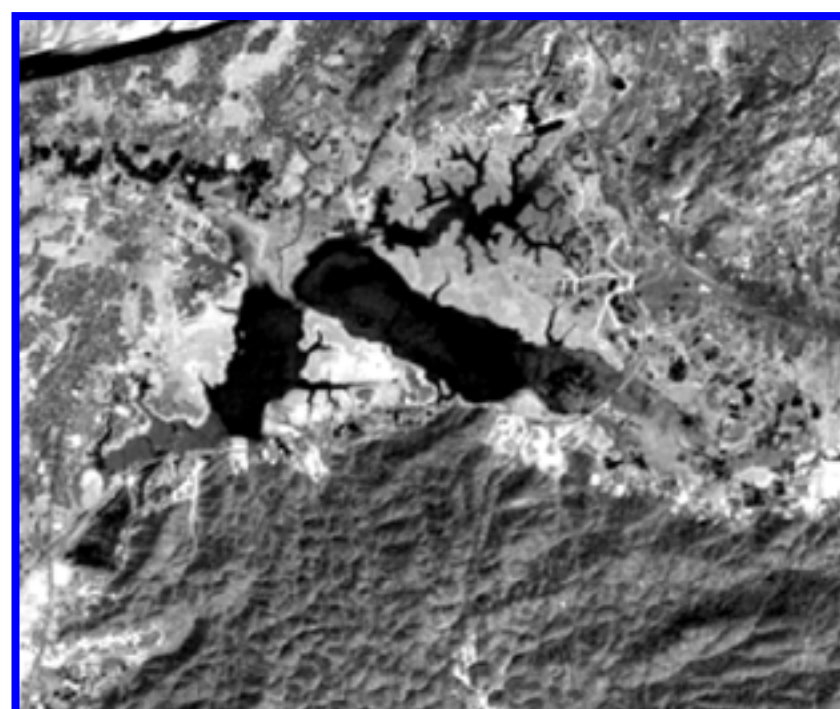
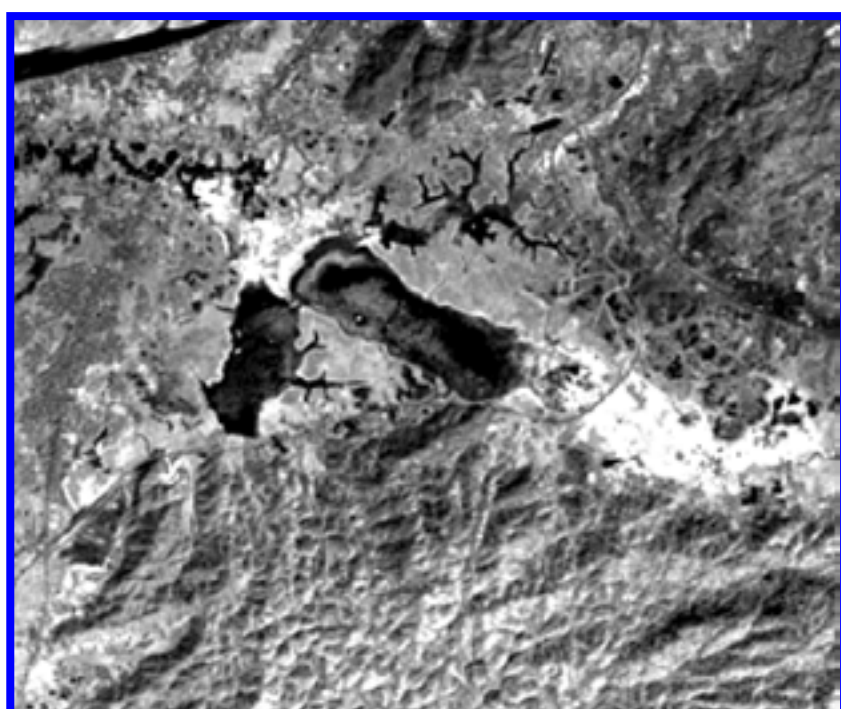


Figure 2: Various land features as they appear in four spectral bands and in a typical three band FCC.

1.3 Wetland Inventory of India

India with its large geographical spread supports large and diverse wetland classes, some of which are unique. Wetlands, variously estimated to be occupying 1-5 per cent of geographical area of the country, support about a fifth of the known biodiversity. Like any other 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, peat-lands, 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, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters”.

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

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

The first scientific mapping of wetlands of India was carried out during 1992-93 by Space Applications Centre (ISRO), Ahmedabad, at the behest of the Ministry of Environment and Forests (MoEF), Govt. of India using remote sensing data from Indian Remote Sensing satellites (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, salt pans, 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 Assam.

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 Spatial Framework and GIS Database

The National Spatial Framework (NSF) has been used as the spatial framework to create the database (Anon. 2005a). 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 extent 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 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: < 2.25 ha) are mapped as point features.
- Base layers like major road network, railway, settlements, and surface drainage are created (either from the current image or taken from other project data base).

Table 1: Wetland Classification System and coding

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

* Wetland type code

3.0 STUDY AREA

Assam is one of the 7 states of Northeast India. It extends between the latitudes of 24°8' N - 28°2' N and longitudes of 89°42' E - 96° E. The T-shaped state is sprawled in an area of 78,438 km²(Figure-3). It is bordered by the Indian states of Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, and West Bengal. The name "Assam" is derived from the term "Asom" which, in Sanskrit, refers to unequal or unrivalled. The uneven topography of the land, full of hills and plains might, have contributed to the name. The Mongolian Ahom dynasty that had ruled Assam for more than six hundred years might also be the cause for the name. Assam can be broadly divided into three distinct physical units, the Brahmaputra Valley in the north, the Barak Valley in the narrow protruding south, and the state's hilly region (Mikir and Cachar) separating the two valleys. Entering Assam, the Brahmaputra becomes a braided river and along with its tributaries, creates the flood plain of the Brahmaputra Valley. The Brahmaputra Valley in Assam is approximately 80 to 100 km wide and almost 1000 km long and the width of the river itself is 16 km at many places within the valley. The hills of Karbi Anglong and North Cachar and those in and around Guwahati and North Guwahati (along with the Khasi and Garo Hills) are originally parts of the South Indian Plateau system. These are eroded and dissected by the numerous rivers in the region. Average height of these hills in Assam varies from 300 to 400mt. The southern Barak Valley is separated by the Karbi Anglong and North Cachar Hills from the Brahmaputra Valley in Assam. The Barak originates from the Barail Range in the border areas of Assam, Nagaland and Manipur and flowing through the district of Cachar, it confluences with the Brahmaputra in Bangladesh. Barak Valley in Assam is a small valley with an average width and length of approximately 40 to 50 km.

Assam weather is characterized by heavy downpour and humidity. The hilly areas usually experience sub-alpine climatic condition, while excessive sultriness is observed in the plain lands of Assam. The humidity that is brought into Assam by the southwest monsoons, shower an average annual rainfall of 120 inches or more on the great Brahmaputra valley and the surrounding region. The temperature ranges from a maximum of 29° to a minimum of 16°. Assam's economy is based on agriculture and oil. Assam produces a significant part of the total tea production of the world. Assam produces more than half of India's petroleum.

The current state capital of Assam, Guwahati, was known in ancient time as Pragjyotishpura or The Eastern City of Light. Other major towns are Dhubri, Barpeta, Dibrugarh, Tinsukia, Jorhat, Nagaon, Sivasagar, Silchar, Tezpur. The population of Assam is 26.66 million according to 2001 census and is scattered over 26312 villages. Administratively, it is divided into 23 districts: Barpeta, Bongaigaon, Cachar, Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Marigaon, Nagaon, Nalbari, North Cachar Hills, Sibsagar, Sonitpur, and Tinsukia.

The spatial framework was prepared using 15' x 15' grid. The state is covered by 171 Survey of India topographic maps on 1:50,000 scale that form the spatial frame work for mapping (Figure 4).

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

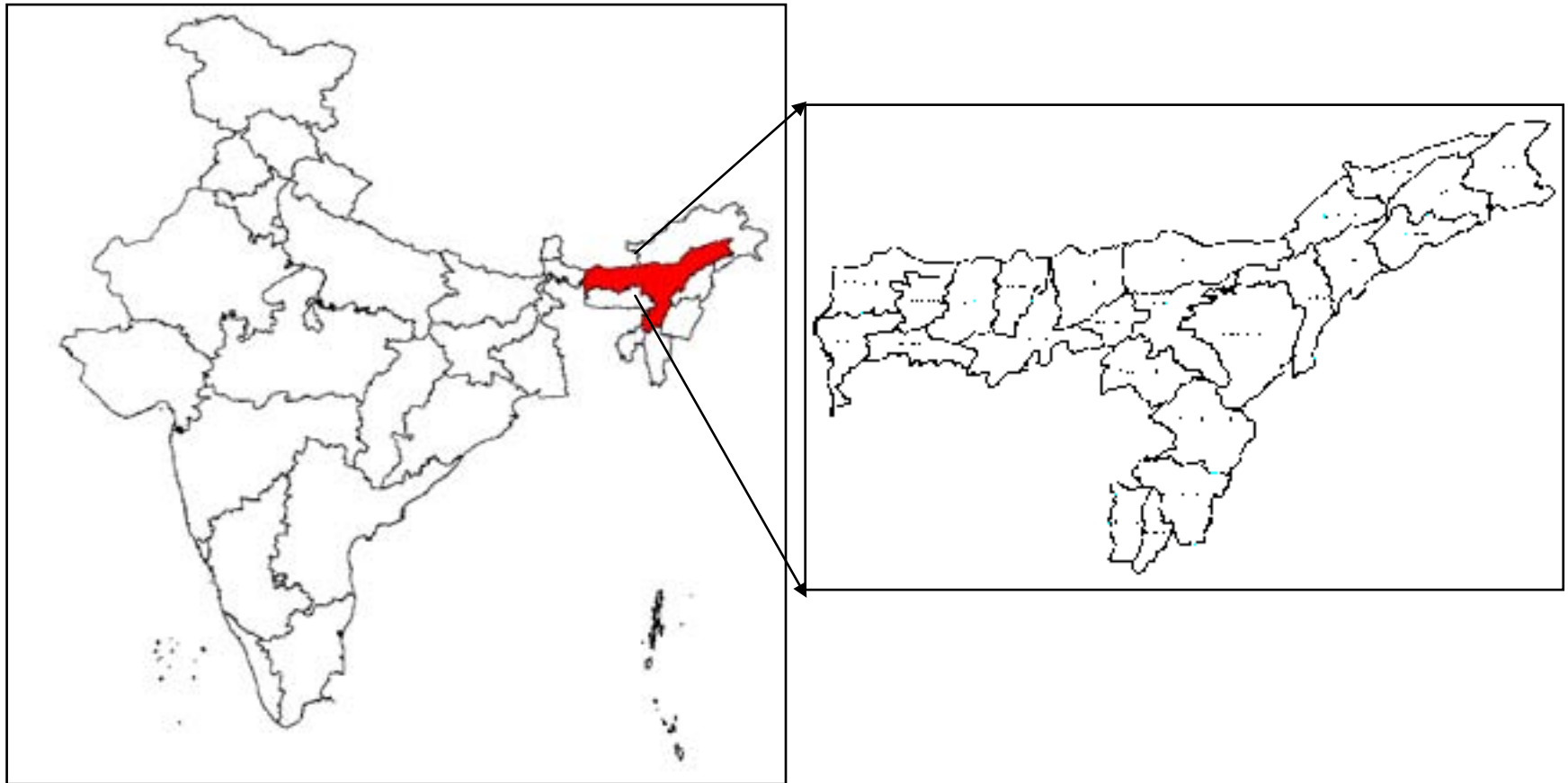


Figure 3: Location Map

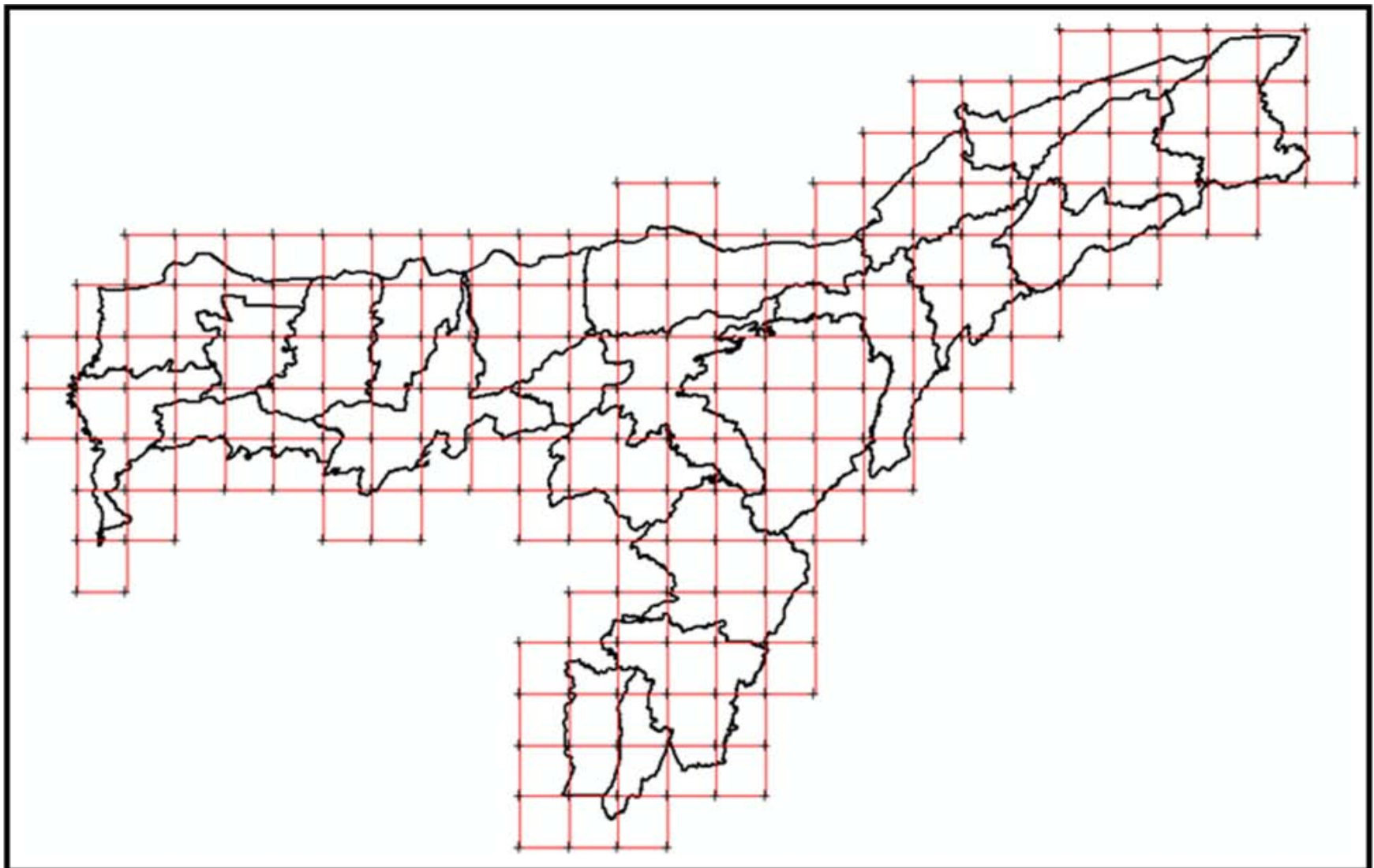


Figure 4: Spatial Framework of Assam

4.0 DATA USED

4.1 Remote sensing data

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

4.2 Ground truth data

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

4.3 Other data

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

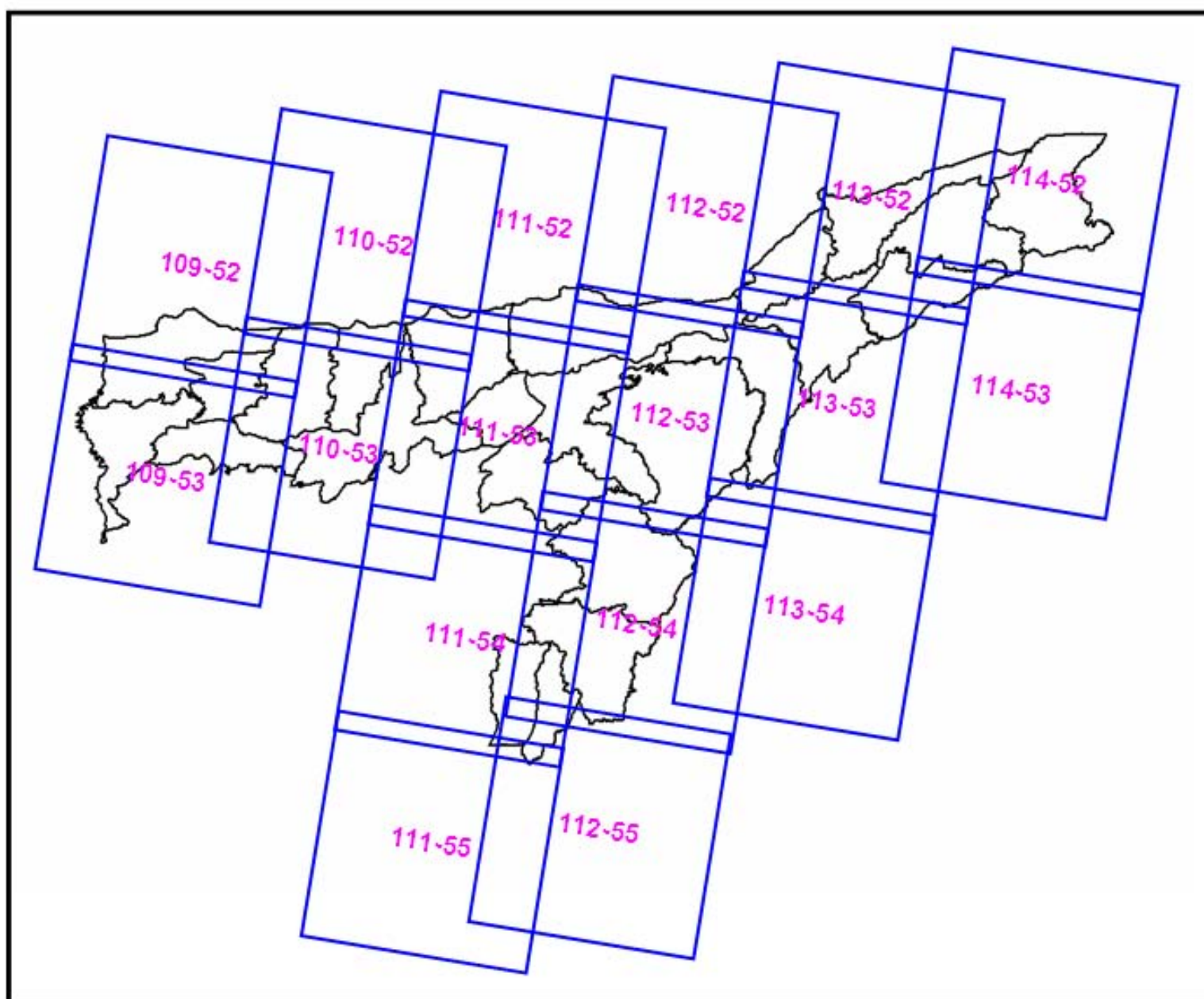


Figure 5: IRS P6 LISS-III coverage (path-row) of Assam

Table-2: Satellite data used

Sr. No.	IRS P6 LISS-III Data (Path / Row)	Date of Acquisition	
		Post-monsoon	Pre-monsoon
1	109-52	October 27, 2006	March 20, 2007
2	109-53	October 27, 2006	March 20, 2007
3	110-52	November 06, 2005	May 17, 2006
4	110-53	November 01, 2006	May 17, 2006 & March 25, 2007
5	111-52	November 11, 2005	January 03, 2007
6	111-53	November 30, 2006	March 30, 2007
7	111-54	November 30, 2006	March 30, 2007
8	111-55	November 11, 2005	-
9	112-52	December 05, 2006	January 27, 2006 & April 14, 2005
10	112-53	December 10, 2005 & December 05, 2006	March 11, 2007 & April 14, 2005
11	112-54	December 10, 2005 & December 05, 2006	January 22, 2007
12	112-55	December 10, 2005	-
13	113-52	January 27, 2007	May 03, 2007
14	113-53	January 27, 2007	May 03, 2007
15	113-54	January 27, 2007	May 03, 2007
16	114-52	September 15, 2005	April 14, 2007
17	114-53	September 15, 2005	February 06, 2006

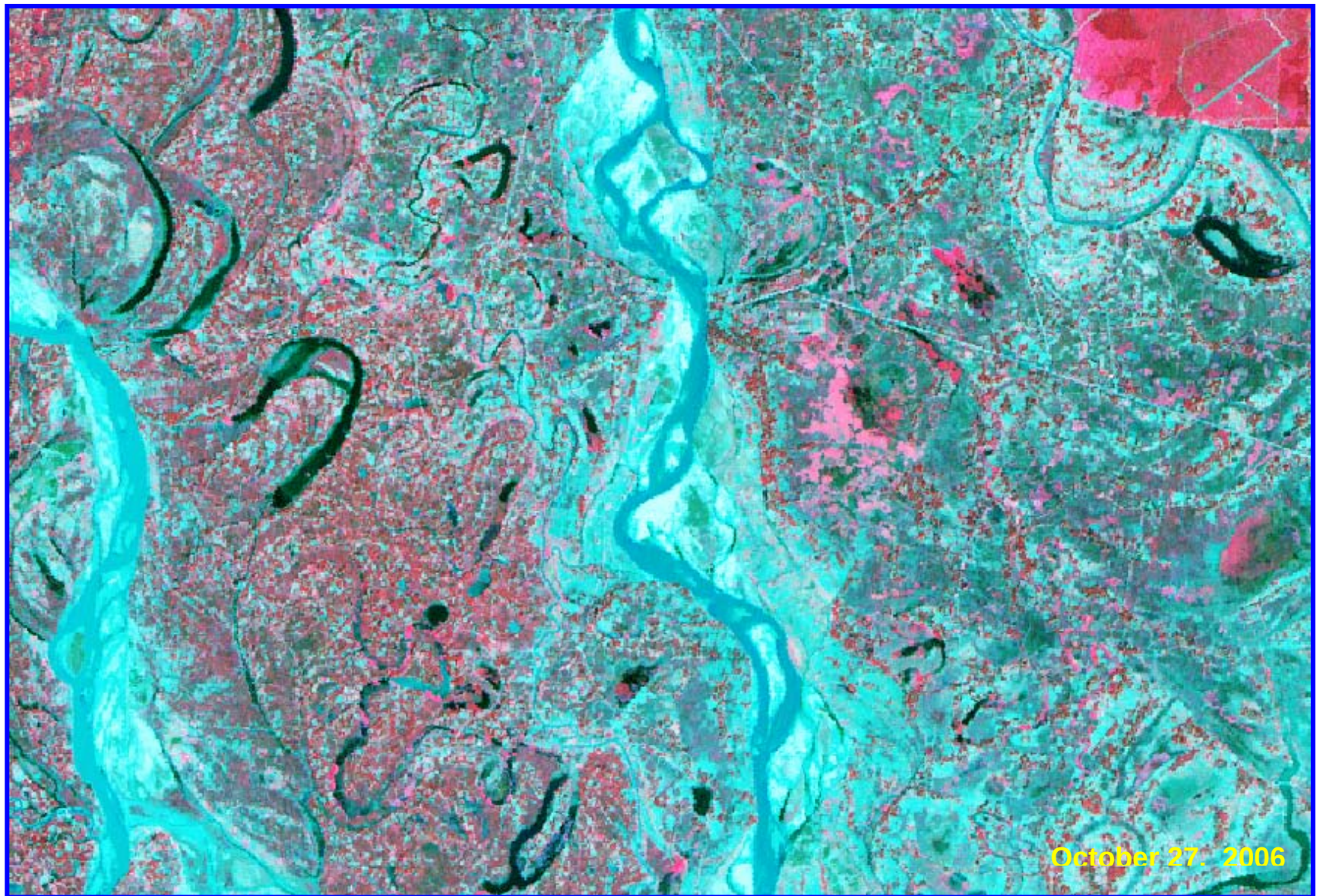


Figure 6: IRS LISS-III FCC (Post-monsoon and Pre-monsoon): Part of Assam state

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 covered in multiple map sheets. To create NWIA database, NNRMS/NRDB standards is followed and four corners of the 1:50,000 (15' x 15') grid is taken as the tics or registration points to create each map taking master grid as the reference. Spatial framework details are given in NWIA manual (Patel and Garg, 2007). The spatial framework for Assam 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 archive geometrically corrected LISS III data (ISRO-NRC-land use / land cover project). Standard image processing software was used for geo-referencing. First one date data was registered with the archive image. The second date data was then registered with the first date data.

5.3 Mapping of Wetlands

The delineation of wetlands through image analysis forms the foundation for deriving all wetland classes and results. Consequently, a great deal of emphasis has been placed on the quality of the image Interpretation. In the present study, the mapping of wetlands was done following digital classification and onscreen visual interpretation. Wetlands were identified based on vegetation, visible hydrology and geography. There are various methods for extraction of water information from remote sensing imagery, which according to the number of bands used, are generally divided into two categories, i.e. Single-band and multi-band methods. Single-band method usually involves choosing a band from multi-spectral image to distinguish water from land by subjective threshold values. It may lead to over- or under-estimation of open water area. Multi-band method takes advantage of reflective differences of each band.

In this project, five indices known in literature that enhances various wetland characteristics were used (McFeetres, 1986; Xu Hanqiu, 2006; Lacaux *et al*, 2007; Townshend and Justice, 1986; Tucker and Sellers, 1986) as given below:

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

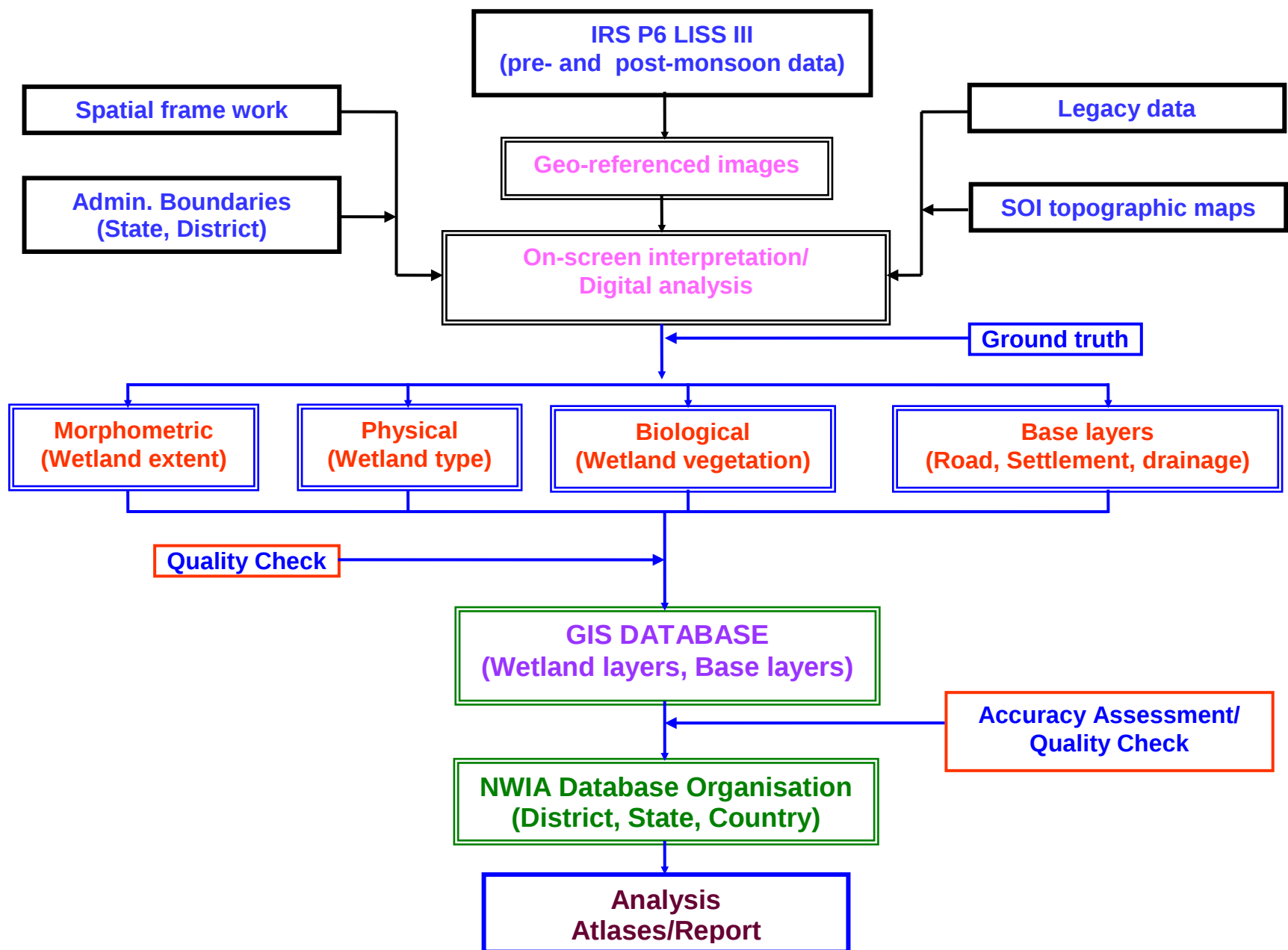


Figure 7: Flow chart of the methodology used

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

- Extraction of wetland extent :
MNDWI, NDPI and NDVI image was used to extract the wetland boundary through suitable hierarchical thresholds.
- Extraction of open water :
MNDWI was used with in the wetland mask to delineate the water and no-water areas.
- Extraction of wetland vegetation :
NDPI and NDVI image was used to generate the vegetation and no-vegetation areas within a wetland using a suitable threshold.
- Turbidity information extraction :
MNDWI image was used to generate qualitative turbidity level (high, moderate and low) based on following steps:
 - a) Conversion of post and pre-monsoon water spread polygons into Area of Interest (AoI).
 - b) Grouping of all AoIs excluding all non-wetland areas into a single entity.
 - c) Generate a signature statistics like minimum, maximum, mean and standard deviations.
 - d) Generate a raster turbidity image through a model for AoI only with *conditional* categorisation.
 - e) Convert the raster into vector and update the attributes or edit the water spread layer (copied as turbidity layer) in polygon mode so as to retain all the attributes.
 - f) Assign turbidity classes as per the table 3.

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	$> -1\sigma$ to $\leq +1\sigma$	Medium blue
3.	High/Bottom reflectance	$\leq \mu - 1\sigma$	Light blue/whitish blue

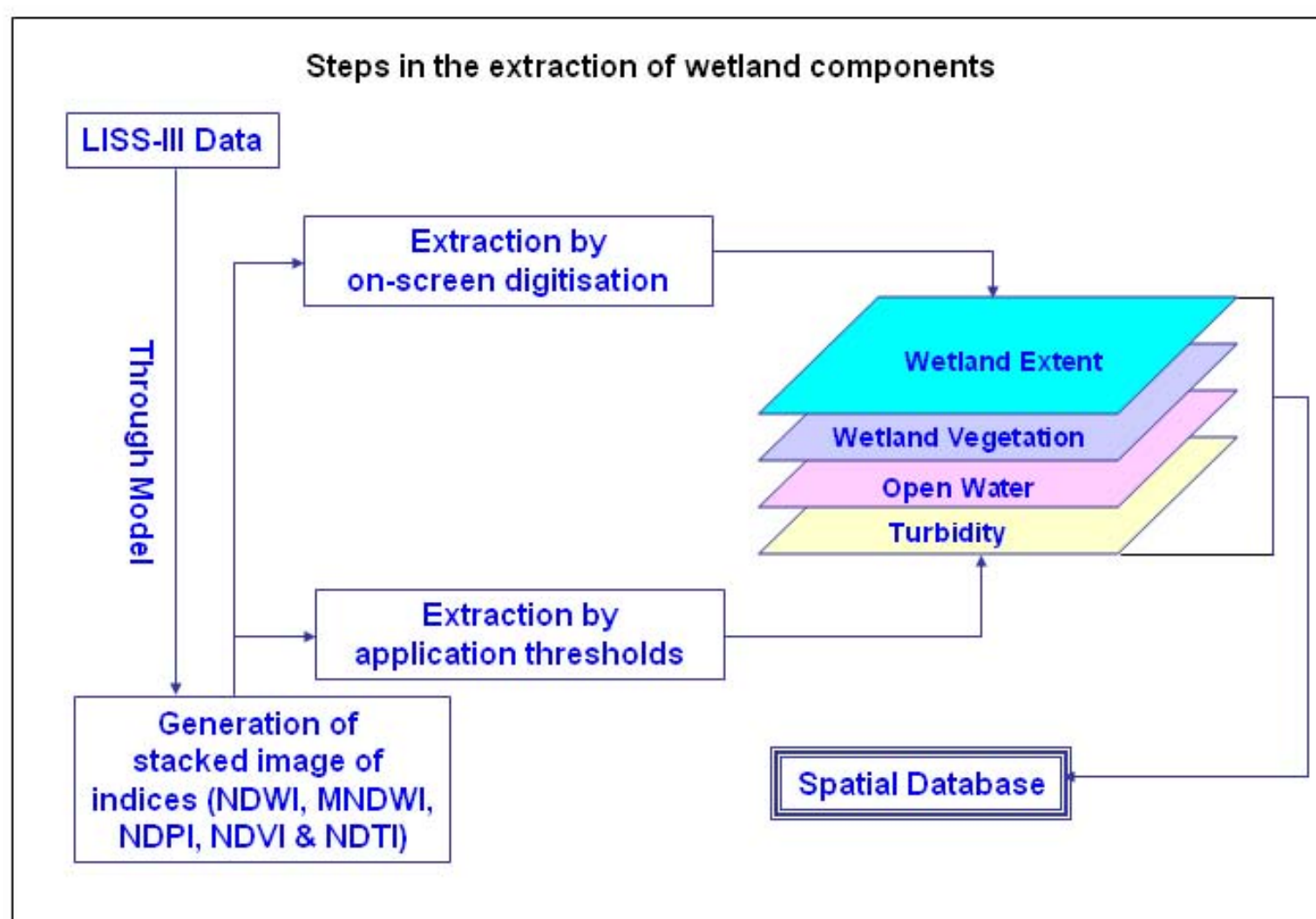


Figure 8: Steps in the extraction of wetland components

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 regional growing properties or on-screen digitization.

5.5 Generation of Reference Layers

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

5.6 Coding and Attribute Scheme

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

5.7 Map composition and output

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

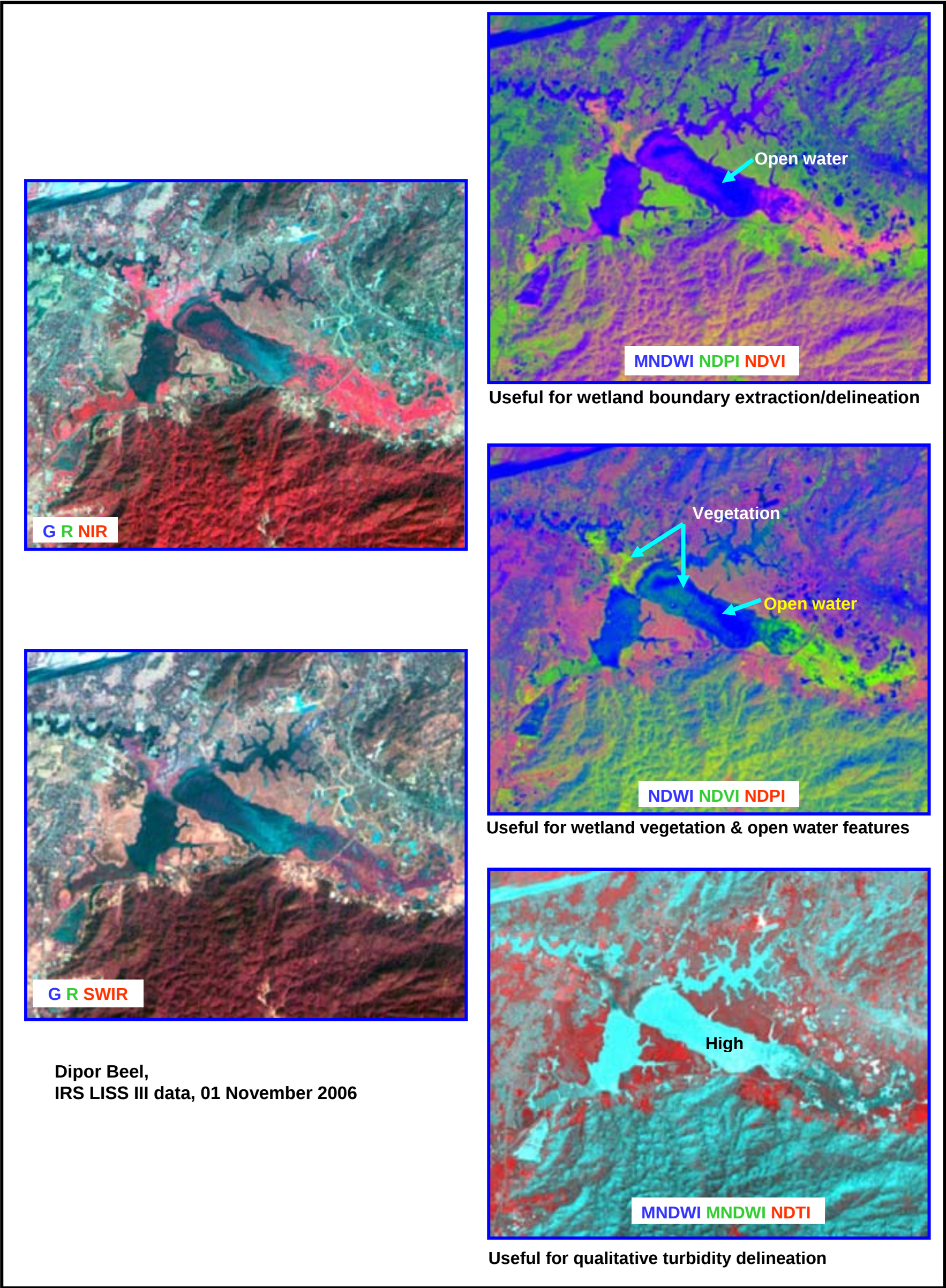


Figure 9: Various combinations of the indices/spectral bands used to identify wetland components

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 location accuracy. In addition, GIS database(s) contents have been also evaluated for accuracy. To ensure the reliability of wetland status data, the project adhered to established quality assurance and quality control measures for data collection, analysis, verification and reporting.

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

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

6.1 Data verification and quality assurance of output digital data files

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

MAPS AND STATISTICS

7.0 WETLANDS OF ASSAM: MAPS AND STATISTICS

Area estimates of various wetland categories for Assam have been carried out using GIS layers of wetland boundary, water-spread, aquatic vegetation and turbidity. Total 5097 wetlands have been mapped at 1:50,000 scale in the state. In addition, 6081 small wetlands (< 2.25 ha) have also been identified. Total wetland area estimated is 764372 ha that is around 9.74 per cent of the geographic area (Table-4). Natural wetlands dominate the state. The major wetland types are River/Stream accounting for 84 percent of the wetlands (637164 ha), Lake/Ponds (51257 ha), waterlogged (47141 ha) and Ox-bow lakes (14173 ha). There are two Reservoir/Barrages mapped with 2833 ha area, which is the major man made wetland type. Graphical distribution of wetland type is shown in Figure 10.

Aquatic vegetation is observed in Lakes/pond, Waterlogged, Riverine wetland type. The area under aquatic vegetation is more during pre monsoon (76036 ha) than that of post monsoon (36817 ha). The open water spread in River/stream showed very little seasonal fluctuations. However, the open water spread in case of Lakes/ponds, Waterlogged is significantly lower during pre monsoon compared to post monsoon.

Table-4: Area estimates of wetlands in Assam

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	1175	51257	6.71	34408	14526
2	1102	Ox-bow lakes/ Cut-off meanders	873	14173	1.85	7721	5848
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	139	4258	0.56	1669	942
5	1105	Waterlogged	2461	47141	6.17	33660	12630
6	1106	River/Stream	213	637164	83.63	342197	353756
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	2	2833	0.37	2185	1346
8	1202	Tanks/Ponds	180	921	0.12	892	801
9	1203	Waterlogged	54	544	0.07	336	303
		Sub-Total	5097	758291	99.20	423068	390152
		Wetlands (<2.25 ha), mainly Tanks	6081	6081	0.80	-	-
		Total	11178	764372	100.00	423068	390152

Area under Aquatic Vegetation	36817	76036
--------------------------------------	-------	-------

Area under turbidity levels		
Low	64137	22834
Moderate	358429	366654
High	502	664

7.1 DISTRICT-WISE WETLAND MAPS AND STATISTICS

There are 23 districts. The geographic area of the districts varies from 1317 sq.km (Hailakandi) to 10434 sq.km (Karbi Anglong) (Table- 5). The wetlands occupy as high as 21.43% of geographic area (Dibrugarh district), and as low as 1.35% (North Cachar Hills). In terms of total wetland area (% wetland area), Sonitpur is the leading district (83427 ha, 10.9%) and Hailakandi is the least (2600 ha, 0.34%).

River/stream is the dominate wetland type in almost all districts, except few districts like Karimganj , Naogaon etc. Lake/pond locally known as beels are the major wetlands in many districts. Naogaon district has very high area under Waterlogged.

District-wise wetland area estimates is given in Table-5. Figure 11 shows district-wise graphical distribution of 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.

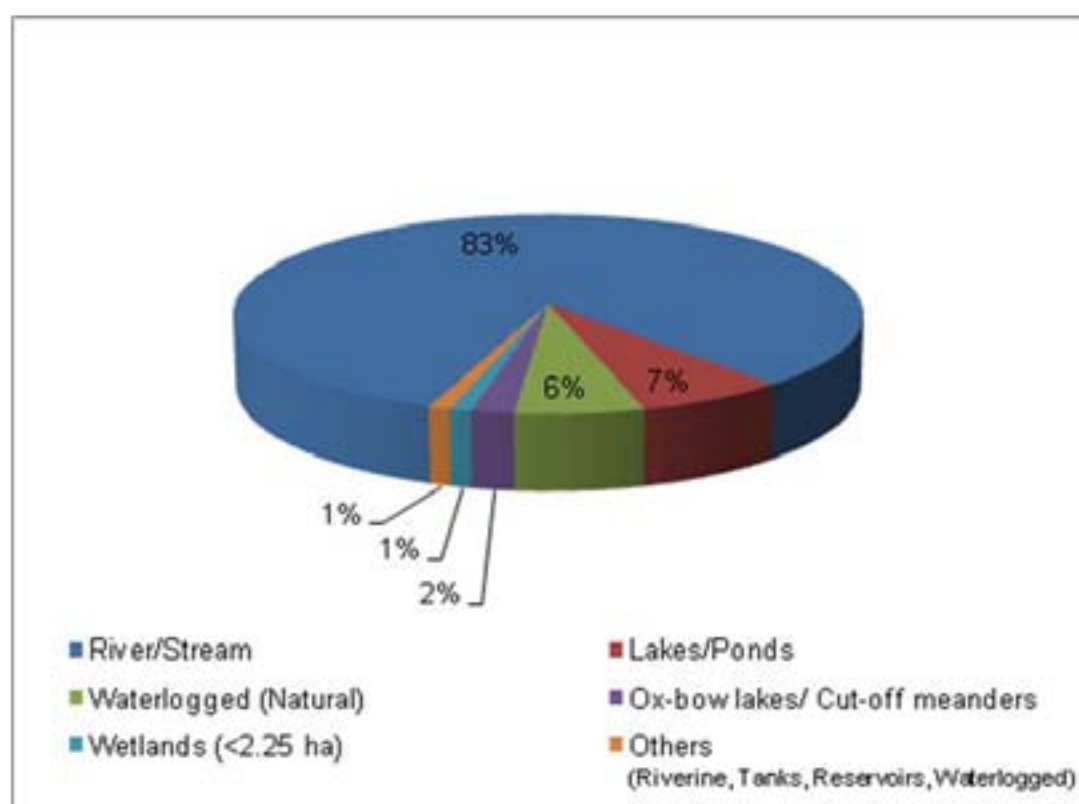


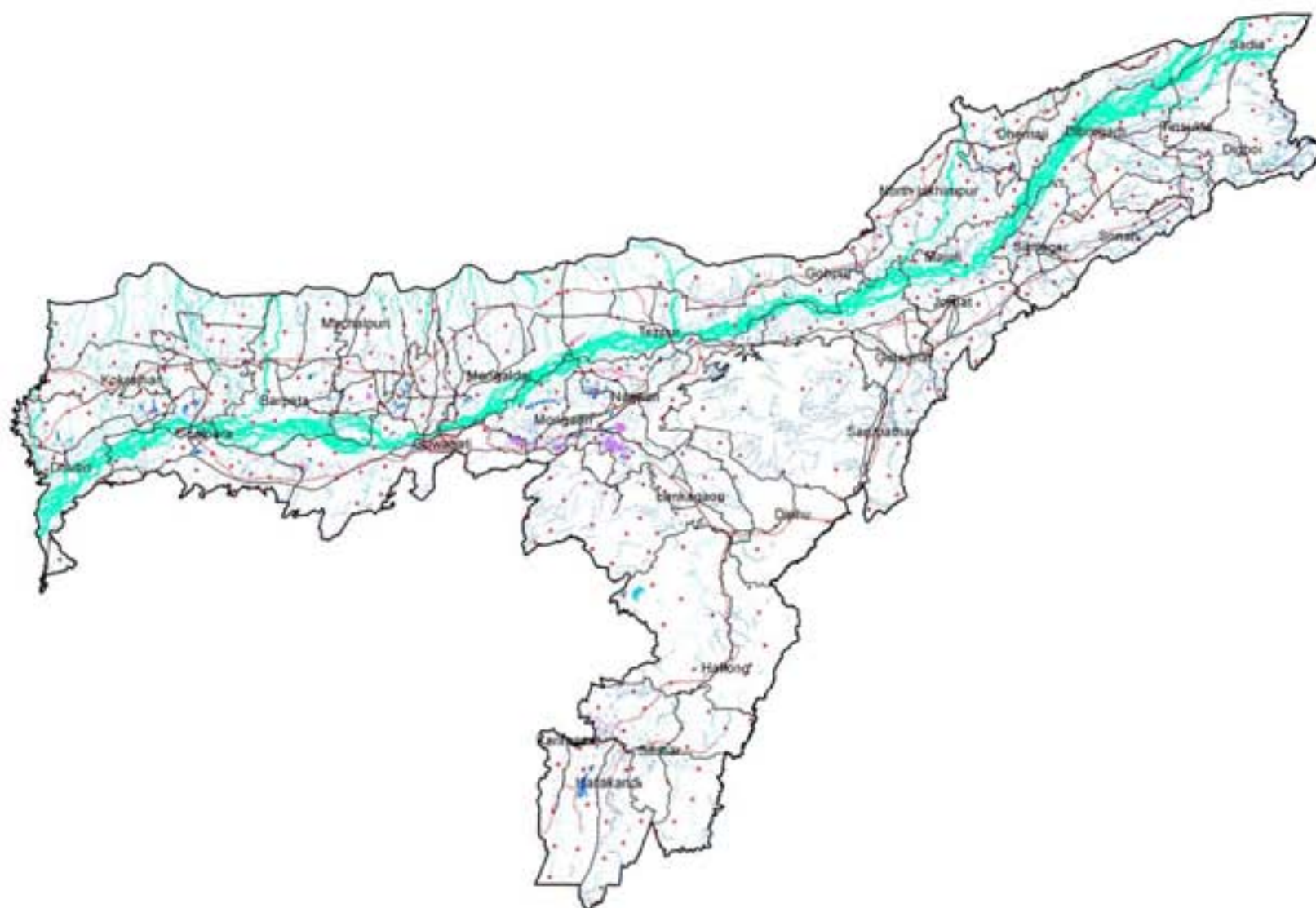
Figure 10: Type-wise wetland distribution in Assam

Table-5: District-wise wetland Area

Sr. No.	District	Geographic Area (sq. km)	Wetland Area (ha)	% of total wetland area	% of district Geographic area
01	Kokrajhar	3129	24833	3.25	7.94
02	Dhubri	2838	56538	7.40	19.92
03	Goalpara	1824	33221	4.35	18.21
04	Bongaigaon	2510	22149	2.90	8.82
05	Barpeta	3245	59038	7.72	18.19
06	Kamrup	4345	43655	5.71	10.05
07	Nalbari	2257	20140	2.63	8.92
08	Darrang	3481	48983	6.41	14.07
09	Marigaon	1704	28737	3.76	16.86
10	Nagaon	3831	35695	4.67	9.32
11	Sonitpur	5324	83427	10.91	15.67
12	Lakhimpur	2277	27307	3.57	11.99
13	Dhemaji	3237	33468	4.38	10.34
14	Tinsukia	3790	40626	5.31	10.72
15	Dibrugarh	3381	72461	9.48	21.43
16	Sibsagar	2668	12582	1.65	4.72
17	Jorhat	2851	45979	6.02	16.13
18	Golaghat	3502	43635	5.71	12.46
19	Karbi Anglong	10434	5810	0.76	0.56
20	North Cachar Hills	4888	6619	0.87	1.35
21	Cachar	3786	10419	1.36	2.75
22	Karimganj	1809	6450	0.84	3.57
23	Hailakandi	1327	2600	0.34	1.96
	Total	78438	764372	100.00	9.74



Figure 11: District-wise graphical distribution of wetlands

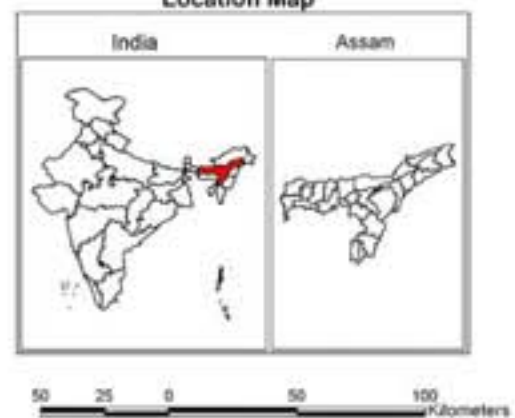


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

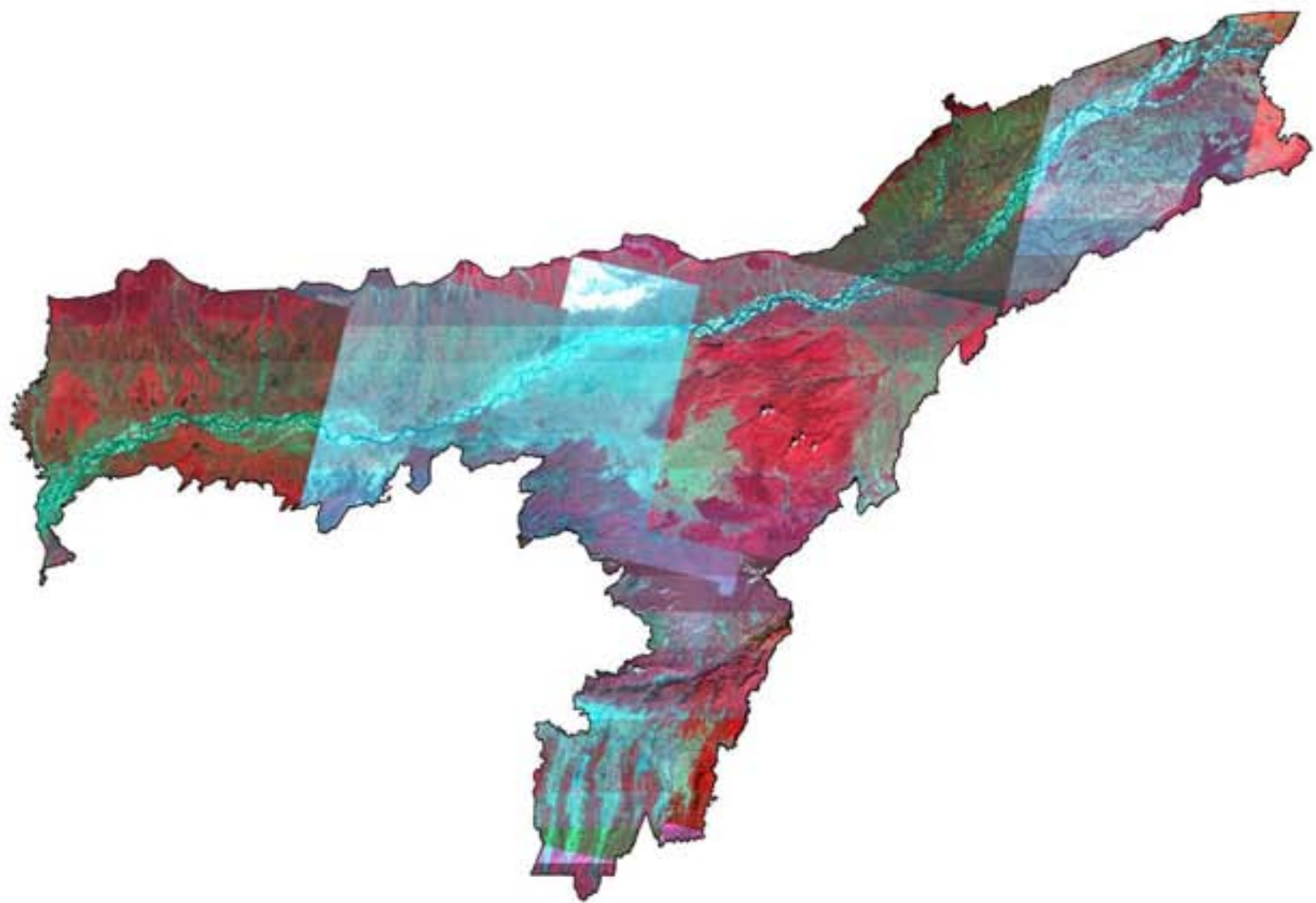
Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Assam



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

7.1.1 Kokrajhar

Kokrajhar district is situated in the lower Brahmaputra valley of Assam between 26° 20'N and 26° 45'N latitudes and 89° 45'E and 91° 00'E longitudes. It occupies 3,49,800 hectares of area. The district is bounded by the inter state boundary of West Bengal on the west and Bhutan in the north. The topography of the district is almost flat, with elevations ranging from 303 meter above m.s.l. in the north and 18 metre above m.s.l. in the south. The major rivers flowing through the district are Gaurang, Ai and Sankosh. All the rivers originate from Bhutan hills and flow into the Brahmaputra. The soil in the hillocks is old mountain valley alluvial and in the foot hills, it is mainly sandy to loamy textured soils. The soil pH ranges from 4.7 to 7.8 i.e. acidic in nature. During monsoon it receives an average rainfall of 248 mm, while in the post monsoon season 280 mm. The maximum and minimum temperatures in the district are 38°C and 10°C respectively. As per Census Report, 2001, the district has a total population of 9, 05,764.

Natural Inland wetlands dominated the district. Total area under wetland is 24833 ha, which includes 152 small wetland (<2.25 ha). River/stream occupies 91.3% of wetlands, followed by Lakes/pond (1.84%) and Waterlogged (1.28%). Under man made wetland type, only one Tank/pond is mapped with 33 ha area. Details of the wetland statistics of the district is given in Table-6.

Aquatic vegetation is not observed in wetlands. Seasonal fluctuation of open water spread is negligible. Qualitative turbidity of water is moderate in both the seasons.

Table-6: Area estimates of wetlands in Kokrajhar

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	37	457	1.84	243	145
2	1102	Ox-bow lakes/ Cut-off meanders	76	1160	4.67	679	331
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	6	32	0.13	32	6
5	1105	Waterlogged	57	318	1.28	214	81
6	1106	River/Stream	105	22681	91.33	22067	22077
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	1	33	0.13	31	19
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	282	24681	99.39	23266	22659
		Wetlands (<2.25 ha), mainly Tanks	152	152	0.61	-	-
		Total	434	24833	100.00	23266	22659

Area under Aquatic Vegetation	-	-
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Area under turbidity levels		
Low	250	161
Moderate	23016	22489
High	-	9

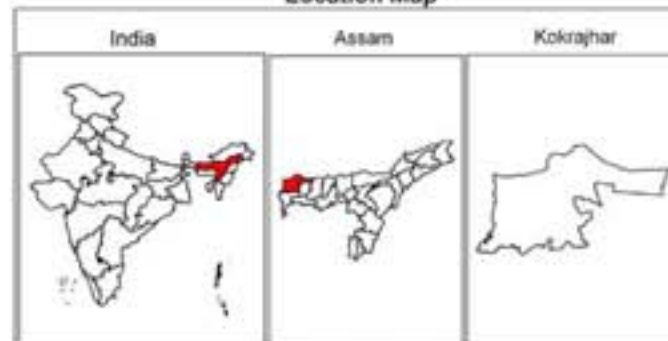


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

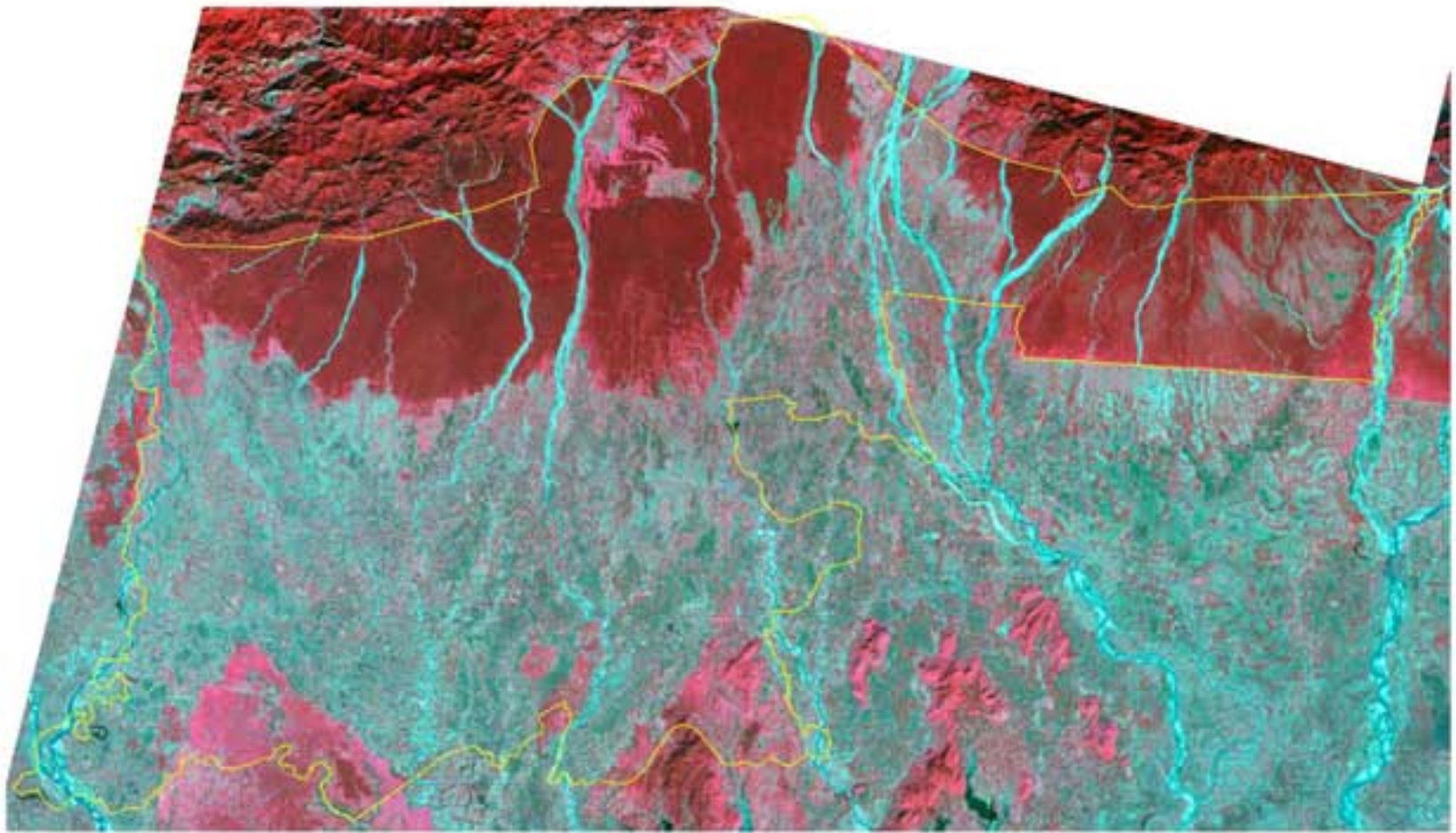


0 4 8 12 Kilometers

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

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

Sponsored By :
Ministry of Environment and Forests
Government of India



7.1.2 Dhubri

The district is situated in the extreme south western part of the lower Brahmaputra valley of Assam between 25°30'N and 26°30'N latitude and 89°40'E and 90°30'E longitude, with an area of 2, 67,572 hectares. The district is characterised by almost flat topography but the eastern part has an undulating topography. The drainage system is dominated by the Brahmaputra river that flows through the district with a sharp south turn in the extreme west end of the district. The northern part is having a number of tributaries of the Brahmaputra namely Champamati, Gourang, Tipkai, Godadhar and Sonkosh which are perennial in nature, originate from Bhutan and flow into the Brahmaputra towards south. Among the southern tributaries, the Jinjiram originates from Urpad beel of Goalpara district and flows parallel to the Brahmaputra for some distance before joining further downstream. The soil in the northern part of the district is composed of Recent Riverine Alluvial soils (Entiso1s), and that of the lowermost part of the district is formed by Old Riverine Alluvial soils (Inceptiso1s). The soil pH of the district varies from 4.5 to 7.5 i.e. acidic to neutral. The annual average rainfall of the district is 2647, mm. The maximum and minimum temperature of the district is 38°C and 7°C respectively. As per 2001 Census, the district has a total population of 16, 37,344.

Total wetland area in the district is 56464 ha that includes 74 small wetlands (<2.25 ha). River/stream occupies 84.5% of wetlands. The second major wetland type is Lake/pond. There are 178 Lake/pond with 5967 ha area (10.55%). The other wetland types are: Ox-bow lakes (2.8%) and Waterlogged-natural (1.8%). Details of wetland statistics is given in Table.7.

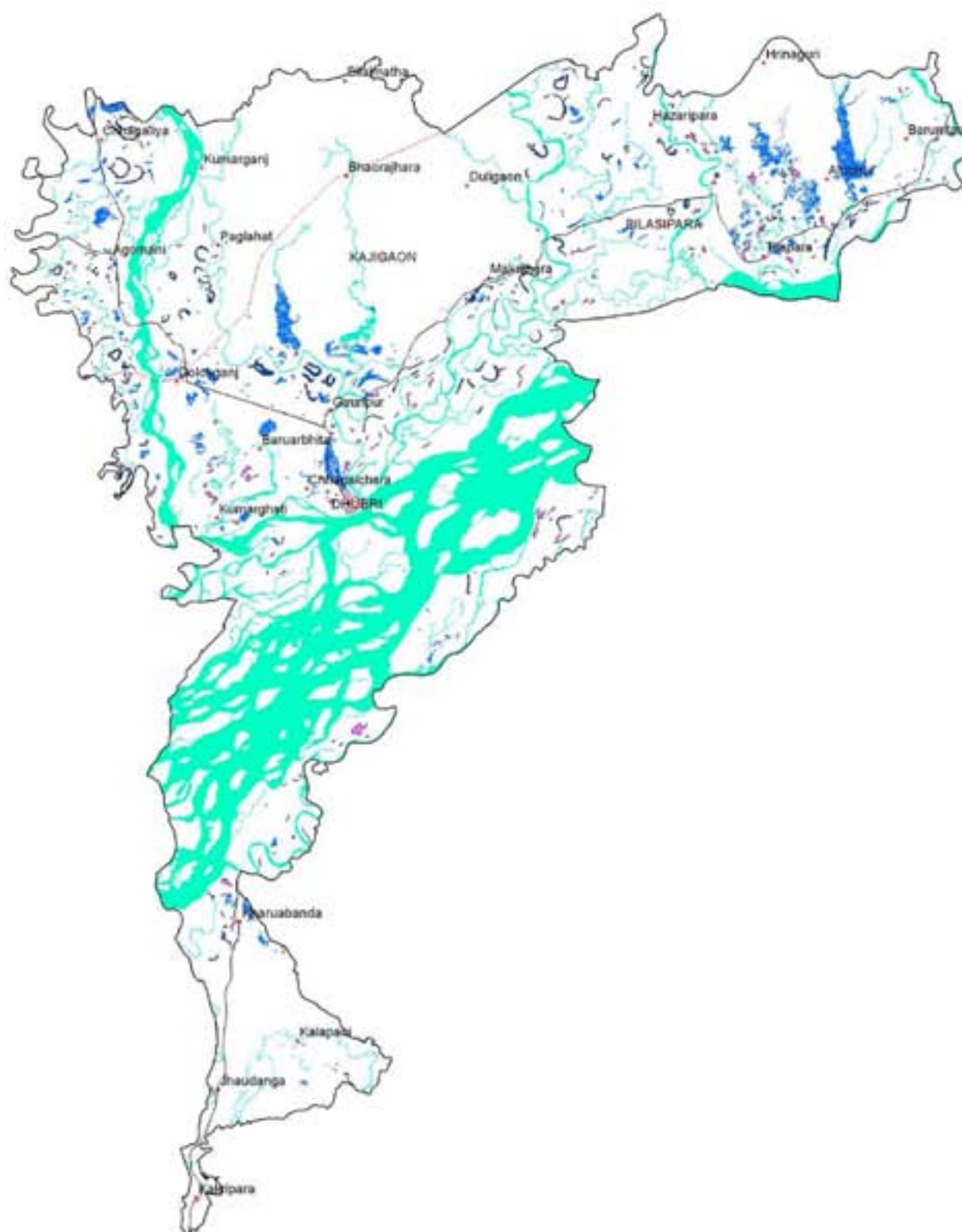
Aquatic vegetation is not observed in wetlands. The open water spread of River/stream is same in both the seasons. However, in case of Lake/pond wetland type, the open water is less (1690 ha) in pre monsoon compared to post monsoon (3703 ha). The turbidity of water is moderate in both the seasons.

Table-7: Area estimates of wetlands in Dhubri

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	178	5967	10.55	3703	1690
2	1102	Ox-bow lakes/ Cut-off meanders	94	1597	2.82	1040	376
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	172	1102	1.95	785	86
6	1106	River/Stream	60	47793	84.53	35541	35541
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	2	5	0.01	3	2
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	506	56464	99.87	41072	37695
		Wetlands (<2.25 ha), mainly Tanks	74	74	0.13	-	-
		Total	580	56538	100.00	41072	37695

Area under Aquatic Vegetation	-	10
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Area under turbidity levels		
Low	4259	1758
Moderate	36813	35937
High	-	-

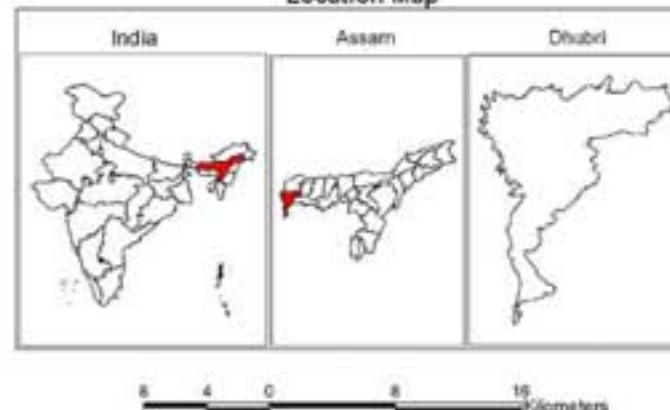


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

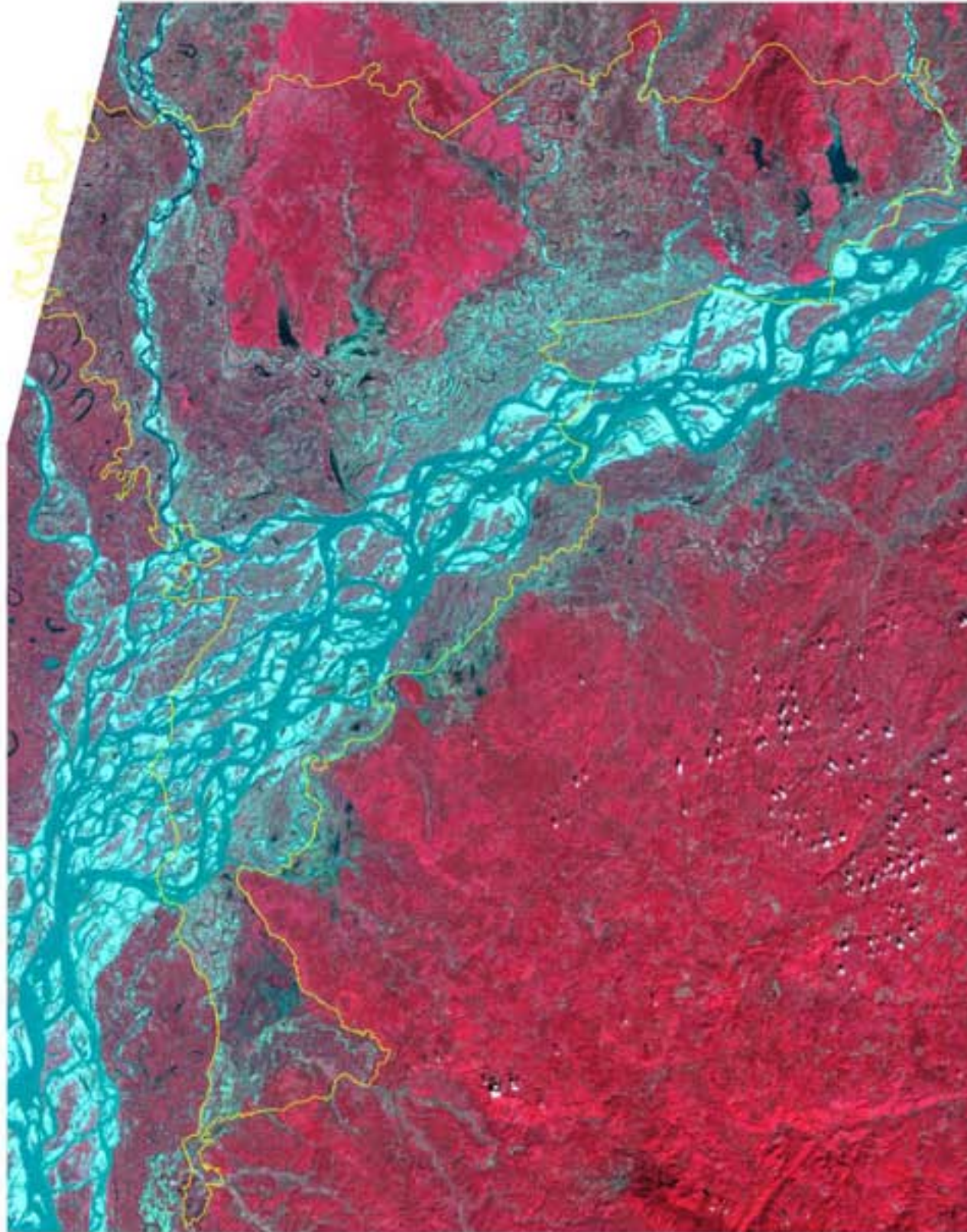
Location Map



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

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

Sponsored By :
Ministry of Environment and Forests
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7.1.3 Goalpara

Goalpara district is situated in the south western part of Assam between 25°53' N and 26° 30' N latitudes and 90°07' E and 91°05' E longitudes having 1,91,100 hectares of area. The Brahmaputra River is flowing along the northern boundary of the district in the east-west direction. The other two main rivers are Dudhnai and Jinjiram. Dhudnai and Krishnai rivers originating from hills of Meghalaya. The rivers are all perennial in nature. The topography of the district is characterised by an almost flat plain except for few hills with elevations ranging from 100 to 500 meters. The soils of the district consist of Newer Alluvium on the bank of the Brahmaputra and Older Alluvium near the hillocks and foot hills. The soil pH ranges from 5.5 to 6.8. The maximum temperature rises up to 33° C during July and August but the minimum temperature falls up to 7° C in January. The average annual rainfall in the district is 1614 mm. As per Census Report, 2001, the district has a total population of 8, 22,035 .A number of wetlands (locally called as Beels) viz. Urpad beel, Hasila beel and several artificial ponds exist in the district.

Total wetland area in the district is 33221 ha that includes 151 small wetlands (<2.25 ha). River/stream occupies 84.77% of wetlands. The other major wetland type is Waterlogged (7.1%) and Lake/pond (7.0%). There are 44 Lake/pond (locally called as Beels) with 2339 ha area. Ox-bow lakes occupied 195 ha area (0.59%). Details of wetland statistics is given in Table.8.

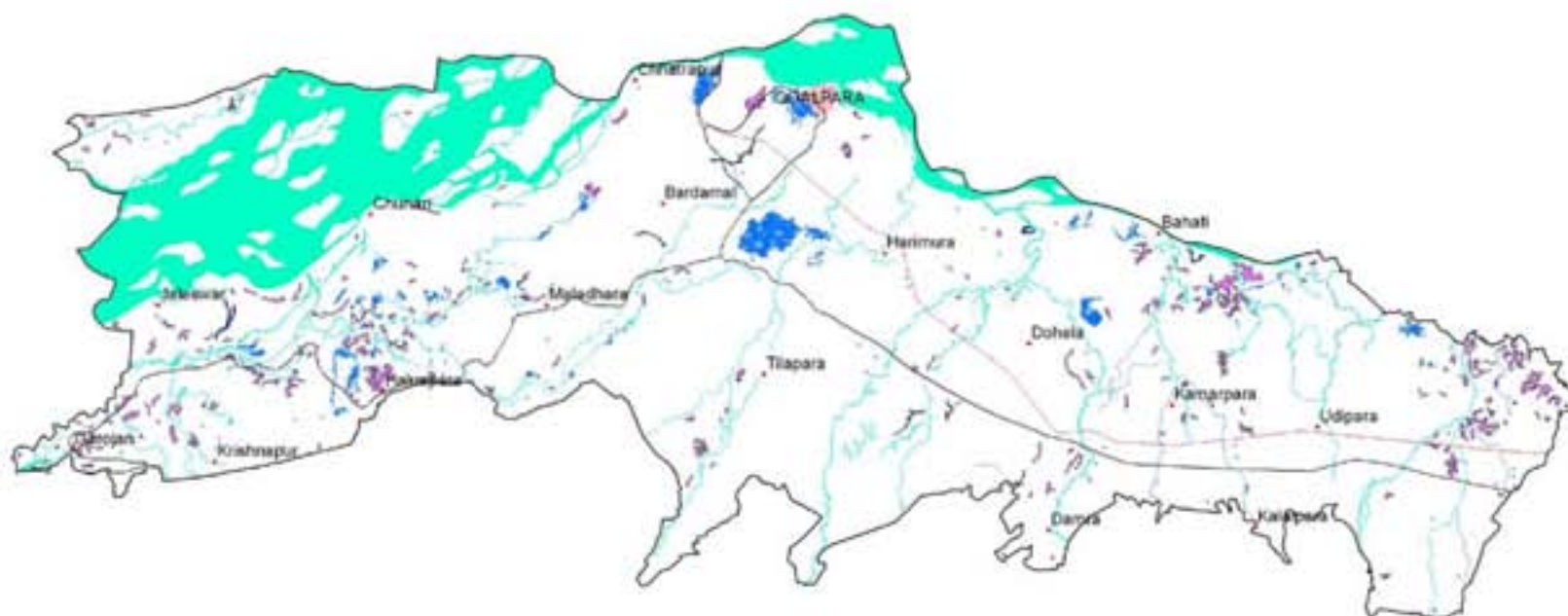
Aquatic vegetation is observed in Lake/pond, Waterlogged wetland types. The area under aquatic vegetation is slightly more in pre monsoon (2670 ha) than that of post monsoon (1901 ha). The open water spread of River/stream is same in both the seasons. However, in case of Lake/pond and Waterlogged wetland types, the open water is less in pre monsoon compared to post monsoon. The turbidity of water is mainly moderate in both the seasons.

Table-8: Area estimates of wetlands in Goalpara

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	44	2339	7.04	1416	1173
2	1102	Ox-bow lakes/ Cut-off meanders	10	195	0.59	39	119
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	245	2374	7.15	1059	939
6	1106	River/Stream	41	28162	84.77	17834	17834
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	-	-	-	-	-
9	1203	Waterlogged	-	-	-	-	-
		Total - Inland	340	33070	99.55	20348	20065
		Sub-Total	340	33070	99.55	20348	20065
		Wetlands (<2.25 ha), mainly Tanks	151	151	0.45	-	-
		Total	491	33221	100.00	20348	20065

Area under Aquatic Vegetation	1901	2670
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Area under turbidity levels		
Low	1959	1887
Moderate	18389	18178
High	0	0

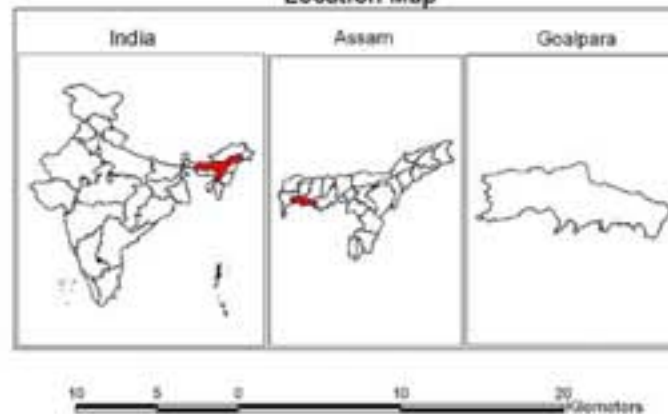


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

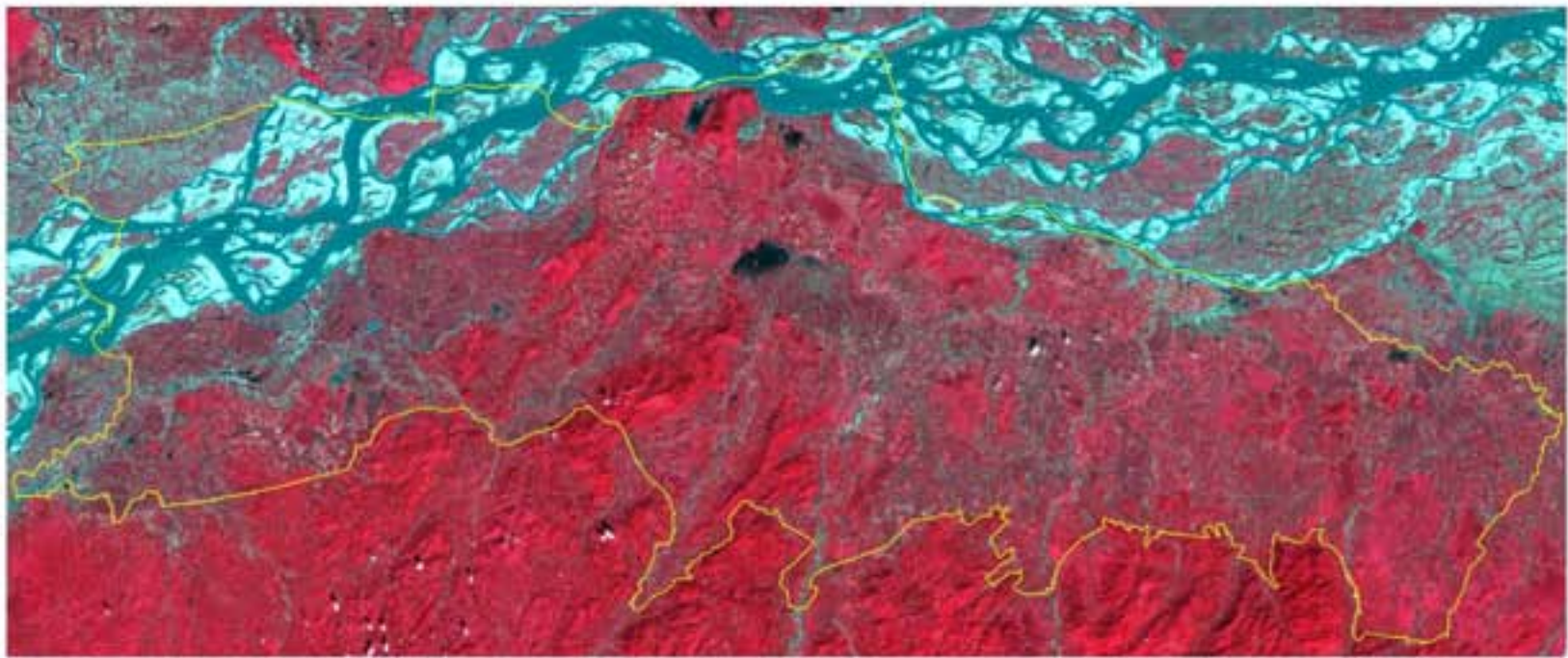
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

Sponsored By :

Ministry of Environment and Forests
Government of India



7.1.4 Bongaigaon

The district is situated in the northwestern part of Assam between 26°10'N and 26°45'N latitudes and 90°50'E and 91°00'E longitudes. It occupies 2, 15,900 hectares of area. It is bounded on the east by Barpeta and on the west by Dhubri district. The topography of the district is n almost flat plain except for few hills with elevations ranging from 100 to 500 metres. The Brahmaputra River flows along the southern part of the district. The other two main rivers are Manas and Ai. Both the rivers rise on the hills of Bhutan, The Rivers are perennial in nature. There are considerable flood prone areas in the district, caused mainly due to inundation by overflowing rivers and congestion of rain water run off from the land side. A number of beels (natural lakes) exist in the district viz. Tamranga , Konara and Dalani. Several artificial ponds are also seen in the district. The soils of the district consist of Newer Alluvium on the bank of the Bramhaputra and Older Alluvium near the hillocks and foot hills. The soil pH ranges from 5.5 to 6.8. The average annual rainfall in the district is 1,614 mm. The maximum temperature rises up to 33° C during July and August but the minimum temperature falls up to 7° C in January. As per Census Report, 2001, the district has a total population of 9, 04,835.

Total wetland area in the district is 22149 ha that includes 71 small wetlands (<2.25 ha). River/stream occupies 84.25% of wetlands. The other major wetland type is Lake/pond (11.37%) and Waterlogged-natural (4.68%). There are 31 Lake/pond (locally called as Beels) with 2519 ha area. Ox-bow lakes occupied 519 ha area (2.34%). Details of wetland statistics is given in Table.9.

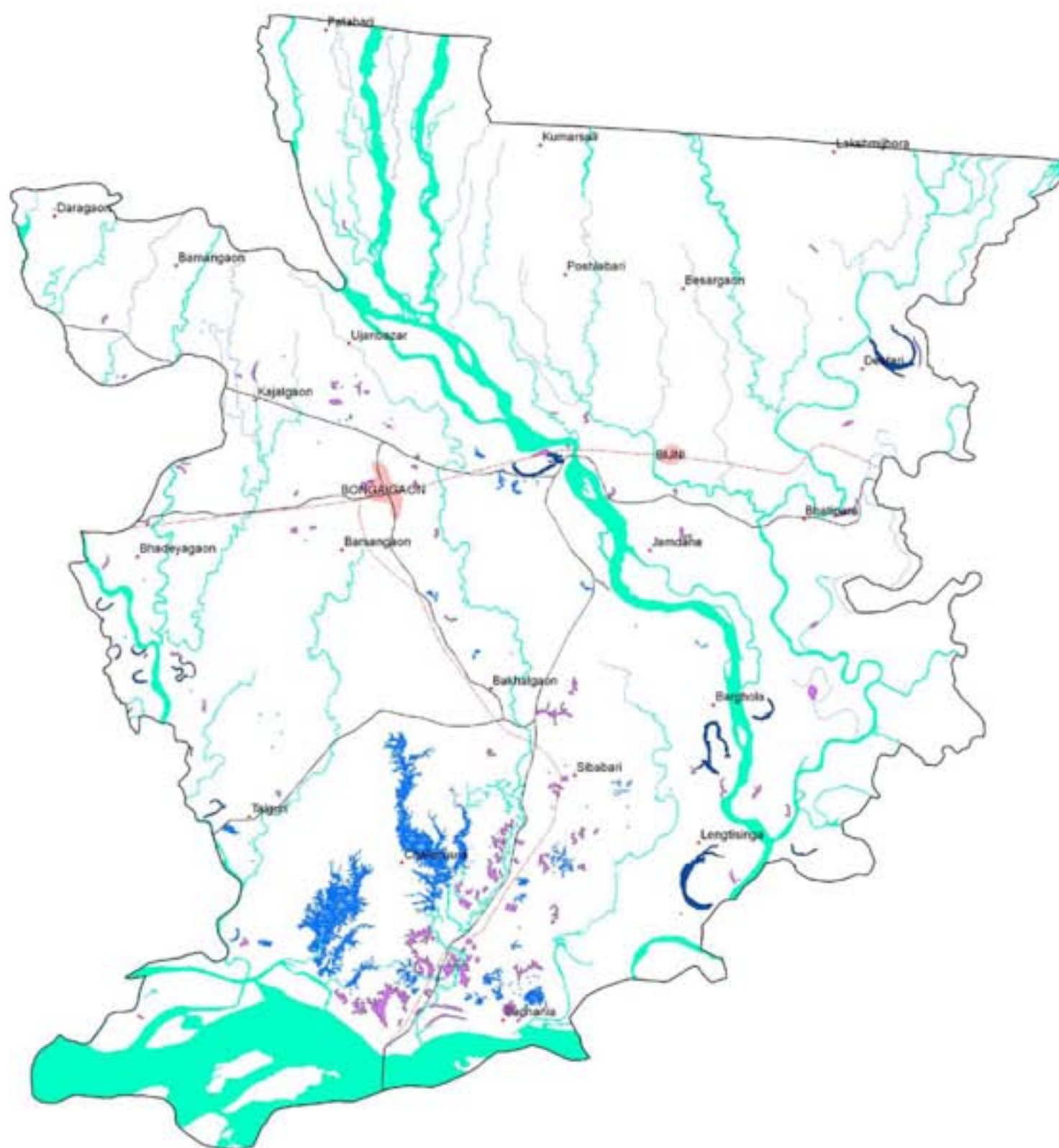
Aquatic vegetation is observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is slightly more in pre monsoon (2353 ha) than that of post monsoon (1571 ha). The open water spread of River/stream is same in both the seasons. However, in case of Lake/pond and Waterlogged wetland types, the open water is less in pre monsoon compared to post monsoon. The turbidity of water is mainly moderate in both the seasons.

Table-9: Area estimates of wetlands in Bongaigoan

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	31	2519	11.37	1781	1224
2	1102	Ox-Bow Lakes/Cutt-Off Meanders	13	519	2.34	203	141
3	1103	High altitude Wetlands	-	-	-	-	-
4	1104	Riverine Wetlands	2	8	0.04	6	0
5	1105	Waterlogged	104	1036	4.68	449	362
6	1106	River/Stream	47	17996	81.25	12494	12494
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	-	-	-	-	-
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	197	22078	99.68	14933	14221
		Wetlands (<2.25 ha), mainly Tanks	71	71	0.32	-	-
		Total	268	22149	100.00	14933	14221

Area under Aquatic Vegetation	1571	2353
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Area under turbidity levels		
Low	1567	1583
Moderate	13366	12638
High	-	-

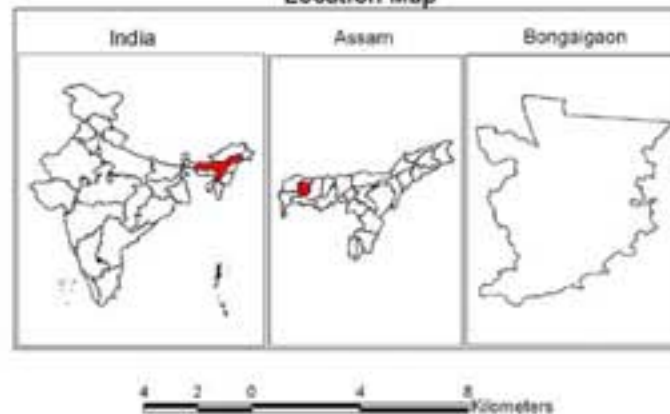


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

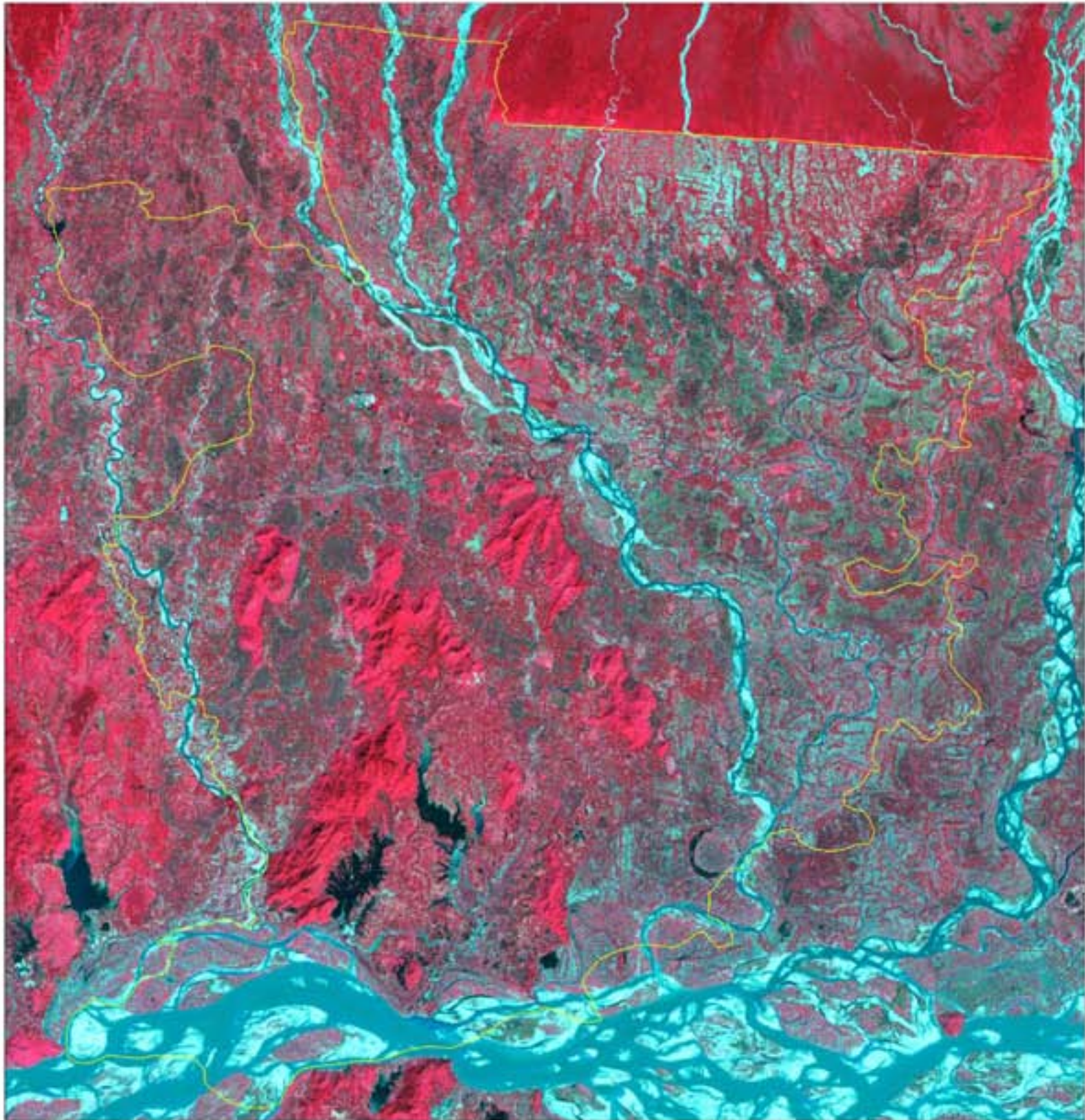
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

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7.1.5 Barpeta

The district is situated in the lower Brahmaputra valley of Assam between 26°5'N and 26°51 'N latitudes and 90°38'E and 91°20'E longitudes. It occupies 320704 hectares of area. It is bounded by Nalbari District on the east and its north boundary is marked by the kingdom of Bhutan. The district is characterised by almost plain topography with the highest elevation of 200 m above m.s.l. in north, while in the south it is below 18 m above m.s.l. The rivers flowing through the district are Tihu, Kaldia, Pahumara, Palla, Beki and Bhalukadoba which originate from Bhutan hills and are perennial in nature. The southern side of the district is very low lying and is frequently subjected to flood. Besides these, there are a number of small streams, abandoned channels and marshy lands. The major soil groups are Recent Riverine Alluvial Soil (Entisols), Old Riverine Alluvial soils (Inceptisols) and Old Mountain Valley Alluvial soils (Alfisols). The general pH value of the soils of the district varies from 4.5 to 7.3 i.e. acidic to neutral. The area receives an average rainfall of 1409 mm. The maximum and minimum temperatures recorded for the district are 35°C and 7°C respectively. As per Census Report, 2001, the district has a total population of 16, 47,201.

Total wetland area in the district is 59038 ha that includes 195 small wetlands (<2.25 ha). River/stream occupies 93.22% of wetlands. The other major wetland type is Lake/pond (4.48%) and Waterlogged (1.57%). There are 37 Lake/pond (locally called as Beels) with 2644 ha area. Ox-bow lakes occupied 235 ha area (0.4%). Details of wetland statistics is given in Table.10.

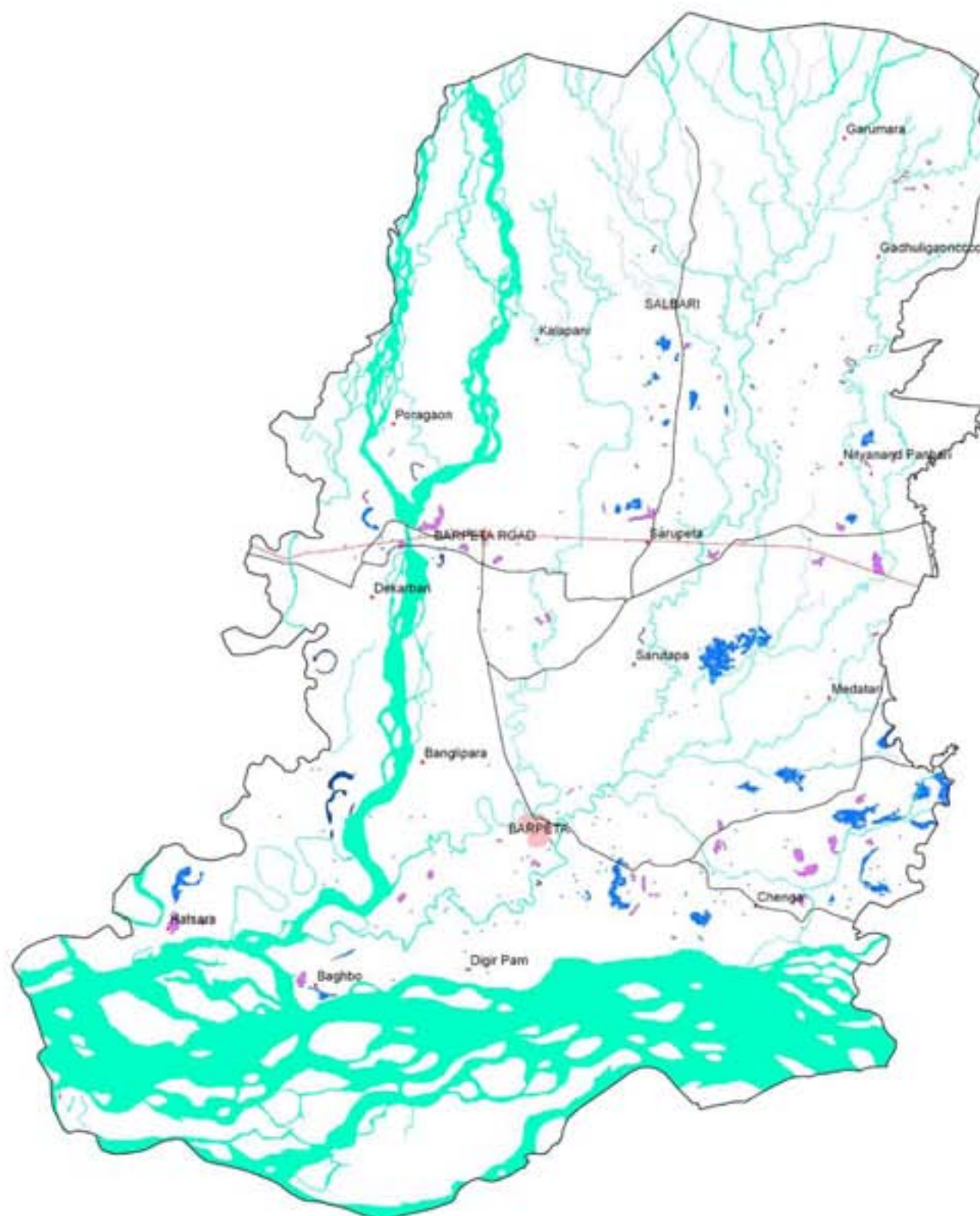
Aquatic vegetation is observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is slightly more in pre monsoon (2967 ha) than that of post monsoon (1187 ha). The open water spread of River/stream is same in both the seasons. However, in case of Lake/pond and Waterlogged wetland types, the open water is less in pre monsoon compared to post monsoon. The turbidity of water is mainly moderate in both the seasons.

Table-10: Area estimates of wetlands in Barpeta

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	37	2644	4.48	1730	589
2	1102	Ox-bow lakes/ Cut-off meanders	14	235	0.40	214	67
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	62	927	1.57	676	209
6	1106	River/Stream	44	55037	93.22	28542	28542
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	-	-	-	-	-
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	157	58843	99.67	31162	29407
		Wetlands (<2.25 ha), mainly Tanks	195	195	0.33	-	-
		Total	352	59038	100.00	31162	29407

Area under Aquatic Vegetation	1187	2967
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Area under turbidity levels		
Low	2468	511
Moderate	28694	28896
High	-	-

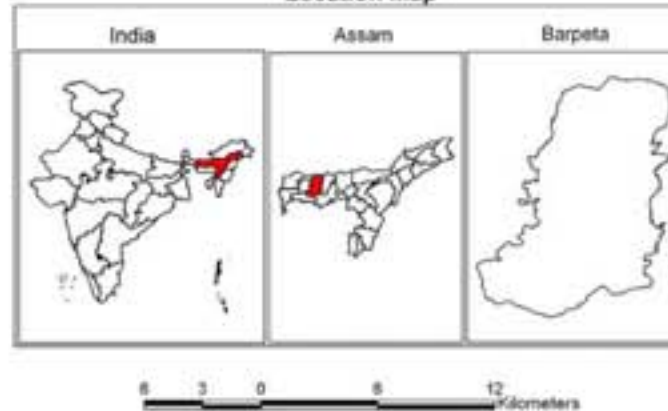


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

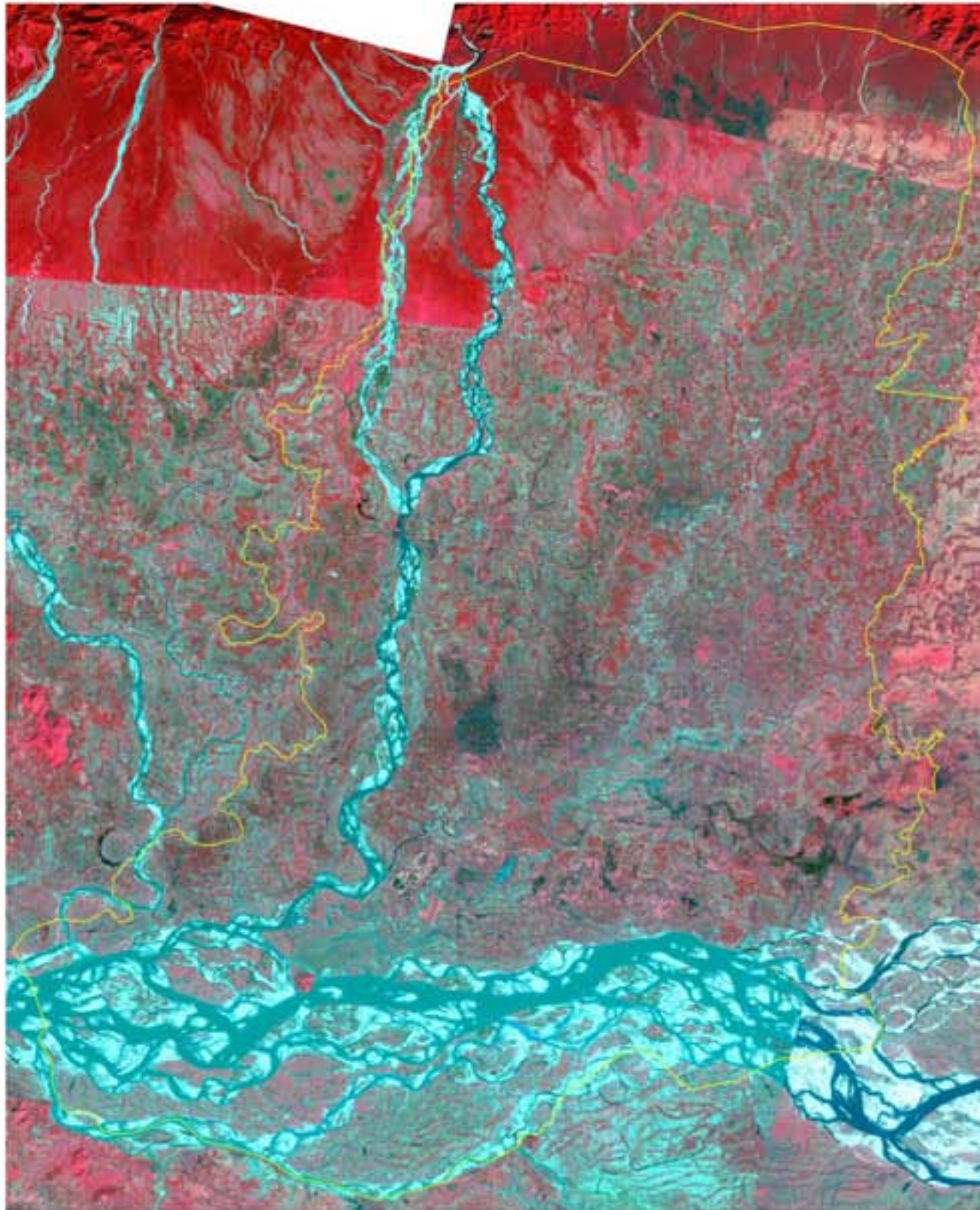
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

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7.1.6 Kamrup

The district is situated in the lower Brahmaputra valley of Assam between 25°44' N and 26°51'N latitudes and 90°56'E and 92°10' E longitudes, with total area of 4,35,009 hectares. It is bounded by Darrang and Nagaon district on the east and the northern boundary is marked by the Kingdom of Bhutan and the Southern boundary is covered by Meghalaya State. The northern and southern parts of the district are characterised by hill ranges. The middle portion of the district, being a part of the Brahmaputra valley, is characterised by almost plain topography. The drainage system of the district is represented by the river Brahmaputra and its tributaries, namely Barnadi, Puthimari, Sessa Noi, Baralia and Nona. All these rivers originate from the Bhutan hills and subsequently flow into the Brahmaputra. Several rivers originating from the Khasi hills in the south, namely Digaru, Kulsi, Kukurmara, Boko and Singra also flow into the Brahmaputra. The general pH value of the soils of the district varies from 4.5 to 6.2. The average rainfall is 2124 mm. The maximum and minimum temperatures recorded in the district are 35°C and 6°C respectively. As per Census Report, 2001, the district has a total population of 25, 22,324.

Total wetland area in the district is 43655 ha that includes 228 small wetlands (<2.25 ha). River/stream occupies 68.29% of wetlands. The other major wetland type is Lake/pond (14.25%) and Waterlogged (15.51%). There are 74 Lake/pond (locally called as Beels) with 6220 ha area. The other wetland types are: Ox-bow lakes (0.62%) and Riverine (0.71%). Details of wetland statistics is given in Table.11.

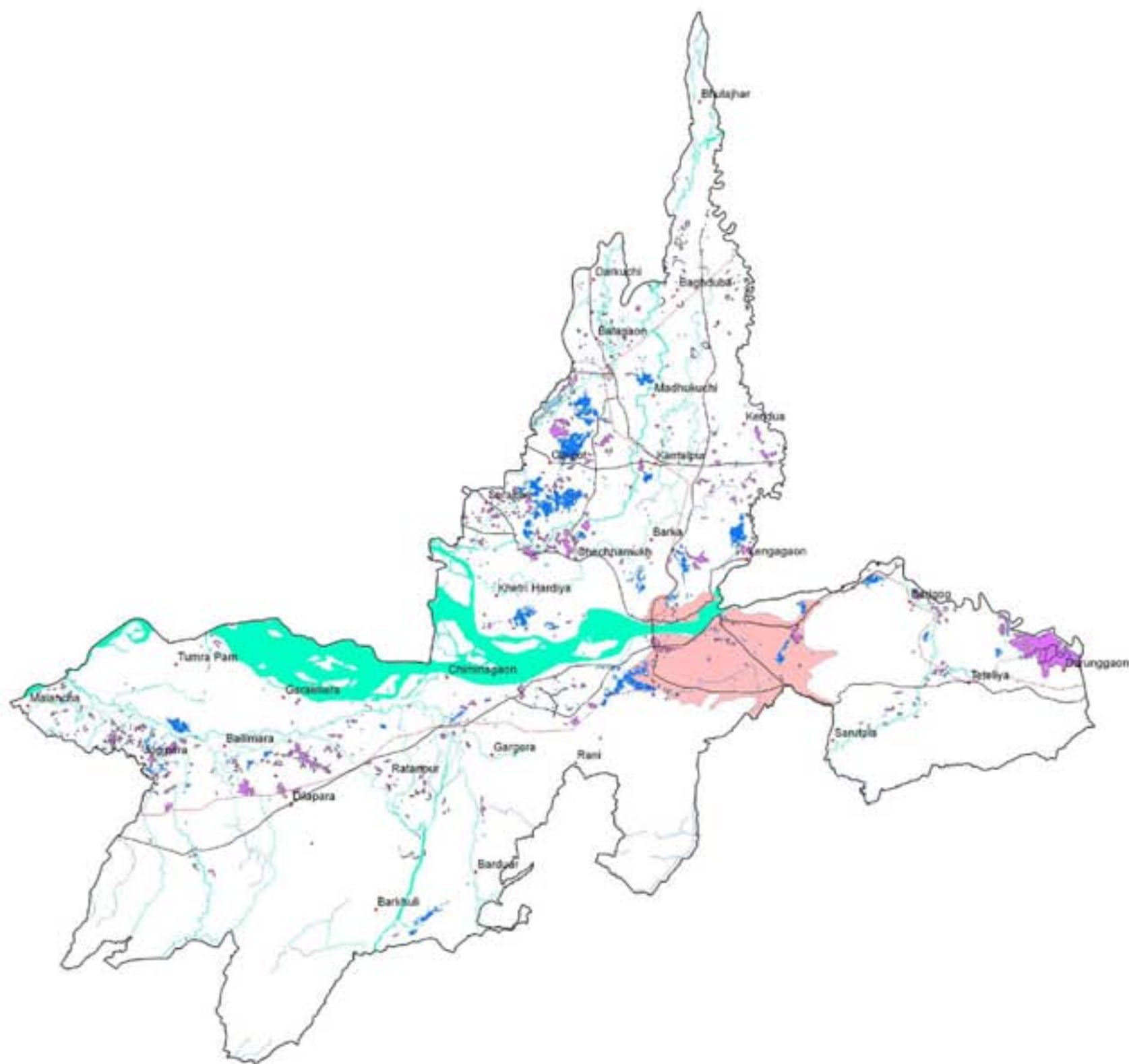
Aquatic vegetation is observed in Lake/pond, Waterlogged wetland types. The area under aquatic vegetation is significantly high in pre monsoon (9833 ha) than that of post monsoon (2992 ha). The open water spread of River/stream is same in both the seasons. However, in case of Lake/pond and Waterlogged wetland types, the open water is less in pre monsoon compared to post monsoon. The turbidity of water is moderate to low in both the seasons

Table-10: Area estimates of wetlands in Kamrup

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Pond	74	6220	14.25	4082	1369
2	1102	Ox-Bow Lakes/ Cut-Off Meanders	36	271	0.62	209	114
3	1103	High altitude Wetlands	-	-	-	-	-
4	1104	Riverine Wetlands	11	310	0.71	225	56
5	1105	Waterlogged	441	6769	15.51	6036	2361
6	1106	River/Stream	41	29813	68.29	14512	14512
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/ Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	11	44	0.10	42	31
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	614	43427	68.39	25106	18443
		Wetlands (<2.25 ha), mainly Tanks	228	228	0.52	-	-
		Total	842	43655	68.92	25106	18443

Area under Aquatic Vegetation	2992	9833
--------------------------------------	------	------

Area under turbidity levels		
Low	10188	3148
Moderate	14918	15246
High	-	49

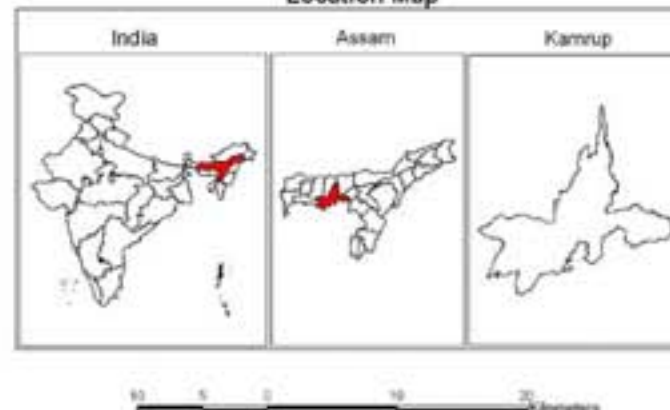


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

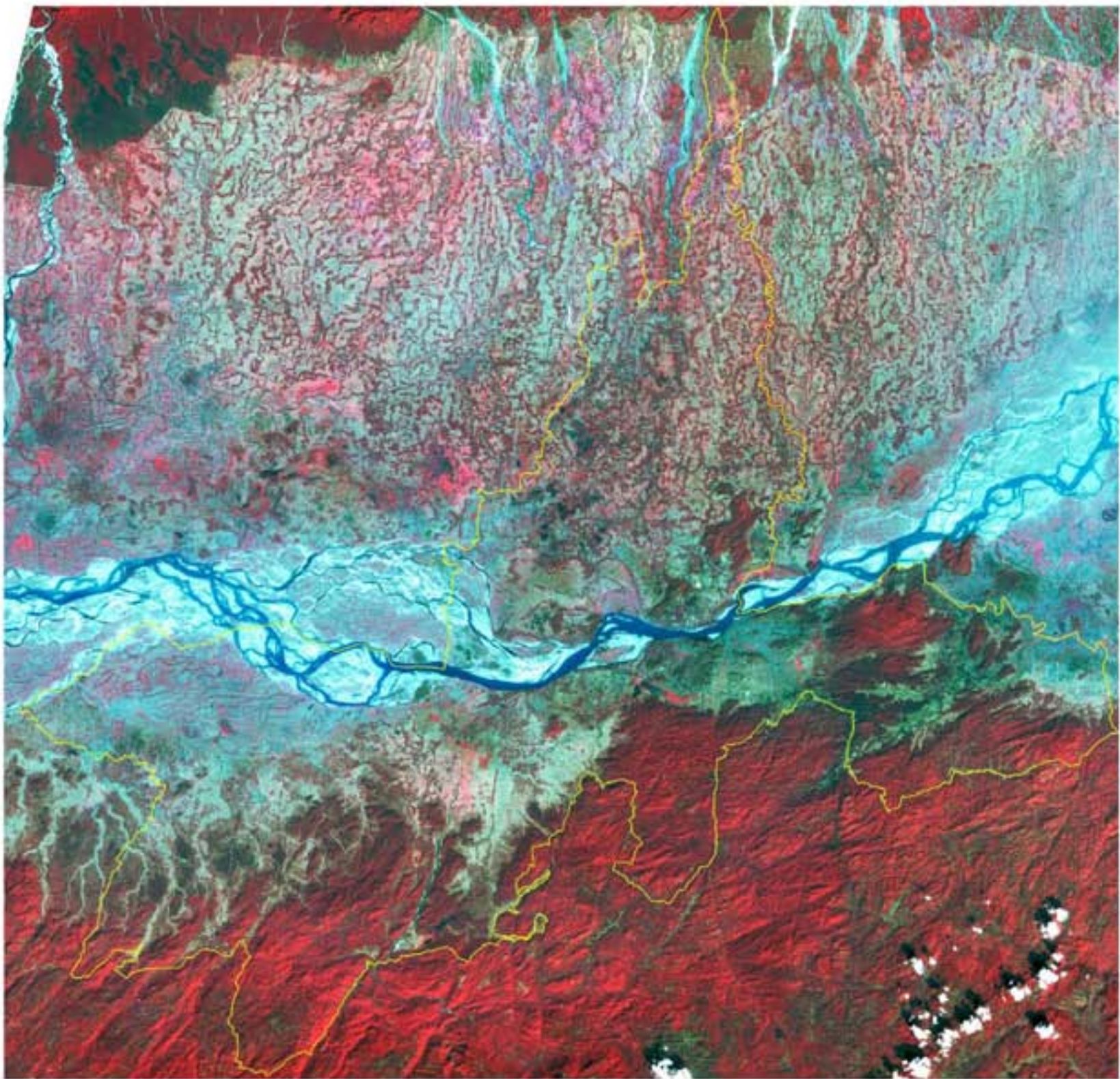
Location Map



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

Prepared By :
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Assam Remote Sensing Applications Centre, Guwahati

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7.1.7 Nalbari

The district is situated in the lower Brahmaputra valley of Assam between 26°07'N and 26°51'N latitude and 91°13'E and 91°43'E longitude. It occupies 221844 hectares area. The district is characterised by almost plain topography with the highest elevation in the north is 219.6 m. above MSL and that in the south below 18 m. above m.s.l.. All the rivers are perennial in nature. The rivers flowing through the district are Pagladia, Nona, Baralia, Mara Pagladia and Buradia. All these rivers originate from Bhutan hills. There are some small streams, abandoned channels and marshy lands existing in the district. The soil texture of the north zone in the district is clay loam and that of south zone sandy loam. The soil pH varies from 4.5 to 7.0 i.e. acidic to neutral. The maximum and minimum temperatures are 35°C and 6°C respectively. The normal rainfall in the district is 2685.5 mm. As per Census Report, 2001, the district has a total population of 11,48,824.

Total wetland area in the district is 20140 ha that includes 239 small wetlands (<2.25 ha). River/stream occupies 87.92% of wetlands. The other major wetland type is Lake/pond (2.63%) and Waterlogged (6.92%). There are 15 Lake/pond (locally called as Beels) with 529 ha area. Details of wetland statistics is given in Table.12.

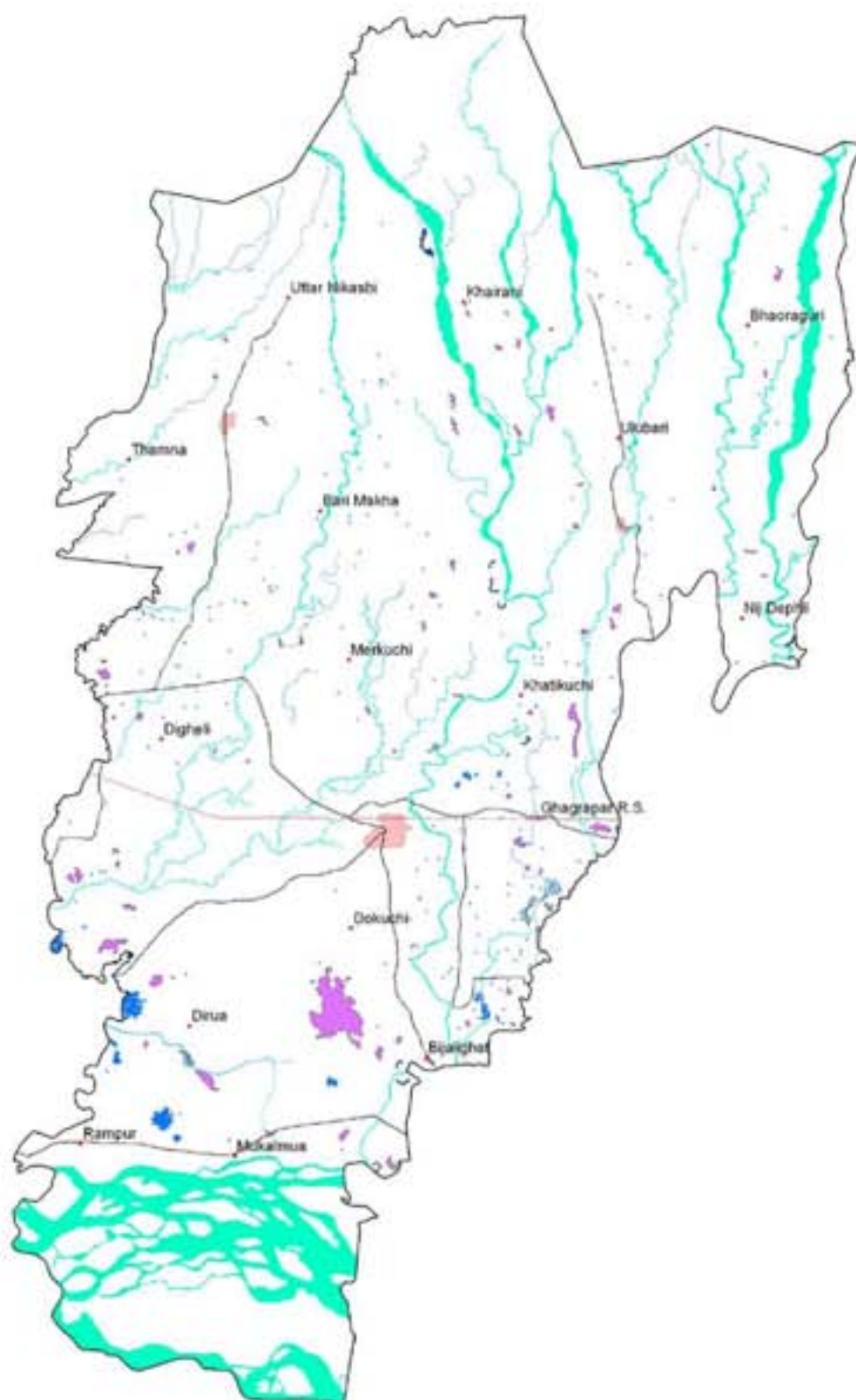
Aquatic vegetation is observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is slightly more in pre monsoon (1811 ha) than that of post monsoon (460 ha). The open water spread of River/stream is same in both the seasons. However, in case of Lake/pond and Waterlogged wetland types, the open water is less in pre monsoon compared to post monsoon. The turbidity of water is mainly moderate in both the seasons

Table-12: Area estimates of wetlands in Nalbari

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	15	529	2.63	338	50
2	1102	Ox-Bow Lakes/ Cut-Off Meanders	12	104	0.52	94	76
3	1103	High altitude Wetlands	-	-	-	-	-
4	1104	Riverine Wetlands	8	160	0.79	82	16
5	1105	Waterlogged	75	1393	6.92	1212	237
6	1106	River/Stream	32	17707	87.92	10315	10315
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	3	8	0.04	8	6
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	145	19901	98.81	12049	10700
		Wetlands (<2.25 ha), mainly Tanks	239	239	1.19	-	-
		Total	384	20140	100.00	12049	10700

Area under Aquatic Vegetation	460	1811
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Area under turbidity levels		
Low	1725	163
Moderate	10324	10537
High	-	-

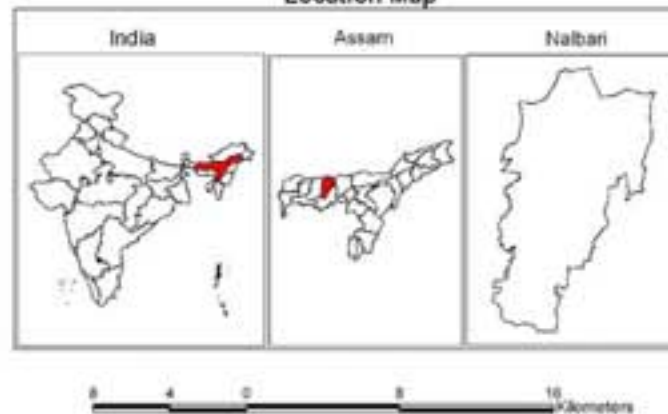


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

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7.1.8 Darrang

The district is situated in the northern part of Assam State between 26°10'N and 26°58'N Latitudes and 91°43'E and 92°22'E longitudes. It occupies 341399 hectares of area. It is bounded on the east by Sonitpur district, on the north by Bhutan and Arunachal Pradesh and on the south by the river Brahmaputra. The topography of the district is almost flat Swampy areas and naturally depressed vast wetlands locally known as beels constitute a sizeable area. The major rivers that traverse through the district are Barnoi, Nanai, Noa-nai, Mangaldai nai, Mora Dhansiri and Dhansiri. The rivers are all perennial in nature. Both new Alluvium Soils (Entisols) and old Alluvium soils (Inceptisols) are found in the district. The average annual rainfall recorded is 1477.72 mm. The maximum temperature recorded is 35.6°C in the month of July-August and the minimum is 6°C in the months of December - January. As per Census Report, 2001, the district has a total population of 15, 04,320

Total wetland area in the district is 48983 ha that includes 450 small wetlands (<2.25 ha). River/stream occupies 93.44% of wetlands. The other major wetland type is Lake/pond (2.62%) and Waterlogged (1.95%). There are 14 Lake/pond (locally called as Beels) with 1282 ha area. Details of wetland statistics is given in Table.13.

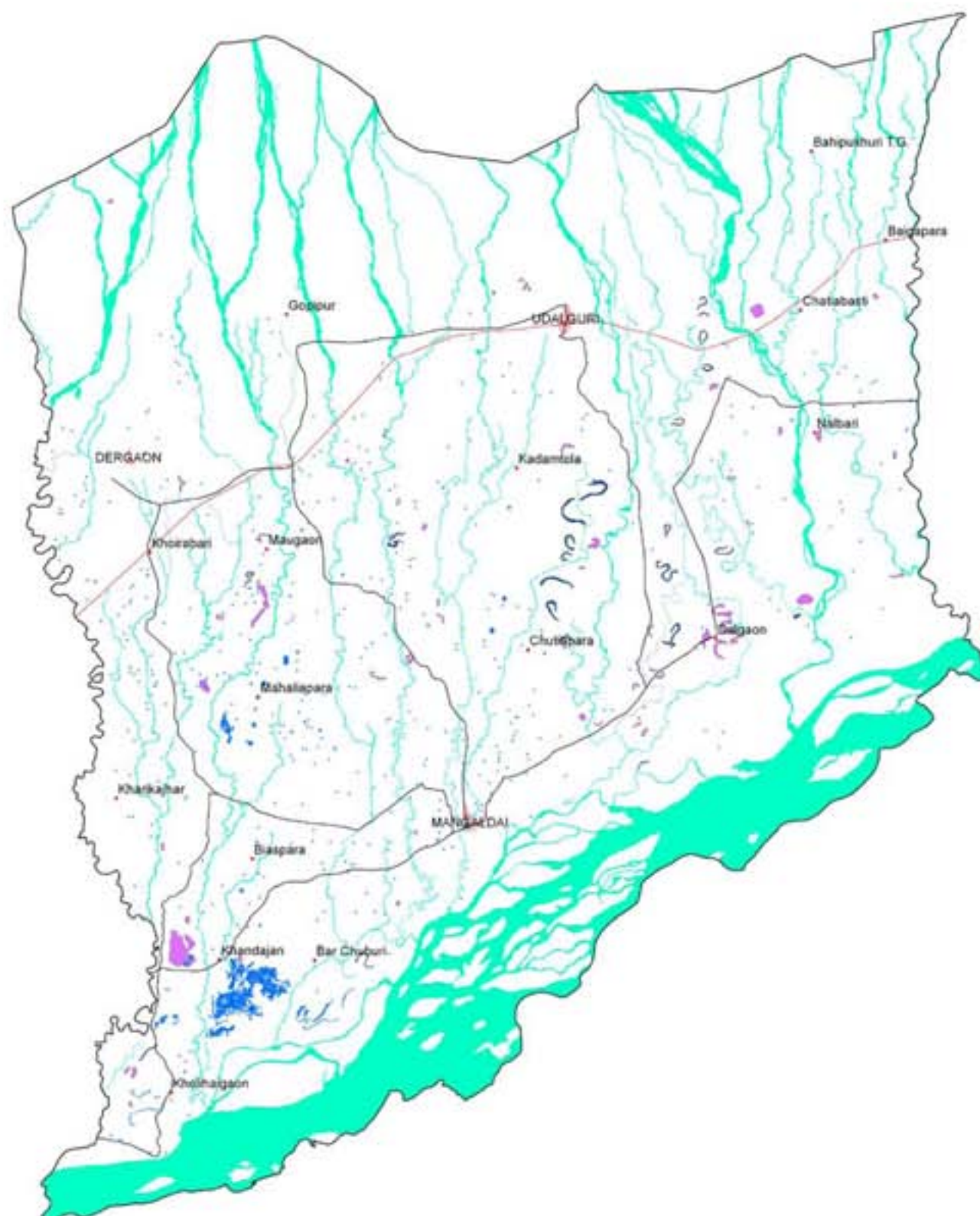
Aquatic vegetation is observed in Lake/pond, Waterlogged wetland types. The area under aquatic vegetation is slightly more in pre monsoon (2288 ha) than that of post monsoon (917 ha). The open water spread of River/stream is almost same in both the seasons. However, in case of Lake/pond and Waterlogged wetland types, the open water is less in pre monsoon compared to post monsoon. The turbidity of water is mainly moderate in both the seasons

Table-13: Area estimates of wetlands in Darrang

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	14	1282	2.62	810	77
2	1102	Ox-bow lakes/ Cut-off meanders	25	404	0.82	372	44
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	1	8	0.02	8	0
5	1105	Waterlogged	50	955	1.95	541	245
6	1106	River/Stream	40	45772	93.44	25788	25706
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	25	112	0.23	112	112
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	155	48533	99.08	27631	26184
		Wetlands (<2.25 ha), mainly Tanks	450	450	0.92	-	-
		Total	605	48983	100.00	27631	26184

Area under Aquatic Vegetation	917	2288
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Area under turbidity levels		
Low	1844	308
Moderate	25787	25876
High	-	-

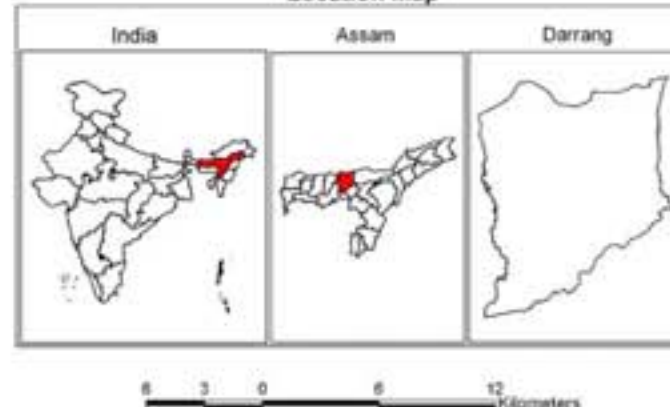


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

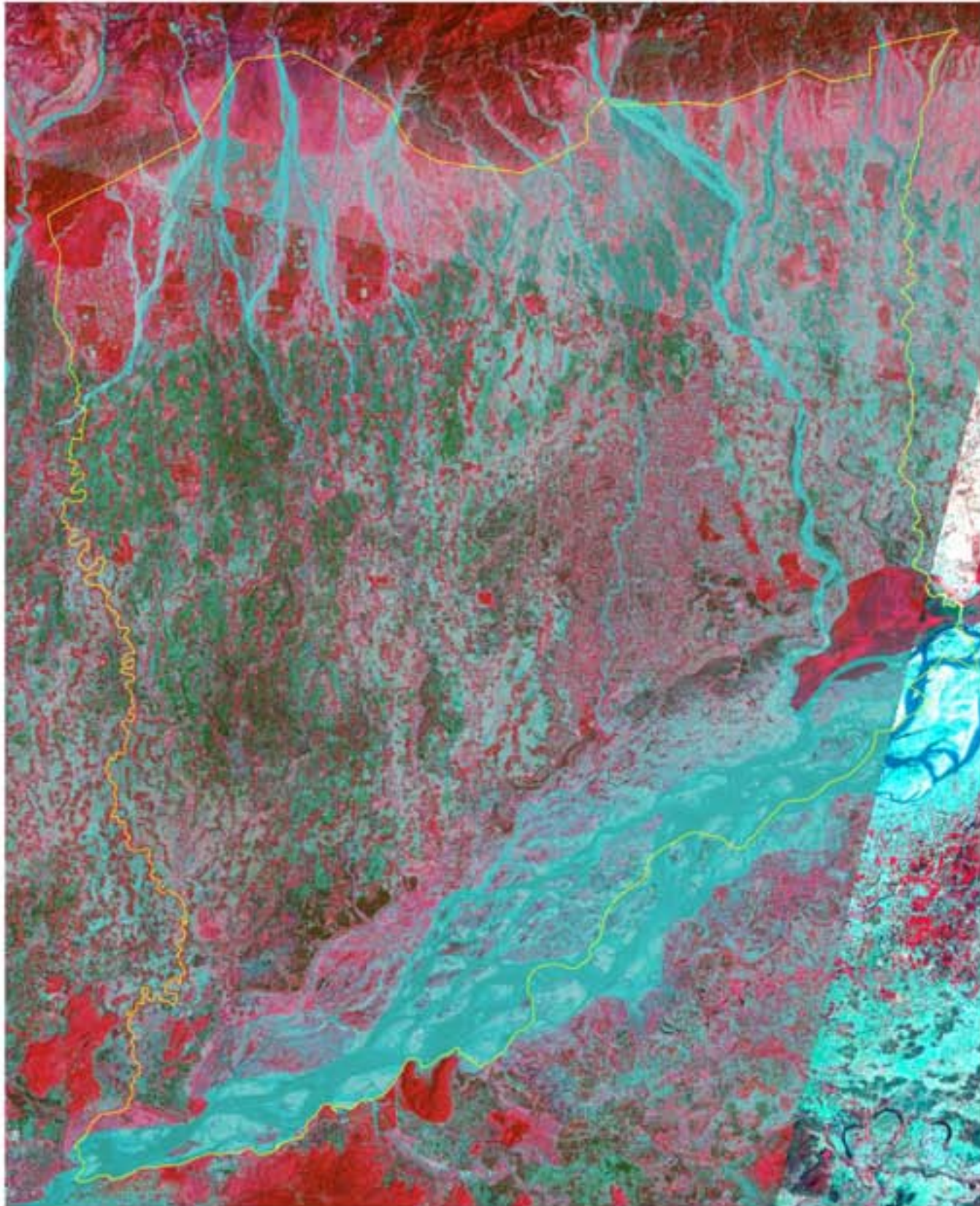
Location Map



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

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
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Assam Remote Sensing Applications Centre, Guwahati

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7.1.9 Marigaon

The district is situated in the Central Brahmaputra valley of Assam between 26° 00' N and 26° 40'N latitudes and 91° 59'E and 92° 35'E longitudes. It occupies 1, 91,100 hectares of area. It is bounded on the east by Nagaon district, on the west by Kamrup district, on the north by Darrang district and south by Karbi Anglong district. The topography of the district is almost flat plain. The Brahmaputra river flows on the northern side of the district. The flood plain along the river Brahmaputra and its tributaries suffer from regular floods during the rainy season. The other major rivers are Kapili, Kalang, Killing and Barapani. The rivers flowing through the district are all perennial in nature. A number of ox-bow lakes and ponds also exist in the district. Besides, there are many low lying areas and swamps. The soils of the district vary from sandy to clay loam and acidic to near neutral in nature. The normal rainfall in the district is 2000 mm. The average minimum and maximum temperatures are 8° C (in January) and 34.3° C (during July/Augus) respectively. As per Census Report, 2001, the district has a total population of 7, 76,256

Total wetland area in the district is 28737 ha that includes 158 small wetlands (<2.25 ha). River/stream occupies 57.65% of wetlands. The other major wetland type is Lake/pond (21.3%) and Waterlogged (17.08%). There are 96 Lake/pond (locally called as Beels) with 6121 ha area. Details of wetland statistics is given in Table.14.

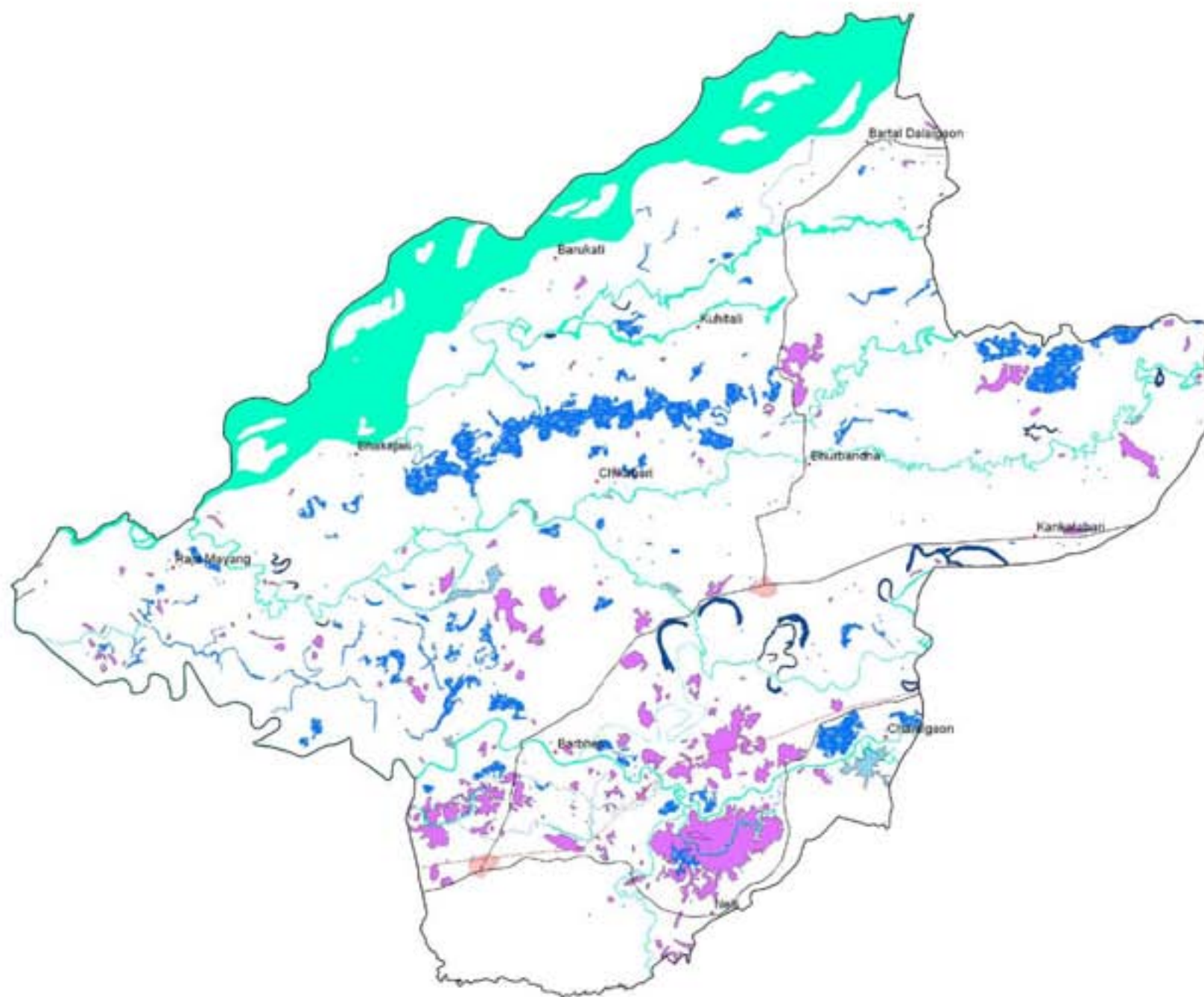
Aquatic vegetation is observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is significantly more in pre monsoon (10118 ha) than that of post monsoon (2328 ha). The open water spread of River/stream show slight seasonal variation. However, in case of Lake/pond and Waterlogged wetland types, the open water is less in pre monsoon compared to post monsoon. The turbidity of water is low to moderate in post monsoon and mainly moderate in pre monsoon.

Table-14: Area estimates of wetlands in Marigaon

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	96	6121	21.30	4494	879
2	1102	Ox-Bow Lakes/ Cut-Off Meanders	16	613	2.13	375	271
3	1103	High altitude Wetlands	-	-	-	-	-
4	1104	Riverine Wetlands	12	357	1.24	305	10
5	1105	Waterlogged	159	4907	17.08	4292	693
6	1106	River/Stream	21	16567	57.65	7822	8013
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	3	14	0.05	14	9
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	307	28579	99.45	17302	9875
		Wetlands (<2.25 ha), mainly Tanks	158	158	0.55	-	-
		Total	465	28737	100.00	17302	9875

Area under Aquatic Vegetation	2328	10118
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Area under turbidity levels		
Low	9064	1781
Moderate	8238	8094
High	-	-

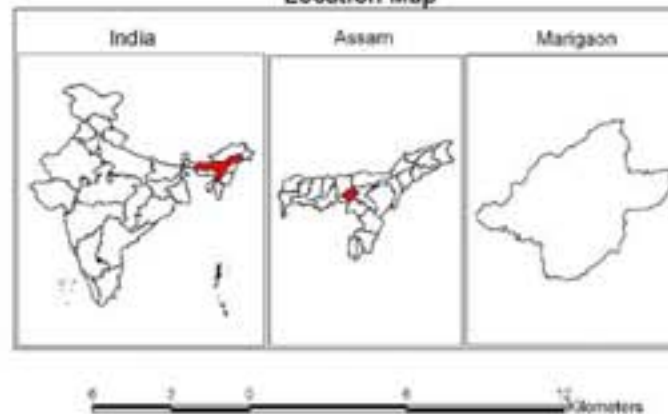


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

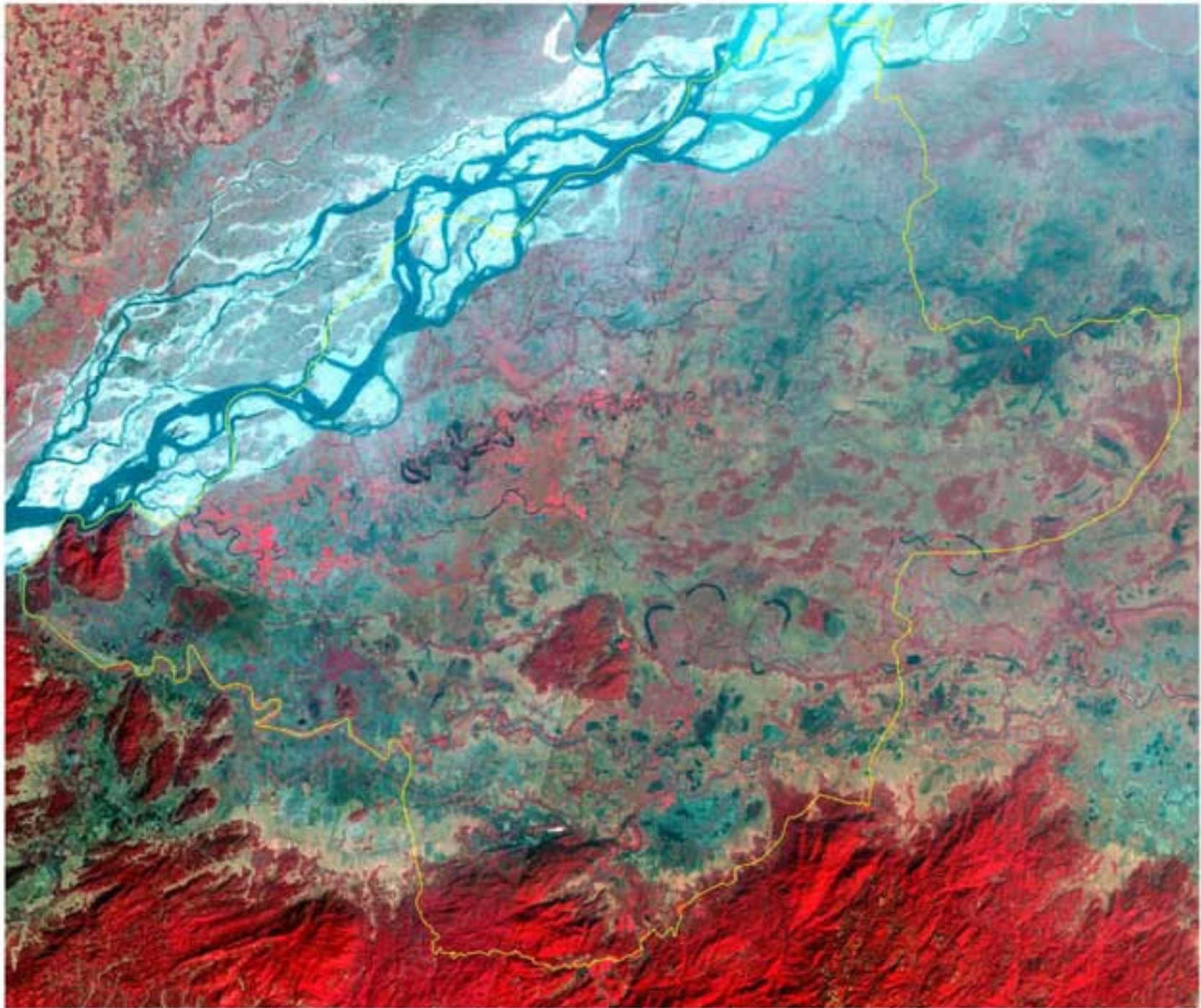
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
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7.1.10 Nagaon

The district is situated in the Central Brahmaputra valley of Assam between 25°35'N and 26°55'N latitudes and 92°15'E and 93°20'E longitudes. It occupies 397600 hectares of area. It is bounded on the east by Golaghat and Karbi Anglong districts, on the west by Marigoan district, on the north by Sonitpur district and south by N.C. Hills and Karbi Anglong district. The topography of the district is almost flat. The Brahmaputra River flows along the northern side of the district. A number of 'Char' area [sand bars] are observed along the Brahmaputra river bed. Kaziranga, Loakhowa wild life sanctuary exists in the valley close to the river Brahmaputra. The other major rivers are Kapili, Diju, Misa, Haria, Jamuna, Kalang and Barapani. A number of ox-bow lakes and ponds also exist in the district. Besides, there are many low lying areas and swamps. The soils of the district vary from sandy to clay loam. and generally acidic to near neutral in nature. The normal average rainfall in the district is 2000 mm. The average minimum and maximum temperatures is 8° C in January and about 34.3° C in July/August. As per Census Report, 2001, the district has a total population of 23, 14,629

Total wetland area in the district is 35659 ha that includes 233 small wetlands (<2.25 ha). River/stream occupies 34.48% of wetlands. The major wetland type is Waterlogged (35.53%). There are 178 Lake/pond with 8670 ha area (21.3%). Ox-bow lakes occupy 8670 ha area (3.36%). Details of wetland statistics is given in Table.15.

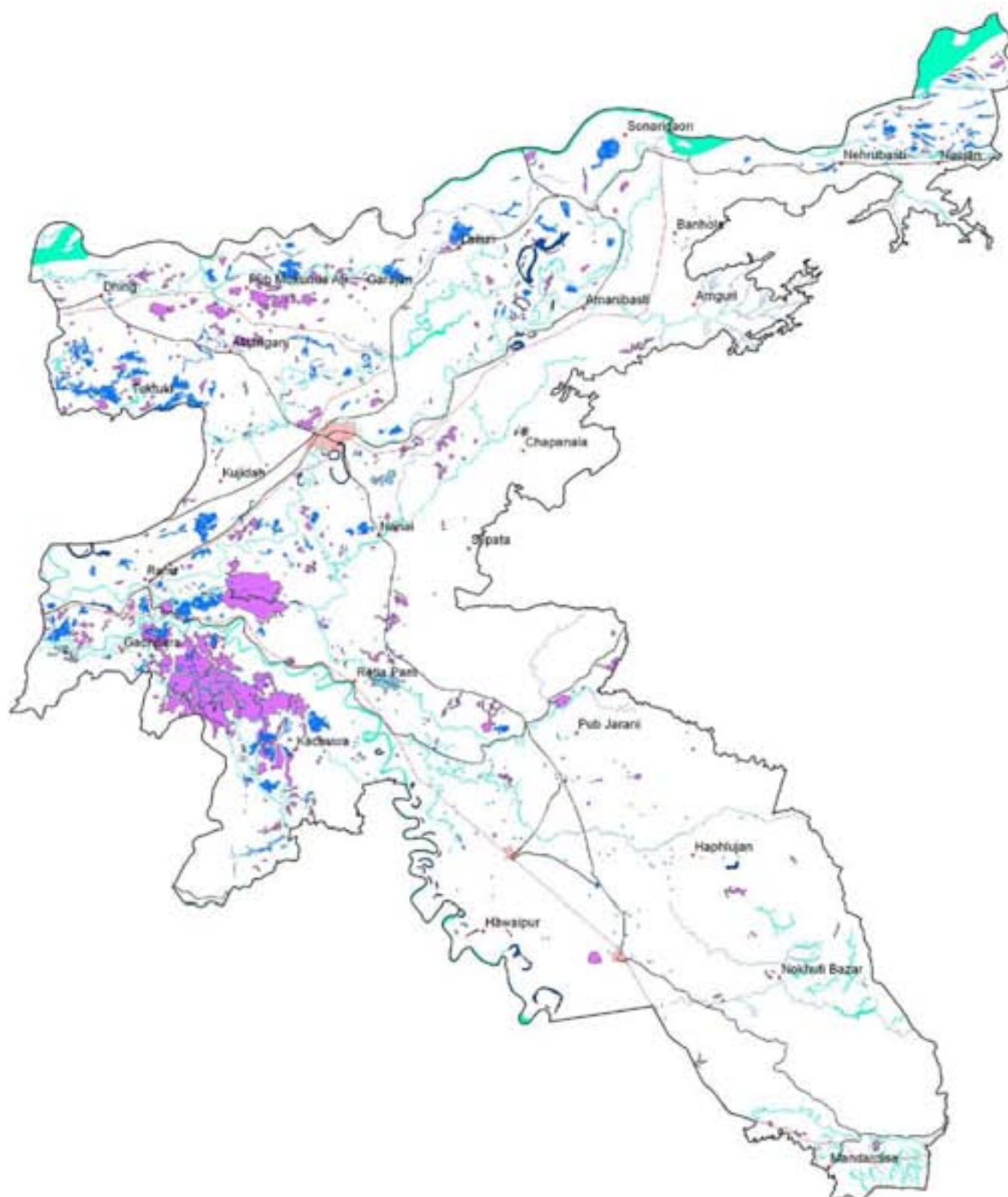
Aquatic vegetation is observed in Lake/pond, Waterlogged wetland types. The area under aquatic vegetation is significantly more in pre monsoon (18235 ha) than that of post monsoon (5271 ha). The open water spread of River/stream is almost same in both the seasons. However, in case of Lake/pond and waterlogged wetland types, the open water is significantly less in pre monsoon compared to post monsoon. The turbidity of water is low to moderate in post monsoon and mainly moderate in pre monsoon.

Table-15: Area estimates of wetlands in Nagaon

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-Monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	178	8670	24.29	6757	1446
2	1102	Ox-bow lakes/ Cut-off meanders	41	1198	3.36	639	470
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Reverine wetlands	15	490	1.37	385	3
5	1105	Waterlogged	410	12682	35.53	11631	2228
6	1106	River/Stream	66	12308	34.48	9300	9319
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	22	114	0.32	114	114
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	732	35462	99.35	28826	13580
		Wetlands (<2.25 ha), mainly Tanks	233	233	0.65	-	-
		Total	965	35695	100.00	28826	13580

Area under Aquatic Vegetation	5271	18235
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Area under turbidity levels		
Low	15427	2498
Moderate	13399	11082
High	-	-

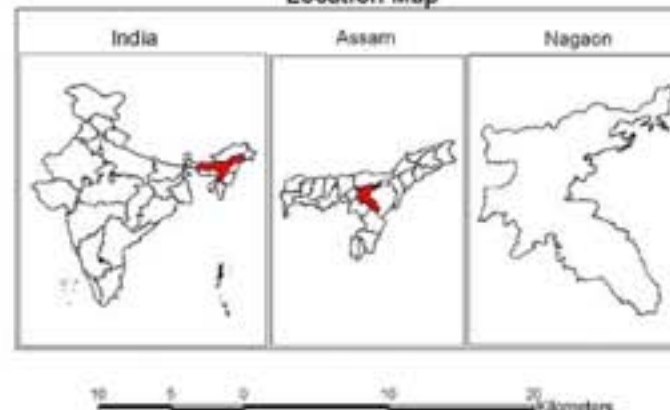


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

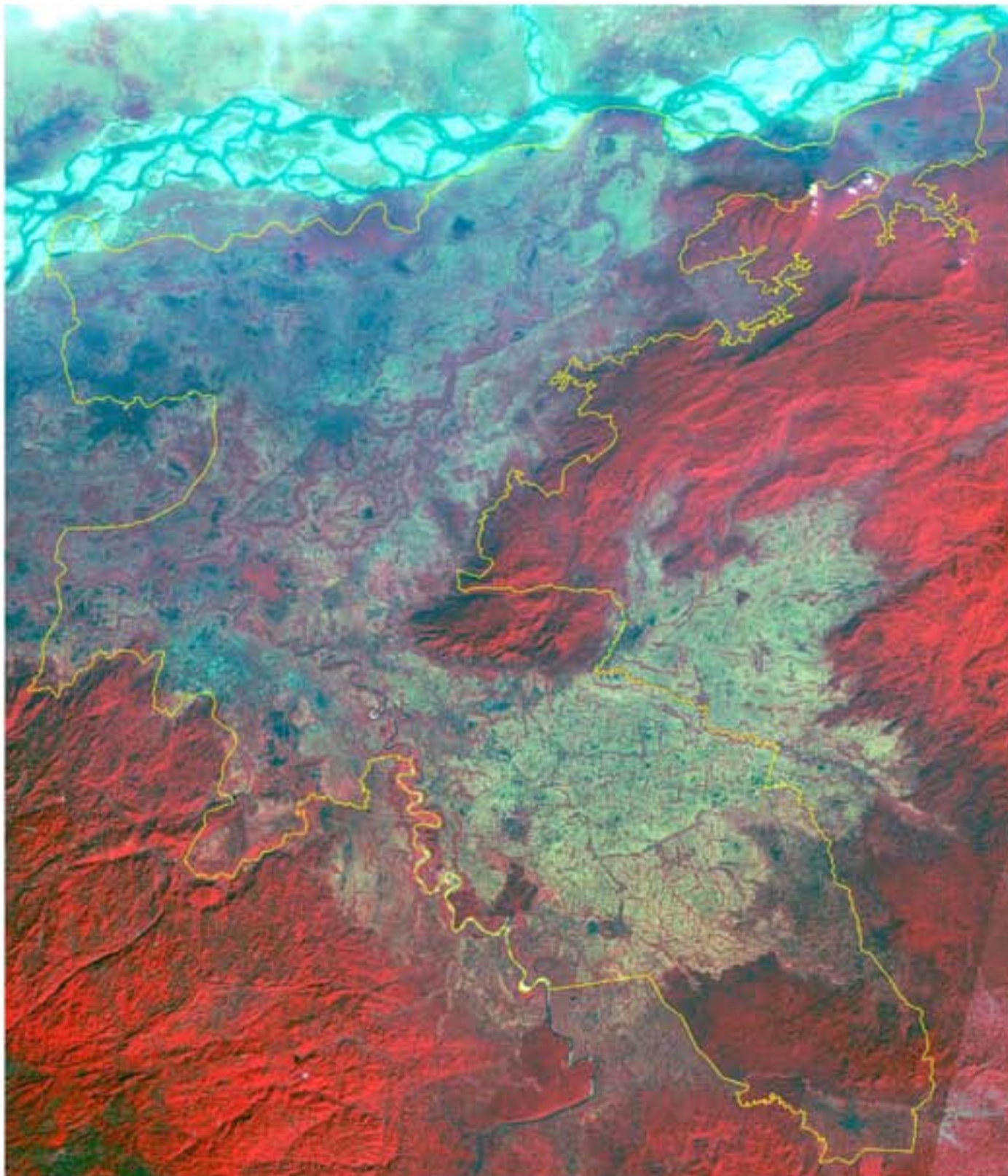
Location Map



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

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

Sponsored By :
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7.1.11 Sonitpur

The district is situated in the northern part of Assam between 26°30'N and 27°02'N latitudes and 92°17'E and 93°47'E longitudes. It occupies an area of 492145 Hectares. It is bounded on the east by Lakhimpur district of Assam, on the west by Darrang district, on the north by Arunachal Pradesh and on the south by the river Brahmaputra. The topography of the district is almost flat. Along the river Brahmaputra and between the central belt and the Brahmaputra are chronically flood affected. Swamps are seen mainly in these areas which represent naturally depressed vast wetlands. The major rivers (tributaries of the Brahmaputra) that traverse this district are Pachnai, Belsiri Nai, Jia Gabharu, Jia Bhoroli, Bardikrai, Bargang and Burai. The rivers are all perennial in nature. Both New Alluvium Soils (Entisols) and Old Alluvium Soils (Inceptisols) are found in the district. Soils are sandy loam to clay loam in texture and are acidic with pH 4.5 to 6.5. The average annual rainfall is 1563 mm. The maximum temperature recorded is 35°C in the months of July-August and the minimum is 11°C in the months of December-January. As per Census Report, 2001, the district has a total population of 16, 81,513.

Total wetland area in the district is 83427 ha that includes 980 small wetlands (<2.25 ha). River/stream occupies 94.52% of wetlands. The other major wetland type is Waterlogged - natural (2.22%) and Ox-bow lakes (1.04%). There are 23 Tank/pond types with 84 ha. Details of wetland statistics is given in Table.16.

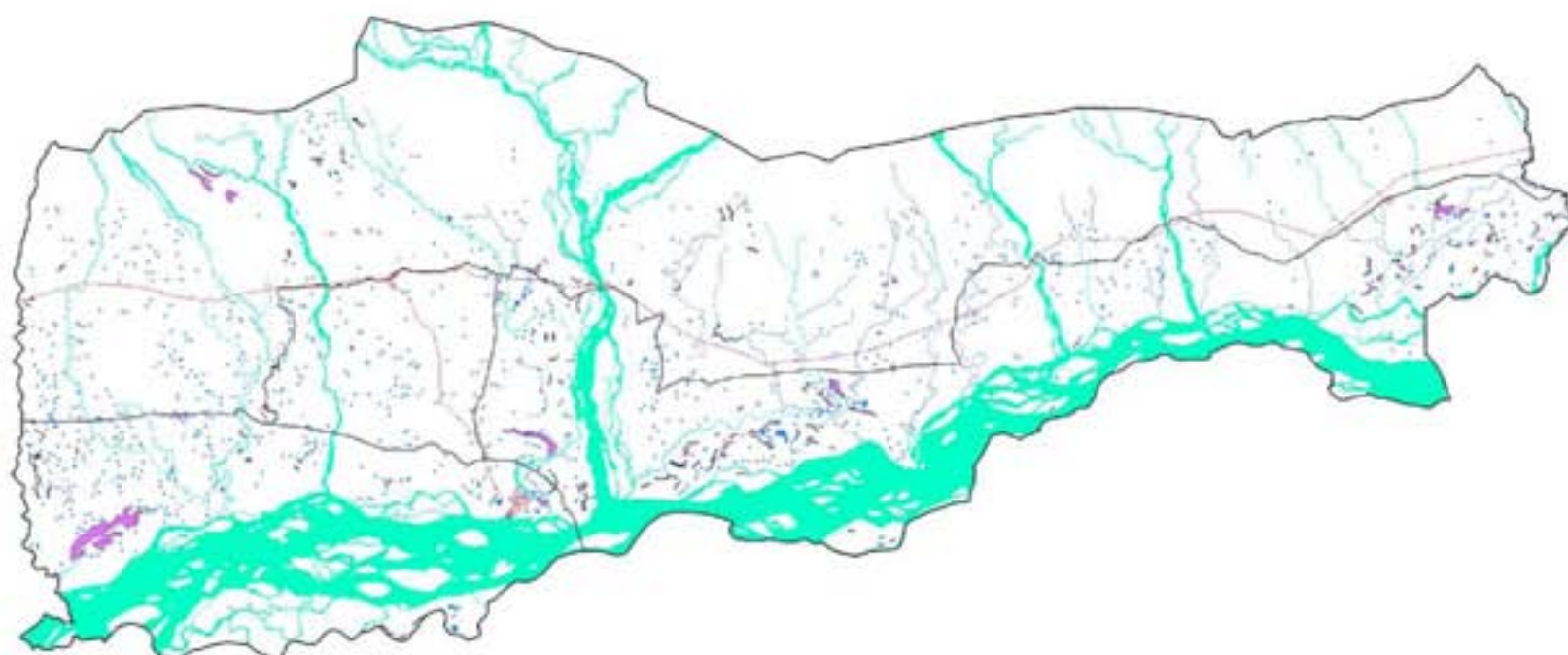
Aquatic vegetation is observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is more or less same in both the seasons. Seasonal fluctuation of open water spread of wetlands is negligible. The turbidity of water is moderate in both the seasons.

Table-16: Area estimates of wetlands in Sonitpur

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	69	740	0.89	391	335
2	1102	Ox-bow lakes/ Cut-off meanders	96	864	1.04	555	427
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Reverine wetlands	-	-	-	-	-
5	1105	Waterlogged	32	1764	2.11	284	201
6	1106	River/Stream	12	78852	94.52	32301	29072
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	23	84	0.10	75	73
9	1203	Waterlogged	15	143	0.17	99	81
		Sub-Total	249	82447	98.65	33705	30189
		Wetlands (<2.25 ha), mainly Tanks	980	980	1.17	-	-
		Total	1229	83427	99.83	33705	30189

Area under Aquatic Vegetation	2203	2489
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Area under turbidity levels		
Low	634	499
Moderate	32956	29615
High	115	75

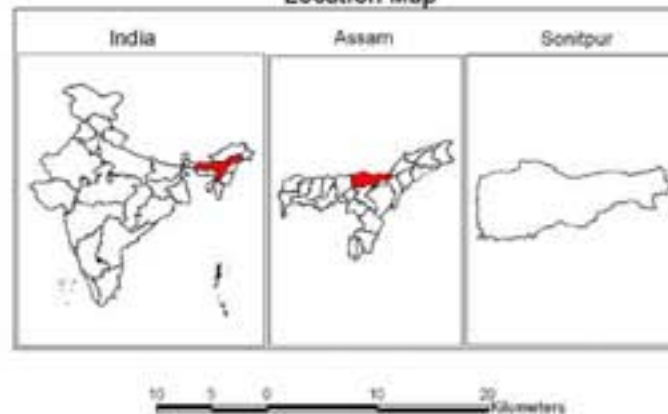


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

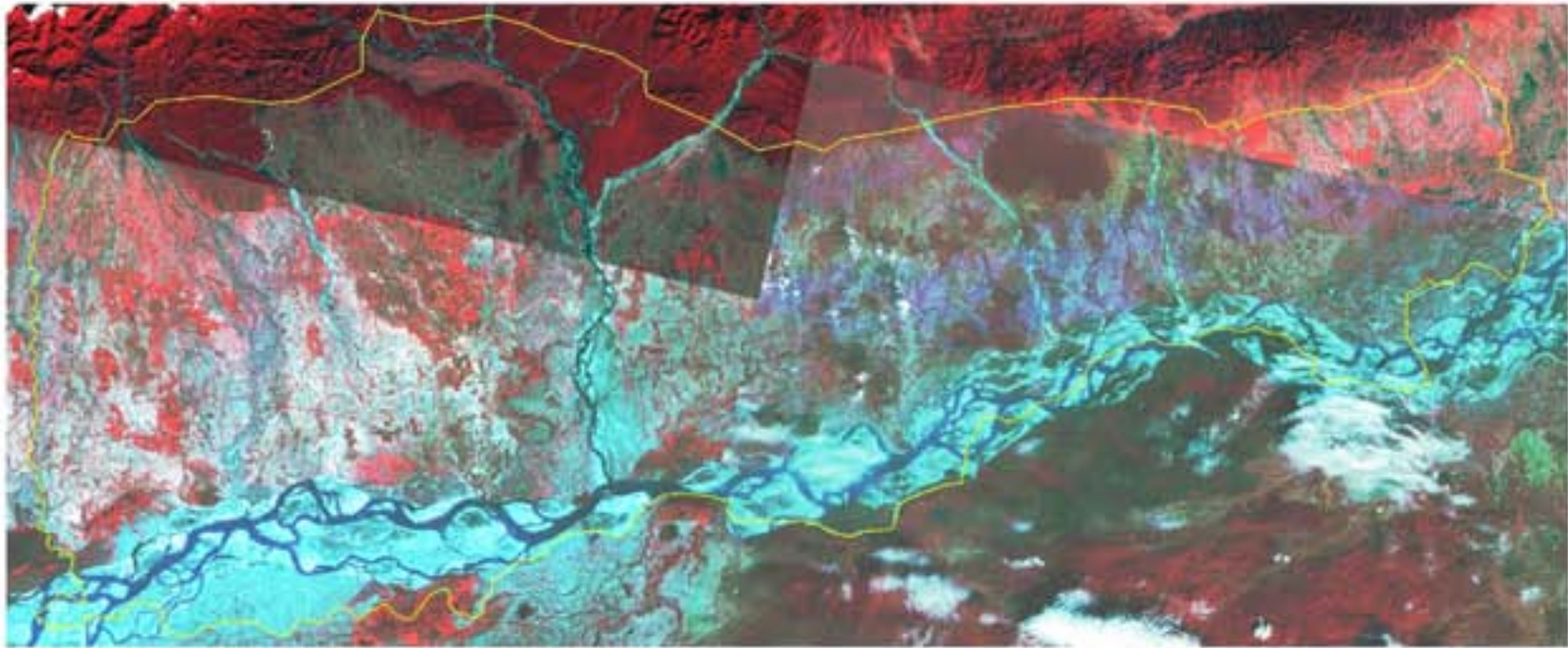
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

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7.1.12 Lakhimpur

The district is situated in the north eastern part of Assam between 26° 45'N and 27° 35'N latitudes and 93° 40'E and 94° 53'E longitudes. It occupies 3, 00,800 hectares of area. It is bounded on the east by Dhemaji and Dibrugarh districts, on the west by Sonitpur district and part of Arunachal Pradesh, on the north by Arunachal Pradesh and Dhemaji district. The topography of the district varies from undulating uplands on the northern foothill belt to low lying plains on the south with elevation range of 35 metres (areas in riverine belt) to 140 metres (areas in the foothill belt) above the m. s.l. The mean altitude of the district is 102 metres above m.s.l. All the rivers in the district are perennial in nature. The river Brahmaputra flows on the southern side of the district. The other major rivers are Subansiri, Simen and Dikrai. The soils of the district are broadly fall into three major groups i.e. Older Alluvium along the foothill Older Alluvium on the flood plains and Newer Alluvium on the recent flood plains. The annual mean rainfall in the district is 300 cm. The maximum and minimum temperatures are 31°C and 7°C respectively, while the mean temperature is 19°C. As per Census Report, 2001, the district has a total population of 8, 89,010.

Total wetland area in the district is 27307 ha that includes 458 small wetlands (<2.25 ha). River/stream occupies 89.34% of wetlands. The other major wetland type is Ox-bow lakes (3.8%), Lake/pond (2.39%) and Waterlogged - natural (1.92%). Details of wetland statistics is given in Table.17.

Aquatic vegetation is observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is more or less in both the seasons. Seasonal fluctuation of open water spread of wetlands is negligible. The turbidity of water is moderate in both the seasons

Table 17: Area estimates of wetlands in Lakhimpur

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	53	652	2.39	388	458
2	1102	Ox-bow lakes/ Cut-off meanders	92	1038	3.80	807	706
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	7	134	0.49	53	66
5	1105	Waterlogged	34	524	1.92	174	322
6	1106	River/Stream	30	24397	89.34	12258	12048
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	14	41	0.15	33	38
9	1203	Waterlogged	4	63	0.23	26	26
		Sub-Total	234	26849	98.32	13739	13664
		Wetlands (<2.25 ha), mainly Tanks	458	458	1.68	-	-
		Total	692	27307	100.00	13739	13664

Area under Aquatic Vegetation	971	836
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Area under turbidity levels		
Low	152	240
Moderate	13495	13320
High	92	104

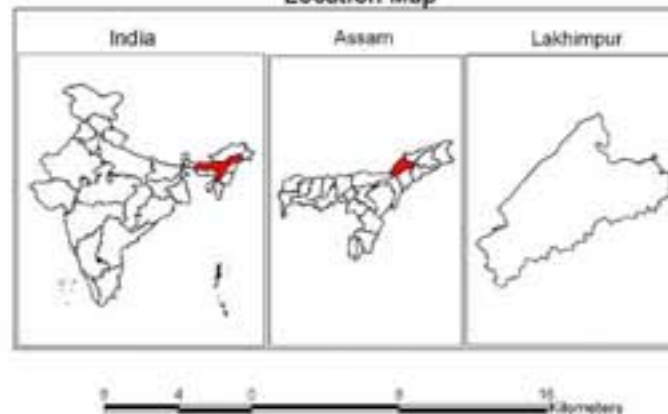


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

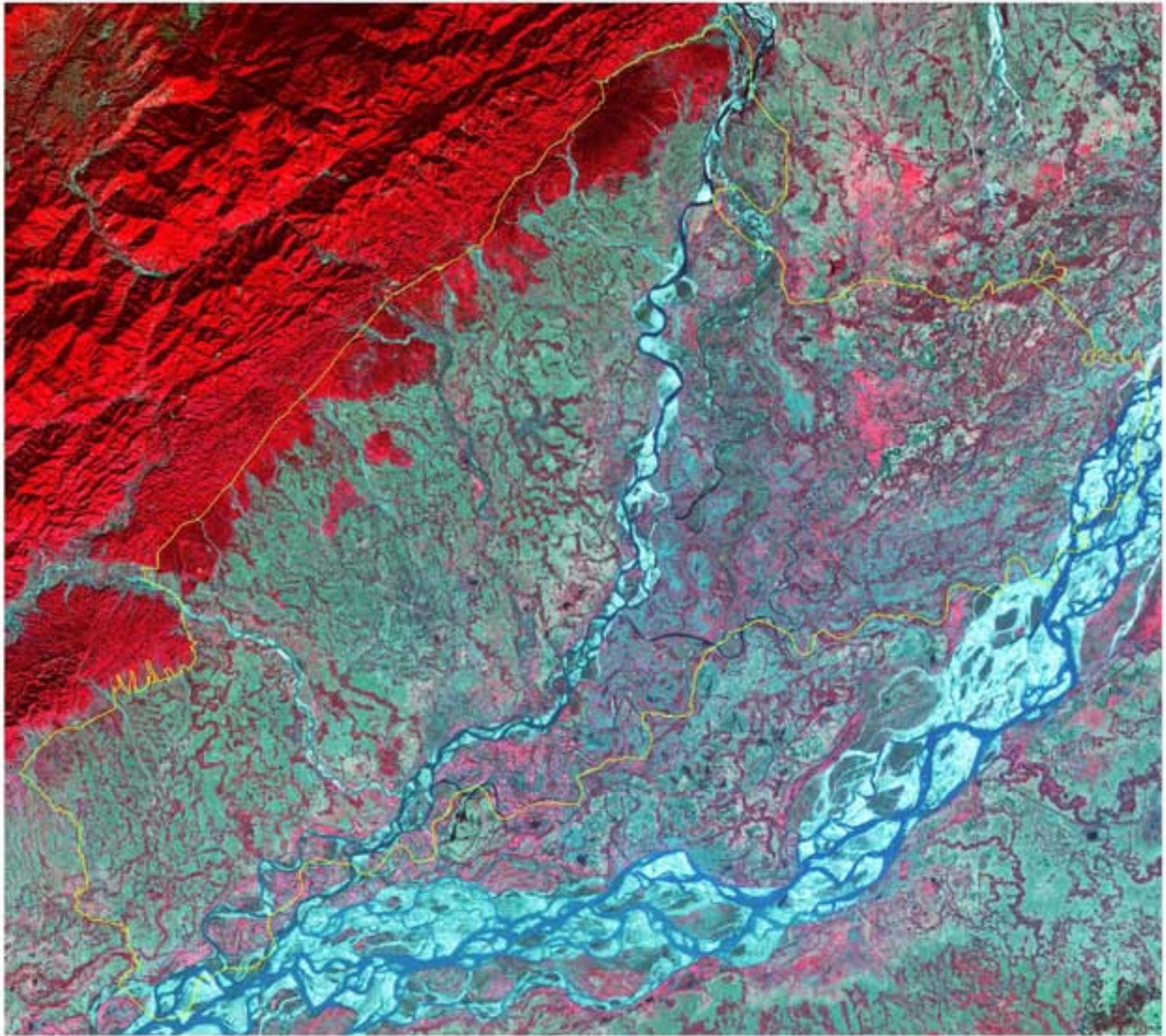
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

Sponsored By :

Ministry of Environment and Forests
Government of India



7.1.13 Dhemaji

The district is situated in the north eastern part of Assam between 27° 15'N and 27° 55'N latitudes and 94° 10'E and 95° 30'E longitudes. It occupies 2, 63,701 hectares of area. It is bounded on the north by Arunachal Pradesh. The topography of the district varies from undulating uplands on the northern foothill belt to low lying plains on the south. The mean altitude of the district is 102 metres above m.s.l. The river Brahmaputra flows along the southern side of the district. The other major rivers are Subansiri, Jiadhal, Simen and Dikrai. All the rivers in the district are perennial in nature. These rivers flow through the high rainfall region at the foothill of the Assam Himalayas; so the district acts as a runoff zone for the excess water from Arunachal Pradesh. An extensive area of the district is, thus invariably subjected to 3 to 4 waves of flood during the monsoon period. The soils of the district broadly fall into Older Alluvium and New Aluvium. The annual mean rainfall in the district is 300 cm. The maximum and minimum temperatures are 31°C and 7°C respectively, while the mean temperature is 19°C. As per Census Report, 2001, the district has a total population of 5, 71,944.

Total wetland area in the district is 33468 ha that includes 314 small wetlands (<2.25 ha). River/stream occupies 87.53% of wetlands. The other major wetland types are waterlogged - natural (4.08%). Riverine wetland (2.78%), Lake/pond (2.32%) and Ox-bow lakes (1.77%). Details of wetland statistics is given in Table.18.

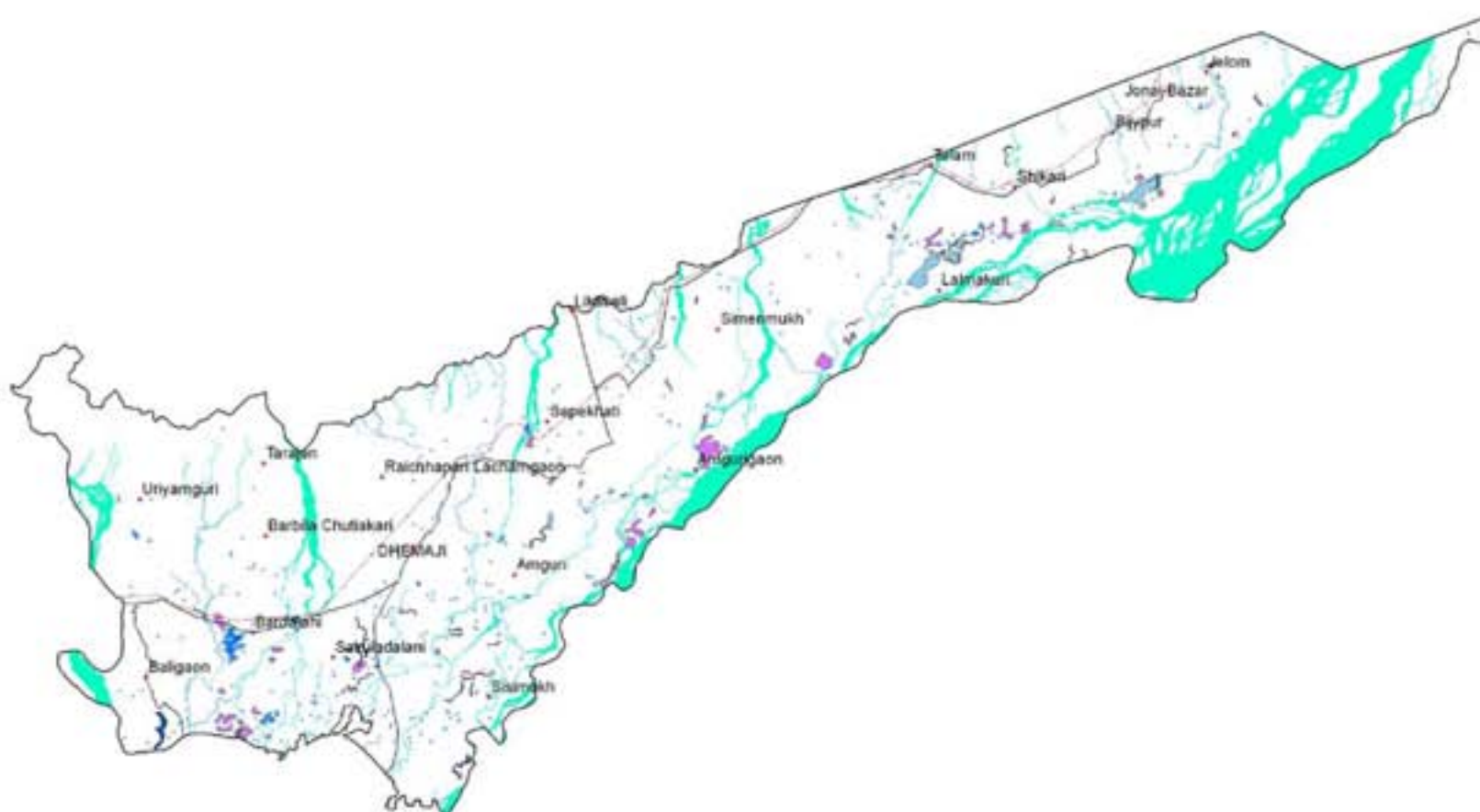
Aquatic vegetation is observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is more or less in both the seasons. Seasonal fluctuation of open water spread of wetlands is negligible. The turbidity of water is moderate in both the seasons.

Table 18: Area estimates of wetlands in Dhemaji

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	36	776	2.32	172	145
2	1102	Ox-bow lakes/ Cut-off meanders	30	592	1.77	248	289
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	14	932	2.78	237	211
5	1105	Waterlogged	46	1365	4.08	277	388
6	1106	River/Stream	35	29293	87.53	11146	11980
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	8	23	0.07	20	23
9	1203	Waterlogged	12	173	0.52	95	82
		Sub-Total	181	33154	99.06	12195	13118
		Wetlands (<2.25 ha), mainly Tanks	314	314	0.94	-	-
		Total	495	33468	100.00	12195	13118

Area under Aquatic Vegetation	2812	2724
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Area under turbidity levels		
Low	581	759
Moderate	11602	12347
High	12	12

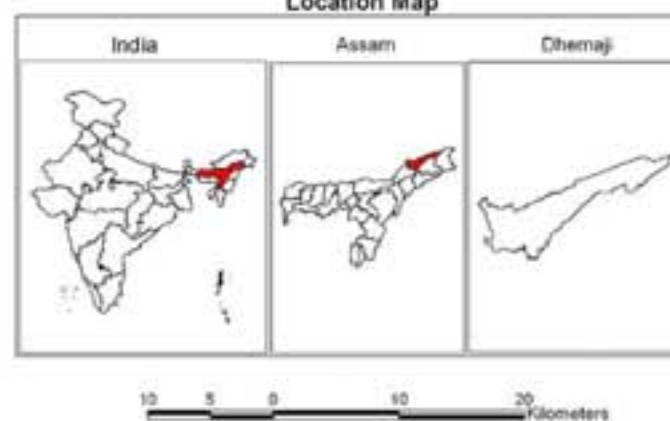


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

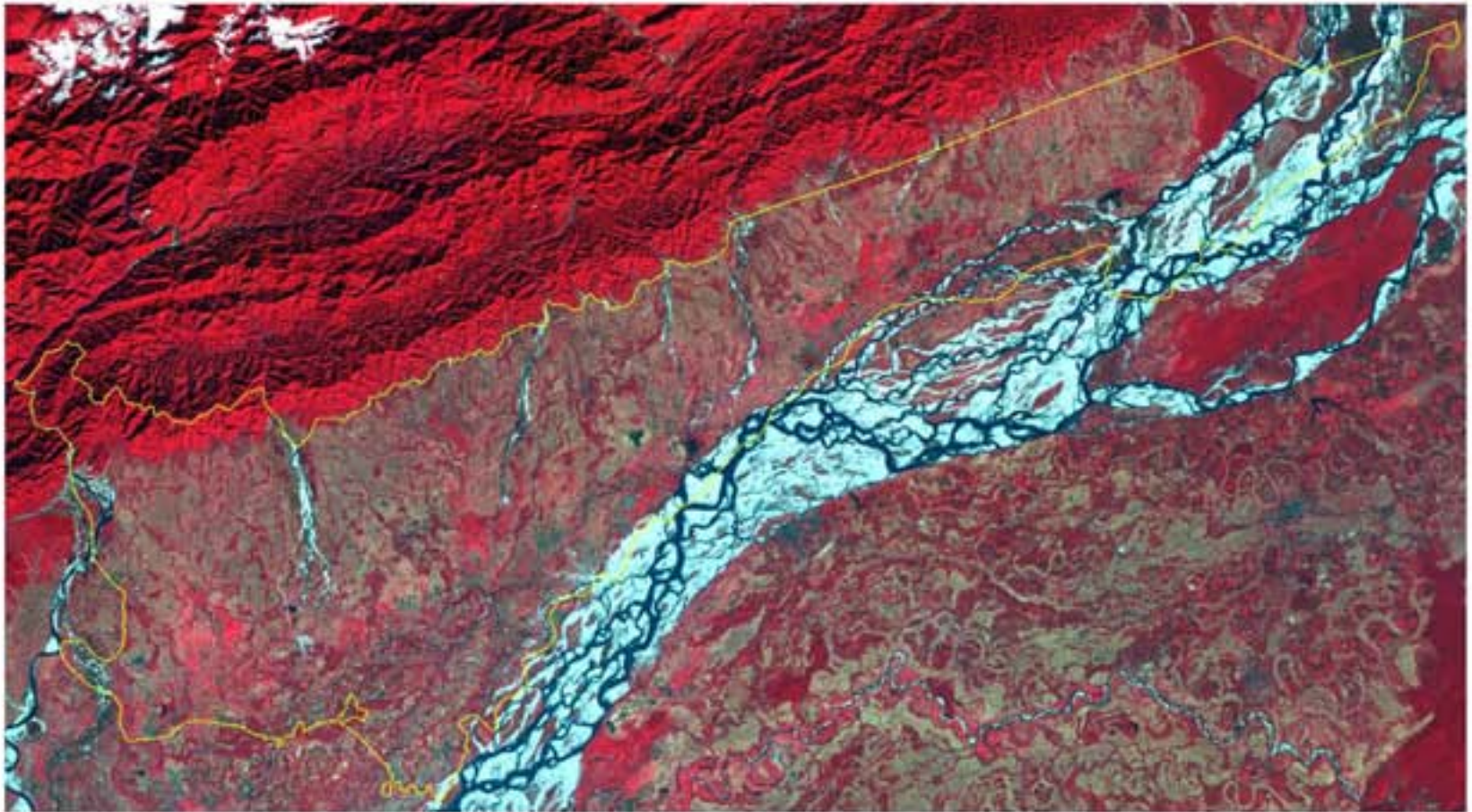
Legend

- 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 Assam Remote Sensing Applications Centre, Guwahati
Sponsored By:
Ministry of Environment and Forests Government of India



7.1.14 Tinsukia

The district is situated in the north eastern part of Assam between 27° 15'N and 28° 00'N latitudes and 95° 15'E and 96° 00'E longitudes. It occupies 3,47,600 hectares of land.. It is bounded on the east by Arunachal Pradesh, on the west by Dibrugarh district, on the north by Lakhimpur district and south by the Dibrugarh district and part of Arunachal Pradesh. The district is characterised by a flat monotonous terrain from the Brahmaputra river southwards upto the upper Dihing R.F. where it starts rising slowly into the broken hills that comprise the foothills of the Tirap district of Arunachal Pradesh. The tract is drained by the Brahmaputra river and its main tributary Burhi Dihing. Soils of this district are divided into three distinct categories. viz. new alluvial soils in an area extending few kms to the south of the Brahmaputra river, old alluvial soils in the central part of the district and old mountain valley alluvial soil located on the foothills of Arunachal Pradesh. .The average annual rainfall ranges from a minimum of 2134 mm to a maximum of 3785 mm. The minimum and maximum temperatures recorded are 7°C and 37°C during winter and summer respectively. As per Census Report, 2001, the district has a total population of 11, 50,062.

Total wetland area in the district is 40626 ha that includes 478 small wetlands (<2.25 ha). River/stream occupies 87.81% of wetlands. The other major wetland types are Waterlogged - natural (4.08%). Riverine wetland (2.83%), Waterlogged-natural (4.15%) and Ox-bow lakes (3.44%). Details of wetland statistics is given in Table.19.

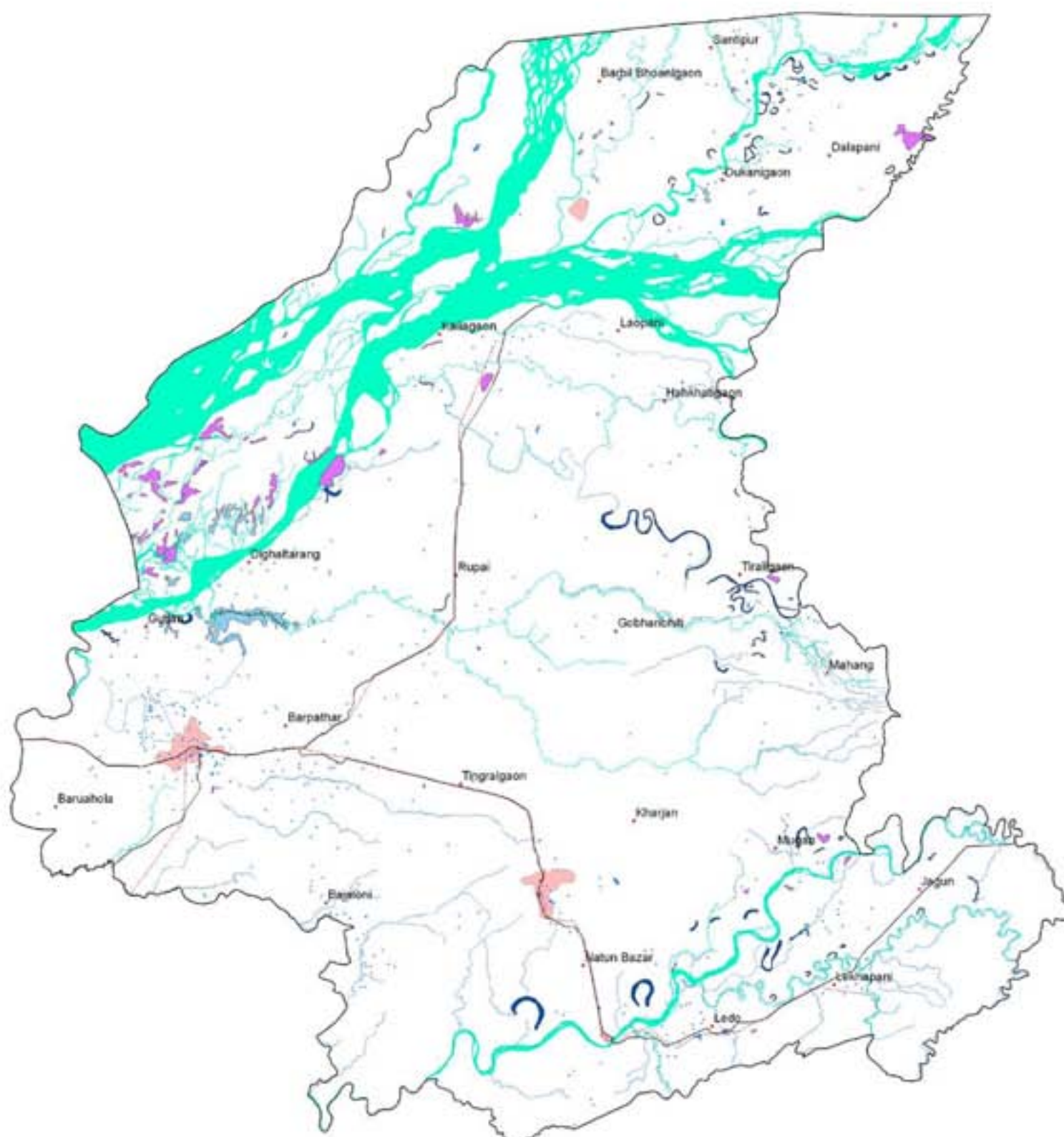
Aquatic vegetation is observed in Lake/pond, Riverine and Waterlogged wetland types. The area under aquatic vegetation is more during pre monsoon (2974 ha) than during post monsoon (3570 ha). Seasonal fluctuation of open water spread of wetlands show more spread during pre monsoon (22854 ha) than post monsoon (17712 ha). The turbidity of water is moderate in both the seasons.

Table 19: Area estimates of wetlands in Tinsukia

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	20	147	0.36	48	41
2	1102	Ox-bow lakes/ Cut-off meanders	59	1399	3.44	148	367
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	30	1151	2.83	290	483
5	1105	Waterlogged	43	1685	4.15	323	500
6	1106	River/Stream	5	35672	87.81	16825	21382
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	23	63	0.16	57	55
9	1203	Waterlogged	4	31	0.08	21	26
		Sub-Total	184	40148	98.75	17712	22854
		Wetlands (<2.25 ha), mainly Tanks	478	478	1.18	-	-
		Total	662	40626	99.92	17712	22854

Area under Aquatic Vegetation	3570	2974
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Area under turbidity levels		
Low	23	25
Moderate	17661	22722
High	28	107

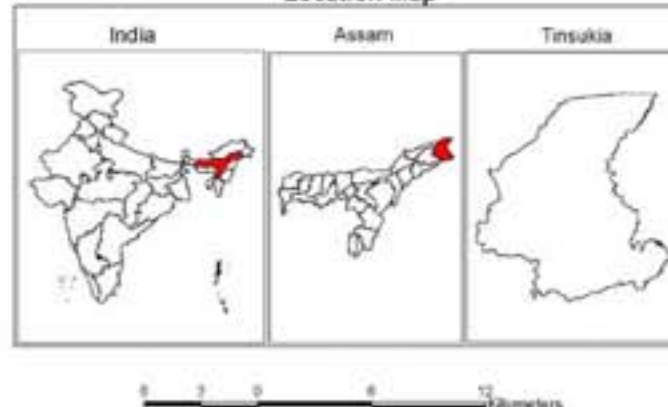


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Sponsored By :
Ministry of Environment and Forests
Government of India



7.1.15 Dibrugarh

The district is situated in the north eastern part of Assam between 27° 10'N and 27° 45'N latitudes and 94° 30'E and 95° 30'E longitudes. It occupies 3,54,500 hectares of area, which accounts for 4.52 per cent area of the state. It is bounded on the east by Tinsukia, on the west by part of Sibsagar and Lakhimpur districts, on the north by Lakhimpur district and south by the Sibsagar district and part of Arunachal Pradesh. The district is characterised by a flat monotonous terrain from the Brahmaputra river southwards upto the upper Dihing R.F. where it starts rising slowly into the broken hills that comprise the foothills of the Tirap district of Arunachal Pradesh. The tract is drained by the Brahmaputra river and its main tributary the Burhi Dihing and the Mai Jan river. Soils of this district are divided into three distinct categories. viz. new alluvial soils in an area extending few kms to the south of the Brahmaputra river, old alluvial soils in the central part of the district and old mountain valley alluvial soil located on the foothills of Arunachal Pradesh on the district. The average annual rainfall ranges from a minimum of 2134mm to a maximum of 3785mm. The minimum and maximum temperatures recorded are 7°C and 37°C respectively. As per Census Report, 2001, the district has a total population of 11, 85,072.

Total wetland area in the district is 72461 ha that includes 535 small wetlands (<2.25 ha). River/stream occupies 95.43% of wetlands. The other major wetland type is Ox-bow lakes (1.79%). There are 11 Lake/pond type mapped with 590 ha area. Details of wetland statistics is given in Table.20.

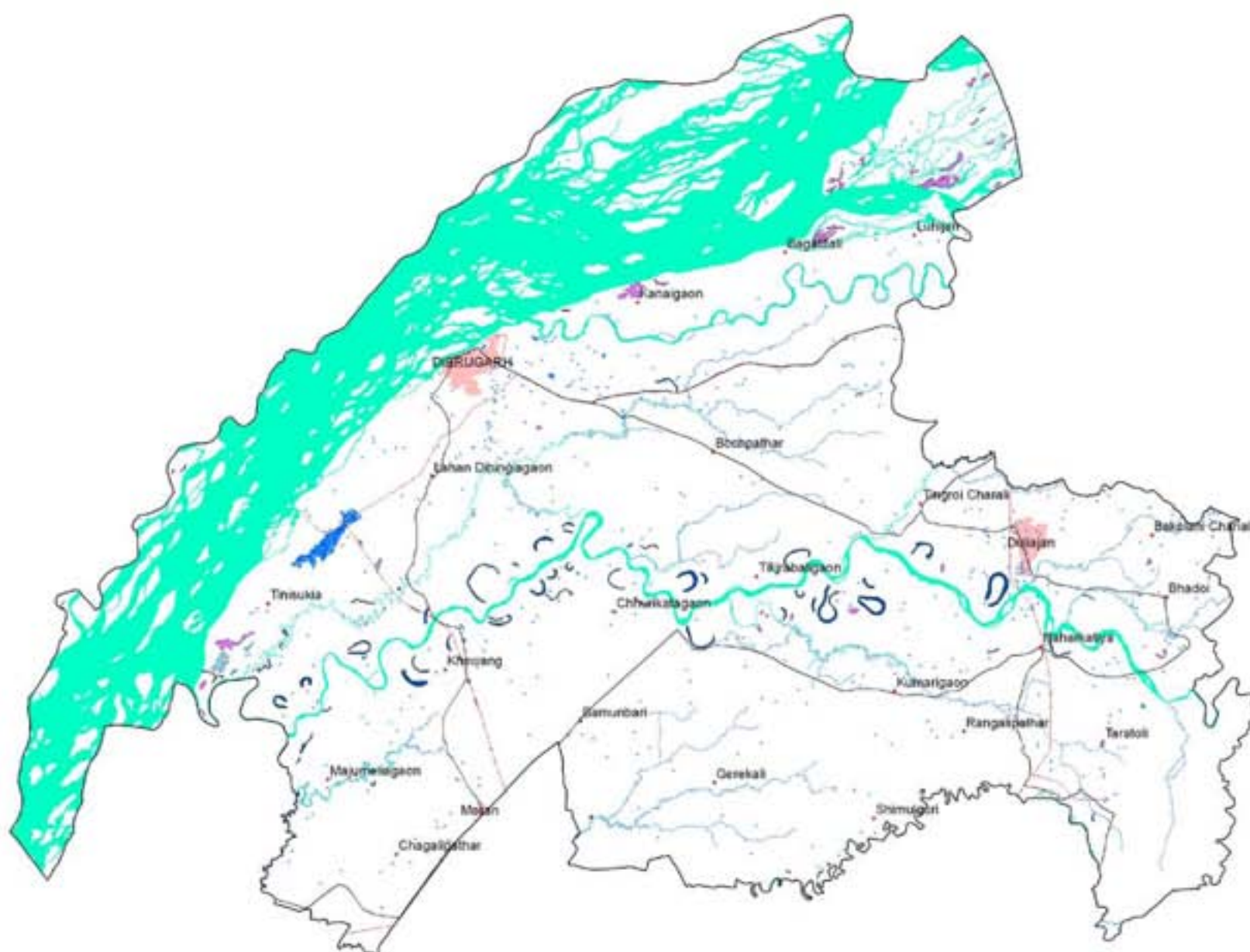
Aquatic vegetation is observed in Lake/pond, Ox-bow lake wetland types. The area under aquatic vegetation is slightly more during pre monsoon (1899 ha) than during post monsoon (1769 ha). Seasonal fluctuation of open water spread of wetlands show more spread during pre monsoon (36766 ha) than post monsoon (28280 ha). The turbidity of water is moderate in both the seasons.

Table 20: Area estimates of wetlands in Dibrugarh

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	11	590	0.81	115	45
2	1102	Ox-bow lakes/ Cut-off meanders	64	1295	1.79	700	456
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	11	146	0.20	0	42
5	1105	Waterlogged	31	656	0.91	103	248
6	1106	River/Stream	76	69149	95.43	27232	35856
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	14	45	0.06	45	41
9	1203	Waterlogged	9	45	0.06	45	45
		Sub-Total	216	71926	99.26	28240	36733
		Wetlands (<2.25 ha), mainly Tanks	535	535	0.74	-	-
		Total	751	72461	100.00	28240	36733

Area under Aquatic Vegetation	1769	1899
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Area under turbidity levels		
Low	187	124
Moderate	27938	36508
High	115	101

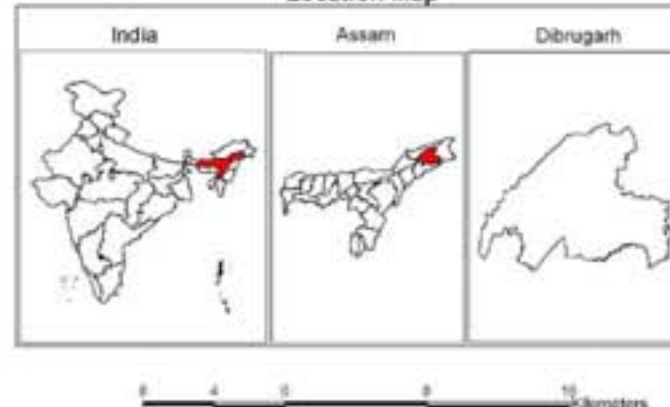


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

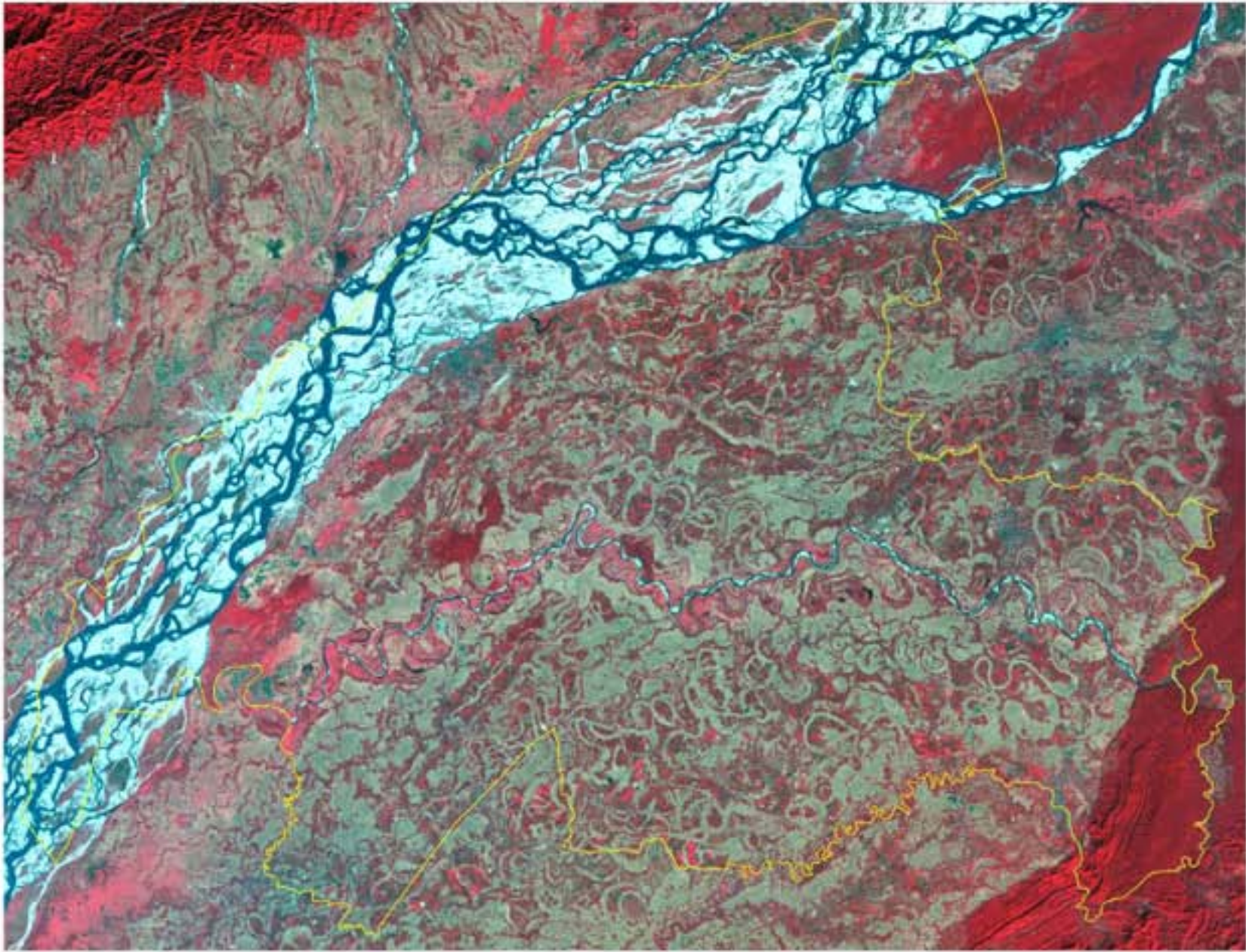
Location Map



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

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

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7.1.16 Sibsagar

The district is situated in the north-eastern part of Assam between 26°42' and 27°15' north latitude and 94°24' and 95°23' east longitude. The district occupies an area of 64250 hectares. It is bounded on the east by Dibrugarh The district is situated in the north-eastern part of Assam between 26°42' and 27°15' north latitude and 94°24' and district of Assam and Tirap district of Arunachal Pradesh, on the west by Jorhat and Dibrugarh districts of Assam, on the north by Dibrugarh district and on the south by Jorhat district of Assam and Mokokchung district of Nagaland. The main rivers of the district are the Brahmaputra and its tributaries viz. Disang, Dikhow, Jhanzi and Burhidihing, which are perennial in nature. The soils of the district are divided into three main categories viz. New alluvial soil in an area of few kilometres on the south of Brahmaputra, old alluvial soil on the central part of the district and old mountain valley alluvial soils located along the foot hills of Nagaland. The district possesses the famous Panidihing wild life sanctuary. The normal annual rainfall in the district is 2244.5 mm. The minimum and maximum temperatures are 6.9°C and 37.2°C during winter and mid summer respectively. As per Census Report, 2001, the district has a total population of 10, 51,736.

Total wetland area in the district is 12582 ha that includes 530 small wetlands (<2.25 ha). River/stream occupies 69.13% of wetlands. The other major wetland types are Waterlogged-natural (10.57%), Lake/pond (8.28%), Ox-bow lakes (4.2%). There are 25 Tank/pond with 310 ha area (2.46%). Details of wetland statistics is given in Table.21.

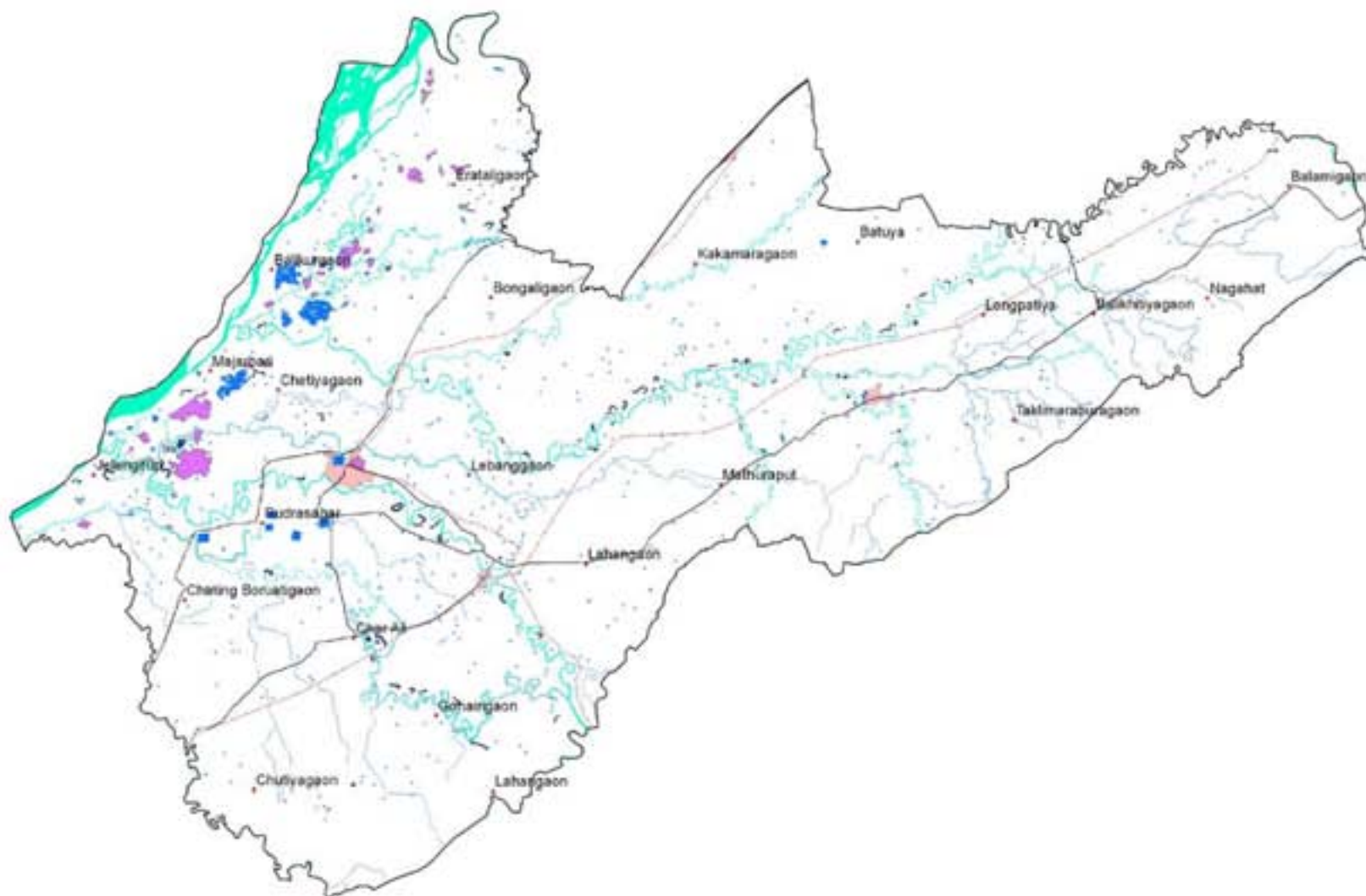
Aquatic vegetation is mainly observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is more or less same in both the seasons. Seasonal fluctuation of open water spread of wetlands does not vary during both the seasons. The turbidity of water is moderate in both the seasons.

Table 21: Area estimates of wetlands in Sibsagar

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	30	1042	8.28	220	262
2	1102	Ox-bow lakes/ Cut-off meanders	75	529	4.20	317	333
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	16	113	0.90	40	36
5	1105	Waterlogged	34	1330	10.57	145	89
6	1106	River/Stream	74	8698	69.13	6045	5773
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	25	310	2.46	304	266
9	1203	Waterlogged	5	30	0.24	30	14
		Sub-Total	259	12052	95.79	7101	6773
		Wetlands (<2.25 ha), mainly Tanks	530	530	4.21	-	-
		Total	789	12582	100.00	7101	6773

Area under Aquatic Vegetation	2403	2458
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Area under turbidity levels		
Low	117	114
Moderate	6894	6591
High	90	68

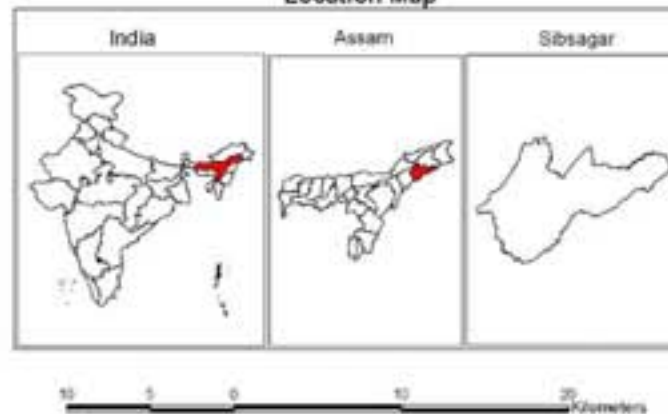


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

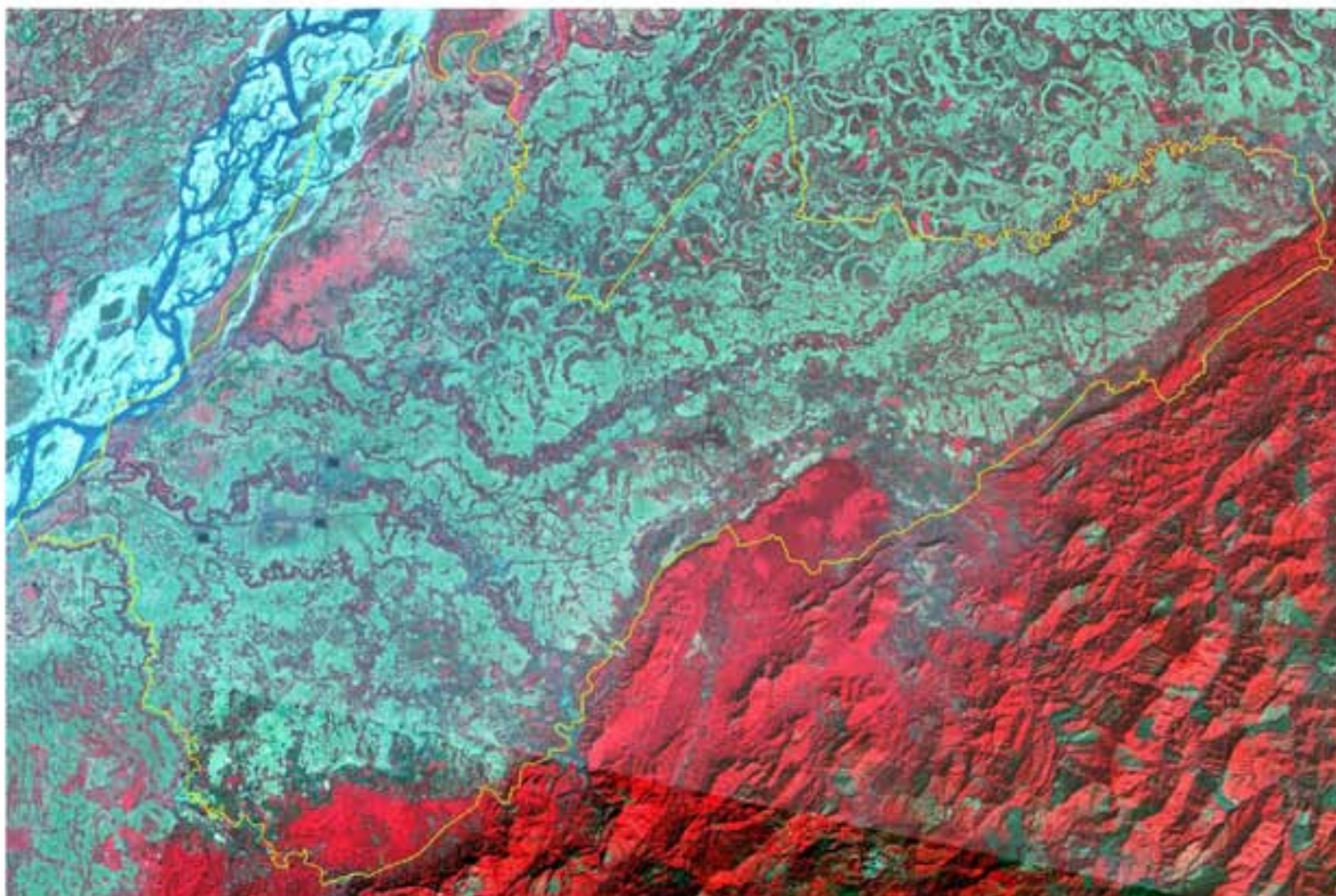
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
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Assam Remote Sensing Applications Centre, Guwahati

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7.1.17 Jorhat

Jorhat district is situated in the eastern part of Assam state between 26°20'N and 27°11'N latitudes and 93°58'E and 94°33'E longitudes. It occupies 2,73,047.15 hectares area.. It is bounded on the north by Lakhimpur district of Assam, and on the south by Wokha and Mokakchung districts of Nagaland. The river Brahmaputra flows along the northern side of the district separating Majuli sub-division from the main land. All rivers in the district are of perennial nature. The soils of the district vary from sandy loam to clay loam. The soil is mainly acidic in reaction with pH ranging from 4.5 to 6.5. Shifting cultivation areas are found in the Disai and Tiru hill region of the district. The mean annual rainfall in the district is 230 cm. The maximum and minimum temperatures recorded in the district are 32°C and 5°C during summer and winter respectively, while the mean temperature is recorded as 18°C. As per Census Report, 2001, the district has a total population of 9,99,221.

Total wetland area in the district is 45979 ha that includes 363 small wetlands (<2.25 ha). River/stream occupies 89.12% of wetlands. The other major wetland types are Waterlogged-natural (2.44%), Lake/pond (5.05%), Ox-bow lakes (1.52%).Details of wetland statistics is given in Table.22.

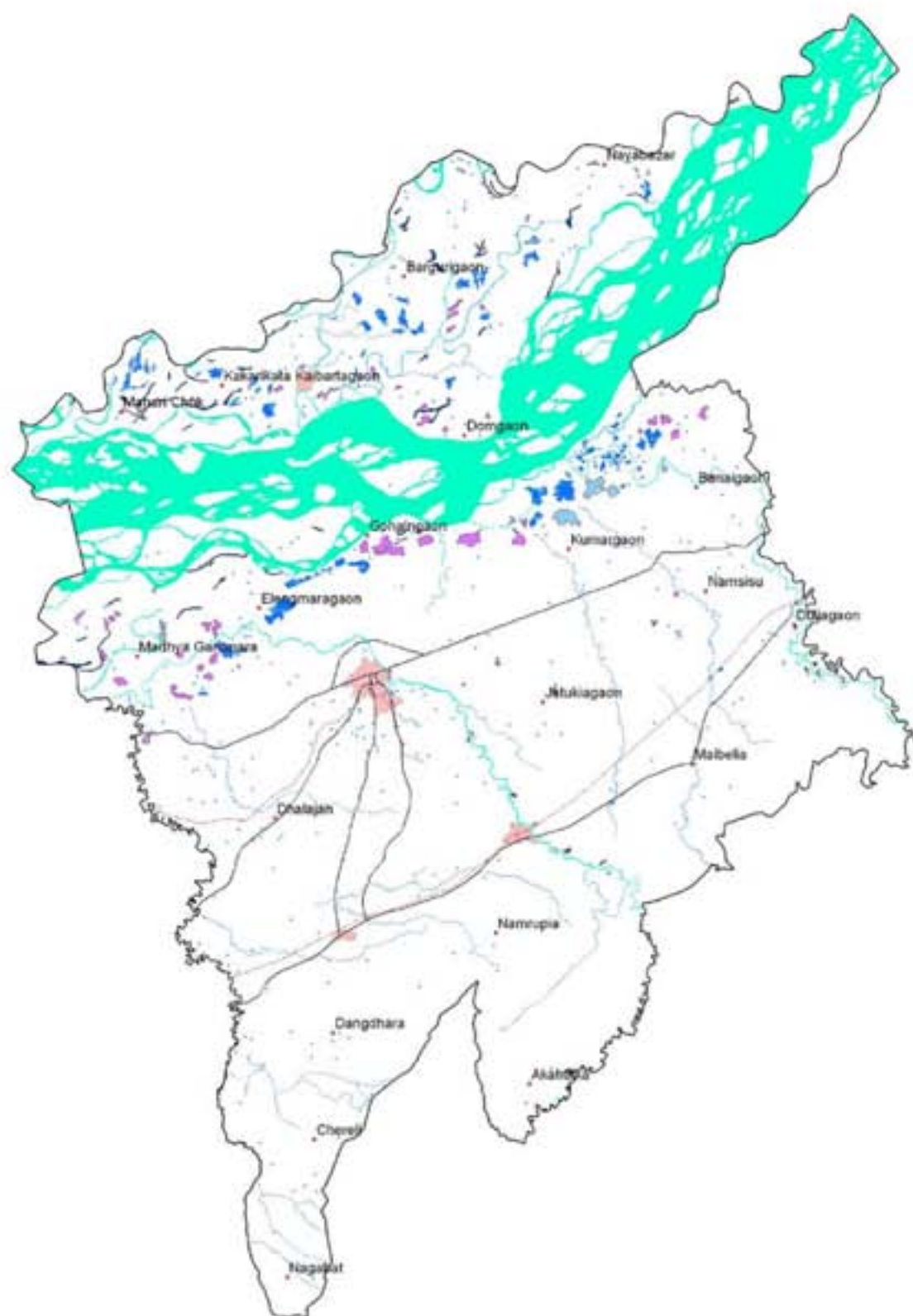
Aquatic vegetation is mainly observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is slightly more during post monsoon (3357 ha) compared to pre monsoon (2586 ha). Seasonal fluctuation of open water spread of wetlands showed slightly more spread during post monsoon. The turbidity of water is moderate in both the seasons.

Table 22: Area estimates of wetlands in Jorhat

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	65	2322	5.05	809	1189
2	1102	Ox-bow lakes/ Cut-off meanders	57	698	1.52	391	556
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	12	417	0.91	6	13
5	1105	Waterlogged	58	1124	2.44	229	448
6	1106	River/Stream	23	40977	89.12	16623	15044
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	4	18	0.04	16	8
9	1203	Waterlogged	6	60	0.13	20	29
		Sub-Total	225	45616	99.21	18094	17287
		Wetlands (<2.25 ha), mainly Tanks	363	363	0.79	-	-
		Total	588	45979	100.00	18094	17287

Area under Aquatic Vegetation	3357	2586
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Area under turbidity levels		
Low	603	834
Moderate	17444	16317
High	47	136

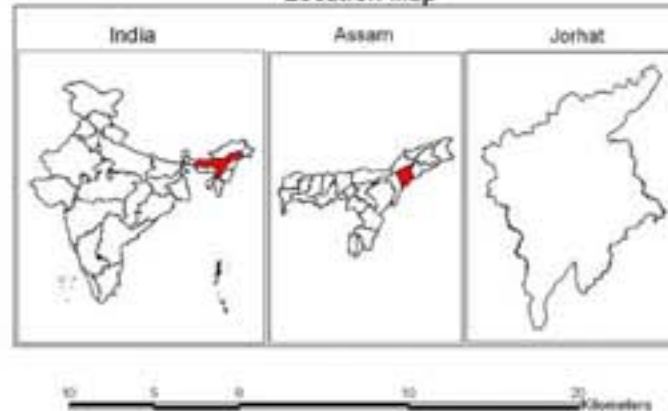


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			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 :
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Assam Remote Sensing Applications Centre, Guwahati

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7.1.18 Golaghat

Golaghat district is situated in the south-east part of Assam state between 25°45'N to 26°40'N latitudes and 93°30'E to 94°29'E longitudes. It occupies 335879.83 hectares. It is bounded on the east by Jorhat district of Assam, on the west by Nowgong and Korbi Anglong districts of Assam, on the north by Sonitpur and Lakhimpur districts of Assam and on the south by Kohima and Wokha districts of Nagaland. The district is characterised by medium and low land topography. In the north-west is the famous Kaziranga National Park, the natural habitat of the one-horned Rhino. The river Brahmaputra flows through the northern side of the district. The other major tributary river is Dhansiri. The soil of the district varies from sandy loam to clay loam. It can be classified into three major soil groups i.e. Recent Riverine alluvial soils (Entisols), Old Riverine alluvial soils (Inceptisols) and Old Mountain valley alluvial soils (Altisols). The soil is acidic, pH ranging from 4.5 to 6.5. The mean annual rainfall in the district is 216 cm. The maximum and minimum temperatures recorded are 32°C and 6°C respectively while, the mean temperature is 19°C. As per Census Report, 2001, the district has a total population of 9, 46,279.

Total wetland area in the district is 43635 ha that includes 165 small wetlands (<2.25 ha). River/stream occupies 88.45% of wetlands. The other major wetland types are Lake/pond (5.16%), Waterlogged-natural (3.49%), and Ox-bow lakes (2.52%). Details of wetland statistics is given in Table.23.

Aquatic vegetation is mainly observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is slightly more during pre monsoon (2304 ha) compared to post monsoon (1437 ha). Seasonal fluctuation of open water spread of wetlands showed slightly more spread during pre monsoon. The turbidity of water is moderate in both the seasons.

Table 23: Area estimates of wetlands in Golaghat

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	120	2253	5.16	1456	976
2	1102	Ox-bow lakes/ Cut-off meanders	57	1099	2.52	518	510
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	172	1522	3.49	1026	675
6	1106	River/Stream	33	38593	88.45	18723	22199
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	1	3	0.01	3	3
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	383	43470	99.62	21726	24363
		Wetlands (<2.25 ha), mainly Tanks	165	165	0.38	-	-
		Total	548	43635	100.00	21726	24363

Area under Aquatic Vegetation	1437	2304
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Area under turbidity levels		
Low	2235	1259
Moderate	19491	23104
High	-	-

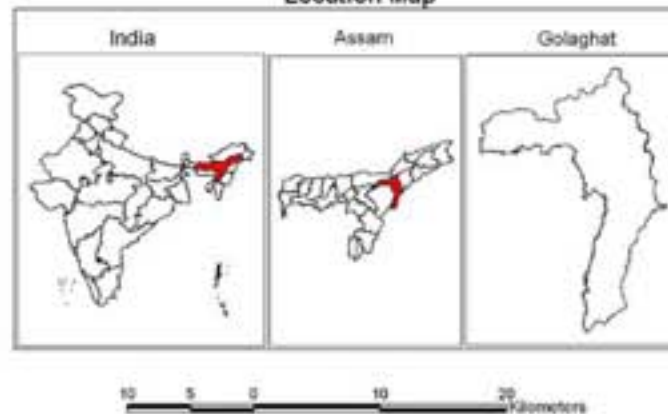


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

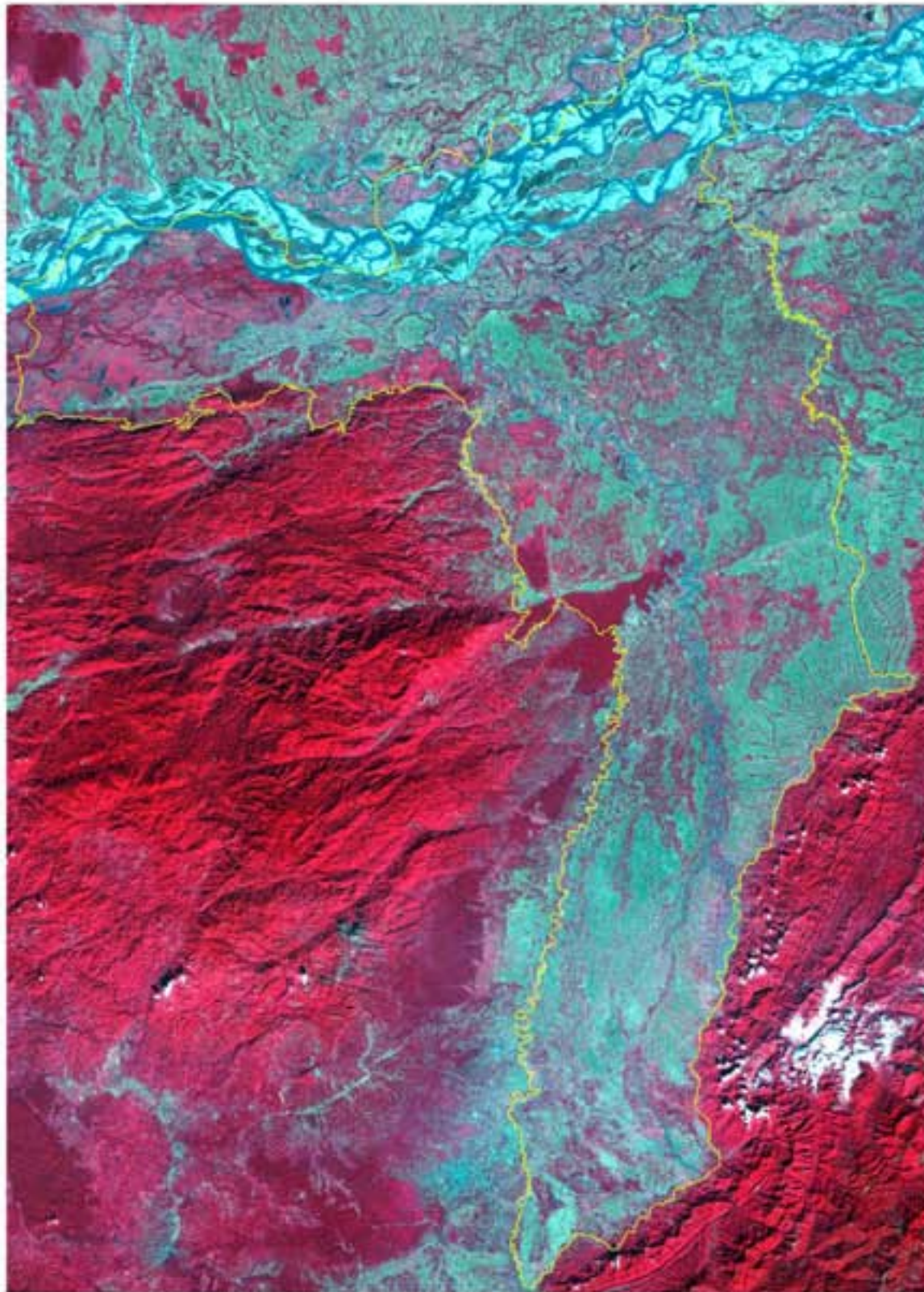
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

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Assam Remote Sensing Applications Centre, Guwahati

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7.1.19 Karbi Anglong

Karbi Anglong district is situated in central part of Assam between 25°32'N to 26° 36'N latitudes and 92° 10' E to 93°50' E longitudes. It occupies an area of 1000257 hectares. It is bounded on the east by Golaghat district of Assam, on the west by East Khasi Hills of Meghalaya, and on the south by Kohima district of Nagaland, North Cachar hills district of Assam and Jaintia hills district of Meghalaya. The district can be broadly divided into two physiographic units viz., hills and plains. About 85 percent of the district is covered by hills. The highest peak in the district rises to a height of 1360 metres. The area located between the northern and southern hills in Diphu sub-division is characterised by undulating plains of subdued relief. The plain areas consist of valleys of the Jamuna, Kapili and Dhansiri rivers flowing through its eastern part. Other minor streams include Kaliani, Barpani, Patradisa and Digaru. The soils of the district are made up of laterised Red soils and non-laterised Red soils. The surface soils are generally pale red to reddish brown or bright red in colour. Shifting cultivation is a part of land use/cover. The mean annual rainfall in the district is 141 cm. The maximum and minimum temperatures recorded are 25°C and 4°C respectively while the mean temperature is 14.5°C. As per Census Report, 2001, the district has a total population of 8, 13,311.

Total wetland area in the district is **5810** ha that includes 89 small wetlands (<2.25 ha). River/stream occupies 85.13% of wetlands. The other major wetland types are Lake/pond (5.46%), Ox-bow lakes (5.71%) and Waterlogged-natural (2.12%). Details of wetland statistics is given in Table.24.

Aquatic vegetation is mainly observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is slightly more during pre monsoon (536 ha) compared to post monsoon (306 ha). Seasonal fluctuation of open water spread of wetlands is more or less same in both the seasons. The turbidity of water is moderate in both the seasons.

Table 24: Area estimates of wetlands in Karbi Anglong

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	17	317	5.46	145	41
2	1102	Ox-bow lakes/ Cut-off meanders	31	332	5.71	142	164
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	23	123	2.12	101	41
6	1106	River/Stream	45	4946	85.13	4399	4399
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	1	3	0.05	15	3
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	117	5721	98.47	4802	4648
		Wetlands (<2.25 ha), mainly Tanks	89	89	1.53	-	-
		Total	206	5810	100.00	4802	4648

Area under Aquatic Vegetation	306	536
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Area under turbidity levels		
Low	198	121
Moderate	4604	4527
High	-	-

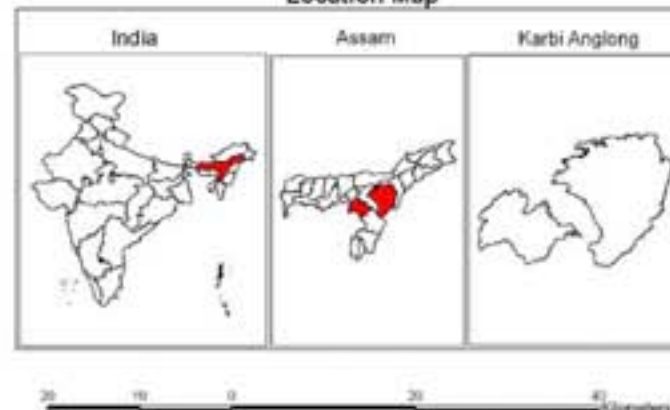


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

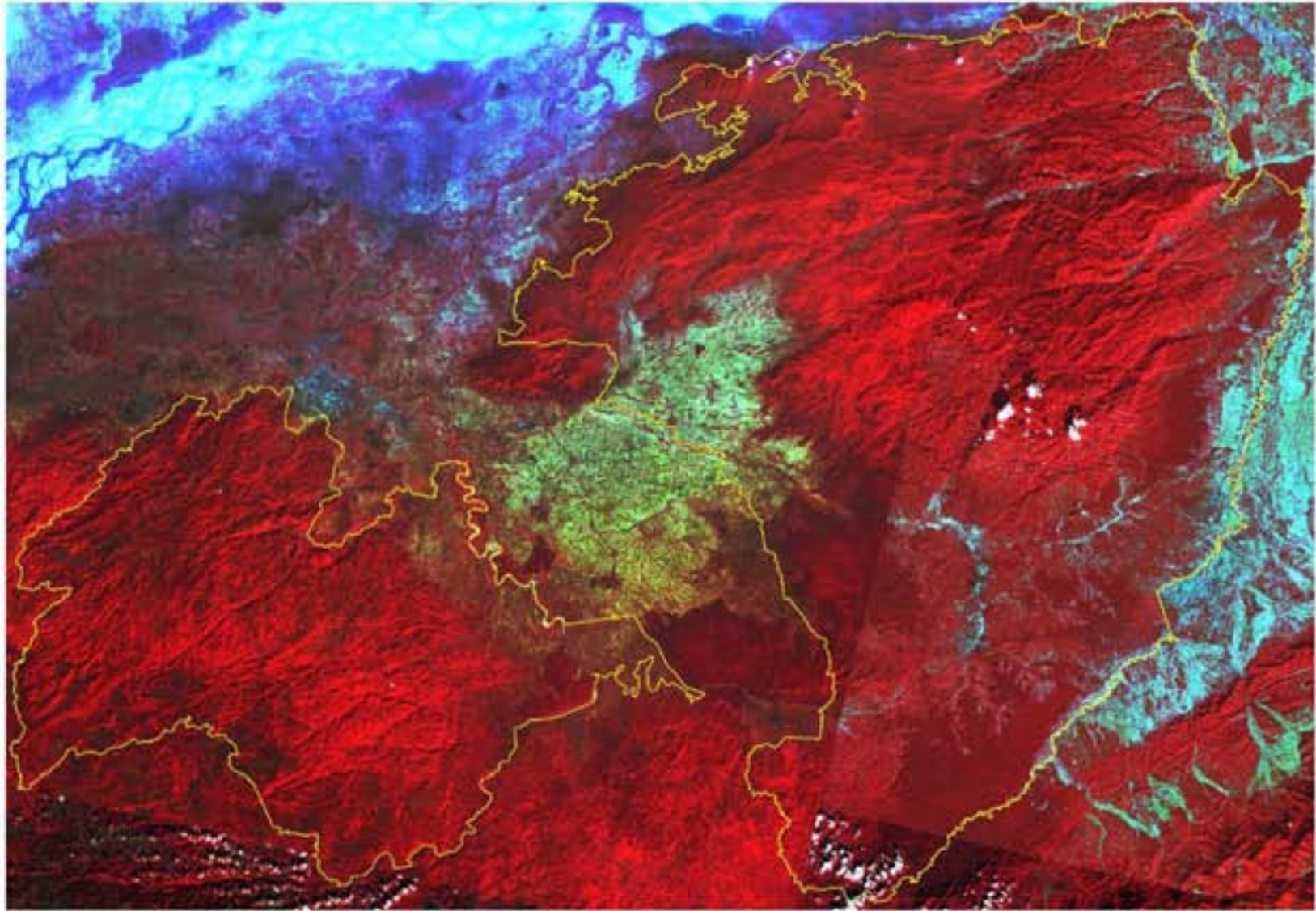
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

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7.1.20 North Cachar Hills

North Cachar Hills is situated in the south central part of Assam between 24°58' and 25°47' North latitudes and 92°32' and 93°28' East longitudes. The district occupies an area of 4,89,793 hectares. The only big town is Haflong which is the district head quarter also It is bounded on the east by the Jaintia hills of Meghalaya state, on the west by Tamenglong and Kohima districts of Nagaland, on the north by Karbi Anglong and Nagaon districts of Assam and on the south by Cachar district of Assam. The district consists mainly of hilly tracts and valleys with a negligible extent of plain area. The topography is rugged with elevations varying from 600 metres to 900 metres. The main rivers are Diyang, Kopili, Jiri and Dhansiri. The soils of the district vary from non-laterised red soil to laterised red soil ranging from sandy loam to clayey loam in texture. The non-laterised red soils occupy a relatively less area along a strip in the southern part of the district. The soil is acidic in reaction with pH varying from 4.10 to 6.20. The average annual rainfall varies from 2200 to 2300 mm. The maximum and minimum temperatures are 25.8°C and 5.3°C respectively. As per Census Report, 2001, the district has a total population of 1, 88,079.

Total wetland area in the district is 6619 ha that includes 44 small wetlands (<2.25 ha). River/stream occupies 56.43% of wetlands. The other major wetland type is Reservoir/Barrage. Two such wetland type are mapped with 2833 ha area and occupying 42.80%. Details of wetland statistics is given in Table.25.

Aquatic vegetation is mainly observed in Reservoir/Barrage wetland types. The area under aquatic vegetation is significantly more during pre monsoon (1487 ha) compared to post monsoon (634 ha). Seasonal fluctuation of open water spread of wetlands is more during post monsoon (6004 ha) compared to pre monsoon (4385 ha). The turbidity of water is low to moderate in both the seasons.

Table 25: Area estimates of wetlands in North Cachar Hills

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	2	7	0.11	7	7
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	3735	56.43	3812	3032
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	2	2833	42.80	2185	1346
8	1202	Tanks/Ponds	-	-	-	-	-
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	15	6575	99.34	6004	4385
		Wetlands (<2.25 ha), mainly Tanks	44	44	0.66	-	-
		Total	59	6619	100.00	6004	4385

Area under Aquatic Vegetation	634	1487
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Area under turbidity levels		
Low	2190	1350
Moderate	3811	3032
High	3	3

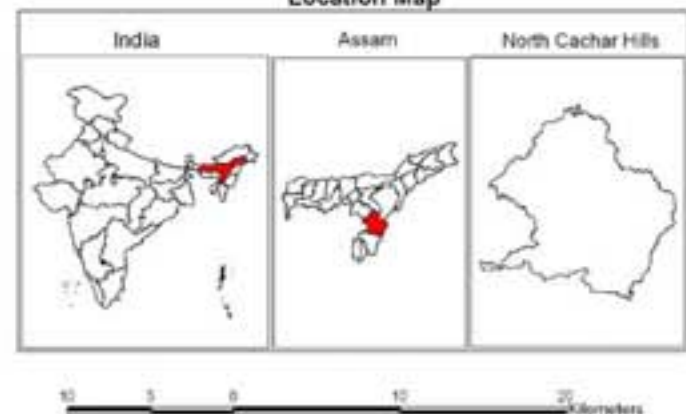


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

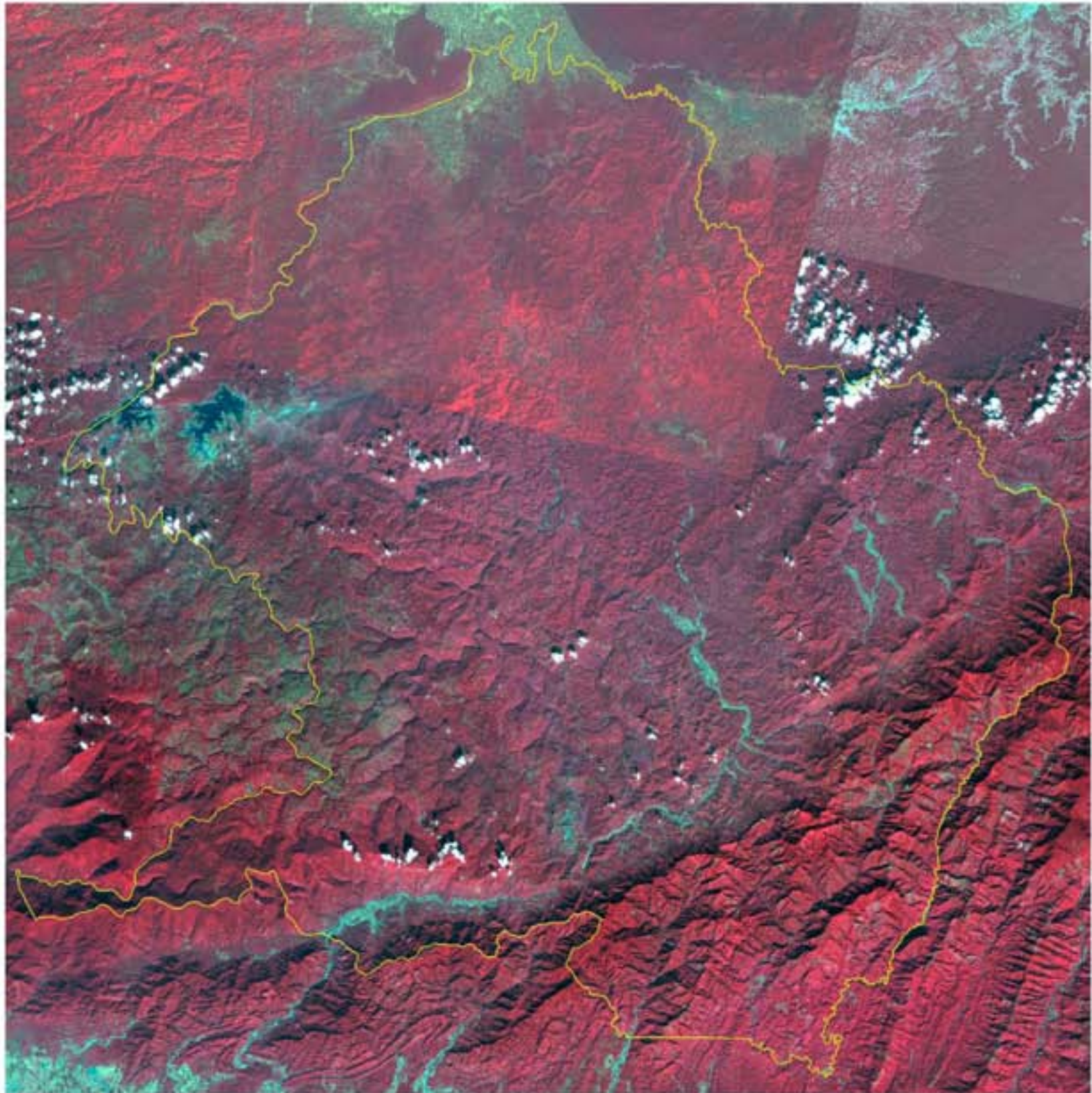
IRS P6 LISS III data (Pre-monsoon and Post-monsoon Season 2006-07)

Prepared By :

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7.1.21 Cachar

Cachar district is situated in the lower Brahmaputra valley of Assam between 24°20'N and 25°10'N latitudes and 92°15'E and 93°15'E longitudes. It occupies 3, 77,600 hectares of area. The district is bounded by Manipur on the east, y Hailakandi district and Bangladesh in west, and Mizoram state on the south. Most of the areas in the district consist of hills and inselbergs leaving behind very little plain area. The main river flowing along the Central part of the district is the Barak and its tributaries viz., the Rukni and the Sonai. The Barak river flows along east-west direction. All the rivers are perennial in nature. The lowlying areas are usually characterised by the presence of natural lakes and swamps, locally known as 'haors'. The soils of the district vary from alluvial to lateritic, the major areas having a clayey loam to clayey texture. Loam to sandy loam soils are found in riverine tracts of the main river Barak and its tributaries. The average annual rainfall as recorded in the district is 2717mm. The maximum temperature recorded is 37.4°C and the minimum temperature is 9°C. As per Census Report, 2001, the district has a total population of 14, 44,921.

Total wetland area in the district is 10419 ha that includes 46 small wetlands (<2.25 ha). The wetlands belong to Inland- Natural type. River/stream occupies 55.22% of wetlands. The other major wetland types area Waterlogged –natural (29.66%) and Lake/pond (14.35%). Details of wetland statistics is given in Table.26.

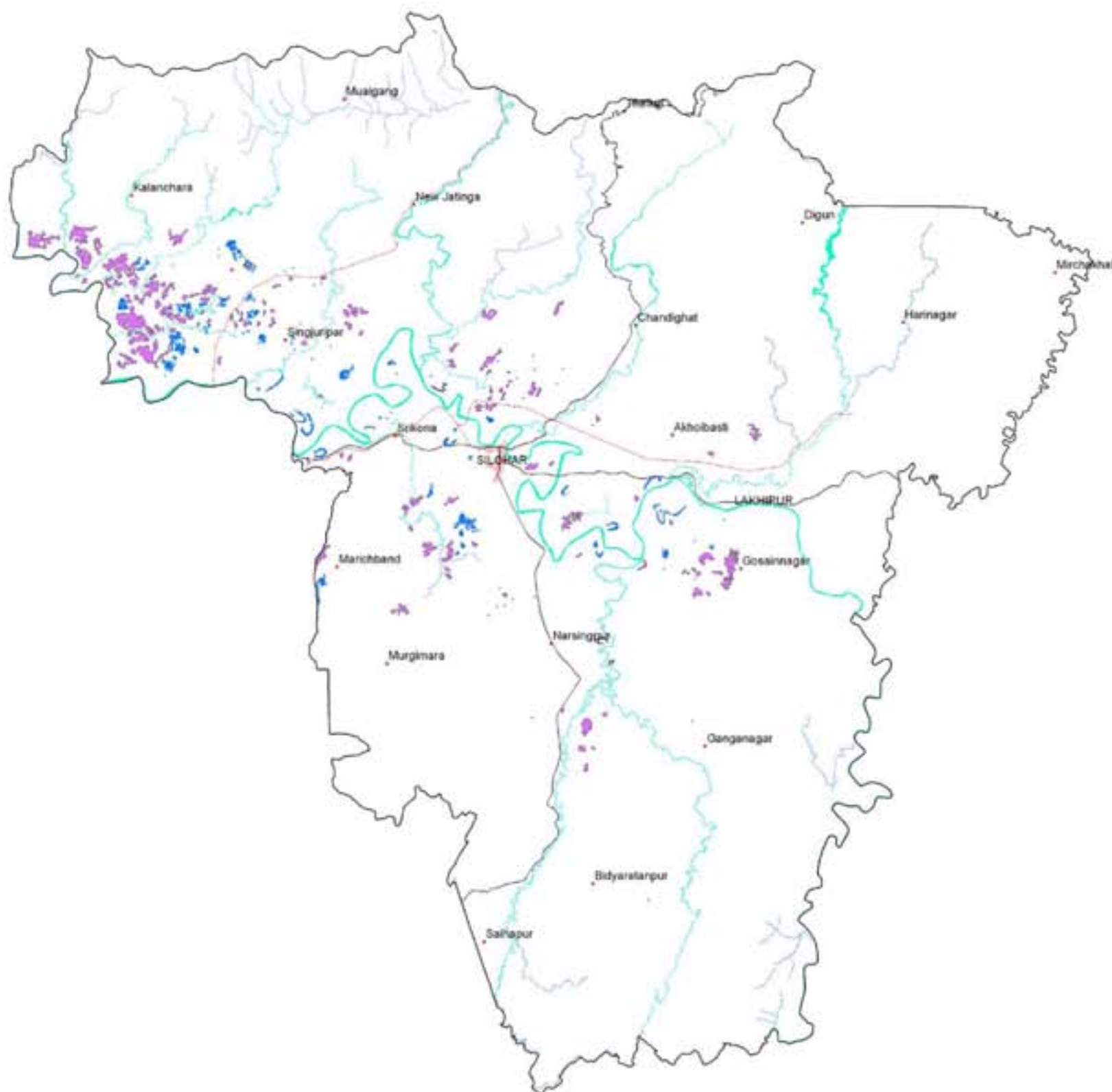
Aquatic vegetation is mainly observed in Waterlogged and Lake/pond wetland types. The area under aquatic vegetation is significantly more during pre monsoon (1872 ha) compared to post monsoon (137 ha). Seasonal fluctuation of open water spread of wetlands is more during post monsoon (10023 ha) compared to pre monsoon (8286 ha). The turbidity of water is low to moderate in both the seasons.

Table 26: Area estimates of wetlands in Cachar

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	49	1495	14.35	1458	1098
2	1102	Ox-bow lakes/ Cut-off meanders	3	31	0.30	31	31
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	142	3090	29.66	2968	1593
6	1106	River/Stream	17	5757	55.25	5566	5564
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	-	-	-	-	-
9	1203	Waterlogged	-	-	-	-	-
		Sub-Total	211	10373	99.56	10023	8286
		Wetlands (<2.25 ha), mainly Tanks	46	46	0.44	-	-
		Total	257	10419	100.00	10023	8286

Area under Aquatic Vegetation	137	1872
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Area under turbidity levels		
Low	3654	2023
Moderate	6369	6263
High	-	-

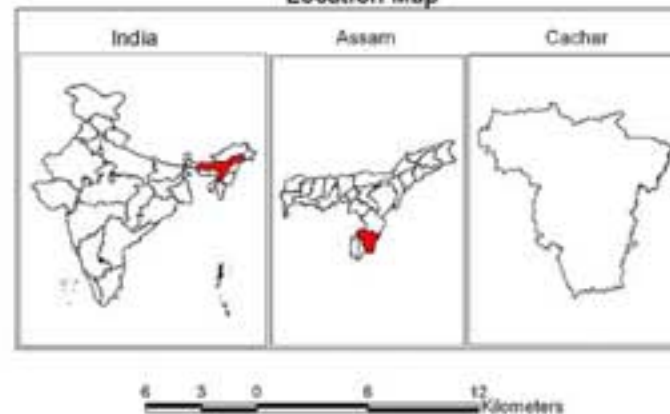


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

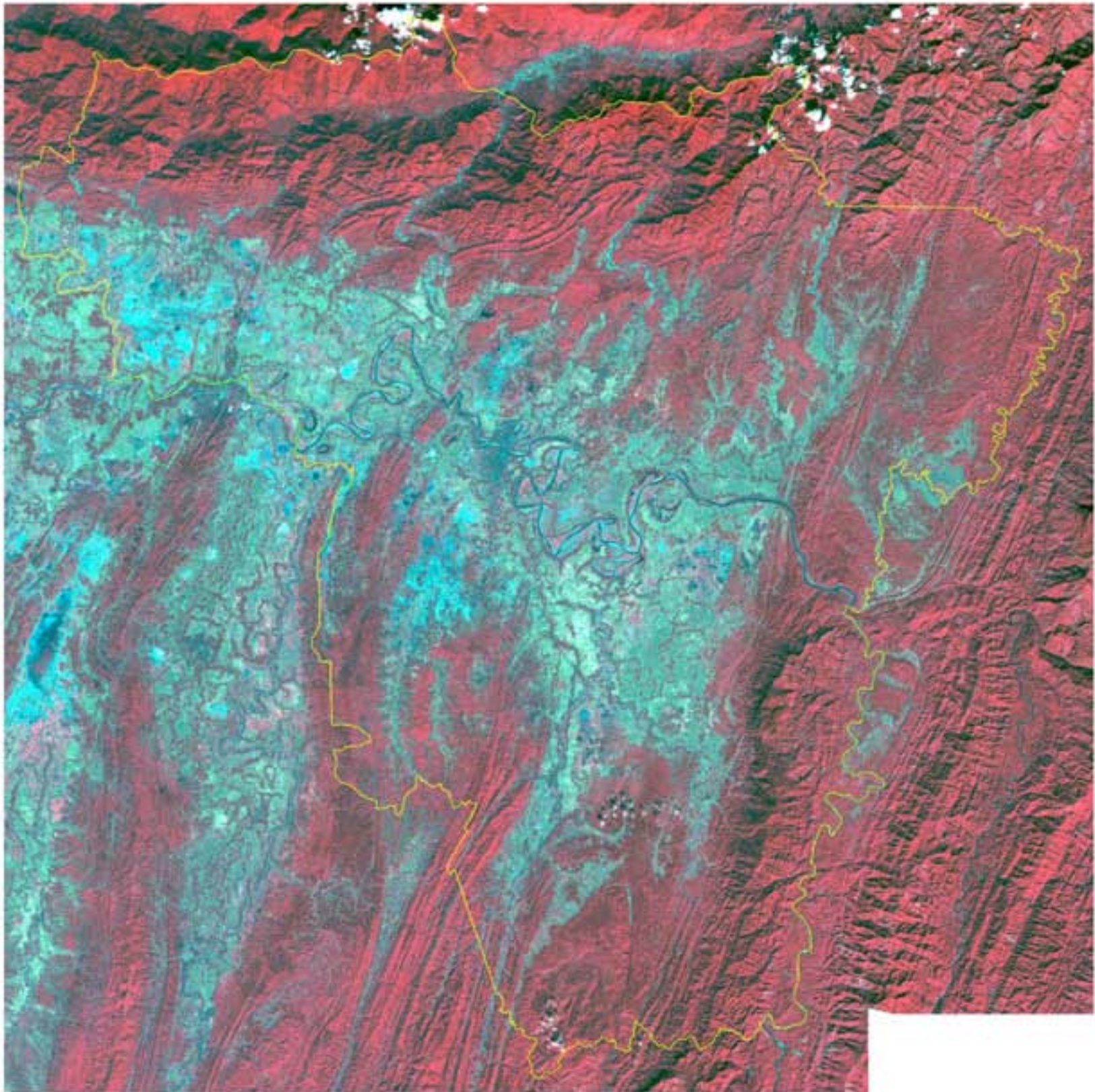
Location Map



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

Prepared By :
Space Applications Centre (ISRO), Ahmedabad
and
Assam Remote Sensing Applications Centre, Guwahati

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7.1.22 Karimganj

Karimganj district is situated in the S-W part of Assam state between 24°14'N and 24°54'N latitudes and 92°16'E and 92°35'E longitudes. It occupies 1, 76,285 hectares of area. It is bounded on the east by the Cachar district of Assam and the state of Mizoram, on the west by the state of Tripura and Bangladesh, on the north by the Cachar district of Assam and Bangladesh and on the south by the state of Mizoram. The topography of the district is characterised by hills and valley fills. The Barak river flows on the northern part of the district and meet the river Surma near Bhanga from where it flows as river Kusiara along the northern boundary of the district. There are two other main rivers flowing from the south to the north and these are Longai and Singla rivers which join with the river Kusiara in the north. The average annual rainfall in the district is 3759.6 mm. The maximum temperature recorded during the month of June is about 36°C and minimum temperature is about 8°C during the month of December-January. The soils of the district are mostly made of older. Alluvium having a texture of clay loam to clayey. In some parts it is sandy loam in texture. The soil in the district is acidic to neutral in reaction with pH ranging from 4.5 to 6.0. As per Census Report, 2001, the district has a total population of 10, 07,976.

Total wetland area in the district is 6450 ha that includes 98 small wetlands (<2.25 ha). The major wetland type is Lake/pond. Total 8 Lake/pond are mapped with 3593 ha area (55.71%). The other major wetland types are River/stream (23.81%) and Waterlogged –natural (18.96%) Details of wetland statistics is given in Table.27.

Aquatic vegetation is mainly observed in Waterlogged and Lake/pond wetland types. The area under aquatic vegetation is significantly more during pre monsoon (3206 ha) compared to post monsoon (527 ha). Seasonal fluctuation of open water spread of wetlands is more during post monsoon (5548 ha) compared to pre monsoon (2857 ha), mainly due to fluctuation of water in Lake/pond type. The turbidity of water is low to moderate in both the seasons.

Table 27: Area estimates of wetlands in Karimgani

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	8	3593	55.71	3305	976
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	82	1223	18.96	890	528
6	1106	River/Stream	5	1536	23.81	1353	1353
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	-	-	-	-	-
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	95	6352	98.48	5548	2857
		Wetlands (<2.25 ha), mainly Tanks	98	98	1.52	-	-
		Total	193	6450	100.00	5548	2857

Area under Aquatic Vegetation	527	3206
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Area under turbidity levels		
Low	4031	1321
Moderate	1517	1536
High	-	-

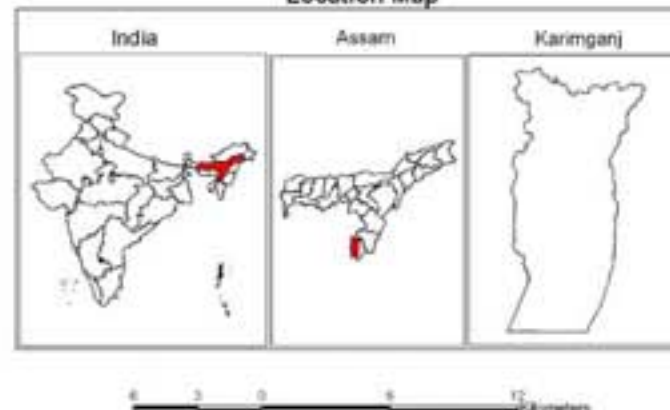


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

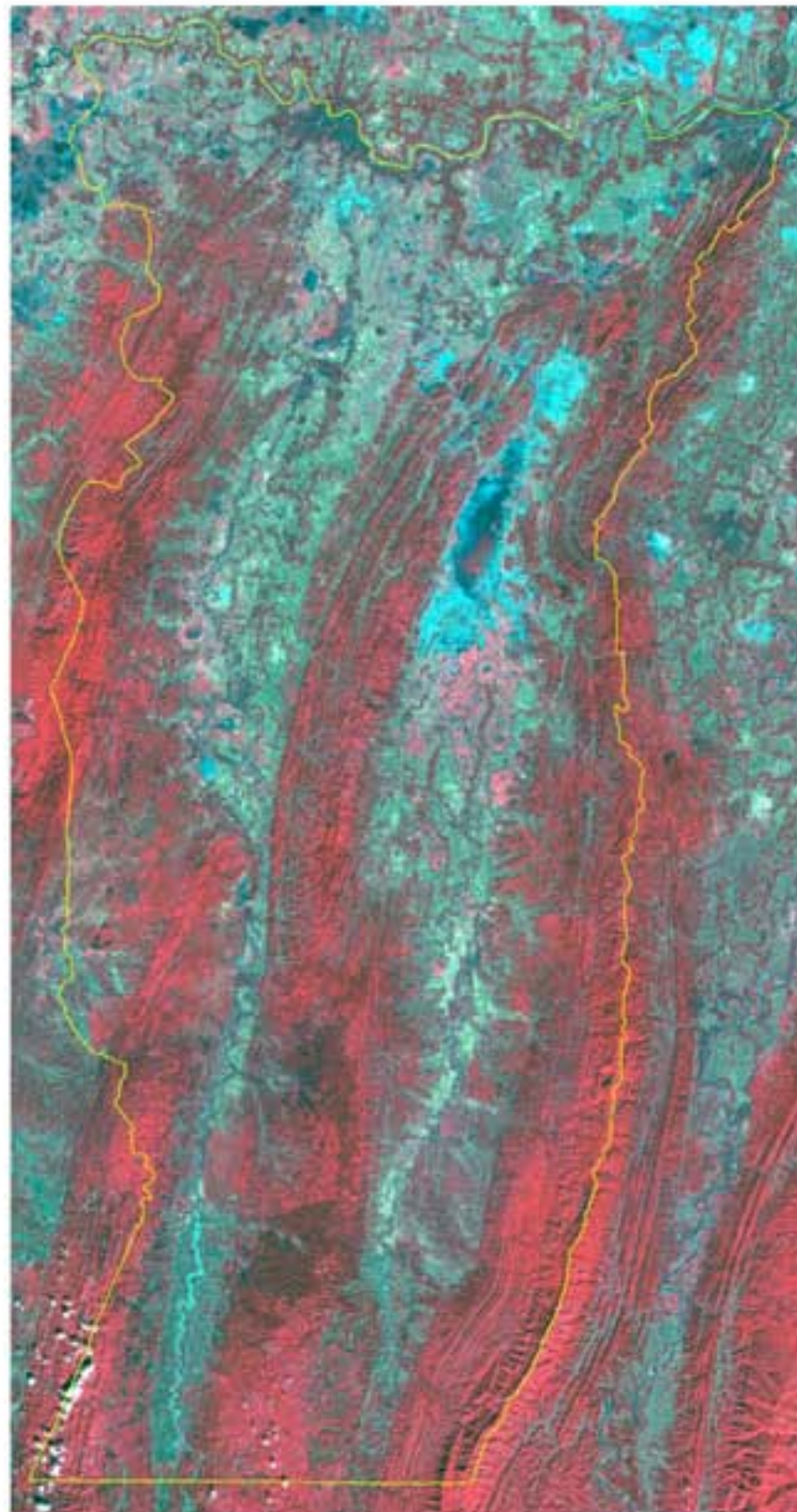
Location Map



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

Prepared By :
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7.1.23 Hailakandi

Hailakandi district is situated in the lower Brahmaputra valley of Assam between 24°10'N and 24°55'N latitudes and 92°25'E and 92°45'E longitudes. It occupies 1, 32,600 hectares of area. The district is bounded by the interstate boundary of Mizoram and Cachar district of Assam on the east, Karimganj district on the west. The north boundary is marked by parts of Cachar and Karimganj districts while Mizoram is on the south. The district shares the Son Beel wetland, largest in the state, along the western boundary with Karimganj district. Most of the areas in the district consist of hills and inselbergs leaving behind very little plain area. The low lying areas are usually characterised by the presence of natural lakes and beels, locally known as 'haors'. The main river flowing along the northern boundary of the district is the Barak and its tributaries viz., the Katakhal and the Dhaleswari. All the rivers flow northwards from the hills of Mizoram. The Barak river flows along east-west direction. The soils of the district mostly made of older alluvium having a texture of clay-loam to clayey. Beel soils (peat soils) are also found in some areas. The soil in the district is acidic to neutral in reaction with pH ranging from 4.5 to 6.0. As per Census Report, 2001, the district has a total population of 5, 42,872. The average annual rainfall is 2717mm. The maximum temperature recorded during summer is 37.4°C and the minimum temperature recorded during winter is 9°C.

Total wetland area in the district is 2600 ha that includes 30 small wetlands (<2.25 ha). The major wetland type is River/stream (66.27%). Total 19 Lake/pond are mapped with 575 ha area (22.12%). The other major wetland type is Waterlogged-natural (10.46%). Details of wetland statistics is given in Table.29.

Aquatic vegetation is mainly observed in Waterlogged and Lake/pond wetland types. The area under aquatic vegetation is significantly more during pre monsoon (380 ha) compared to post monsoon (64 ha). Seasonal fluctuation of open water spread of wetlands is more or less same in both the seasons. The turbidity of water is low to moderate in both the seasons.

Table 29: Area estimates of wetlands in Hailakandi

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Area in ha	
						Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	Inland Wetlands - Natural					
1	1101	Lakes/Ponds	19	575	22.12	540	311
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	27	272	10.46	245	156
6	1106	River/Stream	6	1723	66.27	1699	1699
	1200	Inland Wetlands -Man-made					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	-	-	-	-	-
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	52	2570	98.85	2484	2166
		Wetlands (<2.25 ha), mainly Tanks	30	30	1.15	-	-
		Total	82	2600	100.00	2484	2166

Area under Aquatic Vegetation	64	380
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Area under turbidity levels		
Low	781	367
Moderate	1703	1799
High	-	-

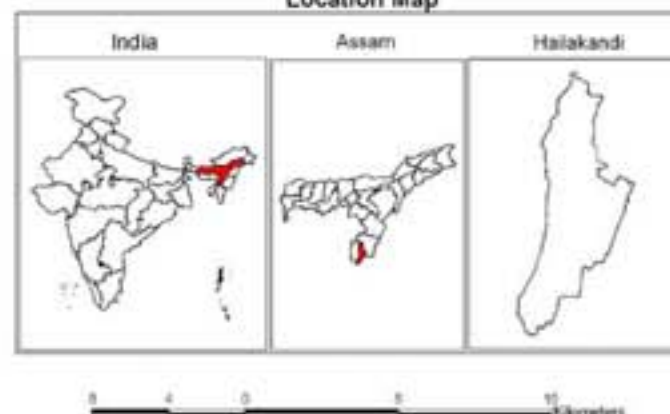


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

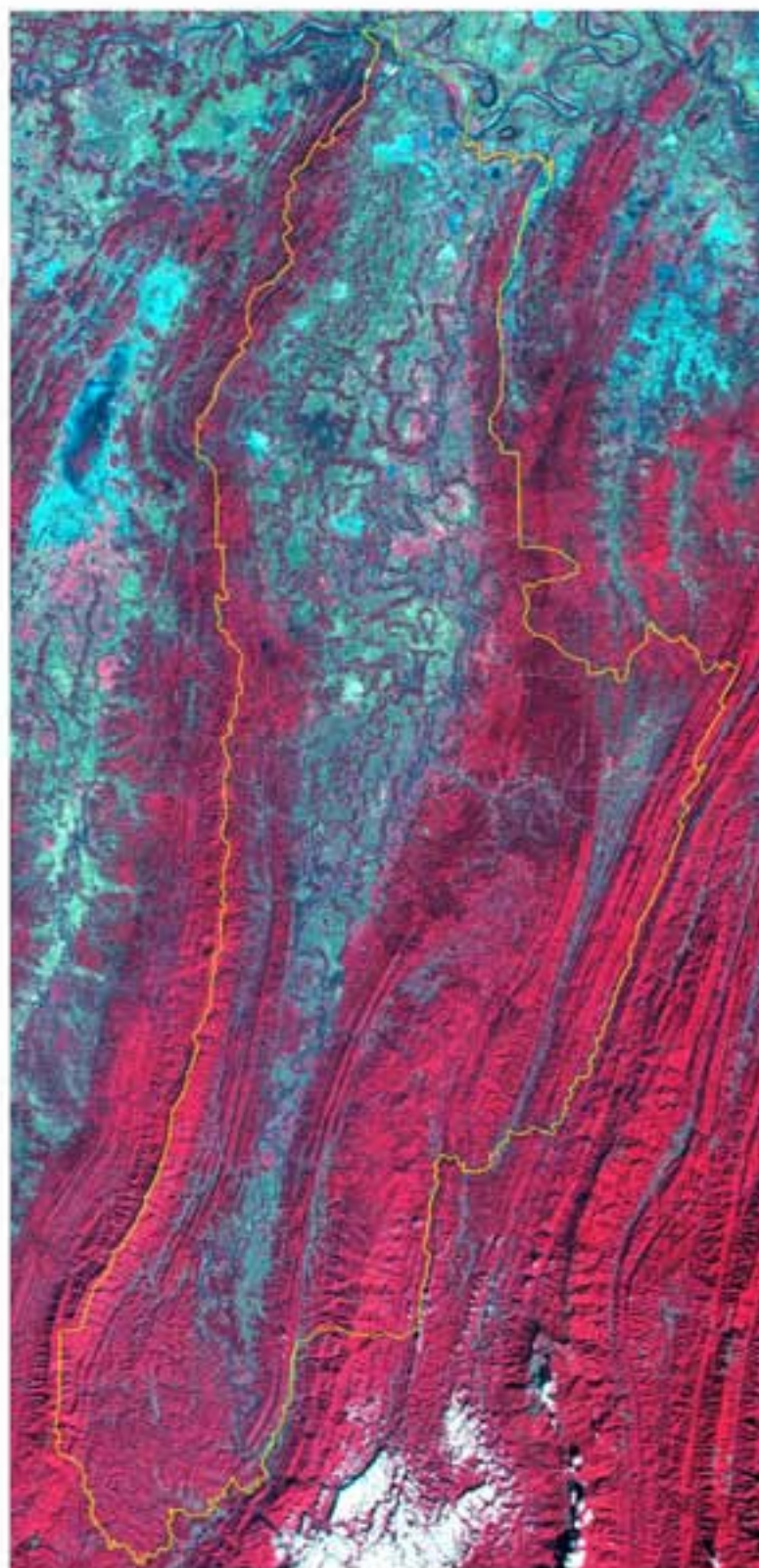
Location Map



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

Prepared By :
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MAJOR WETLAND TYPES

8.0 MAJOR WETLAND TYPES OF ASSAM

Major wetland types observed in the state are Rivers/streams, Lakes/ponds, Waterlogged, and ox-bow lakes. The manifestation of representative wetlands in satellite image is given in Plate-1a and 1b. Field photographs of representative wetland types along with their location are shown in Plates 2a and 2b.

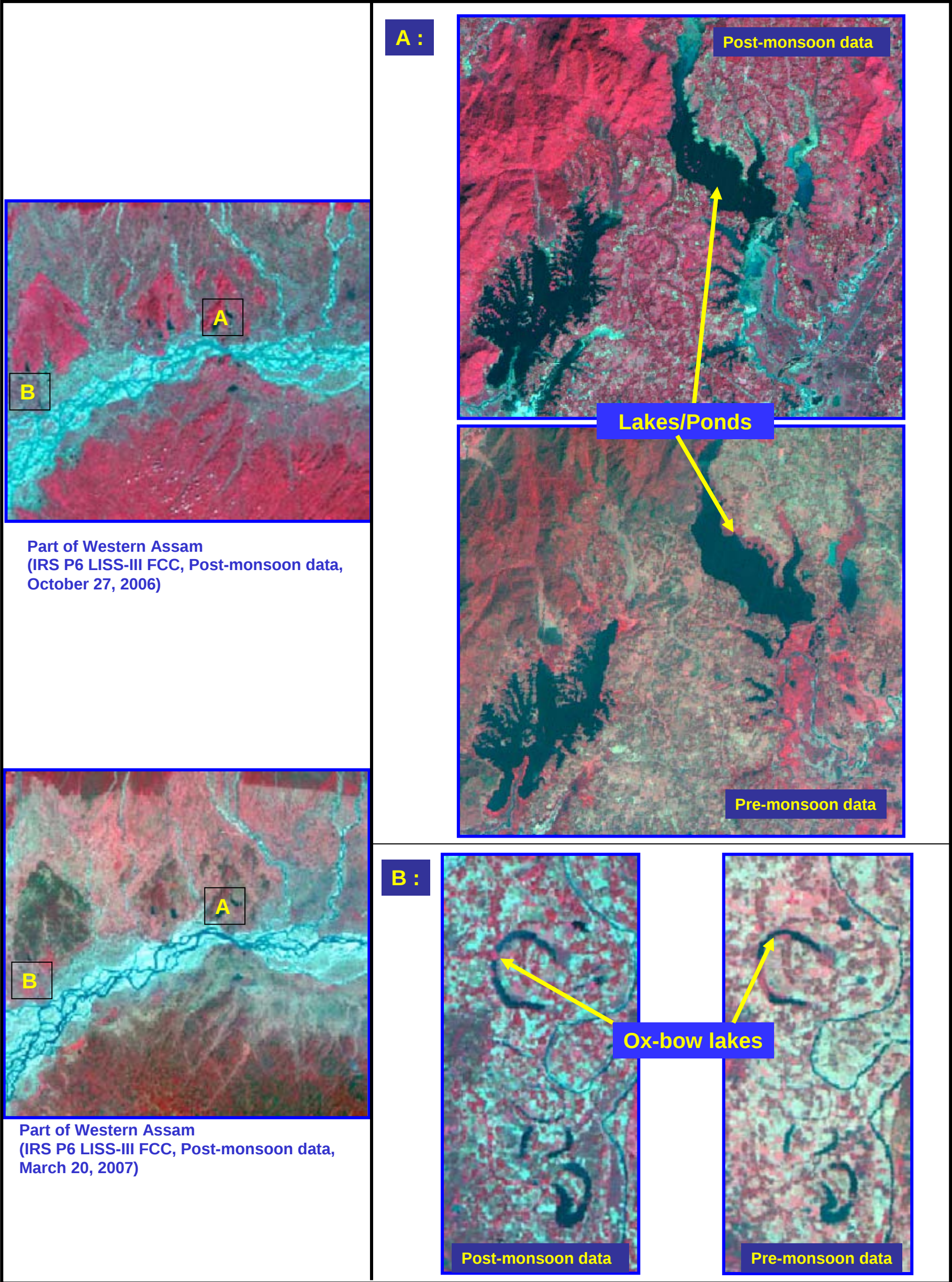
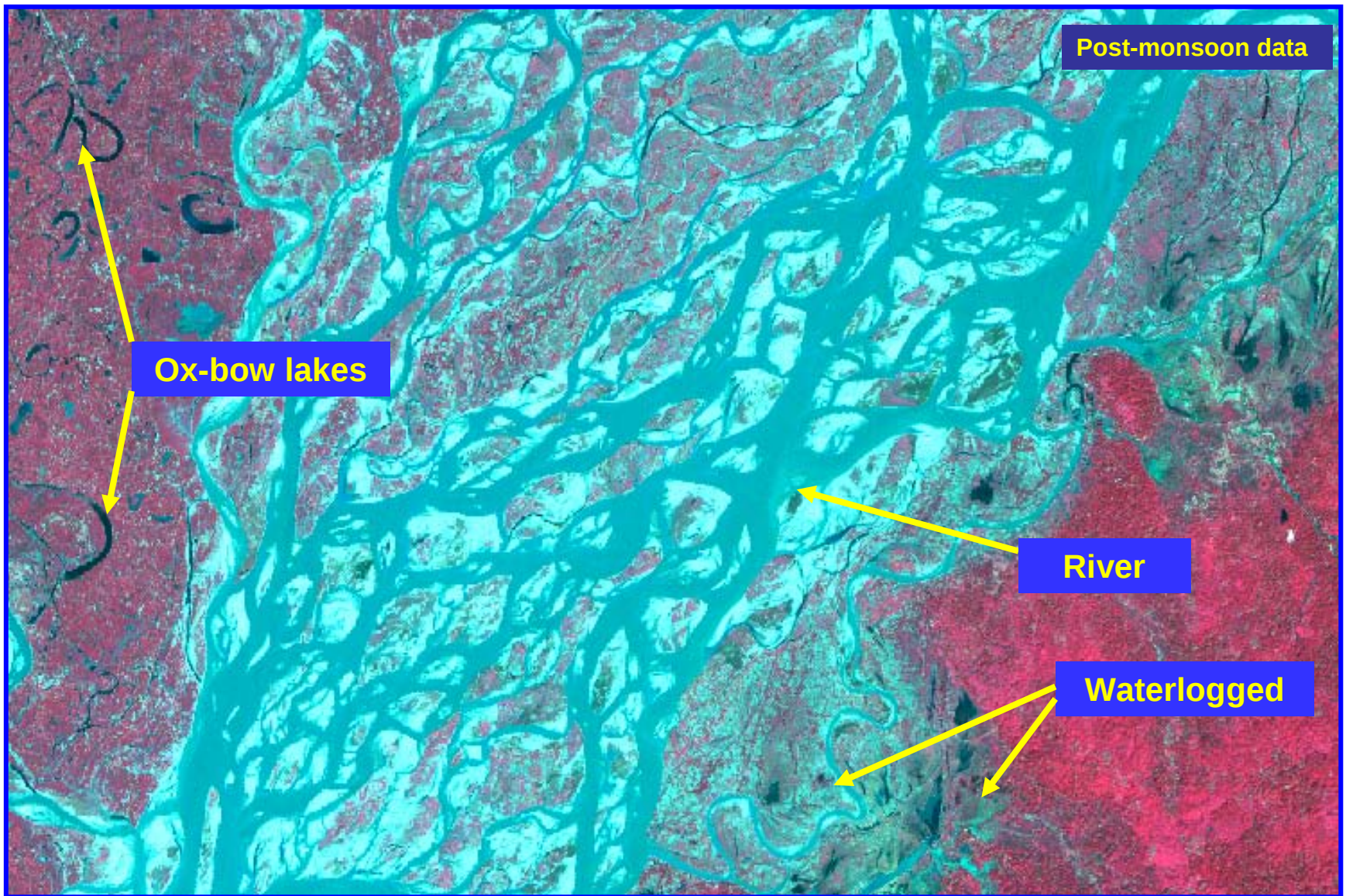


Plate – 1a: Major wetland types of Assam



Part of Western Assam

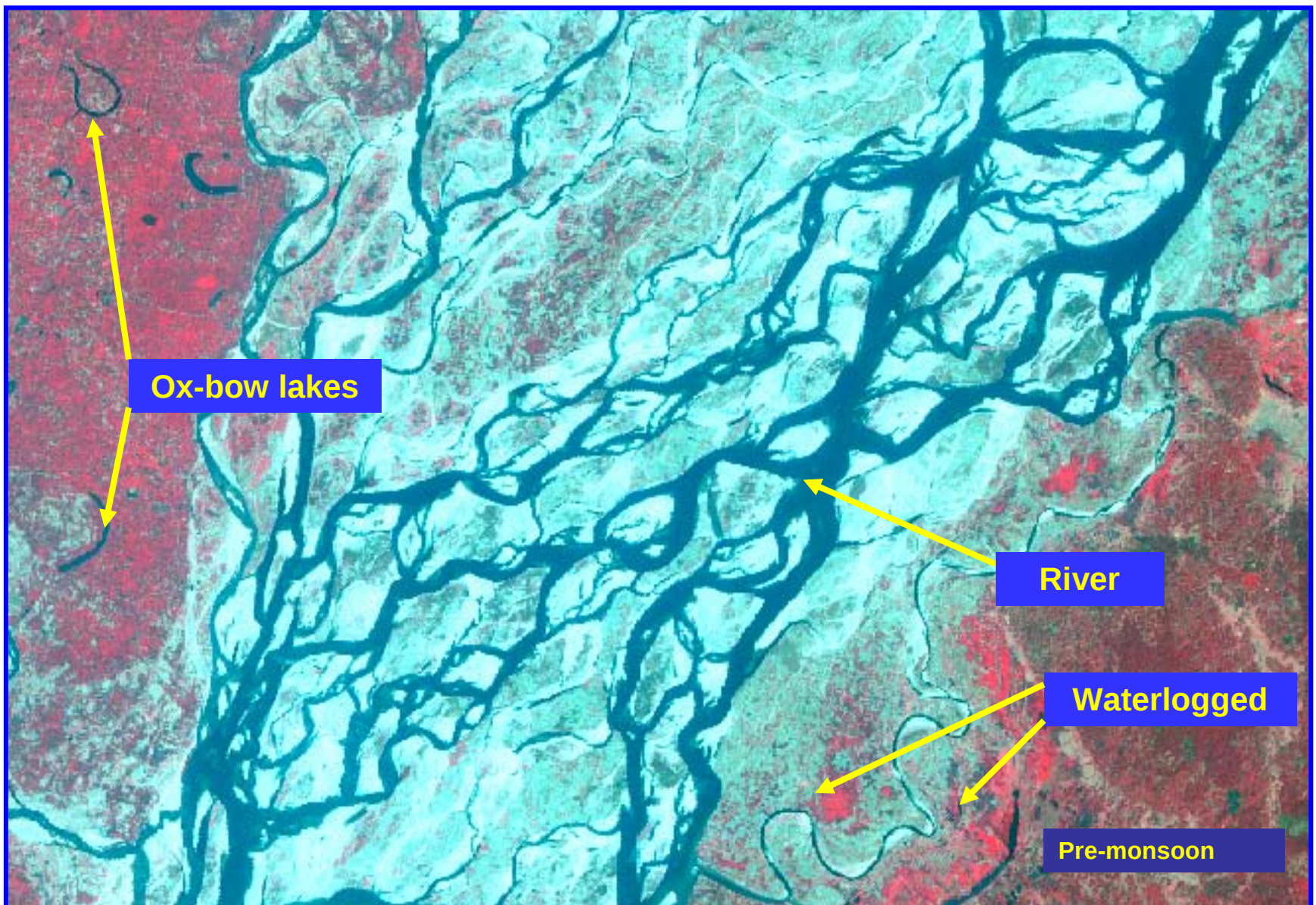


Plate – 1b: Major wetland types of Assam

Sr. No.	Description	Field photograph
1.	Wetland Type: River/stream Wetland Name: Brahmaputra River Location: Longitude: 92°14'10.2"E Latitude : 26°24'29.2" N Turbidity: low	
2.	Wetland Type: Lake Wetland Name: Deepor Beel Location: Longitude: 91°39'30.9" E Latitude : 26°06'46" N Turbidity: High	
3.	Wetland Type: Waterlogged (natural) Location: Longitude : 92°15'30.5"E Latitude : 26°19'29.3"N Turbidity: Moderate	
4.	Wetland Type: Tank / Pond Wetland Name: Anua Beel Location: Longitude: 90°21.02'E Latitude : 26°32.94" N Turbidity: Moderate	

Plate 2a: Field observations of different wetland types in Assam

Sr. No.	Description	Field photograph
5.	Wetland Type: River/streem Wetland Name: Beki River Location: Longitude: 90°55'02.6"E Latitude : 26°31'01.5"N Turbidity: Moderate	
2.	Wetland Type: Ox-bow lake Wetland Name: Saren Beel Location: Longitude: 91°46'42.5"E Latitude : 26°06'46" N Turbidity: Moderate	
3.	Wetland Type: Waterlogged (natura)l Wetland Name: Naitara Beel Location: Longitude : 90°59.07"E Latitude : 26°03.16"N Turbidity: Moderate	
4.	Wetland Type: Tank / Pond Wetland Name: Hajo Pukhuri Location: Longitude: 91°31'54"E Latitude : 26°14'36"N Turbidity : Low	

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

A large diversity of aquatic plants belonging to angiosperms and ferns are found in the wetlands of Assam. The floating and emergent hydrophytes are well captured in the LISS III data (Plate-3), while, the submerged ones are not. Some of the dominant and major hydrophytes belonging to the floating and emergent type observed in the state are listed here.

Free Floating Hydrophytes:

The species are found coming in contact with water and air only. These species has a tendency to form complete carpet over water surface during certain period. Usually these plants grow well in still waters at shallow depths, sometimes in very slow flowing shallow water bodies.

Angiosperms:

Eichhomia crassipes (Mart.) Solms.; *Lemna perpusilla* Torr.; *Pistia stratiotes* L; *Spirodela polyrrhiza* (L) Schleid.,
S. punctata (Meyer.) Thompson; *WoljJia arrhiza* (L) Hook. ex Wimm

Aquatic ferns:

Azolla pinnata RBr.; *Salvinia cucullata* Roxb. ex Bory; *S. natans* (L) All.

Floating leaves anchored Hydrophytes:

The plants are usually in contact with soil, water as well as air. Except the developing leaves, the matured ones remain floating. The leaves frequently form a continuous cover in such an extent that water does not get warmed. Different kinds of fishes are found to take shelter during the hottest period of the day. Usually these plants grow well in still waters. Commonly found plants are:

Aponogeton n,atans (L) Engl. & Krause; *Euryale ferox* Salisb; *Nelumbo nucifera* Gaertn.; *Nymphaea nouchali* Burm. f., *N. pubescens* Willd., *N. rubra* Roxb. ex. Andrews; *Nymphoides cristata* (Roxb.) O. Kuntze, *N. indicum* (L) O. Kuntze; *Potamogeton octandrous* Poir.; *Trapa natans* L var. *bispinosa* (Roxb.) Makino, *T. natans* L var. *quadrispinosa* (Rqxb.) Makino.

Floating shoots anchored Hydrophytes:

These aquatics have contact with soil, water and air. They usually grow along the margins of shallow water pools rooted in marsh and spread branches with their shoots floating on water. The main stem remains submerged wholly or partially. They often produce spongy respiratory roots at the nodes. When water level recede these plants become terrestrial, their stems and leaves get reduced. At the advent of rains these plants again show normal growth and development. The species are:

Hygroryza aristata Nees ex Weight & Am.; *Ipomoea aquatica* Forsk.; *Limnophila sessiliflora* (Vahl) Bl.; *Ludwigia adscendens* (L) Hara; *Myriophyllum indicum* Willd., *M. tuberculatum* Roxb.; *Neptunia prostrata* (Lam.) Bail.; *Paspalidium punctatum* (Burm.) A. Camus; *Polygonum glabrum* Willd.; *Pseudoraphis brunoniana* Griff.

Emergent anchored Hydrophytes:

Usually these plants grow along the water's edge. The roots, lower parts of stems and sometimes the lower leaves remain submerged. The apical parts and flowers rise above the water surface. A large number of species are recorded and found in abundance. Many species of the following genus are observed:

Cyperu, *Eleochari*, *Echinochloa*, *Hygrophila*, *Polygonum*, *Limnophila* , *Ranunculus*, *Scirpus*

Swamps, Marsh vegetation:

This category of plants are found to grow well all along the banks of rivers and tributaries, ponds, heels, ditches, Ox-bow lakes, in swamps and marshes (locally known as '*pitoni*', '*metakani*', '*hola*', '*torani*', '*ikorani*' and '*doloni*') where the soil is saturated with water at least in the early part of plant life. Most of them continue to thrive even after the substratum has considerably dried. Good number of plants have been recorded and are found well distributed in almost all parts of Assam. Amongst these sedges and grasses form the largest component of vegetation. Many species of the following genus occur in abundance:

Alternanthera, *Amaranthus*, *Bacopa*, *Blumea*, *Canna*, *Crataev*, *Hedyotis*, *Justicia*, *Lindemia*, *Ludwigia*
Polygonum, *Ranunculus*



Plate 3: Field observation on the status of hydrophytes (free floating mat type emergent anchored and swamp type)

IMPORTANT WETLANDS OF ASSAM

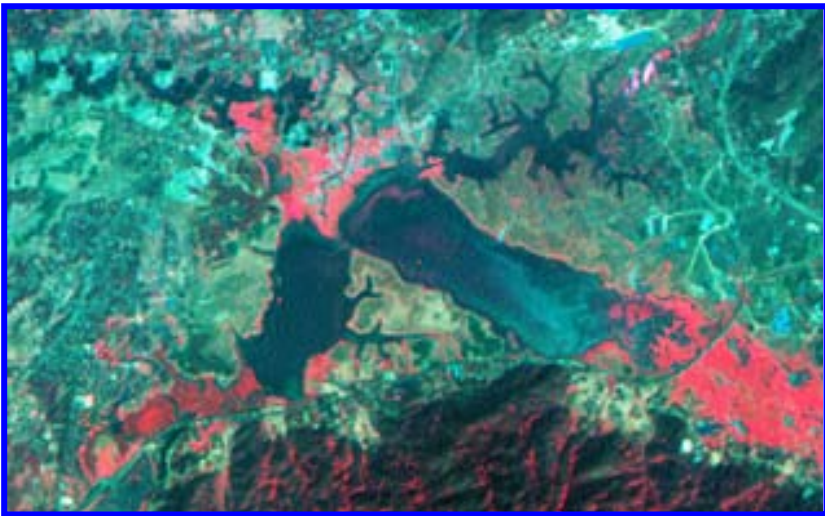
9.0 IMPORTANT WETLANDS OF ASSAM

The state has a large number of lakes/ponds, rivers, ox-bow lakes and waterlogged area. The Brahmaputra and Barak are two important rivers of Assam. Deepor beel, Dhir beel, Sareswar beel, Sone beel, Tamaranga beel and Sonai beel are some of the important wetland sites of Assam .

Extensive field work was carried out for these wetland areas. Wetland maps have been prepared for 5km buffer area of each wetland sites. Details of the wetlands and wetland maps of 5 km buffer area are shown in plates 4 to 21.

9.1 Deepor Beel

Name	Deepor Beel
Location	26° 07' 30" N, 91° 38' 35" E District: Kamrup Ownership: State, Fishery Department
Area	589 ha
Altitude	53 m
Wetland Type	Freshwater Swamp, Lake
Climate	Rainfall : >2000 mm Temperature: 7 °C to 37 °C
Status	Wildlife Sanctuary, established in January 1989. Presently it is a Ramsar Site (designated in November 2002).
Description	This is a fresh water lake, on the southern bank of the Brahmaputra River, covering an area of about 900 ha. The main source of water of this lake is from rainfall runoff and from the Basistha and Kalamoni rivers. The <i>Beel</i> drains into the Brahmaputra River, located about 5 km away through a small rivulet called Khanajan. The southern side of the lake is contiguous with Rani Reserve Forest. About half of the <i>Beel</i> dries out during the winter and the exposed shores are converted into paddy fields. At maximum flooding, it is c. 4 m deep, while during the dry season, the depth drops to about 1.0 m..
Bio-diversity	A large variety of aquatic flora of tropical wetland is found in Deepor <i>Beel</i> and its adjoining areas. The dominant aquatic plants include <i>Azolla pinnata</i>, <i>Nymphaea rubra</i>, <i>Ottelia alismoides</i>, <i>Eleocharis plantaginea</i>, <i>Pistia stratiotes</i> ,<i>Hydrilla verticillata</i>, <i>Potamogeton crispus</i>, <i>Ipomoea reptans</i>, <i>Sagittaria sagittifolia</i>, <i>Nymphaea albea</i>, <i>Vallisneria spiralis</i>. The giant water lily (<i>Euryale ferox</i>) also grows here. <i>Eichhornia crassipes</i> is the dominate weed. The diversity and concentration of indigenous fresh water fish species in this lake is very high (around50 species under 19 families). It harbors many species of migratory birds in winter as well as resident birds. Around 150 species of birds have been recorded so far in and around the Sanctuary, including nine threatened species. The wetland is used for fishery, domestic water supply, collection of natural products, fodder and food supply, transport, and recreation.
Current Status	Current status: Heavy siltation, pollution from city/industry effluents, poaching and unregulated fishing, encroachment.
	As observed in the image, the beel is fragmented, surrounded with waterlogged areas in the 5 km buffer zone. The intensive growth of the weed water hyacinth is very prominent. The field photograph shows the shallowness of water, growth of vegetation in and around the lake.



IRS LISS-III Post monsoon data (November 1, 2006)



IRS LISS-III Pre-monsoon data (May 27, 2007)



Plate 4: Deepor Beel

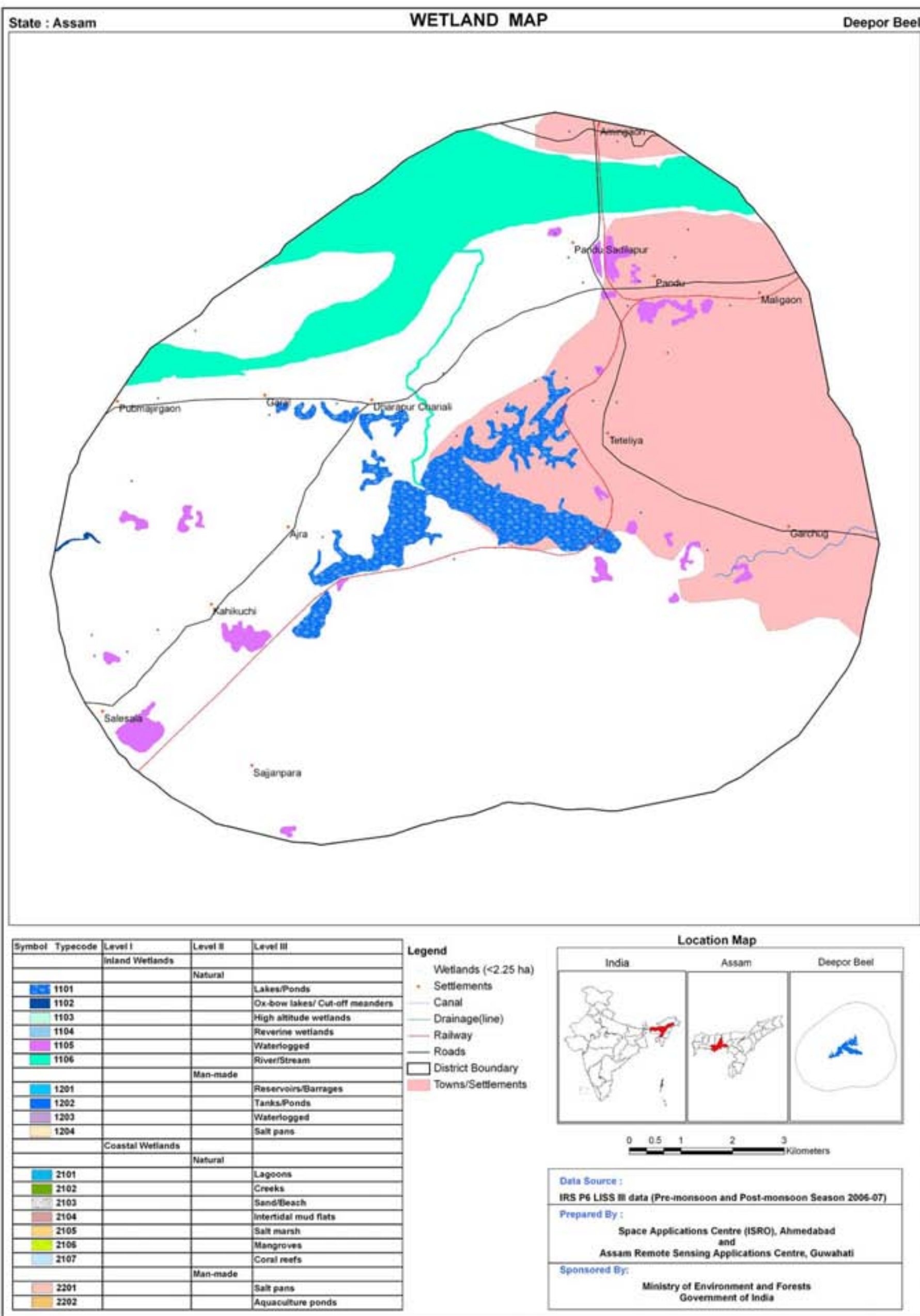


Plate 5: Wetland map - 5 km buffer area of Deepor Beel

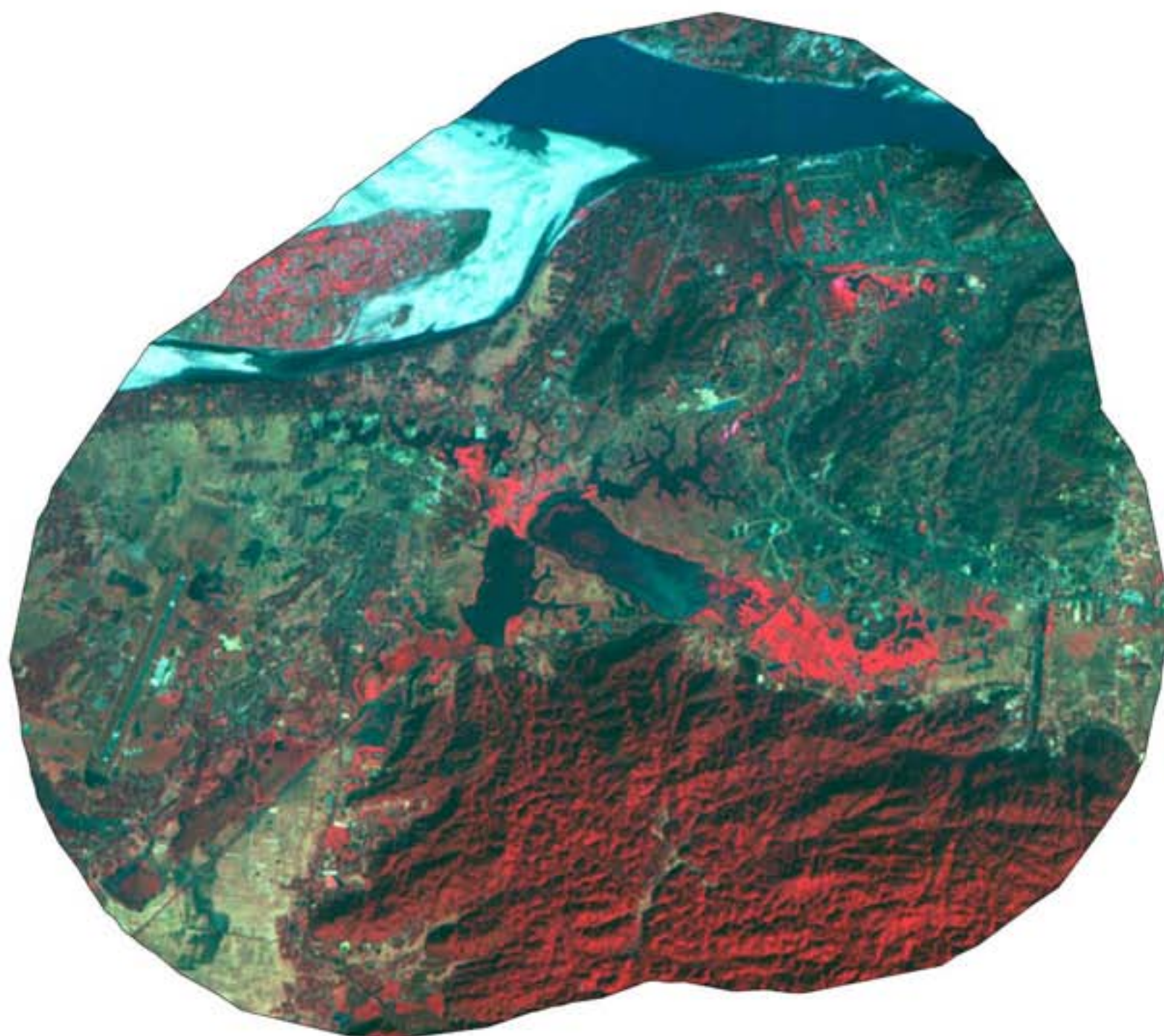


Plate 6: IRS LISS III FCC - 5 km buffer area of Deepor Beel

9.2 Dhir Beel

Name	Dhir Beel
Location	26° 16' 55" N, 90°21' 10"E District : Dhubri Ownership : State (Fisheries Department)
Area	1003 ha
Wetland Type	Lakes/ponds
Description	Dhir <i>beel</i> is situated 30 km from Kokrajhar town at the base of Chakrashila Wildlife Sanctuary. During the rainy season, this wetland gets connected with the Brahmaputra river through a small river called Dhir River. The wetland is rich in aquatic flora and fauna and is a breeding ground for fish. Adjacent to Dhir, there is another Lake- Diplai. These twin lakes attract a lot migratory birds in winter including Near Threatened Ferruginous Duck and the Vulnerable Baer's Pochard <i>Aythya baeri</i>. Swamp Francolin <i>Francolinus gularis</i> (Lahkar 2003) was common in the area till the late eighties, but due to destruction of habitat in the form of agriculture, settlements, and over hunting it has been wiped out gradually
Current Status	Unregulated fishing and poaching are the major threats.
	One can observe the shallowness and drying status of the lake even in post monsoon. Aquatic weed like water hyacinth is not observed. However, encroachment for agriculture is observed.



IRS LISS-III Post monsoon data (October 27, 2006)



IRS LISS-III Pre-monsoon data (March 20, 2007)



Plate 7: Dhir Beel

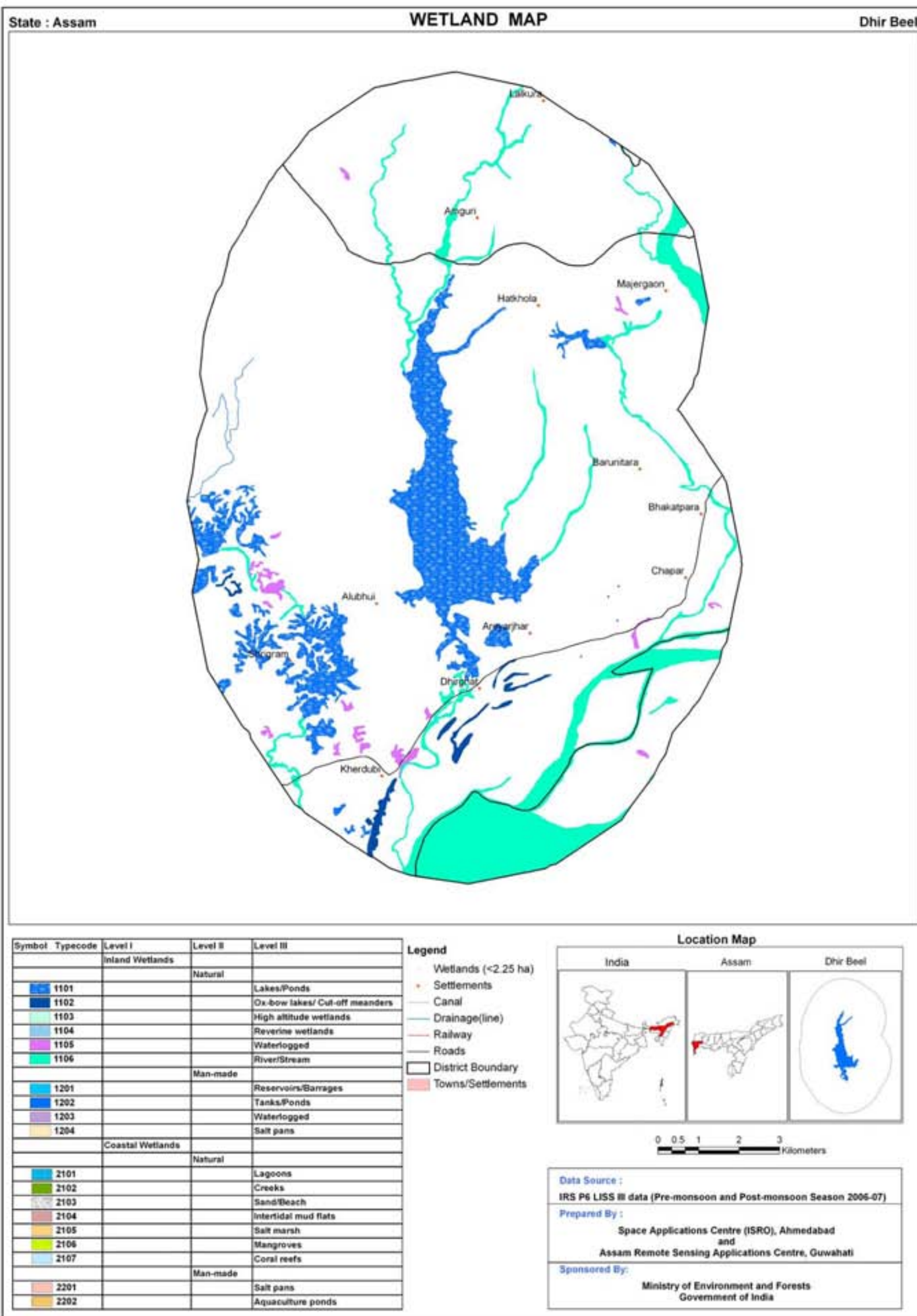


Plate 8: Wetland map - 5 km buffer area of Dhir Beel



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

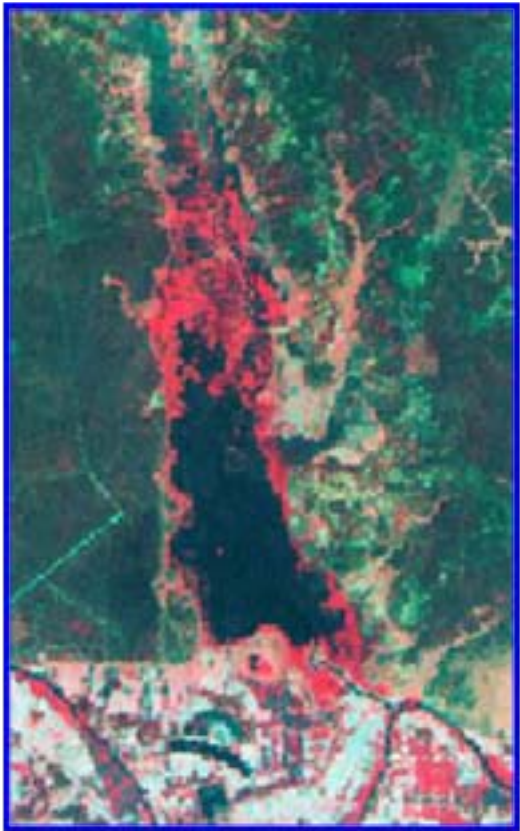
Plate 9: IRS LISS III FCC - 5 km buffer area of Dhir Beel

9.3 Sareswar Beel

Name	Sareswar Beel
Location	26° 9' 14" N, 89° 55' 26"E District : Dhubri Ownership : State (Fisheries Department)
Area	558 ha
Wetland Type	Lakes/ponds
Description	Sareswar beel is a shallow, freshwater lake on the floodplain to the north of the Brahmaputra River in lower Assam. The western edge of the wetland borders on the Rupshi and Bamunijoia Reserved Forests. The total area of the beel is about 1700 ha. At maximum flooding, the beel is about four metres deep; during the dry winter season, the depth falls to about one metre. Rice cultivation is observed on the exposed area during dry season
Vegetation	The lake has abundant aquatic vegetation. The principal aquatic plants are <i>Vallisneria spiralis</i> , <i>Hydrilla verticillata</i> , <i>Monochoria hastata</i> , <i>Trapa bispinosa</i> , <i>Sagittaria</i> , <i>sagittifolia</i> and <i>Pistia stratiotes</i> . <i>Eichhornia crassipes</i> is the major weed.
Fauna	A great diversity of resident and migratory waterfowl are found in the lake. , and is particularly important in winter. Both the lesser adjutant (<i>Leptoptilos javanicus</i>) and greater adjutant (<i>L. dubius</i>) are regular in the winter months. The lake supports a large variety of fish fauna.
	The Lake and Reserve Forests to the west are State-owned; other adjacent areas are privately owned.



IRS LISS-III Post monsoon data (October 27, 2006)



IRS LISS-III Pre-monsoon data (March 20, 2007)



Plate 10: Sareswar Beel

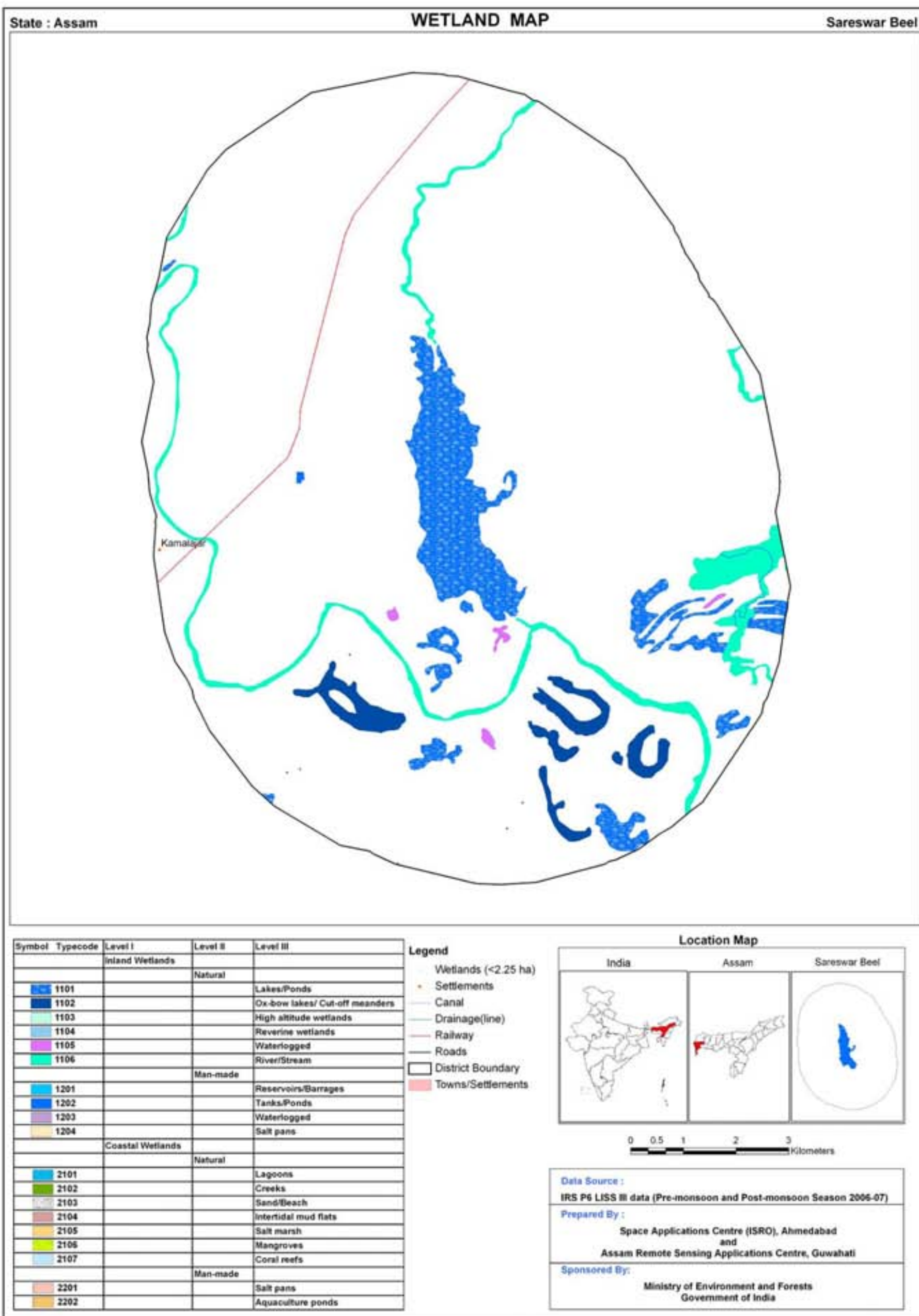
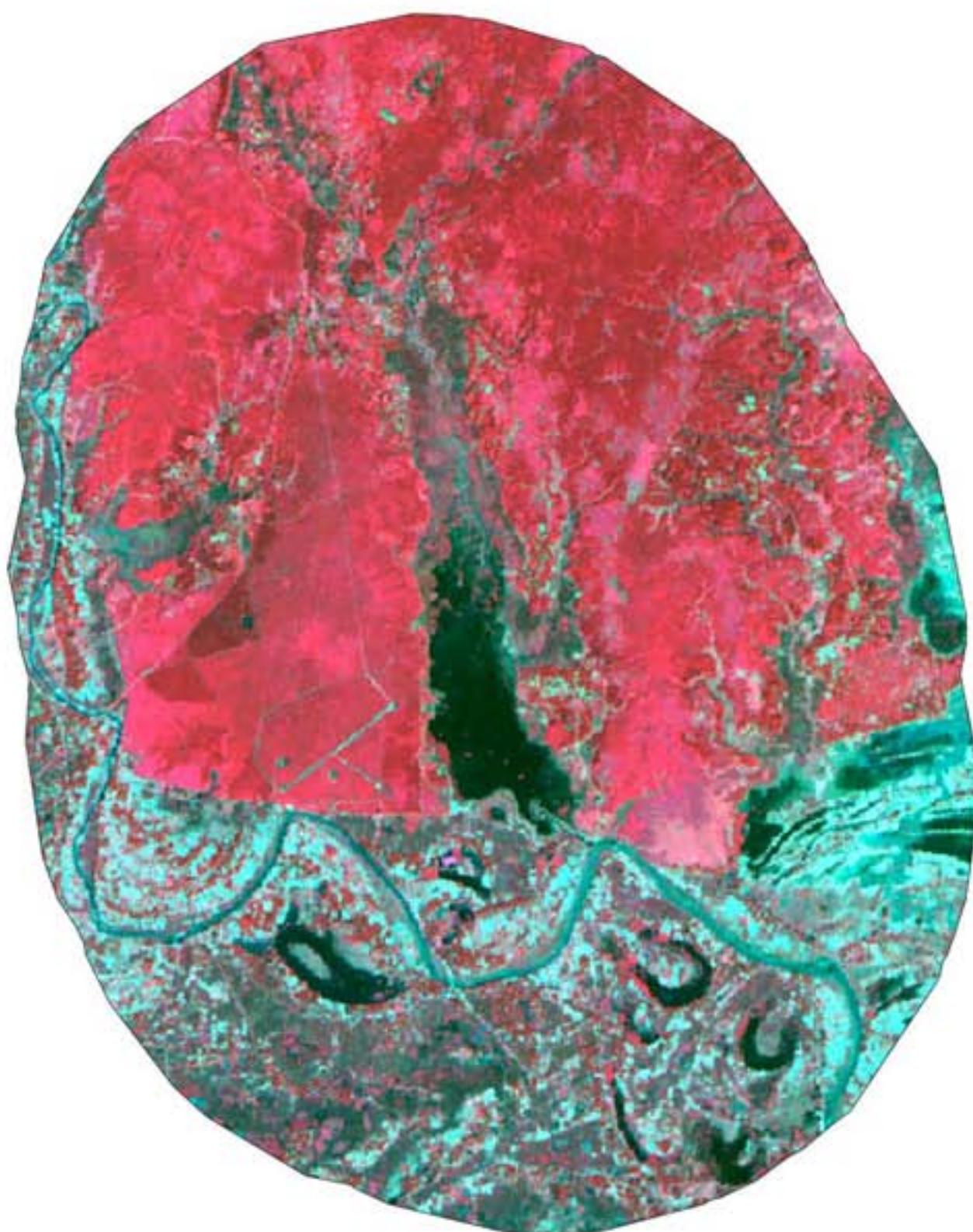


Plate 11: Wetland map - 5 km buffer area of Sareshwar Beel

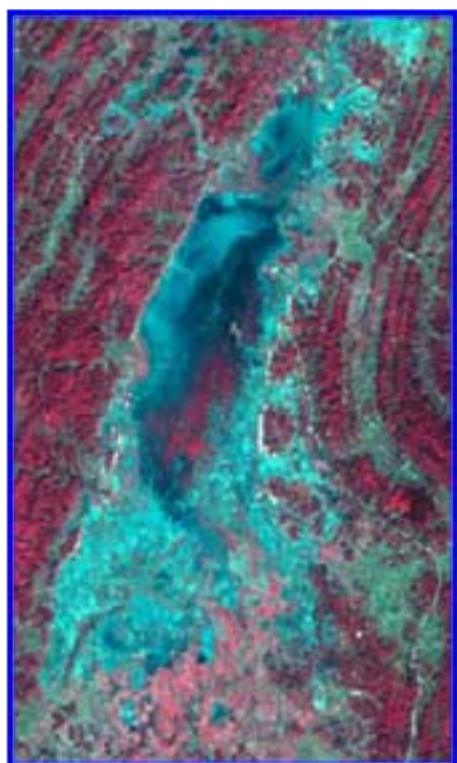


IRS P6 LISS-III post-monsoon data (2006)

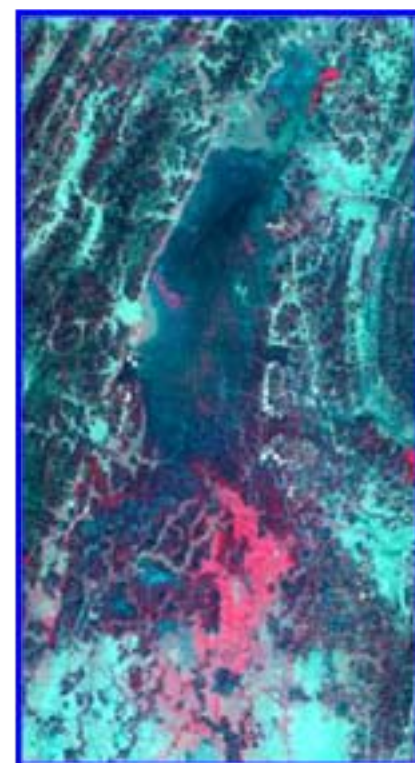
Plate 12: IRS LISS III FCC - 5 km buffer area of Sareswar Beel

9.4 Sone Lake

Name	Sone Lake
Location	24° 40' 00" N, 92° 26' 10" E District : Karimganj, Ownership : State / Private
Area	2914 ha
Altitude	40m
Wetland Type	Lakes/ponds
Climate	Rainfall : >3,000 mm Temperature : 7 °C to 36 °C
Description	Sone <i>beel</i> is the largest wetland in Assam. It is in Karimganj district of southern Assam. Son <i>beel</i> is accessible from Hailakandi and Karimganj towns. The lake is 12.5 km long and 3.9 km wide, with a 35.4 km shoreline. The catchments of the lake has ravines, slopes and hilly terrains, with loamy, sandy or gravelly soil in the plains and fine-grained sandstones in the hilly region. It is flanked by hills on its west and east. In winter, the extent is becomes fragmented and totaling as low as 500 ha of area. The Shingla River, originating in Mizoram, is the only major inlet as well as outlet of Son beel wetland. Further downstream, there is another large lake known as Rata <i>beel</i>, beyond which the Shingla river bifurcates into two rivers Kochua and Kakra which drain the lake water into the Kushiya River. <i>Barringtonia acutangula</i> is the main tree that grows in the <i>beel</i> besides reeds such as <i>Arundo donax</i> and various aquatic plants. Son Beel, is a reservoir of 70 species of fish belonging to 49 genera under 24 families have been recorded. Mostly made up of <i>Puntius chola</i> followed by <i>Labeo rohita</i>, <i>Wallago attu</i>. It is also home to a large number of resident bird species such as the bareheaded goose, adjutant stork, lesser whistling teal, white-breasted water hen, spotted dove and purple heron. More than 150 species of birds have been recorded, although the actual diversity must be much more. The lake attracts thousands of waterfowl. Not information is there on mammals, reptiles and amphibians of this important wetland. However, only two species of otters (<i>Lutra lutra</i> and <i>Lutrogale perspicillata</i>) are found. There are unconfirmed reports of Fishing Cat <i>Prionailurus viverrina</i>. Hog Deer <i>Axis porcinus</i> is also reported but its number is much reduced due to poaching and disturbance.
Socio-Economic Value	The wetland supports a locally important fishery and reed harvesting industry, and provides excellent opportunities for sport hunting and scientific research. As a water way more than 50 country Boats are plying every day on regular Transport Service. About 300 families fully depend on income from Boat Services for six months. Similar number of families are engaging in Boat making factory in a form of rural Artisans. Inland transport services can be promoted to link up 4 AP with Dist. Head Quarters. Sone beel touches 9 numbers of G.Ps. directly and double of the number along the inlet and towards the outlet and acts as source of drinking water for these areas. The beel is a traditional fishing ground for ages. More than 35,000 families are directly dependent on the Beel for traditional fishing. Extensive fertile and flat land around and along the water body has potentially to higher yield from agricultural crop.
Threats and Conservation Issues :	Reclamation and paddy cultivation, Siltation, Excessive fishing and Poaching of birds are major threats to this wetland. The entire area has been silted up and reclaimed to a great extent. Winter paddy is widely grown, and that again has threatened the <i>beel</i> by accelerating reclamation and siltation. Excessive fishing activities disturb the wetland biodiversity. However, there is proposal by Government of Assam to declare this wetland as a Ramsar Site.



IRS LISS-III Post monsoon data (November 30, 2006)



IRS LISS-III Pre-monsoon data (March 30, 2007)

Plate 13: Sone Lake

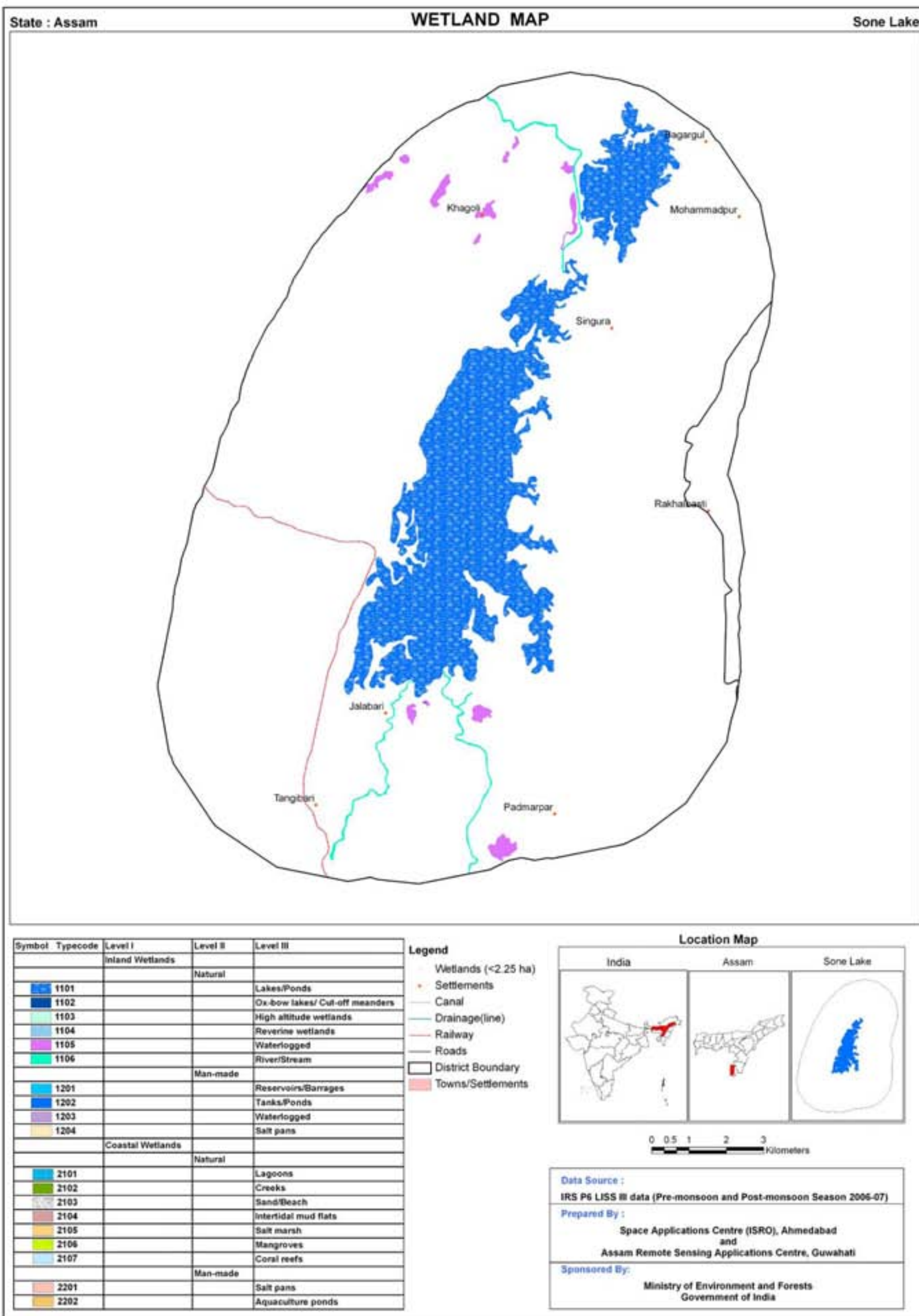
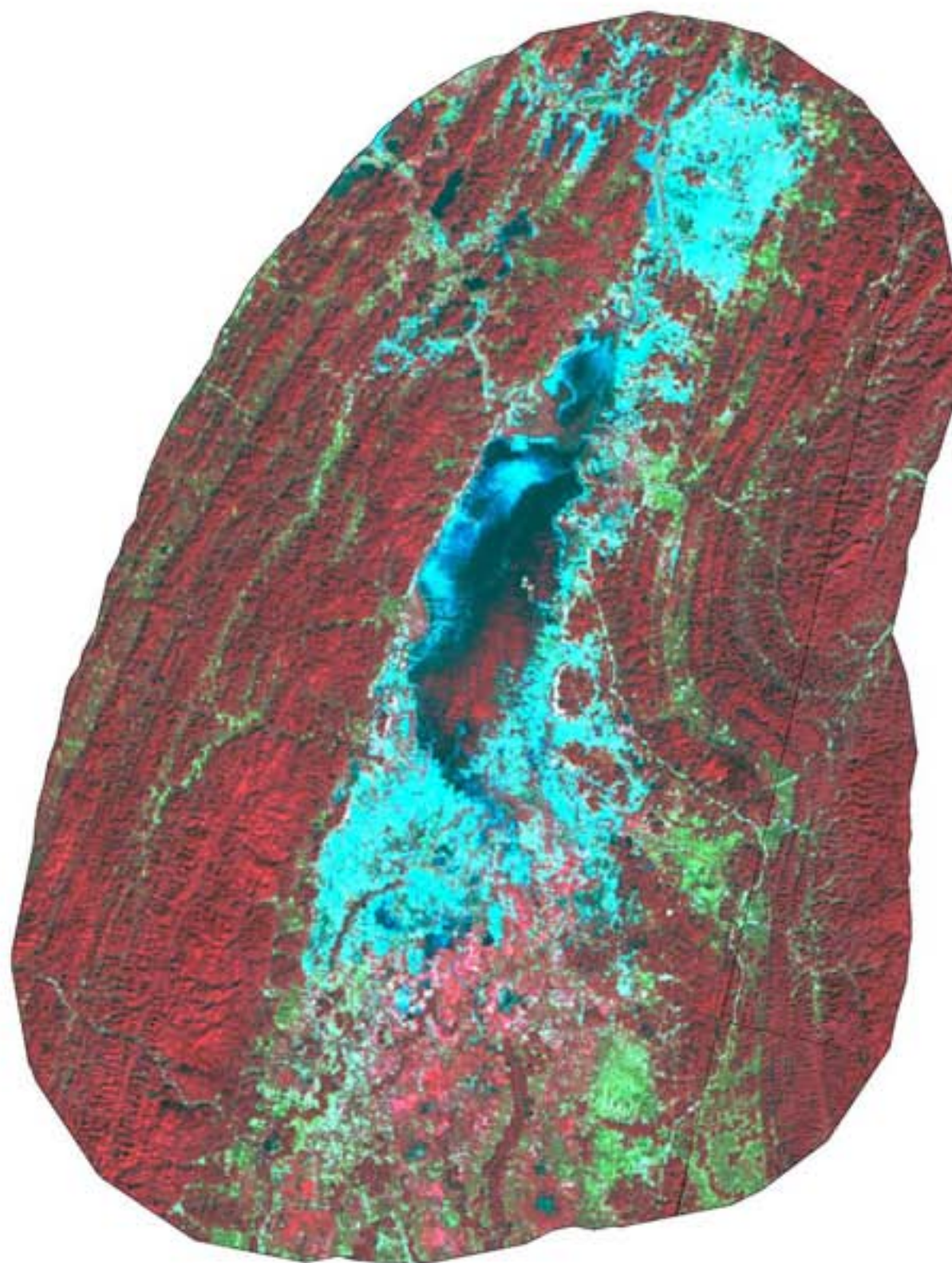


Plate 14: Wetland map - 5 km buffer area of Sone Lake



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

Plate 15: IRS LISS III FCC - 5 km buffer area of Sone Beel

9.5 Tamaranga Beel

Name	Tamaranga Beel
Location	Coordinates : 26° 19' 8" N, 90° 34' 19" E District : Bongaigaon Ownership : State
Area	627 ha
Wetland Type	Inland – Natural - Lakes/ponds
Climate	Rainfall : >3,000 mm Temperature : 7 °C to 36 °C
Description	Tamaranga beel is actually a complex of wetlands known as Tamaranga -Dalani-Bhairab Complex which includes the wetlands of Tamaranga, Konora, Paropota and Dalani in western Assam. The Tamaranga beel wetland is situated only 30 km south from Bongaigaon town, the district headquarters of Bongaigaon district of Assam. This is an important freshwater lake (<i>beel</i>) and has been listed as a Site of Global Importance in the Directory of Asian Wetlands as it plays hosts to a large number of avifauna. The nearby Bhairab Reserve Forest is rocky hillock, part of an Archaean plateau, covered with degraded Tropical Moist Deciduous Forest dominated by Sal <i>Shorea robusta</i> and Bamboo brakes.
Bio-diversity	The <i>beel</i> attracts many migratory birds and is a good breeding ground for resident water birds. More than 150 bird species are known to occur in this Complex. More than 20,000 waterfowl are reported regularly in winter. The nearby Bhairab Pahar harbours an important population of the Golden Langur and Gaur. The adjacent area is used for agriculture. Water Hyacinth <i>Eichhorniacrassipes</i> is the major weed. Wherever this pernicious weed is not found, submerged and emergent plants are observed. The wetland is being overexploited for fishing. The spread of Water Hyacinth also is the major problems for birds.

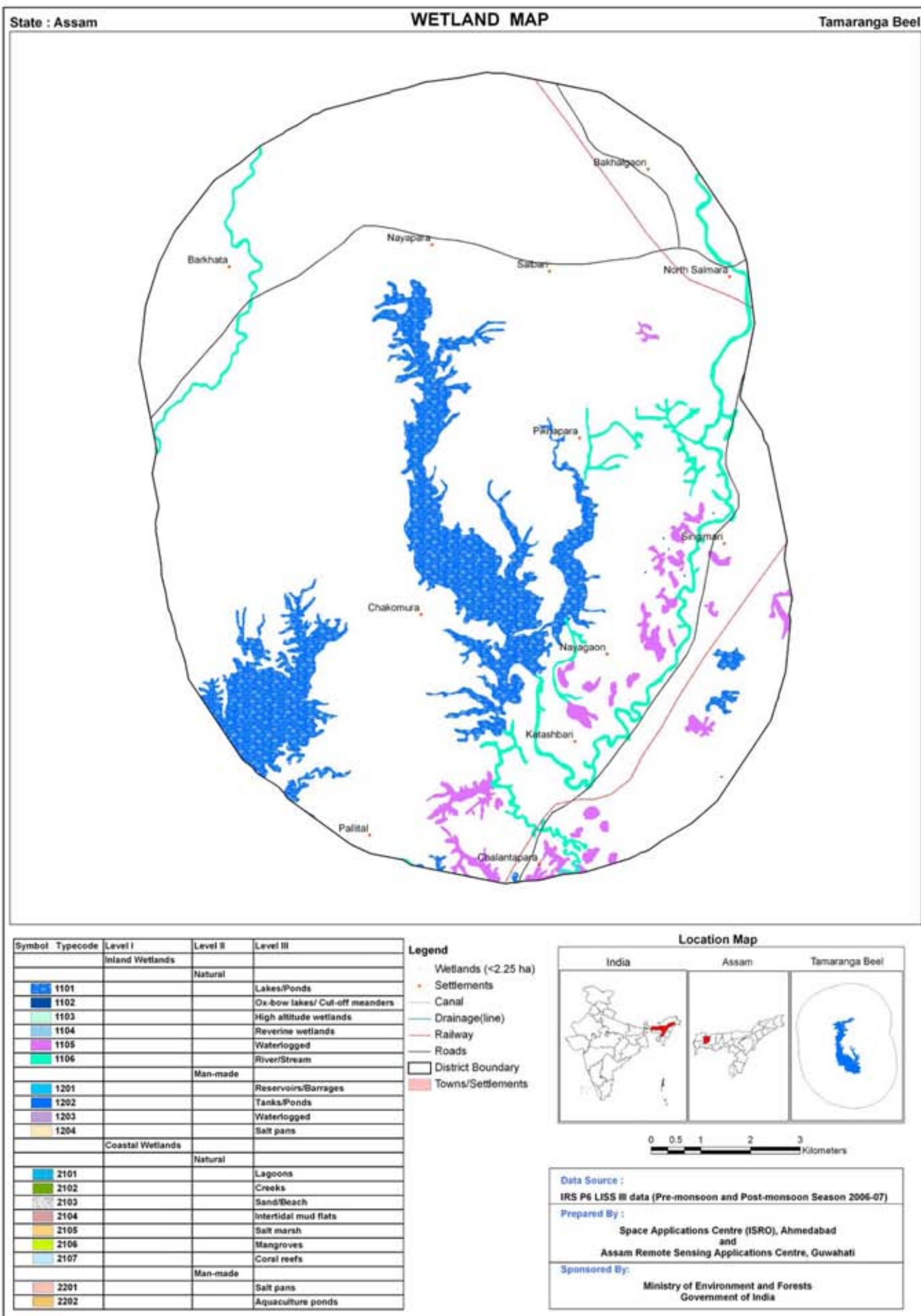


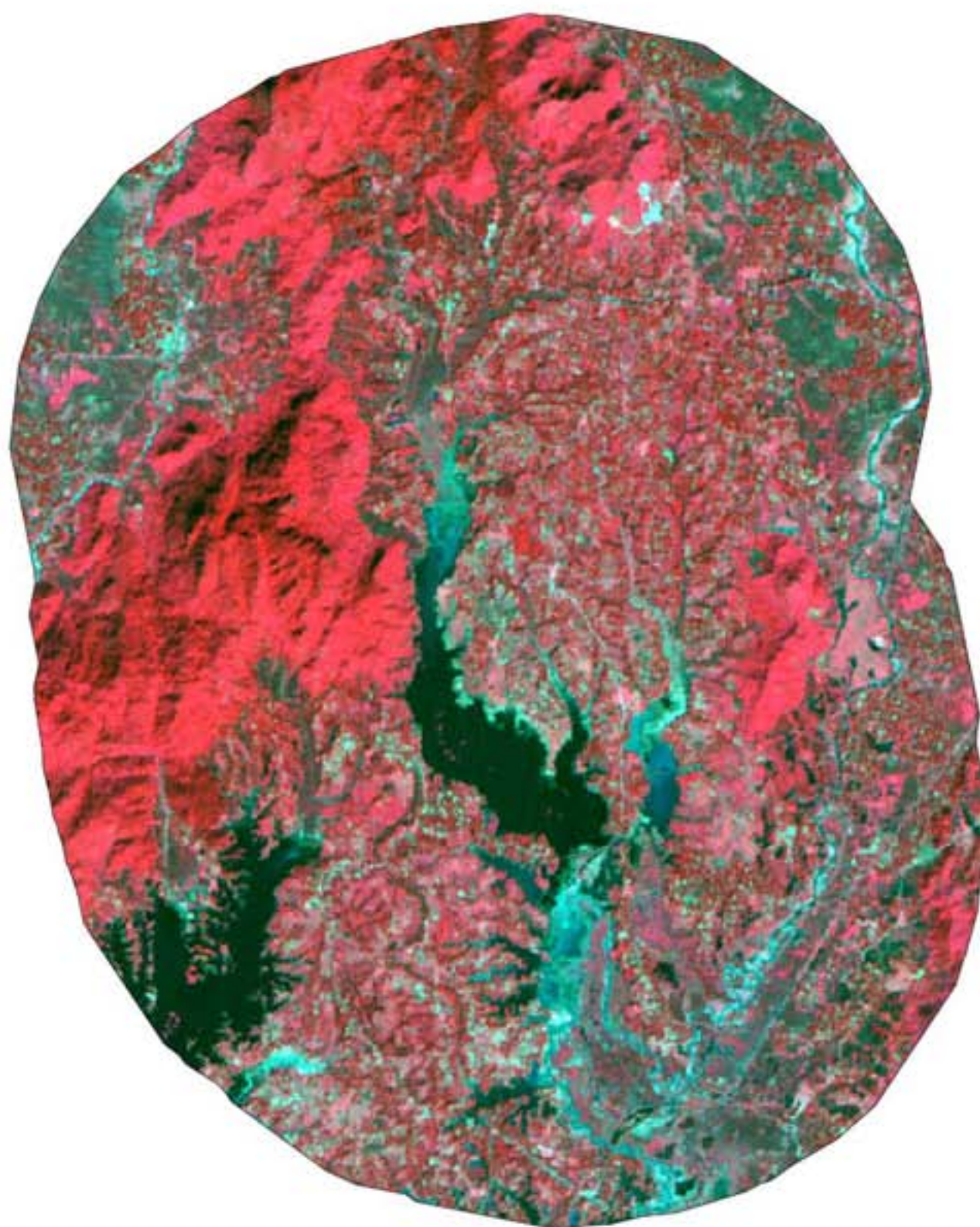
IRS LISS-III Post monsoon data (October 27. 2006)



IRS LISS-III Pre-monsoon data (March 20. 2007)

Plate 16: Tamaranga Beel



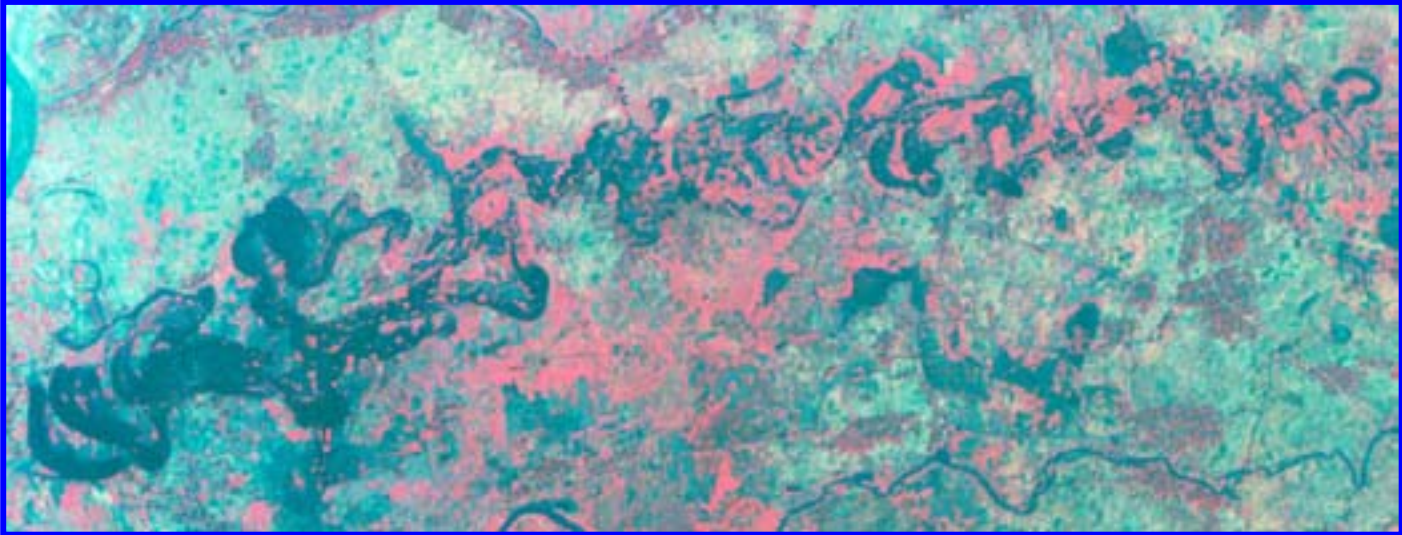


IRS P6 LISS-III post-monsoon data (2006)

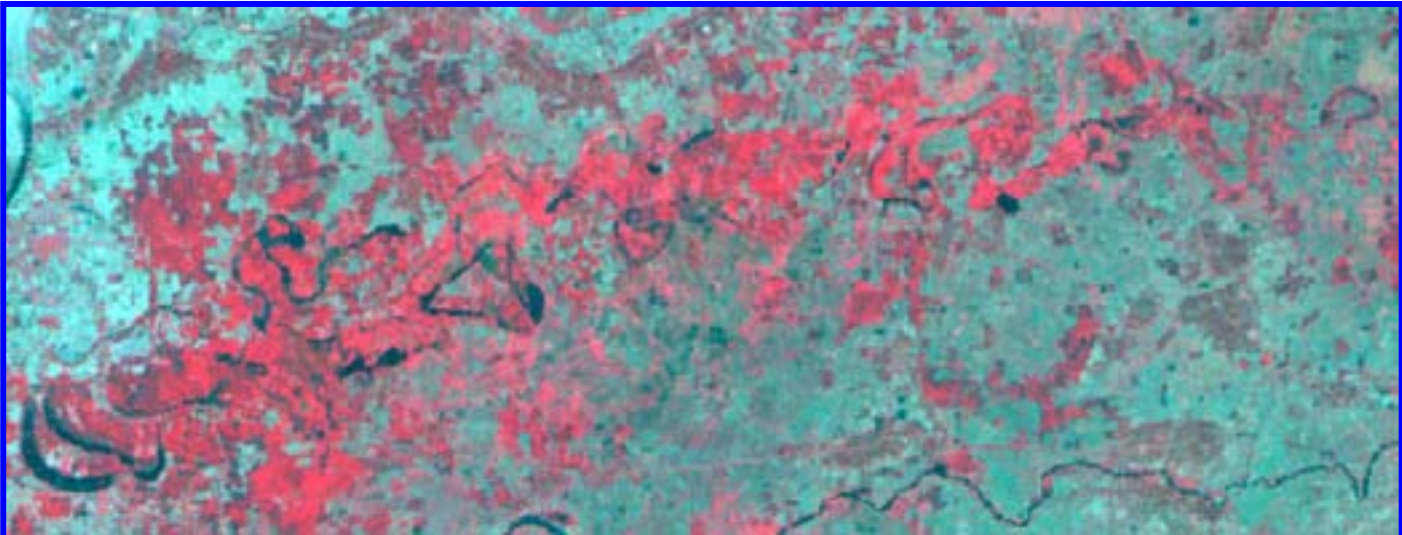
Plate 18: IRS LISS III FCC - 5 km buffer area of Tamaragna Beel

9.6 Sonai Beel (Nandini/Mer/Sonai/Raumari/Dobarani/Patiabandha beel)

Name	Sonai Beel (Nandini/Mer/Sonai/Raumari/Dobarani/Patiabandha beel)
Location	Coordinates : 26° 19' 41" N, 92° 14' 9" E District : Marigaon Ownership : State
Area	1936 ha
Wetland Type	Lakes/ponds
Climate	Humid tropical monsoon climate, typical of the Brahmaputra Valley. Rainfall : 2750 mm Temperature : 7 °C to 35 °C
Description	Sonai beel is a cluster of natural lakes namely Nandini, Mer, Sonai, Raumari, Dobarani, and Patiabandha beel in Marigaon district of Assam. The wetlands are situated in the Brahmaputra valley between Gauhati and Tezpur, Assam. Three small wildlife sanctuaries (Laokhawa Sanctuary, Orang Sanctuary and Sonai Rupai Sanctuary) on the flood plain of the Brahmaputra River, with areas of riverine swamp and seasonally flooded grassland interspersed amongst tropical deciduous and semievergreen forests. The area of wetlands is 1936 ha
Bio-diversity	The wetlands are important for a wide variety of resident and migratory waterfowl, The Bengal Florican <i>Houbaropsis bengalensis</i> occurs in the wetland site.



IRS LISS-III Post monsoon data (November 30, 2006)



IRS LISS-III Pre-monsoon data (March 30, 2007)



Plate 19: Sonai Beel (Nandini/Mer/Sonai/Raumari/Dobarani/Patiabandha beel)

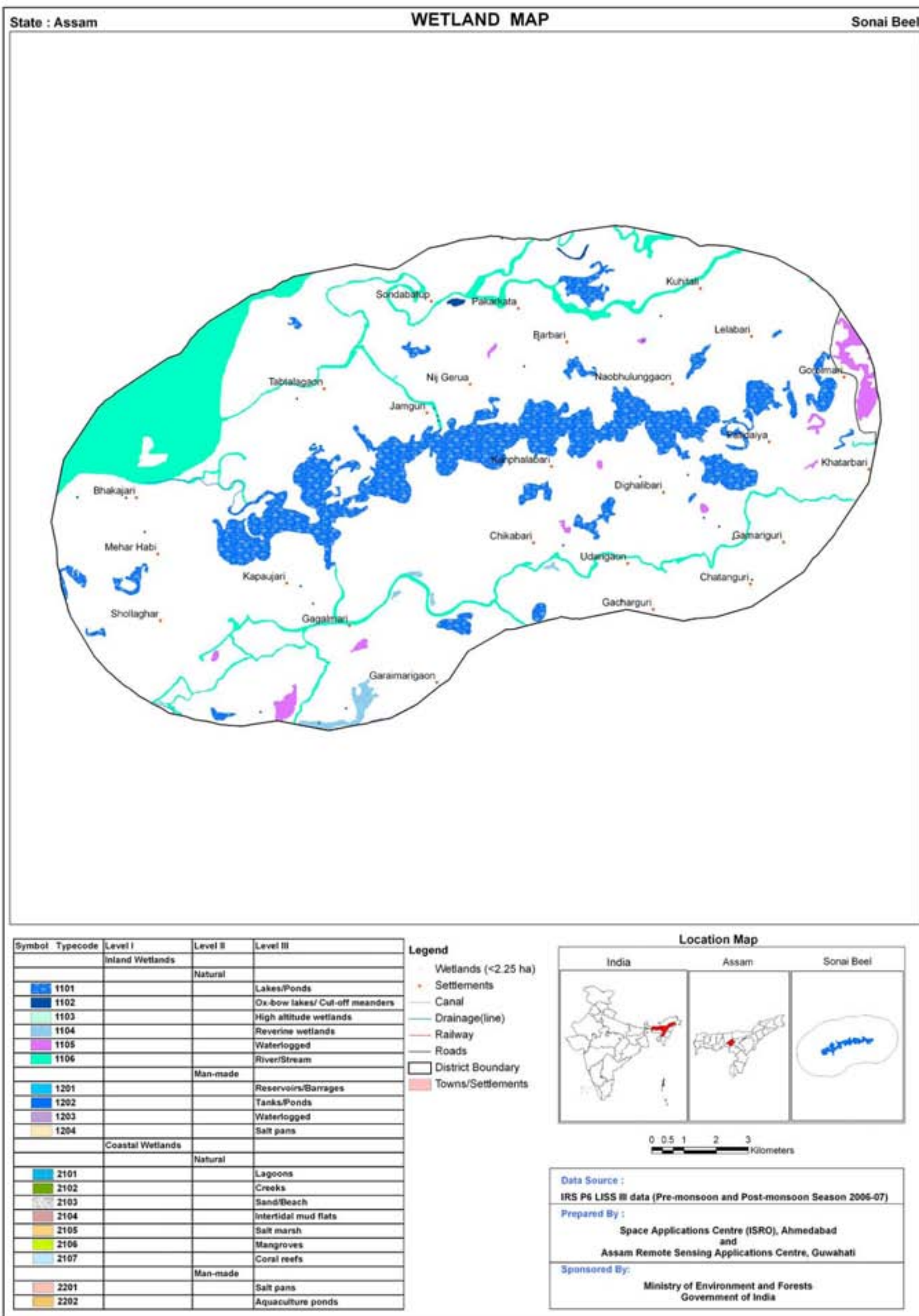
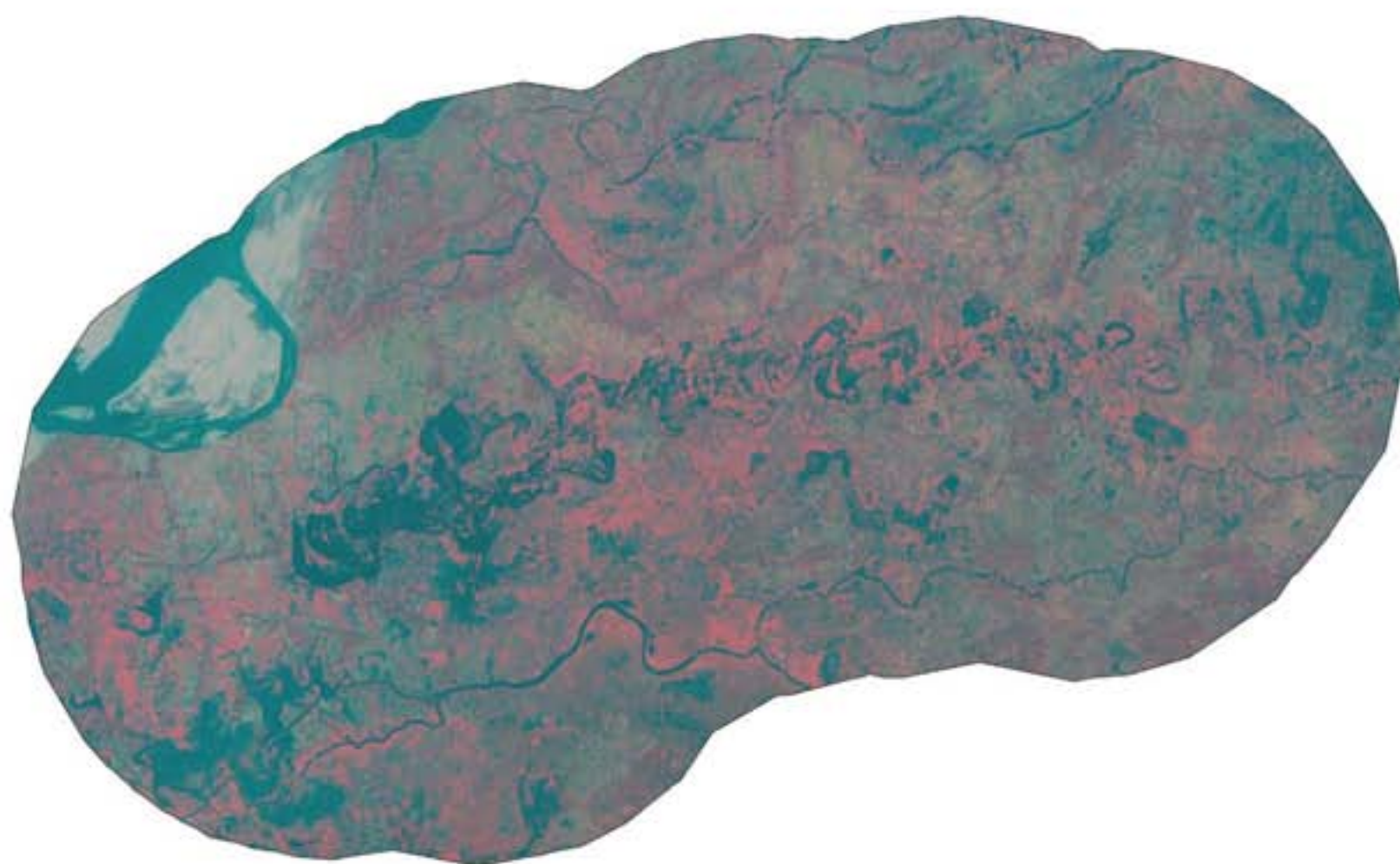


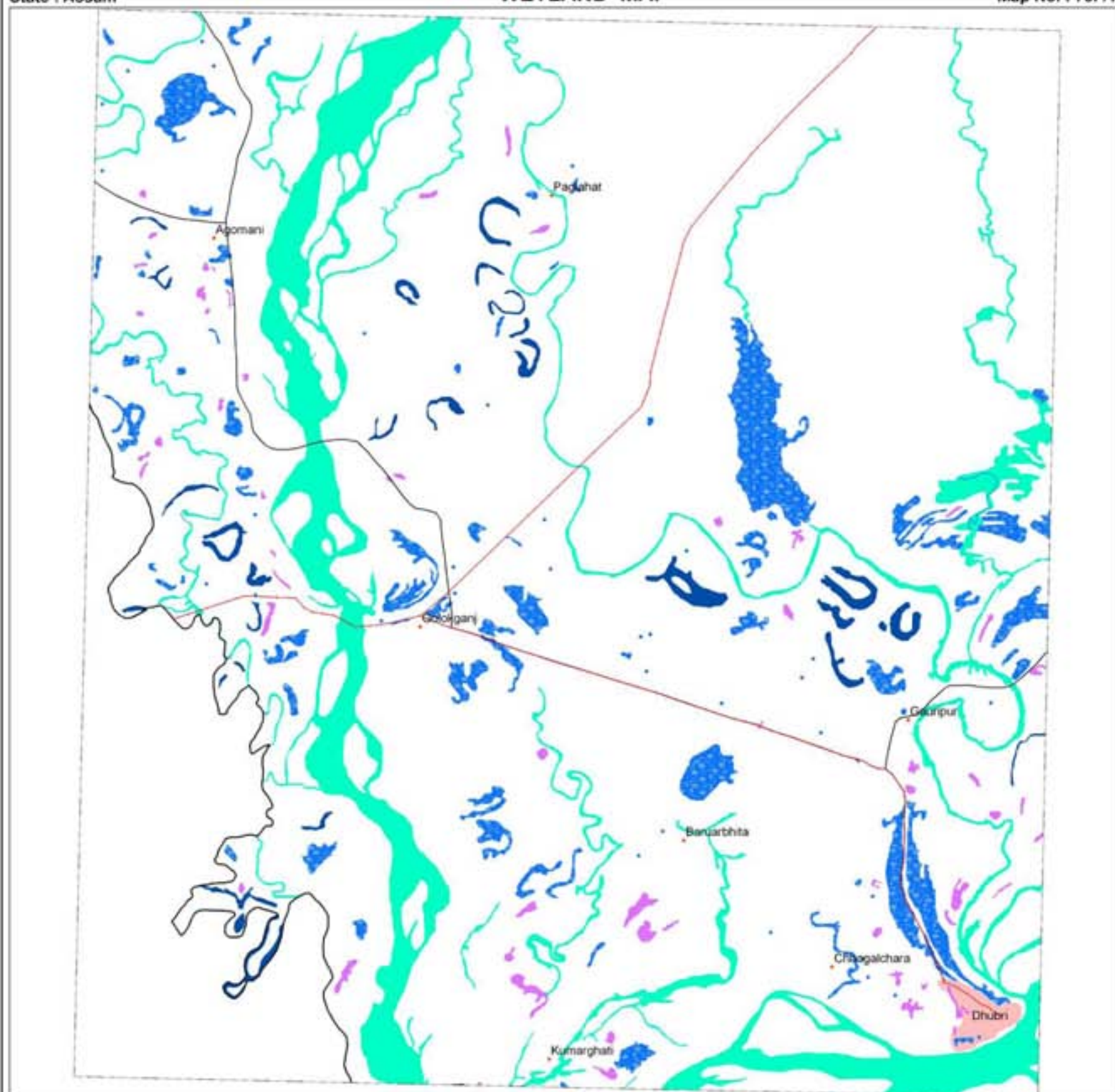
Plate 20: Wetland map - 5 km buffer area of Sonai Beel (Nandini/Mer/Sonai/Raumari/Dobarani/Patiabandha beel)



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

Plate 21: IRS LISS III FCC - 5 km buffer area of Sonai Beel (Nandini/Mer/Sonai/Raumari/Dobarani/Patiabandha beel)

SOI MAP-SHEET WISE WETLAND MAPS (Selected)

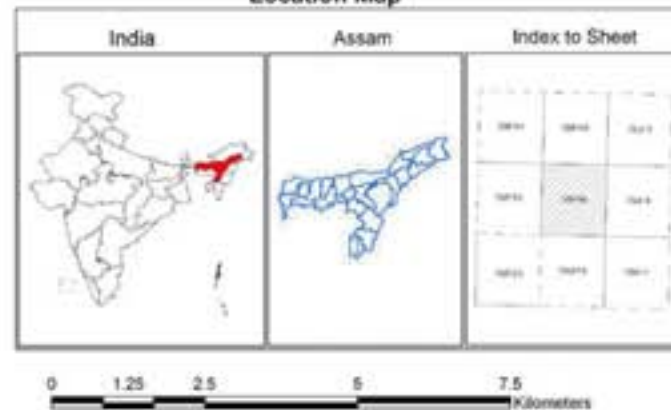


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

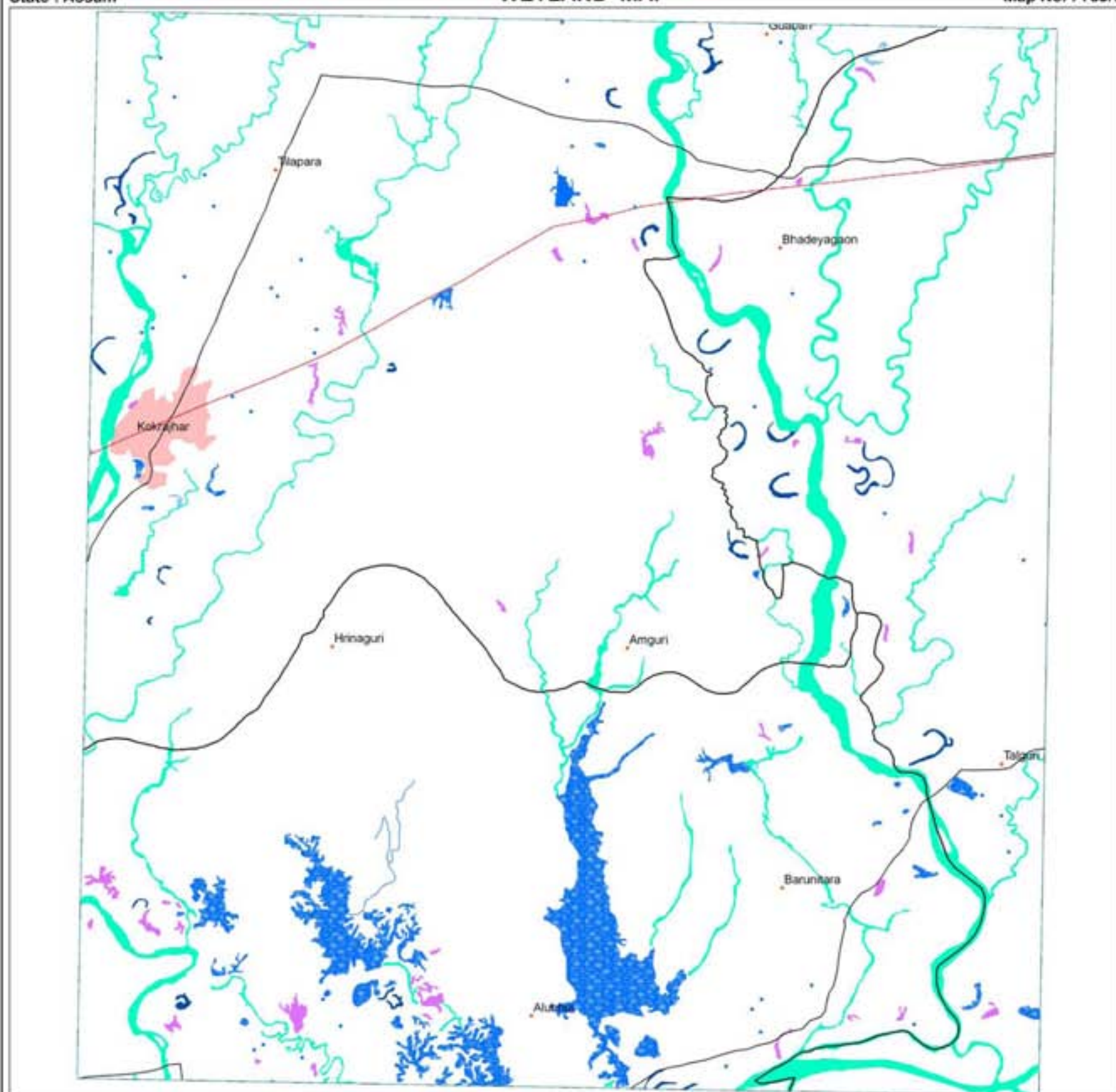
Location Map



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

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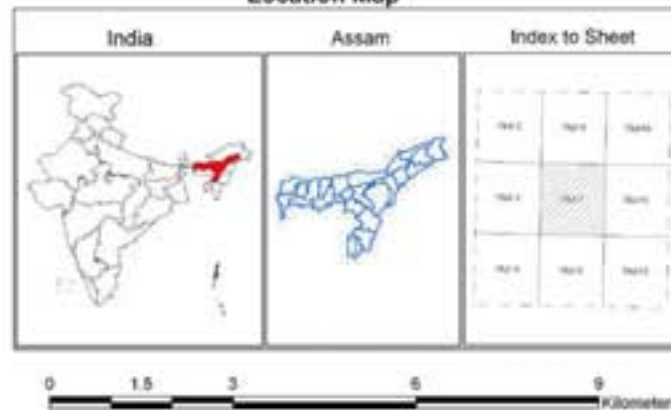


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		Inland Wetlands		
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	1103			High altitude wetlands
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		Coastal Wetlands		
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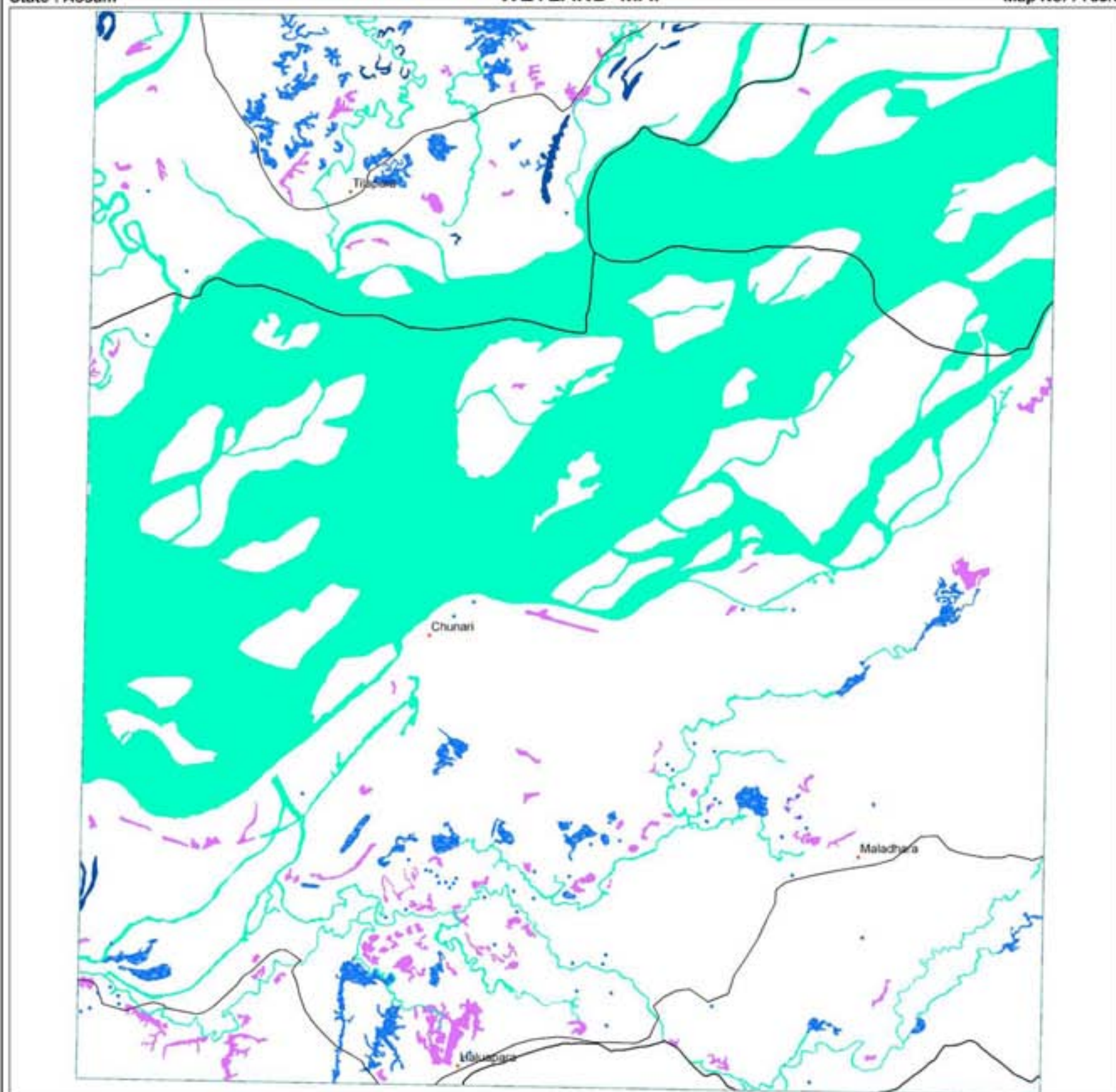
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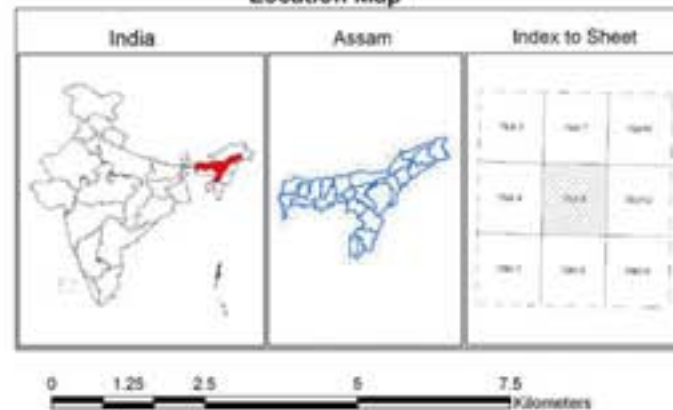


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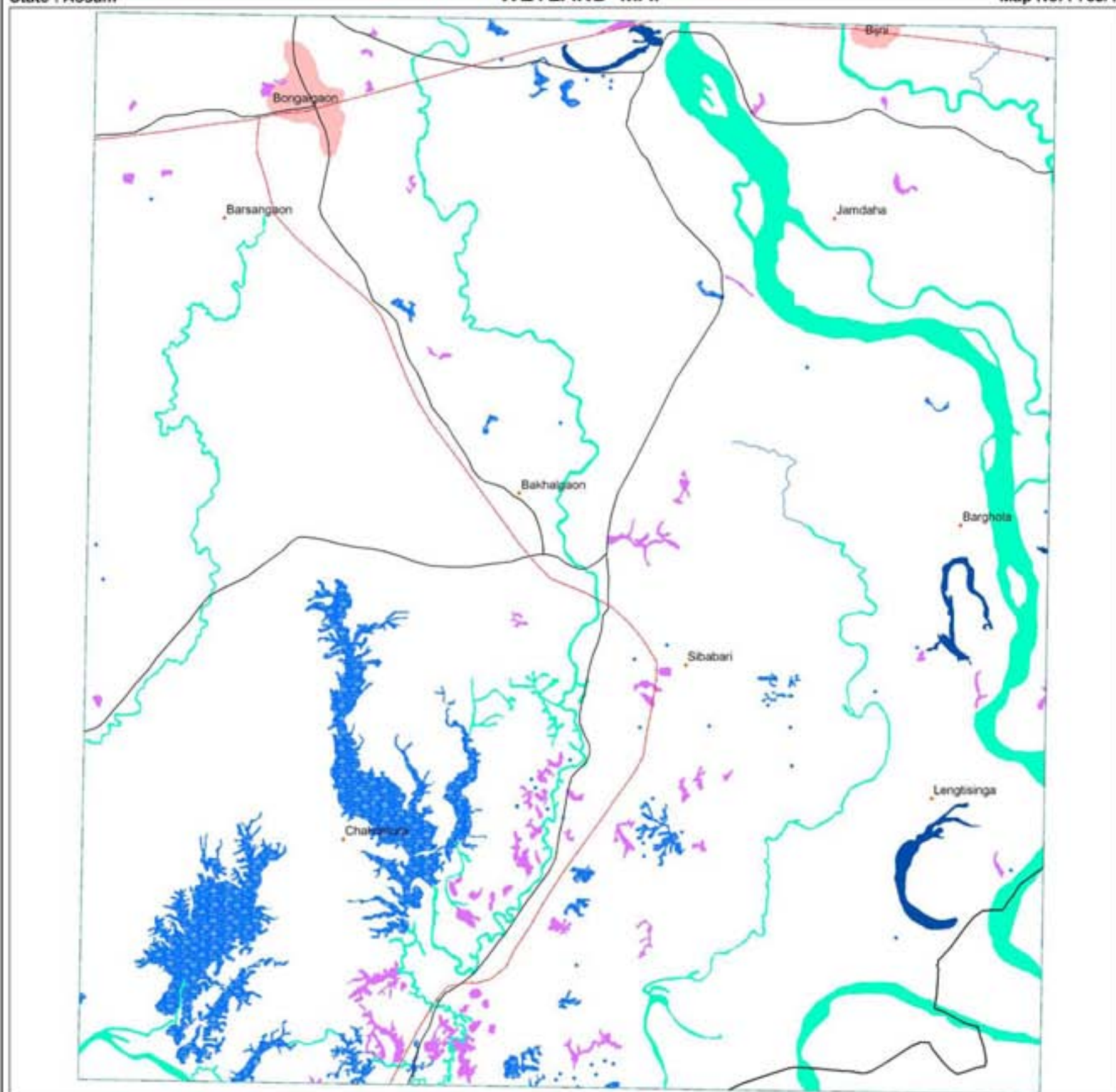
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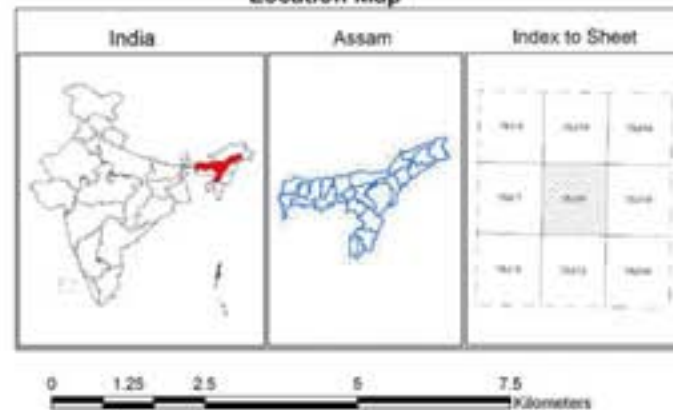


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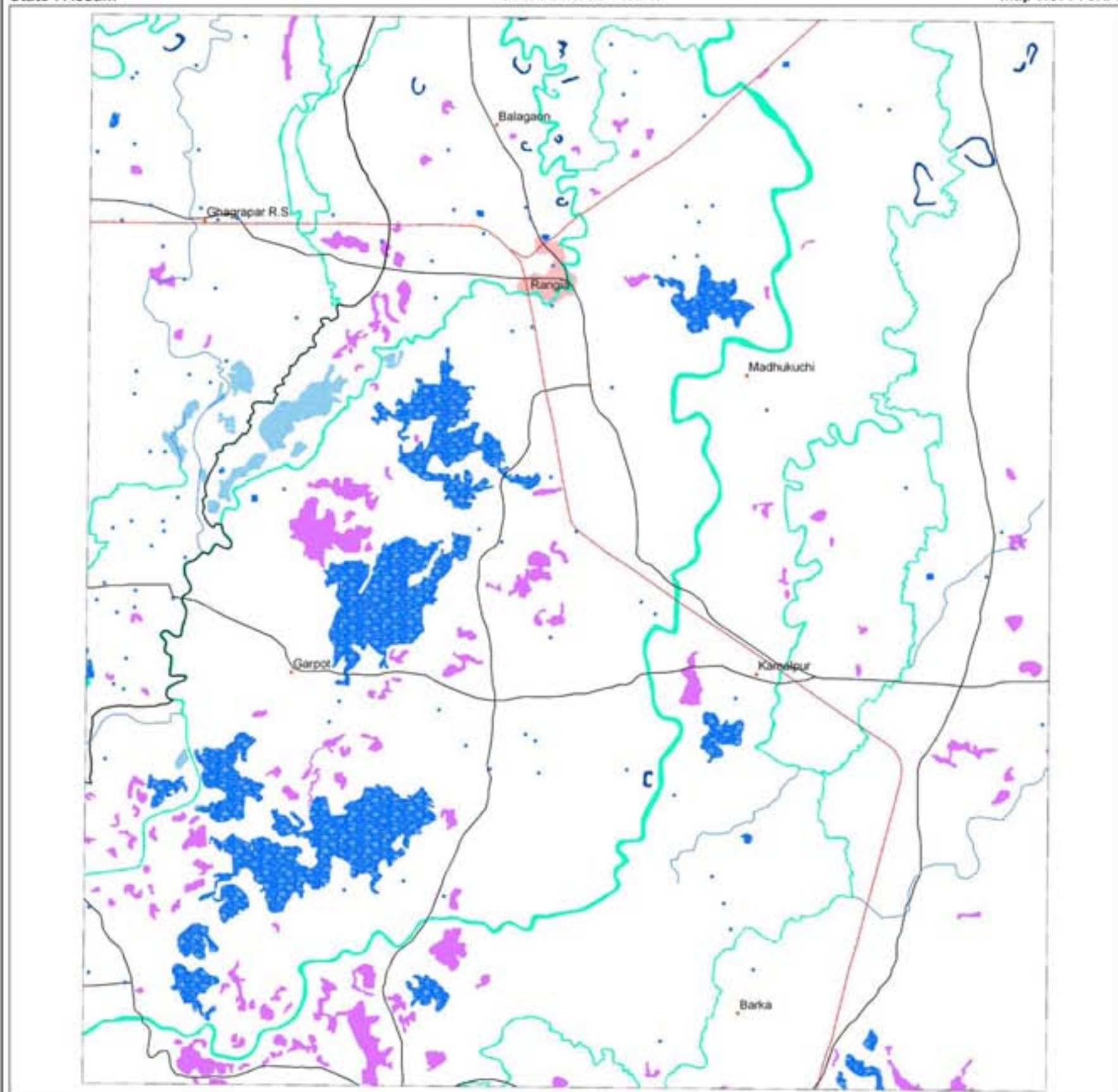
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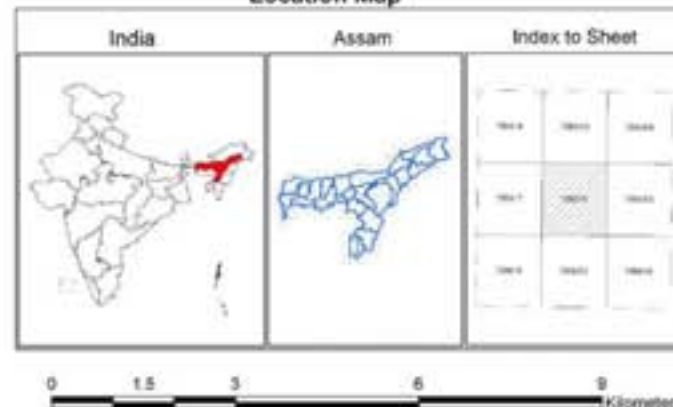


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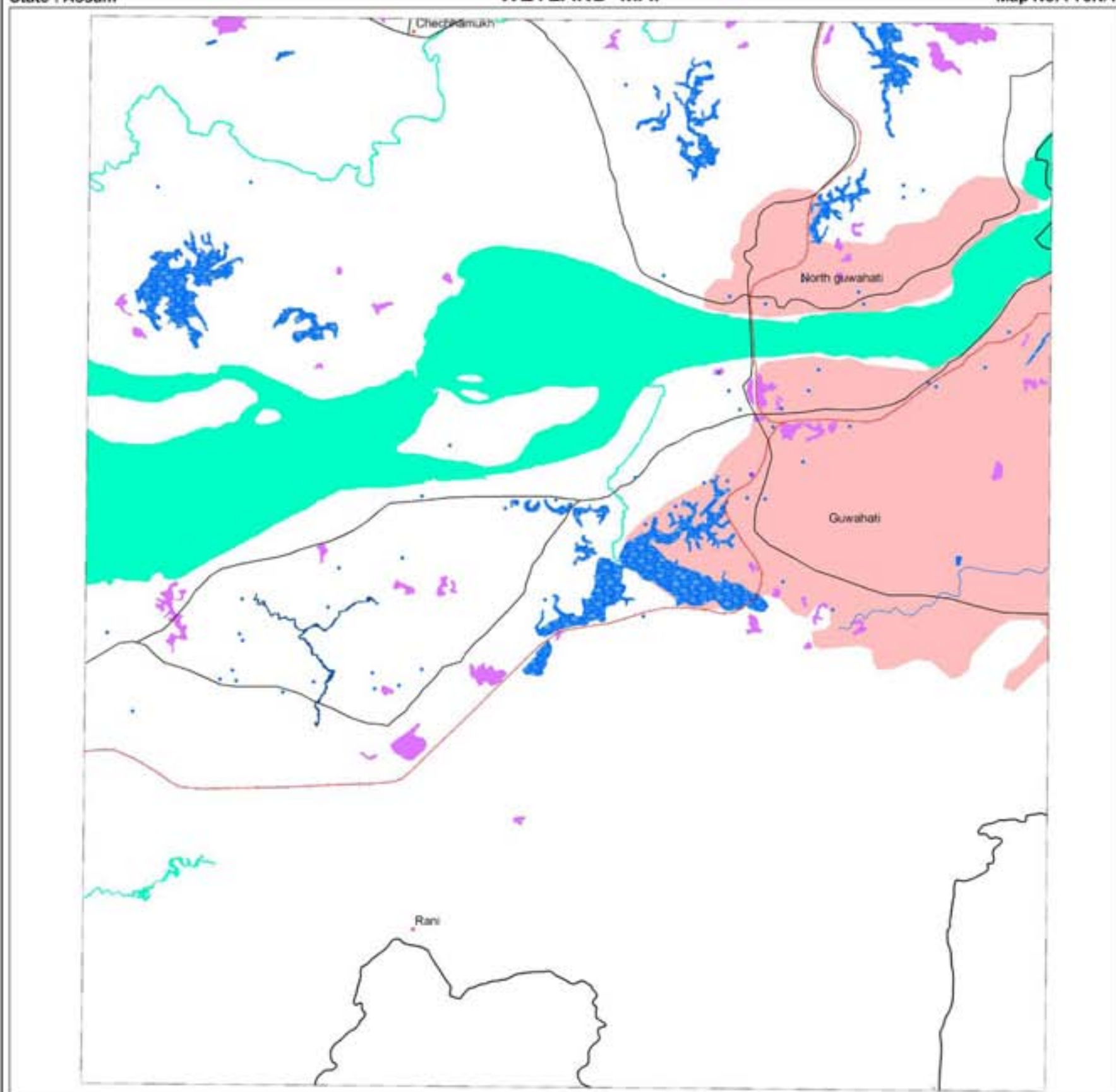
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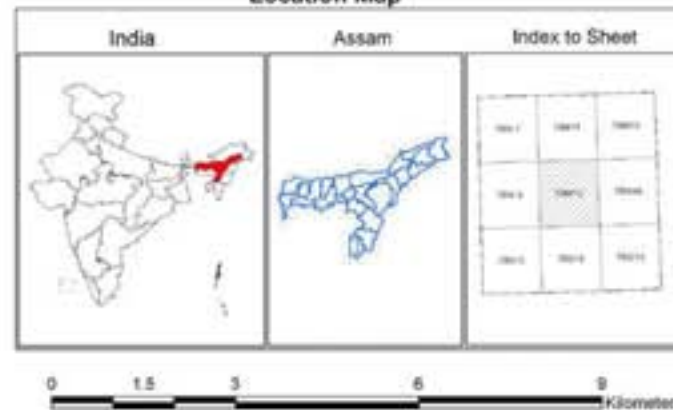


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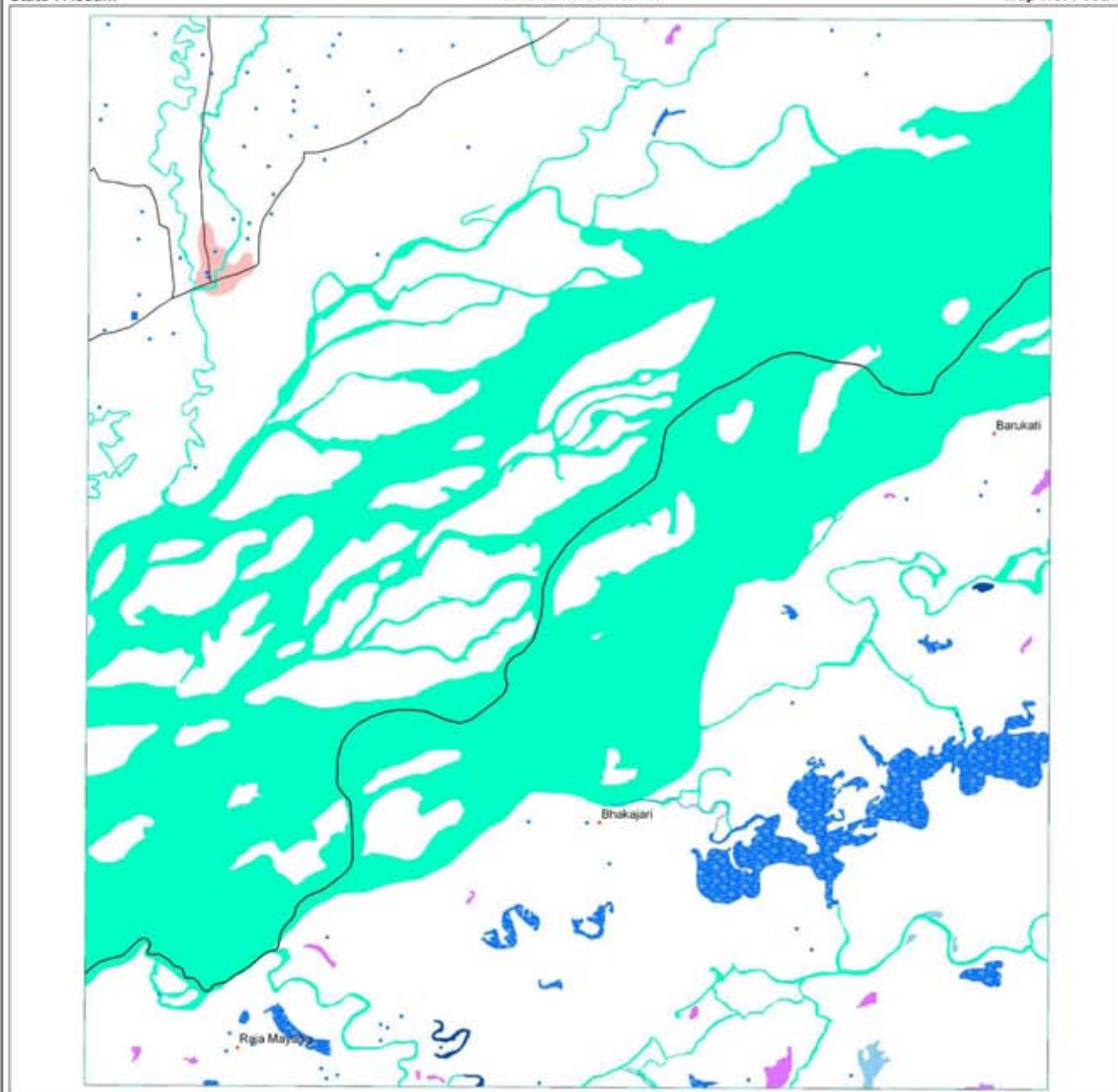
Location Map



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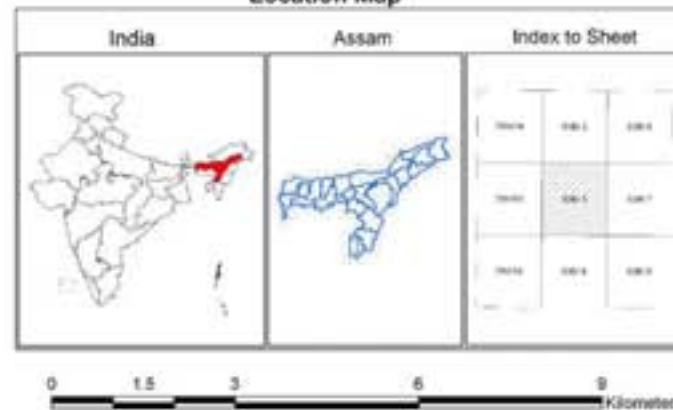


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- District Boundary
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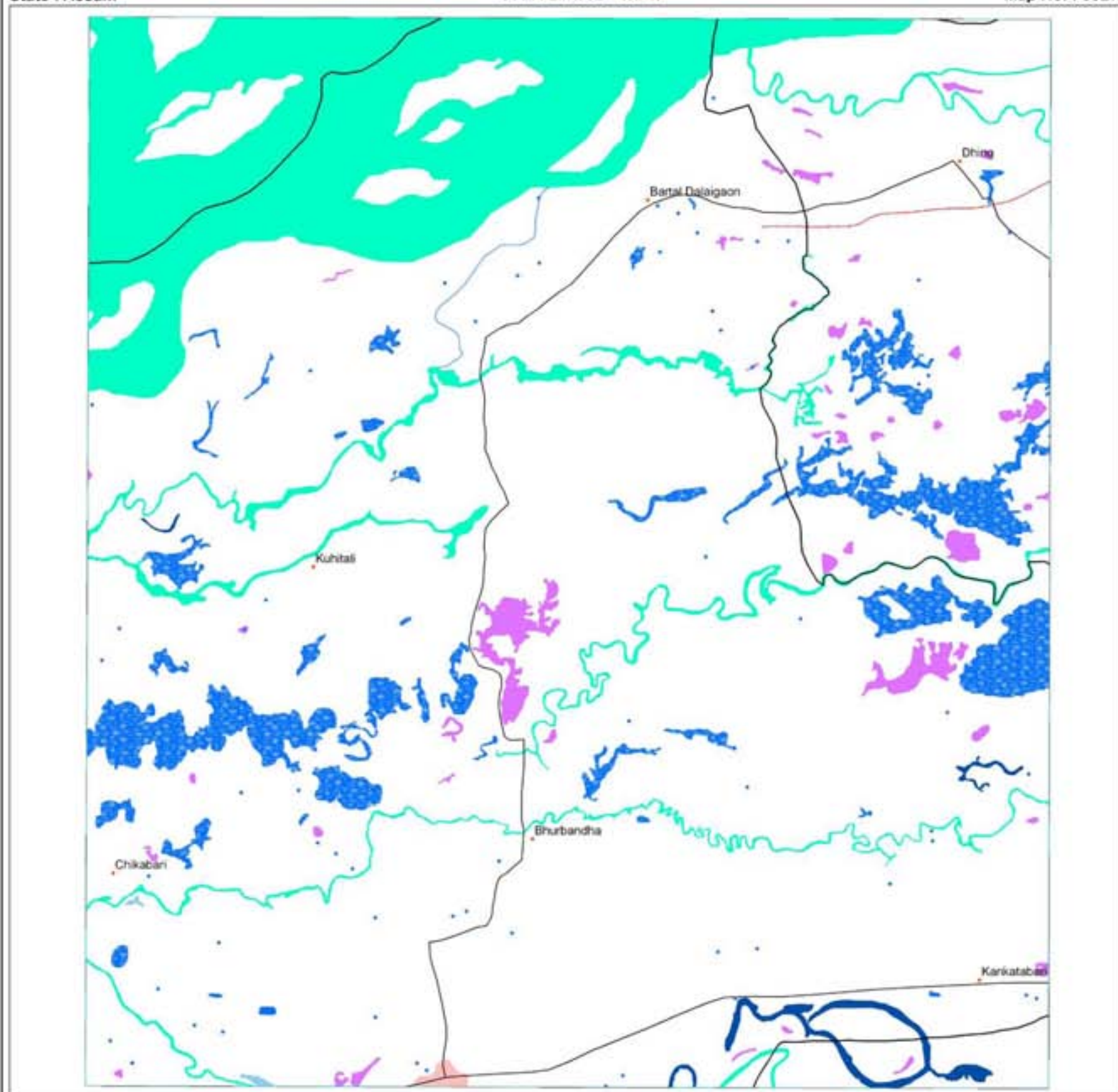
Location Map



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

Prepared By :
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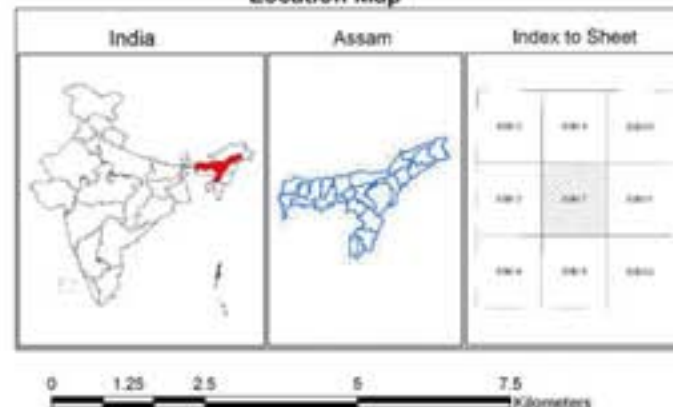


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

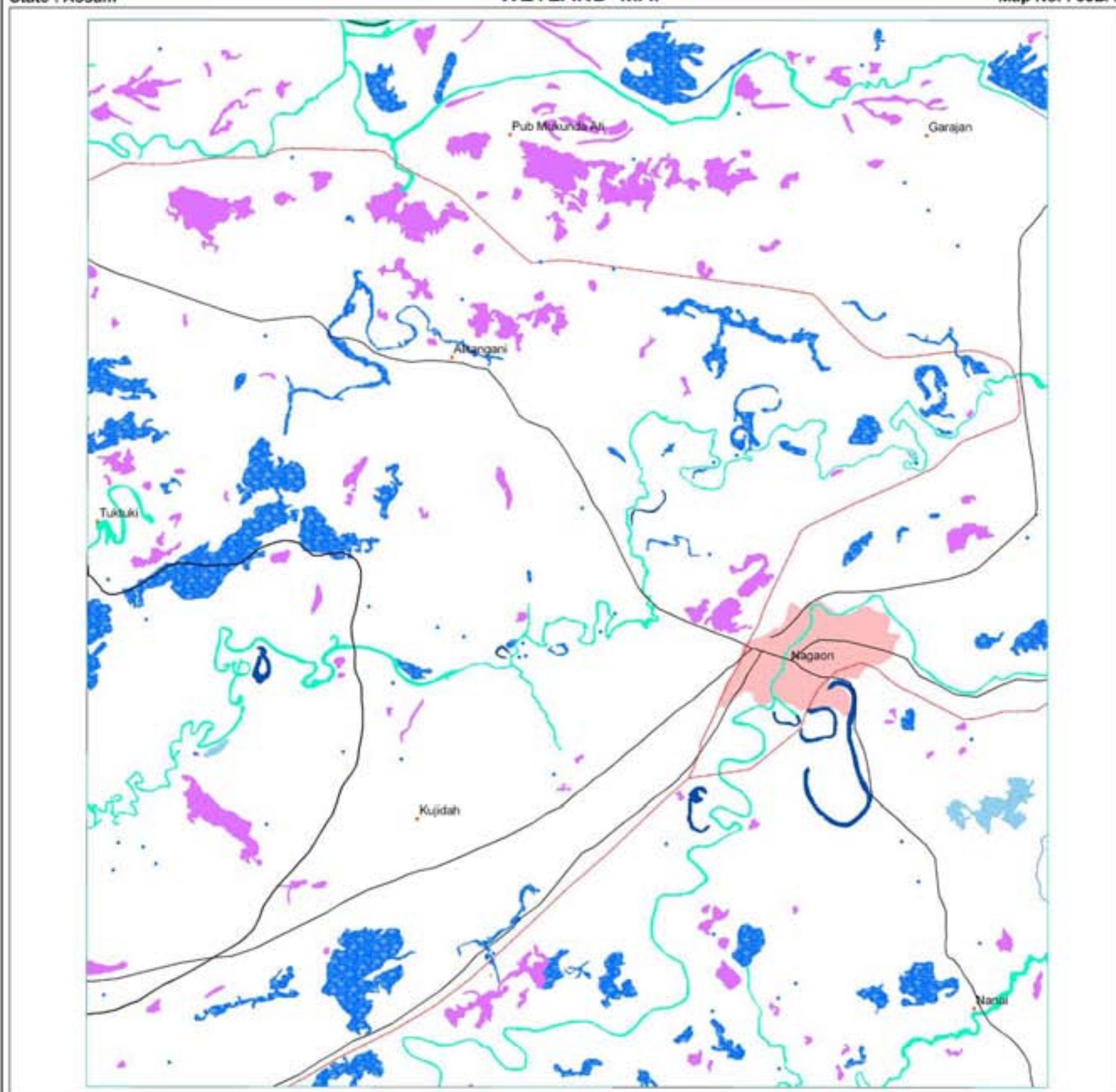
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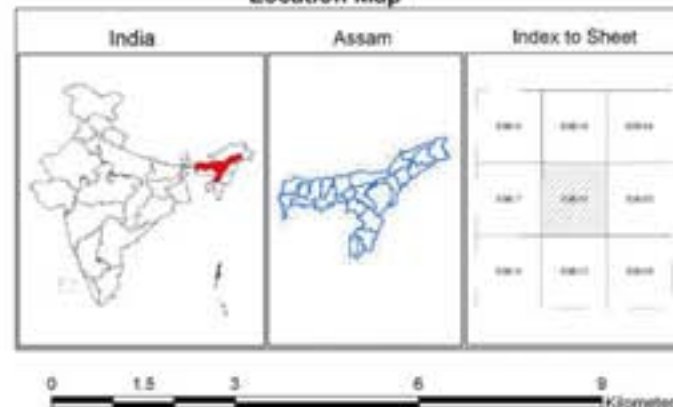


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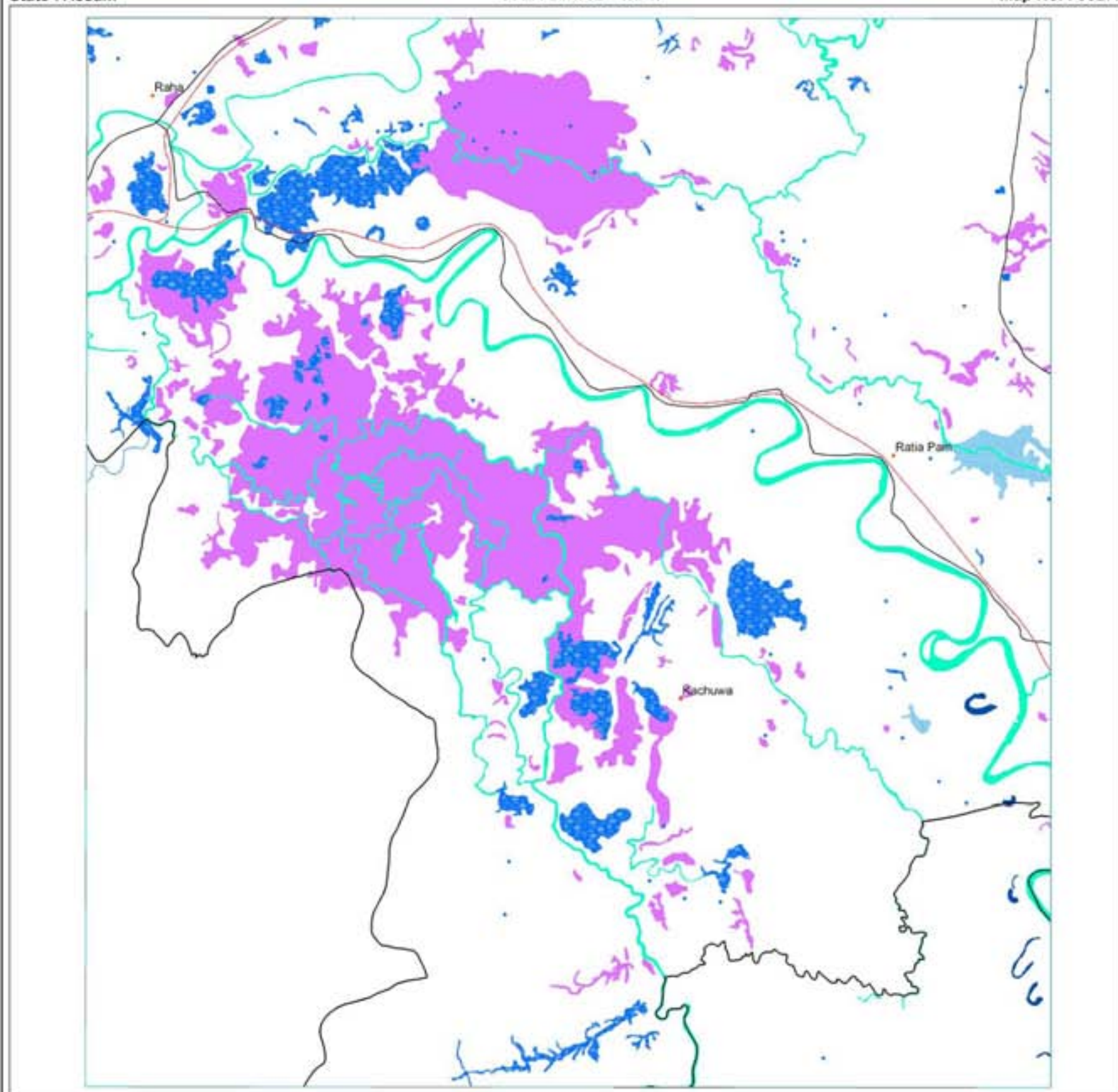
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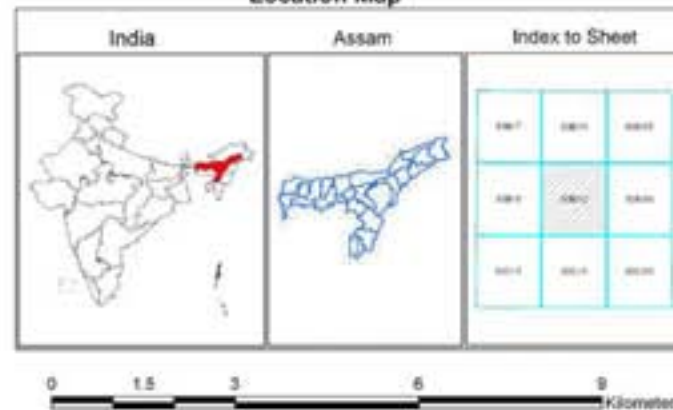


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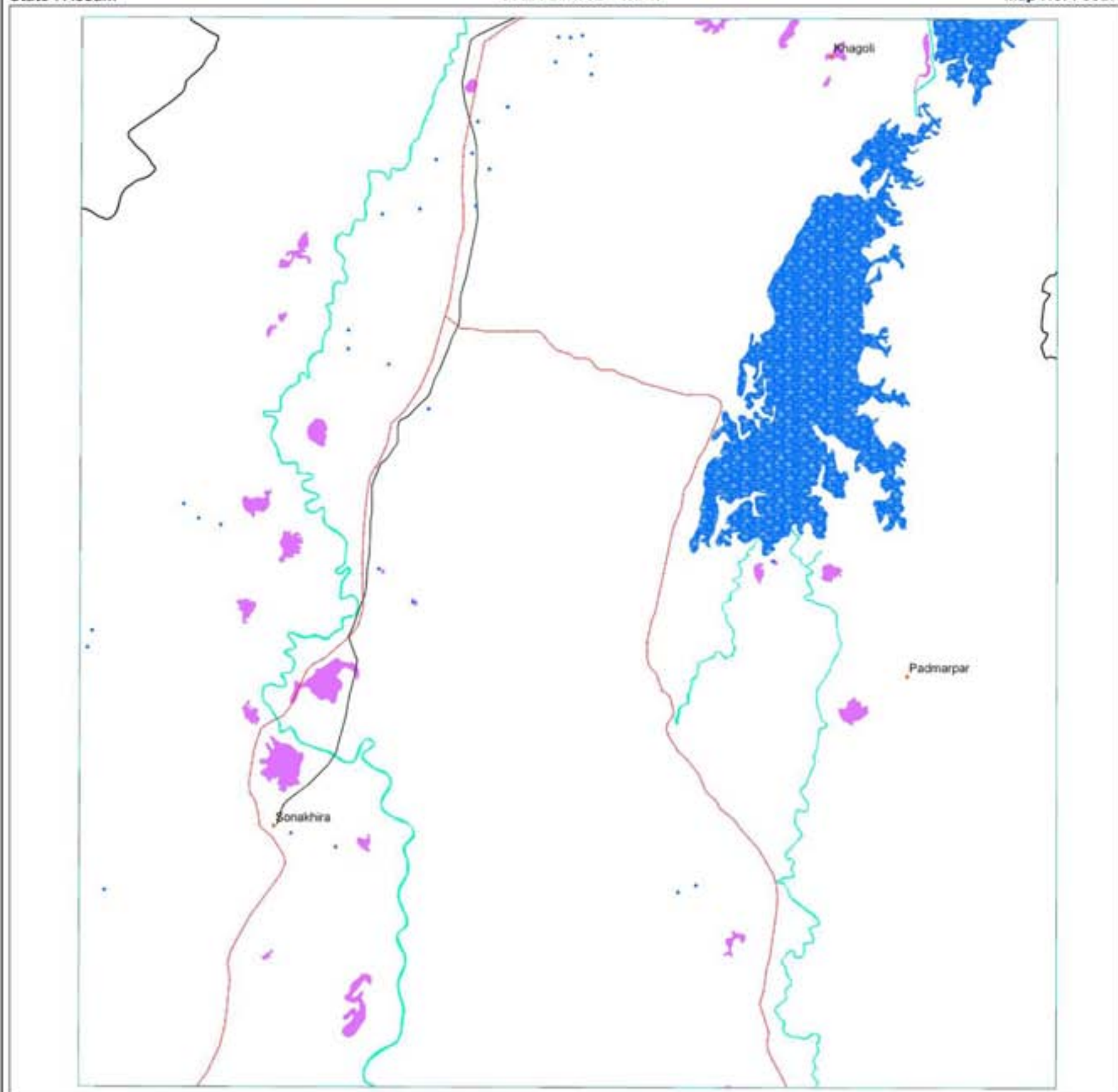
Location Map



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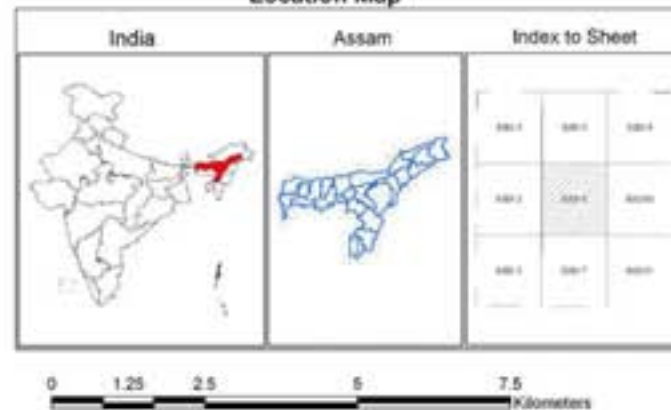


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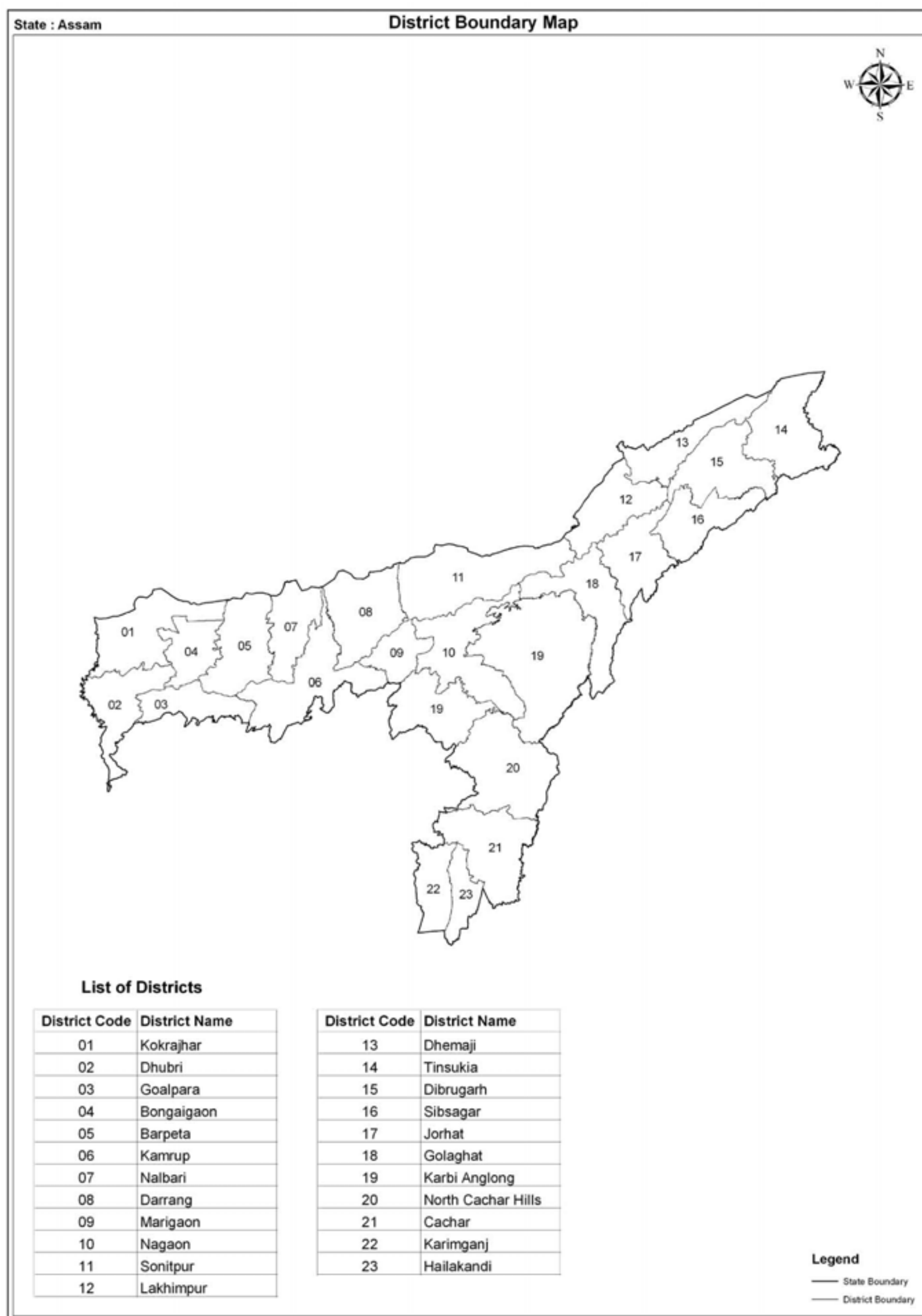
Annexure I
Definitions of wetland categories used in the project

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

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

1202	Tanks/Ponds: A term used in Ceylon and the drier parts of Peninsular India for an artificial pond, pool or lake formed by building a mud wall across the valley of a small stream to retain the monsoon (Margarate <i>et al</i>, 1974). Ponds Generally, suggest a small, quiet body of standing water, usually shallow enough to permit the growth of rooted plants from one shore to another (Reid <i>et al</i>, 1976). Tanks appear in light blue colour showing bottom reflectance. 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 <i>et al</i>, 1976). Backwater: A creek, arm of the sea or series of connected lagoons, usually parallel to the coast, separated from the sea by a narrow strip of land but communicating with it through barred outlets (Margarate <i>et al</i>, 1974).
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 <i>et al</i>, 1974). Salt pans are square or rectangular in shape. When water is there appearance is blue while salt is formed tone is white.
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



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

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