NATIONAL WETLAND ATLAS:

HARYANA

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

Space Applications Centre (ISRO), Ahmedabad

and

Haryana Space Applications Centre, Hisar

and

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MESSAGE

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

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

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

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

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

(Jairam Ramesh)

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FOREWORD

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

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

January 25, 2010

(Ranganath R. Navalgund)

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

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

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(Sushma Panigrahy)

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1.0 INTRODUCTION

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

1.1 Wetlands

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

Provisioning services: The resources or products provided by ecosystems, such as food, raw materials (wood), genetic resources, medicinal resources, ornamental resources (skin, shells, flowers).

Regulating services: Ecosystems maintain the essential ecological processes and life support systems, like gas and climate regulation, water supply and regulation, waste treatment, pollination, etc.

Cultural and Amenity services: Ecosystems are a source of inspiration to human culture and education throughout recreation, cultural, artistic, spiritual and historic information,
science and education.

Supporting services: Ecosystems provide habitat for flora and fauna in order to maintain biological and genetic diversity.

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

1.2 Mapping and Geospatial technique

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

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

From a general perspective, remote sensing is the science of acquiring and analyzing information about objects or phenomena from a distance (Jensen, 1986; Lillesand and Keifer, 1987). Today, we define satellite remote sensing as the use of satellite borne sensors to observe, measure, and record the electromagnetic radiation (EMR) reflected or emitted by the earth and its environment for subsequent analysis and extraction of information. EMR sensors includes visible light, near-, mid- and far-infrared (thermal), microwave, and long-wave radio energy. The capability of multiple sources of information is unique to remote sensing. Of specific advantage is the spectral, temporal, and spatial resolution. Spectral resolution refers to the width or range of each spectral band being recorded. Since each target affects different wavelengths of incident energy differently, they are absorbed, reflected or transmitted in different proportions. Currently, there are many land resource remote sensing satellites that have sensors operating in the green, red, near infrared and short wave Infra red regions of the electromagnetic spectrum giving a definite spectral signature of various targets due to difference in radiation absorption and reflectance of targets. These sensors are of common use for land cover studies, including wetlands**.** Figure 1 shows typical spectral signature of few targets from green to SWIR region. Converted to image, in a typical false colour composite (FCC) created using NIR, red and green bands assigned as red, green and blue colour, the features become very distinct as shown in Figure 2 - A typical wetland located in Taoru block, Mewat district. In FCC, the vegetation thus appears invariably red (due to high reflection in NIR from green leaves).

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

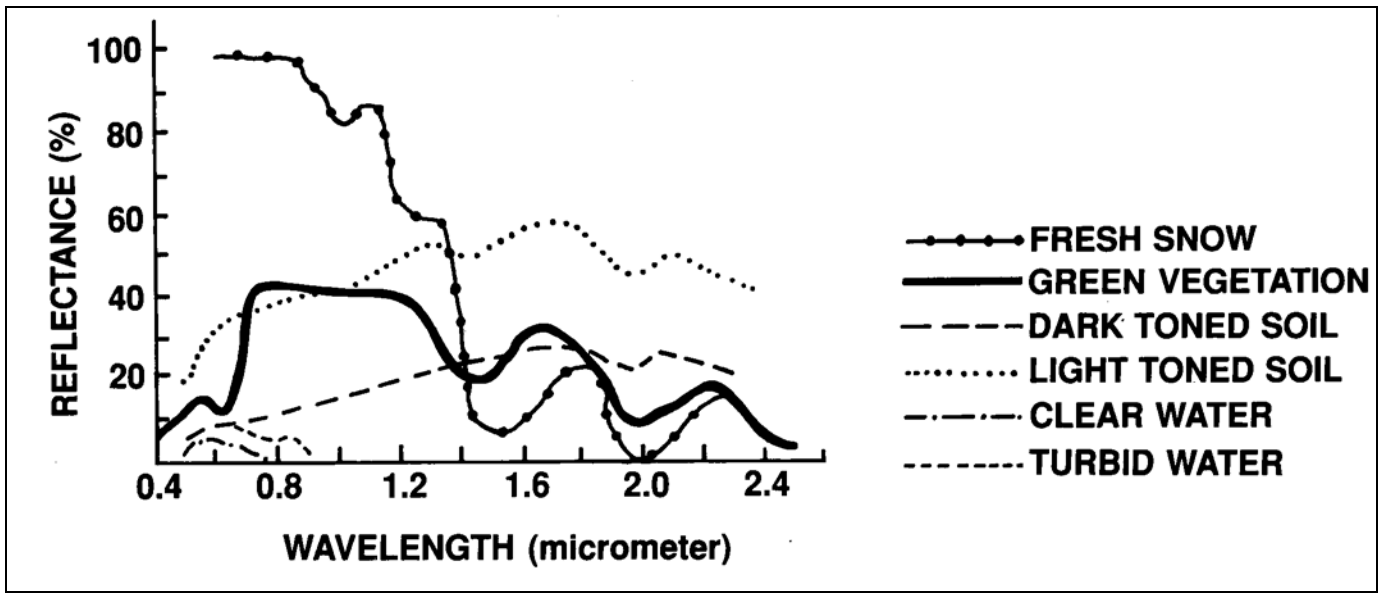


Figure 1: Spectral Signature of various targets

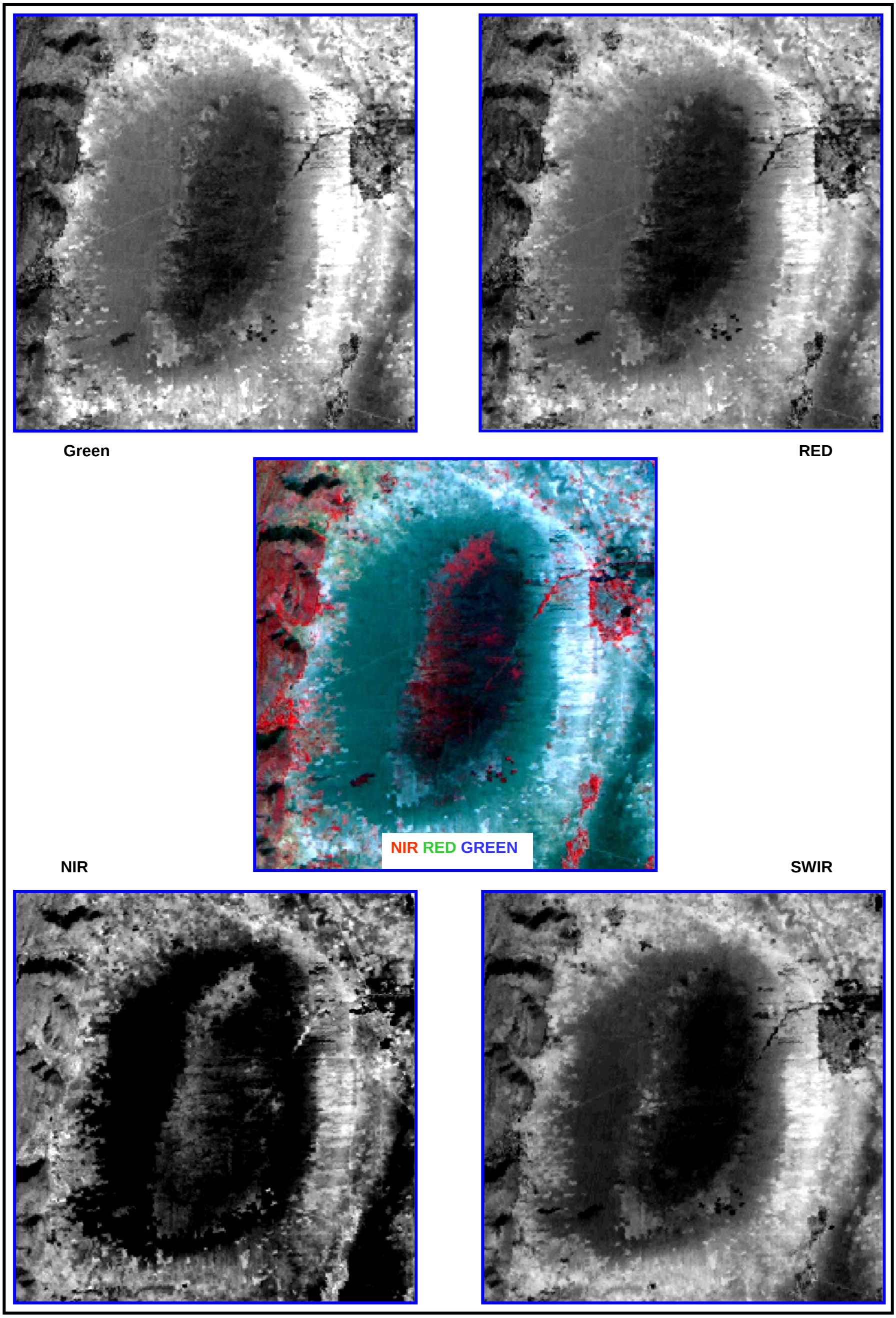


Figure 2: Various wetland features as they appear in four spectral bands and in a typical three band FCC.

1.3 Wetland Inventory of India

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

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

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

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

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

The first scientific mapping of wetlands of India was carried out during1992-93 by Space Applications Centre (ISRO), Ahmedabad, at the behest of the Ministry of Environment and Forests (MoEF), Govt. of India using remote sensing data from Indian Remote Sensing 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, saltpans, reservoirs, gravel pits were also included as wetlands. This inventory put the wetland extent (inland as well as coastal) at about 8.26 million ha. (Garg et al, 1998). These estimates (24 categories) do not include rice/paddy fields, rivers, canals and irrigation channels.

Further updating of wetland maps of India was carried out by SAC using IRS P6/Resourcesat AWiFS data of 2004-05 at 1:250000 scale. In recent years, a conservation atlas has been brought out by Salim Ali Centre for Ornithology and Natural History (SACON, 2004), which provide basic information required by stakeholders in both wetland habitat and species conservation. Space Applications Centre has carried out many pilot projects for development of GIS based wetland information system (Patel et al, 2003) and Lake Information system (Singh et al, 2003).

2.0 NATIONAL WETLAND INVENTORY AND ASSESSMENT (NWIA) PROJECT

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

The main objectives of the project are:

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

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

2.1 Wetland Classification System

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

2.2.1 Spatial Framework and GIS Database

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

Following wetland layers are generated for each inland wetland:

- Wetland extent: As wetlands encompass open water, aquatic vegetation (submerged, floating and emergent), the wetland boundary should ideally include all these. Satellite image gives a clear signature of the wetland extends from the imprint of water spread over the years.
- Water spread: There are two layers representing post-monsoon and pre-monsoon water spread during the year of data acquisition.

- Aquatic vegetation spread: The presence of vegetation in wetlands provides information about its trophic condition. As is known, aquatic vegetation is of four types, viz. benthic, submerged, floating, and emergent. It is possible to delineate last two types of vegetation using optical remote sensing data. A qualitative layer pertaining to presence of vegetation is generated for each season (as manifested on pre-monsoon and post-monsoon imagery).
- Turbidity level of open water: A layer pertaining to a qualitative turbidity rating is generated. Three qualitative turbidity ratings (low, medium and high) is followed for pre and post-monsoon turbidity of lakes, reservoirs, barrages and other large wetlands.
- Small wetlands (smaller than minimum mappable unit) are mapped as point features.
- Base layers like major road network, railway, settlements, and surface drainage are created (either from the current image or taken from other project data base).

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

Table 1: Wetland Classification System and coding

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

* Wetland type code

3.0 STUDY AREA

Haryana is a small state situated between 27^0 29' to 30^0 56' N latitudes and 74^0 27' to 77^0 36' E longitudes, covering as area of about 44, 212 sq. km. The State mainly occupies the Indo- Gangetic Alluvial Plain. It is basically an agriculture state and about 75 % of the population is engaged in agriculture and related activities. Haryana is known as 'land' of milk. The state covers about 3.3 % cultivated area of the country and contributes about 5.6 % to the total food grain production. The per capita availability of the land has been decreasing progressively over the years and is likely to decreases further due to the population pressure,, urbanization and the industrial expansion of the arable lands. The state came into existence on 1st January 1966. The state shares a common boarder with the states of Delhi, Rajasthan, Punjab, Himachal Pradesh and Uttar Pradesh. Location map is shown in Figure-3.

The state represents a variety of landscapes varying from hills in the northern region to almost flat alluvial plains in the central parts, and sand dunes in the southern regions. The state has mainly 4 physiographic regions namely, i) Siwalik Hills: ii) Alluvial Plains: iii) Aravalli Hills, and iv) Aeolian plains. The general slope of the state is from north to south but the slopes become reserve further south and southwest due to the presence of subdued ranges of Aravalli Hills. The entire state is drained by the tributaries mainly the Markanda, the Saraswati, The Chautoung, and the Tangri apart from other seasonal streams. The Sahibi, the Dohan and the Krishnavati originating from Aravalli ridges are flowing from south to north.

The Geological formations range from Precambrian to the recent and can be divided into three geological system namely - i) Aravalli system, ii) Siwalik system and iii) Indo-Gangetic. Soils in the state are mainly derived from these geological units.

The climate of the state is sub-tropical, semi-arid to sub-humid, continental and monsoonal. The average annual rainfall of the state is about 650 mm which varies from less than 300 in south western parts to over 1000 mm in the hilly tracts of Siwalik. The state has 3 main climatic regions- Hot Arid region, Hot semi arid region and Hot sub humid region. The mean rainfall (mm) in hot arid region ranges from 300 -500, where as 500- 750 mm in hot semi arid region and 750- 1050 in hot sub humid region of Haryana. The mean temperature ranges from 27^0 c, 26^0 c, and 24^0 c respectively. The soil temperature regime is Hyperthermic and the soil moisture regimes are Ustic Aridic.

Among the flora of Haryana, the largest of truly indigenous trees namely Shisham (*Dalbergia sisso*) and Kikar (*Acacia Arabica*). The shrub comprises Jal (*Salvadora oleodes*), Jand (*Prosopis specigera*) and coral flowered leafless Kair (*Capparis aphylla*) besides other common trees and grasses.

Forest area in Haryana is limited to only 1,66,000 ha (3.7) of which 85% is under state forest and rest is under private forests.

The state has fourteen districts and is covered by 102 Survey of India topographical maps on 1:50,000 scale that form the spatial frame work for mapping (Figure 4). The spatial framework was prepared using 15' x 15' grid.

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

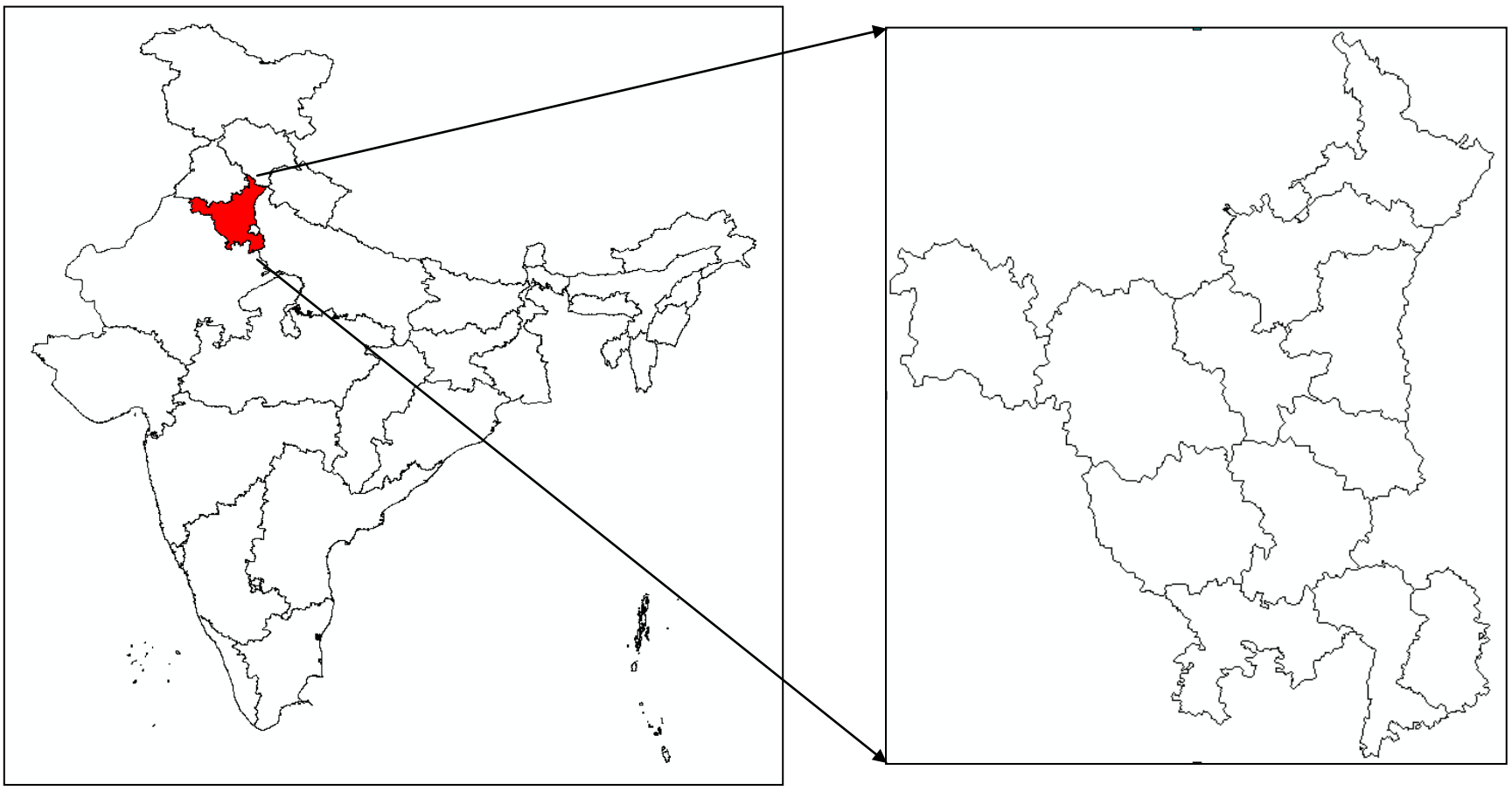


Figure 3: Location Map

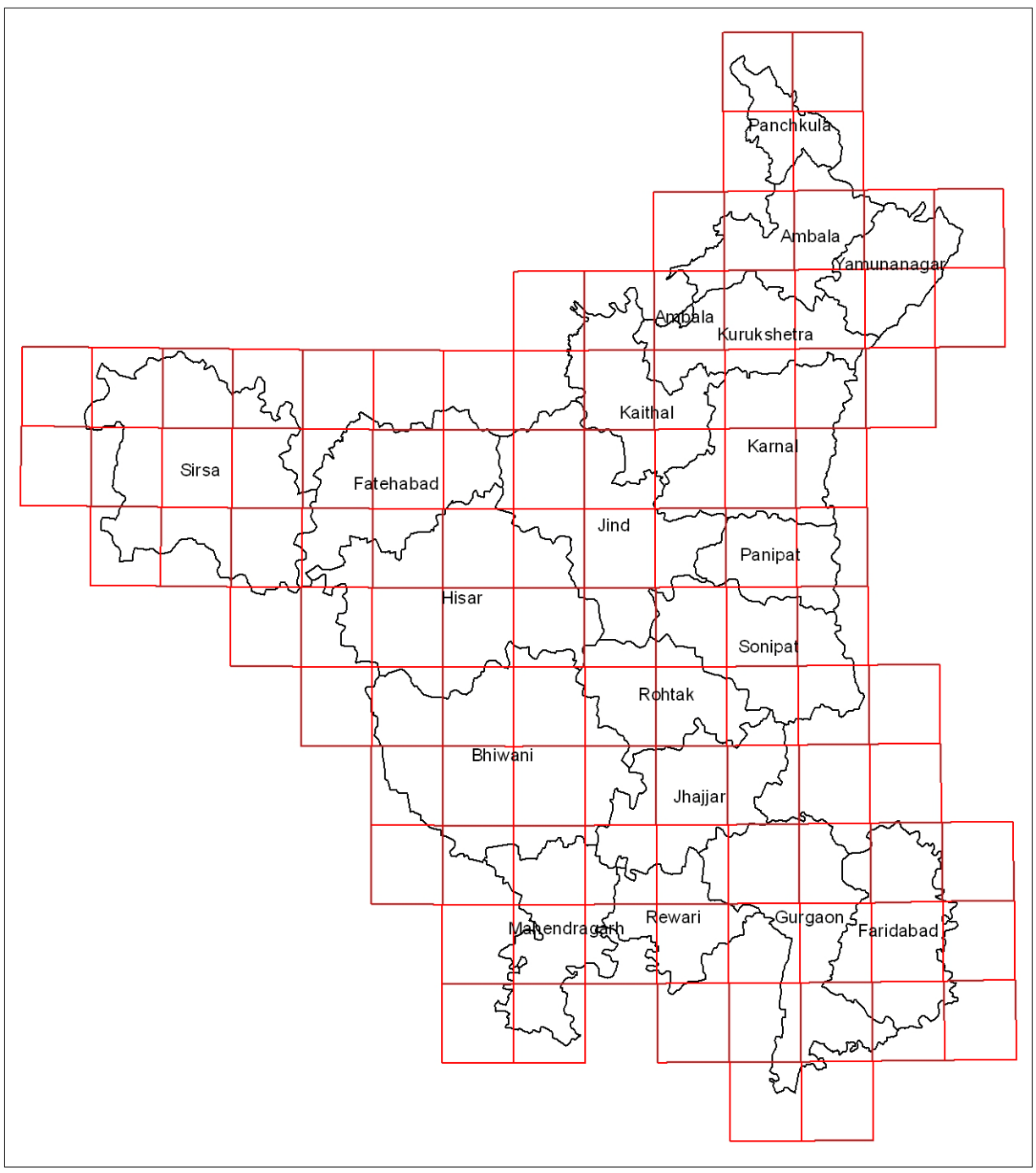


Figure 4: Spatial Framework of Haryana

4.0 DATA USED

Remote sensing data

IRS P6 LISS III data was used to map the wetlands. IRS P6 LISS III provides data in 4 spectral bands; green, red, Near Infra Red (NIR) and Short wave Infra Red (SWIR), with 23.5 m spatial resolution and 24 day repeat cycle. The spatial resolution is suitable for 1:50,000 scale mapping. The state of Haryana is covered in 9 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 5 shows the overview of the part of Haryana as seen in the LISS III FCC of post- monsoon pre-monsoon data respectively.

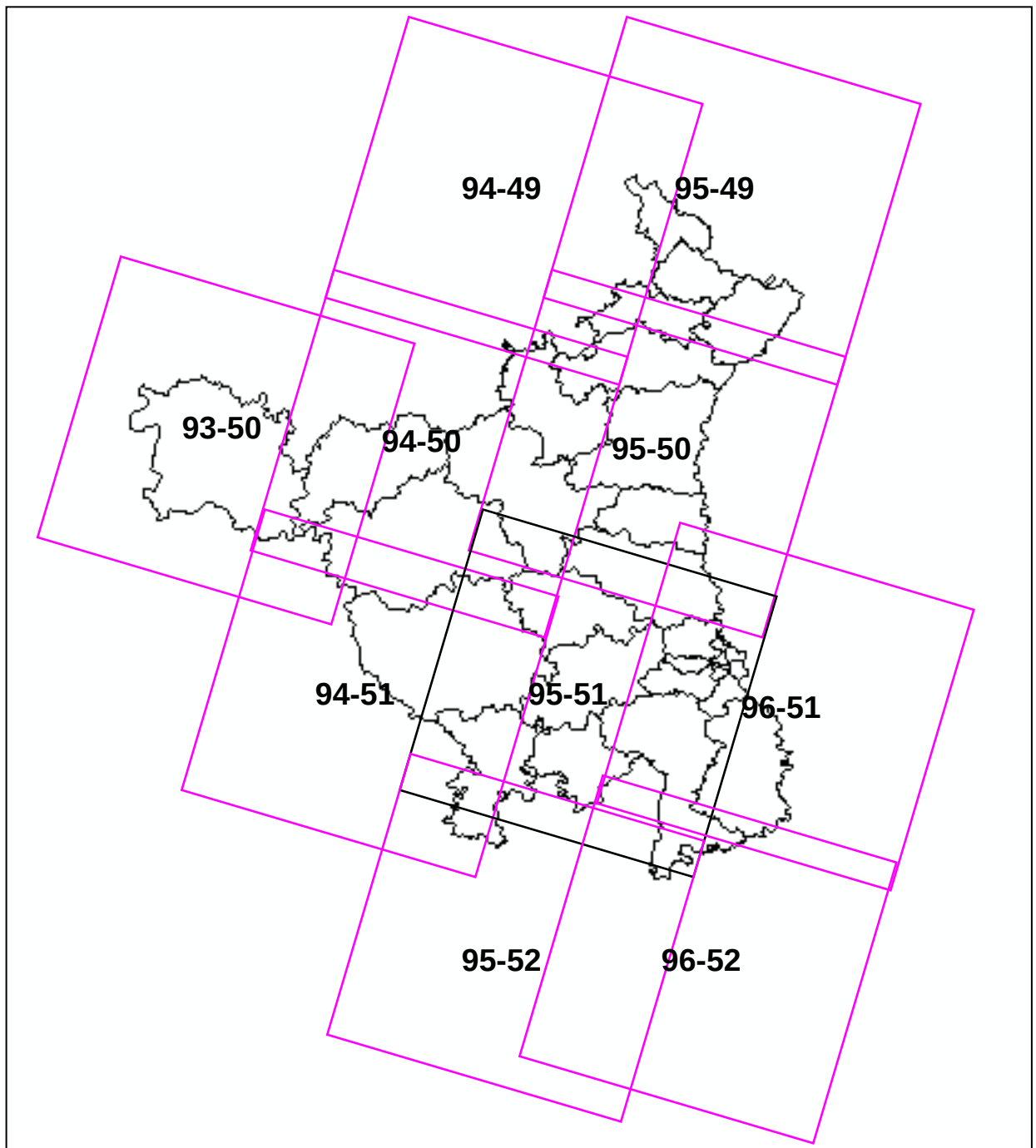


Figure 5: IRS P6 LISS-III coverage (path-row) of Haryana

Table-2: Satellite data used

Sr. No.	Sensor	Path-Row	Date of acquisition	
			Post-monsoon	Pre-monsoon
1.	LISS-III	94-50	Sep 30, 2006	Apr 10, 2007
2.	LISS-III	94-51	Sep 30, 2006	Apr 10, 2007
3.	LISS-III	96-51	Oct 10, 2006	May 14, 2007
4.	LISS-III	93-50	Oct 24, 2006	May 23, 2007
5.	LISS-III	95-49	Oct 5, 2006	May 9, 2007
6.	LISS-III	95-50	Oct 5, 2006	May 9, 2007
7.	LISS-III	95-51	Oct 10, 2005	March 3, 2006
8.	LISS-III	95-52	Oct 10, 2005	Feb 7, 2006
9.	LISS-III	96-52	Oct 10, 2006	May 14, 2007

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 data. The location of the features is recorded using the GPS. The standard proforma as per the NWIA manual was used to record the field data. Field photographs are also taken to record the water quality (subjective), status of aquatic vegetation and water spread. All field verification work has been done during October and November 2008.

Other data

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

5.0 METHODOLOGY

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

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

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

5.1 Creation of spatial framework

This is the most important task as the state forms a part of the national frame work and is covered in multiple map sheets. To create NWIA database, NNRMS/NRDB standards is followed and four corners of the 1:50,000 (15’ x 15’) 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 (Garg and Patel 2007). The spatial framework for Haryana state is shown in Figure 4.

5.2 Geo-referencing of satellite data

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

5.3 Mapping of wetlands

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

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

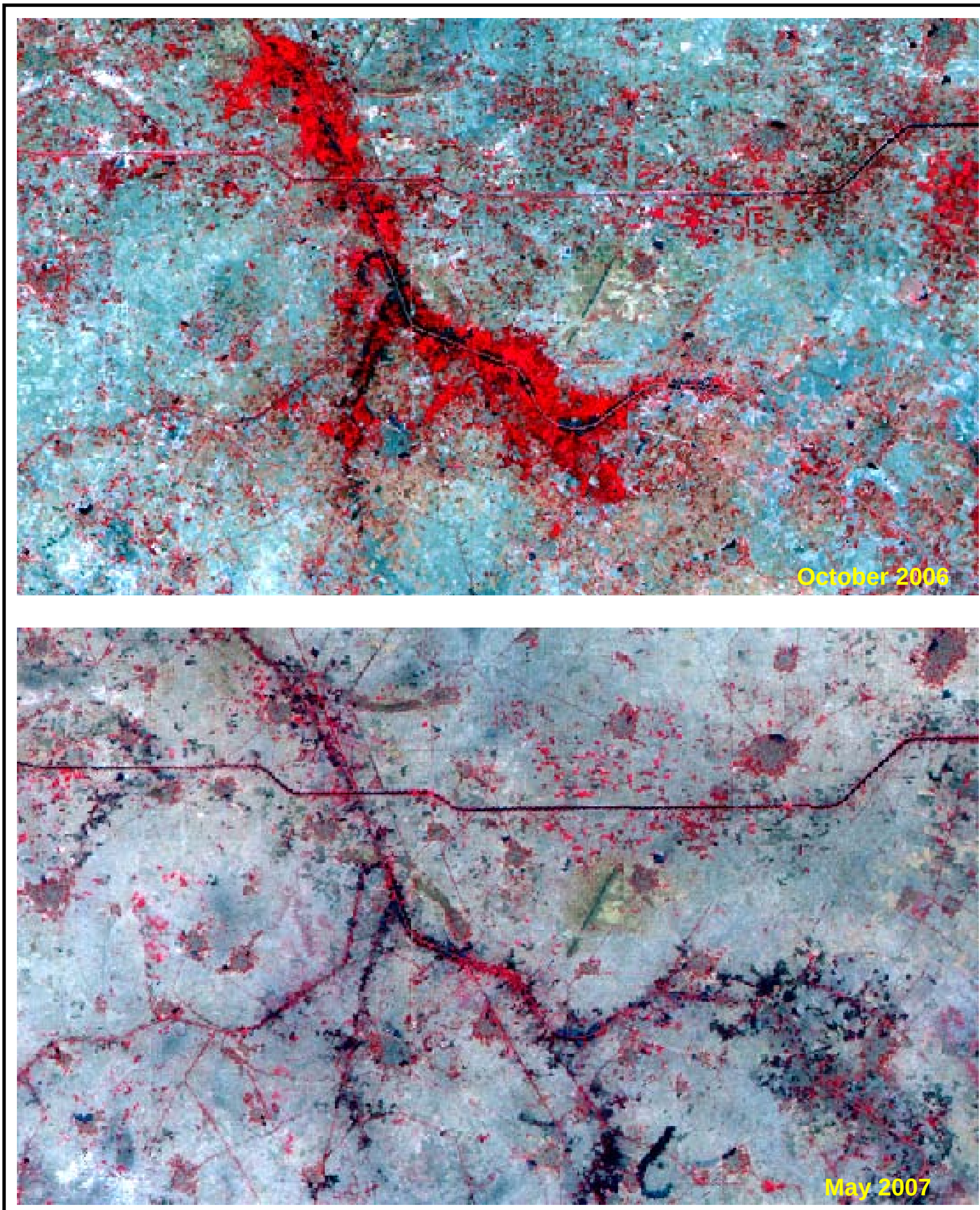


Figure 6: IRS LISS-III FCC (Post-monsoon and Pre-monsoon): Part of Haryana state

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

- Extraction of wetland extent :

  MNDWI, NDPI and NDVI image was used to extract the wetland boundary through suitable hierarchical thresholds.

- Extraction of open water :

  MNDWI was used within the wetland mask to delineate the water and no-water areas.

- Extraction of wetland vegetation :

  NDPI and NDVI image was used to generate the vegetation and no-vegetation areas within a wetland using a suitable threshold.

- Turbidity information extraction :

  NDTI and MNDWI image was used to generate qualitative turbidity level (high, moderate and low) based on signature statistics and standard deviations. In the False Colour Composite (FCC) these generally appear in different hues (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	> -1σ to <= $+1\sigma$	Medium blue
3.	High/Bottom reflectance	<= $\mu - 1\sigma$	Light blue/whitish blue

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

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

5.5 *Generation of reference layers*

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

5.6 Coding and attribute scheme

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

5.7 Map composition and output

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

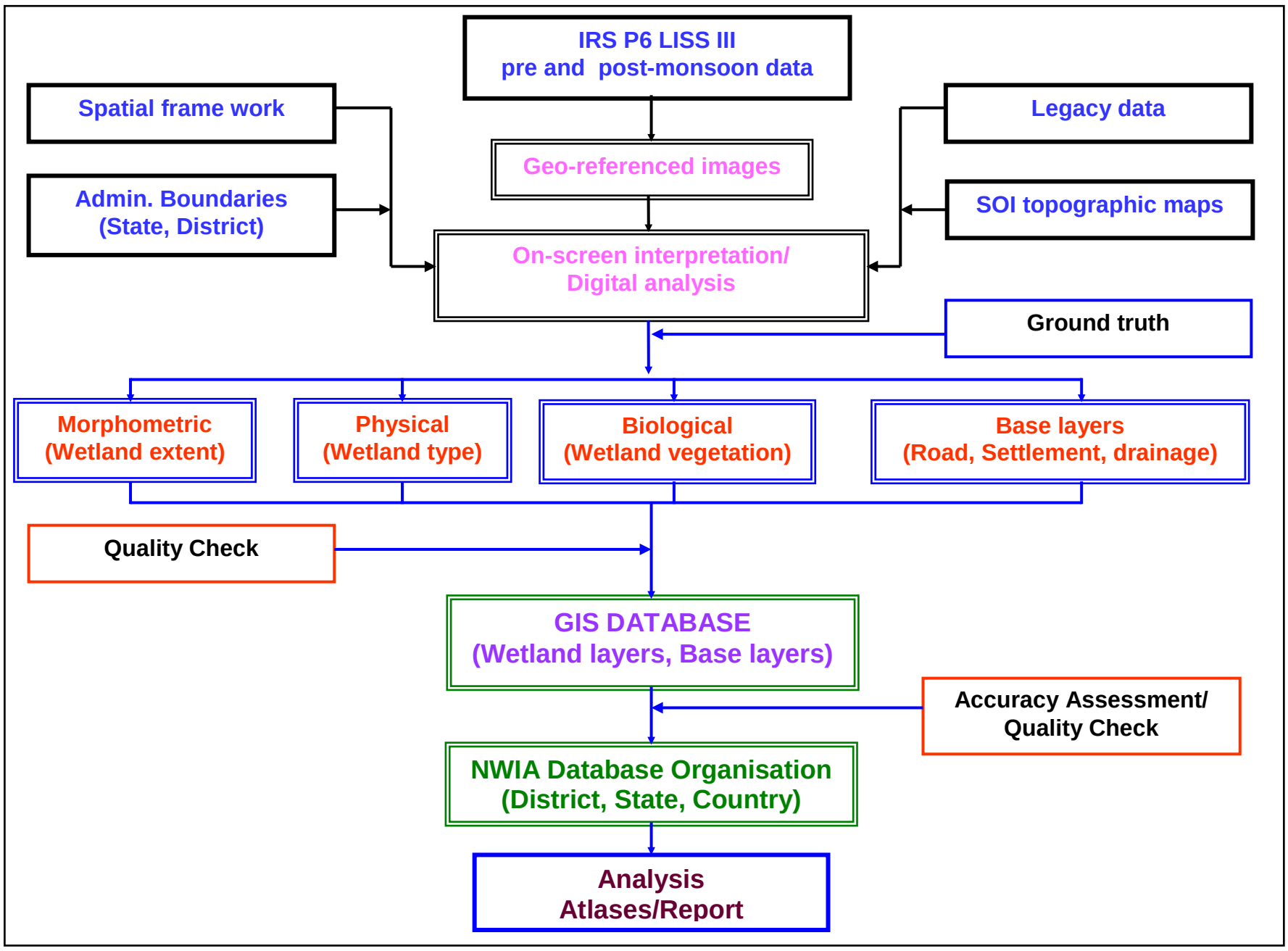


Figure 7: Flow chart of the methodology used

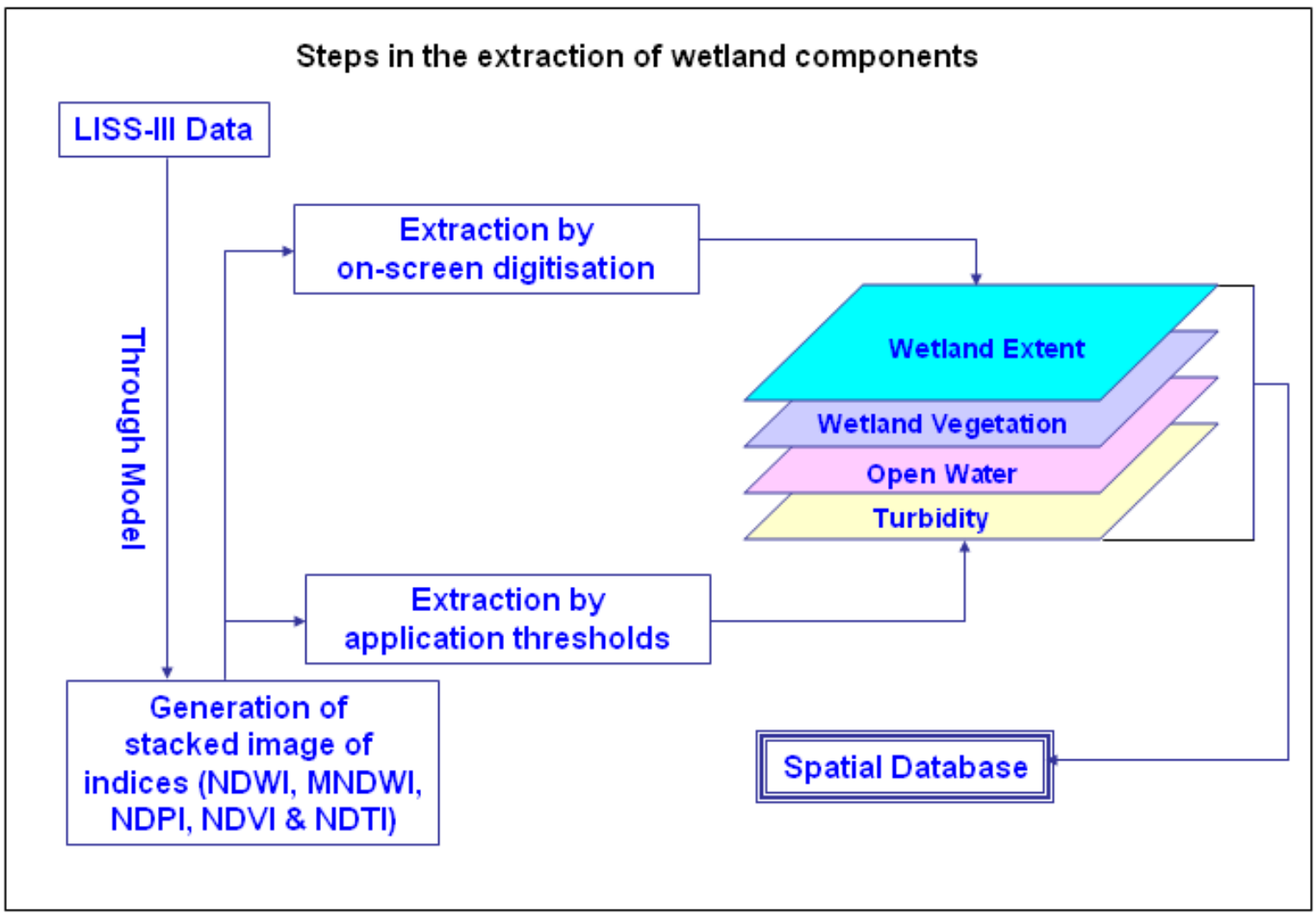


Figure 8: Steps in the extraction of wetland components

6.0 ACCURACY ASSESSMENT

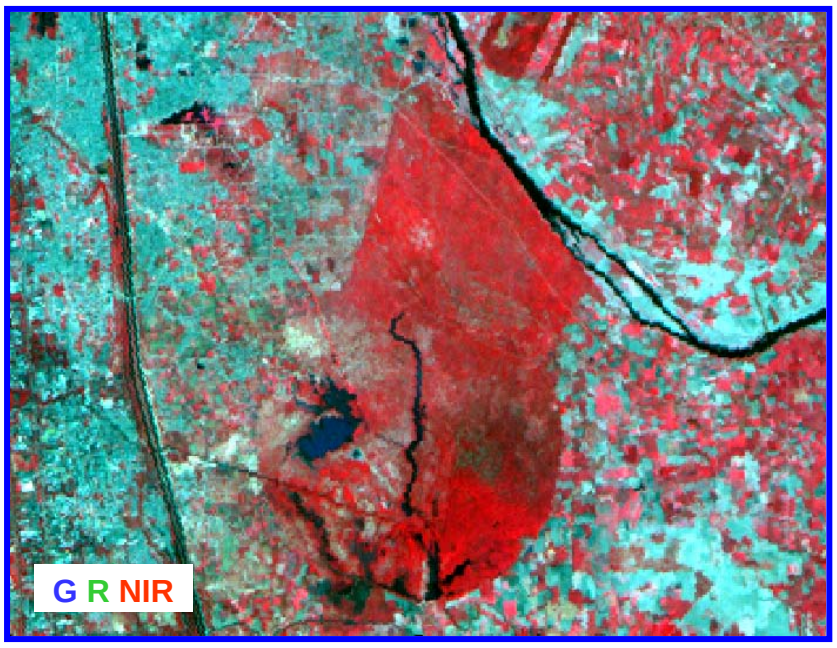
A comprehensive accuracy assessment protocol has been followed for determining the quality of information derived from remotely sensed data. Accuracy assessment involves determination of thematic (classification) as well as locational accuracy. In addition, GIS database(s) contents have been also evaluated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

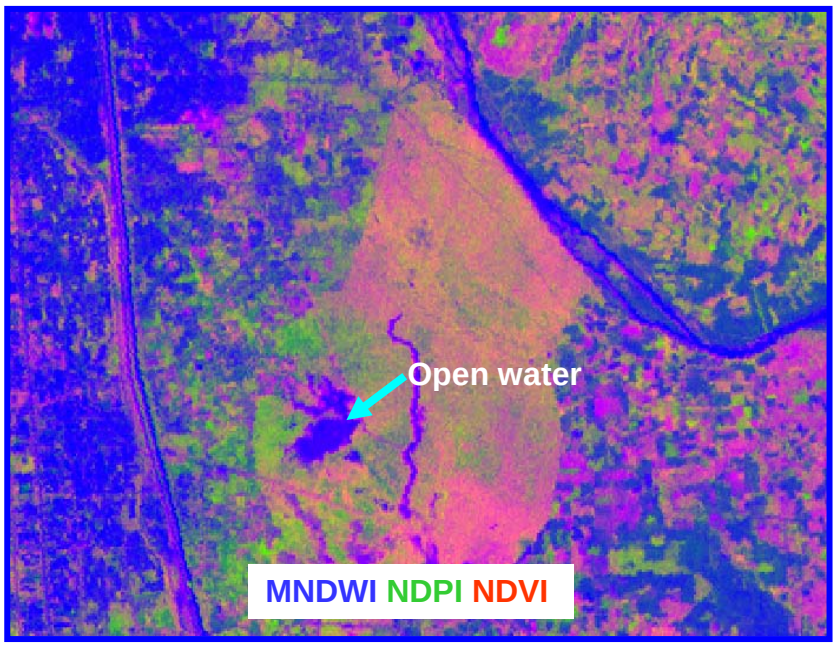
This study used well established, time-tested, fully documented data collection conventions. It employed skilled and trained personnel for image interpretation, processing and digital database creation. All interpreted imageries were reviewed by technical expert team for accuracy and code. The reviewing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

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

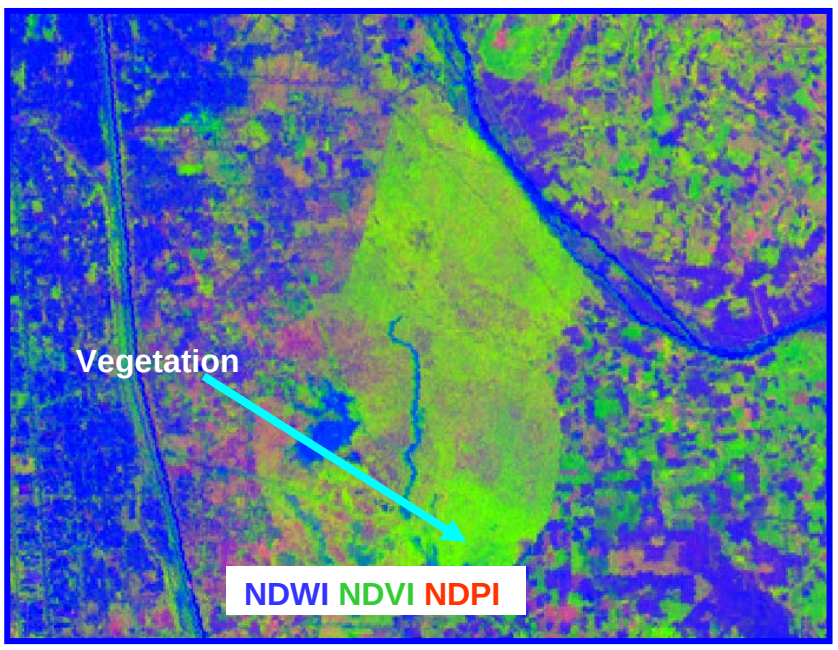
6.1 Data verification and quality assurance of output digital data files

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

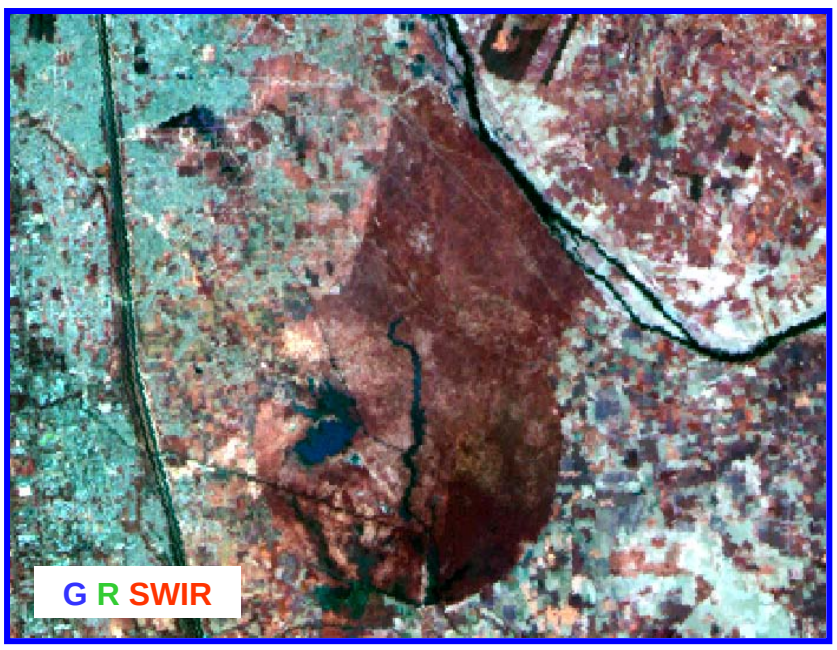


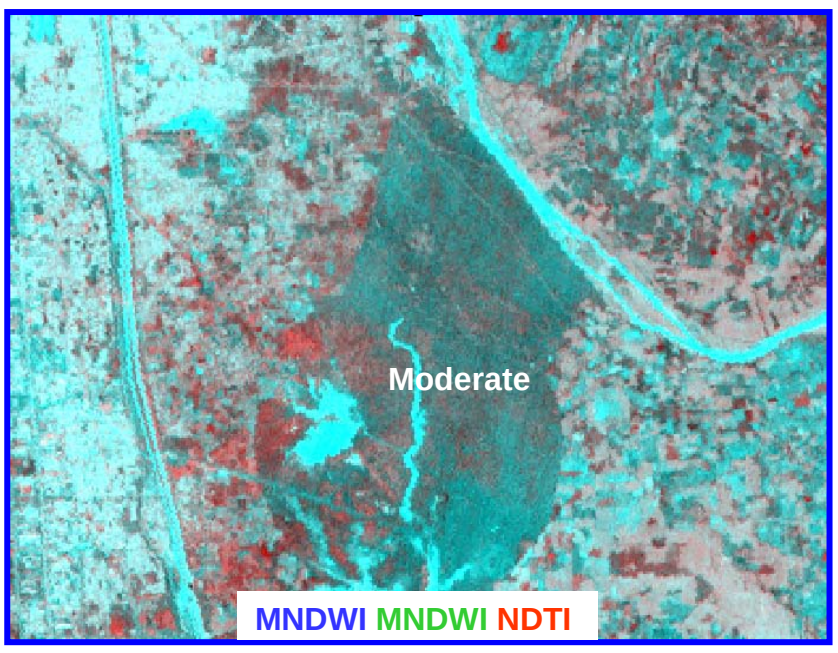


Useful for wetland boundary extraction/delineation



Useful for wetland vegetation & open water features





Useful for qualitative turbidity delineation

IRS LISS III data, 10 October 2006

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

MAPS AND STATISTICS

7.0 WETLANDS OF HARYANA: MAPS AND STATISTICS

Area estimates of various wetland categories for Haryana have been carried out using GIS layers of wetland boundary, water-spread, aquatic vegetation and turbidity. Total 1441 wetlands have been mapped at 1:50,000 scale in the state. In addition, 10529 wetlands (smaller than 2.25 ha) have also been identified. Total wetland area estimated is 42478 ha that is around 0.86 per cent of the geographic area (Table 4). The major wetland types are River/Stream accounting for 40.08 per cent of the wetlands (17025 ha), Tank/Ponds (7573 ha), waterlogged (3339 ha) and Reservoirs/Barrage (1775 ha). Graphical distribution of wetland type is shown in Figure 10.

Analysis of wetland status in terms of open water and aquatic vegetation showed that around 14216 ha and 2245 ha respectively. Lotic wetlands include rivers and major streams and contribute an area of 17025 ha. Open water in post-monsoon season is very less (3121 ha). It clearly indicates that these rivers are mainly seasonal and receives scanty rainfall. Perennial rivers are few and river flow is restricted to narrow streams of the river. Presence of aquatic vegetation is more during post monsoon season and it is mainly due to dispersion of floating vegetation by wind and water current. Aquatic vegetation occupies an area of 2245 and 1497 during post-and pre-monsoon respectively. High turbidity (3968 ha) is observed during post-monsoon season. Lakes and ponds showed low turbidity in general where as tanks/ponds located around thermal plants and industrial area showed high turbidity. Inland wetlands mainly lakes and ponds shown drastic decrease in terms of area in pre-monsoon season (20 ha) and it is due to high temperature during this season.

Table 4: Area estimates of wetlands in Haryana

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	5	801	1.89	284	20
2	1102	Ox-bow lakes/ Cut-off meanders	3	24	0.06	17	17
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	76	1412	3.32	1123	819
6	1106	River/Stream	20	17025	40.08	3121	9362
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	4	1775	4.18	59	175
8	1202	Tanks/Ponds	1097	7573	17.83	6782	6344
9	1203	Waterlogged	236	3339	7.86	2830	2175
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**1441**	**31949**	**75.21**	**14216**	**18912**
		Wetlands (<2.25 ha), mainly Tanks	10529	10529	24.79	-	-
		Total	**11970**	**42478**	**100.00**	**14216**	**18912**

Area under Aquatic Vegetation	2245	1497

Area under turbidity levels		
Low	6953	6423
Moderate	3295	9481
High	3968	3008

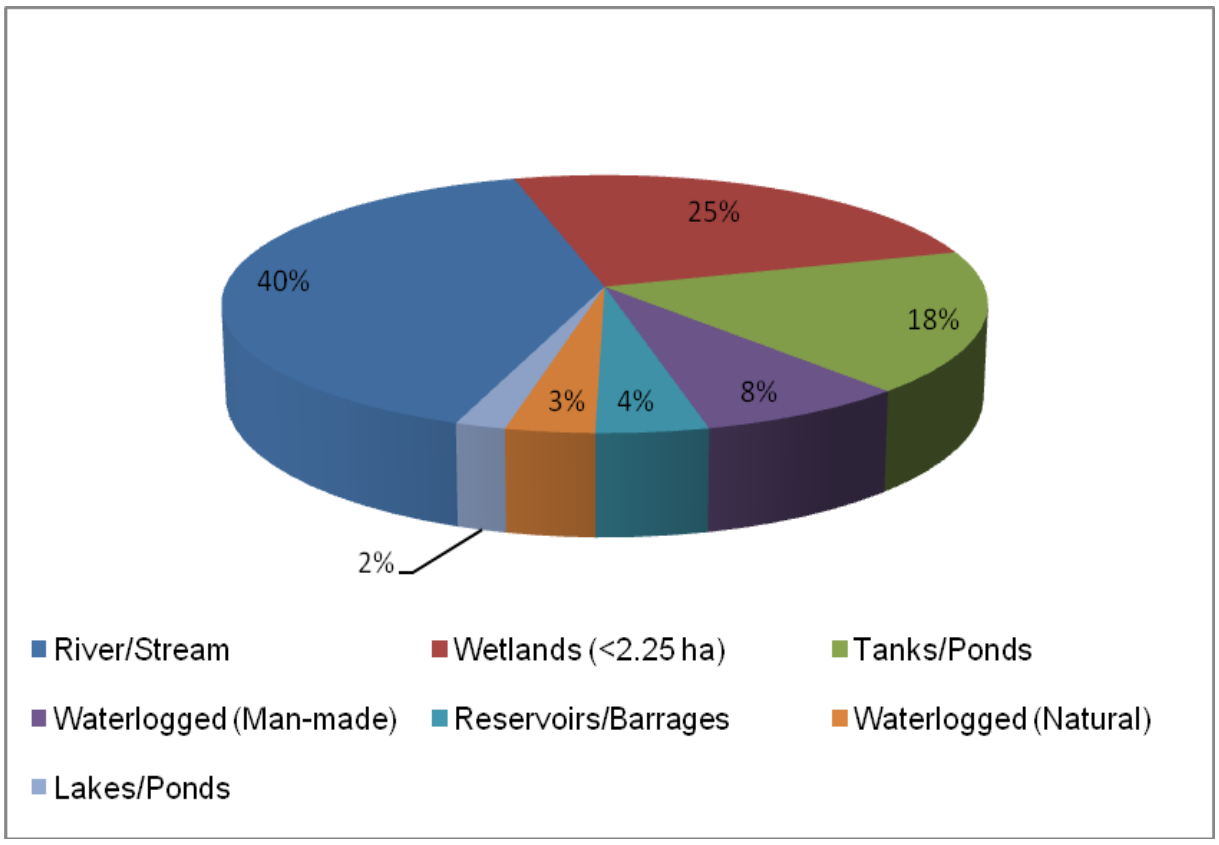


Figure 10: Type-wise wetland distribution in Haryana

7.1 DISTRICT-WISE WETLAND MAPS AND STATISTICS

The state has nineteen districts. District-wise distribution of wetlands showed that three districts could be called as wetland rich. Panchkulla has highest concentration which is around 3.53 percent of geographic area under wetland. The other two districts are: Yamunanagar and Karnal have 2.79 and 1.65 per cent area under wetland respectively. Five districts Kaithal Fatehabad, Sirsa, and Bhiwani have least amount of wetland area. These districts are small in terms of geographic area and highly industrialized due to proximity to national capital. District-wise wetland area estimates is given in Table-5. Figure 11 shows district-wise graphical distribution of wetlands. Mahendragadh and Rewari have less wetland area.

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.

Table-5: District-wise wetland area

Sr. No.	District	Geographic Area (sq. km)	Wetland Area (ha)	% of total wetland area	% of district geographic area
1	Panchkulla	898	3173	7.47	3.53
2	Ambala	2385	3036	7.15	1.27
3	Yamunanagar	1756	4893	11.52	2.79
4	Kurukshetra	1217	1671	3.93	1.37
5	Kaithal	2799	1332	3.14	0.48
6	Karnal	1967	3246	7.64	1.65
7	Panipath	1754	1862	4.38	1.06
8	Sonipath	1385	2154	5.07	1.56
9	Jind	2736	2153	5.07	0.79
10	Fatehabad	2760	1539	3.62	0.56
11	Sirsa	4276	1776	4.18	0.42
12	Hisar	6279	2811	6.62	0.45
13	Bhiwani	5099	1748	4.12	0.34
14	Rohtak	4411	1683	3.96	0.38
15	Jhajjar	1834	2194	5.17	1.20
16	Mehendragarh	1683	442	1.04	0.26
17	Rewari	1559	442	1.04	0.28
18	Gurgaon	2105	2764	6.51	1.31
19	Faridabad	2760	3559	8.38	1.29
	Total	**49663**	**42478**	**100.00**	

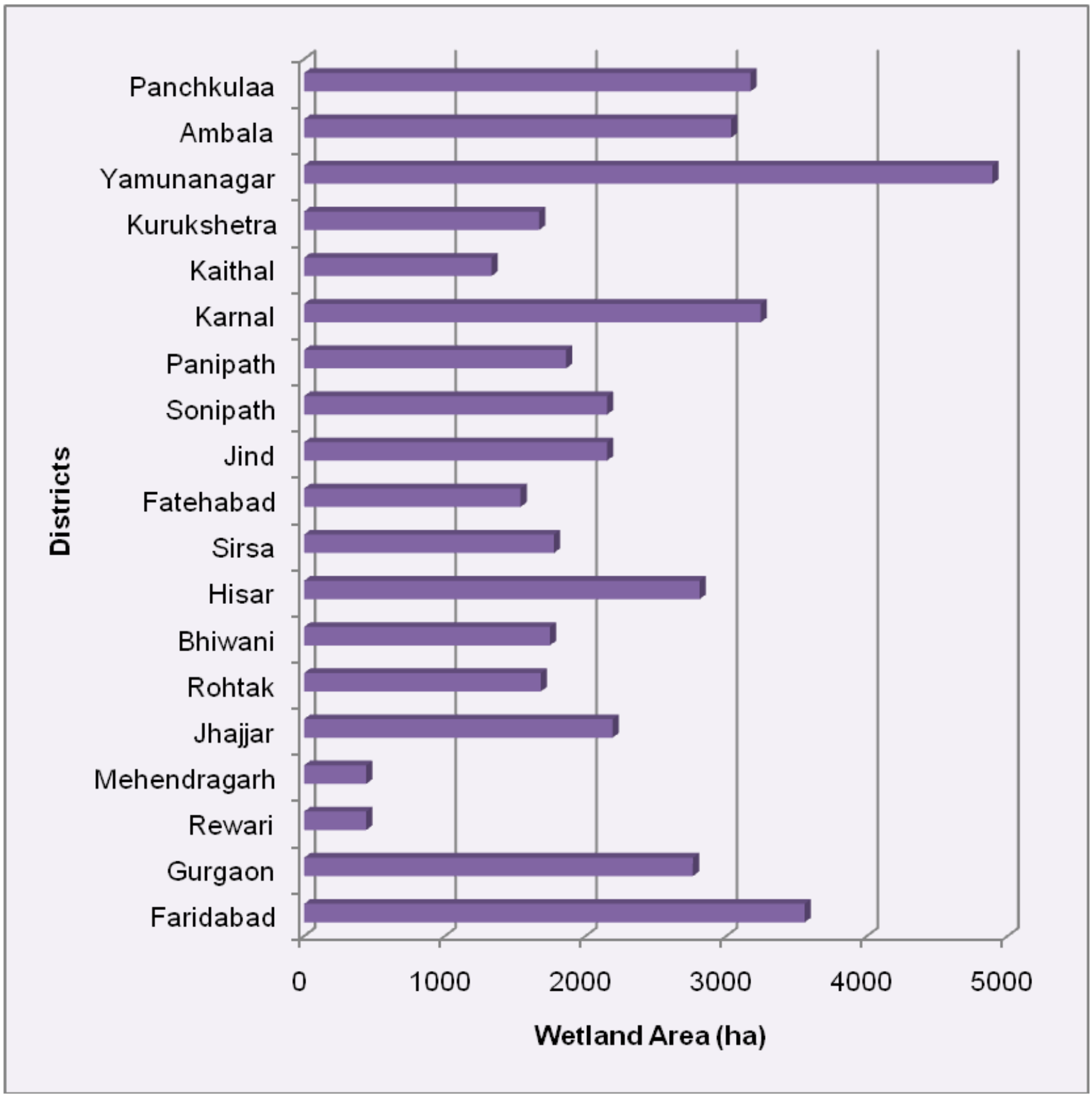
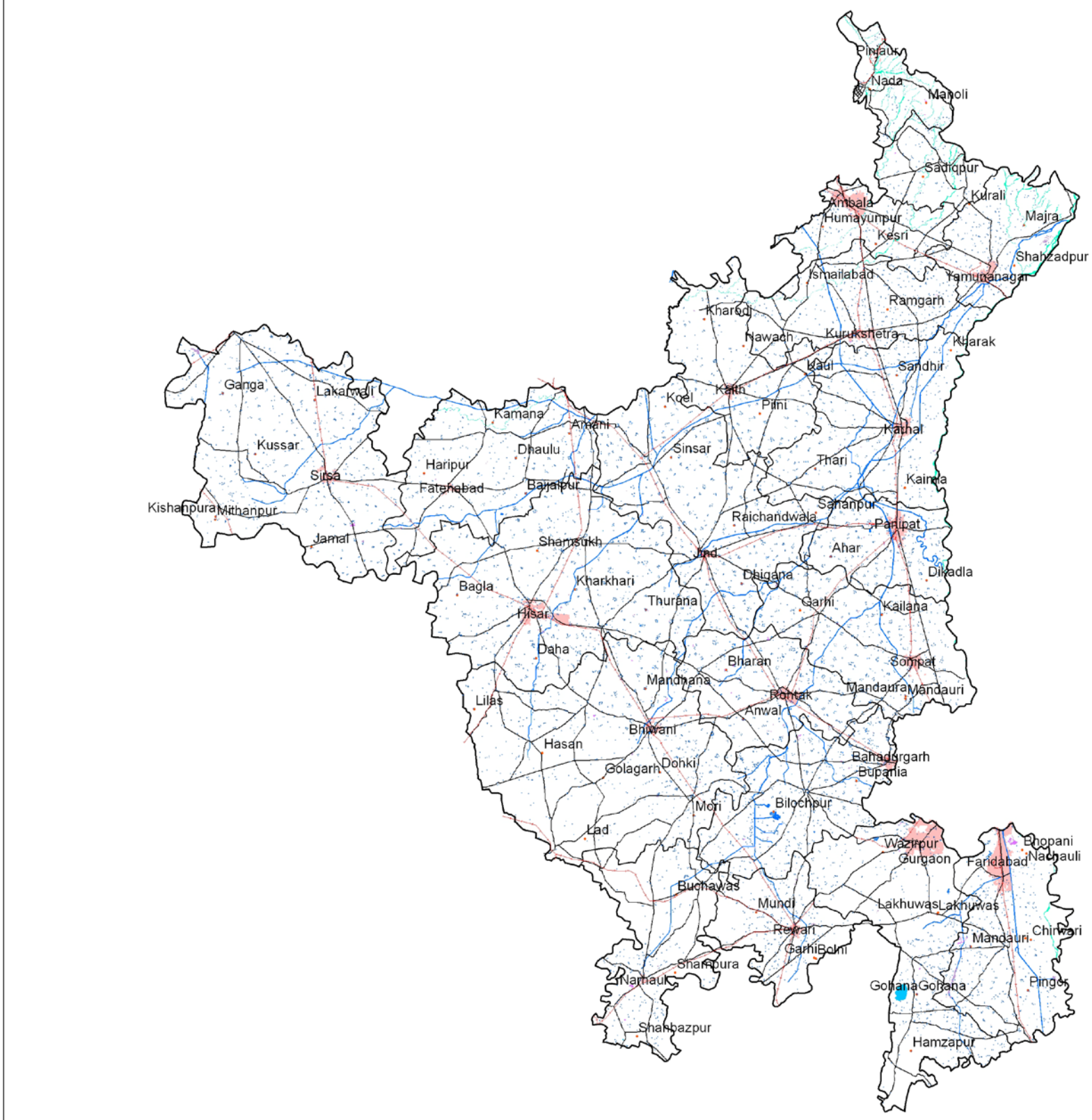


Figure 11: District-wise graphical distribution of wetlands

State : Haryana

WETLAND MAP

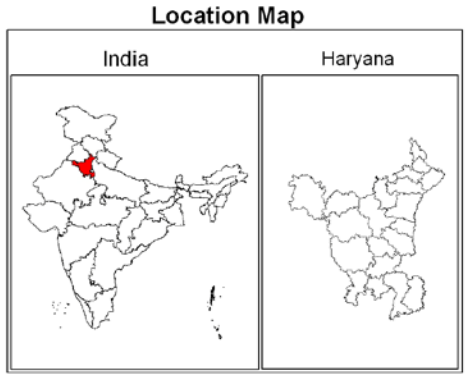


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



0 15 30 60 90 Kilometers

Data Source :

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

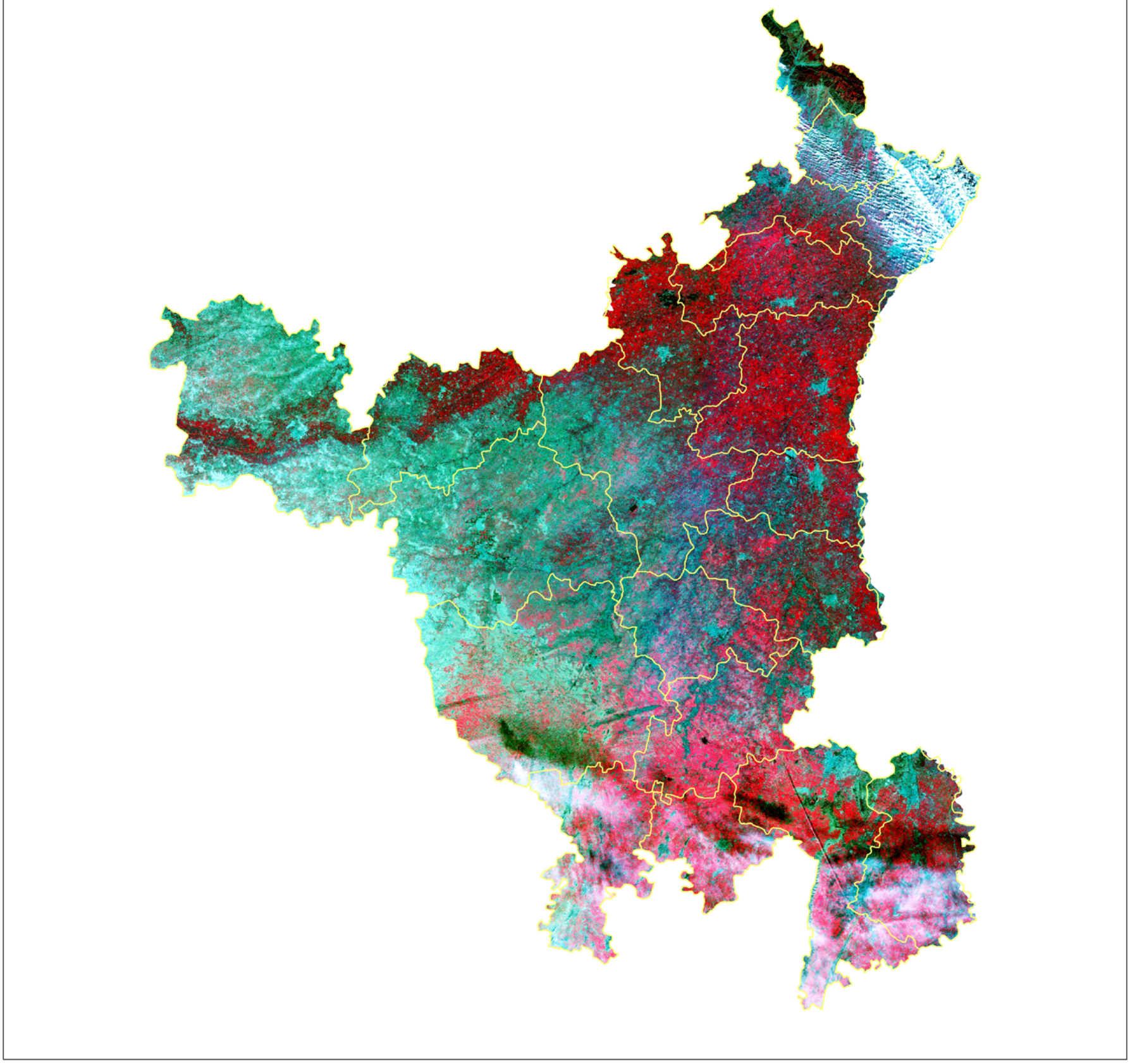
Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana



IRS P6 AWiFS post monsoon data (2004)

7.1.1 Panchkula

Panchkula district is the northern most part of the Haryana State. It has been carved out from Ambala district in the year of 1995. It comprises of a total area of about 898 sq. km. It lies between north latitudes $30^0$21' to $30^0$56' and $76^0$48' to $77^0$10' east longitudes. The average rainfall of Panchkula district is about 1430 mm. about 80 percent of its annual rainfall is received in months of June to September. It also receives some rains in the winter months due to western disturbances. Despite heavy rainfall in this area, the water retention is very low. It is due to high surface runoff because of high slopes in the area. Temperature starts rising steadily from February onwards till the onset of monsoon. The hottest months in the year are May and June with mean daily maximum temperature is about 45^0 C. The coldest month of the year is January with mean daily minimum temperature of 3^0 C.

The Panchkula district comprises of four distinct physiographic units, which are roughly parallel to each other. The districts form a part of the Indo-Gangetic plain and the Himalayan ranges. These physiographic units are: Siwalik Hills, Kandi Belt, Intermountain Valley and Alluvial Plain. Siwalik Hills: The Siwalik hills form the north and eastern parts of the area. These hill ranges are roughly run in NNW-SSE direction, attain an altitude of 600 meters and slopes towards southwest with an average gradient of about 28 m/km. These hills are deeply eroded and furrowed to form bad land topography.

The geological milieu in the district represents the lithological formation belonging to the Indo-Gangetic plain and Extra-Peninsular regions. The district can be divided in two different geological units as Tertiary rocks of Lesser Himalayas & Siwalik and Quaternary deposits of Indo-Gangetic Plains.
Details of the wetland statistics of the district are given in Table 6.

Table 6: Area estimates of wetlands in Panchkula

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	5	37	1.17	37	37
6	1106	River/Stream	15	3051	96.16	43	2680
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	1	7	0.22	6	6
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**21**	**3095**	**97.54**	**86**	**2723**
		Wetlands (<2.25 ha), mainly Tanks	78	78	2.46	-	-
		Total	**99**	**3173**	**100.00**	**86**	**2723**

Area under Aquatic Vegetation	-	-

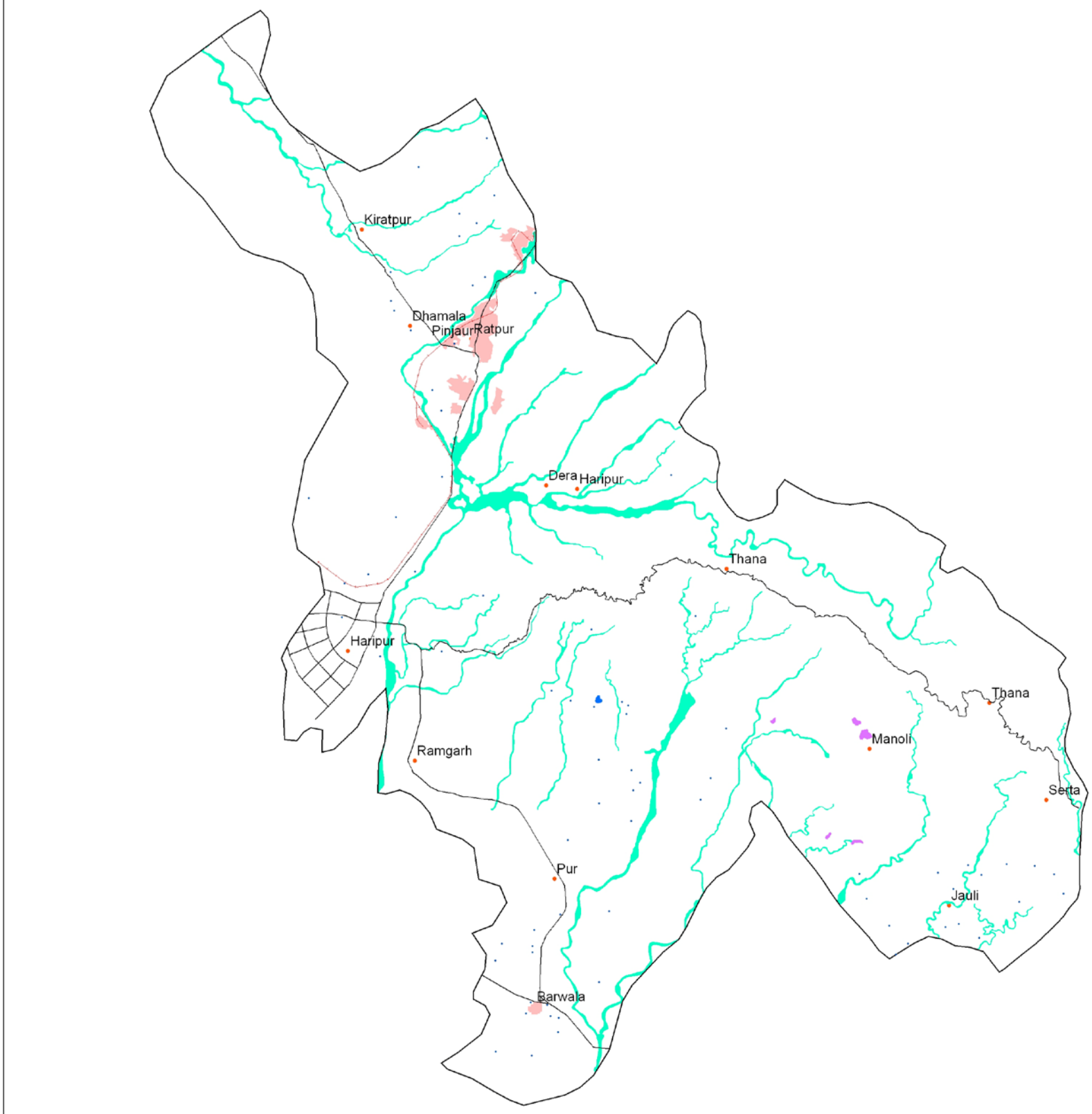
Area under turbidity levels		
Low	6	6
Moderate	42	2681
High	39	36

The total wetland area in the district is 3173 ha and river/streams contribute 96 per cent. Water spread area in post-monsoon season is 86 ha. Where as in pre-monsoon season the area increased to 2723 ha and it is due to melting of snow in the up streams of the snow fed rivers. In all there are only 21 wetlands having area more than 2.25 ha in the district and less than 2.25ha wetlands are78. Qualitative turbidity ranges from moderate to high and open water devoid of aquatic vegetation in both the season. High turbidity is due to dispersion of silt and clay originated because of erosion.

State : Haryana

WETLAND MAP

District : Panchkula

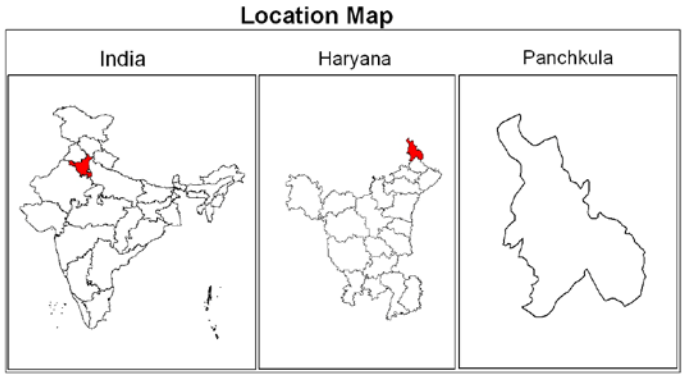


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

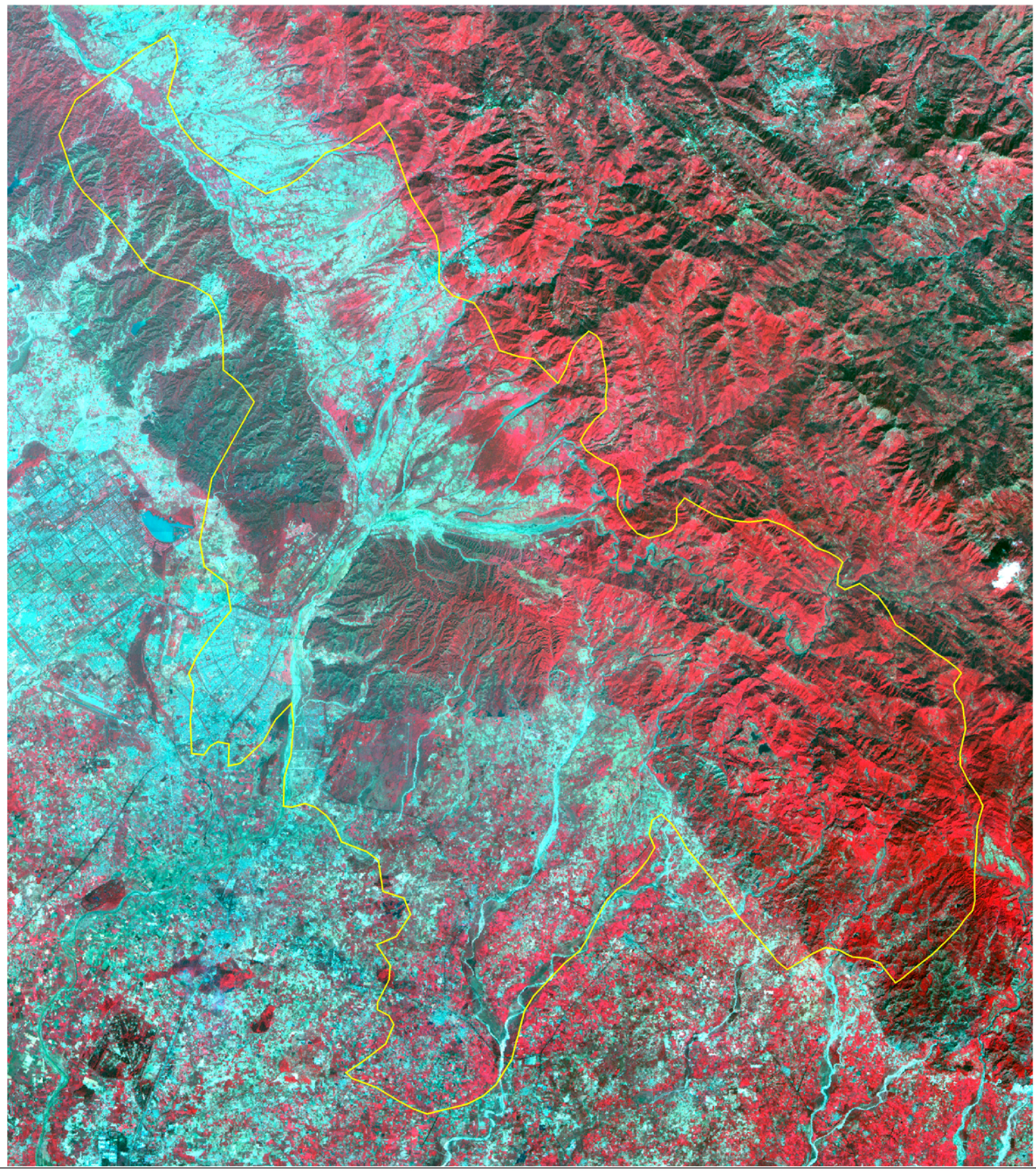
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Panchkula



IRS P6 LISS-III post monsoon data (2006)

7.1.2 Ambala

The Ambala district is located between $30^{0}07^{'}$ N to $30^{0}34^{'}$ N latitude and $76^{o}20^{'}$ E to $77^{o}10^{'}$ E longitude. The total area of the district is 1574 sq. km. A very hot and dry summer, southwest monsoon season and a bracing cold season characterize the climate of district. The average annual rainfall ranges between 1175 to 1345 mm (based on averages of 1995-99, 1996-2000 & 1997-01). About 71 per cent of annual rainfall is received during the short south-western monsoon period. There is a rapid increase in temperature after February. The mean daily maximum temperature is reached up to 43.7 in May, which is the hottest months and lowest reached up to 2.2 ^{0}C in January, which is the coldest month. Foothill Rolling Plain is a long belt of undulating, fairly sloping plain with elevation 300-400 meter, adjoining the Shiwalik range. The district is mainly drained by non- perennial stream. From the east to west the drainage system of the district comprises of Chautang, Rakshi, Saraswati, Markanda**,** and the tributaries and Dangri (Tangri) and its tributaries. The northern part of the district constitutes territory rocks including lime stone, sand stone, shale and boulder conglomerate and these from low lying hill ranges known as the Shiwalik foot hills. The southern part of district is occupies by the Indo-Gangetic alluvial comprising clay, silt and sand.

Details of the wetland statistics of the district are given in Table 7.

Table 7: Area estimates of wetlands in Ambala

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	3	23	0.76	23	23
6	1106	River/Stream	9	2583	85.08	0	934
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	17	85	2.80	79	78
9	1203	Waterlogged	3	27	0.89	26	15
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**32**	**2718**	**89.53**	**128**	**1050**
		Wetlands (<2.25 ha), mainly Tanks	318	318	10.47	-	-
		Total	**350**	**3036**	**100.00**	**128**	**1050**

Area under Aquatic Vegetation	4	11

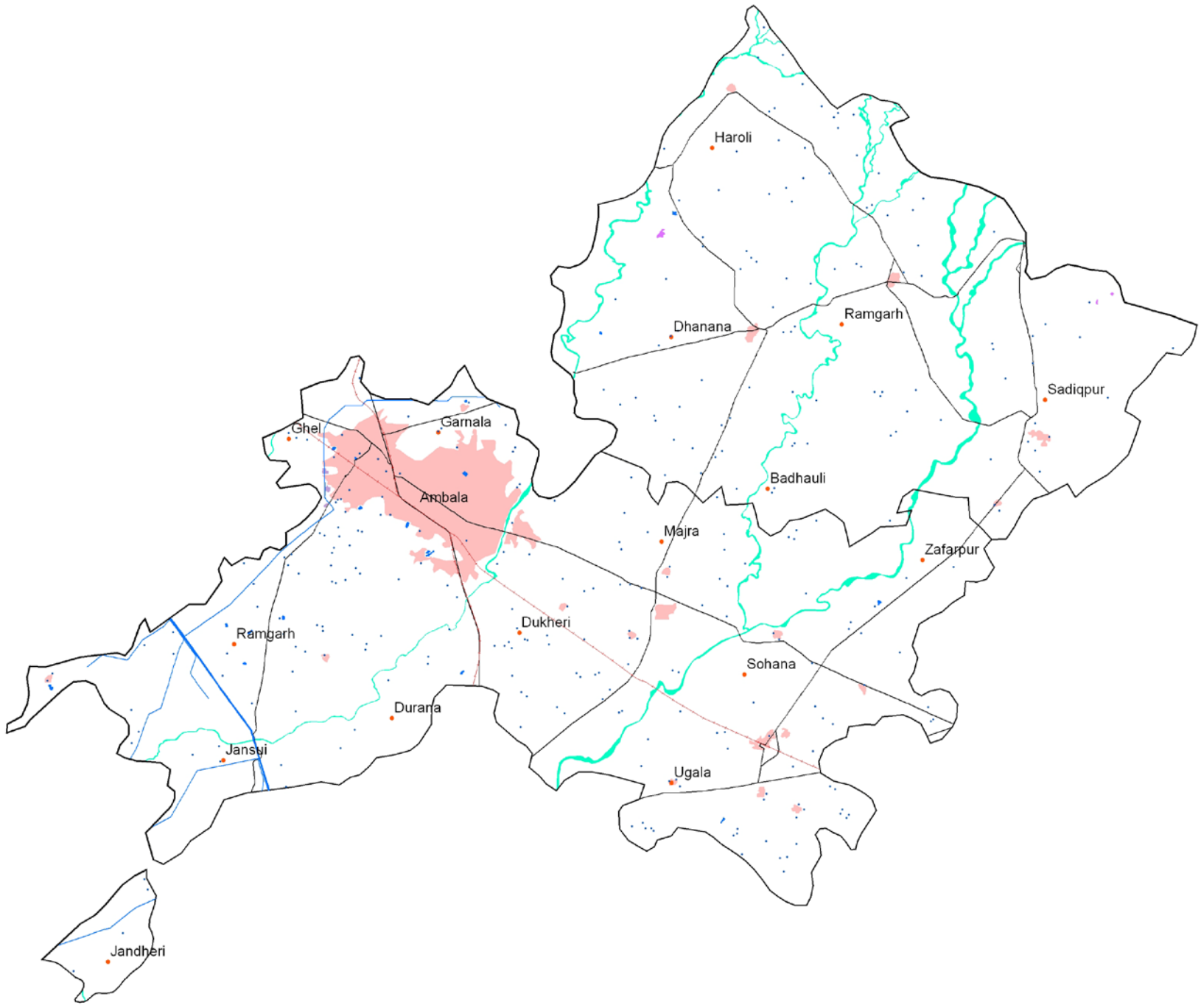
Area under turbidity levels		
Low	78	78
Moderate	0	935

The total wetland area in the district is 3036 ha. and river/streams contribute 95 per cent. Water spread area in post-monsoon season is almost negligible. Where as in pre-monsoon season the area increased to 935 ha. due to melting of snow in upper stretches rivers. In all there are only 32 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 318. Qualitative turbidity ranges from low to high. High turbidity is observed in rivers/ streams during pre-monsoon season. Out of 32 wetlands 4 wetlands infested by aquatic vegetation whereas in pre-monsoon season 11 wetlands. High turbidity is due to dispersion of sediments in rivers.

State : Haryana

WETLAND MAP

District : Ambala

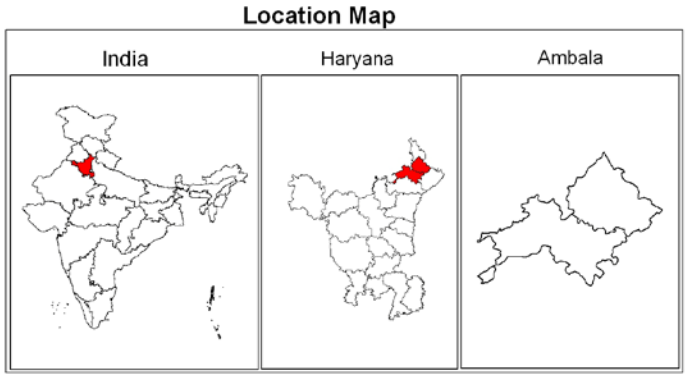


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
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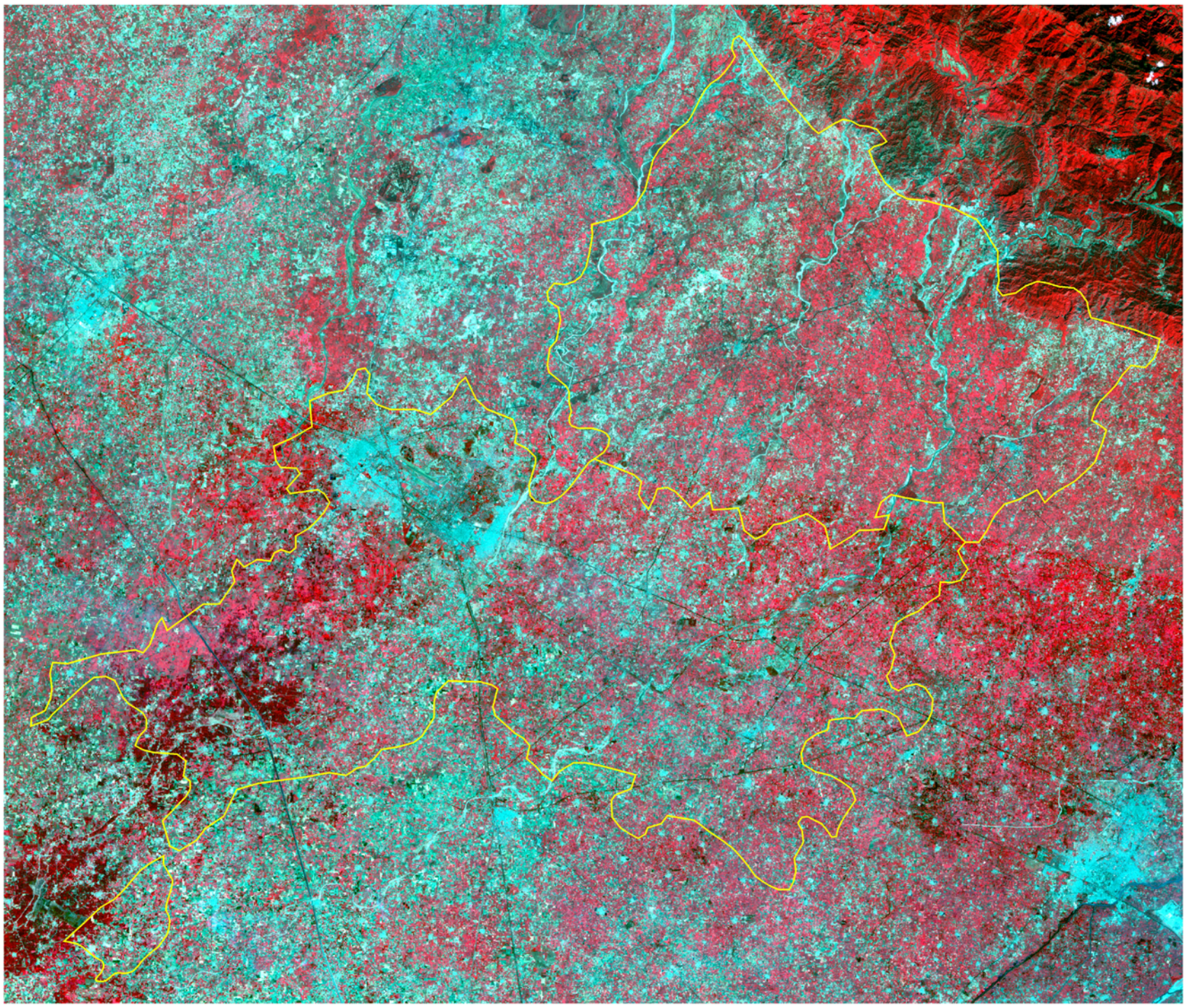
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Ambala



IRS P6 LISS-III post monsoon data (2006)

7.1.3 Yamunanagar

The district lies between east longitude 77°13' to 77°36' and northern latitude 29°50'to 30°3'. The area of the district is 1,768 sq. kms. The climate of the district is sub-tropical and characterized by a very hot and dry summer, southwest monsoon season and a bracing cold season. The average annual rainfall in the district is 1116 mm. About 81 per cent of the annual normal rainfall in the district is received during June to September whereas about 11 percent is received in the winter month of December to February. May and June are generally the hottest months in the year with the mean daily maximum temperature at about 41°C and the mean daily minimum at about 25°C to 27°C.

On the basis of similarities in local relief, slope, texture, surface material and arrangement of landform features, the district can be divided into three distinct physiographic units *viz.* shiwalik hill tracts, foothill rolling plain and Yamuna upland plain.

The main rivers/ streams of the district are Yamuna, Markanda, Bata Nala, Giri and Asan most of which are non-perennial streams. The Yamuna is a perennial river, which borders the district on its southeast. The soils in the district are mainly silty loam (Khadar), loam (Bhangar and Nardak), Piedmont (Ghar and Kandi) silty clay (Naili and Chhachhra-Dakar), and light loam (Seoti).

Table 8: Area estimates of wetlands in Yamunanagar

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	5	4335	88.60	391	1963
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	1	37	0.76	34	19
8	1202	Tanks/Ponds	8	34	0.69	24	26
9	1203	Waterlogged	12	240	4.90	240	69
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**26**	**4646**	**94.95**	**689**	**2077**
		Wetlands (<2.25 ha), mainly Tanks	247	247	5.05	-	-
		Total	**273**	**4893**	**100.00**	**689**	**2077**

Area under Aquatic Vegetation	9	8

Area under turbidity levels		
Low	57	45
Moderate	392	1965
High	240	67

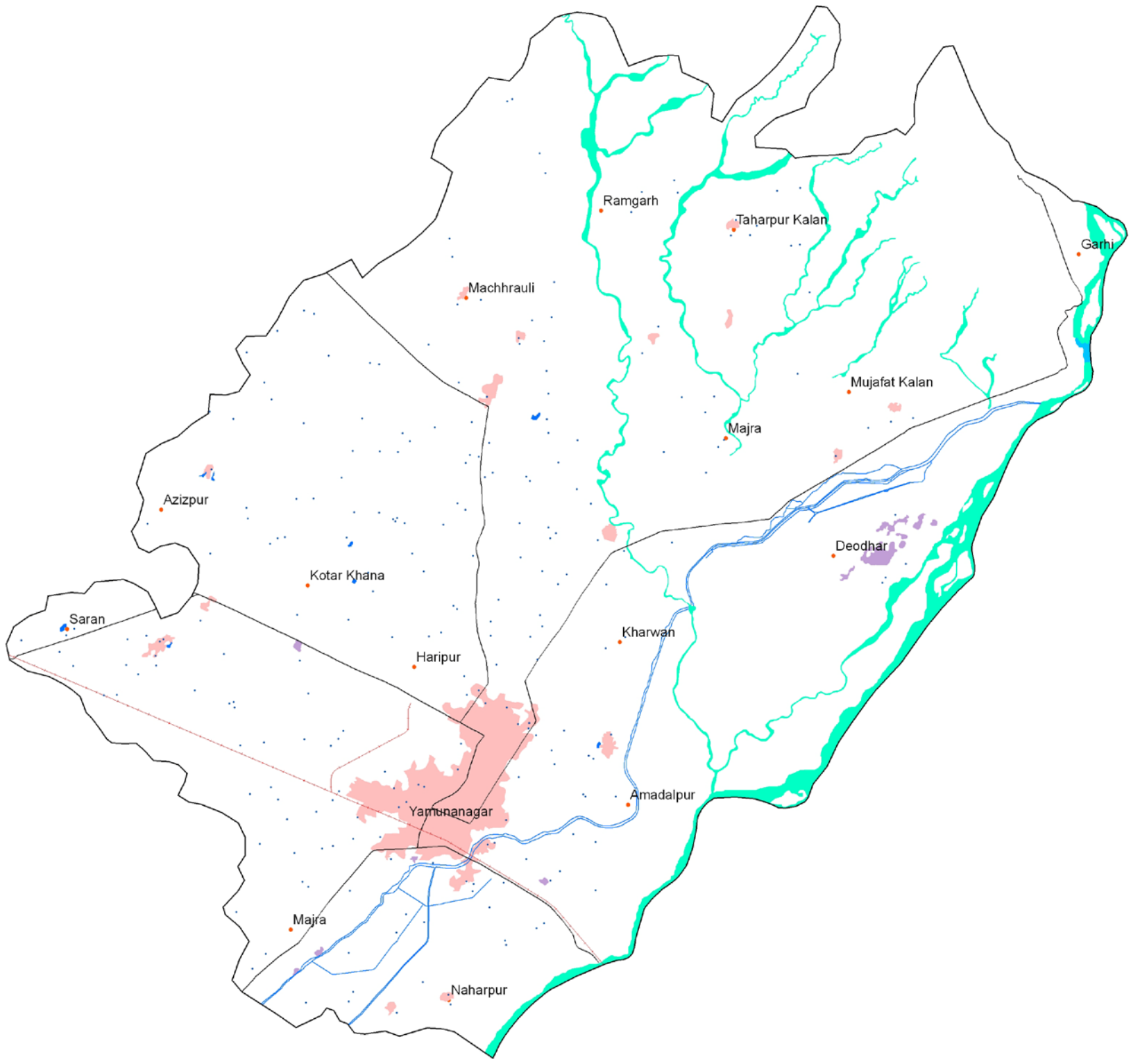
The total wetland area in the district is 4893 ha and river/streams contribute 87 per cent. Water spread area in post-monsoon season is less 689 ha and in pre-monsoon season 2077 ha. In all there are only 26 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 247. Man made waterlogged area is second dominating wetland category which accounts for an area of 240 ha. This wetland type is common in the district due to sugar cane cultivation and well-connected canals and distributaries. Qualitative turbidity ranges from low to high. Most of the wetlands showed moderate turbidity in post monsoon (392 ha) and 1965 ha in pre-monsoon season.

Out of 26 wetlands 9 wetlands are infested by aquatic vegetation during post-monsoon season and 8 in pre-monsoon season.

State : Haryana

WETLAND MAP

District : Yamunanagar

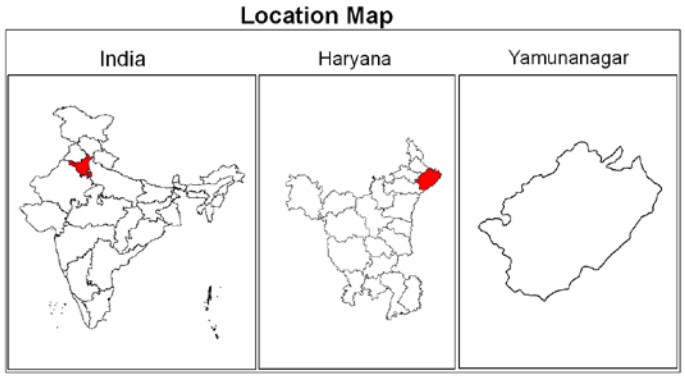


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2 4 8 12 Kilometers

Data Source :

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

Prepared By :

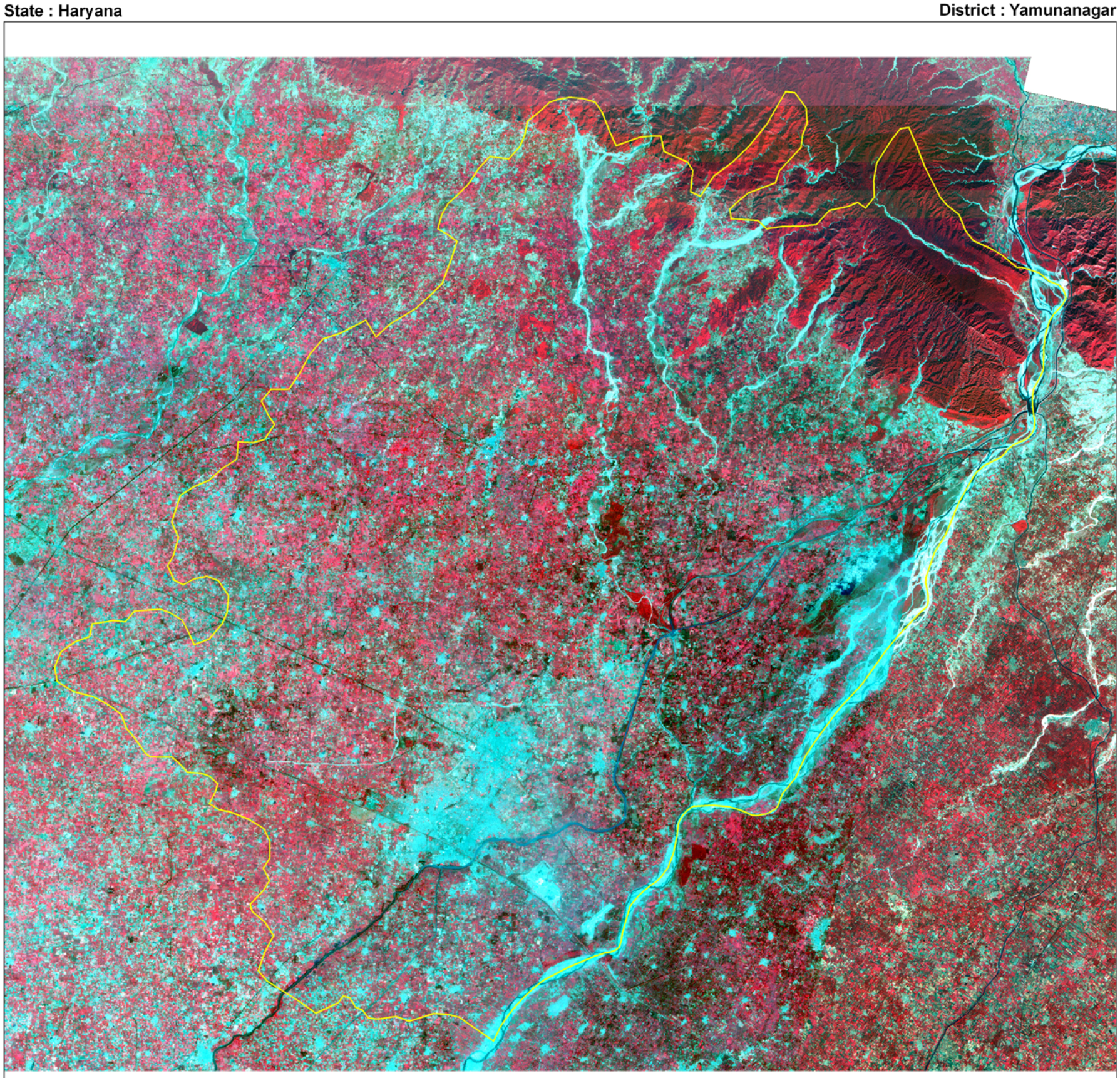
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Yamunanagar



IRS P6 LISS-III post monsoon data (2006)

7.1.4 Kurukshetra

The Kurukshetra district is located between $29^0$36' to $3^0$18, N latitudes and $76^0$10, to $77^0$19' E longitudes. The district covers a total area of 1530 sq.km. Hot summer, cold winter and dry air characterize the climate of district. Only during monsoon period i.e. July to September, the air becomes mild. The average annual rainfall in the district is 742.6mm. About 81 percent of the annual rainfall is received during June to September. Temperature starts rising from March and continues till the end of June. May and June are the hottest months with mean daily maximum temperature at about 40^0C. Temperature sometimes may rise to 45^0 c. During winter the temperature starts decreasing by the middle of November, January is the coldest month.

The district is a part of the alluvial plain and appears monotonous with a general slope of 0.38 meter per kilometer towards southwest. Physiographically the district may be divided into two units (1) the upland plain and (2) the low-lying areas. Seasonal streams including the Ghaggar, the Markanda, the Umls, the Chutang and relicts of the Saraswati run through or form inland drainage. These streams drain large quantity of water during rainy season.

Table 9: Area estimates of wetlands in Kurukshetra

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	7	46	2.75	27	34
6	1106	River/Stream	4	904	54.10	105	123
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	26	181	10.83	153	166
9	1203	Waterlogged	5	67	4.01	55	9
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**42**	**1198**	**71.69**	**340**	**332**
		Wetlands (<2.25 ha), mainly Tanks	473	473	28.31	-	-
		Total	**515**	**1671**	**100.00**	**340**	**332**

Area under Aquatic Vegetation	63	65

Area under turbidity levels		
Low	153	167
Moderate	105	117
High	82	49

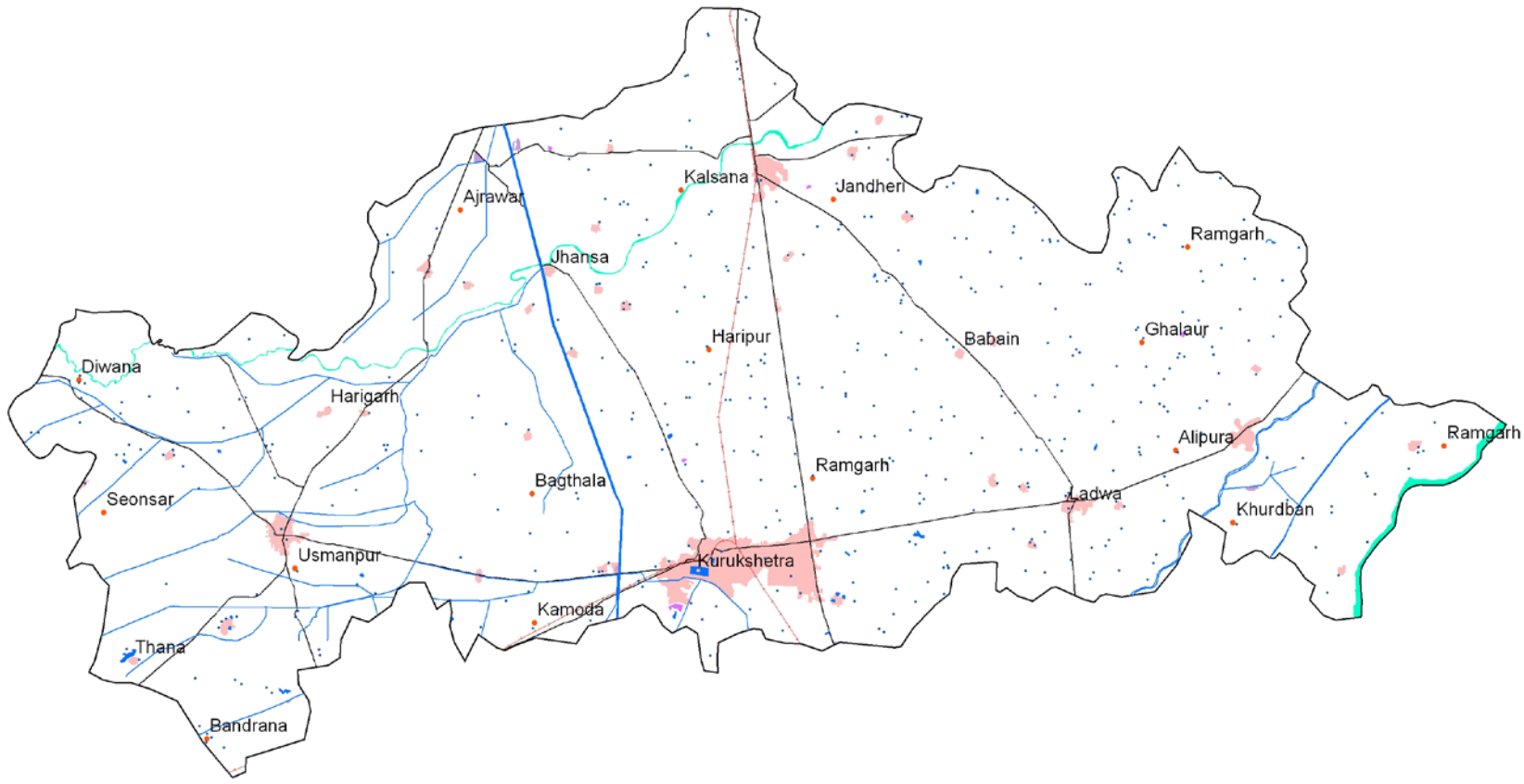
The total wetland area in the district is 1671 ha and river/streams contribute around 54 per cent. Water spread area in post-monsoon season is 340 ha and in pre-monsoon season 332 ha. It indicates that there is almost same rate of water discharge through these rivers. In all there are only 42 wetlands having an area of 1198 ha. Small wetlands, which are less than minimum mapping unit, are 473. Natural waterlogged area is 46 ha. Qualitative turbidity ranges from low to high. Most of the wetlands showed low and moderate turbidity.

Most of the tanks and waterlogged areas were infested by aquatic vegetation during both the seasons.

State : Haryana

WETLAND MAP

District : Kurukshetra

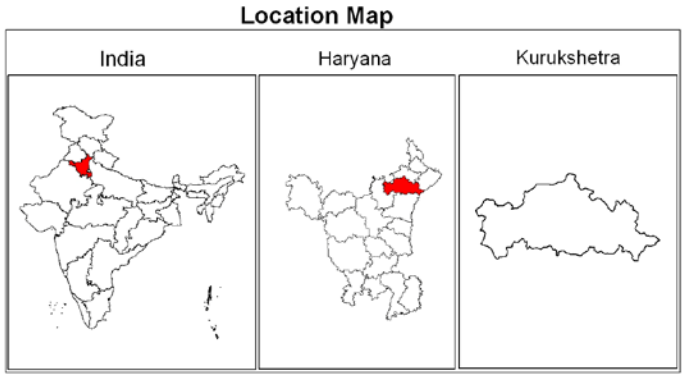


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

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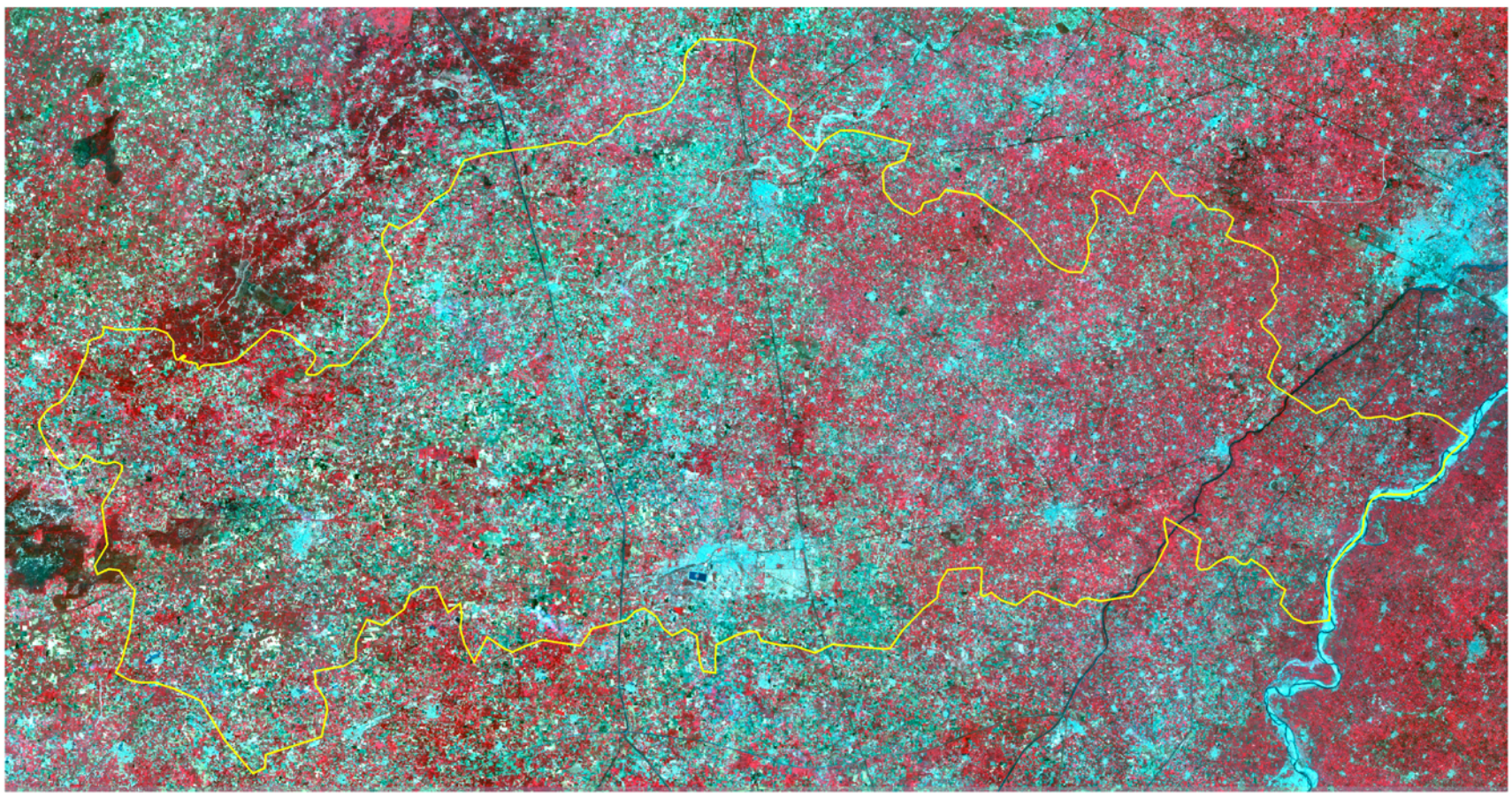
Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Kurukshetra



IRS P6 LISS-III post monsoon data (2006)

7.1.5 Kaithal

The Kaithal district is located between $29^0$32' to $30^0$12' N latitudes and $76^0$08' to $76^0$45' E longitudes. Total area of the district is 2317 sq. km. The Kaithal district has a sub-tropical continental monsoon climate with hot summer and cool winter. The average annual rainfall for the five years 1997-2001 in the district is 435.4 mm. about 81 percent of the annual rainfall is received during June to September. Temperature starts rising from March and continues till the end of June. May and June are the hottest months with mean daily maximum temperature at about 40^0C. Temperature sometimes may rise to 45^0C.

The district is a part of the alluvial plain and appears monotonous. Generally, slope of the district is from northeast to southwest. Physiographically, the district may be divided into two units the upland plain and the low-lying areas. The upland plain is spread along the northeastern boundary of the district. It is the westward extension of the upland plain of the Kurukshetra district, which is inclined towards south and southwest. It is irrigated by wells and canals and is a prosperous agricultural area. It is made up of old alluvium. The low-lying areas include the southern part of the district. The district is entirely covered by 58 per cent alluvial deposits of quaternary to recent age consisting of clay, and sand with kankar. Gravel, cemented and unconsolidated sand are also found in beds.

Table 10: Area estimates of wetlands in Kaithal

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	1	4	0.30	4	0
6	1106	River/Stream	1	373	28.00	0	321
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	85	556	41.74	393	466
9	1203	Waterlogged	3	26	1.95	16	20
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**90**	**959**	**72.00**	**413**	**807**
		Wetlands (<2.25 ha), mainly Tanks	373	373	28.00	-	-
		Total	**463**	**1332**	**100.00**	**413**	**807**

Area under Aquatic Vegetation	173	97

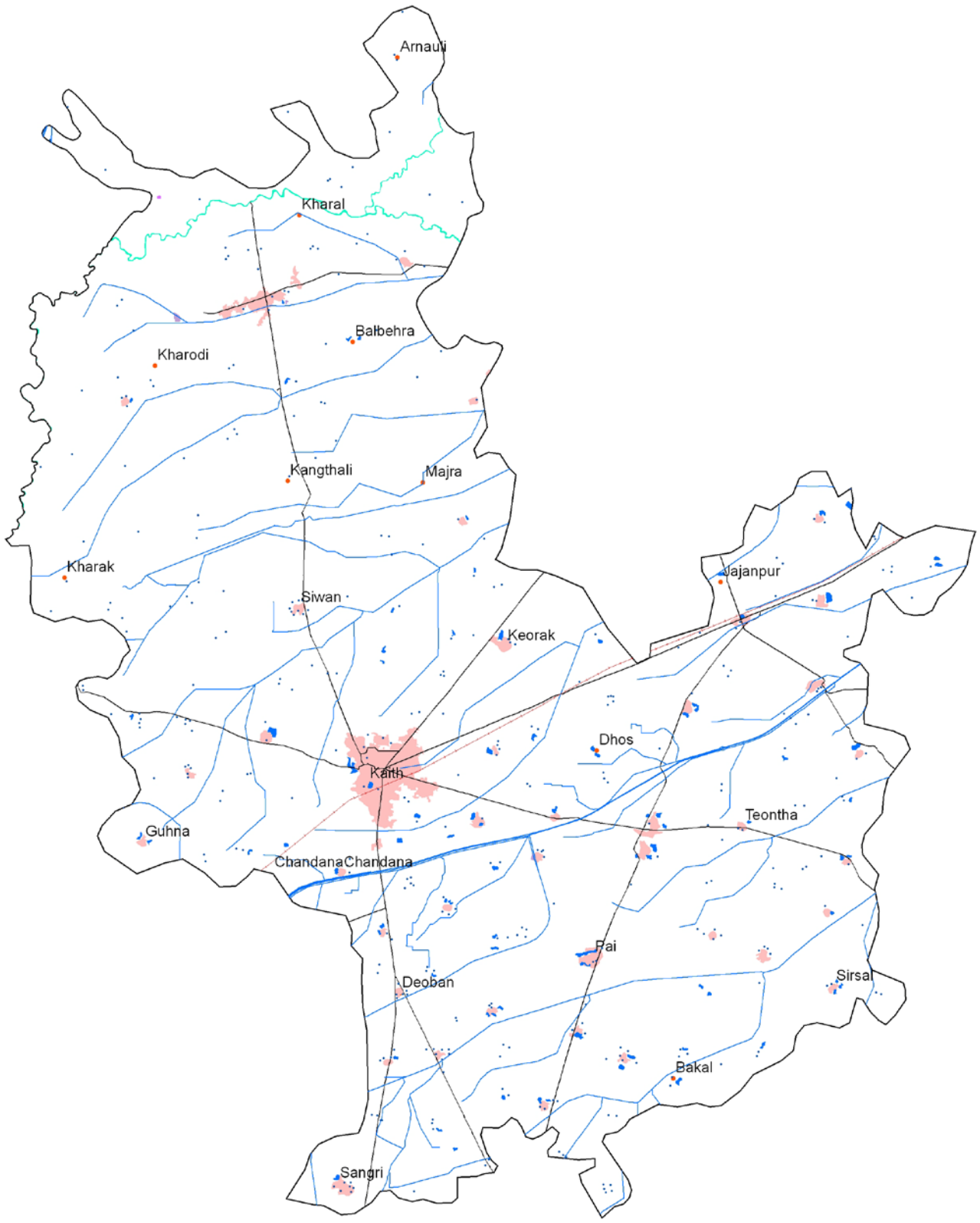
Area under turbidity levels		
Low	387	459
Moderate	7	328
High	19	20

The total wetland area in the district is 1332 ha and tanks (42 per cent) and river/streams (28 per cent) together contribute almost 97 per cent wetland area. Water spread area of rivers/stream is almost nil during post-monsoon season while in pre-monsoon season 321 ha. In all there are only 90 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 373. Tanks/ponds have an area of 393 ha and it is dominating wetland category during post monsoon season. Most of the wetlands showed low turbidity and tanks/ponds are infested by macrophytes.

State : Haryana

WETLAND MAP

District : Kaithal

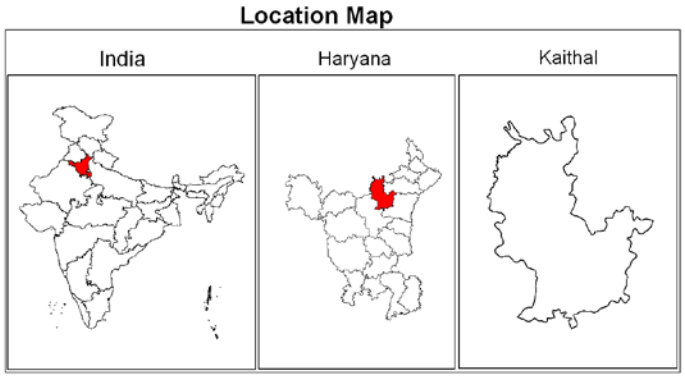


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

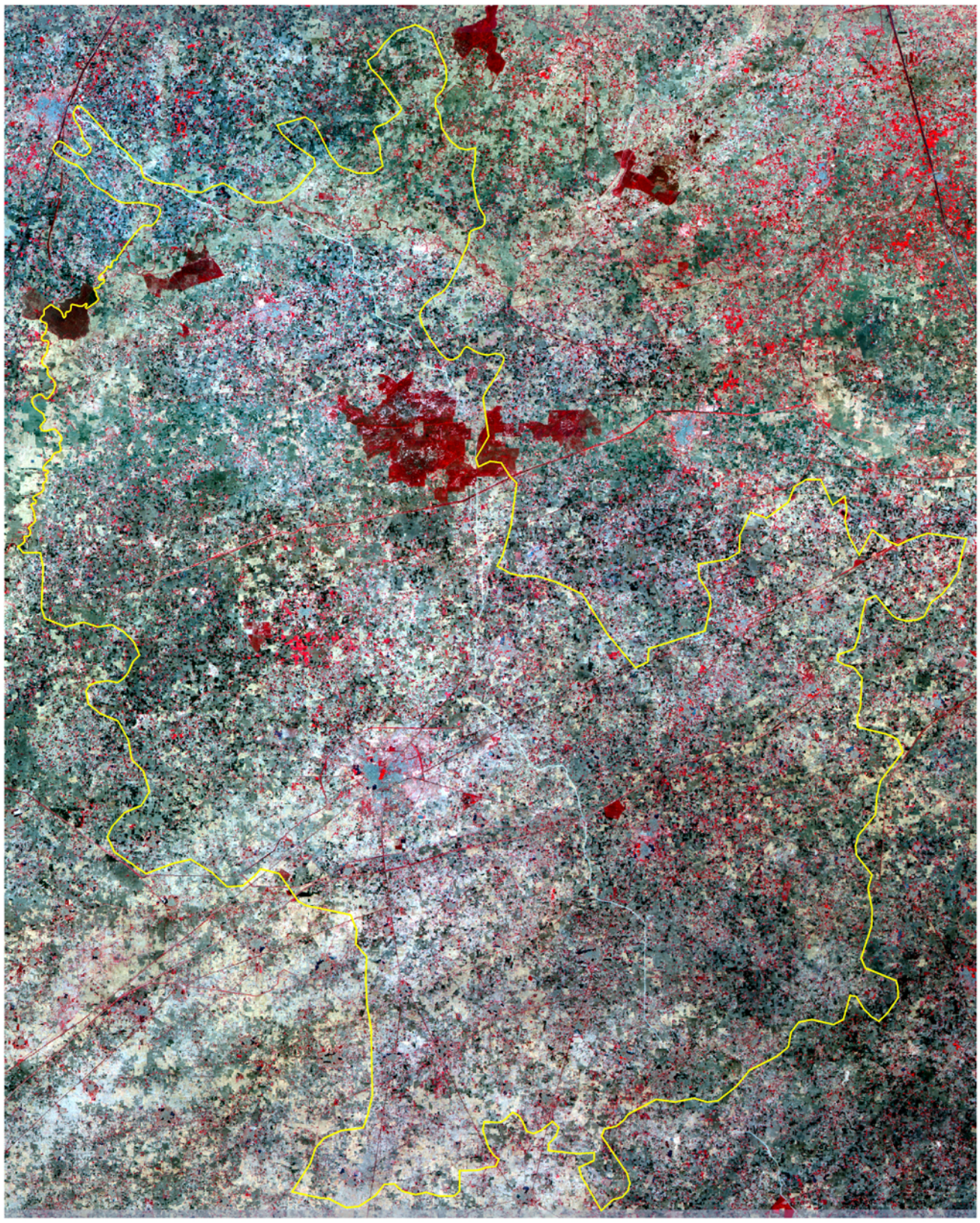
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Kaithal



IRS P6 LISS-III post monsoon data (2006)

7.1.6 Karnal

The district lies along the eastern border of the state between $29^0$10' to $29^0$59' North latitudes and $71^0$31' to $72^0$13' East longitudes. The district covers a total area of 2538 sq. km. Hot summer, cold winter and dry air, except during rainy season characterize the climate of the district. Temperature starts rising from March and continues till the late of the June. May and June are the hottest months with mean daily maximum temperature of about 40 0C, which may sometimes rise to 45 0C. It starts decreasing by the middle of November. January is the coldest month. The average annual rainfall in the district is 528.9 mm. The district is a part of alluvial plain of Yamuna river. It slopes from west to east and water of the area flows towards Yamuna. There are two major physiographic units in the area. The Khadar, is within one mile of the Yamuna River. It has light soils and the water table is very near to the surface. It is a flood plain of the river Yamuna is suitable for rice and sugarcane cultivation. The other unit is the upland plain spreading in the western part of the district and is inclined towards the south and southwest and covers the Karnal Bangar area. This area is eastward extension of the upland plain of Kaithal district. It is irrigated by tube wells and & canal and is a prosperous agricultural area. The district enjoys perennial river the Yamuna that forms the eastern boundary of the district. The Khadar, flood plain of this river is very fertile. A seasonal stream, the Chautang runs in the northeast of the district.

Table 11: Area estimates of wetlands in Karnal

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	3	27	0.83	27	11
6	1106	River/Stream	1	2048	63.09	528	661
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	105	555	17.10	524	493
9	1203	Waterlogged	7	61	1.88	51	33
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**116**	**2691**	**82.90**	**1130**	**1198**
		Wetlands (<2.25 ha), mainly Tanks	555	555	17.10	-	-
		Total	**671**	**3246**	**100.00**	**1130**	**1198**

Area under Aquatic Vegetation	34	54

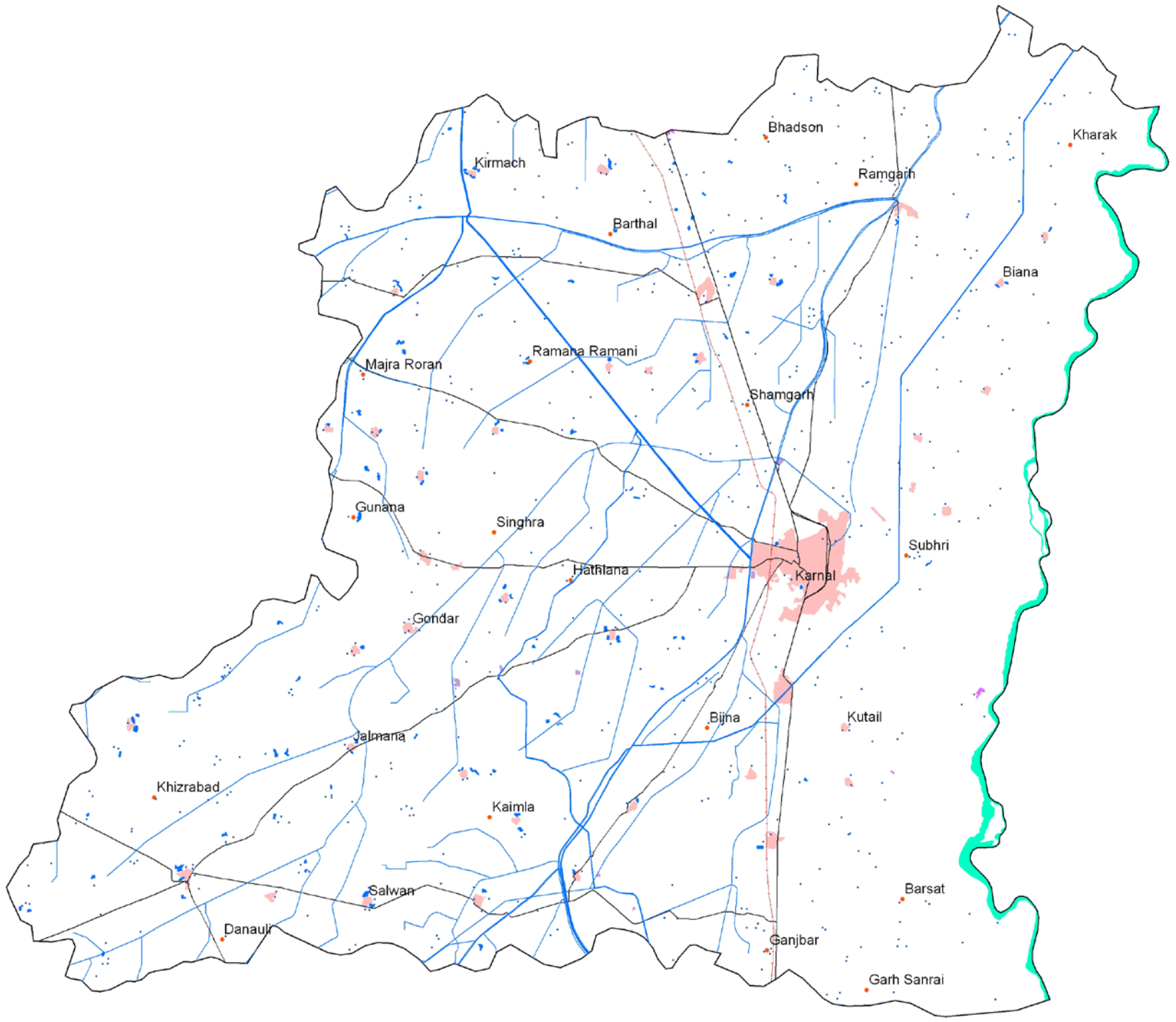
Area under turbidity levels		
Low	518	487
Moderate	528	661
High	84	50

The total wetland area in the district is 3246 ha and tanks/ponds (17 per cent) and river/streams (63 per cent) together contribute almost 80 per cent wetland area. Water spread area of rivers/stream is 528 ha during post-monsoon season while in pre-monsoon season 661 ha. In all there are only 116 wetlands contributing an area of 2691 ha. There are 555 small wetlands having the size less than 2.25 ha. Tanks/ponds have an area of 555 ha and it is second dominating wetland category after rivers/streams in both the seasons. Most of the wetlands showed low and moderate turbidity in both the season. Out of total wetland area (3246 ha), 54 ha wetland area is infested by aquatic vegetation during pre-monsoon season.

State : Haryana

WETLAND MAP

District : Karnal

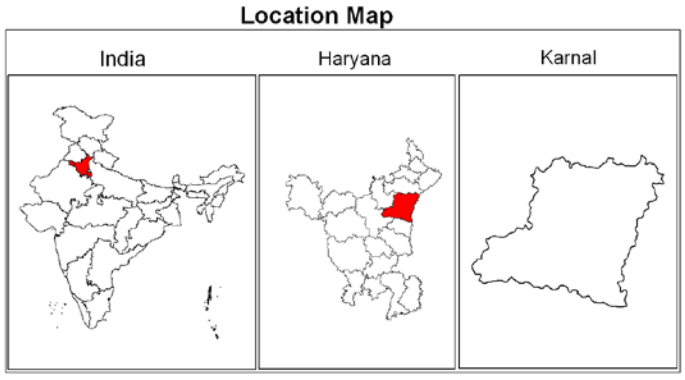


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

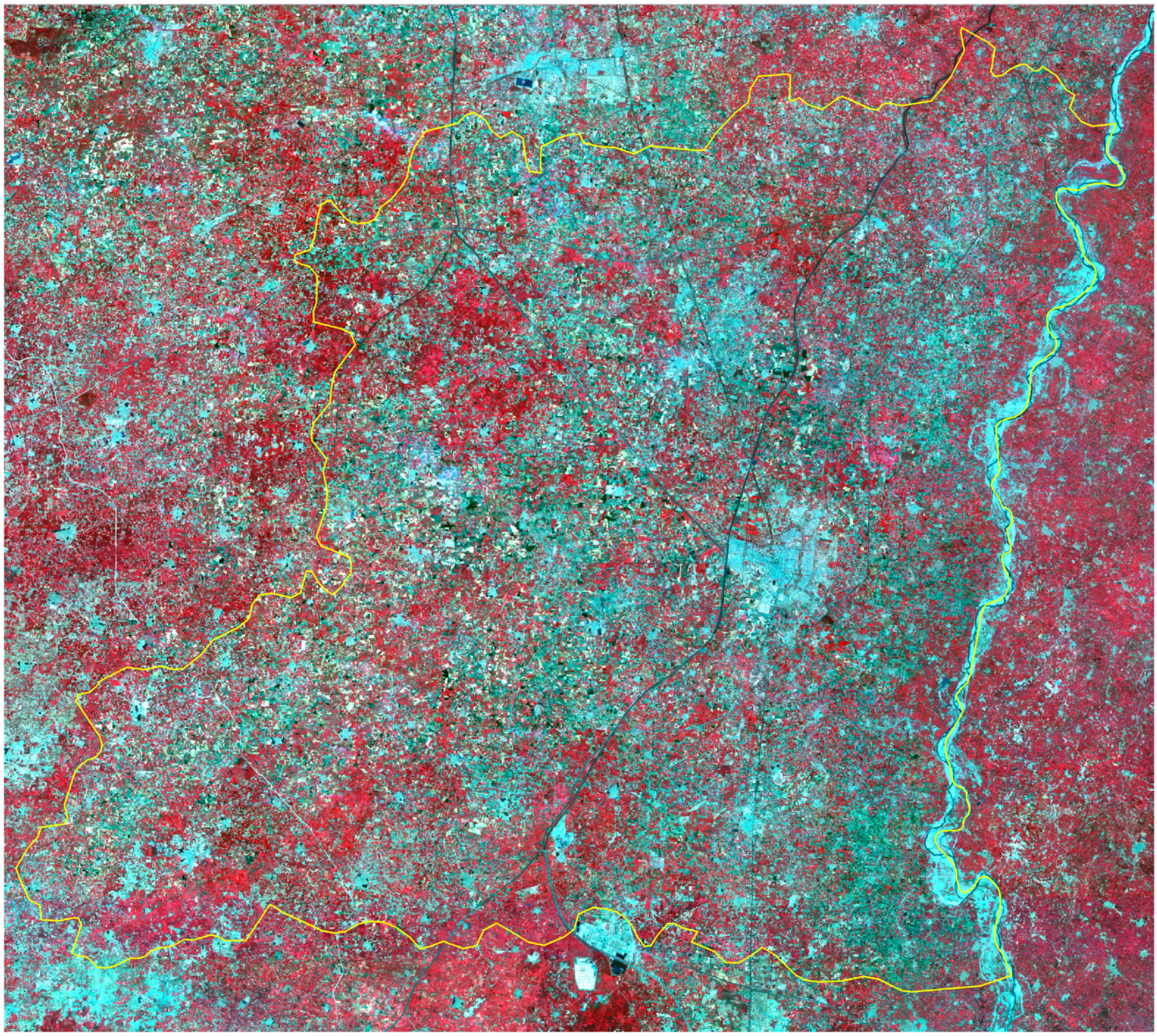
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Karnal



IRS P6 LISS-III post monsoon data (2006)

7.1.7 Panipath

The district lies between 29º10’0” to 29º40’0” N latitudes and 76º29’40” to 77º9’50” E longitudes. The area of the district is 1268 sq. kms. Hot summer, cold winter and dry air, except during rainy season characterize the climate of the district. Temperature starts rising from March and continues till the end of June. May and June are the hottest months with mean daily maximum temperature of about 40°C, which may sometimes rise to 45°C. It starts decreasing by the middle of November. January is the coldest month. The average annual rainfall in the district is 625.8mm.The variation in annual rainfall is very large. About 84 percent of the annual rainfall is received during the monsoon month i.e. July to September. The district is a part of alluvial plain of Yamuna river. It slopes from west to east and water of the area flows towards Yamuna. There are two major physiographic units in the area. The flood plain, which is within one mile of the Yamuna River, has light soils and the water table is very near to the surface. This flood plain of the river Yamuna is suitable for rice and sugarcane cultivation. The other unit i.e. older alluvial plain spreading in the western part of the district is inclined towards the south and southwest area. This area is irrigated by tube wells and canals and is a prosperous agricultural area. The district has a perennial river Yamuna**,** which forms the eastern boundary of the district.

Table 12: Area estimates of wetlands in Panipath

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	2	33	1.77	19	31
6	1106	River/Stream	1	987	53.01	274	793
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	25	325	17.45	306	303
9	1203	Waterlogged	7	111	5.96	47	87
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**35**	**1456**	**78.20**	**646**	**1214**
		Wetlands (<2.25 ha), mainly Tanks	406	406	21.80	-	-
		Total	**441**	**1862**	**100.00**	**646**	**1214**

Area under Aquatic Vegetation	85	36

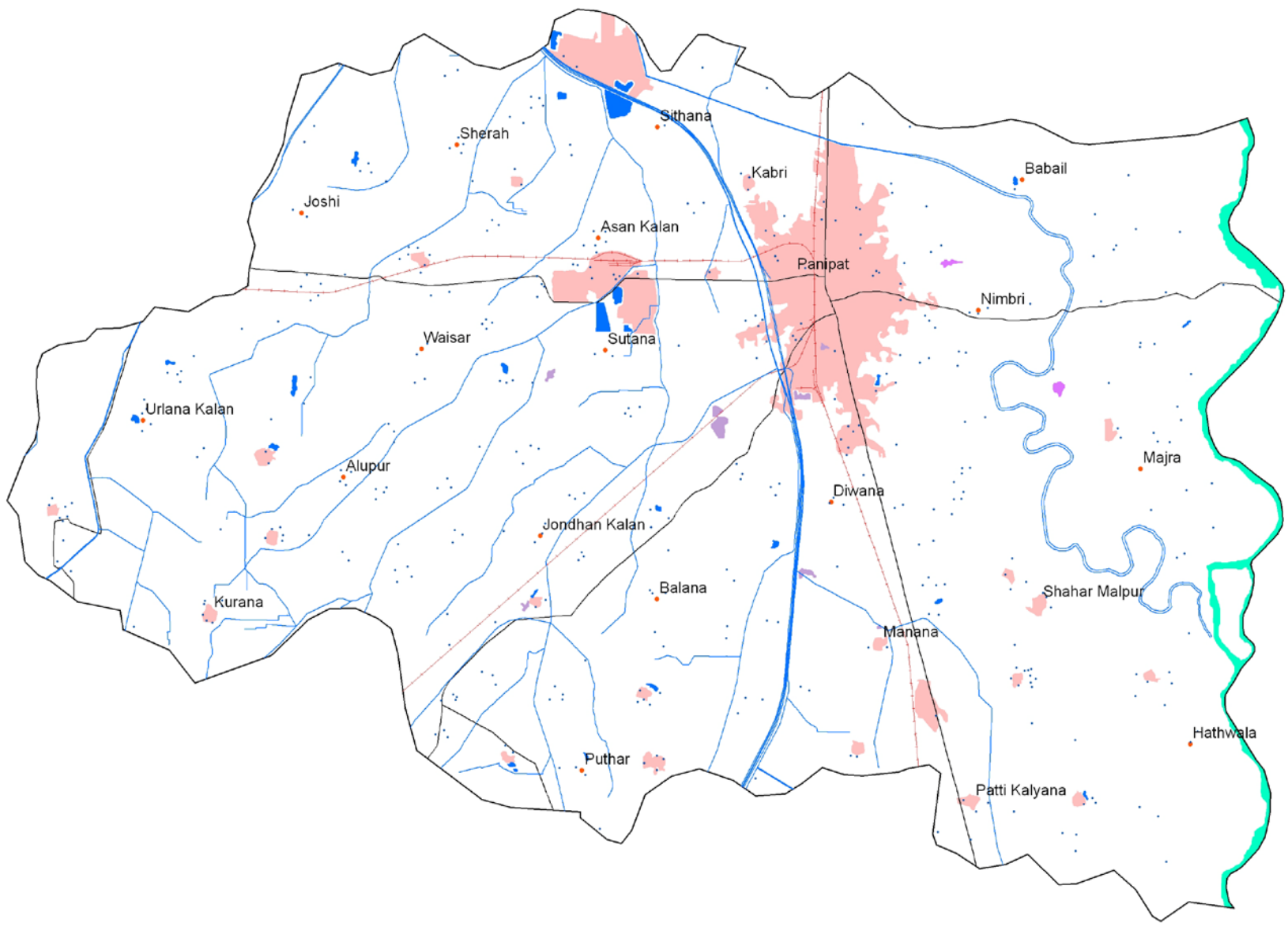
Area under turbidity levels		
Low	307	303
Moderate	273	794
High	66	117

The total wetland area in the district is 1862 ha and tanks/ponds (17 per cent) and river/streams (53 per cent) together contribute almost 70 per cent wetland area. Water spread area of rivers/stream is 274 ha during post-monsoon season while in pre-monsoon season 793 ha. In all there are only 35 wetlands contributing an area of 1456 ha. There are 406 small wetlands having the size less than 2.25 ha. Tanks/ponds have an area of 325 ha and it is second dominating wetland category after rivers/streams (987 ha) in both the seasons. Most of the wetlands showed moderate to low turbidity in both the season. Out of total wetland area (1862 ha), 85 ha and 36 ha wetland area is infested by aquatic vegetation during post and pre-monsoon season respectively.

State : Haryana

WETLAND MAP

District : Panipat

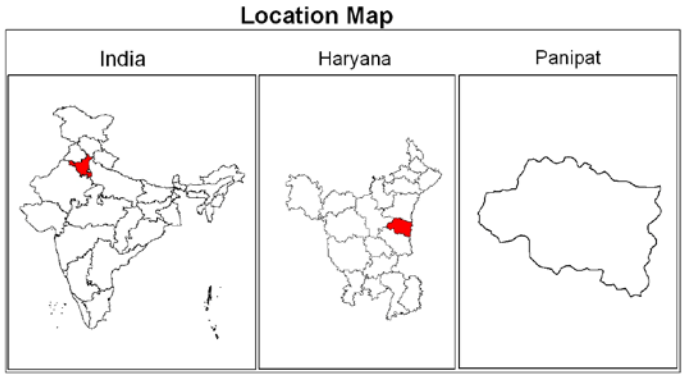


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
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and
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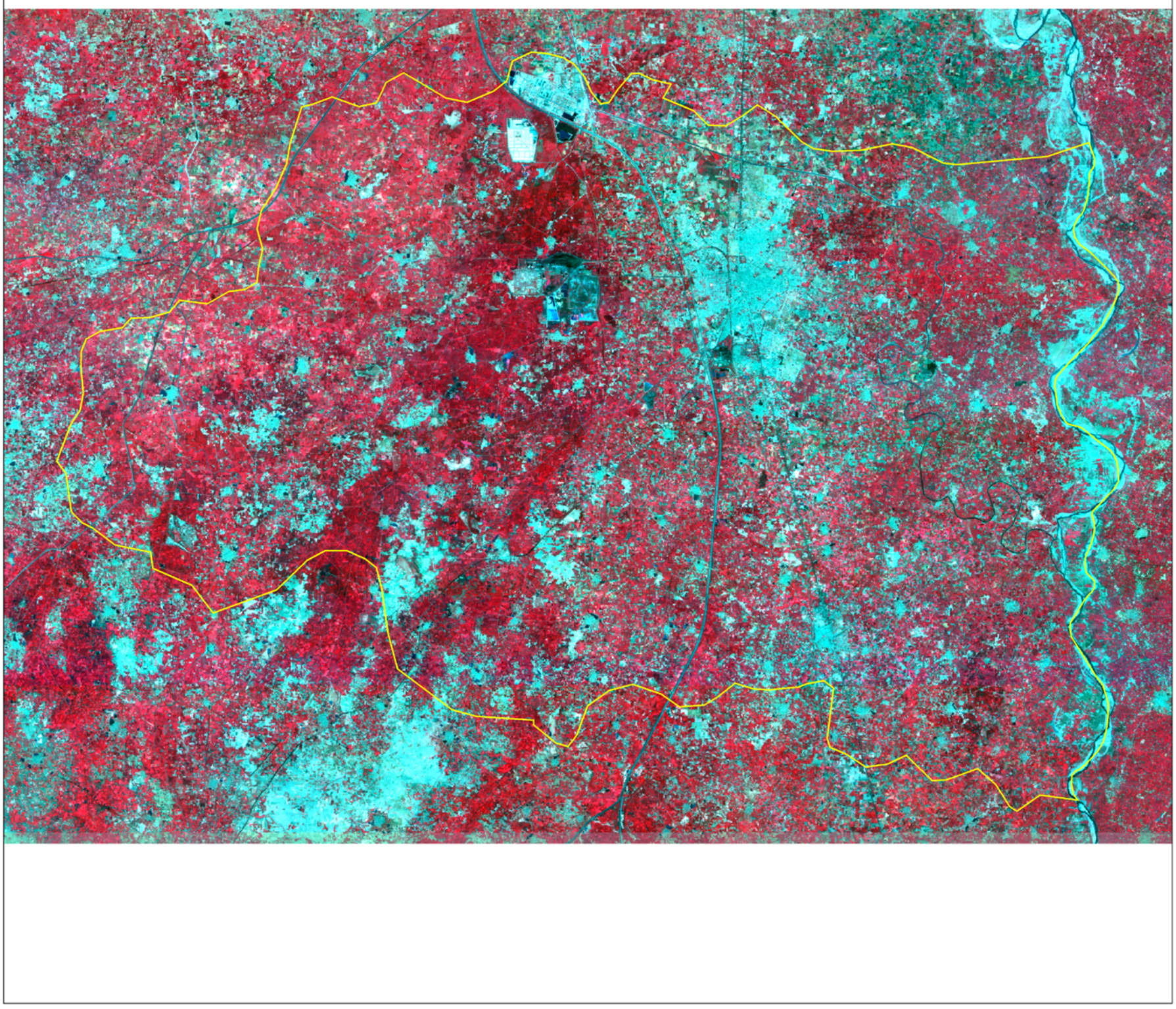
Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Panipat



IRS P6 LISS-III post monsoon data (2006)

7.1.8 Sonipath

The Sonipat district is located in the east of Haryana State between 28º49' N to 29º19' N latitudes and 76º30' to 77 º13'E longitudes. It covers a total area of 2122 sq. km. Yamuna River forms the eastern boundary of the district along Uttar Pradesh state. The climate of the district is dry with intensely hot summer and cold winter. Only during the three monsoon months of July to September, the weather becomes mild. The average annual rainfall in the district is 612.3 mm.. About 74 percent of annual rainfall is received during the monsoon season. The district experiences extreme temperatures. During winter, temperature goes down to below 4ºC. In January, which is the coldest month, the mean daily maximum temperature is about 21ºC and the mean daily minimum temperature is about 7ºC. On the arrival of cold waves with western disturbances, temperature may go down to freezing point.

The district has almost a plain topography. Physiographically, it may roughly be divided into two units. The Khadar, which lies along the Yamuna in a narrow flood plain ranging from two miles in width, has medium to fine textured soils. The upland plain is spread in the west of the Khadar. It is about 20 to 30 feet higher than the Khadar and is 735 feet above mean sea level. It is covered with old alluvium. There is no perennial or seasonal stream in the district except the Yamuna, which borders the district on the east. The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Table 13: Area estimates of wetlands in Sonipath

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	1	6	0.28	6	6
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	2	29	1.35	29	14
6	1106	River/Stream	1	733	34.03	348	310
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	90	549	25.49	531	475
9	1203	Waterlogged	24	185	8.59	162	141
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**118**	**1502**	**69.73**	**1076**	**946**
		Wetlands (<2.25 ha), mainly Tanks	652	652	30.27	-	-
		Total	**770**	**2154**	**100.00**	**1076**	**946**

Area under Aquatic Vegetation	6	11

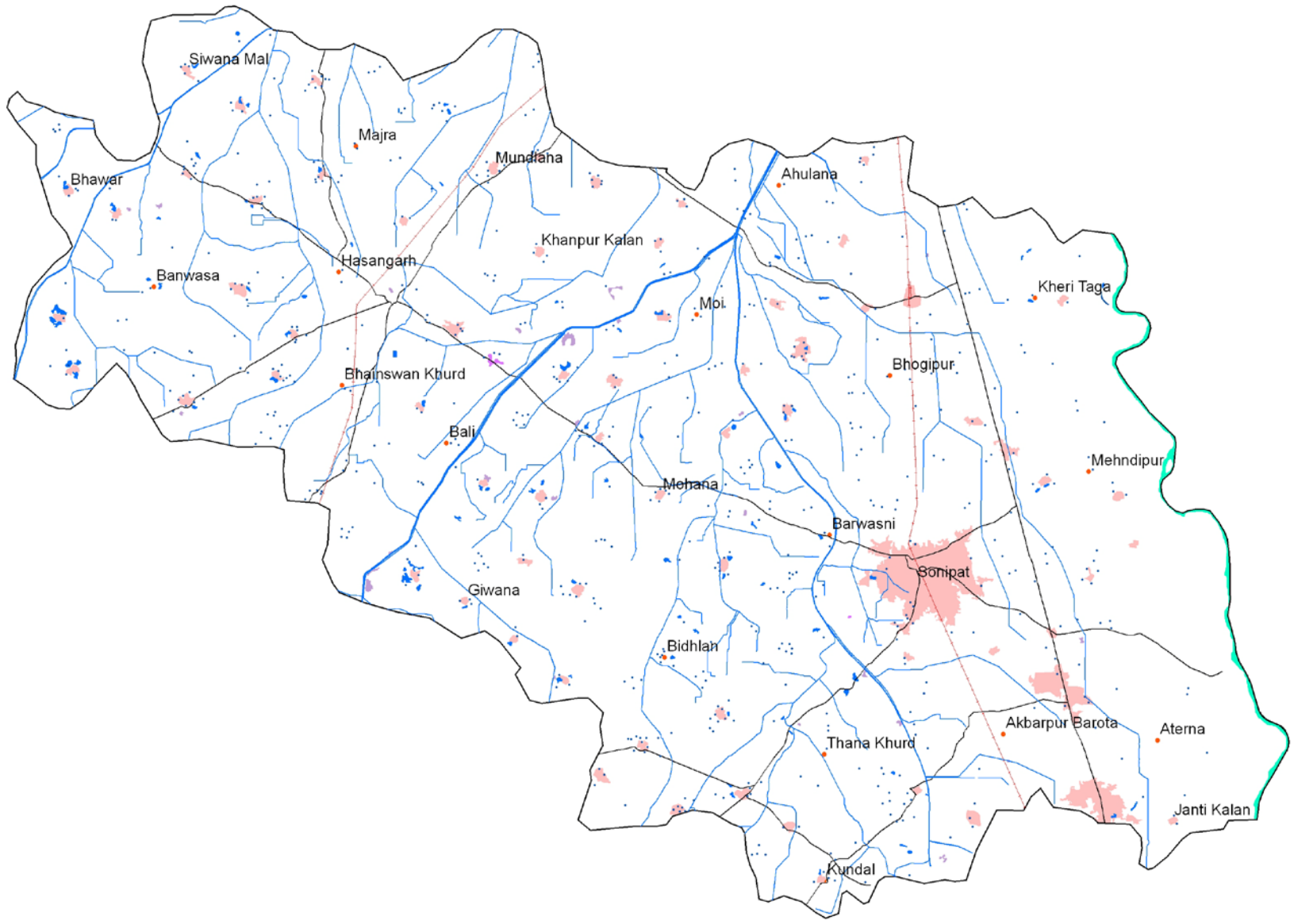
Area under turbidity levels		
Low	497	441
Moderate	380	342
High	199	163

The total wetland area in the district is 2154 ha and tanks/ponds (25 per cent) and river/streams (34 per cent) together contribute almost 59 per cent wetland area. Water spread area of rivers/stream is 348 ha during post-monsoon season while in pre-monsoon season 310 ha. In all there are only 118 wetlands contributing an area of 1502 ha. There are 652 small wetlands having the size less than 2.25 ha. Tanks/ponds have an area of 549 ha and it is second dominating wetland category after rivers/streams (733 ha) in both the seasons. Most of the wetlands showed low and moderate turbidity in both the season. Out of total wetland area (2154 ha), 06 ha and 11 ha wetland area is infested by aquatic vegetation during post and pre-monsoon season respectively.

State : Haryana

WETLAND MAP

District : Sonipath

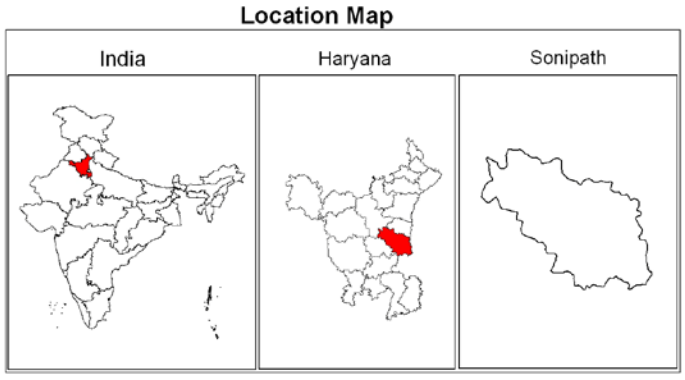


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

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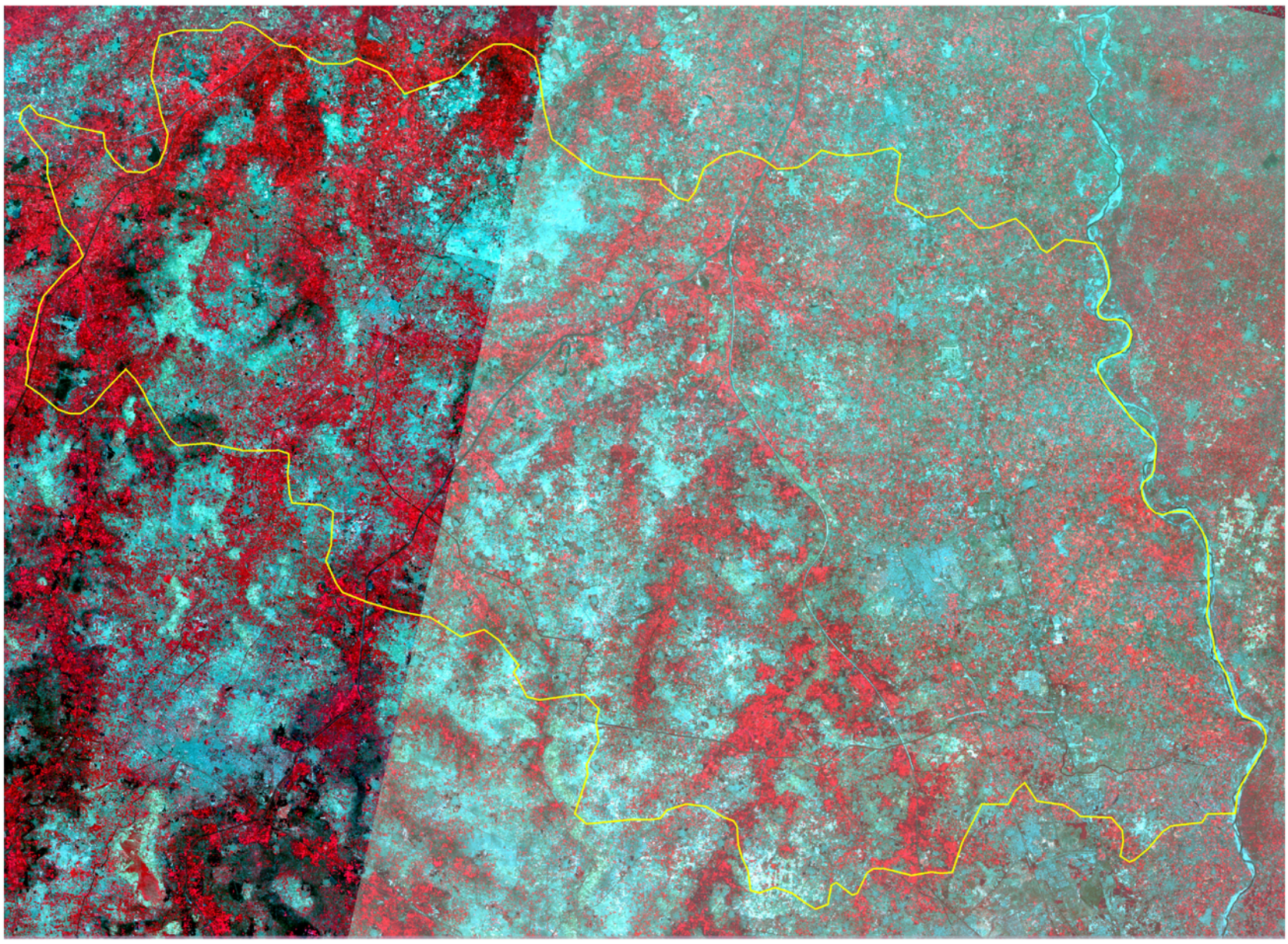
Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Sonipat



IRS P6 LISS-III post monsoon data (2006)

7.1.9 Jind

The district lies in the north- central part of Haryana between 29º03’ and 29º 51' north latitudes and 75º53’ and 76º47' east longitudes. The district covers a total area of 2702 sq. km. The climate of this district is on the whole dry, hot in summer and cold in winter. The average rainfall in the district is 599 mm. Over 70% of the annual rainfall is received during the monsoon months of July to September. A little rainfall is also received during the winter months (December to February) in association with western disturbances, which pass through the district or in the vicinage from west to east, affecting the weather in this season. The temperature in the district starts increasing from the beginning of March till June, which is generally the hottest month. The mean daily maximum temperature during June is around 41°C and the mean daily minimum around 27°C. Scorching dust laden winds blow during the hot season render the weather very tiring. After October, both day and night temperature decreases rapidly. January is usually the coldest month with the mean daily maximum temperature at about 21°C. and the mean daily minimum at about 6°C.

Physiographical, it constitutes a part of the alluvial plain, which is largely flat, featureless and is formed due to Pleistocene and sub-recent alluvial deposits of the Indo-Gangetic system.

Table 14: Area estimates of wetlands in Jind

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	5	61	2.83	61	60
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	160	1033	47.98	967	929
9	1203	Waterlogged	9	106	4.92	94	81
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**174**	**1200**	**55.74**	**1122**	**1070**
		Wetlands (<2.25 ha), mainly Tanks	953	953	44.26	-	-
		Total	**1127**	**2153**	**100.00**	**1122**	**1070**

Area under Aquatic Vegetation	69	92

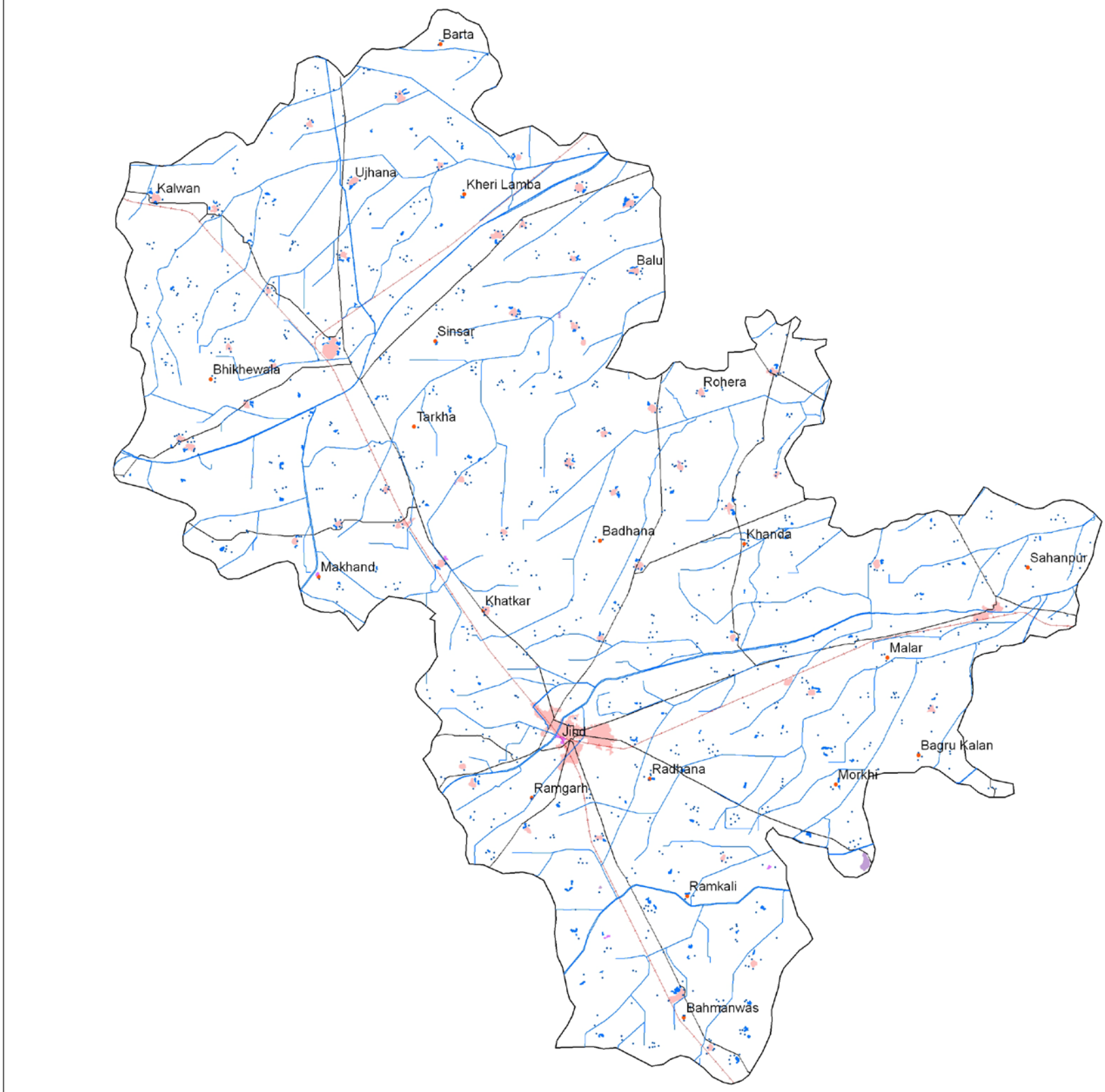
Area under turbidity levels		
Low	963	926
Moderate	4	4
High	155	140

The total wetland area in the district is 2153 ha and tanks/ponds contribute 48 per cent water spread area in post and pre-monsoon season. There are no major rivers in the district. In all there are only 174 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 953. Qualitative turbidity is mostly low in both the season. Out of 2153 ha 69 ha and 92 ha area is infested by aquatic vegetation in post-monsoon season whereas in pre-monsoon season respectively.

State : Haryana

WETLAND MAP

District : Jind

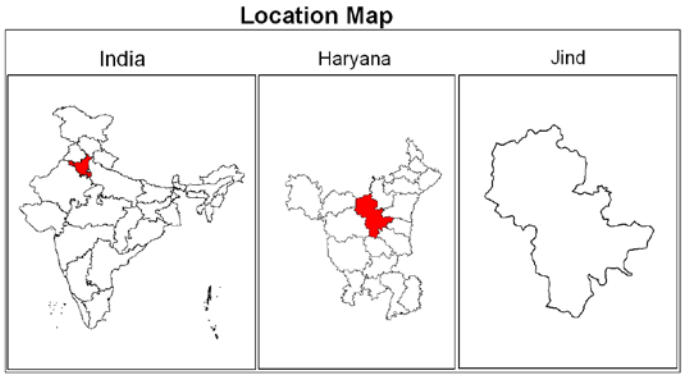


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 5 10 20 30 Kilometers

Data Source :

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

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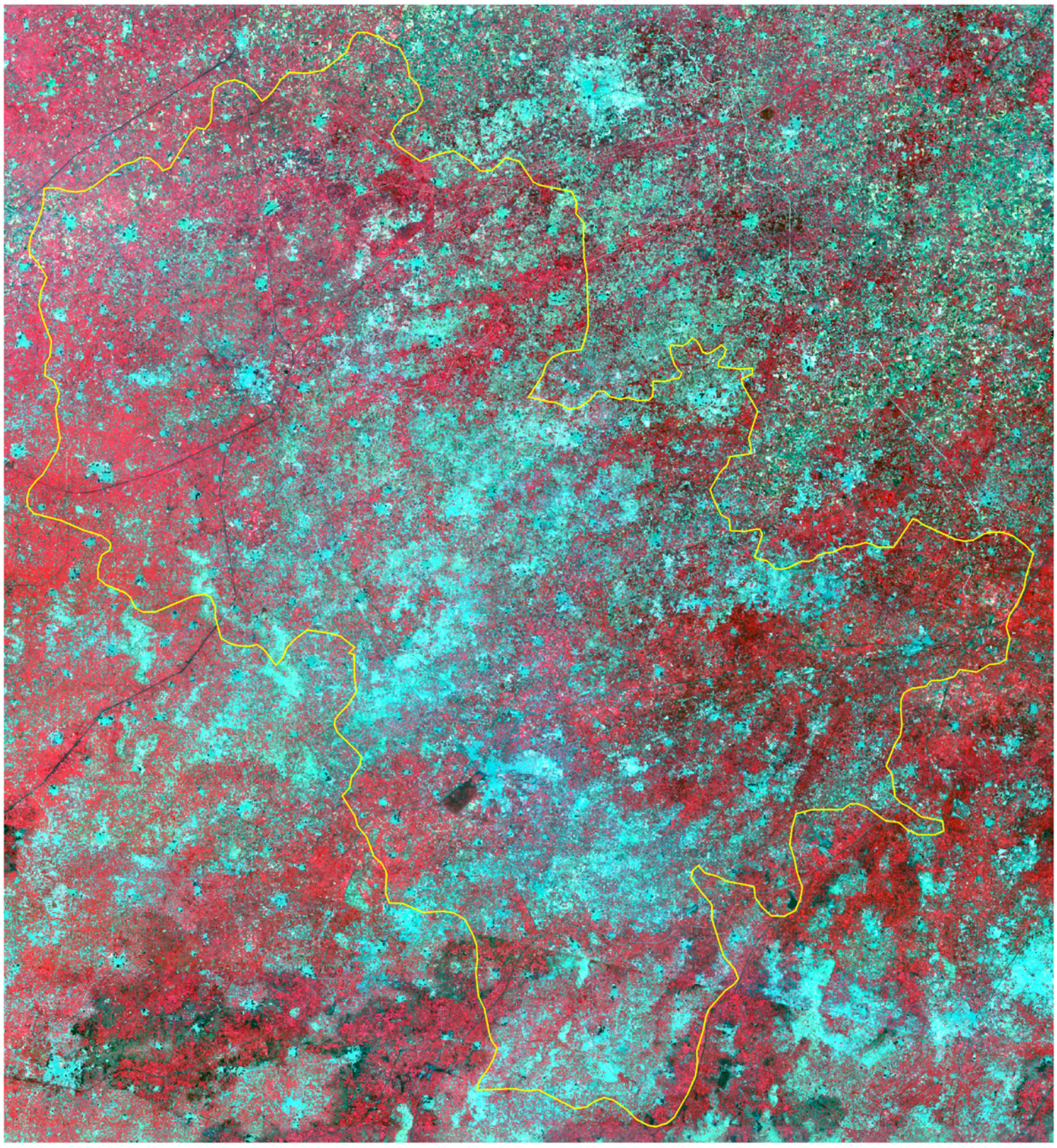
Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Jind



IRS P6 LISS-III post monsoon data (2006)

7.1.9 Fatehabad

Fatehabad district, situated in western part of Haryana, has an area of 2520 sq. km. Geographically it falls between $29^0$15' to $29^0$49' North latitude and $75^0$13' to $75^0$58' East longitude. The climate of the Fatehabad district is characterized by its dryness and extreme temperature variations and scanty rainfall. There is a rapid increase in temperature after February. The mean daily maximum temperature is 41.6^0C in June, which is the hottest month. Sometimes, during the drought period the maximum temperature of the district may rise up to 47 to 48^0C in summer. The major part of the rainfall occurs during the monsoons. The latter half of September and October constitutes the post monsoon period. The average annual rainfall ranges between 323.5 to 497.5 mm. About 71 per cent of annual normal rainfall is received during the short southwestern monsoon period.

The district is the part of the Ghaggar alluvial plain and its southern and western portion mark a gradual transition to the Thar Desert. The soils of the district change generally from sand to clay.

Table 15: Area estimates of wetlands in Fatehabad

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	2	29	1.88	29	13
6	1106	River/Stream	1	602	39.12	602	461
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	47	332	21.57	200	208
9	1203	Waterlogged	9	105	6.82	17	59
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**59**	**1068**	**69.40**	**848**	**741**
		Wetlands (<2.25 ha), mainly Tanks	471	471	30.60	-	-
		Total	**530**	**1539**	**100.00**	**848**	**741**

Area under Aquatic Vegetation	139	106

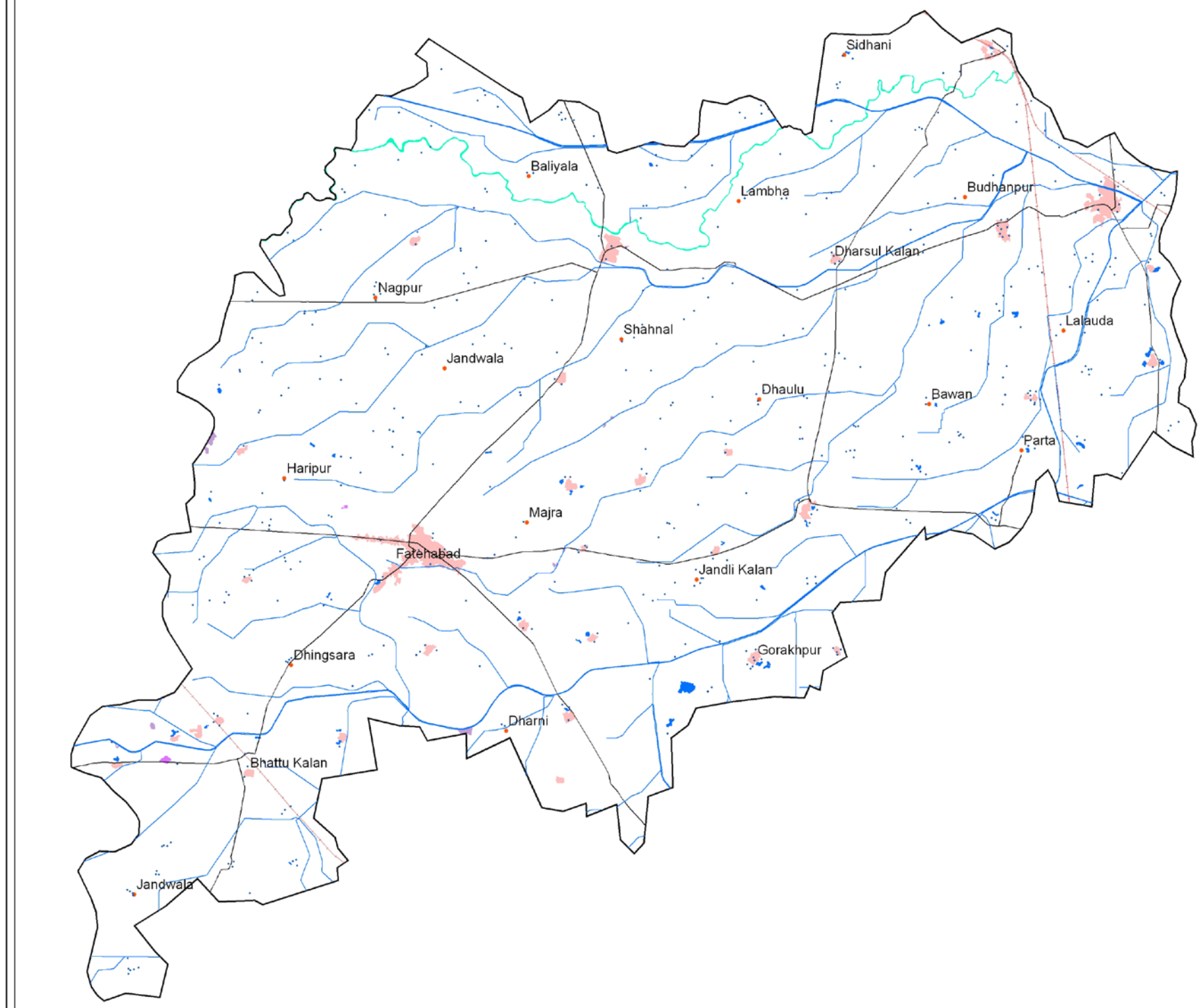
Area under turbidity levels		
Low	199	207
Moderate	604	462
High	45	72

The total wetland area in the district is 1539 ha and tanks/ponds and river/streams contribute 60 per cent wetland area in post-monsoon and pre-monsoon season. There is a single river, which has an area of 602 ha. In all there are only 59 wetlands having area more than 2.25 ha in the district where as less than 2.25ha wetlands are 471. Qualitative turbidity ranges from moderate to low in both the season. Out of 1539 wetland area 139 ha and 106 ha wetland is under aquatic vegetation during post-monsoon and pre-monsoon season respectively.

State : Haryana

WETLAND MAP

District : Fatehabad

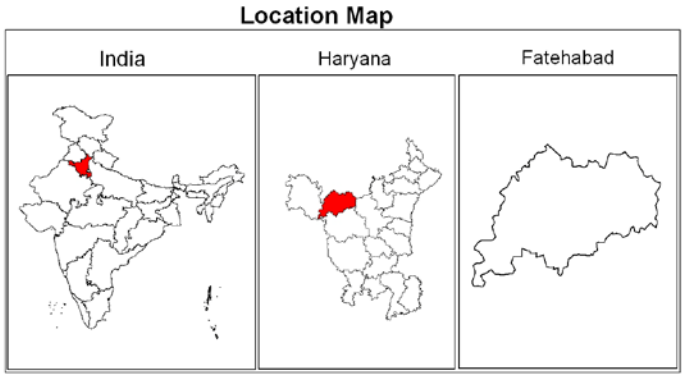


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

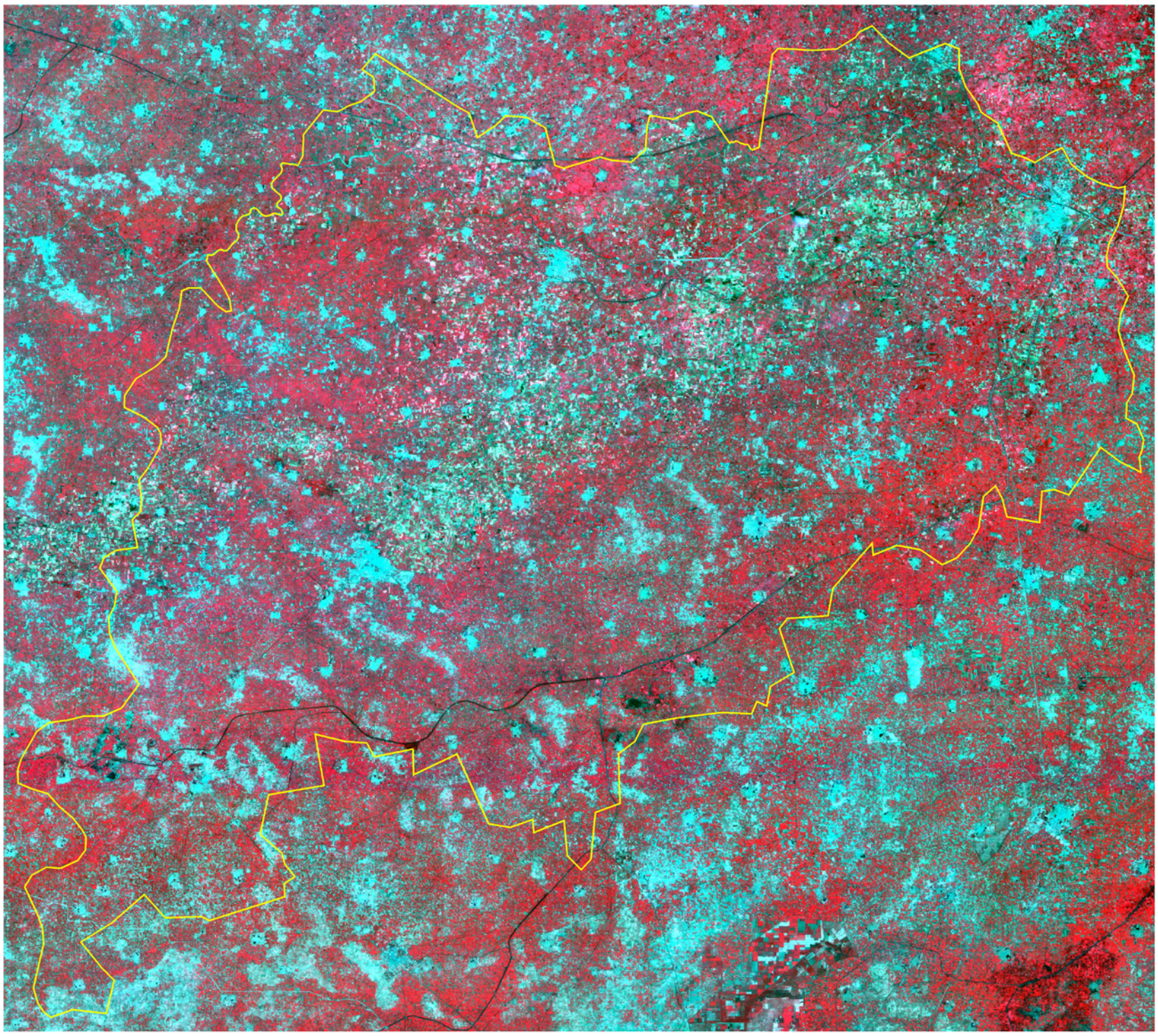
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Fatehabad



IRS P6 LISS-III post monsoon data (2006)

7.1.10 Sirsa

The Sirsa district lies in the extreme west corner of Haryana State. It touches the interstate boundaries on three sides and is connected with its own state only on the eastern side. The district is stretched between 29º14’ to 30ºN latitudes and 74º29' to 75º18'E longitudes covering an area of 4277 Sq. Kms. Its ancient name was Sairishaka and from that it seems to have been changed to Sirsa. According to a local tradition, an unknown king named Saras founded the town in 7th century A.D. and on his name the town was called Sirsa. According to another tradition, the name has its origin from the 'sacred river Saraswati which once flowed near it. During medieval period, the town was known as Sarsuti. The derivation of the name Sirsa is also attributed to the abundance of siris trees. In ancient period, Sirsa was also known as Sirsa pattan. The climate of this district is characterized by its dryness and extreme temperature and scanty rainfall. It can be defined as sub-tropical, semi-arid, continental and monsoon type. The average annual rainfall ranged between 260.3, 275.8 mm. Physiographically the Sirsa district consists of alluvial and sandy aeolian plain.

Table 16: Area estimates of wetlands in Sirsa

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	1	98	5.52	98	98
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	1	12	0.68	12	0
8	1202	Tanks/Ponds	57	305	17.17	259	237
9	1203	Waterlogged	5	319	17.96	266	110
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**64**	**734**	**41.33**	**635**	**445**
		Wetlands (<2.25 ha), mainly Tanks	1042	1042	58.67	-	-
		Total	**1106**	**1776**	**100.00**	**635**	**445**

Area under Aquatic Vegetation	48	147

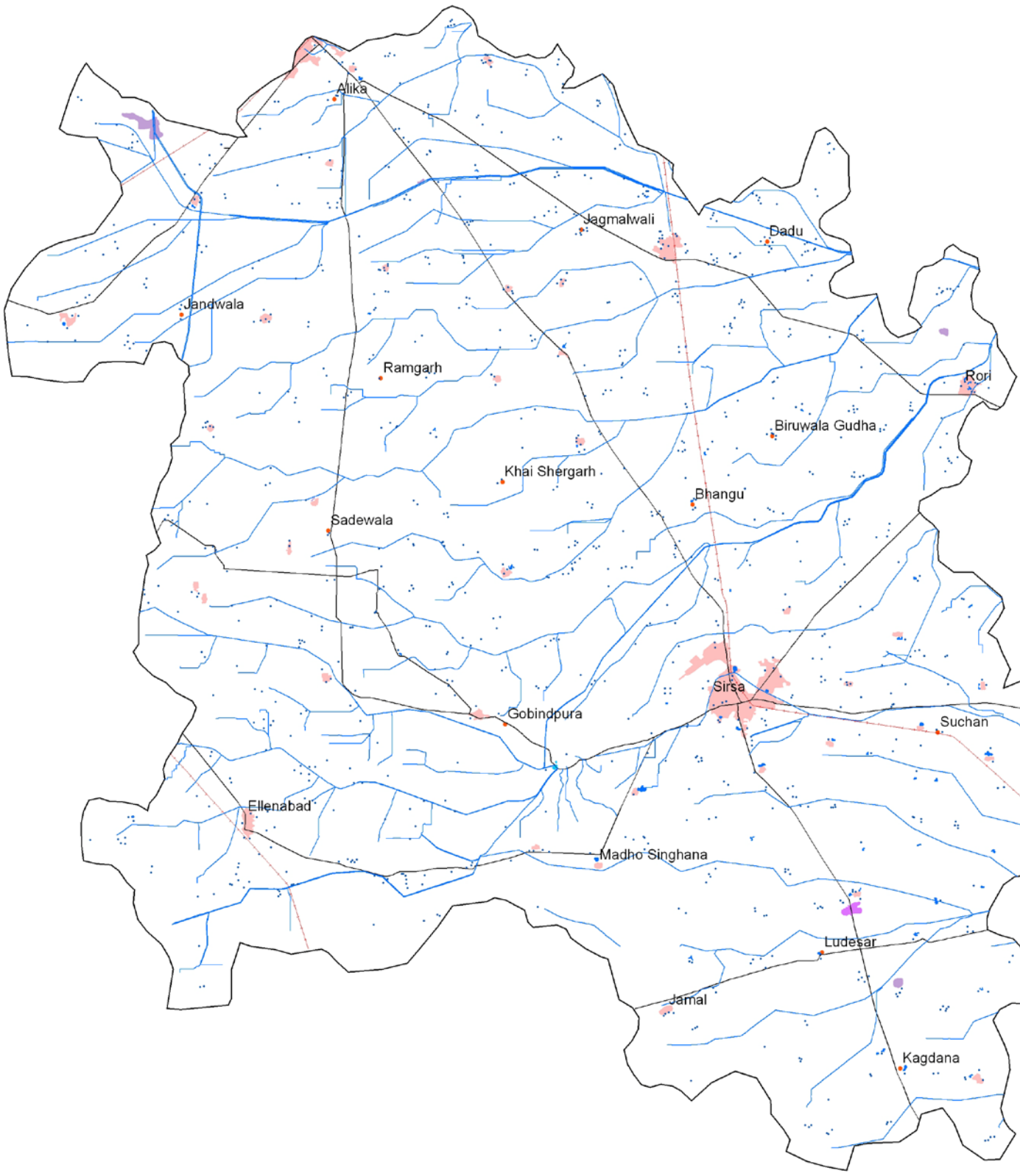
Area under turbidity levels		
Low	259	238
Moderate	12	0
High	364	207

The total wetland area in the district is 1776 ha and Tanks/Ponds and man-made waterlogged contribute 35 per cent of total wetland area. In all there are only 64 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 1042. Qualitative turbidity ranges from low to high. High and low turbidity is observed in both seasons. Out of 1776 ha 48 ha and 147 ha area was covered by aquatic vegetation.

State : Haryana

WETLAND MAP

District : Sirsa

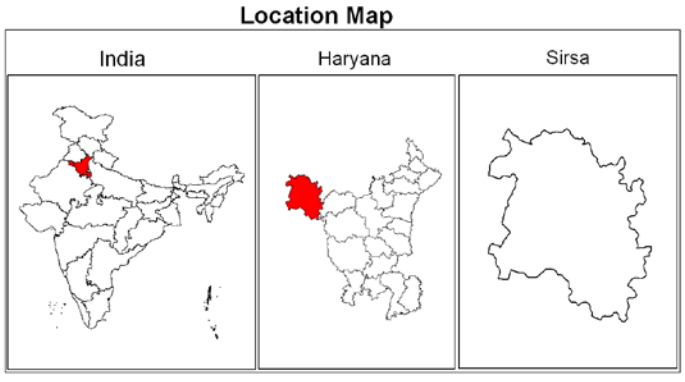


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 5 10 20 30 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
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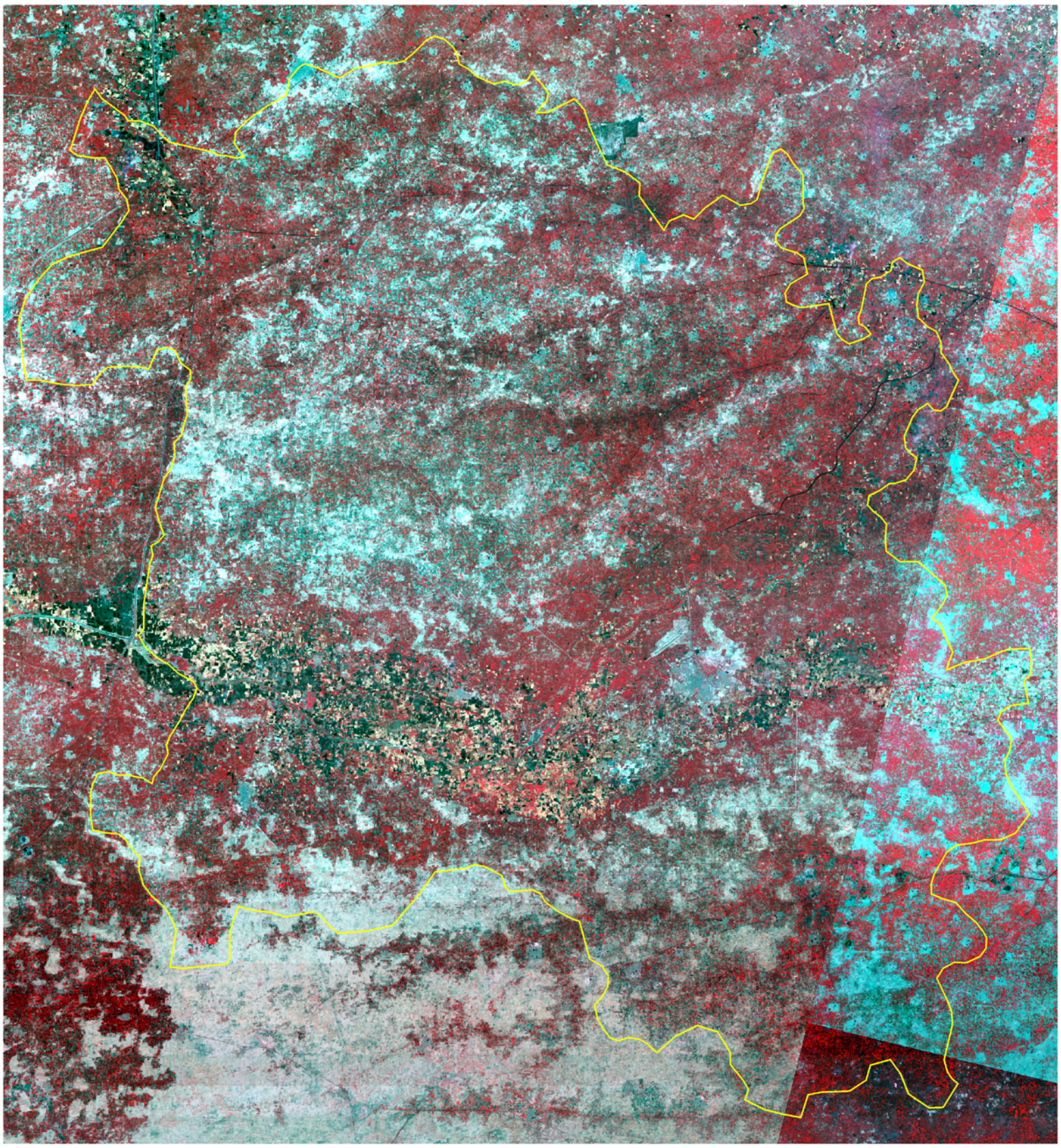
Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Sirsa



IRS P6 LISS-III post monsoon data (2006)

7.1.11 Hisar

The Hisar district, a part of the Indo-Gangetic alluvial plain is situated between 28°53'45" to 29°49'15" N latitudes and 75°13'15" to 76°18'15" E longitudes. It has an area of 3983 sq.km. The Hisar district experiences a sub-tropical climate. The climate is influenced by westerly winds in summer months raising temperature as high as 47 °C, whereas; in winter north-westerly cold winds provide low temperature touching even -1.70 °C. The average rainfall in the district during the period of 1999 to 2004 is 361.20 mm. About 85 per cent of annual rainfall is received during the short south- western monsoon period. May and June are the hottest months. December and January are generally the coldest months. The lowest temperature -1.70 °C was recorded on January 15, 2003 and highest 47°C was recorded on May 12, 2001.

The area is nearly level, with imperceptible slopes, except for the regions in and around the sand dunes or tibbas. The general gradient of the terrain is from northeast to southwest and then west. Hisar district comprises of three major physiographic units i.e. Aeolian plain, older alluvial plain and Chautang flood plain. The soils of the districts are conventionally referred to as alluvial and aeolian .

Table 17: Area estimates of wetlands in Hisar

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	3	18	0.64	18	18
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	152	1308	46.53	1161	1135
9	1203	Waterlogged	31	375	13.34	355	249
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**186**	**1701**	**60.51**	**1534**	**1402**
		Wetlands (<2.25 ha), mainly Tanks	1110	1110	39.49	-	-
		Total	**1296**	**2811**	**100.00**	**1534**	**1402**

Area under Aquatic Vegetation	129	106

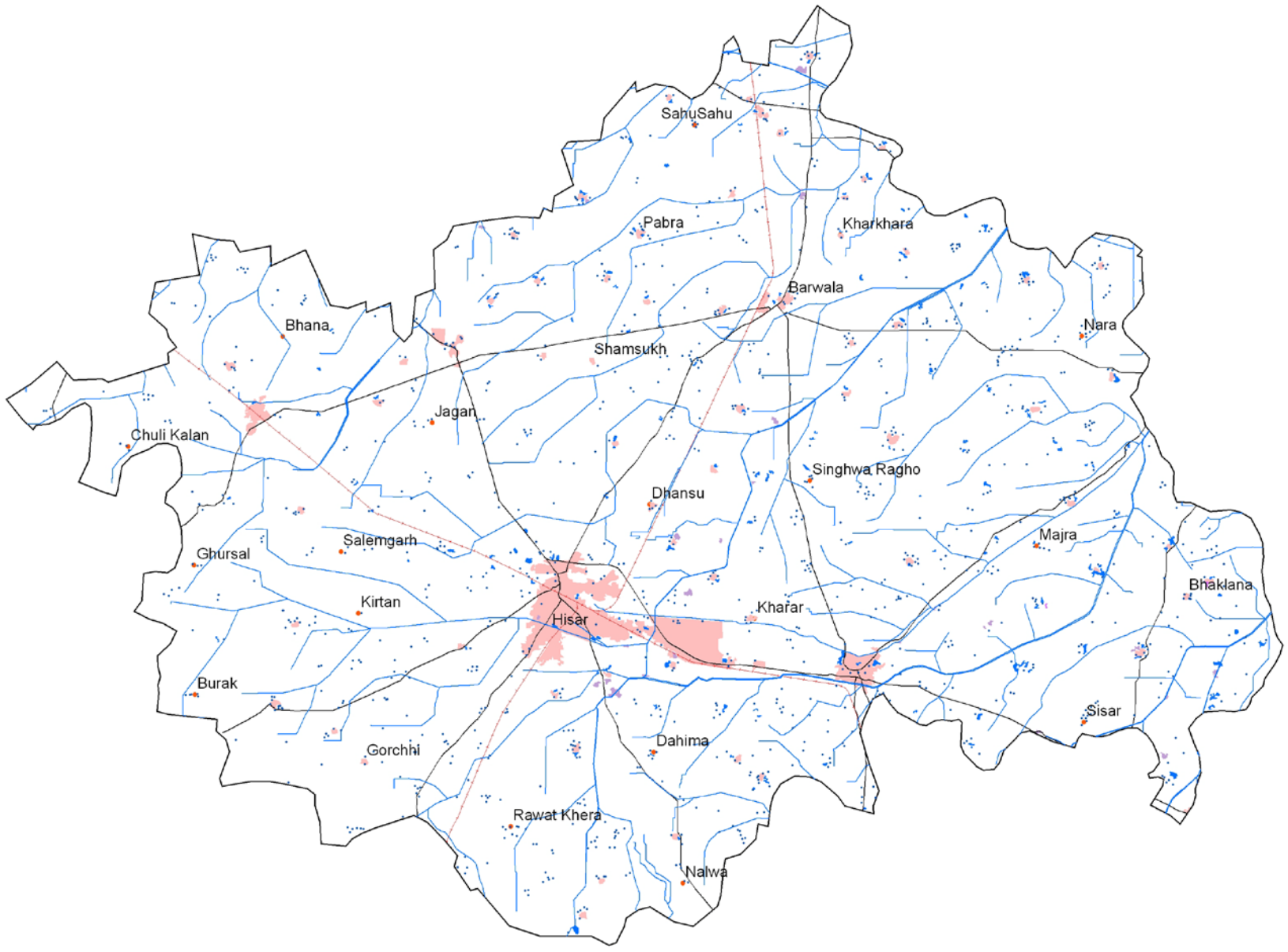
Area under turbidity levels		
Low	1162	1135
Moderate	0	0
High	372	267

The total wetland area in the district is 2811 ha and tanks/ponds and waterlogged contribute 59 per cent wetland area. Wetland area of tanks/ponds in both the season not showed any drastic variation in water spread. In all there are only 186 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 1110. Qualitative turbidity ranges from low to high. High and low turbidity is observed in both seasons. Out of 2811 ha wetland area 129 ha and 106 ha area was covered by aquatic vegetation during post and pre-monsoon season respectively.

State : Haryana

WETLAND MAP

District : Hisar

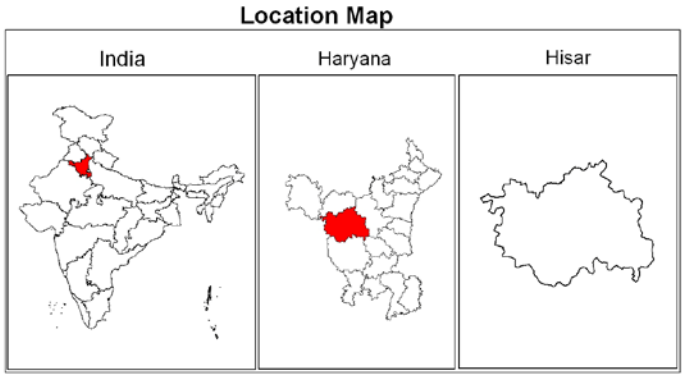


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 5 10 20 30 Kilometers

Data Source :

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

Prepared By :

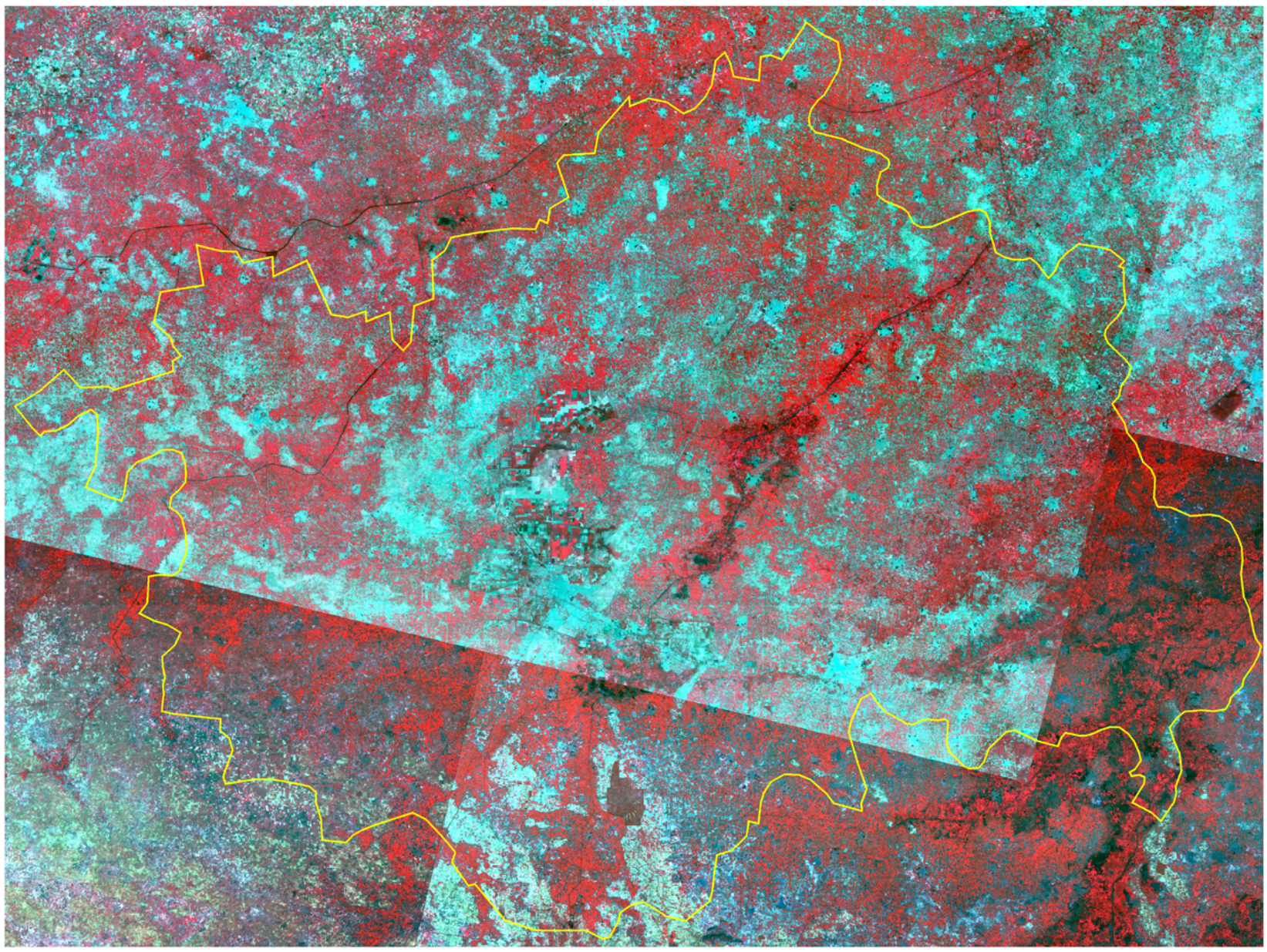
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Hisar



IRS P6 LISS-III post monsoon data (2006)

7.1.12 Bhiwani

The Bhiwani district occupies a traditional position between the fairly flat and featureless Punjab, Haryana plains and the Rajasthan desert and Aravali hills. It occupies an area of 4,778 sq. km and located between $28^0$19'N to $29^0$05' N latitudes and $75^0$28' to $76^0$28' E longitudes. The far inland location and bordering with Rajasthan desert in the west have profoundly influenced the climate, which is very hot in summer and cold in a fairly long winter. The average annual rainfall ranges between 315.2 to 410.2 mm (based on averages of 1995-99, 1996-2000 & 1997-01). Winter rains occur during January to march due to western disturbances but the amount is very less. About 75 percent of the annual rainfall is received during the monsoon month.

Temperature starts rising rapidly from March and reaches 41°C till with minimum temperature 28°C. Maximum temperature may occasionally touch 48°C on individual days during the period. Broadly speaking the district is a sandy, undulating plain dotted with sand dunes of varying shapes and dimensions occurring in different directional dispositions.

Table 18: Area estimates of wetlands in Bhiwani

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	7	94	5.38	92	59
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	72	562	32.15	498	458
9	1203	Waterlogged	13	210	12.01	179	136
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**92**	**866**	**49.54**	**769**	**653**
		Wetlands (<2.25 ha), mainly Tanks	882	882	50.46	-	-
		Total	**974**	**1748**	**100.00**	**769**	**653**

Area under Aquatic Vegetation	72	14

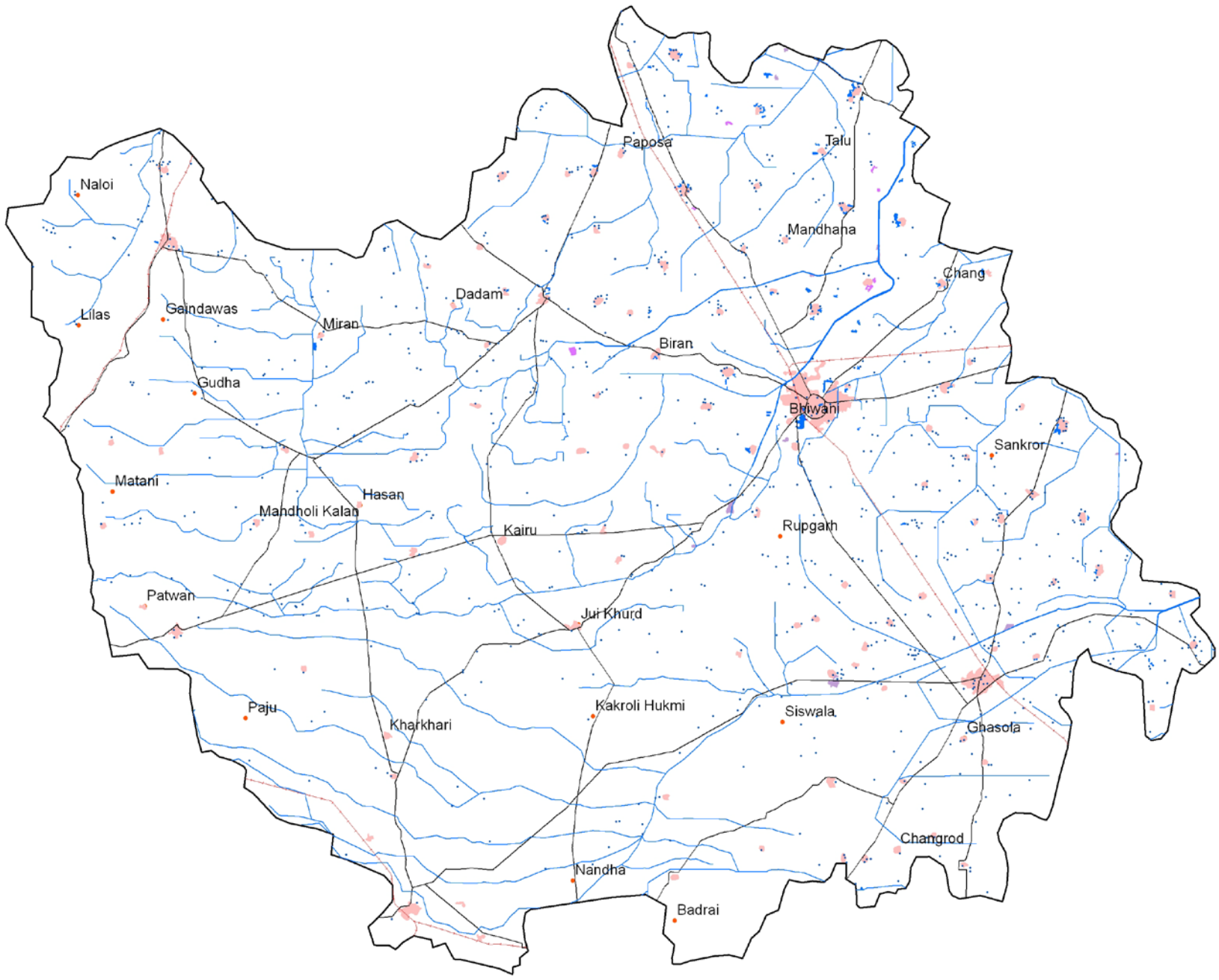
Area under turbidity levels		
Low	498	458
Moderate	0	0
High	271	195

The total wetland area in the district is 1748 ha and tanks/ponds and waterlogged contribute 44 per cent wetland area. Wetland area of tanks/ponds in both the season not showed any drastic variation in water spread. Natural waterlogged wetlands were observed low-lying areas and contribute around 5 per cent in total wetlands of the district. In all there are only 92 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 882. Qualitative turbidity ranges from low to high and moderate turbidity is observed. High and low turbidity is observed in both seasons. Out of 1748 ha wetland area 72 ha and 14 ha area was covered by aquatic vegetation during post and pre-monsoon season respectively.

State : Haryana

WETLAND MAP

District : Bhiwani

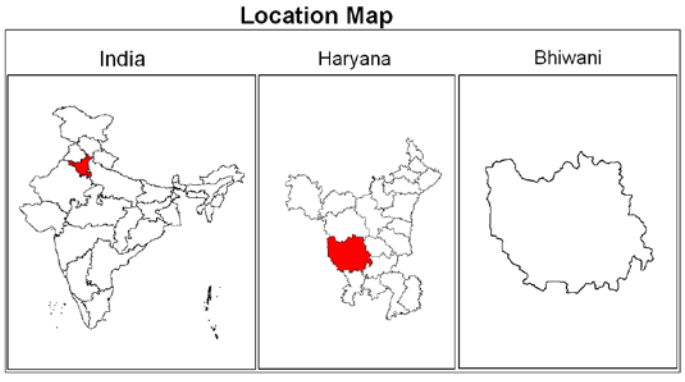


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 5 10 20 30 Kilometers

Data Source :

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

Prepared By :

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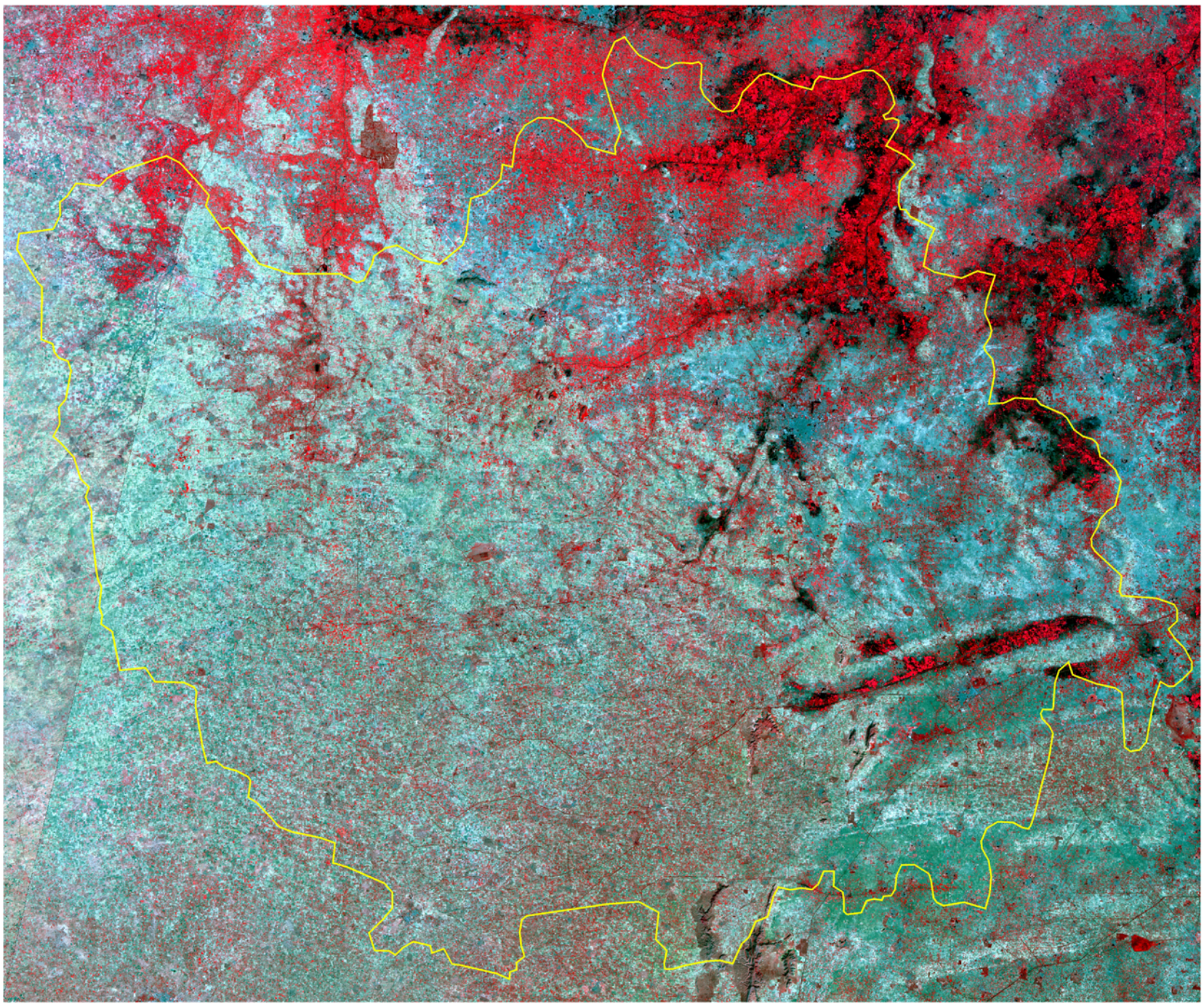
Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Bhiwani



IRS P6 LISS-III post monsoon data (2006)

7.1.13 Rohtak

The Rohtak district is located between 28º23' to 29º06' N latitudes and 76º13' to 76º58' E longitudes. It covers a total area of 1745 sq. km. The climate of the district is dry with intensely hot summer, and cold winter. The average annual rainfall of the district is 577.0 mm. It generally increases towards northeast. About 74 per cent of annual rainfall is received during the monsoon season. The district experiences extreme temperatures. During January the temperature goes down to below 1ºC. May and June are the hottest months with mean daily maximum temperature at about 40ºC. Temperature sometimes may rise to 45ºC.

The district is comprised of the vast Indo-Gangetic alluvial plains called older alluvial plain. This older alluvial plain is further divided into sand dunes, plain and depressions. The sediment derived in the old alluvial plain are mostly from the Himalayan rivers having a heterogeneous composition. This landform is formed predominantly by medium to fine textured soils. Since the soils are fertile with good irrigation facilities (canal and tube wells), these have been put into maximum use over a long time. This landform has been further divided into the following subunits:

Table 19: Area estimates of wetlands in Rohtak

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	8	150	8.91	148	108
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	126	888	52.76	874	696
9	1203	Waterlogged	25	232	13.78	229	170
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**159**	**1270**	**75.46**	**1251**	**974**
		Wetlands (<2.25 ha), mainly Tanks	413	413	24.54	-	-
		Total	**572**	**1683**	**100.00**	**1251**	**974**

Area under Aquatic Vegetation	13	0

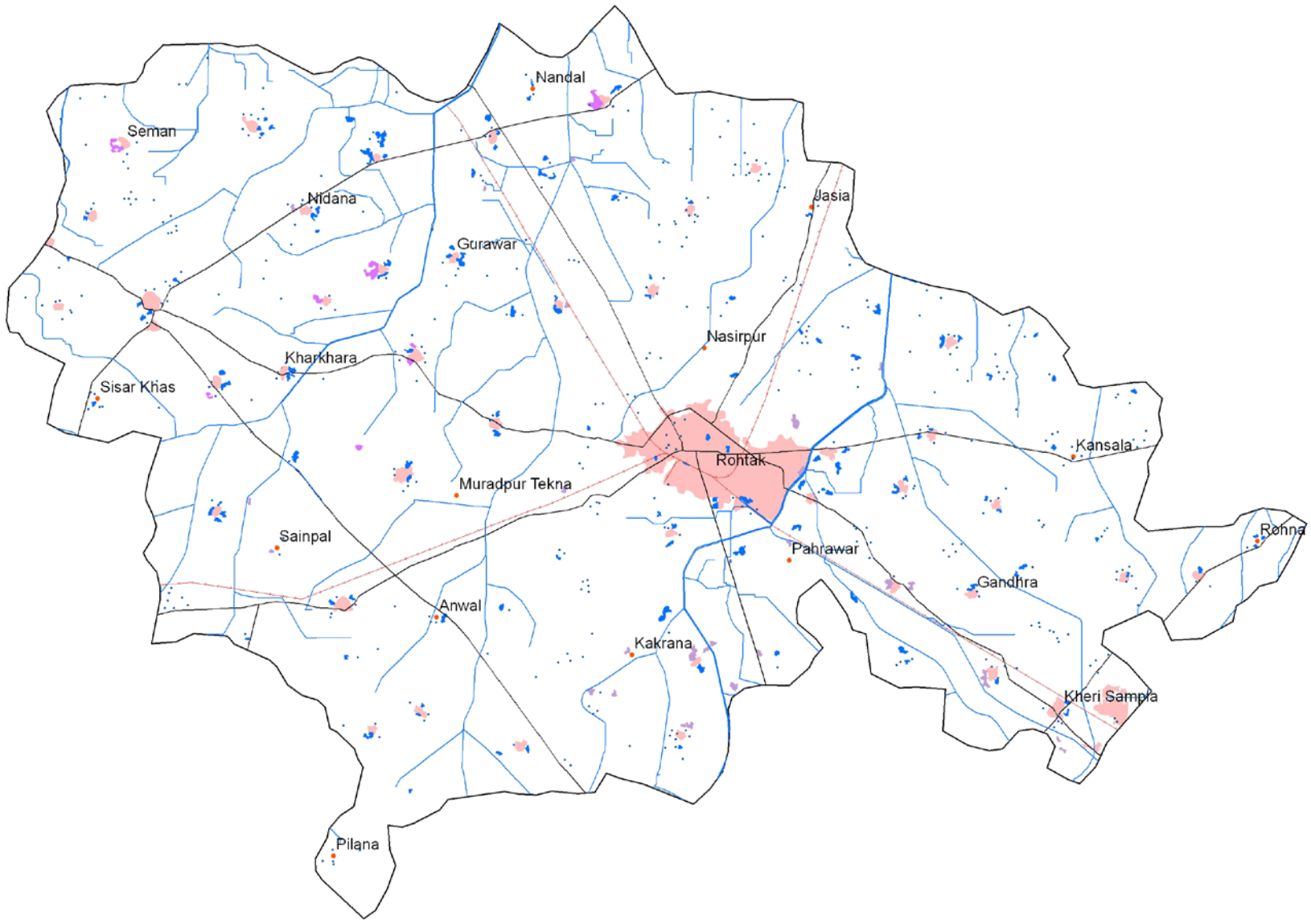
Area under turbidity levels		
Low	875	696
Moderate	0	0
High	376	278

The total wetland area in the district is 1983 ha and tanks/ponds and waterlogged contribute around 67 per cent wetland area. There are 126 tanks/ ponds and their wetland area in both the season not shown any drastic fluctuations in water spread. Natural waterlogged wetlands were observed low-lying areas and contribute around 9 per cent in total wetlands of the district. In addition there are 413 wetlands having less than 2.25 ha area. Qualitative turbidity ranges from low to high and is observed in both seasons. Out of 1683 ha wetland area 13 ha area was covered by aquatic vegetation during post monsoon season.

State : Haryana

WETLAND MAP

District : Rohtak

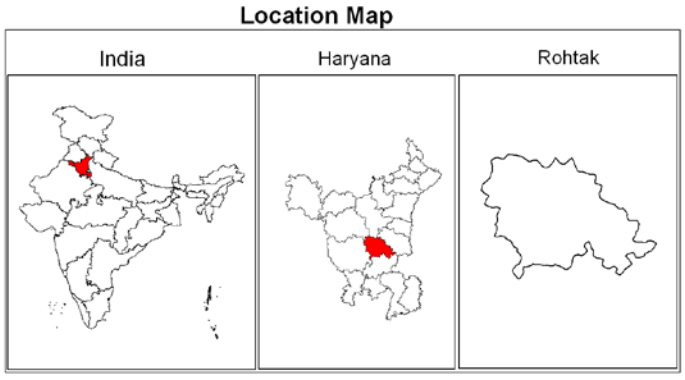


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

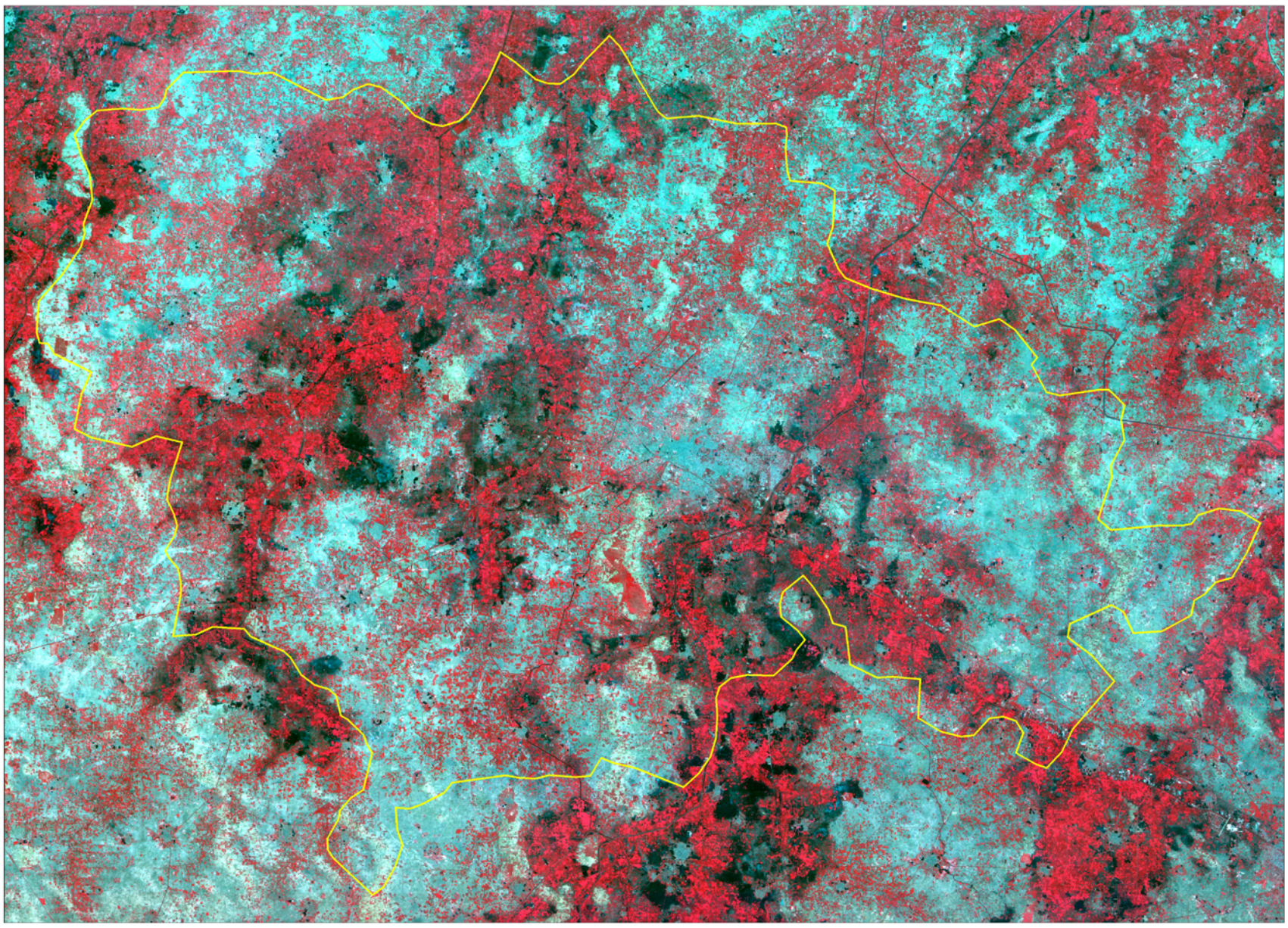
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Rohtak



IRS P6 LISS-III post monsoon data (2006)

7.1.14 Jhajjar

The Jhajjar district is located between 29°21'30” to 29°51'30" N latitudes and 76°16'30" to 76°58'45" E longitudes. It covers a total area of 1834 sq. km. The climate of the district is dry with intense hot summer, and cold winter. The average annual rainfall of the district is 577.0 mm. The maximum rainfall received during the months of July and August. About 74% of annual rainfall is received during the monsoon season. Temperature starts rising from March and continues till the end of June. May and June are the hottest months with mean daily maximum temperature is about 40ºC. During winter the temperature starts decreasing by the middle of November, January is the coldest month.

The main physiographic units of the district are as under: The upland plain spreads in the north- eastern part of the district. It slopes towards south. This plain is covered with old alluvium of high productivity. The sandy region is spread in the southern and south- western parts of the district. It comprises of permanent sand dunes, most of them now have been leveled. Sahibi is the only seasonal stream, which enters the district from the southeastern part and flows from the south.

Table 20: Area estimates of wetlands in Jhajjar

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	2	563	25.66	203	0
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	6	76	3.46	76	76
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	72	499	22.74	480	369
9	1203	Waterlogged	27	227	10.35	219	247
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**107**	**1365**	**62.22**	**978**	**692**
		Wetlands (<2.25 ha), mainly Tanks	829	829	37.78	-	-
		Total	**936**	**2194**	**100.00**	**978**	**692**

Area under Aquatic Vegetation	378	49

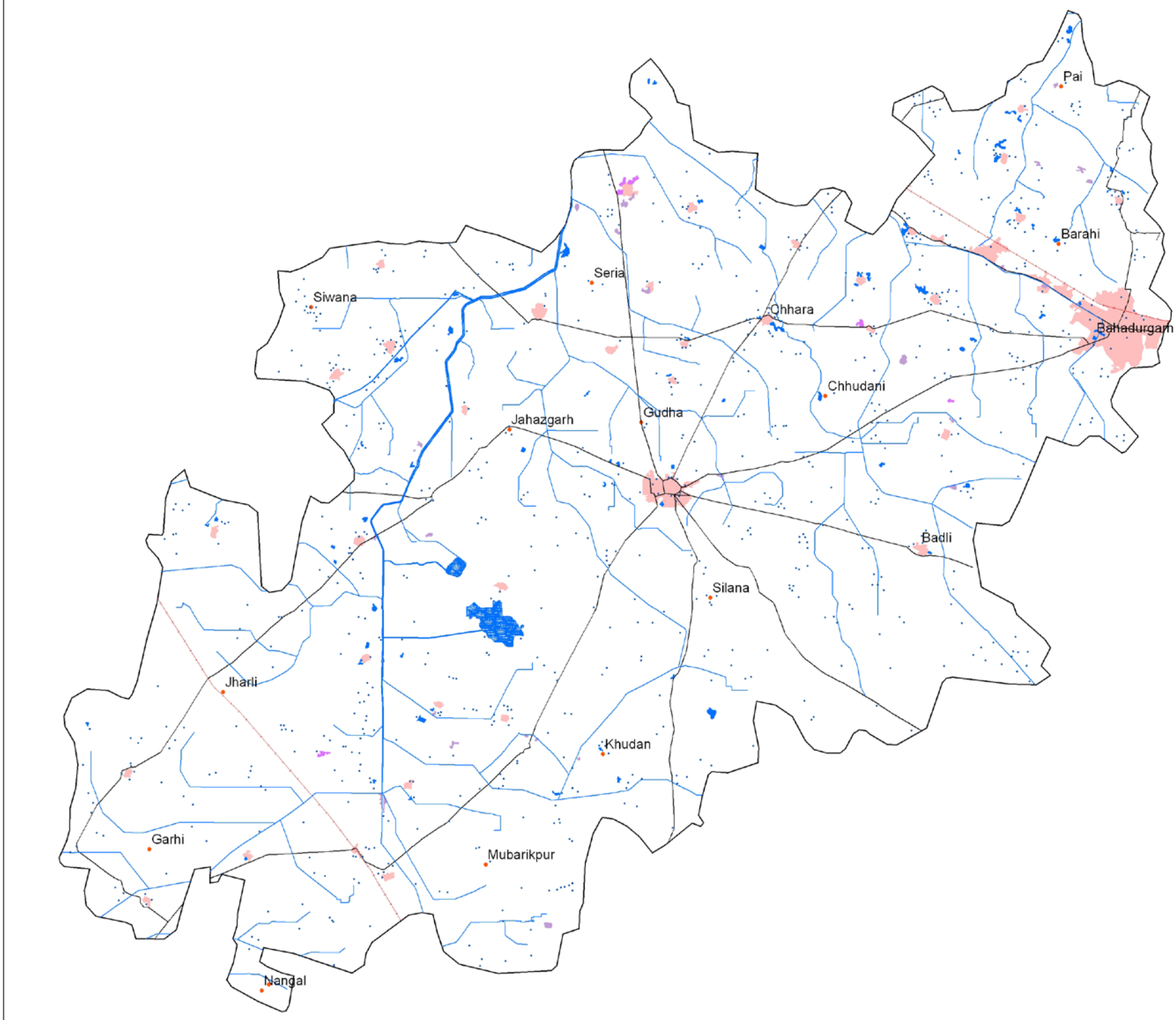
Area under turbidity levels		
Low	683	369
Moderate	0	0
High	295	323

The total wetland area in the district is 2194 ha and lakes/ ponds and tanks/ponds contribute around 49 per cent wetland area. There are 72 tanks/ ponds and their wetland area in both the season not shown any drastic fluctuations in water spread. There are only two lakes and the wetland area in post-monsoon season 203 ha but during summer these wetlands dried. There are 107 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 829. Qualitative turbidity ranges from low to high and is observed in both seasons. Out of 2194 ha wetland area 378 ha area was covered by aquatic vegetation during post monsoon season while in pre-monsoon season it is only 49 ha. .

State : Haryana

WETLAND MAP

District : Jhajjar

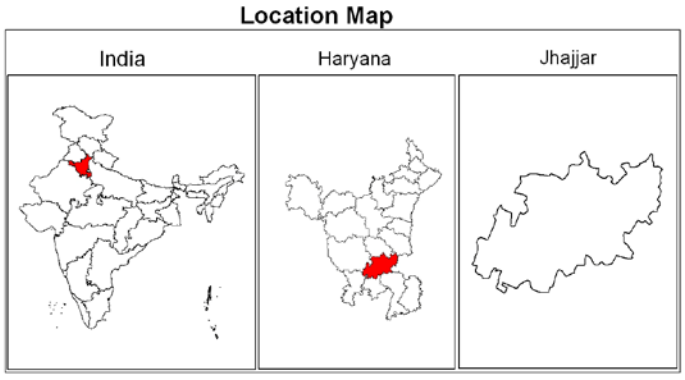


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

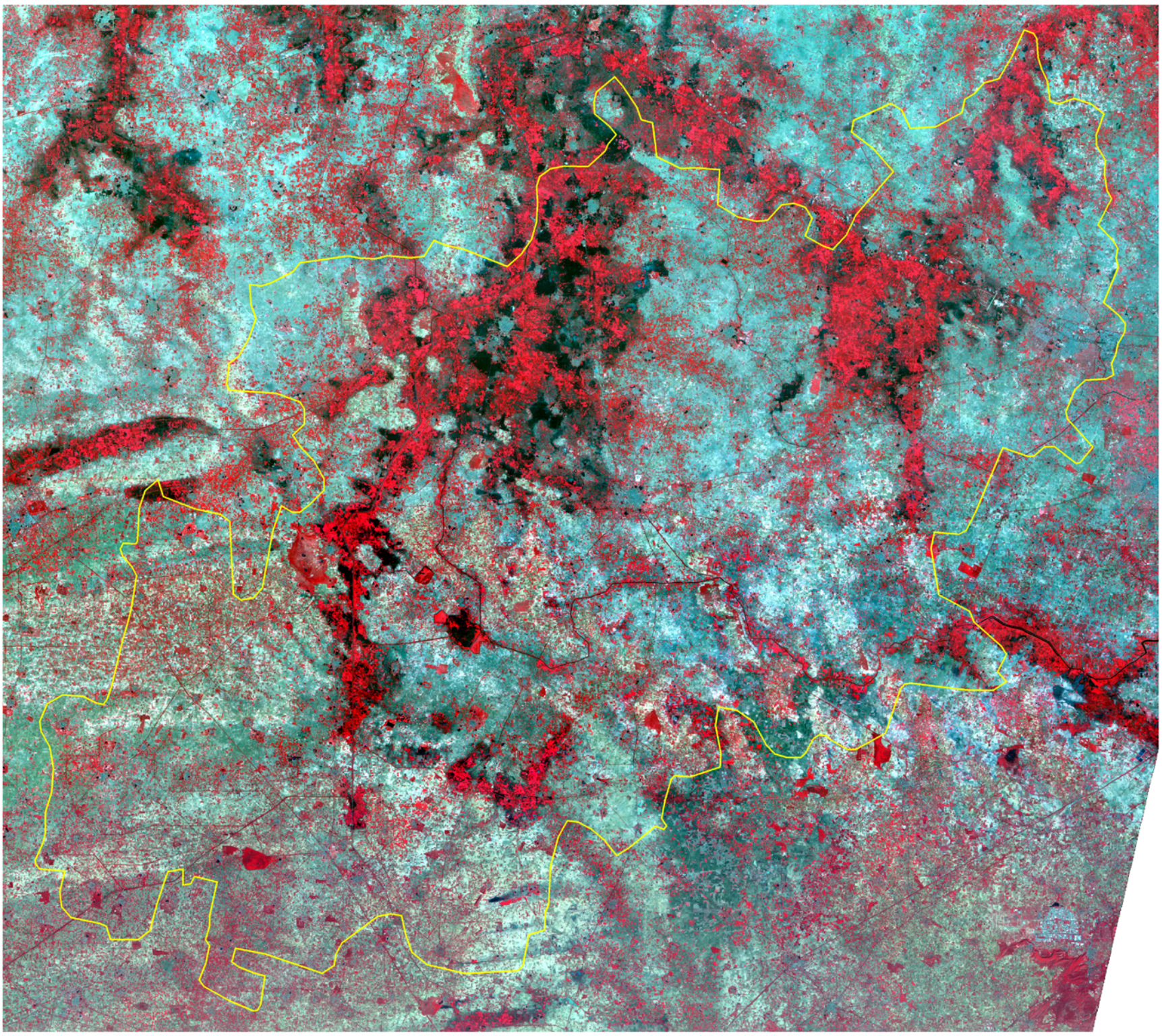
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Jhajjar



IRS P6 LISS-III post monsoon data (2006)

7.1.15 Mahendragarh

Mahendergarh district, situated in south- western part of Haryana, has an area of 1859 sq. km. Geographically, it stretches in between 27°48' N to 28°28' N latitudes and 75°54' E to 76°22' E longitudes. The climatic conditions in the district vary from arid to semi arid. The summer months are very hot whereas, winter season is fairly cool and dry, but there is sometimes freezing temperature during the months of December and January. Occasionally, frost also occurs in winter. The annual rainfall in the district increases from west to east. About 75% of annual rainfall is received during the southwest monsoon months i.e. July to September. During winter months light rainfall occurs due to western cyclonic disturbance of Mediterranean sea. Temperature begins to rise from March to June. June is the hottest month. The mean daily maximum temperature varies from 41°C to 45°C and mean daily temperature is about 27°C. Maximum temperature may go up to 48°C.

The district is dominated by dry lands with presence of inland streams, sandy plains, shifting sand dunes, stabilized sand dunes, dissected upland tracts and often barren, denuded, rocky hill ranges and their outcrops.

Table 21: Area estimates of wetlands in Mahendranagar

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	2	97	21.95	97	12
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	1	13	2.94	13	3
8	1202	Tanks/Ponds	2	17	3.85	17	4
9	1203	Waterlogged	3	26	5.88	26	5
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**8**	**153**	**34.62**	**153**	**24**
		Wetlands (<2.25 ha), mainly Tanks	289	289	65.38	-	-
		Total	**297**	**442**	**100.00**	**153**	**24**

Area under Aquatic Vegetation	0	0

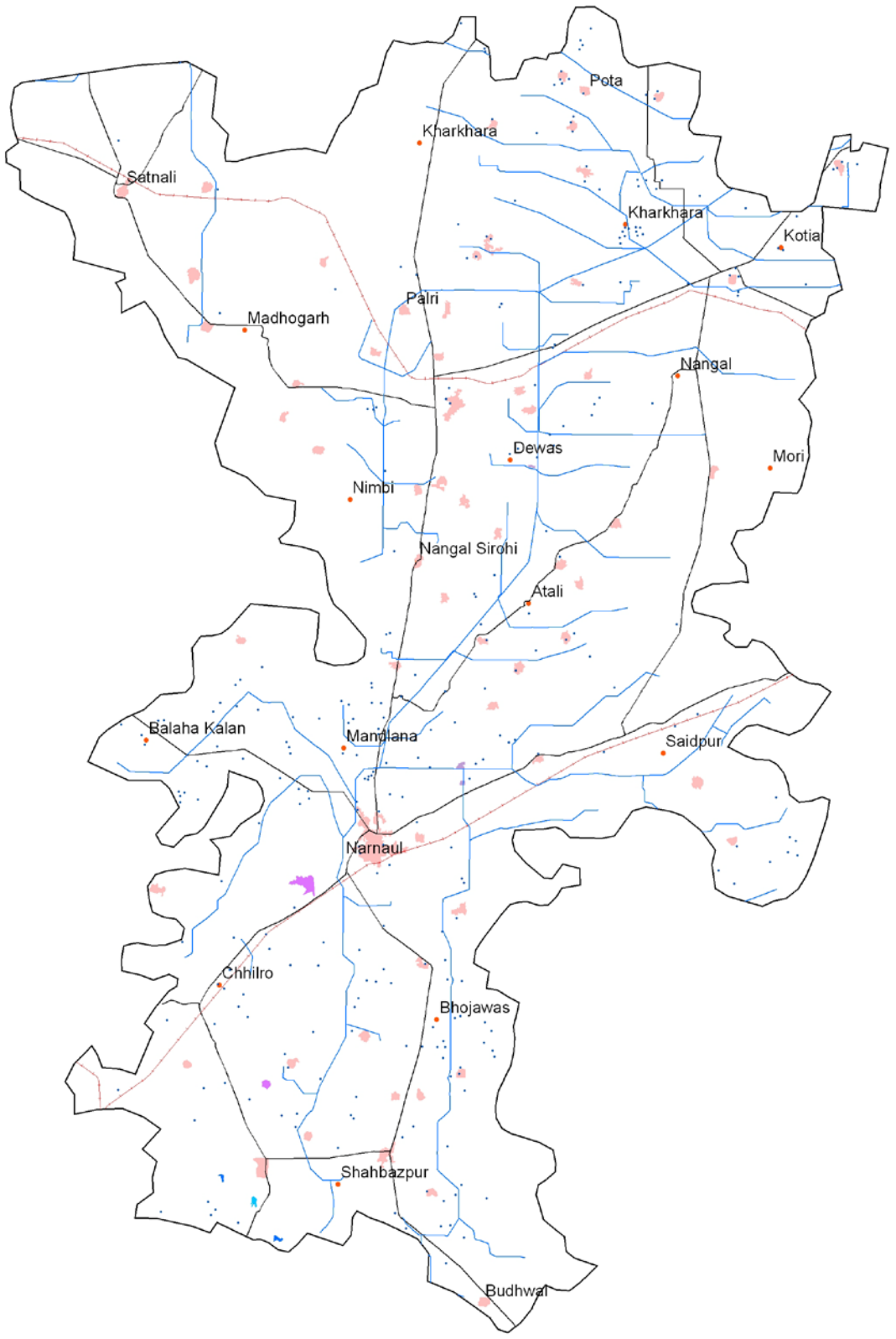
Area under turbidity levels		
Low	16	3
Moderate	13	2
High	124	19

The total wetland area in the district is 442 ha and waterlogged area contributes around 28 per cent wetland area. There are 18 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 289. Qualitative turbidity ranges from low to high and is observed in both seasons. Almost all wetlands are devoid of aquatic vegetation. Many wetlands are dried during pre-monsoon season.

State : Haryana

WETLAND MAP

District : Mahendragarh

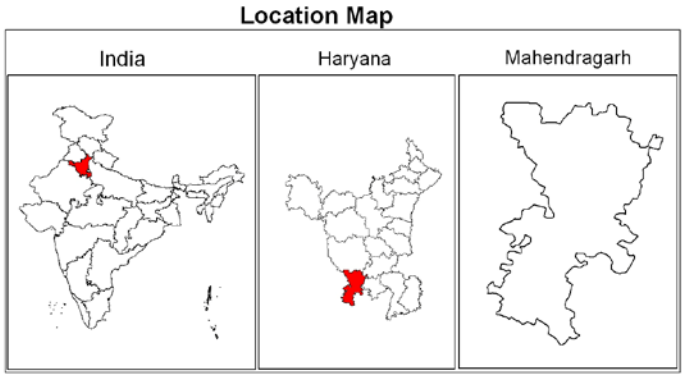


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

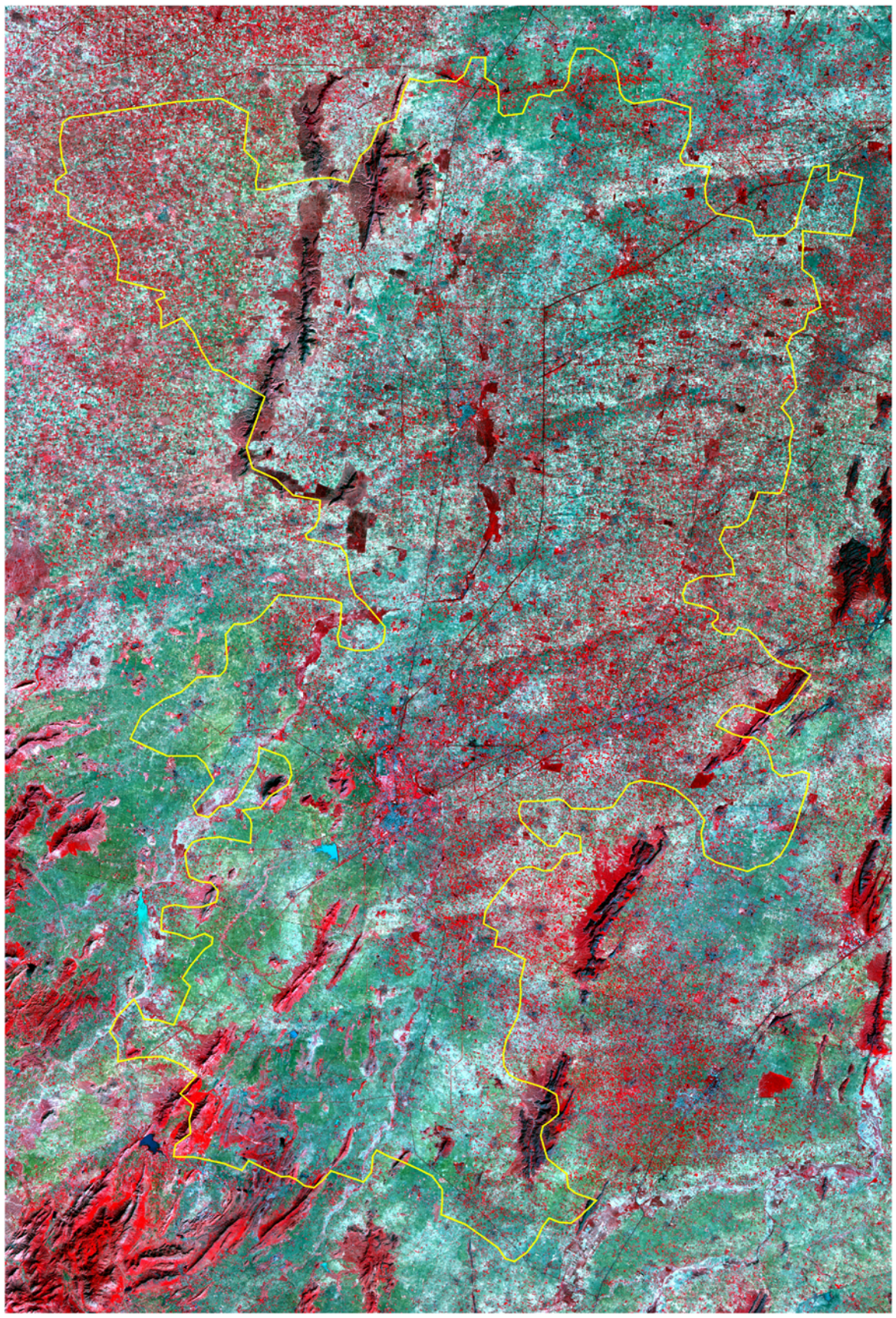
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Mahendragarh



IRS P6 LISS-III post monsoon data (2006)

7.1.16 Rewari

Rewari district lies in southwestern part of Haryana, which extends from 27º57' north to 28º17' north latitudes and from 76º17' cast to 76º51’ east longitudes encompassing an area of 1582 sq. km. The climate in the district varies from arid to semi arid. The incidence of thunderstorm also occurs during August and September. These are sometimes accompanied by heavy shower and occasional hail. The district has an average annual rainfall of about 686.6 mm. The major part of it (70 to 80%) is received during summer monsoon i.e. July to September. Due to western cyclonic disturbances coming through Afghanistan and Pakistan, the district receives about 10 to 15 percent of total rainfall during winter season. Eastern part of the district gets more rainfall and it starts decreasing towards west and southwest. The summer months are very hot with maximum temperature ranging from 41°C to 46°C in May and June. June is the period of highest incidence of dust storm. Sometimes, the temperature touches 48°C.

Table 22: Area estimates of wetlands in Rewari

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	2	20	4.52	20	20
9	1203	Waterlogged	7	106	23.98	106	4
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**9**	**126**	**28.51**	**126**	**24**
		Wetlands (<2.25 ha), mainly Tanks	316	316	71.49	-	-
		Total	**325**	**442**	**100.00**	**126**	**24**

Area under Aquatic Vegetation	0	0

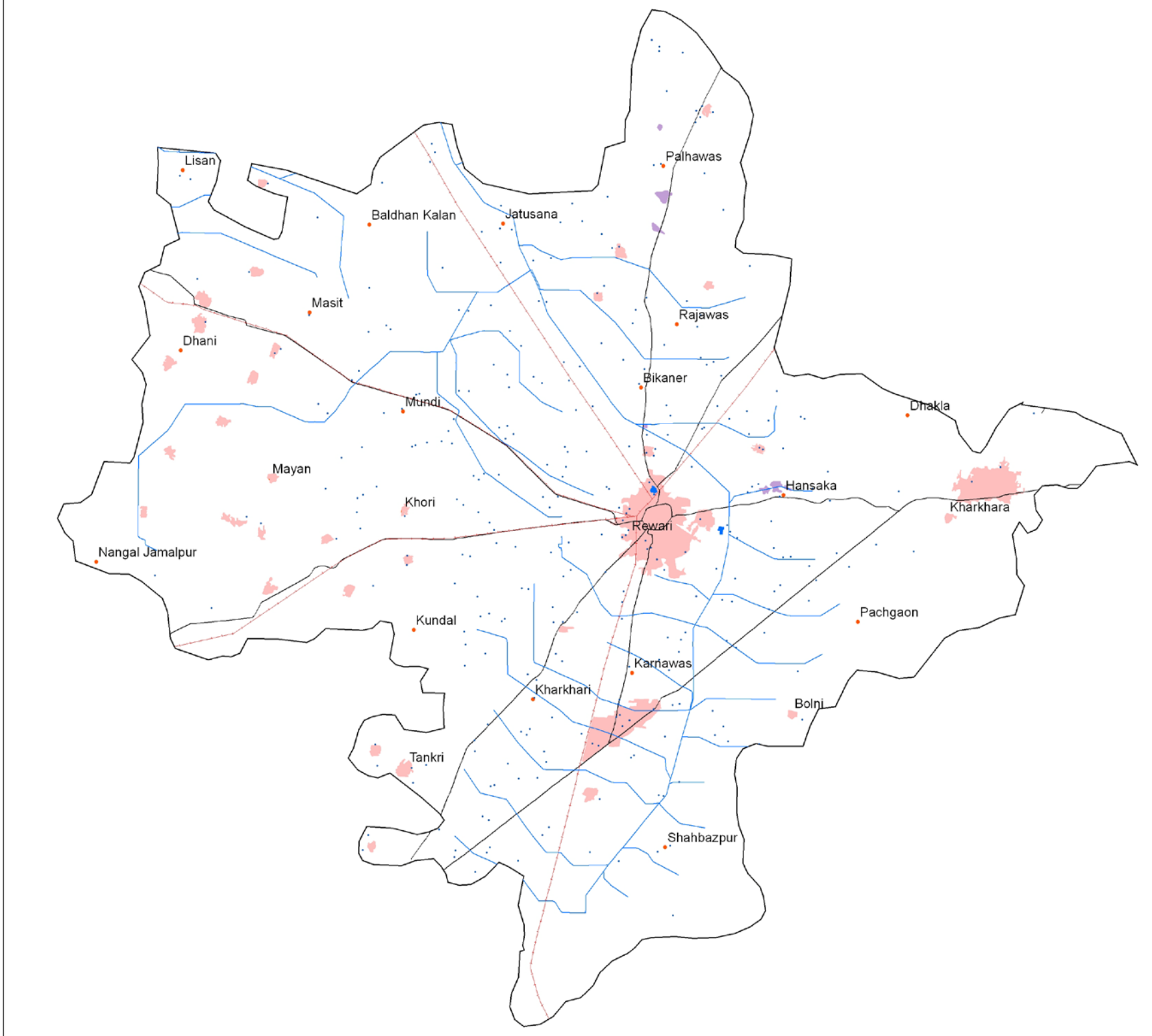
Area under turbidity levels		
Low	20	20
Moderate	0	0
High	106	4

The total wetland area in the district is 442 ha and man made waterlogged area contribute around 24 per cent wetland area. There are no natural wetlands in the district. There are only two tanks and water level fluctuations are very high. There are 9 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 316. Two classes of turbidity were observed. Area of high turbidity is 106 ha and low turbidity is restricted to 20 ha. Almost all wetlands are devoid of aquatic vegetation. Many wetlands mainly waterlogged are dried during pre-monsoon season.

State : Haryana

WETLAND MAP

District : Rewari

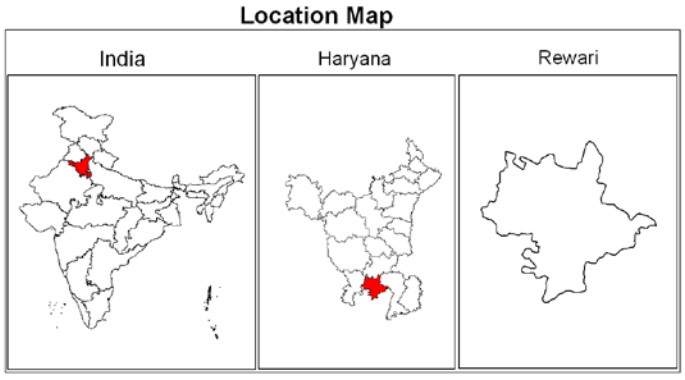


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

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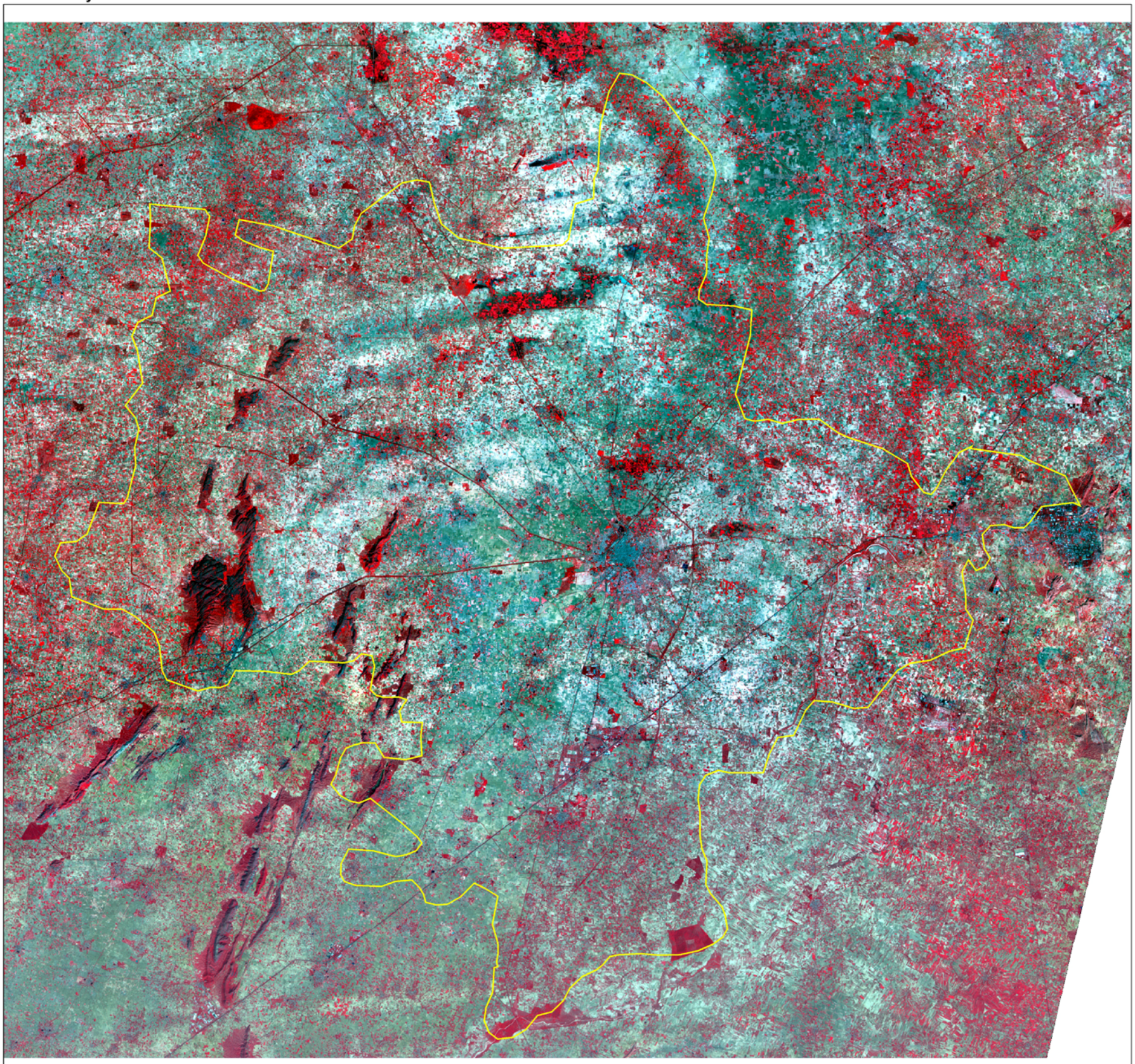
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Rewari



IRS P6 LISS-III post monsoon data (2006)

7.1.18 Gurgaon

The Gurgaon district is one of the southern districts of Haryana state and named after its headquarter town Gurgaon. The district lies between 27º39' N and 28º32'N latitudes and 76º39' and 77º20'E longitudes. It stretches towards the outlying hills of the Rajasthan in the south. It is bounded on the northwest by the Jhajjar district and on the north-east by the Union Teritory of Delhi. On the east Faridabad district forms its boundary. On the south the Alwar district of Rajasthan and on the west Rewari district marks the district boundary. Total area of the district is 1254 sq.km.

The district experiences dry air except during the monsoon, hot summer and cold winter. The monthly average annual rainfall of the district is 442.4mm. Maximum rainfall is received during the months of July, September, August about 76%. Some rainfall is also received during the winter season from December to February but the amount is very low (6%).

Temperature begins to rise from March to June. June is the hottest month. Maximum temperature may go up to 48°C. With the onset of monsoon, temperature starts falling and during monsoon period weather remains uncomfortable due to increased humidity and warm night. After October, there is decrease temperature, the decrease being steeper after middle of November. January is the coldest month. Occasionally during winter season, cold in association with western disturbances brings temperature down to freezing point.

The drainage of the district is typical of the arid and semi-arid areas. It comprises of large depressions and seasonal streams. Important depressions of the district are: Khalilpur lake, Chandaini lake, Sangel-Ujina lake, Kotla Dahar lake and Najafgarh lake. Sahibi and Indari are two important seasonal streams of the district. They originate from Aravalli hills. Both these streams cause heavy damage to crops during heavy rainfall.

Table 23: Area estimates of wetlands in Gurgaon

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	2	158	5.72	70	20
2	1102	Ox-bow lakes/ Cut-off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	9	79	2.86	51	61
6	1106	River/Stream	-	-	-	-	-
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	1	1713	61.98	0	153
8	1202	Tanks/Ponds	14	63	2.28	54	59
9	1203	Waterlogged	18	155	5.61	114	128
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**44**	**2168**	**78.44**	**289**	**421**
		Wetlands (<2.25 ha), mainly Tanks	596	596	21.56	-	-
		Total	**640**	**2764**	**100.00**	**289**	**421**

Area under Aquatic Vegetation	599	312

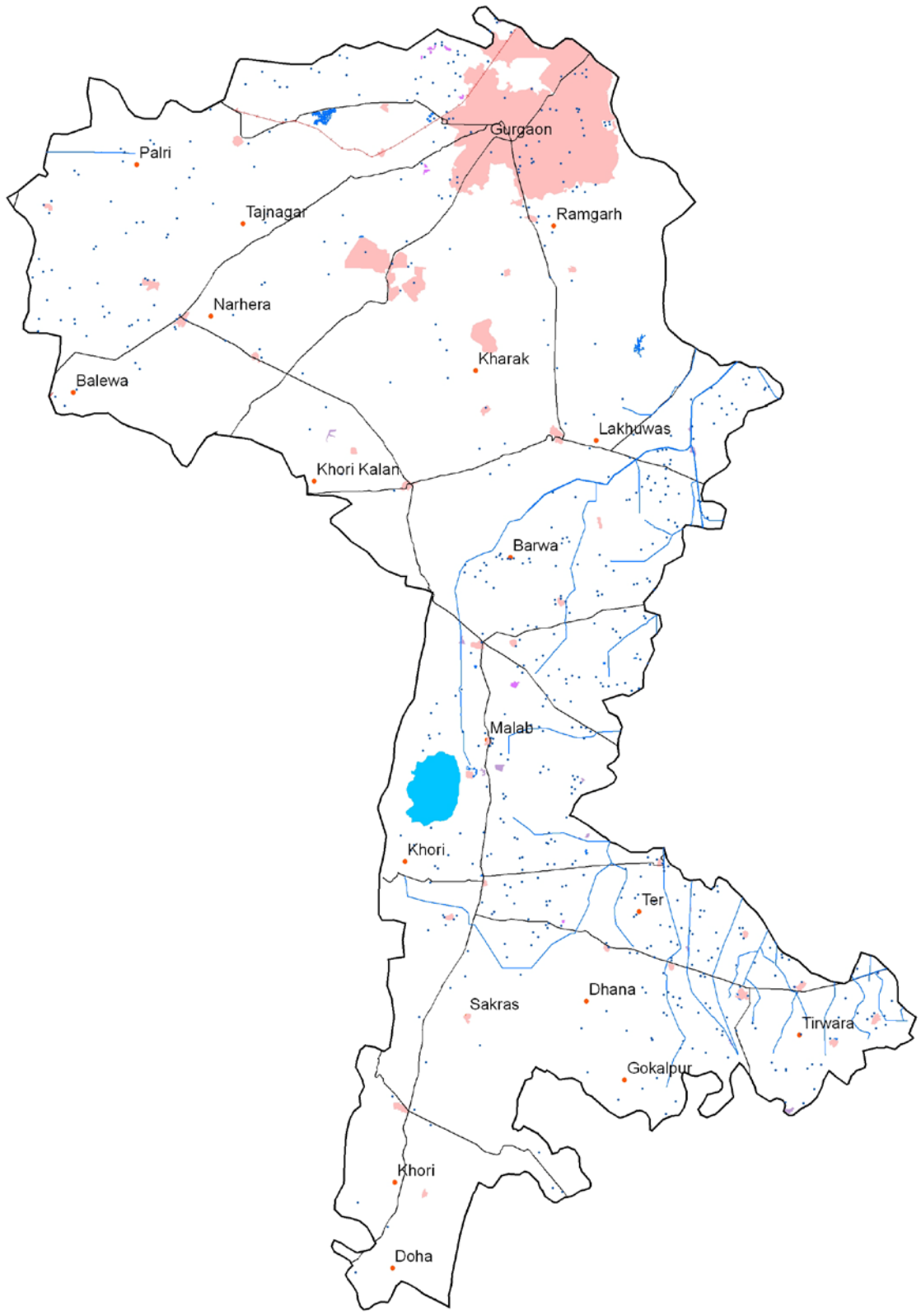
Area under turbidity levels		
Low	75	212
Moderate	48	20
High	166	189

The total wetland area in the district is 2764 ha and man made reservoirs/barrages contribute around 62 per cent wetland area. The contribution of natural wetlands to total wetlands of the district is around 3 per cent. There are 44 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 596. Three classes of turbidity were observed in both the season. Area of high turbidity is 166 ha and 189 ha in post and pre-monsoon season respectively. Out of 2764 wetland area 599 ha area was covered by aquatic vegetation while pre-monsoon season it was 312 ha.

State : Haryana

WETLAND MAP

District : Gurgaon

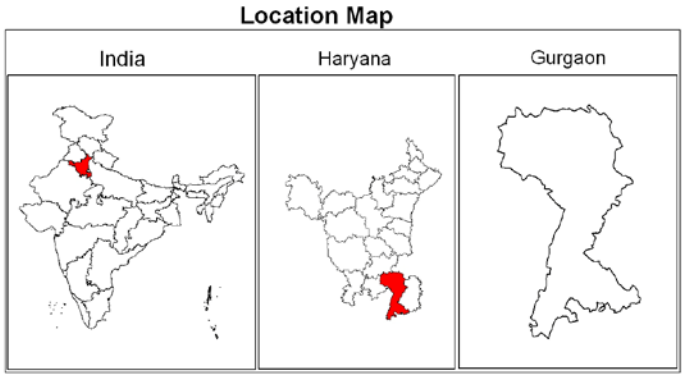


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 5 10 20 30 Kilometers

Data Source :

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

Prepared By :

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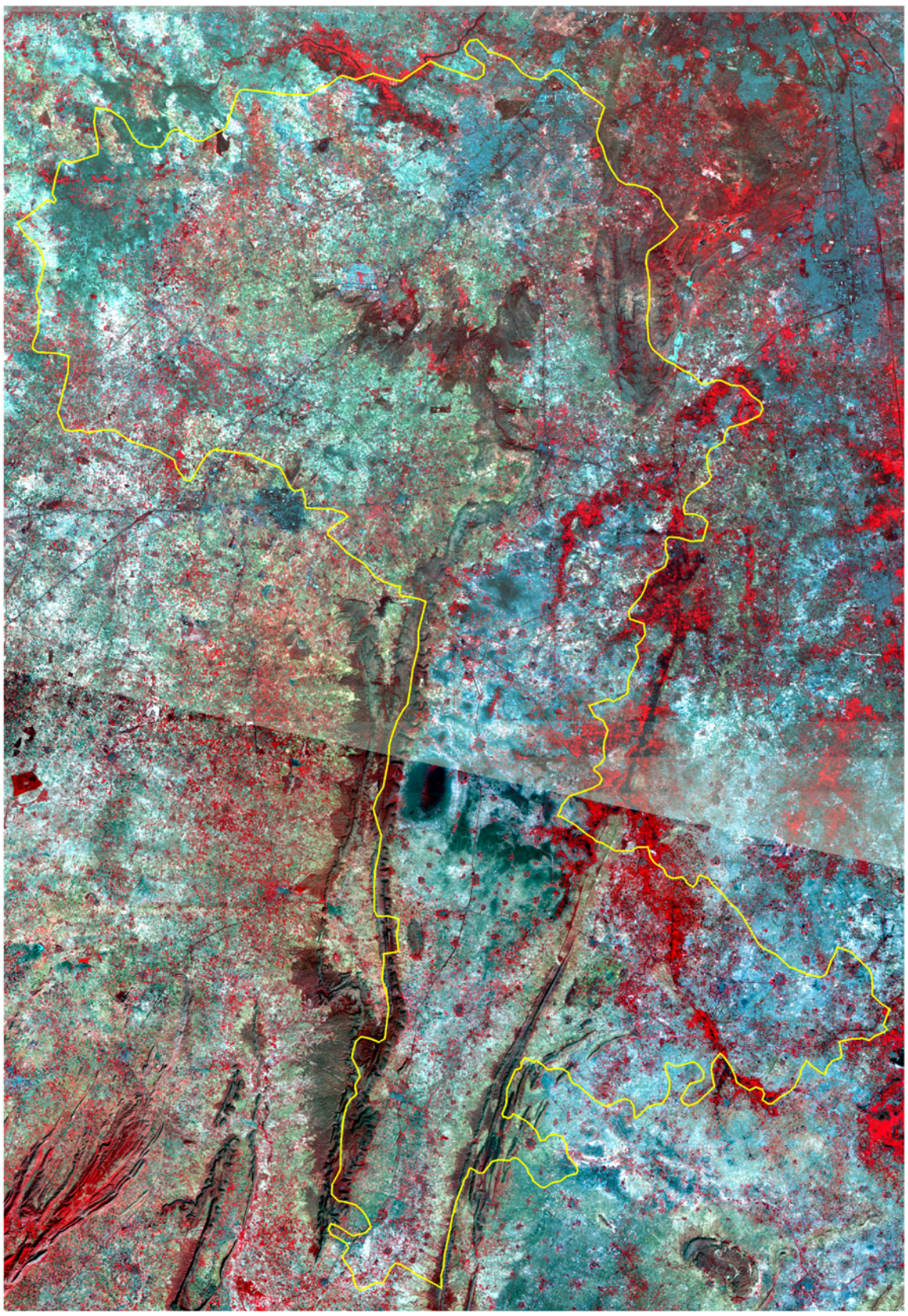
Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Gurgaon



IRS P6 LISS-III post monsoon data (2006)

7.1.19 Faridabad

The Faridabad district is located in the southern part of Haryana state. The district lies between 28°23'1.141" and 28°22'39.975" north latitudes and 77°20'44.617" and 77°32'36.575" east longitudes. The total geographical area of this district as per Census is 764 sq.kms. The district is named after the town Faridabad, which is said to have been founded in 1607 by Shaikh Farud, treasurer of Jahangir, with the object of protecting the highway, which passed through the town in those days.

The climate condition of the district slightly differs from other southern districts of Haryana state. The climate characteristics of the district are dry air, except during monsoon, hot summer and cold winters. The normal annual rainfall is 521.1 mm. It increases towards east. About 77 percent of annual rainfall in the district is received during the monsoon months i.e. July to September. On an average there are 28 rainy days in a year in the district. Temperature begins to rise from March to June. June is the hottest month. Maximum temperature may go up to 48°C. With the onset of monsoon, temperature starts falling and during monsoon period weather remains uncomfortable due to increased humidity and warm night. January is the coldest month. Occasionally during winter season, cold in association with western disturbances brings temperature down to freezing point.

The district has monotonous physiography and has alluvium deposits. The district is enjoying with very good network of canals, wells and tube- wells alongwith the river Yamuna as its natural water source. The district is also having a good potential for ground water in most of the places.

The western part the district is the extension of Rajasthan desert. The natural vegetation of the district is dominated by Kikar (Acacia).

Table 24: Area estimates of wetlands in Faridabad

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area	Open Water	
						Post-monsoon Area	Pre-monsoon Area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	1	80	2.25	11	0
2	1102	Ox-bow lakes/ Cut-off meanders	2	17	0.51	11	11
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	12	511	14.36	287	164
6	1106	River/Stream	1	1409	39.59	830	1116
	1200	**Inland Wetlands -Man-made**					
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	37	254	7.14	236	216
9	1203	Waterlogged	29	761	21.38	628	612
10	1204	Salt pans	-	-	-	-	-
		Sub-Total	**82**	**3033**	**85.22**	**2003**	**2119**
		Wetlands (<2.25 ha), mainly Tanks	526	526	14.78	-	-
		Total	**608**	**3559**	**100.00**	**2003**	**2119**

Area under Aquatic Vegetation	424	389

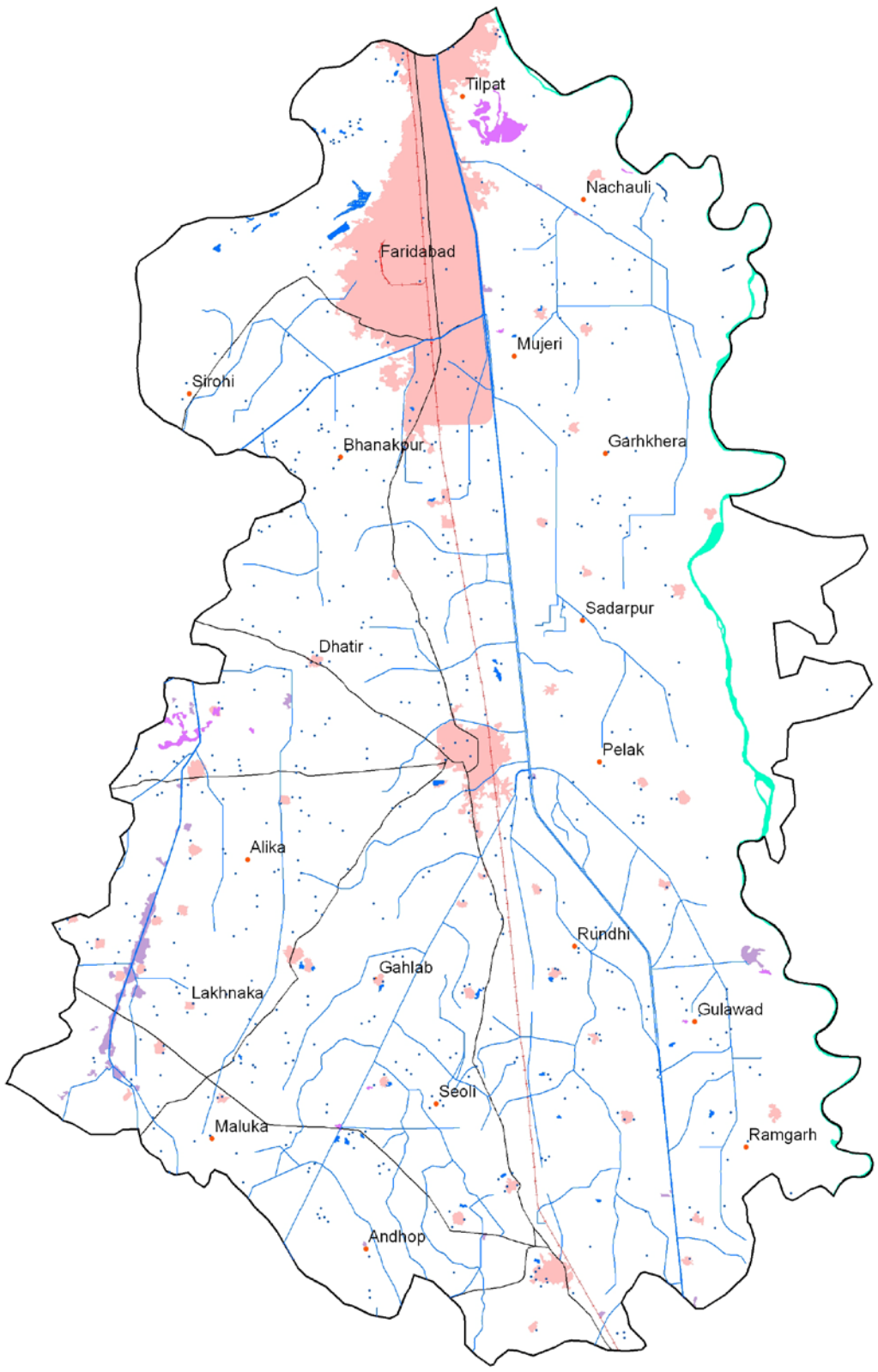
Area under turbidity levels		
Low	200	173
Moderate	887	1170
High	916	776

The total wetland area in the district is 3559 ha and rivers/streams contribute around 40 per cent wetland area and natural and manmade waterlogged area contributes almost equally to the total wetland area of the district. There are 82 wetlands having area more than 2.25 ha in the district where as less than 2.25 ha wetlands are 526. Three classes of turbidity were observed in both the season. Area of high turbidity is 916 ha and 776 ha in post and pre-monsoon season respectively. Out of 3559 wetland area 424 ha area was covered by aquatic vegetation while pre-monsoon season it was 389 ha.

State : Haryana

WETLAND MAP

District : Faridabad

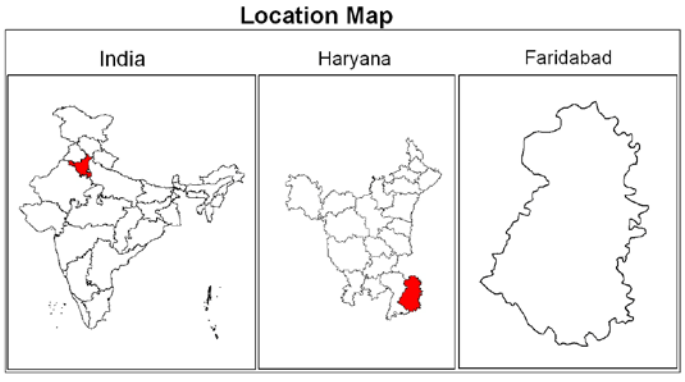


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



0 2.5 5 10 15 Kilometers

Data Source :

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

Prepared By :

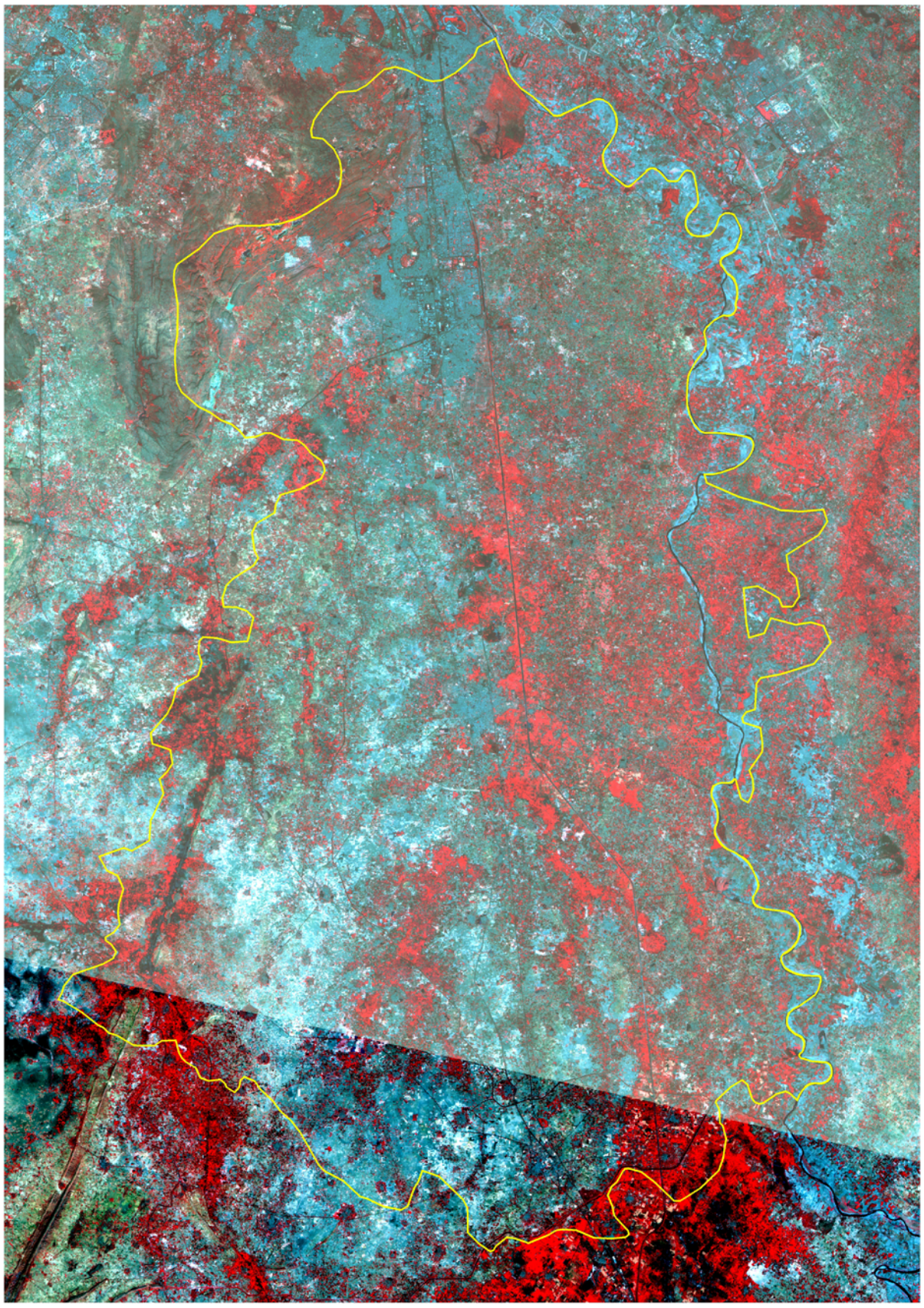
Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

Ministry of Environment and Forests
Government of India

State : Haryana

District : Faridabad



IRS P6 LISS-III post monsoon data (2006)

MAJOR WETLAND TYPES

8.0 MAJOR WETLAND TYPES OF HARYANA

Major wetland types observed in the state are Rivers, Waterlogged areas and Tanks/Ponds. Details are given in Plate-1. Ground truth data was collected for selected wetland sites. The standard proforma was used to record the field data. Field photographs are also taken to record the water quality (subjective), status of aquatic vegetation and water spread. The location of the features was recorded using GPS. Field photographs of different wetland types are shown in Plates 2a, and 2b.

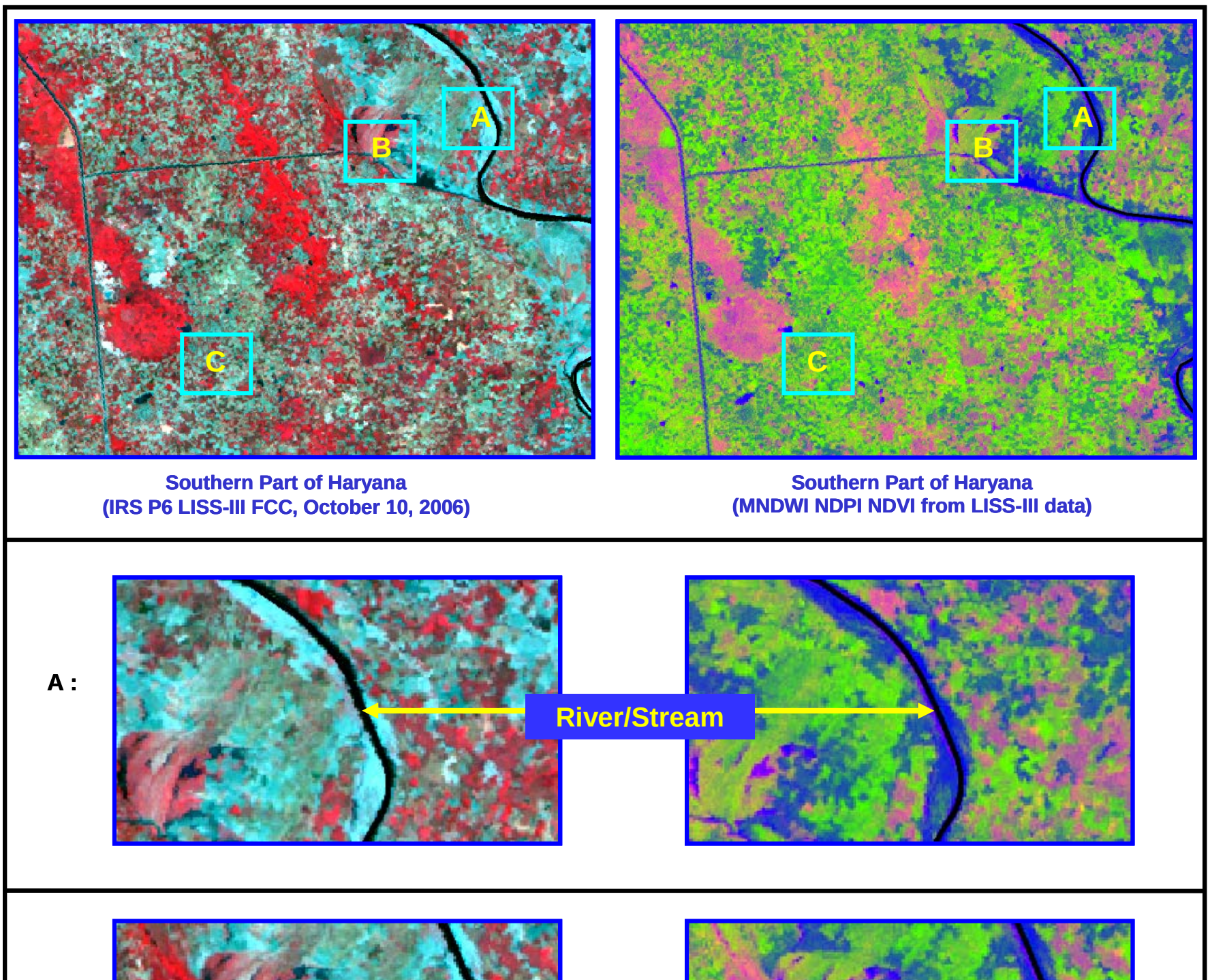


Plate - 1: Major wetland types of Haryana

Sr. No.	Description	Field photograph
1	**Wetland Type**: Waterlogged Area (Natural) **Location**: Longitude: 76^0 37’ 33” E Latitude : 28^0 45’ 55” N **Turbidity**: High **Aquatic vegetation**: Present	
2	**Wetland Type**: Tanks/Ponds **Location**: Longitude: 76^0 18’ 05” E Latitude : 28^0 57’ 18” N **Turbidity**: Low **Aquatic vegetation**: Present	
3	**Wetland Type**: River/Stream **Location:** Longitude : 77^0 15’ 55” E Latitude : 28^0 24’ 14” N **Turbidity**: Moderate **Aquatic vegetation**: Present	
4	**Wetland Type**: Waterlogged Area (Natural) **Location**: Longitude: 77^0 21’ 12” E Latitude : 28^0 26’ 30” N **Turbidity**: High **Aquatic vegetation**: Present	

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

Sr. No	Description	Field Photograph
5	**Wetland Type**: Tanks/Ponds **Location**: Longitude: 76^0 49’ 38” E Latitude : 29^0 57’ 40” N **Turbidity**: Low **Aquatic vegetation**: Nil	
6	**Wetland Type**: Tanks/Ponds **Location**: Longitude: 77^0 15’ 54” E Latitude : 28^0 24’ 13” N **Turbidity**: High **Aquatic vegetation**: Present (Algal-bloom)	
7	**Wetland Type**: Lake (Sultanpur Bird Sanctuary) **Location**: Latitude : 28º 27' 49" N Longitude : 76º 53' 30" E **Aquatic vegetation**: Present (Floating / Submerged / Emergent) **Turbidity**: Low	
8	**Wetland Type**: Waterlogged Area (Man-made: Bhindawas Bird Sanctuary) **Location**: Latitude : 28º 32' 2" N Longitude : 76º 33' 3" E **Aquatic vegetation**: Present (Floating / Submerged) **Turbidity**: Moderate	

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

IMPORTANT WETLANDS OF HARYANA

9.0 IMPORTANT WETLANDS OF HARYANA

The wetlands of the state mainly comprise of small lakes/ tanks and waterlogged areas mainly associated with canals. Most of the waterlogged areas are infested by phragmatis grass. Some of the village tanks have been restored and well managed to meet the local needs. There are three wetlands which attract migratory birds and two are named as bird sanctuaries - sultanpur Bird sanctuary and Bhindawas Bird Sanctuary located in Gurgaon district and Jhajjar district respectively. These wetlands are located near to national capital and attract large number of tourists during winter season. Shallow wetlands are being used for agriculture and fodder production and it is a regular practice observed in and around Mewat district. Othe than two bird sanctuaries, Damdama lake and Brahm Sarovar are important wetland sites of Haryana.

Extensive field work was carried out for important wetland sites. Wetland maps have been prepared for 5 km buffer area of each wetland sites. Details of each wetland and wetland map of 5 km buffer area are shown in plates 3 to 17.

9.1 Sultanpur Bird Sanctuary

Name: Sultanpur Bird Sanctuary

Location:

Latitude : 28° 28 ' 15" N and 28° 27' 14" N
Longitudes:76° 52' 50" E and 76° 54' 2" E

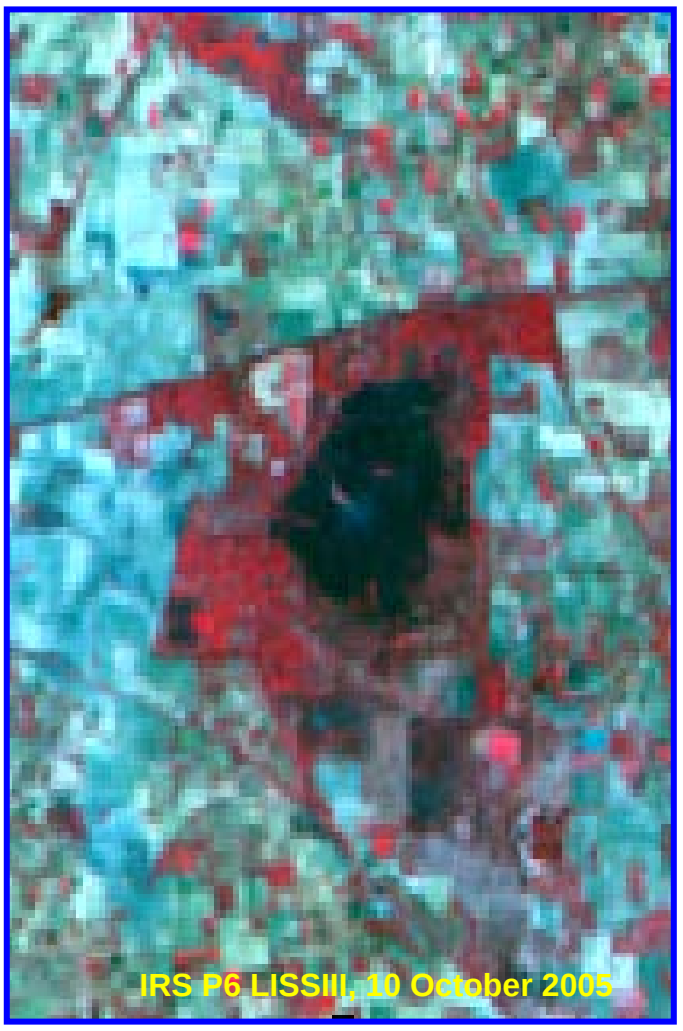
Area: 145 ha
Altitude: 220 – 230 m
Average Annual Rainfall:
Average annual rainfall: 300 mm
Mean Temperature: 24 to 28° C.
Morphometric features :
Maximum depth 1- 2m
Average depth30 cm

Sultanpur bird sanctuary is one of the early notified bird sanctuaries by the state of Haryana. It is situated on National High way no. 8 in Gurgaon district. It is a heaven for bird lovers in the state. This is one of the famous lakes in the country, so far as the variety of the migrant birds from Europe and Siberia. These birds come here with the onset of winter and returns back at the onset of summer. One can see the abundance of birds, more than a 100 species in a day, in a most natural surrounding at really close quarters.

Vegetation:
There are some areas dominated by Typha sps. and phragmites (Grasses). Shoreline is dominated by emergent vegetation and floating vegetation mainly limna and water hyacinth. Most of the area around the core area is under cultivation.

Fauna:
The wildlife in the park includes ungulates, a verity of waterfowl, notably pelicans, ducks, geese, and cranes. Many species of raptors occur in the area, including the Imperial eagle, greater spotted eagle, and tawny eagle and marsh harrier.

Overall turbidity of lake water is moderate.



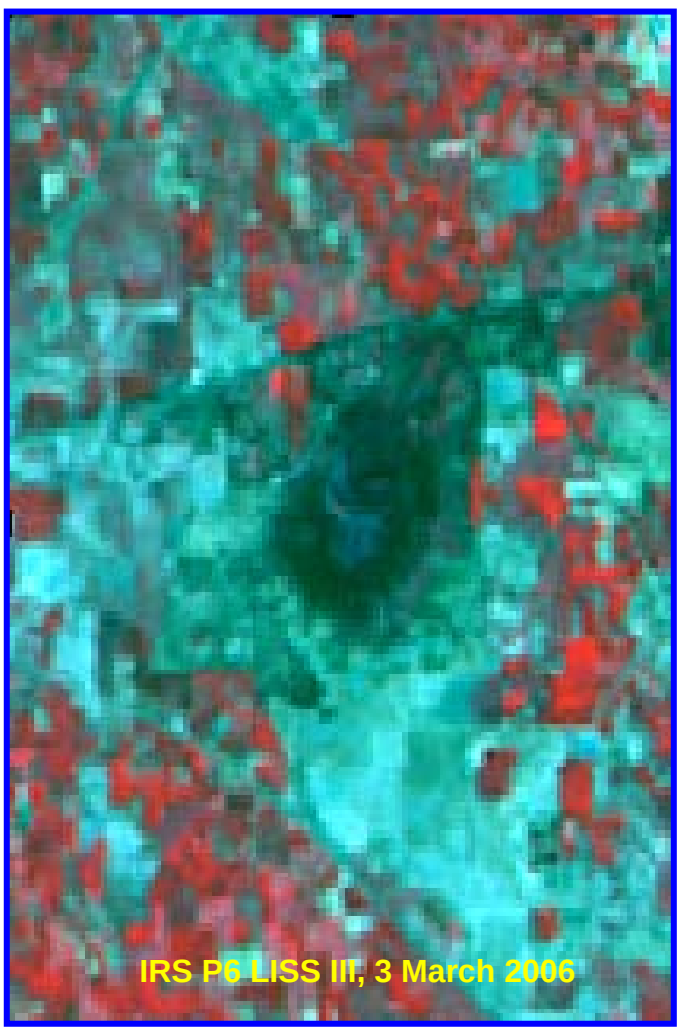
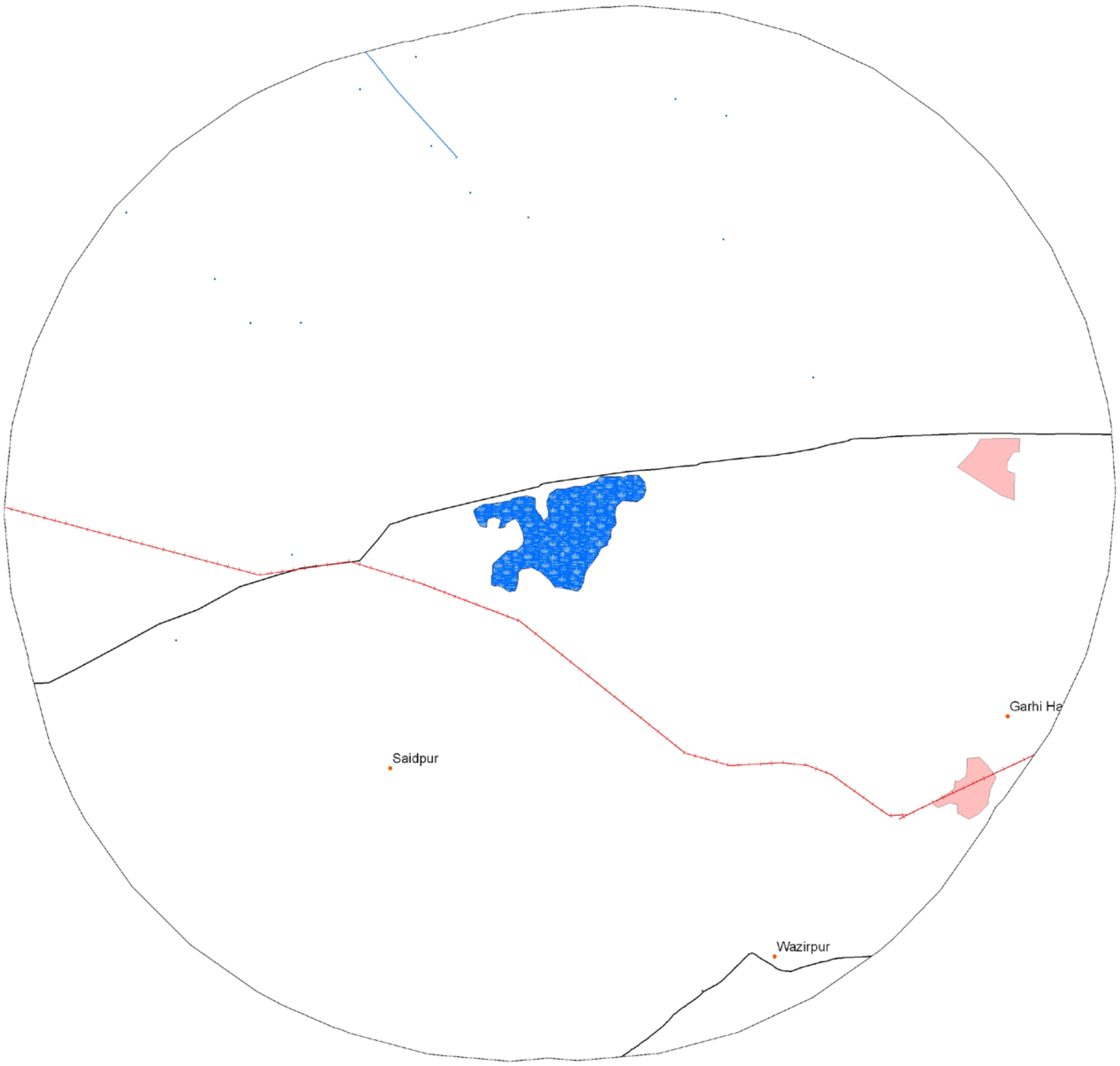


Plate 3: Sultanpur Bird Sanctuary

State : Haryana

WETLAND MAP

Sultanpur Bird Sanctuary

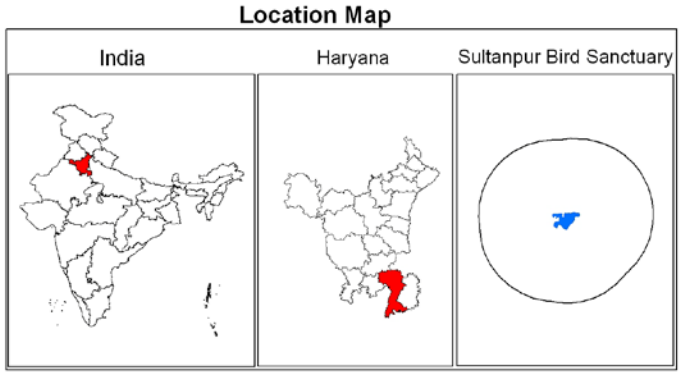


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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



0 0.5 1 2 3 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

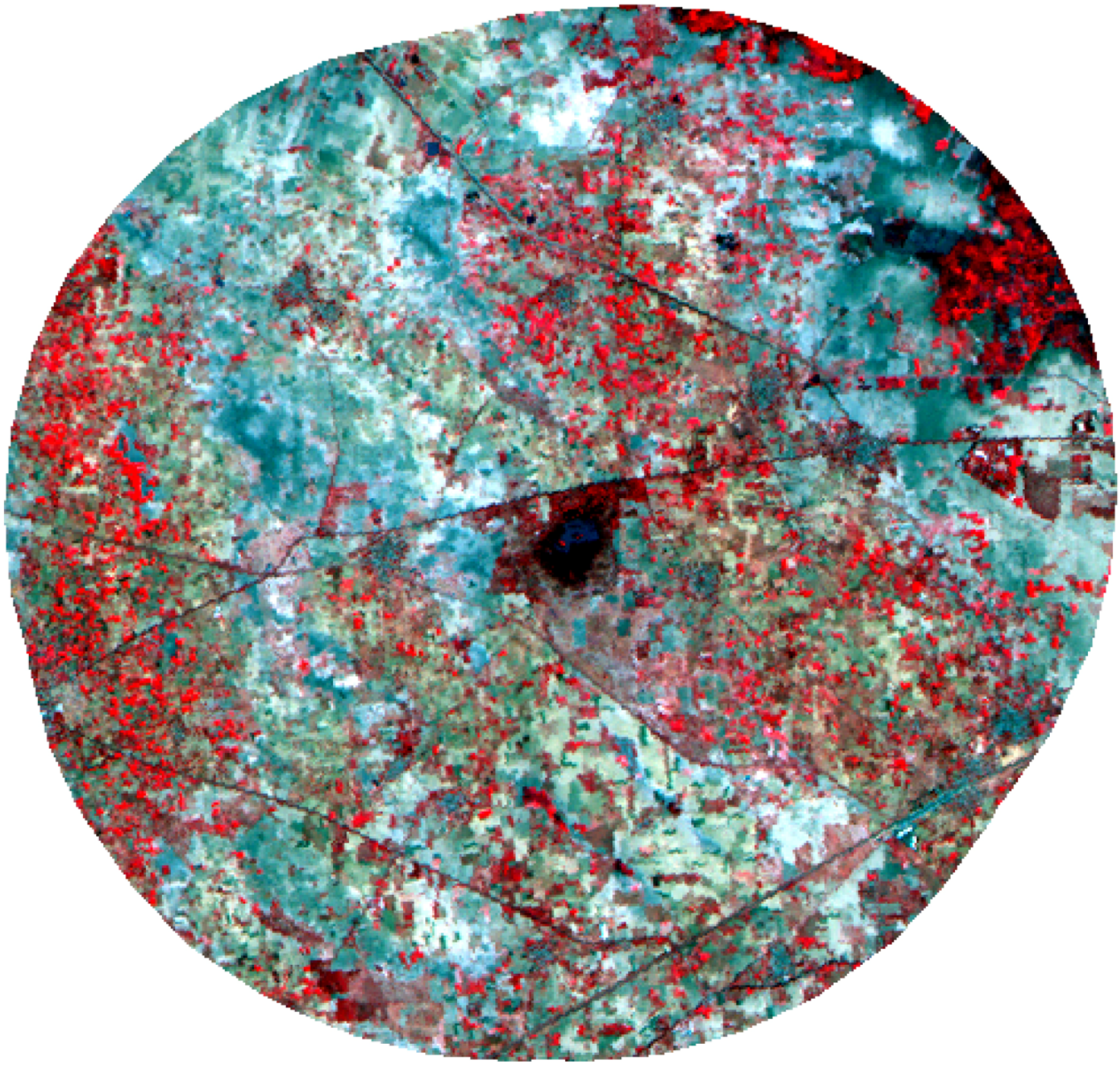
Sponsored By :

Ministry of Environment and Forests
Government of India

Plate 4: Wetland map - 5 km buffer area of Sultanpur Bird Sanctuary

State : Haryana

Sultanpur Bird Sanctuary



IRS P6 LISS-III post monsoon data (2006)

Plate 5: IRS LISS-III FCC - 5 km buffer area of Sultanpur Bird Sanctuary

9.2 Bhindawas Bird Sanctuary

Name: Bhindawas Bird Sanctuary

The peripheral embankment is man made and basically constructed to store the escaped water of Jawaharlal Nehru canal through an escape channel

Location:

Latitude : 28^{o} 32 ' 47" N and 28^{o} 31' 57" N
Latitude : 76^{o} 31' 54" E and 76^{o} 34' 10" E

Area: 435 ha
Altitude: 200 – 230 m
Average Annual Rainfall:
Average annual rainfall: 300 mm
Mean Temperature: 24 to 28^{o} C.
Morphometric features :
Maximum depth 1- 2m
Average depth30 cm
Vegetation:
Mainly acacias and eucalyptus species plantations are found. The 412 ha low lying storage area has twelve kilometers of motorable embankments running round the perimeter which is planted with acacias and eucalyptus species.
Fauna:
Blue Peafowl, White-throated Kingfisher, Rose-ringed, Great Egret, Eurasian Collared Dove, Mallard, Crested Lark, Jungle Babbler, Ashy Prinia etc are some of the more common birds found in the sanctuary. In addition to the above birds, the antelope Neelgain (Blue Bull) and Jungle Cat can also be seen in the sanctuary.

Overall turbidity of lake water is low.
.

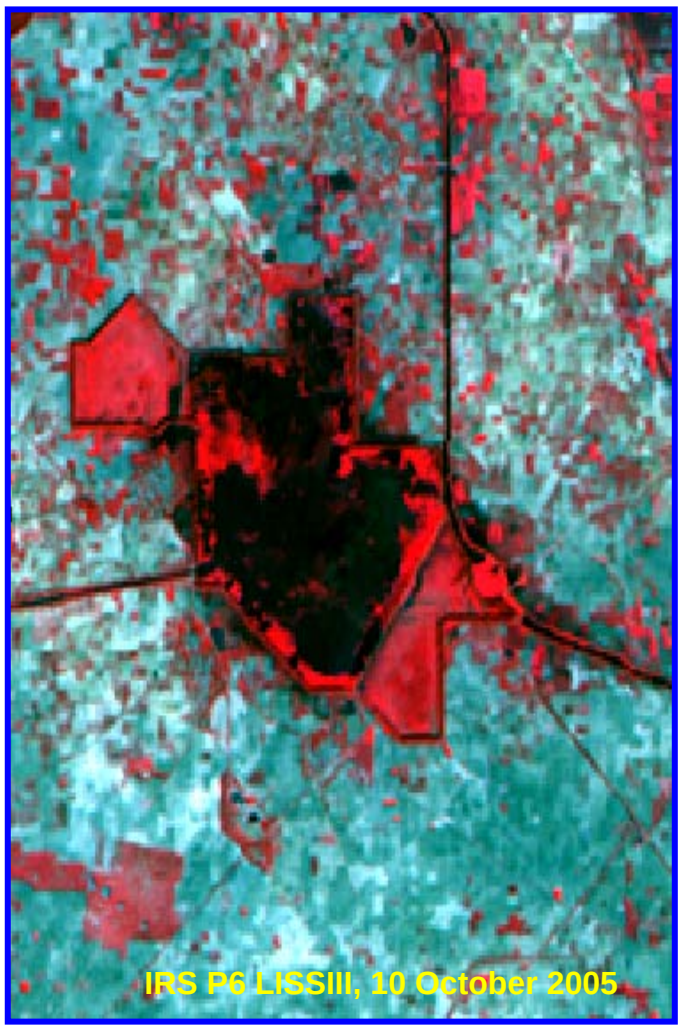
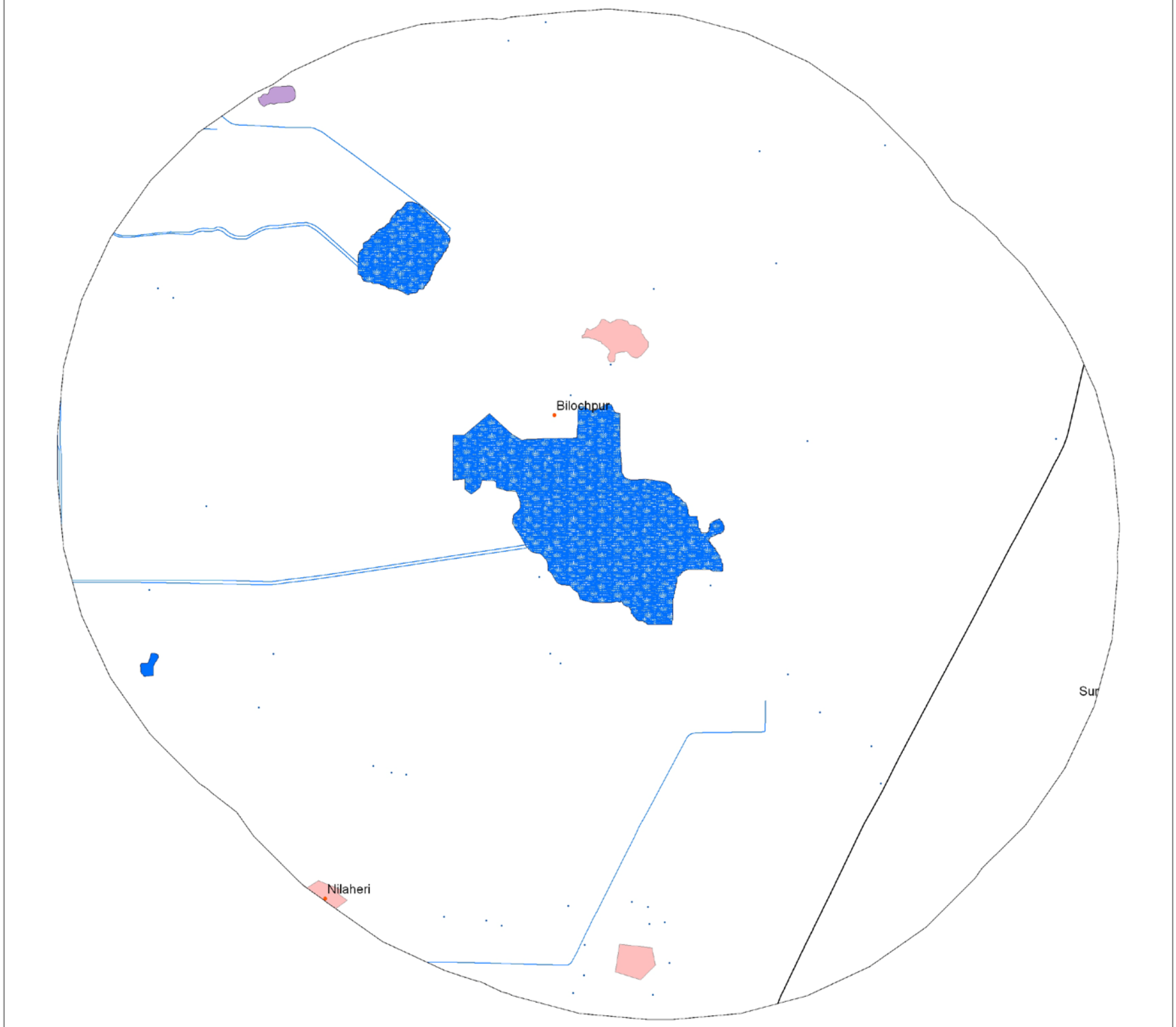


Plate 6: Bhindawas Bird Sanctuary

State : Haryana

WETLAND MAP

Bhindawas Bird Sanctuary

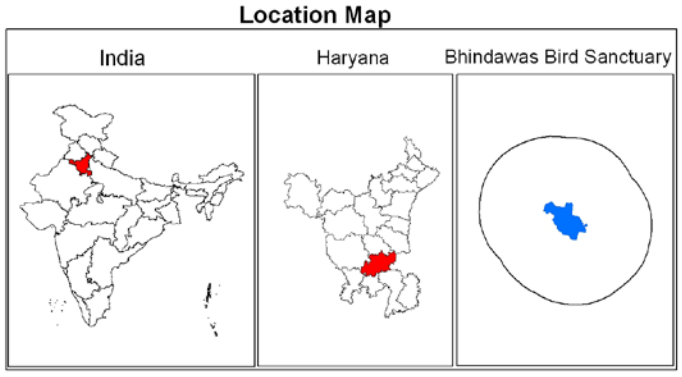


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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



0 0.5 1 2 3 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

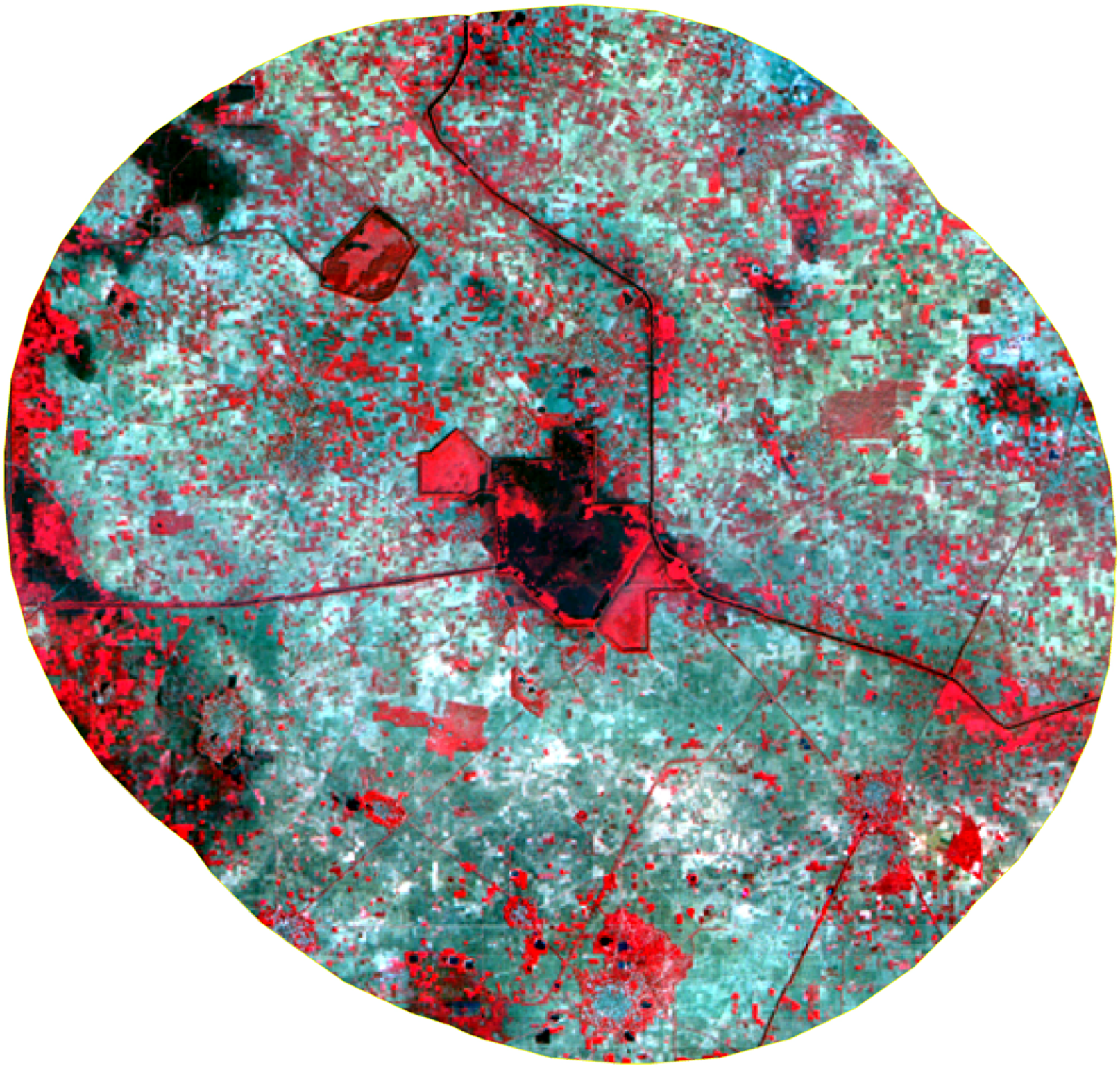
Sponsored By :

Ministry of Environment and Forests
Government of India

Plate 7: Wetland map - 5 km buffer area of Bhindawas Bird Sanctuary

State : Haryana

Bhindawas Bird Sanctuary



IRS P6 LISS-III post monsoon data (2006)

Plate 8: IRS LISS-III FCC - 5 km buffer area of Bhindawas Bird Sanctuary

9.3 Damdama Lake

Name: Damdama Lake

Location:

Latitude : 28° 18 ' 50" N and 28° 17' 54"
Longitudes:77° 07' 37" E and 77° 08' 09" E

Area: 43 ha

Average Annual Rainfall:

Average annual rainfall: 300 mm
Mean Temperature: 24 to 28° C.

Morphometric features :

Maximum length: 1.5 km
Maximum breadth: 0.5 km
Average depth: 38 cm

Vegetation:

Aquatic vegetation of this lake includes grasses, reeds, water hyacinth, Ipomea aquatica and acacia sps. .

Fauna:

White-throated Kingfisher, Great Egret, Eurasian Collared Dove, spoon bill, Crested Lark, Jungle Babbler, cormorant, Green bee eater etc are some of the more common birds found in and around the lake.
Overall turbidity is moderate.

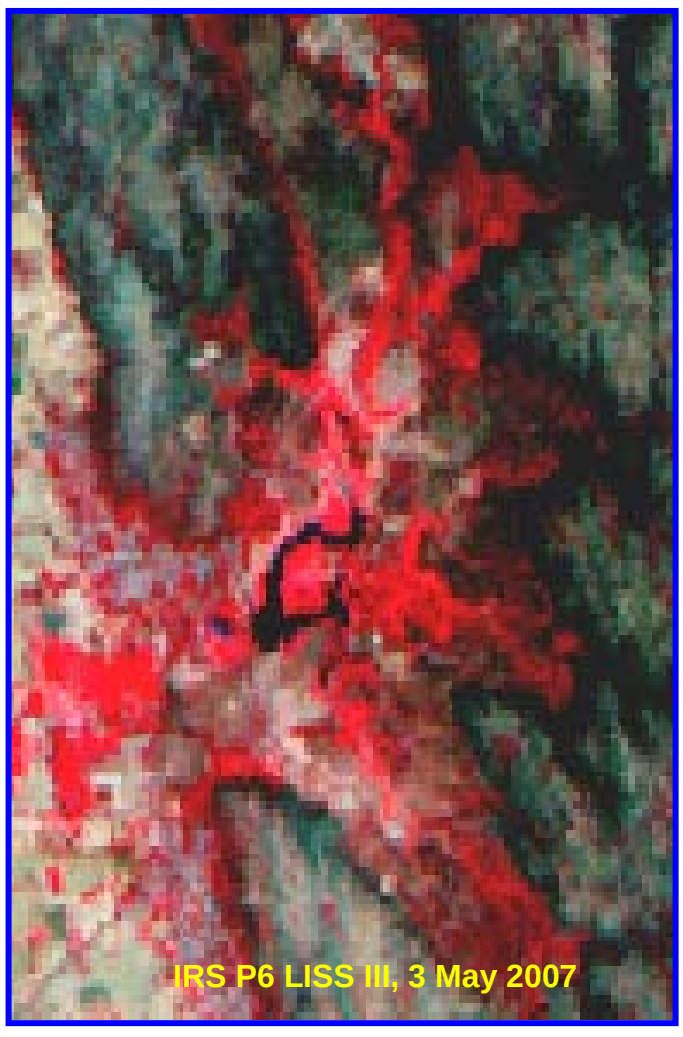
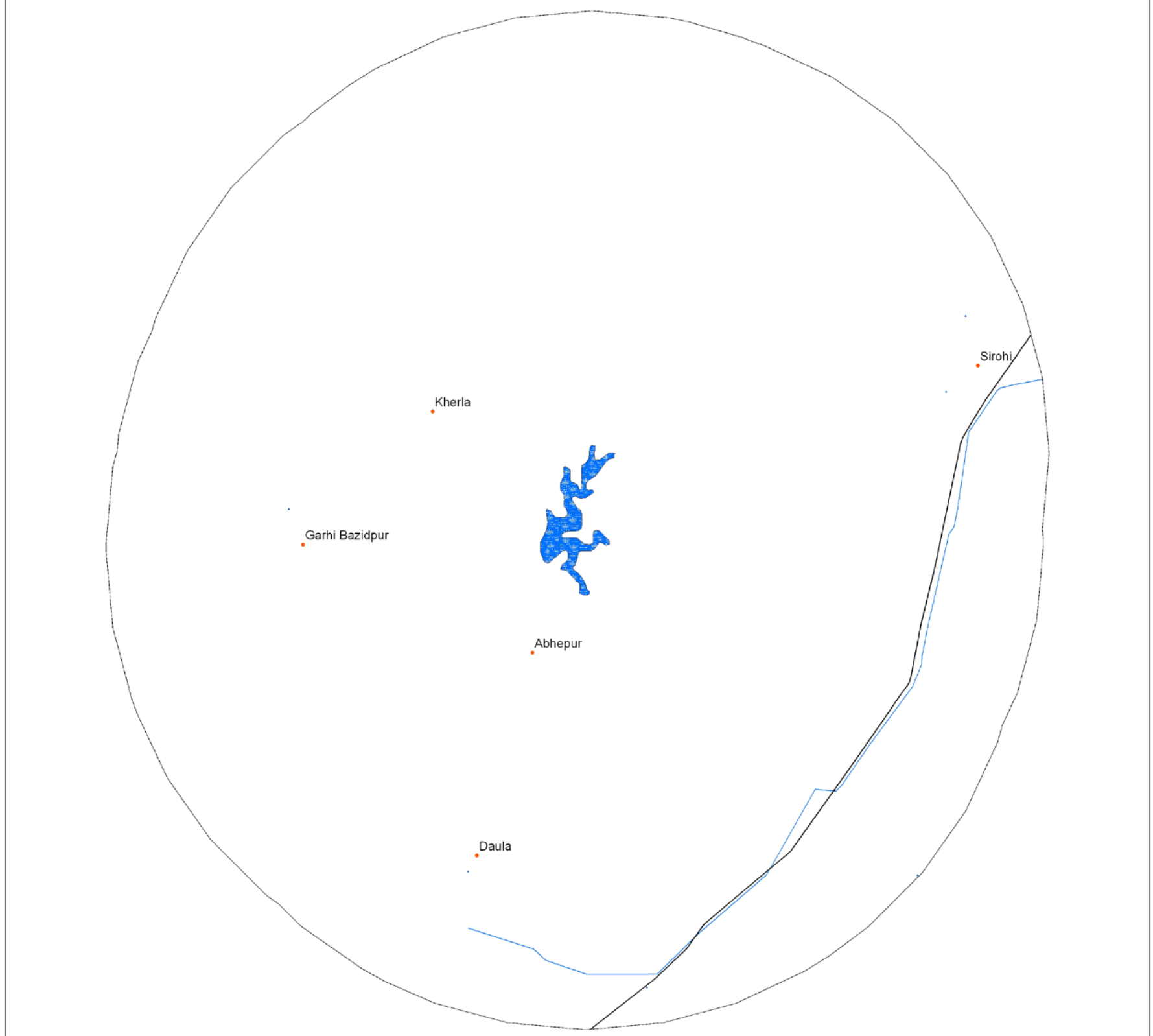


Plate 9: Damdama Lake

State : Haryana

WETLAND MAP

Damdama Lake

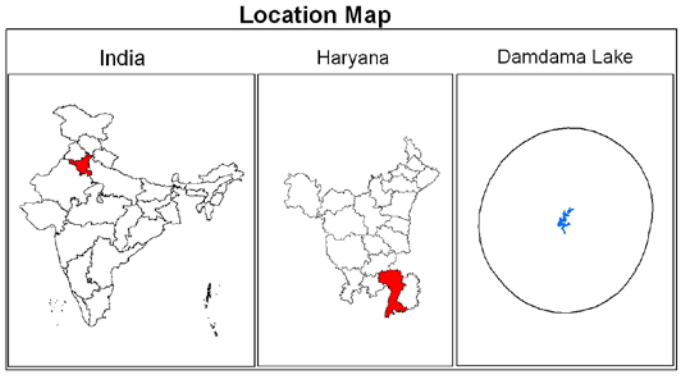


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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



0 0.5 1 2 3 Kilometers

Data Source :

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Prepared By :

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Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

Sponsored By :

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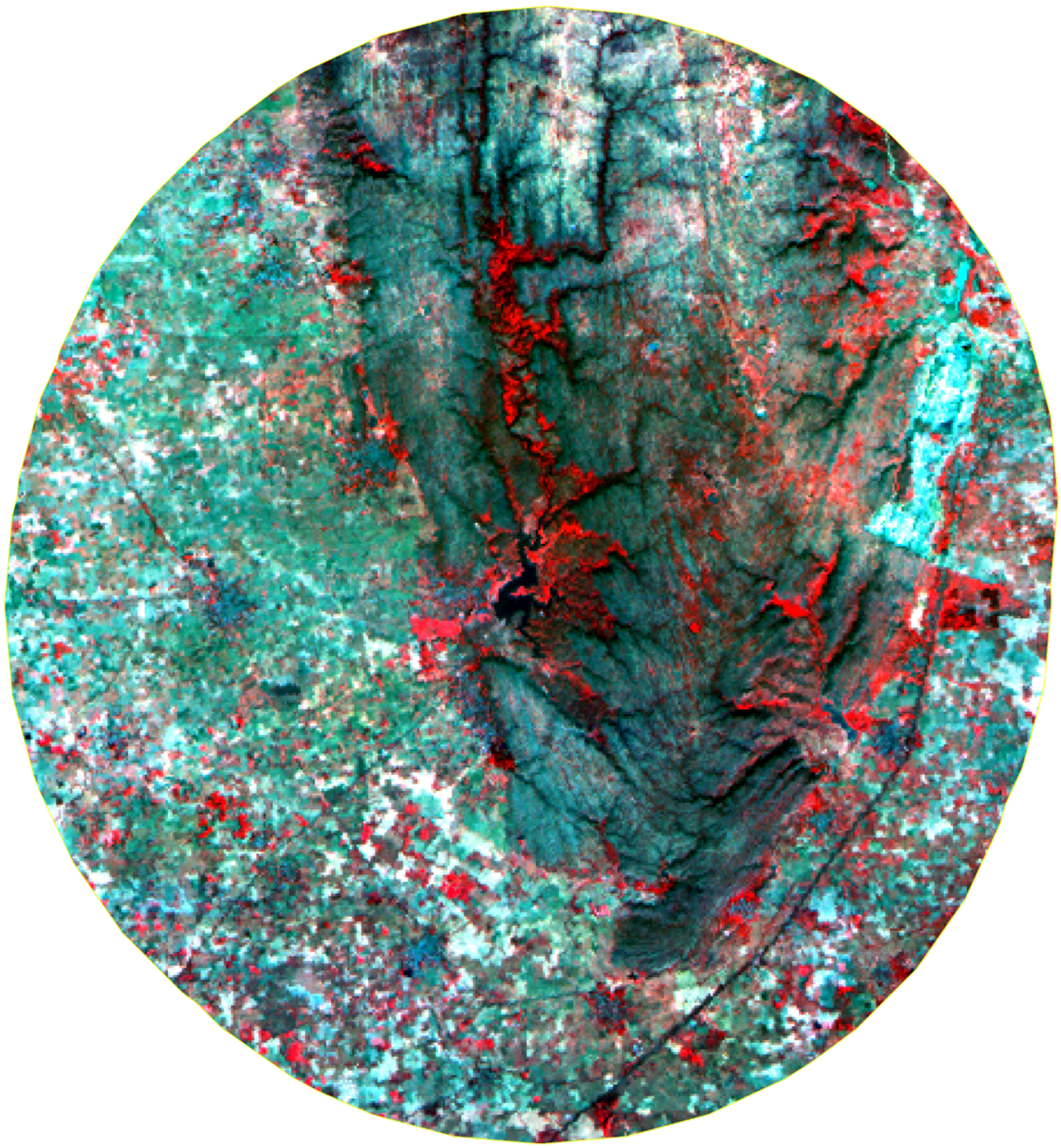
Government of India

Plate 10: Wetland map - 5 km buffer area of Damdama Lake

State : Haryana

Damdama Lake



IRS P6 LISS-III post monsoon data (2006)

Plate 11: IRS LISS-III FCC - 5 km buffer area of Damdama Lake

9.4 Brahm Sarovar

Name: Brahm Sarovar

Location:
Latitude : 29° 57’ 51” N and 29° 57’ 32” N
Longitudes:76° 49’ 20” E and 76° 49‘ 59” E

Area: 44 ha

Average Annual Rainfall:
Average annual rainfall: 300 mm
Mean Temperature: 24 to 28° C.

Morphometric features :
Maximum depth 1 km
Average depth 475 cm

Vegetation:
There is no aquatic vegetation except phytoplankton.

Fauna:
It is a man made lake and managed by the authorities to encourage recreational and religious rites. Fauna mainly includes zooplankton and fishes.
Overall turbidity is moderate.

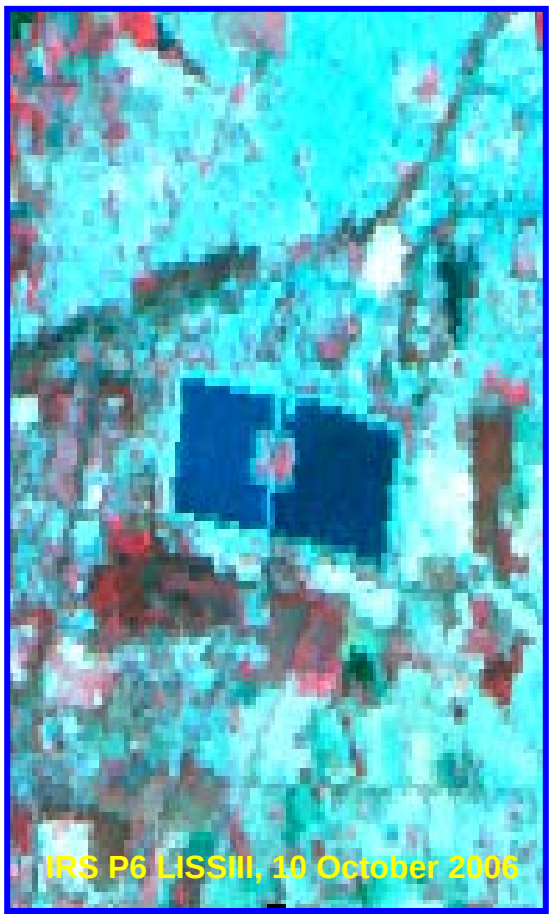
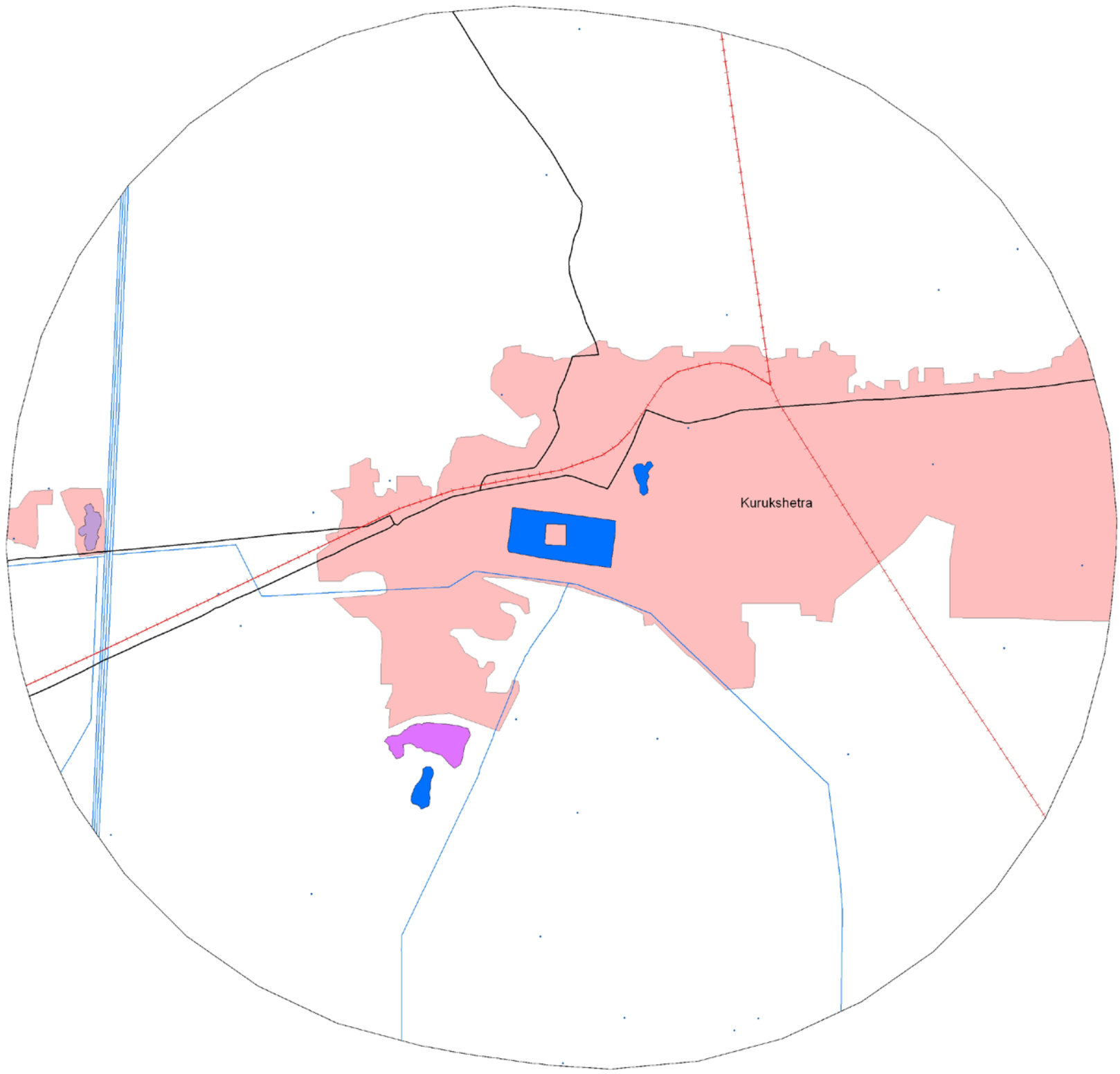


Plate 12: Brahm Sarovar

State : Haryana

WETLAND MAP

Brahm Sarovar

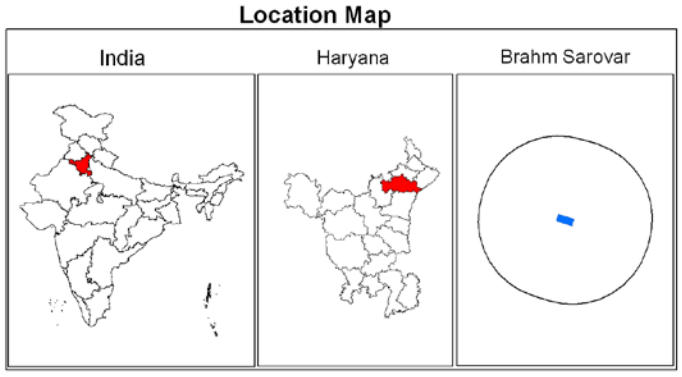


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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



0 0.5 1 2 3 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
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and
M. G. Science Institute, Ahmedabad

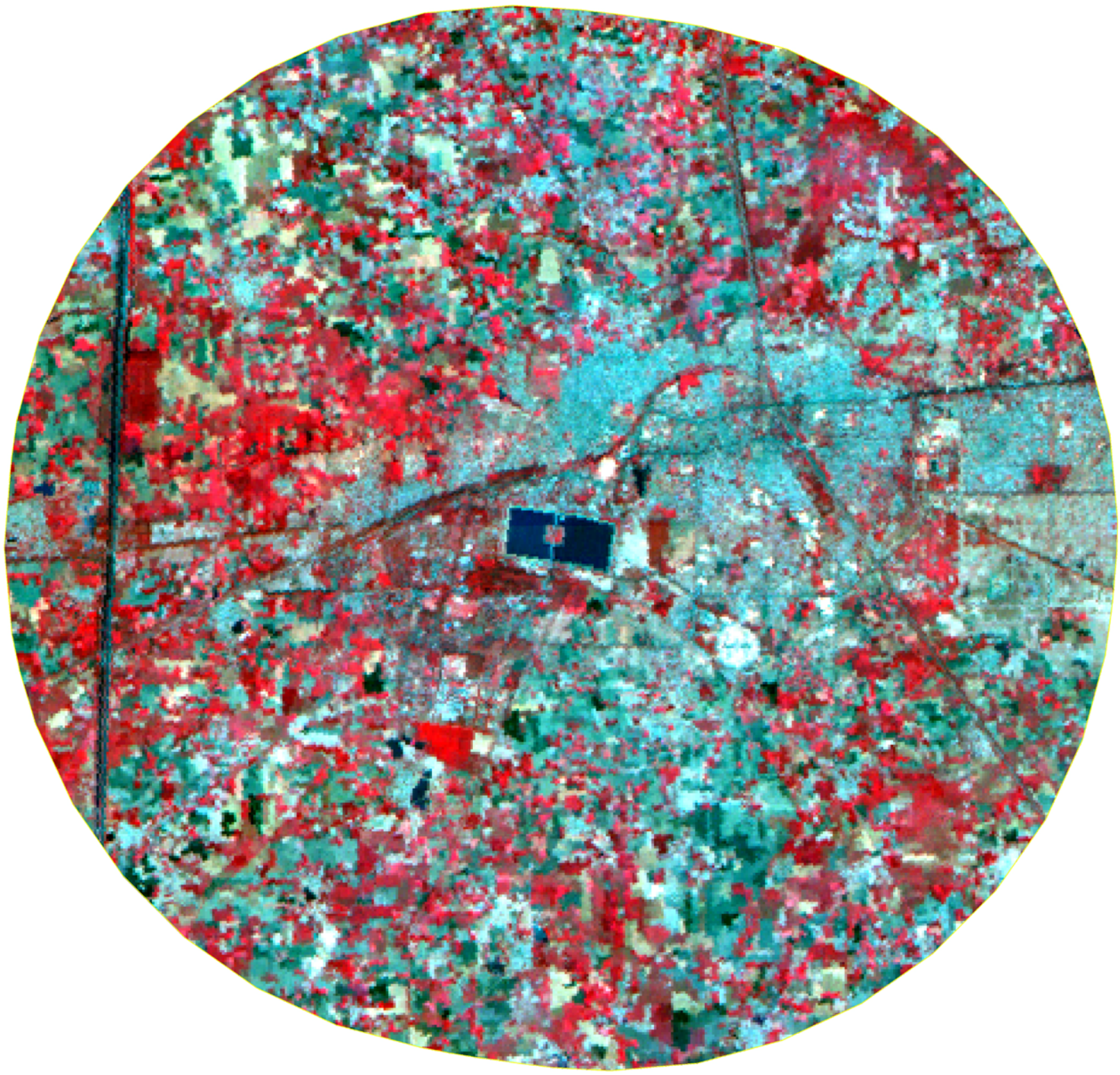
Sponsored By :

Ministry of Environment and Forests
Government of India

Plate 13: Wetland map - 5 km buffer area of Brahm Sarovar

State : Haryana

Brahm Sarovar



IRS P6 LISS-III post monsoon data (2006)

Plate 14: IRS LISS-III FCC - 5 km buffer area of Brahm Sarovar

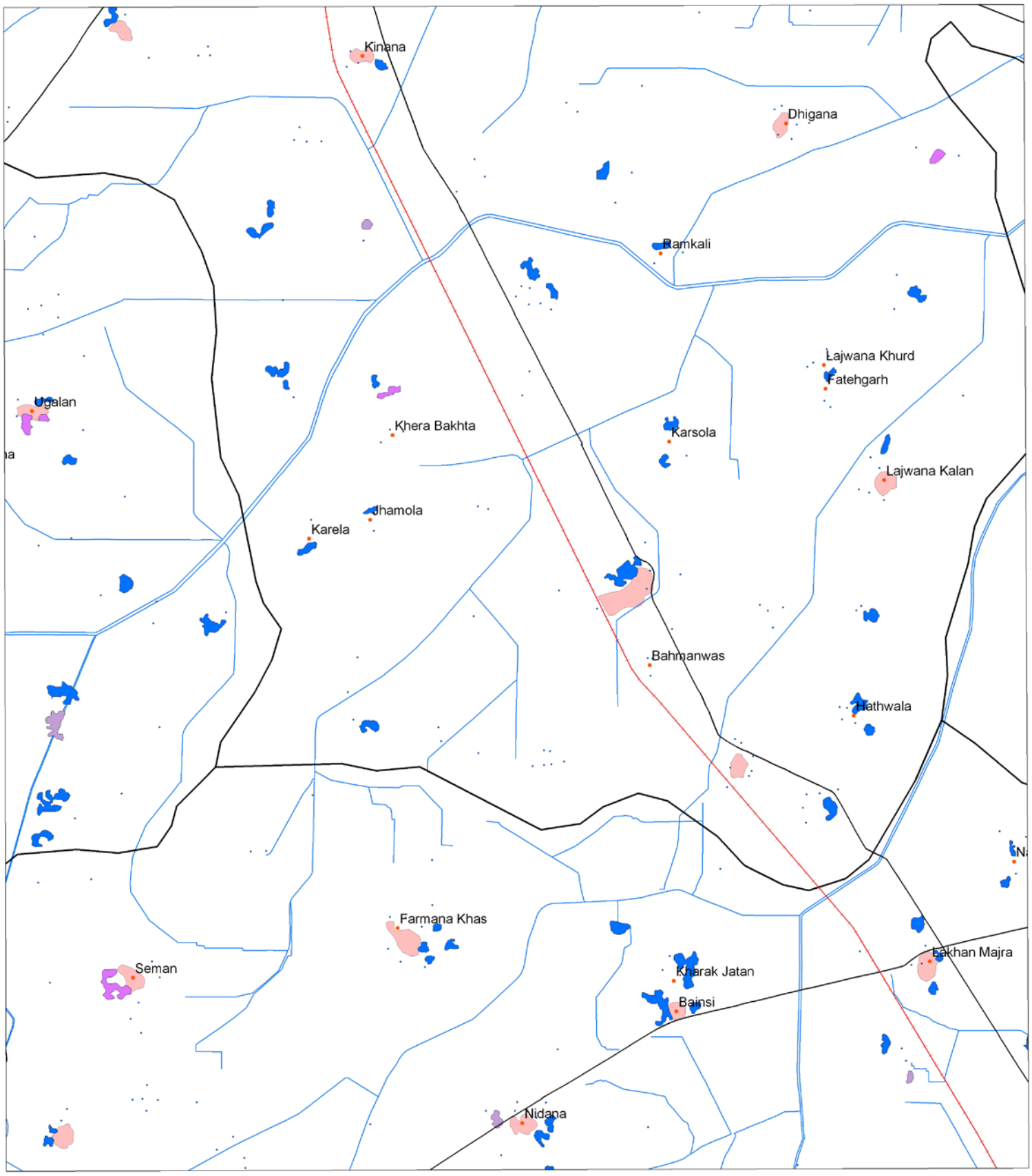
SOI MAP SHEET-WISE WETLAND MAPS

(Selected)

State : Haryana

WETLAND MAP

Map No. : 53C/08

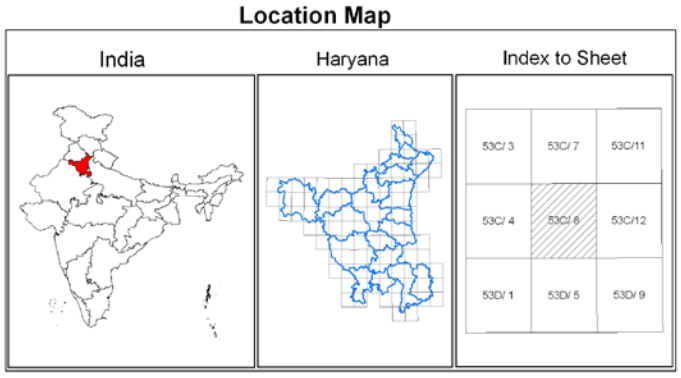


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

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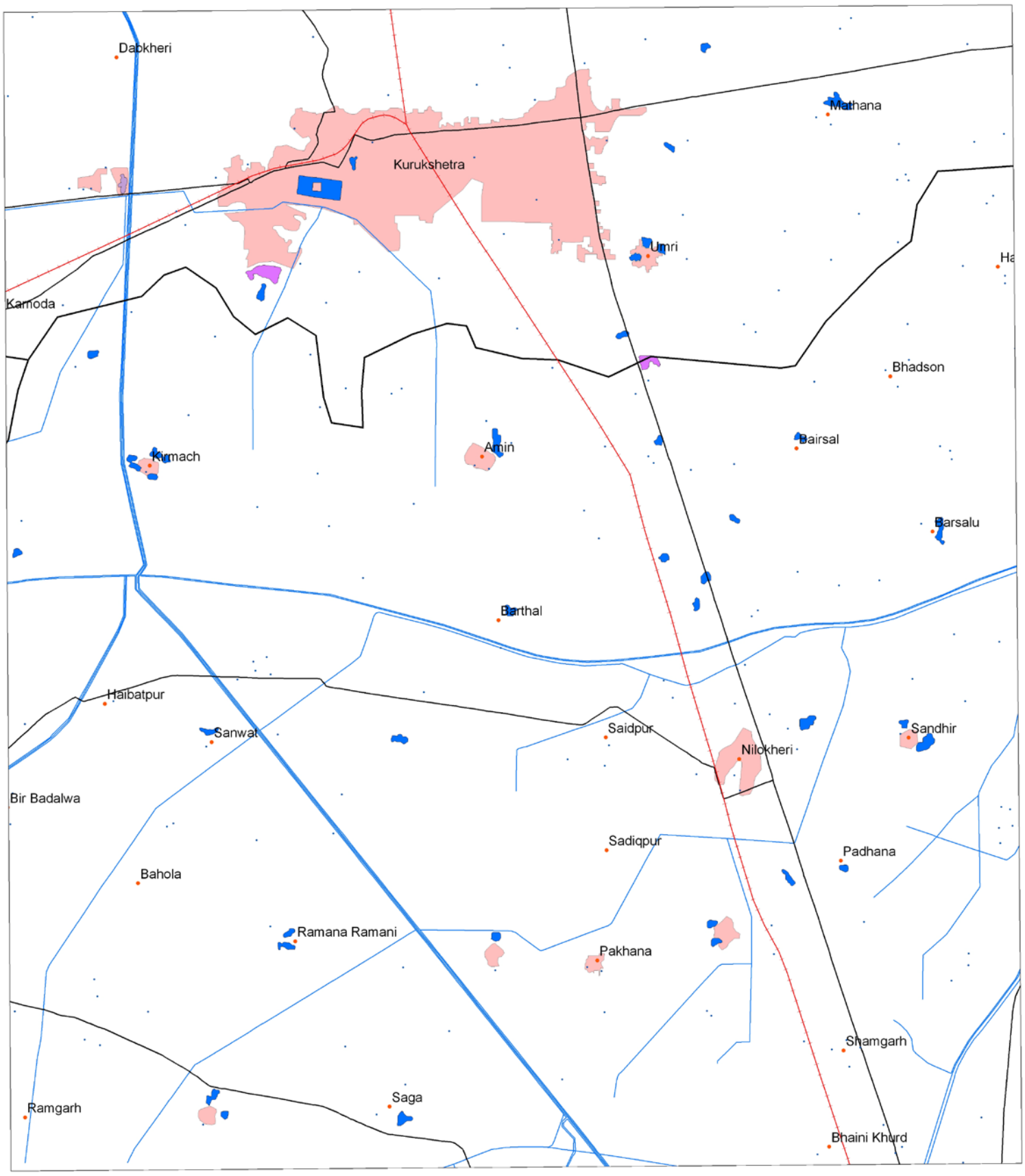
Government of India

State : Haryana

WETLAND MAP

Map No. : 53C/13

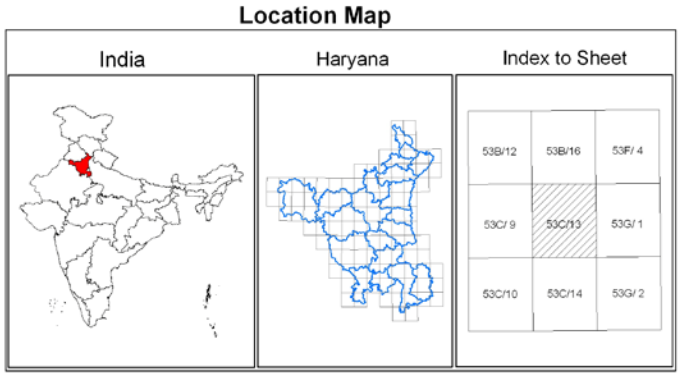


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Prepared By :

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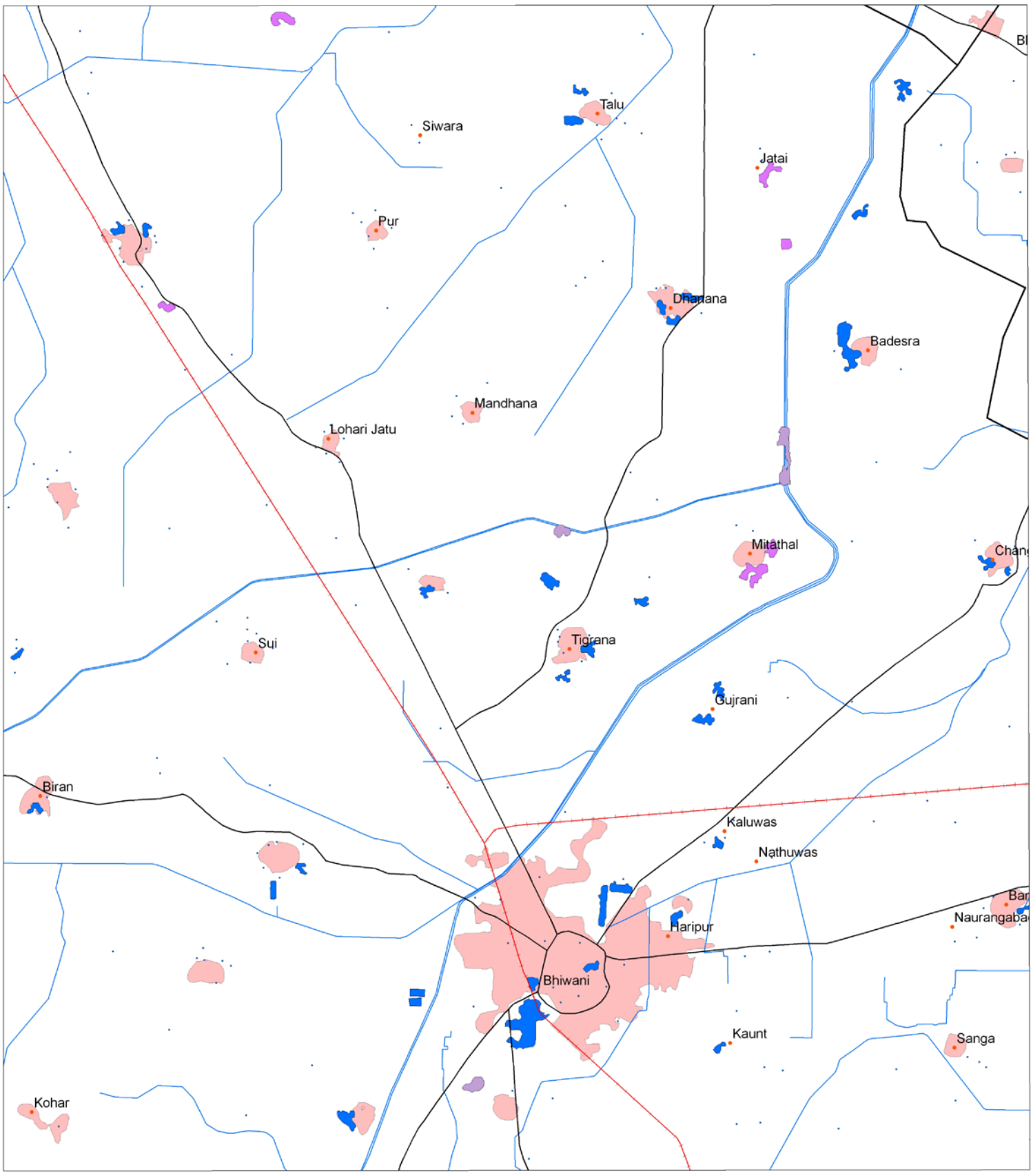
Government of India

State : Haryana

WETLAND MAP

Map No. : 53D/01

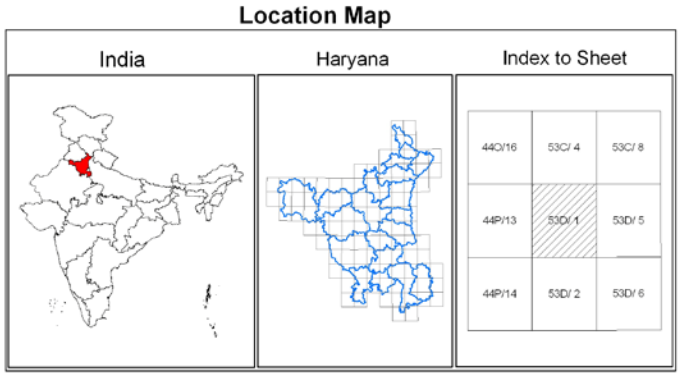


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

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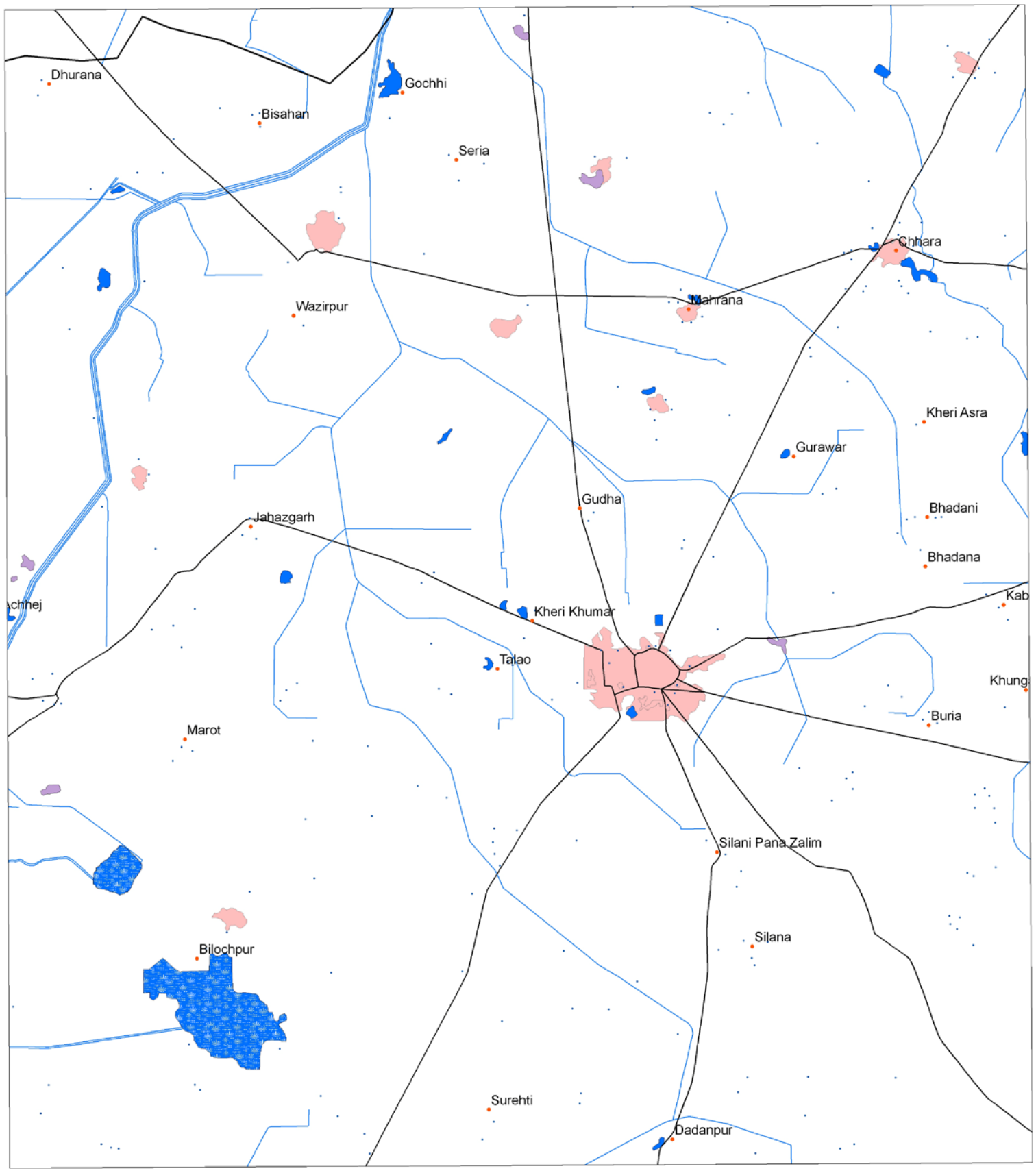
State : Haryana

WETLAND MAP

Map No. : 53D/10

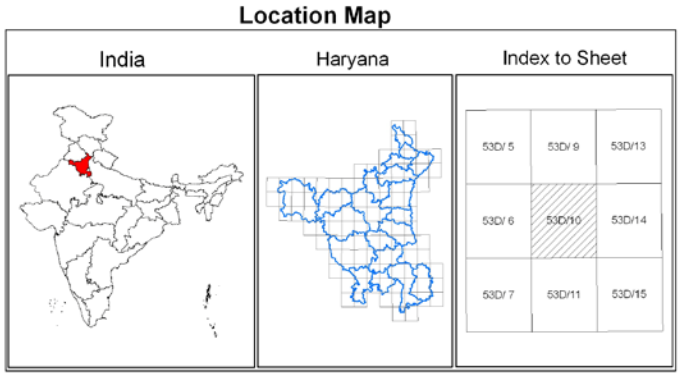


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

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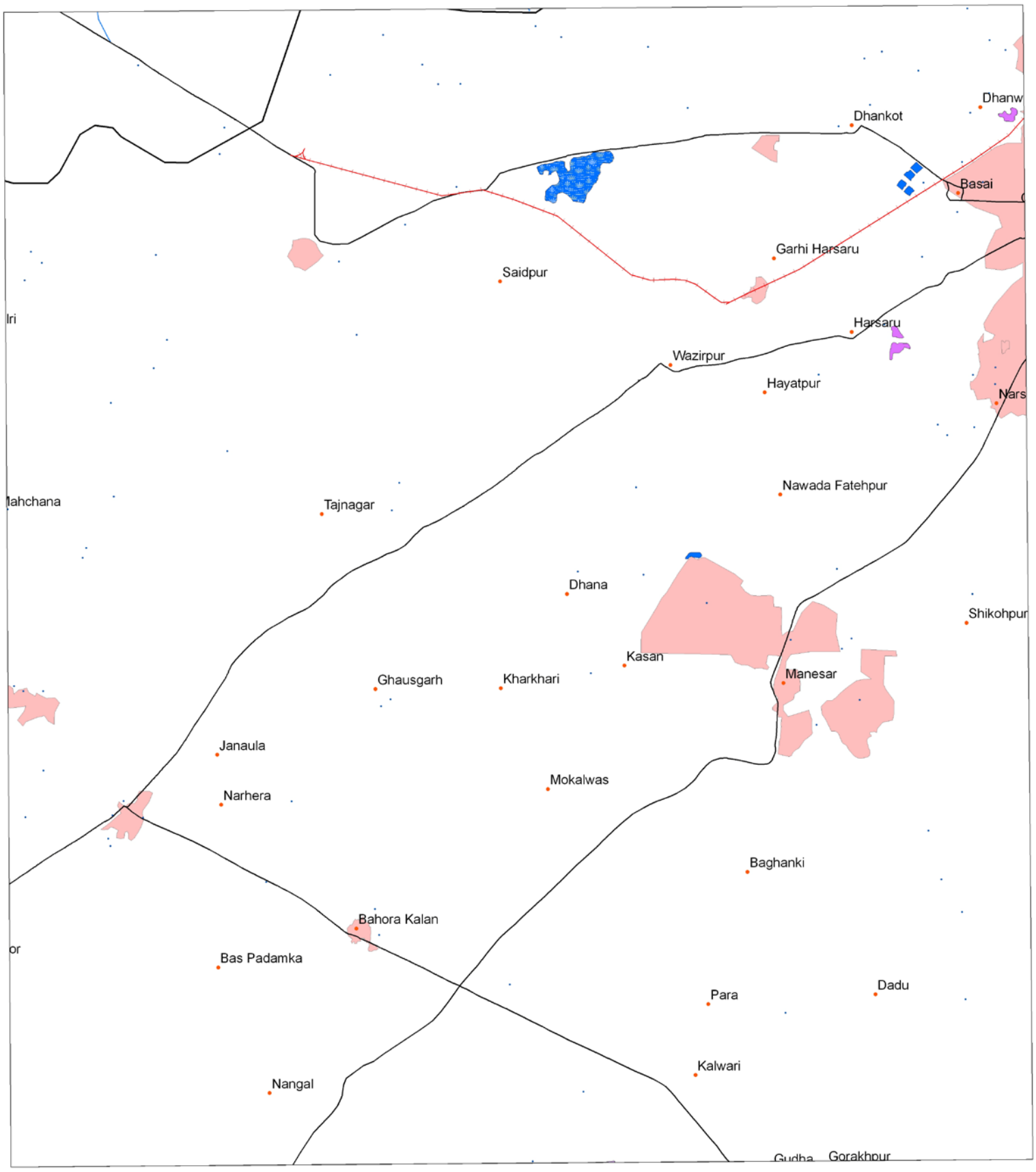
Government of India

State : Haryana

WETLAND MAP

Map No. : 53D/15

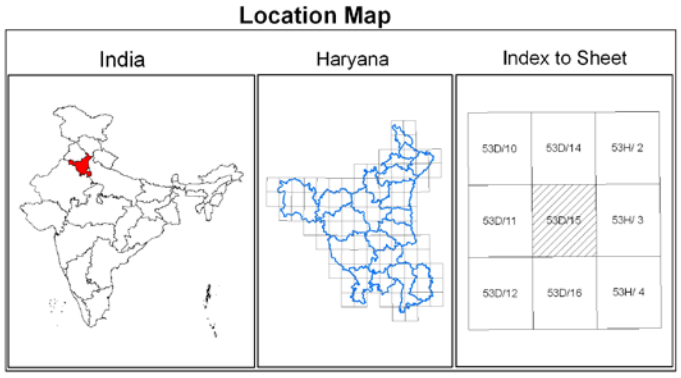


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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



0 1 2 4 6 Kilometers

Data Source :

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

Prepared By :

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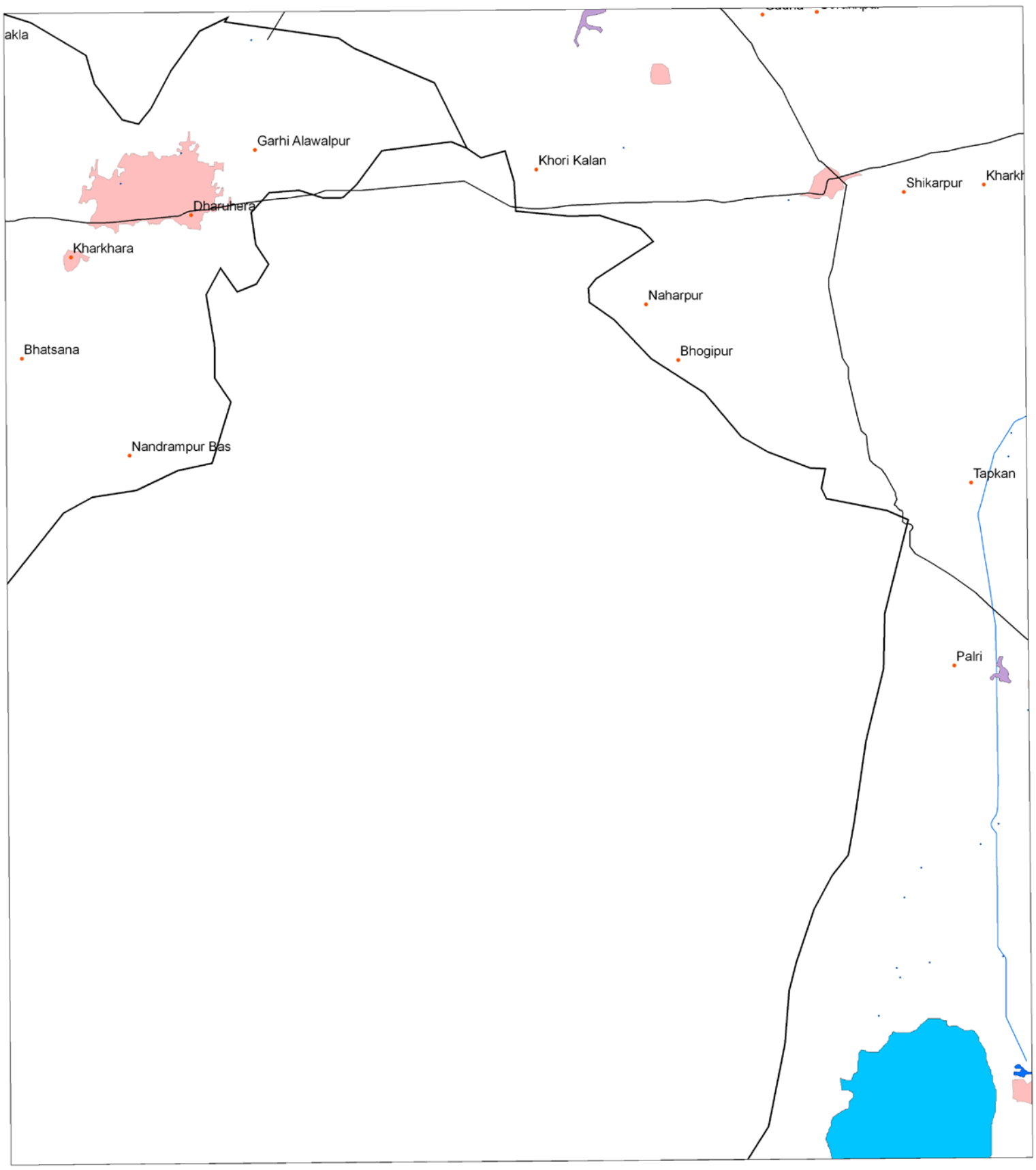
Government of India

State : Haryana

WETLAND MAP

Map No. : 53D/16

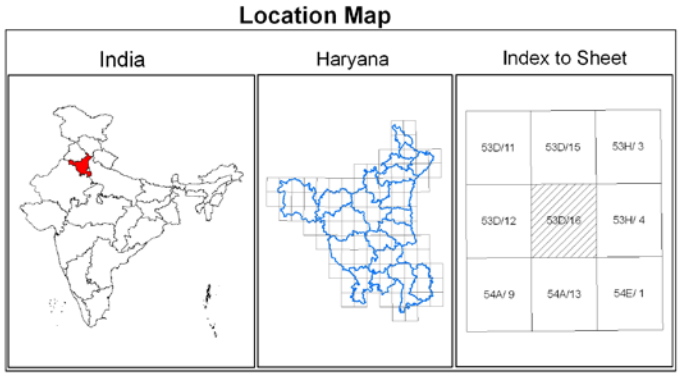


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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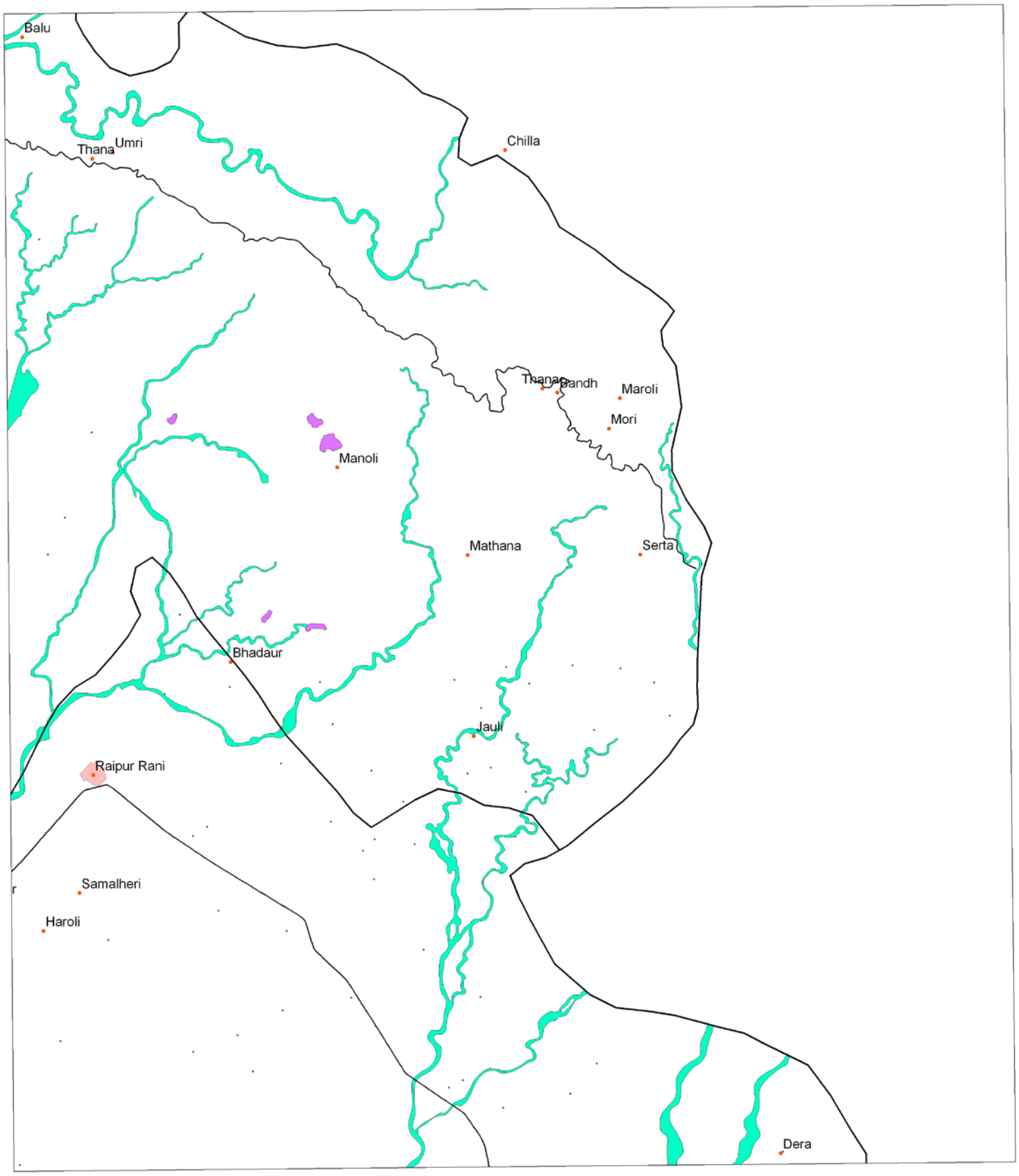
Government of India

State : Haryana

WETLAND MAP

Map No. : 53F/02

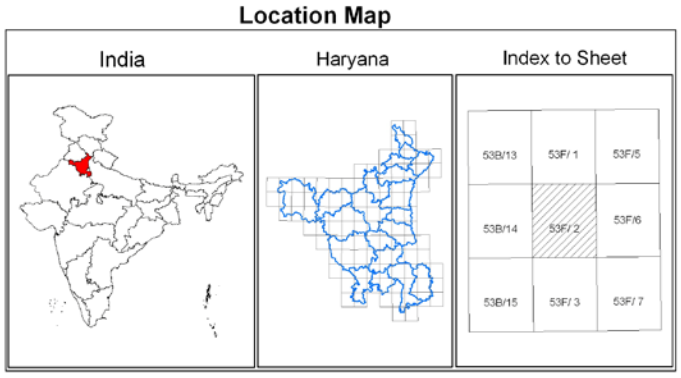


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Prepared By :

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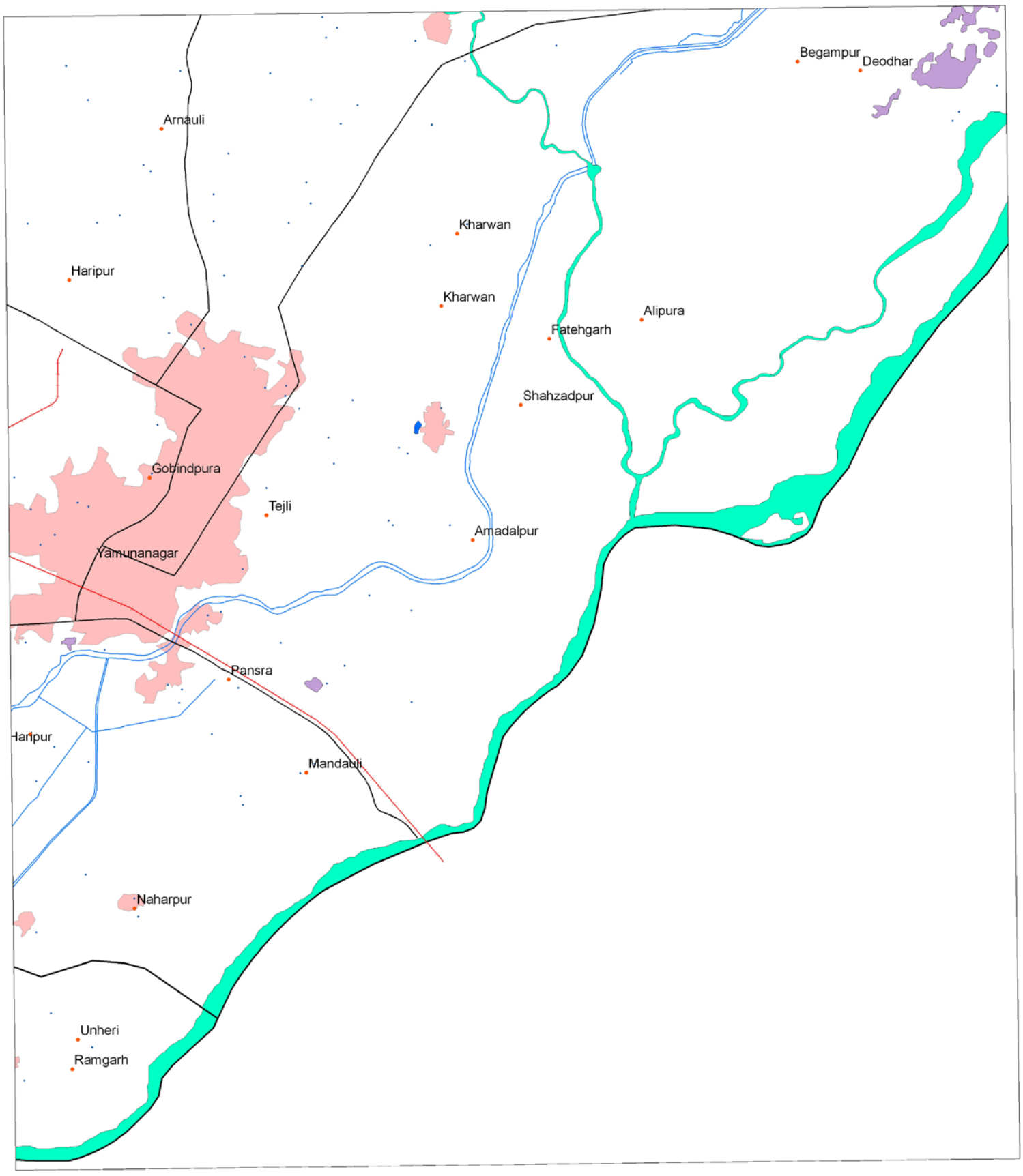
Government of India

State : Haryana

WETLAND MAP

Map No. : 53F/08

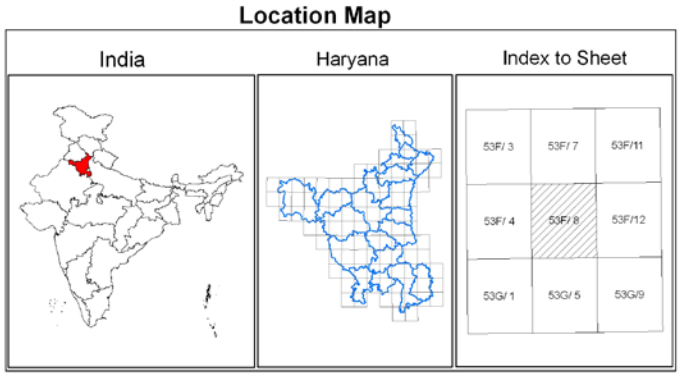


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Prepared By :

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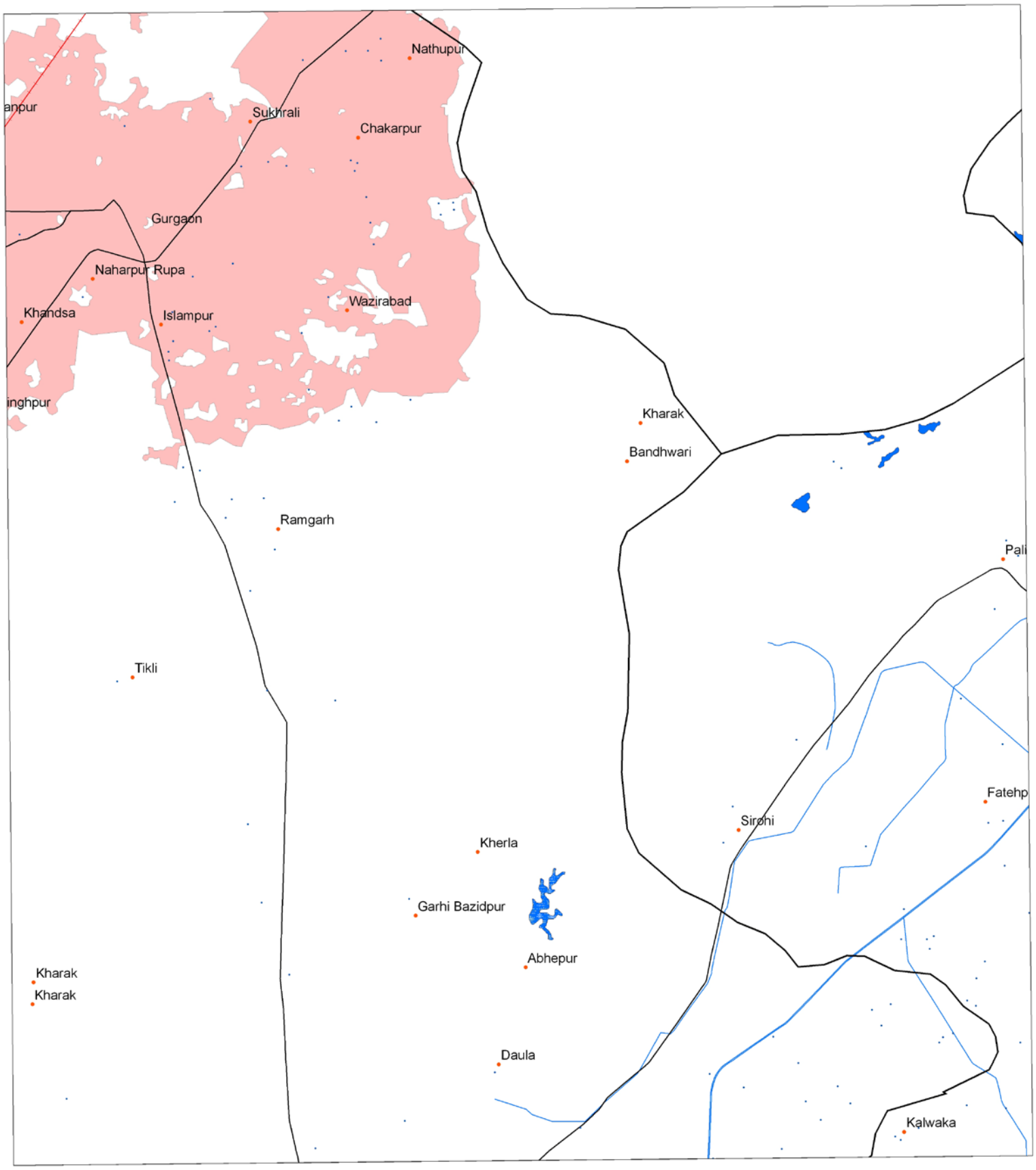
Government of India

State : Haryana

WETLAND MAP

Map No. : 53H/03

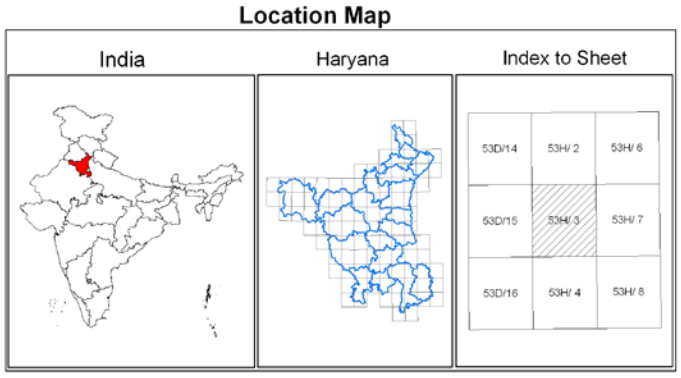


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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



0 1 2 4 6 Kilometers

Data Source :

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

Prepared By :

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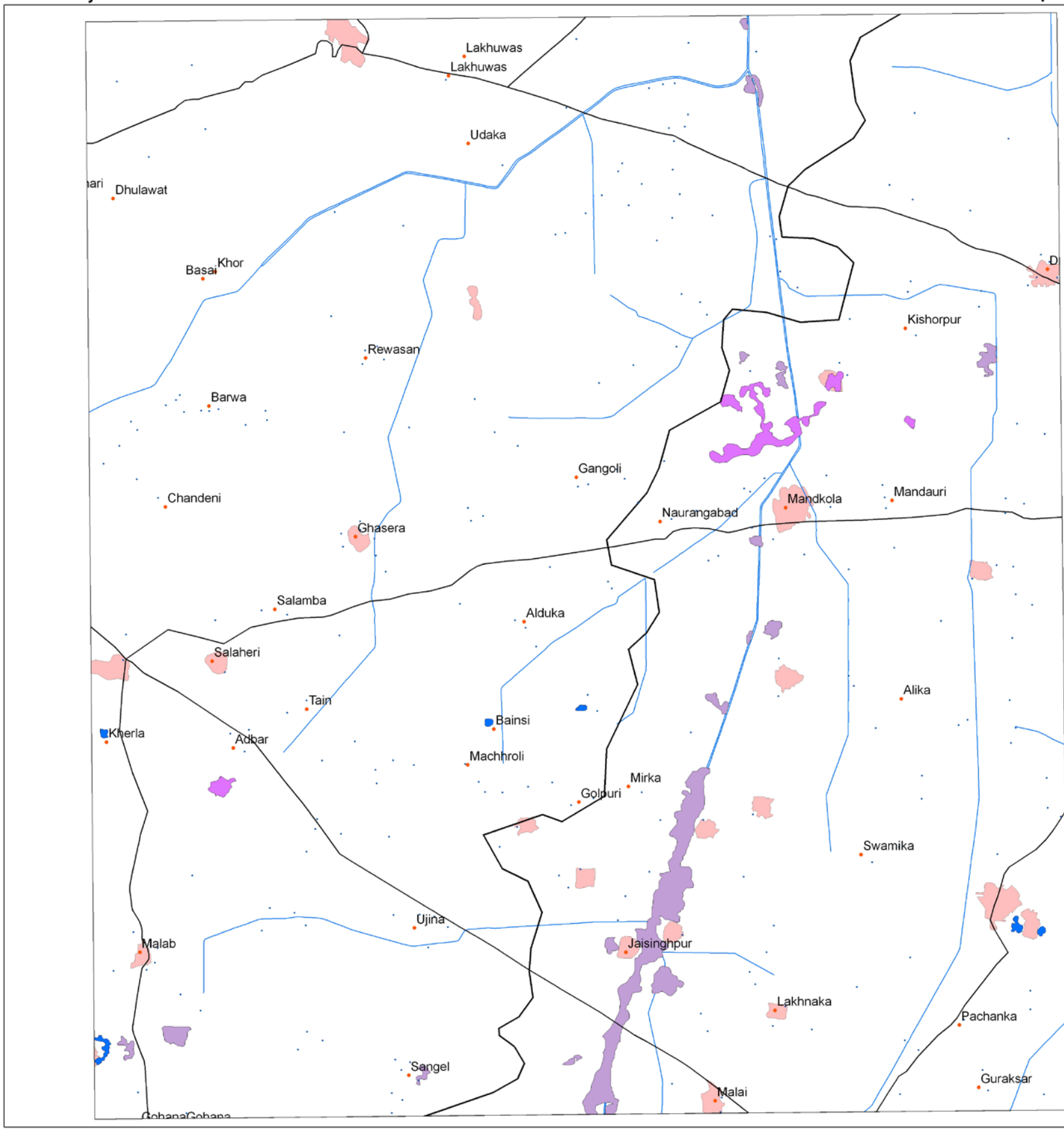
Government of India

State : Haryana

WETLAND MAP

Map No. : 53H/04

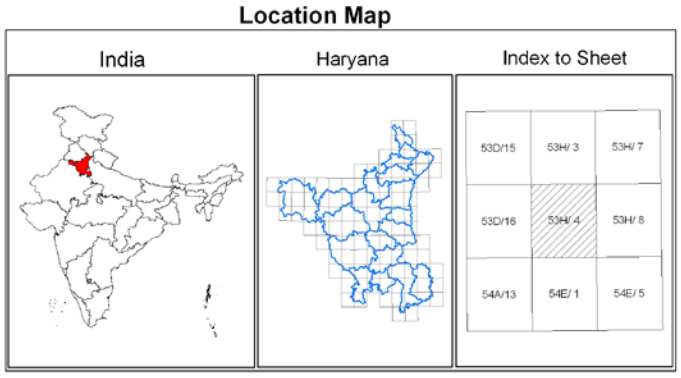


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Prepared By :

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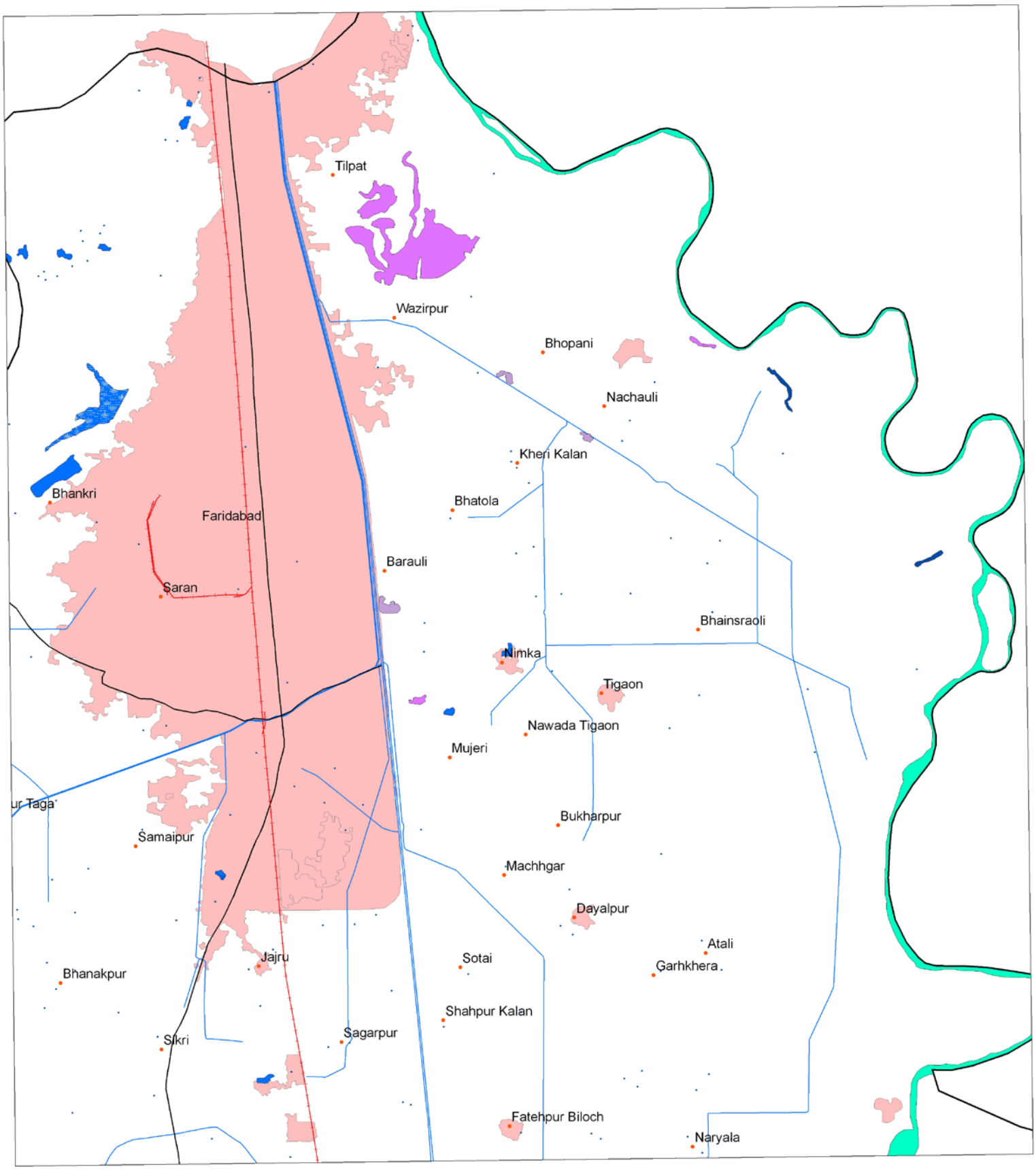
Government of India

State : Haryana

WETLAND MAP

Map No. : 53H/07

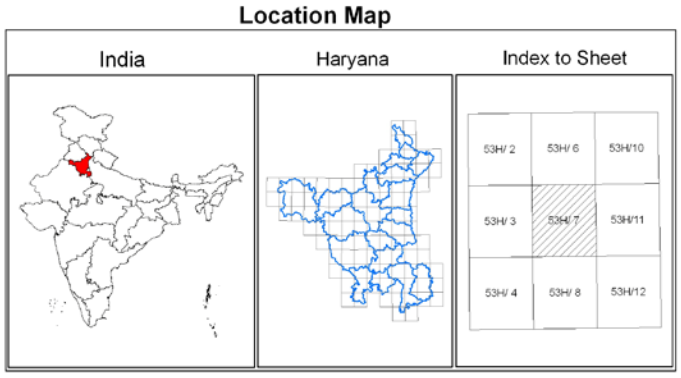


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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



0 1 2 4 6 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
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Haryana Space Applications Centre, Hisar
and
M. G. Science Institute, Ahmedabad

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Government of India

REFERENCES

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Annexure I
Definitions of wetland categories used in the project

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

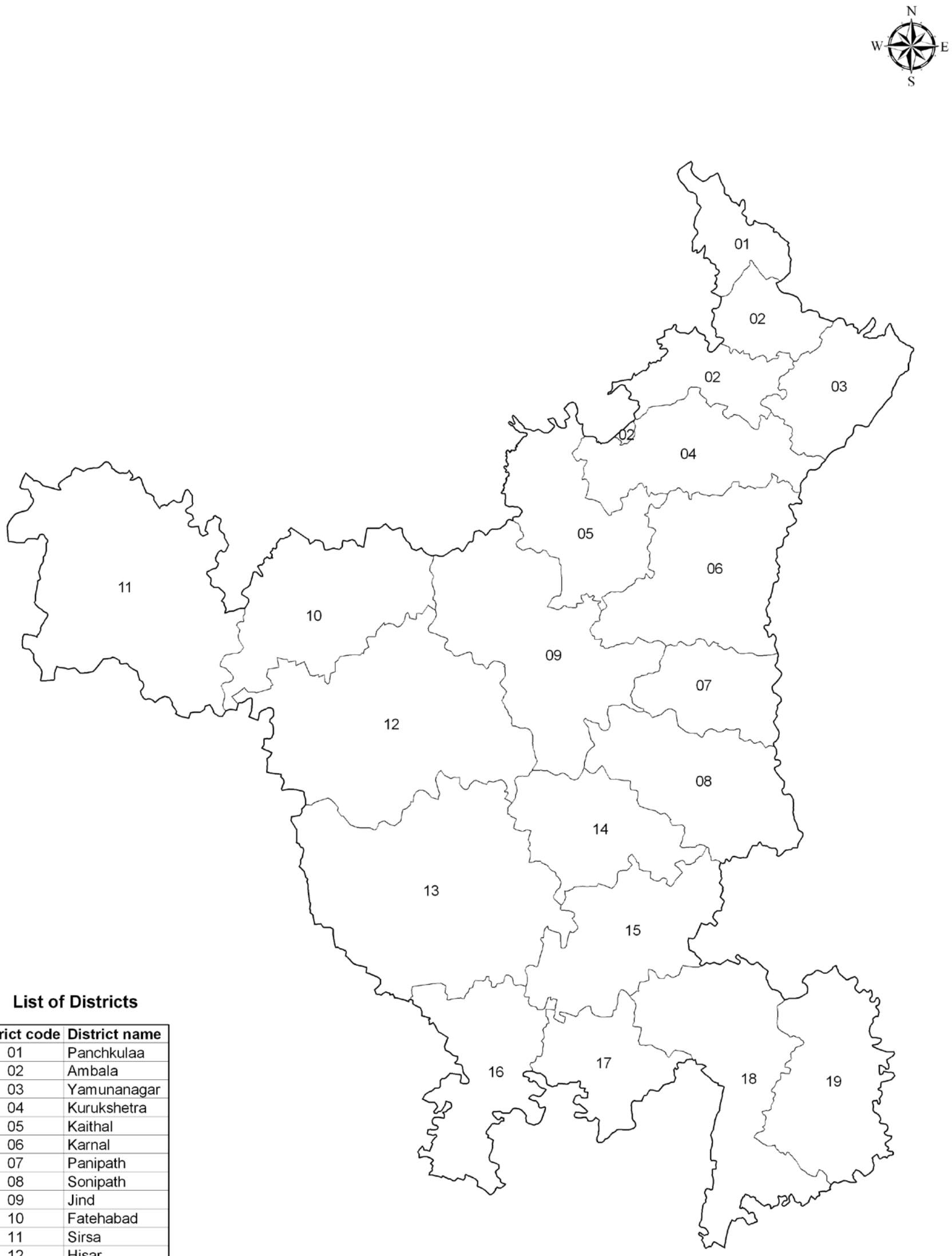
Wetland type code	Definition and description
1000	**Inland Wetlands**
1100	**Natural**
1101	**Lakes**: Larger bodies of standing water occupying distinct basins (Reid *et al*, 1976). These wetlands occur in natural depressions and normally fed by streams/rivers. On satellite images lakes appear in different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

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

Annexure – II
Details of District information followed in the atlas

State : Haryana

District Boundary Map



List of Districts

District code	District name
01	Panchkulaa
02	Ambala
03	Yamunanagar
04	Kurukshetra
05	Kaithal
06	Karnal
07	Panipath
08	Sonipath
09	Jind
10	Fatehabad
11	Sirsa
12	Hisar
13	Bhiwani
14	Rohtak
15	Jhajjar
16	Mehendragarh
17	Rewari
18	Gurgaon
19	Faridabad

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

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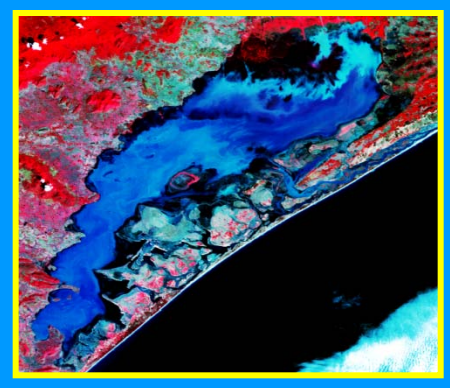

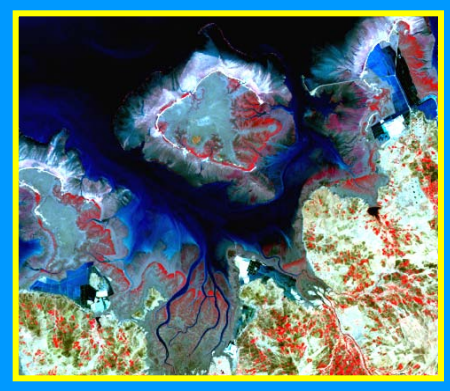

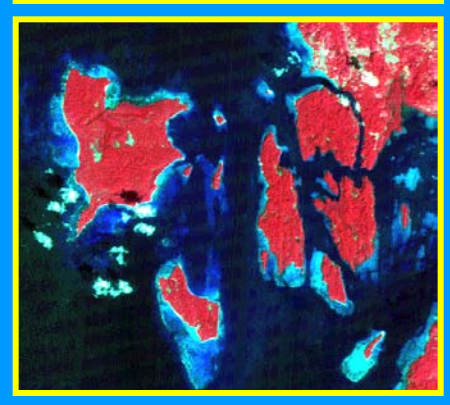

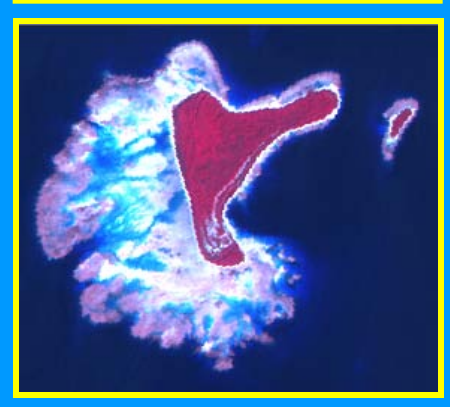

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