NATIONAL WETLAND ATLAS:

ANDHRA PRADESH

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

A.P. State Remote Sensing Application Centre, Hyderabad

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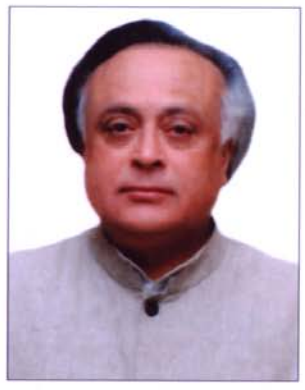
जयराम रमेश
JAIRAM RAMESH



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MESSAGE

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

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

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

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

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

(Jairam Ramesh)

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FOREWORD

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

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

January 25, 2010

(Ranganath R. Navalgund)

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

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

We are grateful to Dr G V Subramanyam, Adviser, MoEF, for his very active and positive role for implementation of the project. We are thankful to Dr Jag Ram, Director, MoEF and Dr Harendra Kharwal, MoEF for their support in budget and project management related issues. We acknowledge the support received from Dr P S Roy, Dy Director, NRSC and Dr S Sudhakar, Head, LRD, NRSC in terms of valuable suggestions and providing the geo-referenced image of NRC-LU&LC project for use as master image in this project. We are thankful to the “Technical Review” team of SAC for critical comments and suggestion to finalise the Atlas.

(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 Andhra Pradesh, 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 categories 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, 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. 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.

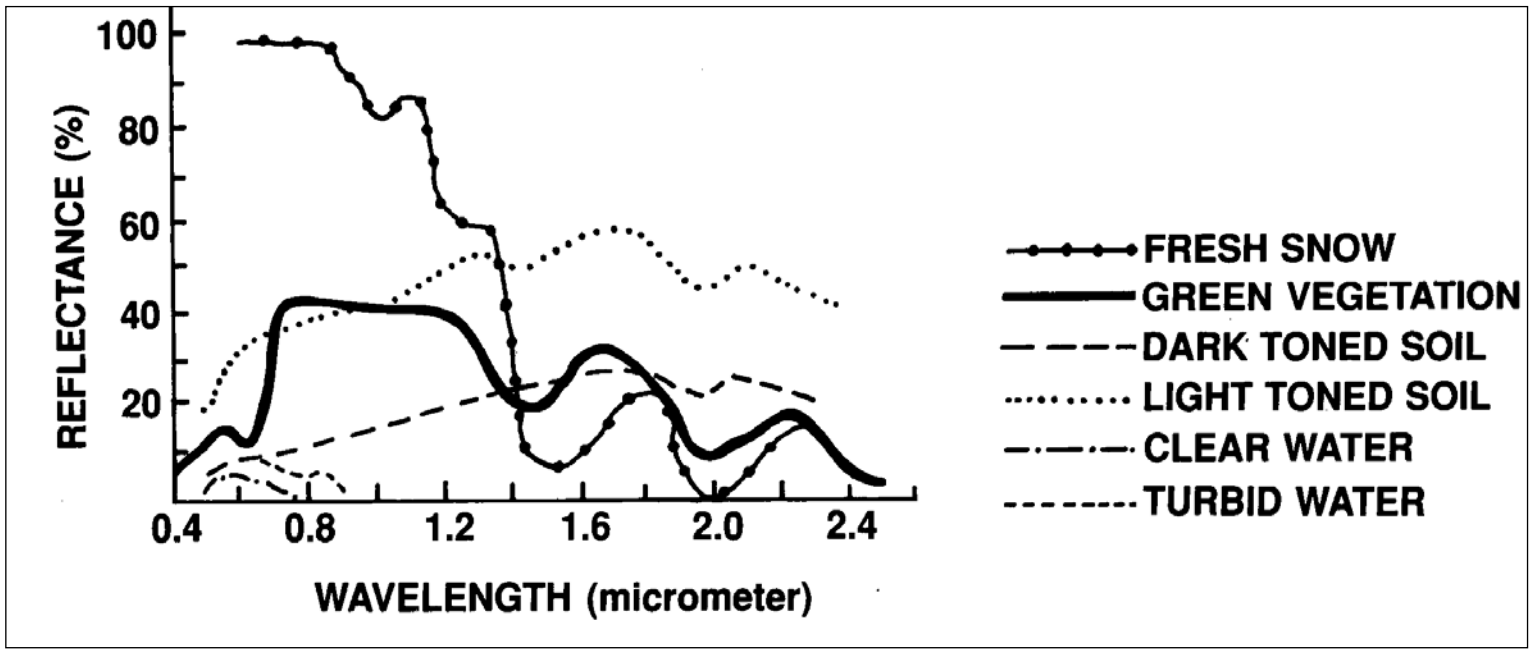
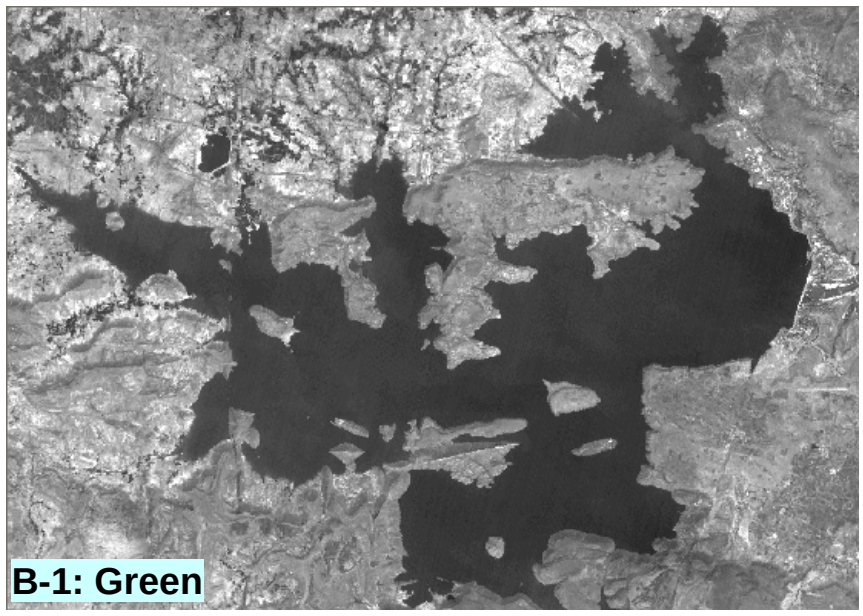
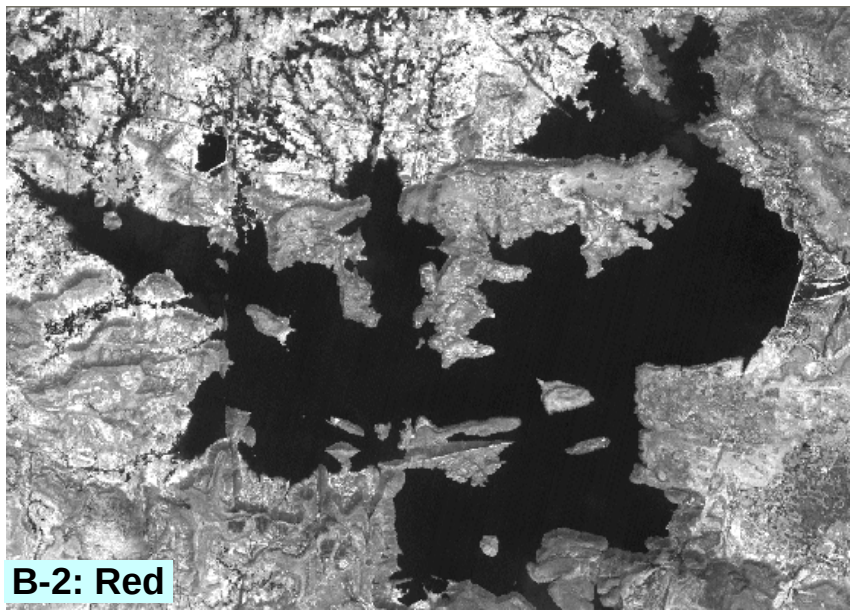
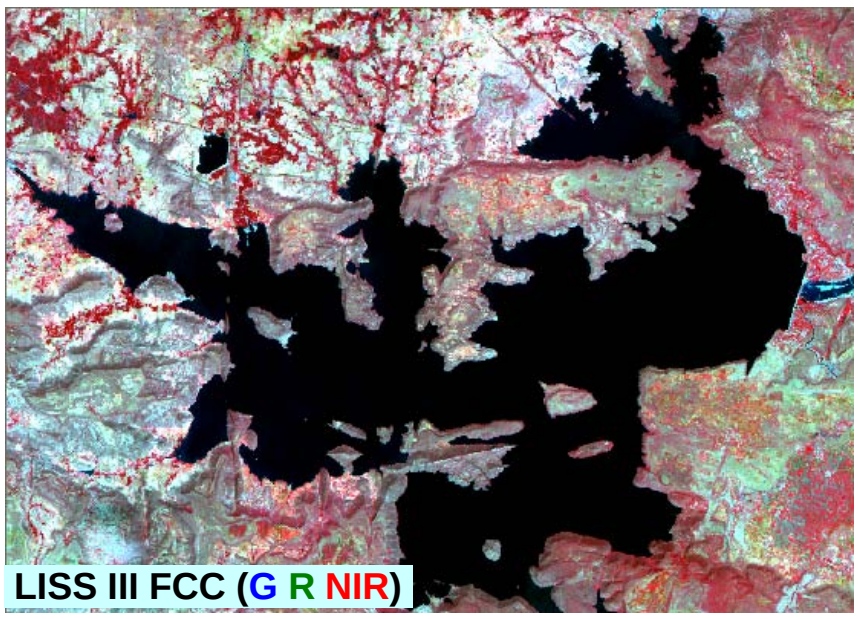
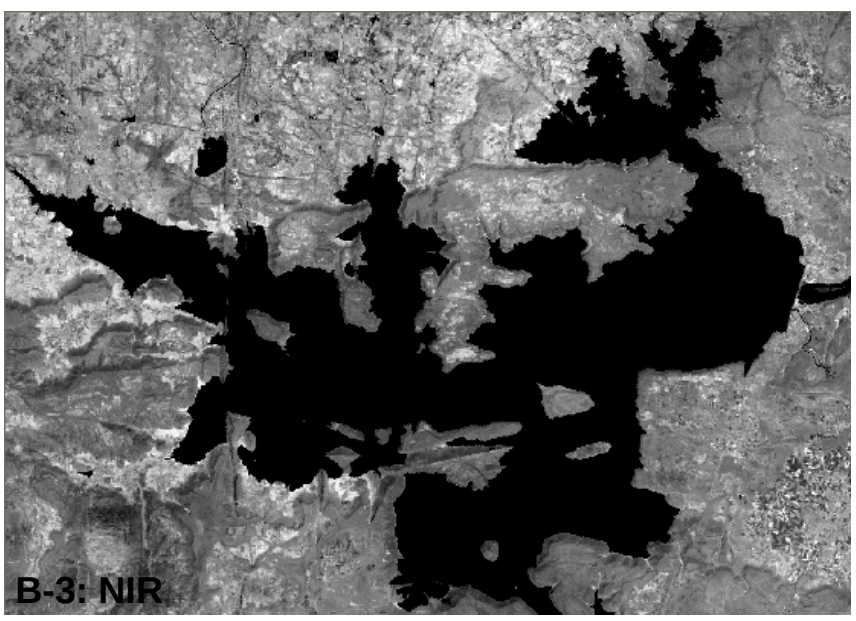


Figure 1: Spectral Signature of various targets









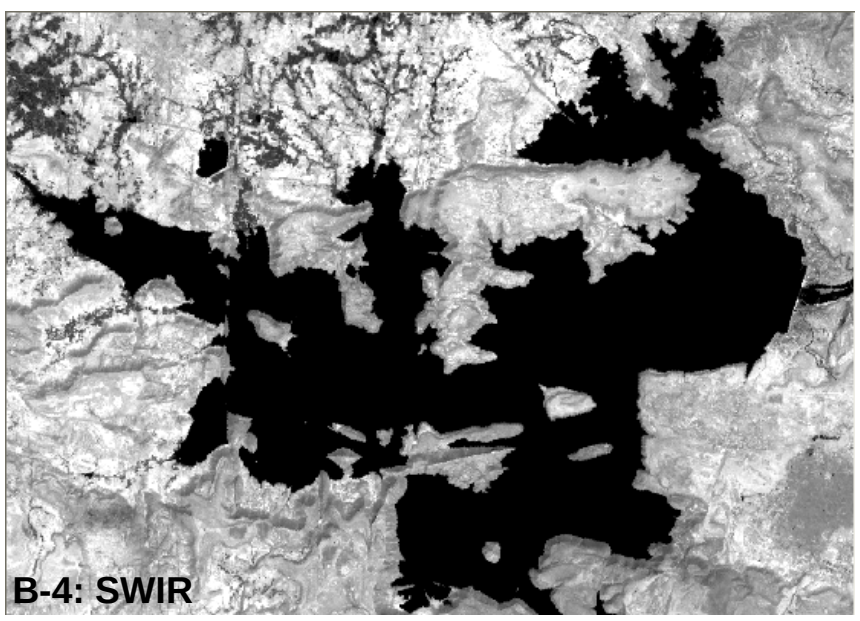


Figure 2: Various land features as they appear in four spectral bands and in a typical three band FCC

1.3 Wetland Inventory of India

India with its large geographical spread supports large and diverse wetland classes, some of which are unique. Wetlands, variously estimated to be occupying 1-5 per cent of geographical area of the country, support about a fifth of the known biodiversity. Like any other place in the world, there is a looming threat to the aquatic biodiversity of the Indian wetlands as they are often under a regime of unsustainable human pressures. Sustainable management of these assets therefore is highly relevant. Realising this, Govt. of India has initiated many appropriate steps in terms of policies, programmes and plans for the preservation and conservation of these ecosystems. India is a signatory to the Ramsar Convention for management of wetland, for conserving their biodiversity and wise use extending its scope to a wide variety of habitats, including rivers and lakes, coastal lagoons, mangroves, 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 Andhra Pradesh.

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 extent from the imprint of water spread over the years.
- Water spread: There are two layers representing post-monsoon and pre-monsoon water spread during the year of data acquisition.

- Aquatic vegetation spread: The presence of vegetation in wetlands provides information about its tropic 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).

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

The state of Andhra Pradesh lies between 12^0 41' 00" and 23^0 00' 00" N latitudes and 77^0 00' 00" and 84^0 40' 00" E longitudes. It is bounded by Maharashtra, Chhattisgarh and Orissa in the north, the Bay of Bengal in the east, Tamil Nadu in the south and Karanataka in the west (Figure 3). It is situated on the Deccan plateau in south India. As per the 2001 census, the state population is 76.21 million and the geographical area is 275045 hectares. It is ranked fourth in population and fifth in area in India. The state is largely dependent on agriculture. About 70 % of the total population depends on farming and it is one of India's main rice producing states.

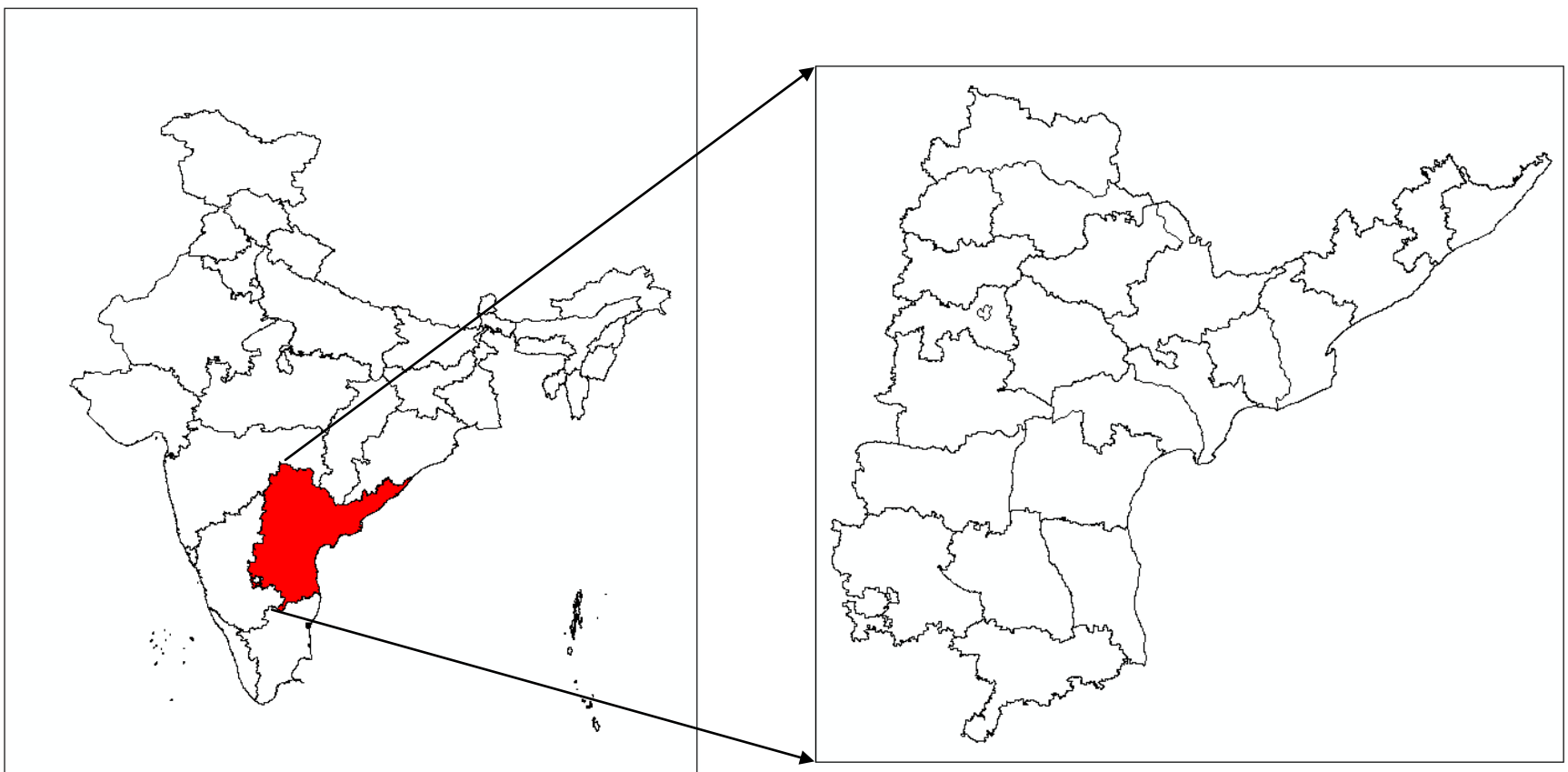


Figure 3: Location Map

The state has twenty three districts broadly divided into three geographic regions – the coastal region generally called Andhra comprises of nine districts, the interior region known as Rayalaseema comprises of four districts and Telangana region comprises of ten districts.

The state has three main physiographic regions namely; a) the coastal plain to the east extending from the Bay of Bengal to the mountain ranges, the mountain ranges themselves, b) the Eastern Ghats which form the western flank of the coastal plain, and c) the plateau to the west of the Ghats. The coastal plain runs almost the entire length of the state and is watered by several rivers, flowing from west to east through the hills into the bay. The deltas formed by the Rivers Godavari and Krishna make up the central part of the plains, an area of fertile alluvial soil.

A wide variety of geological formations occur in Andhra Pradesh. All kinds of rocks from the oldest Archean to the recent Alluvium are found in the state. Major portion of the peninsular shield lies in the state. The stratigraphic units found in the state are Peninsular Gneiss complex, Dharwars, Eastern Ghats, Kadapa super group, Pakhals, Bhimas, Pengana, Kurnool group, Gondwana super group, Deccan Traps, Tertiary formations and Quartenary. The types of rocks found in state are volcanic rocks, charnacolites, granite rocks, Kurnool formations, dolomites and Kadapa stones.

Andhra Pradesh is endowed with a variety of soils ranging from coastal sands to highly fertile deltaic alluvium. The six major soil groups present in the state are red soils, black soils, alluvial soils, coastal sands, laterite and lateritic soils, and problem soils which include saline and alkali soils. Red soils occupy over 66 % of the cultivated area and are mostly situated in Rayalaseema districts. These soils have a low nutrient status. Red soils can be sub-classified as Dubba soils (loamy soils to sandy loams), Chalkas (sandy loam soils), Sandy

clay loams, Loams including silty soils, Deep loamy soils and Sandy loams with clay subsoil. Chalkas occur mostly in Telangana districts while red loams combined with sands occur in the upland regions of coastal districts. Black soils cover nearly 25 % of the cultivated area and are generally associated with poor drainage. They are also called as Regurs or vertisols and are of two types - in-situ and transported. The in-situ soils occur in the coastal districts and parts of Telangana and Rayalaseema districts and the transported soils occur in the valley regions of the slopes with calcareous concentrations. The in-situ soils are generally heavy in texture and high in salt concentration. The alluvial loamy soils found in Krishna and Godavari deltas cover 5 % of the cultivated area. The coastal sands occupy only 3 % while the remaining 1 % is covered by laterite soils in certain pockets of the state.

The state has a tropical climate with moderate diffusion to sub-tropical weather. Semi humid conditions prevail in the coastal areas. The average annual rainfall for the state is 940 mm that varies considerably from 715 mm in Rayalaseema, 907 mm in Telangana and 1078 mm in Andhra. The average annual temperature is 29^0 C. The state is divided into seven zones based on agro-climatic conditions. These are: Krishna-Godavari Zone, North Coastal Zone, Southern Zone, Northern Telangana Zone, Southern Telangana Zone, Scarce Rainfall Zone of Rayalaseema and High Altitude Tribal Areas.

As mentioned earlier, the Andhra Pradesh state has 23 districts and is covered by 462 Survey of India (SOI) topographical maps on 1:50,000 scale that form the spatial frame work for mapping (Figure 4) prepared using 15’ x 15’ grid. A detail of district information followed in the atlas is given in Annexure-II.

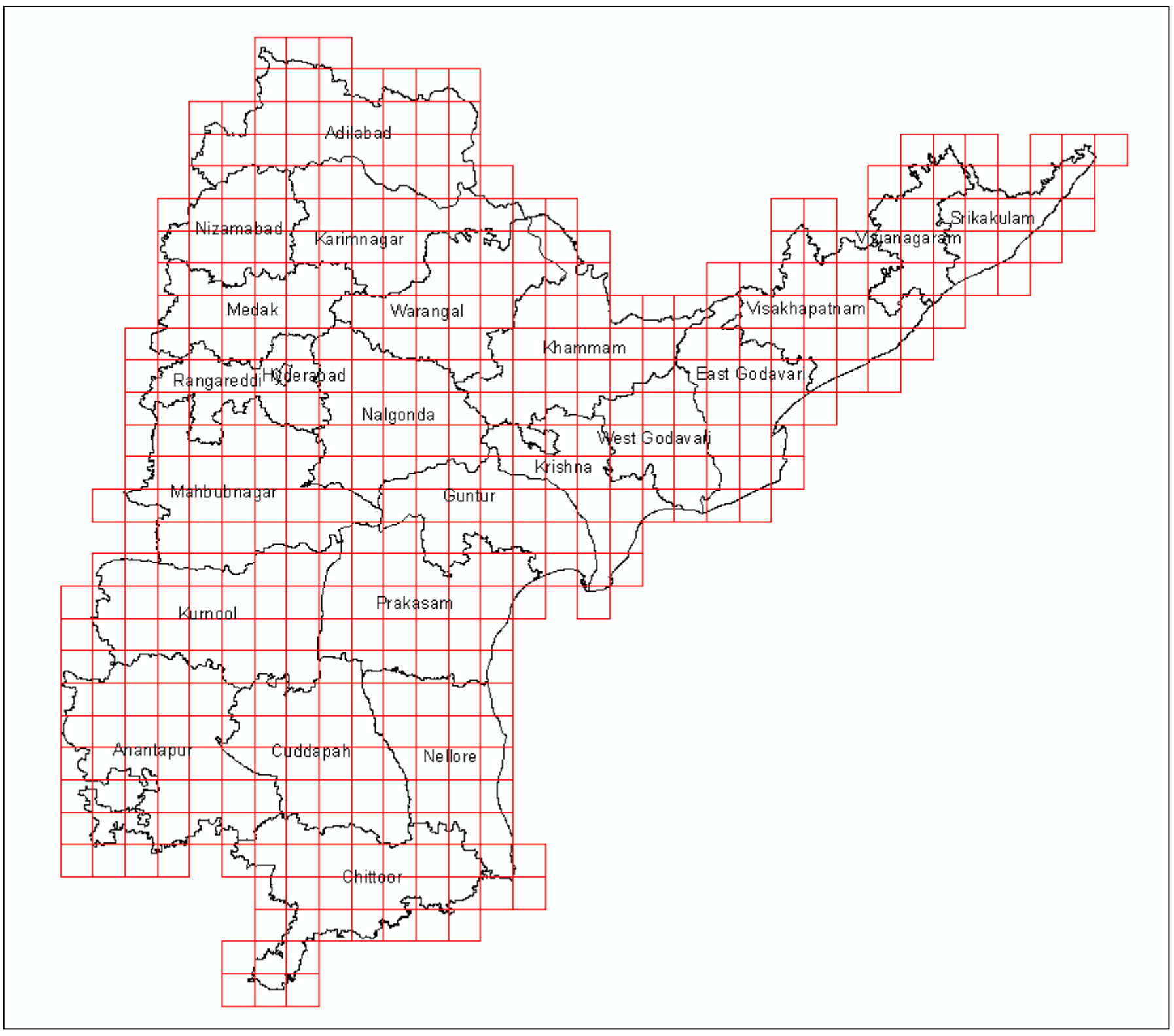


Figure 4 : Spatial Framework of Andhra Pradesh

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 Andhra Pradesh is covered in 27 IRS LISS III scene (Figure 5). Two-date data, one acquired during October/November and another during April/May were used to capture the post-monsoon and pre-monsoon hydrological variability of the wetlands respectively (Table-2). Figure 6 shows the overview of the part of Andhra Pradesh as seen in the LISS III FCC of post- monsoon pre-monsoon data respectively.

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

Ground truth data

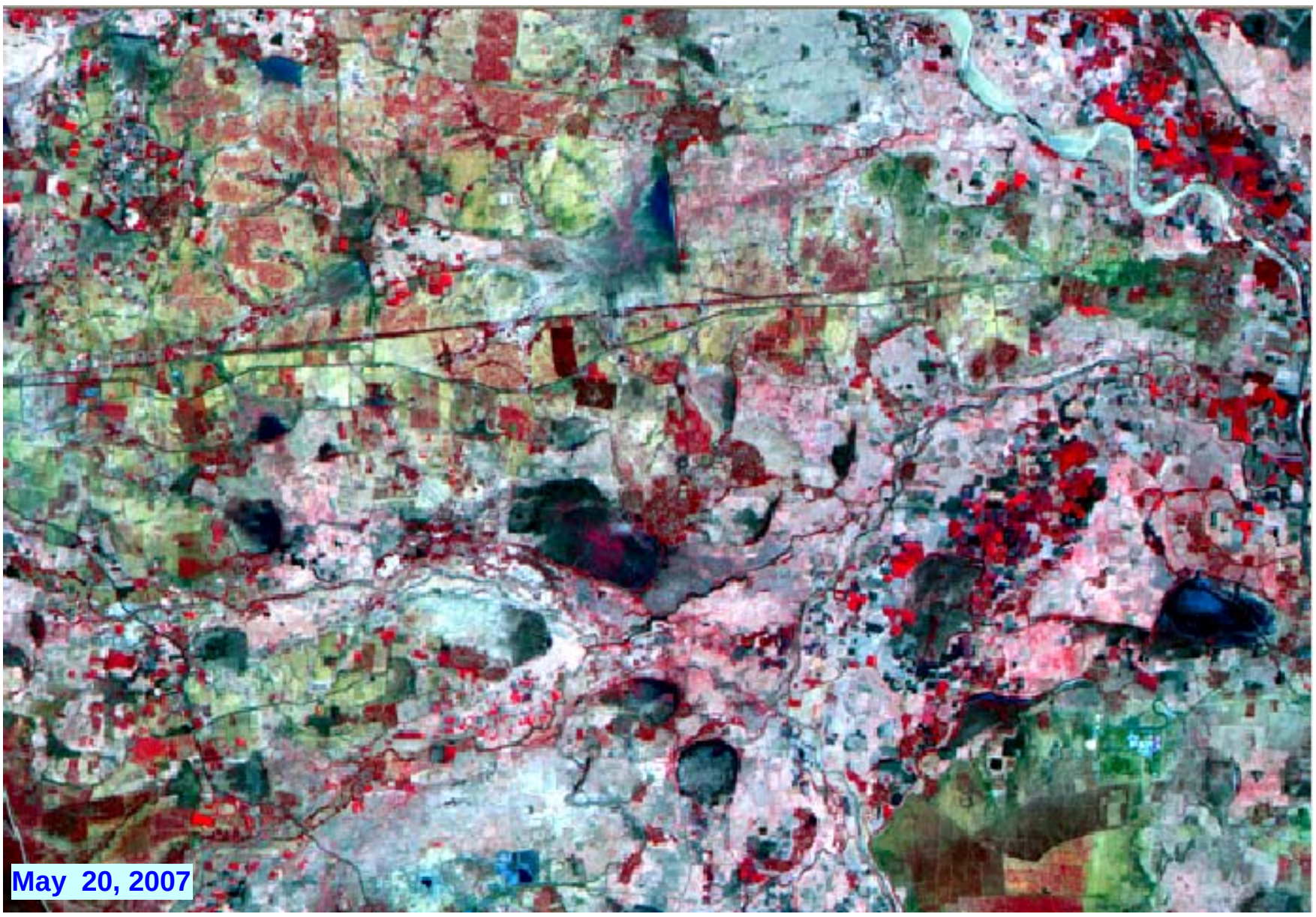
Remote sensing techniques require certain amount of field observation called “ground truth” in order to deduce meaningful information. Such work involves visiting a number of test sites, usually taking the satellite data. The location of the features is recorded using the GPS. The standard proforma as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

Other data

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

Table-2: Satellite data used

Sr. No	Resourcesat LISS III	Post-monsoon	Pre-monsoon
1	099-58	October 25, 2006	May 05, 2007
2	099-59	October 25, 2006	April 11, 2007
3	099-60	October 25, 2006	
4	099-61	January 05, 2007	April 11, 2007
5	099-62	-	March 08, 2007
5	099-63	January 05, 2007	April 11, 2007
6	100-59	January 10, 2007	June 03, 2007
7	100-60	February 27, 2007	March 23, 2007
8	100-61	February 27, 2007	May 10, 2007
9	100-62	February 27, 2007	May 10, 2007
10	100-63	February 27, 2007	May 10, 2007
11	100-64	-	May 23, 2007
12	101-59	February 13, 2006	May 15, 2007
13	101-60	February 13, 2006	June 06, 2007
14	101-61	October 11, 2006	March 28, 2007
15	101-62	October 11, 2006	May 15, 2007
16	101-63	February 13, 2006	April 02, 2006
17	101-64	February 08, 2007	May 15,2007
18	102-60	December 27, 2006	May 20, 2007
19	102-61	December 27, 2006	May 20, 2007
20	102-62	January 25, 2006	April 07, 2006
21	102-63	January 25, 2006	June 26, 2007
22	102-64	January 25, 2006	May 20, 2007
23	103-60	December 08, 2006	April 12, 2006
24	103-61	December 08, 2006	March 08, 2008
25	104-59	November 19, 2006	April 12, 2007
26	104-60	November 19, 2006	April 12, 2007
27	105-59	December 18, 2006	April 22, 2006
28	105-60	December 18, 2006	April 04, 2007



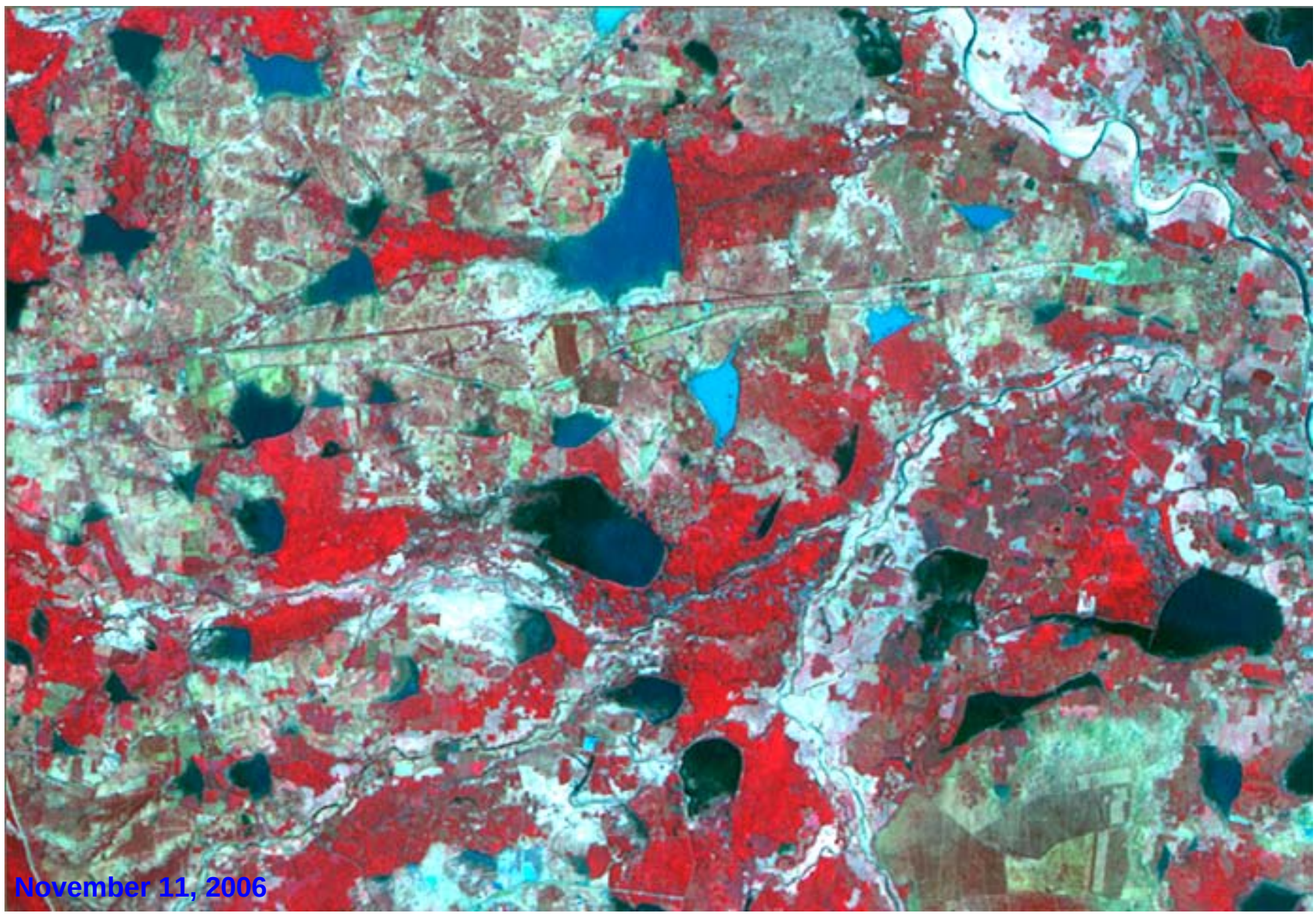


Figure 6: Part of Andhra Pradesh state as seen on IRS P6 LISS-III FCC

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 6. Salient features of methodology given as under:

- 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 on-screen 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 are followed and four corners of the 1:50,000 (15' x 15') grids are 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 Andhra Pradesh 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 on-screen visual interpretation. Wetlands were identified based on vegetation, visible hydrology and geography. There are various methods for extraction of water information from remote sensing imagery, which according to the number of bands used, are generally divided into two categories, i.e. single-band and multi-band methods. Single-band method usually involves choosing a band from multi-spectral image to distinguish water from land by subjective threshold values. It may lead to over- or under-estimation of open water area. Multi-band method takes advantage of reflective differences of each band. In this project, five indices known in literature that enhances various wetland characteristics were used (McFeetres, 1986; Xu Hanqiu, 2006; Lacaux *et al*, 2007; Townshend and Justice, 1986; Tucker and Sellers, 1986) as given below:

i) Normalised Difference Water Index (NDWI) = (Green-NIR) / (Green + NIR)

ii) Modified Normalised Difference Water Index (MNDWI) = (Green - MIR) / (Green + MIR)

iii) Normalised Difference Vegetation Index (NDVI) = (NIR - Red) / (NIR + Red)

iv) Normalised Difference Pond Index (NDPI) = (MIR - Green / MIR + Green)

v) Normalised Difference Turbidity Index (NDTI) = (Red - Green) / (Red + Green)

The indices were generated using standard image processing software, stacked as layers (Figure 7). Various combinations of the indices/spectral bands were used to identify the wetland features as shown in Figure 8. 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 delineate the vegetation areas within a wetland using a suitable threshold.

- Turbidity information extraction :

  MNDWI image was used to generate qualitative turbidity level (high, moderate and low) based on signature statistics and standard deviations. 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 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.

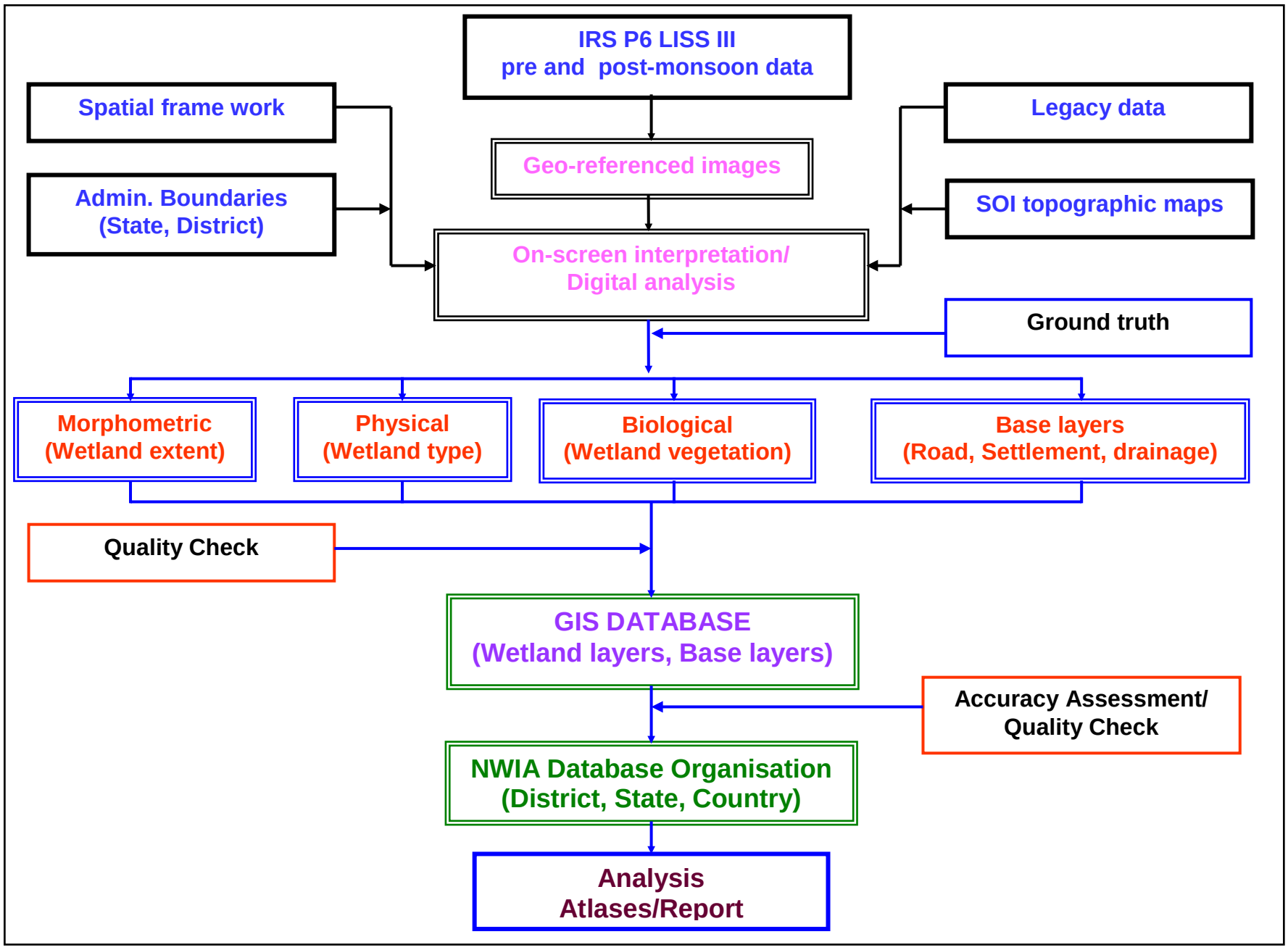


Figure 7: Flow chart of the methodology used

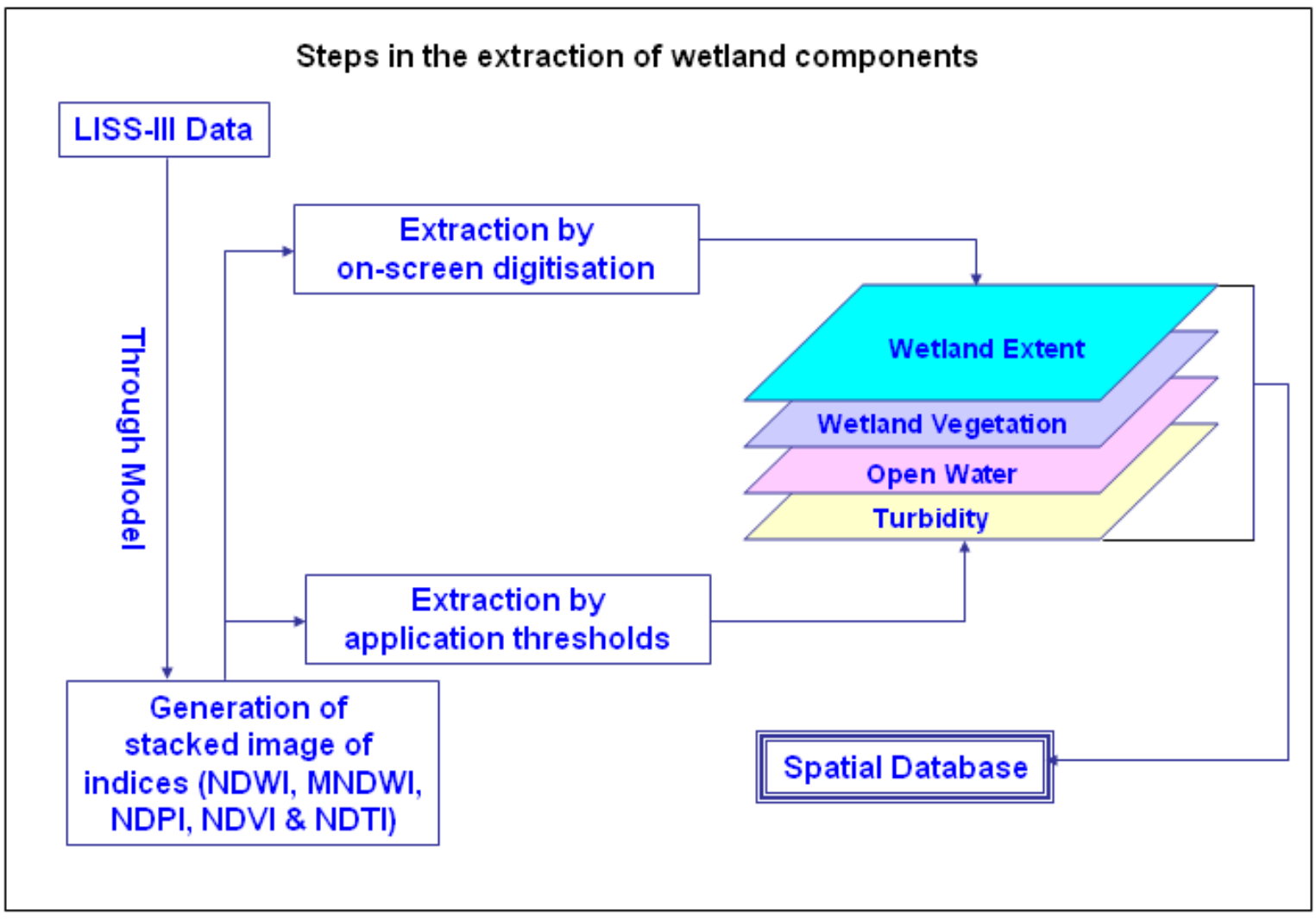
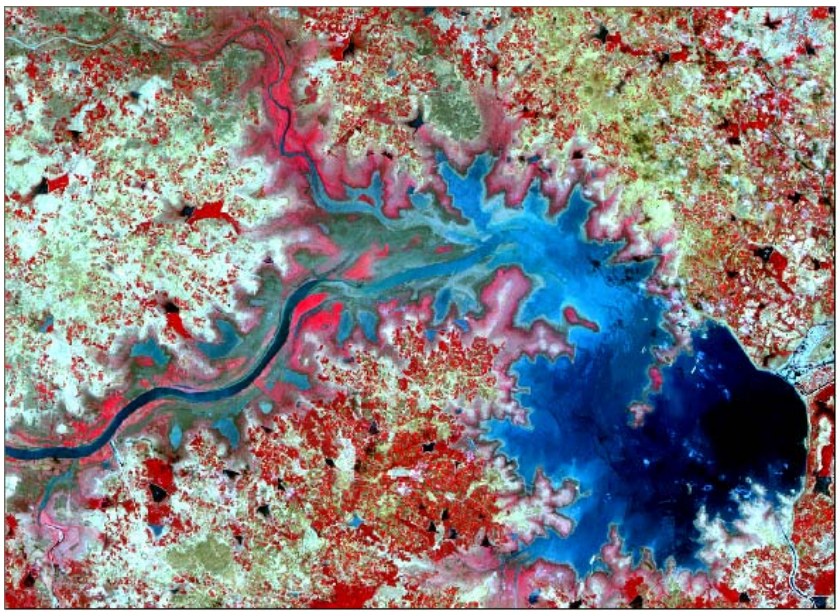
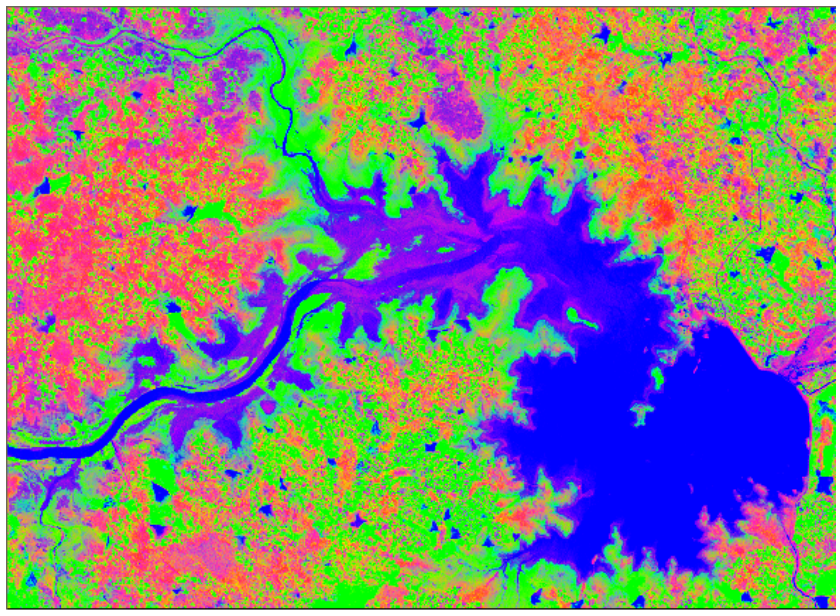


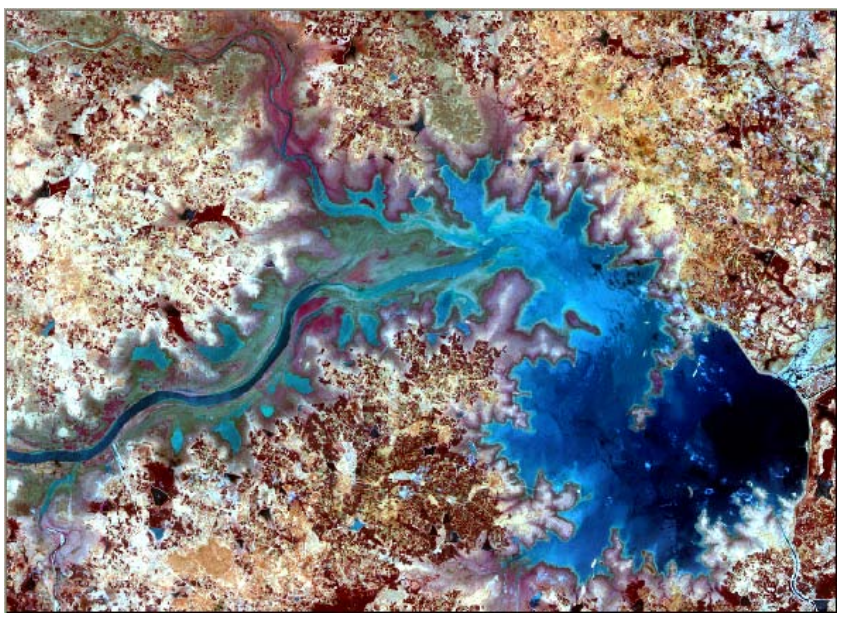
Figure 8: Steps in the extraction of wetland components



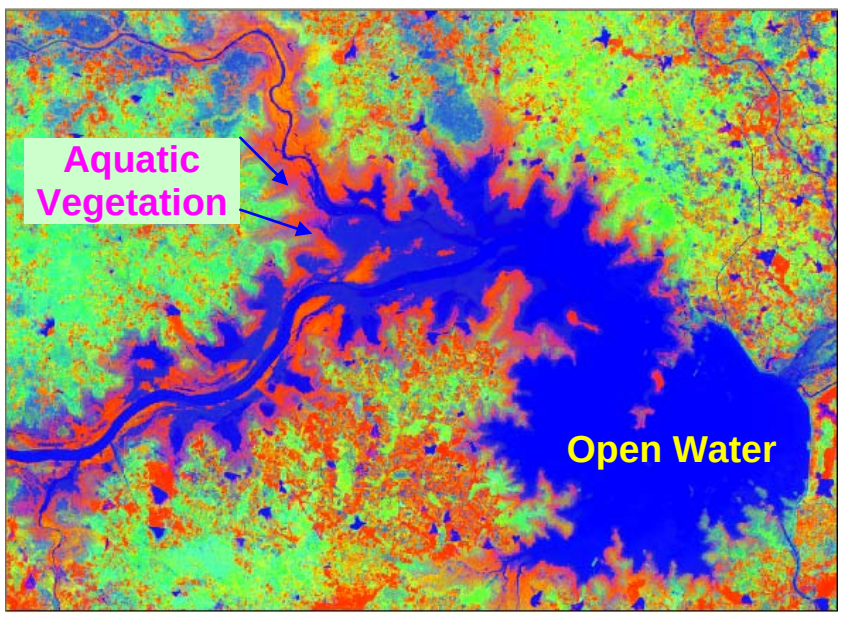
LISS-III FCC (Green Red NIR)



LISS-III FCC of Indices (MNDWI NDVI NDTI)



LISS-III FCC (Green Red SWIR)

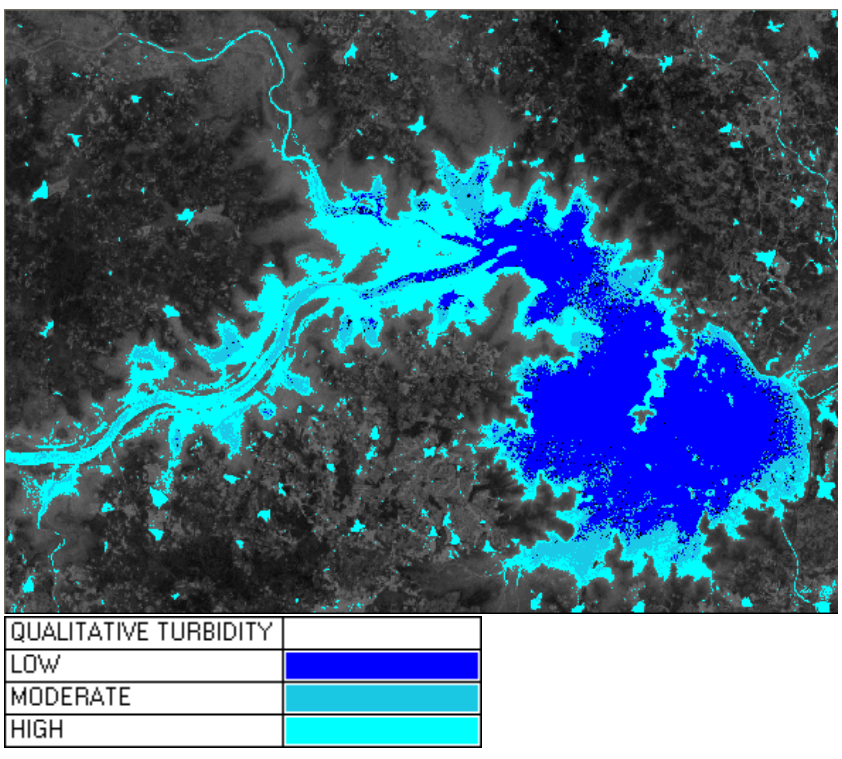


LISS-III FCC of Indices (MNDWI NDPI NDVI)

LISS-III FCC of Indices (MNDWI NDVI NDTI) is useful for delineation of wetland boundary.

LISS-III FCC of Indices (MNDWI NDPI NDVI) is useful for delineation of extent of open water and wetland vegetation.

MNDWI is useful for classification open water into various levels of qualitative turbidity based on the σ derived from signature statistics.



Classified MNDWI image based on σ

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

6.0 ACCURACY ASSESSMENT

A comprehensive accuracy assessment protocol has been followed for determining the quality of information derived from remotely sensed data. Accuracy assessment involves determination of thematic (classification) as well as 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.

MAPS AND STATISTICS

7.0 WETLANDS OF ANDHRA PRADESH: MAPS AND STATISTICS

Area estimates of various wetland categories for Andhra Pradesh have been carried out using GIS layers of wetland boundary, water-spread, aquatic vegetation and turbidity. In the state of Andhra Pradesh 20477 wetlands have been delineated, in addition to 18037 wetlands smaller than 2.25 ha, which have been shown as point features. Total wetland area is estimated to be 1447133 ha, which is 5.26 per cent of state geographical area (Table 4). Inland wetlands dominated in terms of aerial extent (1020750 ha) comprising about 70.5 per cent of wetland area in the state. Of this, man-made wetlands accounted for about 42 per cent of total wetland extent. Coastal wetlands were estimated to be about 28 per cent besides the small wetlands (<2.25 ha) constituting about 1.25 per cent of the wetland area.

Table 4: Summary statistics of aerial estimates of wetlands in Andhra Pradesh

Area in ha

Sr. No.	Wettcode	Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon	Pre-monsoon
1	1100	Inland Wetlands - Natural	415	410396	28.36	172407	128870
2	1200	Inland Wetlands -Man-made	18289	610354	42.18	496692	272510
		Total - Inland	18701	1020750	70.54	669099	401380
3	2100	Coastal Wetlands - Natural	565	150147	10.38	56409	56353
4	2200	Coastal Wetlands - Man-made	1211	258199	17.84	161635	152935
		Total - Coastal	1776	408346	28.22	218044	209288
		Sub-Total	**20477**	**1429096**	**98.75**	**887143**	**610668**
5		Wetlands (<2.25 ha)	18037	18037	1.25	-	-
		Total	**38514**	**1447133**	**100.00**	**887143**	**610668**

The major wetland types are Reservoirs/Barrages (404499 ha) followed by River/Streams (385839 ha) and Aquaculture ponds (240474 ha). Reservoirs/Barrages were dominant in terms of number (4527) as well as extent and accounted for about 28 per cent of wetland extent in the state (Table 5). River/Streams category fewer in number (353) compared to Tank/Pond but registered second highest comprising about 27 per cent of wetland extent. The open water extent (887143 ha) is estimated to be about 62 per cent out of 1429096 ha of wetland extent in post-monsoon that has shown a decrease to 610668 ha, which turns about to be about 43 per cent. This reduction is pronouncedly observed in case of Tank/Pond (77 % to 35 %) followed by Reservoir/Barrage (84 % to 50 %) and River/Stream (44 % to 32 %). Graphical distribution of wetland type is shown in Figure 9.

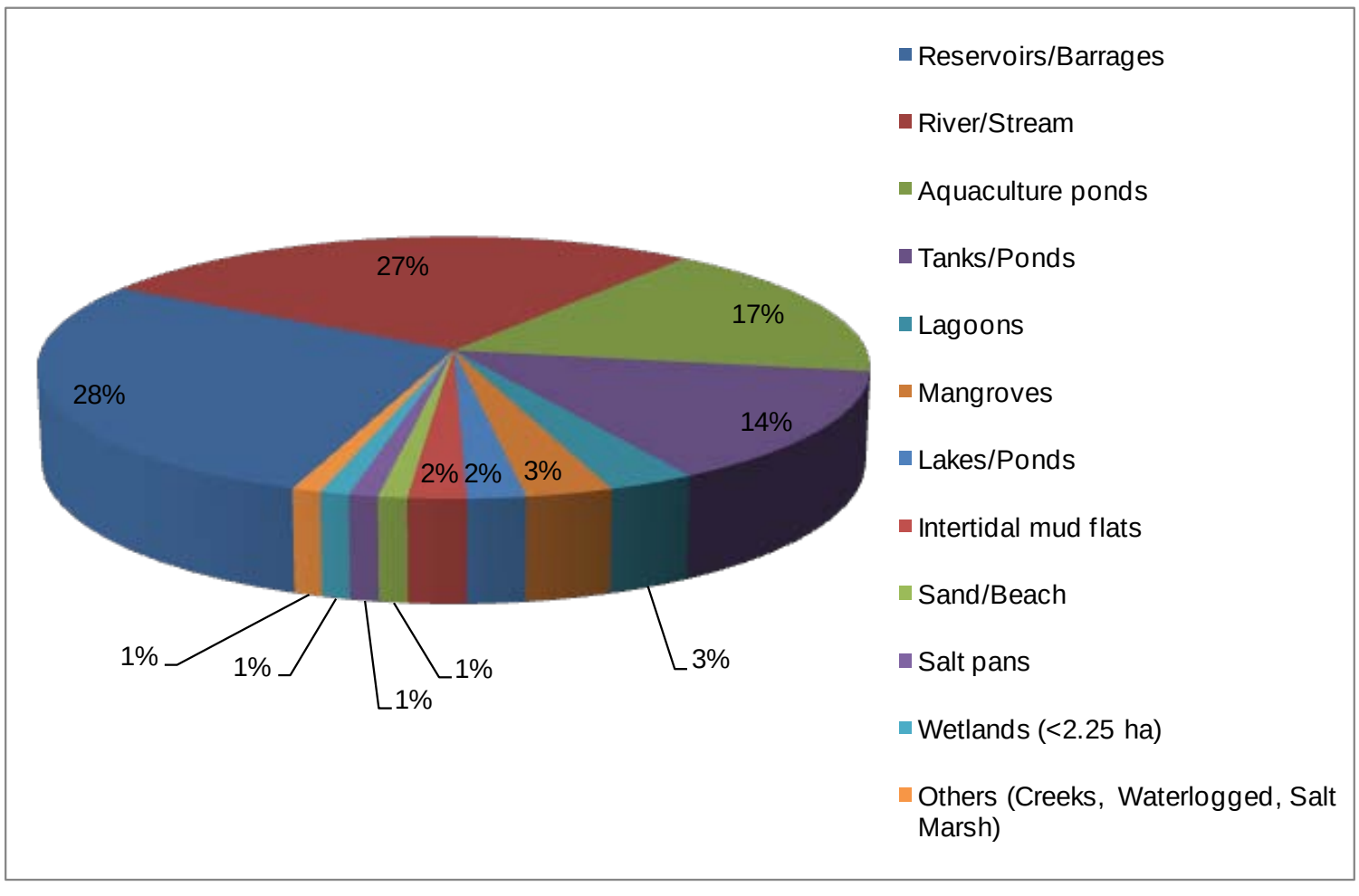


Figure 10: Type-wise wetland distribution in Andhra Pradesh

In terms of vegetation specific to wetlands, has shown an increase from 126187 ha in post-monsoon to 268267 ha in pre-monsoon. This accounts for about 9 and 19 % in post- and pre-monsoon seasons respectively out of the total wetland area of 1429096 ha (Table 5). Qualitative turbidity estimated for open water shows that moderate turbidity is predominant in wetlands of Andhra Pradesh in both the seasons. Out of 887143 ha of open water in post-monsoon, about 60 per cent is moderately turbid followed by low (33 %) and high (7%). In case of pre-monsoon the there is change in the trend. Out of 610668 ha of open water in pre-monsoon, about 57 per cent is under moderate turbidity followed by low (37 %) and high (5 %). The decrease in the aerial extent under high turbidity may be attributed to the settling of sediments received by the wetlands during monsoon. On the other hand the increase in extent under low turbid zones from post- to pre-monsoon may be attributed to churning of bottom sediments in shallower parts of open water.

Table 5: Area estimates of wetlands in Andhra Pradesh

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon	Pre-monsoon
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	8	21843	1.51	3368	4334
2	1105	Waterlogged	54	2714	0.19	902	609
3	1106	River/Stream	353	385839	26.66	168137	123927
	1200	**Inland Wetlands -Man-made**					
4	1201	Reservoirs/Barrages	4527	404499	27.95	340275	200496
5	1202	Tanks/Ponds	13708	201677	13.94	155503	71456
6	1203	Waterlogged	51	4178	0.29	914	558
		Total - Inland	**18701**	**1020750**	**70.54**	**669099**	**401380**
	2100	**Coastal Wetlands - Natural**					
7	2101	Lagoons	2	47407	3.28	47306	47407
8	2102	Creeks	80	9594	0.66	9103	8946
9	2103	Sand/Beach	70	15891	1.10	-	-
10	2104	Intertidal mud flats	131	31767	2.20	-	-
11	2105	Salt Marsh	28	4002	0.28	-	-
12	2106	Mangroves	254	41486	2.87	-	-
	2200	**Coastal Wetlands - Man-made**					
13	2201	Salt pans	57	17725	1.22	7551	7064
14	2202	Aquaculture ponds	1154	240474	16.62	154084	145871
		Total - Coastal	**1776**	**408346**	**28.22**	**218044**	**209288**
		Sub-Total	**20477**	**1429096**	**98.75**	**887143**	**610668**
		Wetlands (<2.25 ha), mainly Tanks	18037	18037	1.25	-	-
		Total	**38514**	**1447133**	**100.00**	**887143**	**610668**

Area under Aquatic Vegetation	126187	268267

Area under turbidity levels		
Low	295604	227855
Moderate	531282	350782
High	60257	32031

7.1 DISTRICT-WISE WETLAND MAPS AND STATISTICS

Andhra Pradesh comprises of 23 districts and over all the extent of wetlands accounts for 5.3 per cent of geographical area of the state (Table 6). District-wise distribution of wetlands shown that Krishna district ranked first in the extent in terms per cent to the geographical area of the district registering 19 % (Table 6) followed by Nellore (16.47) and West Godavari (11.81). On the other hand Rangareddy district constitute least (1.37 %). Rest of them range in between 2 to 9 per cent. In terms of extent during post-monsoon, Hyderabad has least extent of wetlands (685 ha) while Nellore has registered highest area (141494 ha). Overall there is a reduction of about 31 per cent area in the open water from post-monsoon (887143 ha) to pre-monsoon (610668 ha). The seasonal change is least in East Godavari (4.68 %) while highest in Chittoor (76.56 %). Nellore district ranked first in terms of open water spread (41254 ha) in post- as well as in pre-monsoon (114398 ha). 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. District-wise distribution of wetlands is depicted graphically in figure 10.

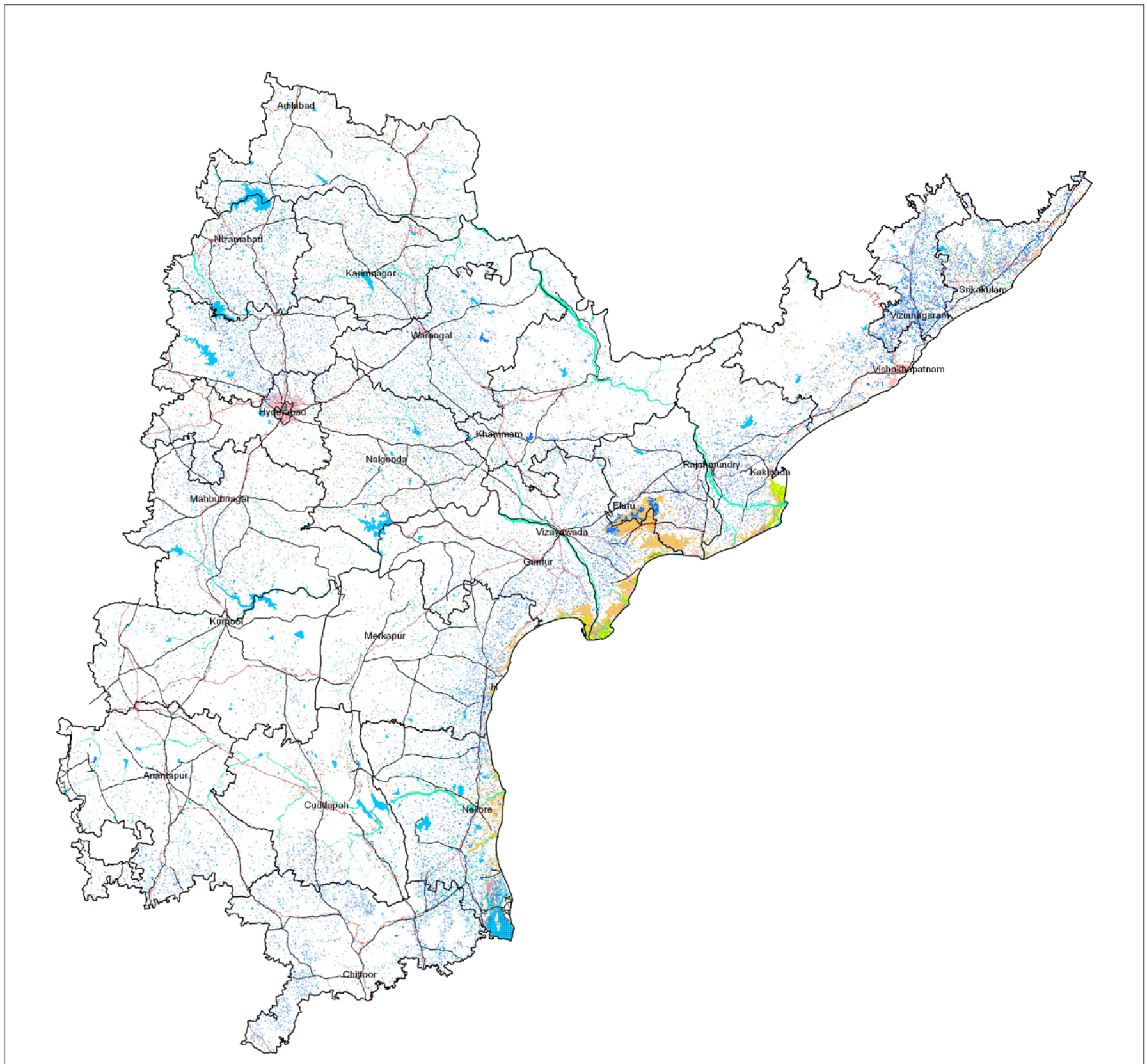
Table-6: District-wise wetland area

Sr. No.	District	Area of district (km^2)	Wetland area (ha)	% of total wetland area	% of district area	Open water extent (ha)		Seasonal change (%)
						Post-monsoon	Pre-monsoon	
1	Adilabad	16105	68907	4.76	4.28	44355	21557	51.40
2	Nizamabad	7956	69213	4.78	8.70	55961	27030	51.70
3	Karimnagar	11823	67017	4.63	5.67	37710	21283	43.56
4	Medak	9699	47639	3.29	4.91	39574	21476	45.73
5	Hyderabad	217	935	0.06	4.31	685	626	8.61
6	Rangareddi	7493	10257	0.71	1.37	6914	4417	36.12
7	Mehbubnagar	18432	52327	3.62	2.84	32655	20367	37.63
8	Nalgonda	14240	66606	4.60	4.68	44338	32498	26.70
9	Warangal	12846	51046	3.53	3.97	35760	13092	63.39
10	Khammam	16029	63422	4.38	3.96	33552	21795	35.04
11	Srikakulam	5837	34849	2.41	5.97	14645	11079	24.35
12	Vizianagaram	6539	23674	1.64	3.62	14741	6461	56.17
13	Visakhapatnam	11161	24988	1.73	2.24	16984	11185	34.14
14	East Godavari	10807	99057	6.85	9.17	54716	52154	4.68
15	West Godavari	7742	91447	6.32	11.81	67601	51421	23.93
16	Krishna	8727	165818	11.46	19.00	87097	74772	14.15
17	Guntur	11391	67652	4.67	5.94	31185	29031	6.91
18	Prakasam	17626	52565	3.63	2.98	25489	18743	26.47
19	Nellore	13076	215404	14.88	16.47	141494	114398	19.15
20	Cuddapah	15359	56470	3.90	3.68	34973	27073	22.59
21	Kurnool	17658	38479	2.66	2.18	26782	13972	47.83
22	Anantapur	19130	38400	2.65	2.01	10481	9334	10.94
23	Chittoor	15152	40961	2.83	2.70	29451	6904	76.56
	Total	275045	1447133	100.00	5.26	887143	610668	31.16

Figure 11: District-wise graphical distribution of wetlands

State : Andhra Pradesh

WETLAND MAP

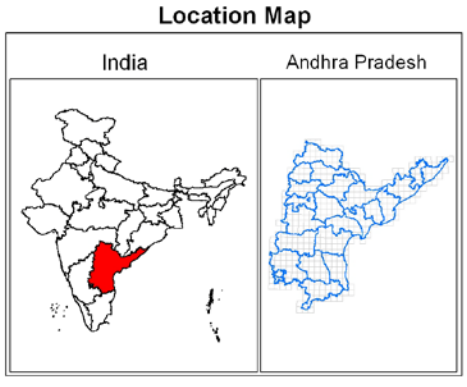


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



Data Source :

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

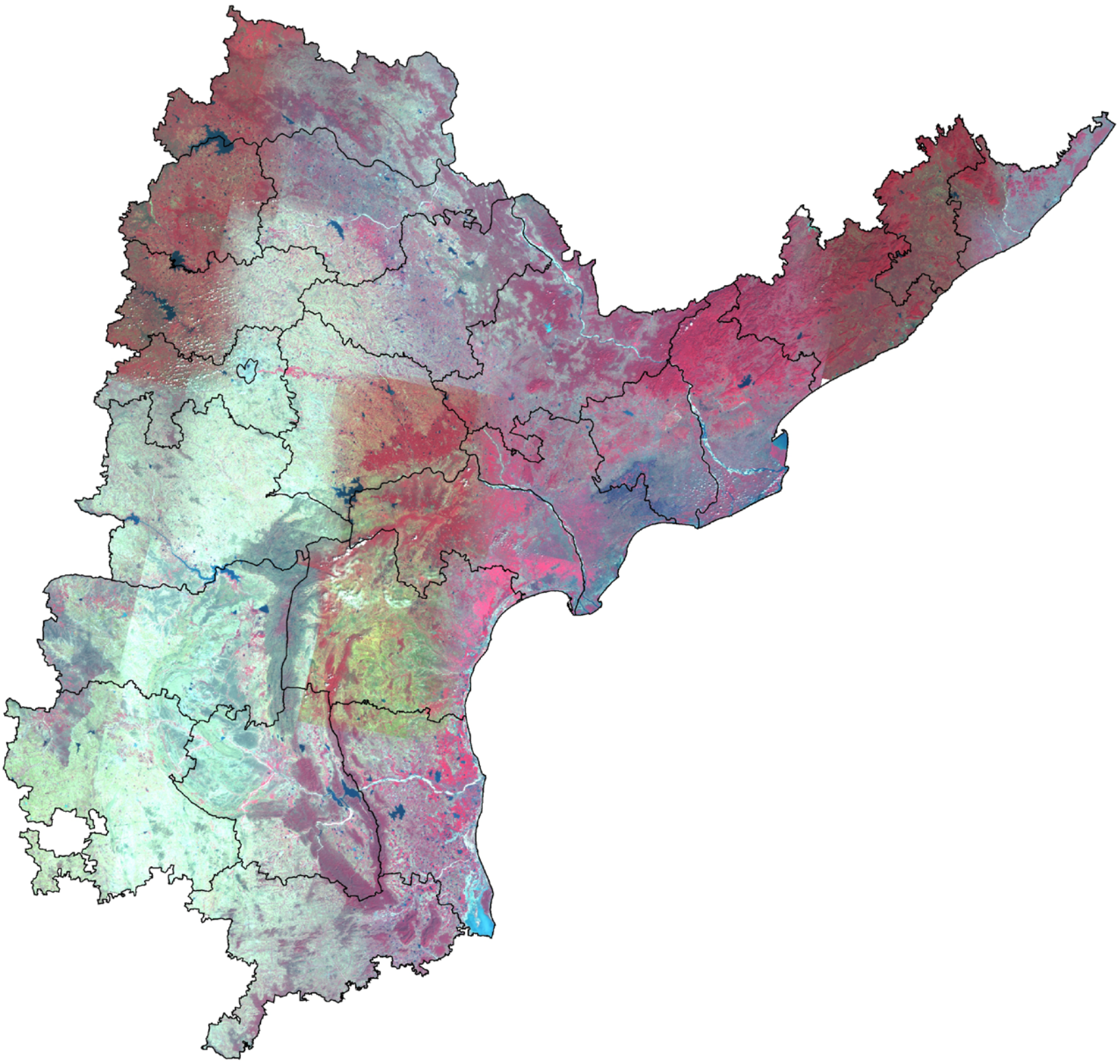
Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh



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

7.1.1 Adilabad

This district is bounded on the north by Yeovatmal and Chandrapur districts of Maharastra, on the east by Gadchiroli district of Maharastra, on the south by Karimnagar and Nizamabad districts and on the west by Nanded district of Maharashtra. The population of the district according to 2001 census is 24, 88,003.

Major part of the district is hilly and densely forest. The western half of the district is characterized by plateaus in the north and gently undulating topography in the south, while the eastern half is covered by NW-SE trending structural ridges and plains. Sahyadri Parvat or Satnala range traverses the district from the north-west to the south-east for about 281.5 km. Important rivers that drain the district are the river Godavari. Penganga, Wardha and Pranahita. Penganga forms part of the northern boundary of the district, while Wardha and Pranahita form the northern and eastern boundaries of the district. Then these three rivers merge in to the river Godavari. Kadam and Peddavagu, the tributaries of the river Godavari, are also drain the district. Besides these, there are also rivulets like Satnala, Swarna vagu and Suddavagu, which drain the district.

The climate of Adilabad district is characterized by hot summer and is generally dry except during the south-west monsoon season. During summer, the mean daily maximum temperature is at about 46^0 C and the minimum daily is 30^0 C. December is generally the coldest month; with the mean daily maximum temperature at about 29^0 C and the minimum daily is 15^0 C. The rainfall in the district, in general increases from the south-west towards the north-east. About 85% of annual rainfall is received during the south-west monsoon season. The annual normal rainfall of the district is 1153 mm, which ranges from 995 mm at Tiryani mandal to 1348 mm at Indervally mandals. The relative humidity is high, generally during the south-west monsoon season and the air is generally dry during the rest of the year.

The district comprises of 866 wetlands, which were mapped besides 361 small wetlands (<2.25 ha). These wetlands account for 68907 ha. Three major wetland types (Table 7) namely; River/Stream (34133 ha) followed by Reservoir/Barrages, (27008 ha) and Tanks/Ponds (7383 ha) exist in the district. Aquatic vegetation has an increase from 4785 ha in post-monsoon to 13041 ha in pre-monsoon. Analysis of wetland status in terms of open water, the district has recorded 44355 ha and 21557 ha of during post-monsoon and pre-monsoon respectively out of 68546 ha (excluding wetlands <2.25 ha) of wetland extent. This amounts to a large seasonal reduction (about 63 %). Qualitative turbidity of the open water dominated by moderate (22756 ha) followed by low turbidity (17976 ha) and high turbidity (3623 ha) in post-monsoon. The trend continued in pre-monsoon where the turbidity was dominated by moderate (16303 ha) followed by low (4159 ha) and high (1095 ha).

Table 7: Area estimates of wetlands in Adilabad

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon	Pre-monsoon
	1100	**Inland Wetlands - Natural**					
1	1105	Waterlogged	1	15	0.02	4	10
2	1106	River/Stream	57	34133	49.53	15054	9179
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	217	27008	39.19	24202	10421
4	1202	Tanks/Ponds	590	7383	10.71	5090	1947
5	1203	Waterlogged	1	7	0.01	5	-
		Sub-Total	**866**	**68546**	**99.48**	**44355**	**21557**
		Wetlands (<2.25 ha), mainly Tanks	361	361	0.52	-	-
		Total	**1227**	**68907**	**100.00**	**44355**	**21557**

Area under Aquatic Vegetation	4785	13041

Area under turbidity levels		
Low	17976	4159
Moderate	22756	16303
High	3623	1095

State : Andhra Pradesh

WETLAND MAP

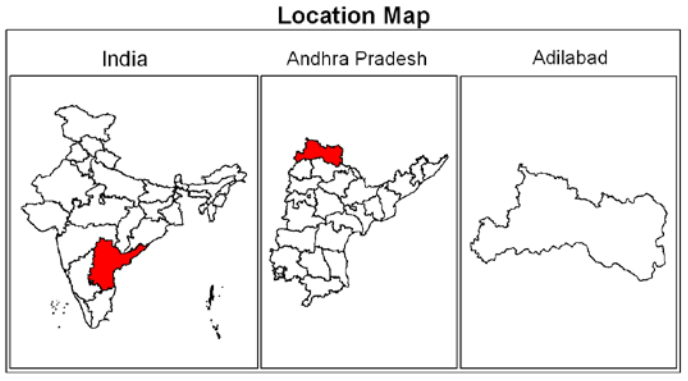
District : Adilabad

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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

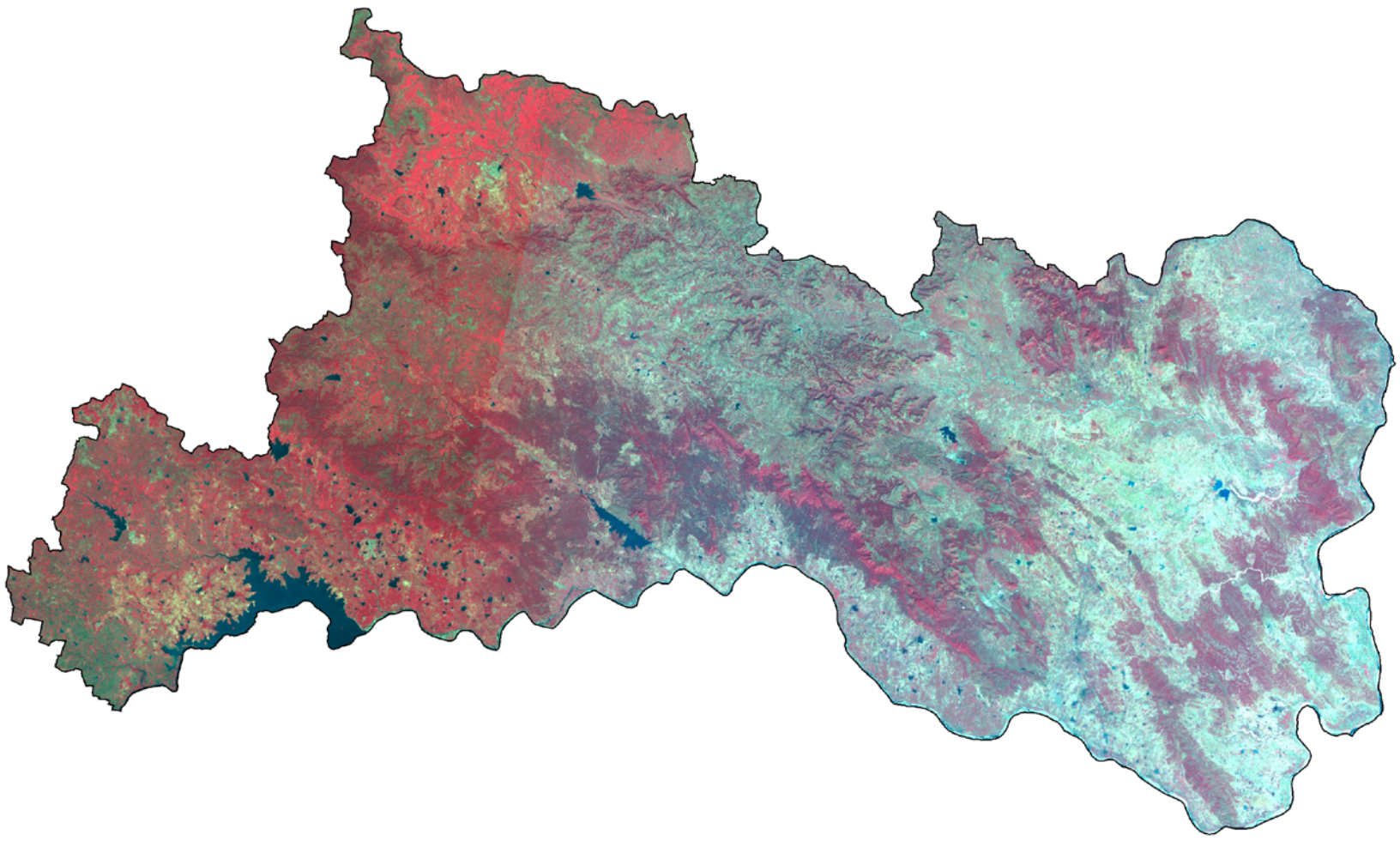
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Adilabad



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

7.1.2 Nizamabad

It is bounded on the north by Adilabad district, on the east by Karimnagar district, on the south by Medak district and on the west by Nanded district of Maharashtra. The district has an undulating terrain partially cover with forests. Godavari river flows along the northern boundary of the district and enters Karimnagar district. The two tributaries of river Godavari namely Manjeera and Maneru are the next important rivers, which drain this district. The climatic condition of the district is tropical and temperature fluctuations. The normal mean minimum temperature is 13.7º C and mean maximum is 39.9º C. Annual rainfall ranges from 878 mm to 1220 mm.

The district comprises of 1064 wetlands, which were mapped besides 530 small wetlands (<2.25 ha). These wetlands account for 69213 ha. Major wetland types existing in the district (Table 8) are Reservoir/Barrages (36349 ha) followed by Tanks/Ponds (19152 ha) and River/Stream (13151 ha). Analysis of wetland status in terms of open water, indicates that about 52 per cent seasonal reduction in open water from the post-monsoon (559611 ha) and pre-monsoon (27030 ha) out of 68546 ha (excluding wetlands <2.25 ha) of wetland extent. There is a tremendous increase in the extent of aquatic vegetation (about 44 %) from post-monsoon (8432 ha) to pre-monsoon (14894 ha). Qualitative turbidity of the open water dominated by moderate (26880 ha) and low turbidity (26810 ha) followed by high turbidity (2271 ha) in post-monsoon. However, moderate turbidity remained dominant in pre-monsoon (17024 ha) followed by low (9923 ha) and high (83).

Table 8: Area estimates of wetlands in Nizamabad

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	1105	Waterlogged	1	31	0.04	5	8
2	1106	River/Stream	26	13151	19.00	9635	2840
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	122	36349	52.52	32740	16553
4	1202	Tanks/Ponds	915	19152	27.67	13581	7629
		Sub-Total	**1064**	**68683**	**99.23**	**55961**	**27030**
		Wetlands (<2.25 ha), mainly Tanks	530	530	0.77	-	-
		Total	**1594**	**69213**	**100.00**	**55961**	**27030**

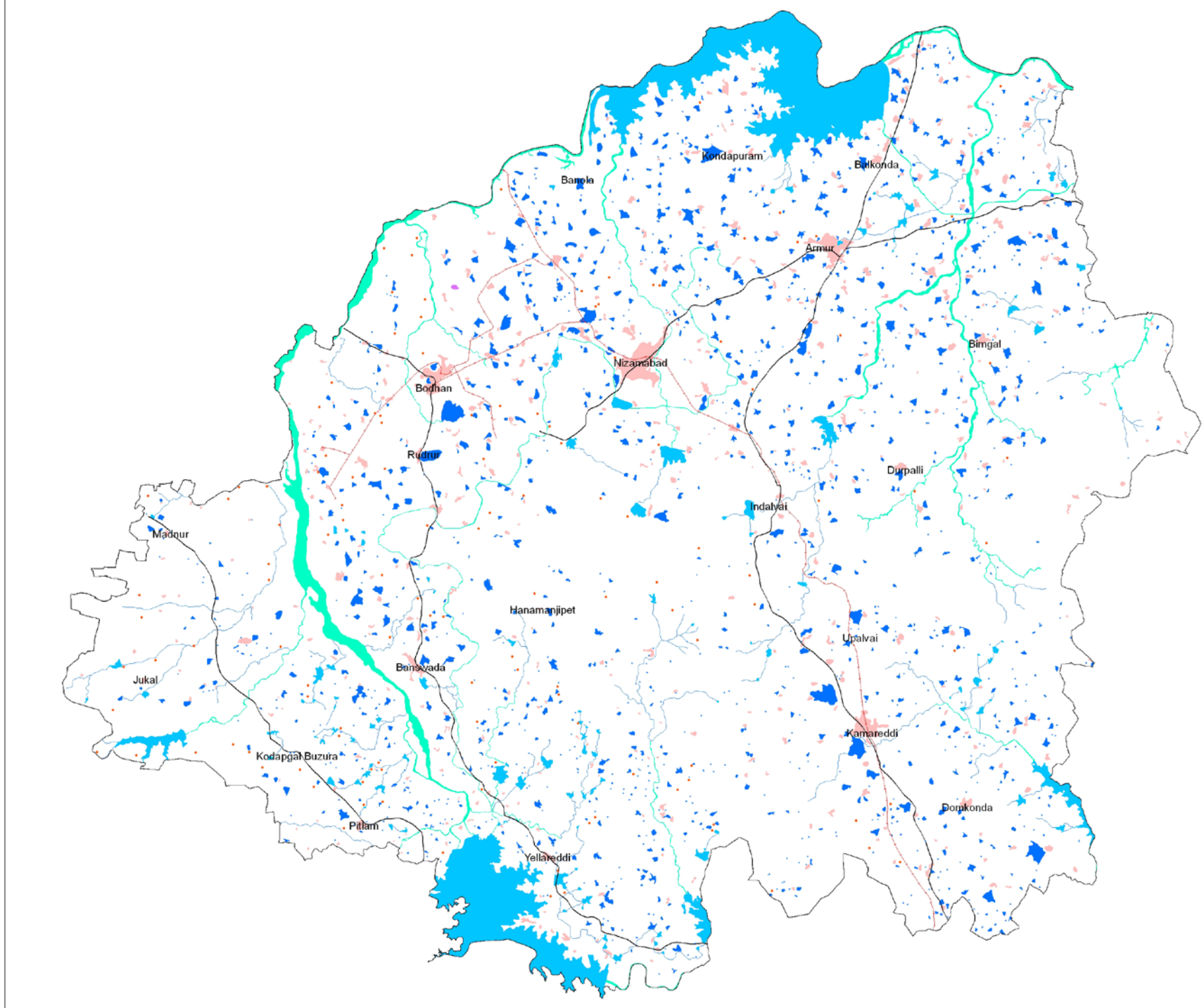
Area under Aquatic Vegetation	8432	14894

Area under turbidity levels		
Low	26810	9923
Moderate	26880	17024
High	2271	83

State : Andhra Pradesh

WETLAND MAP

District : Nizamabad

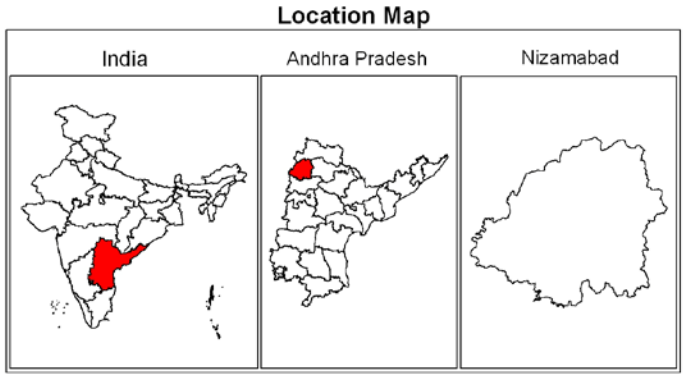


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

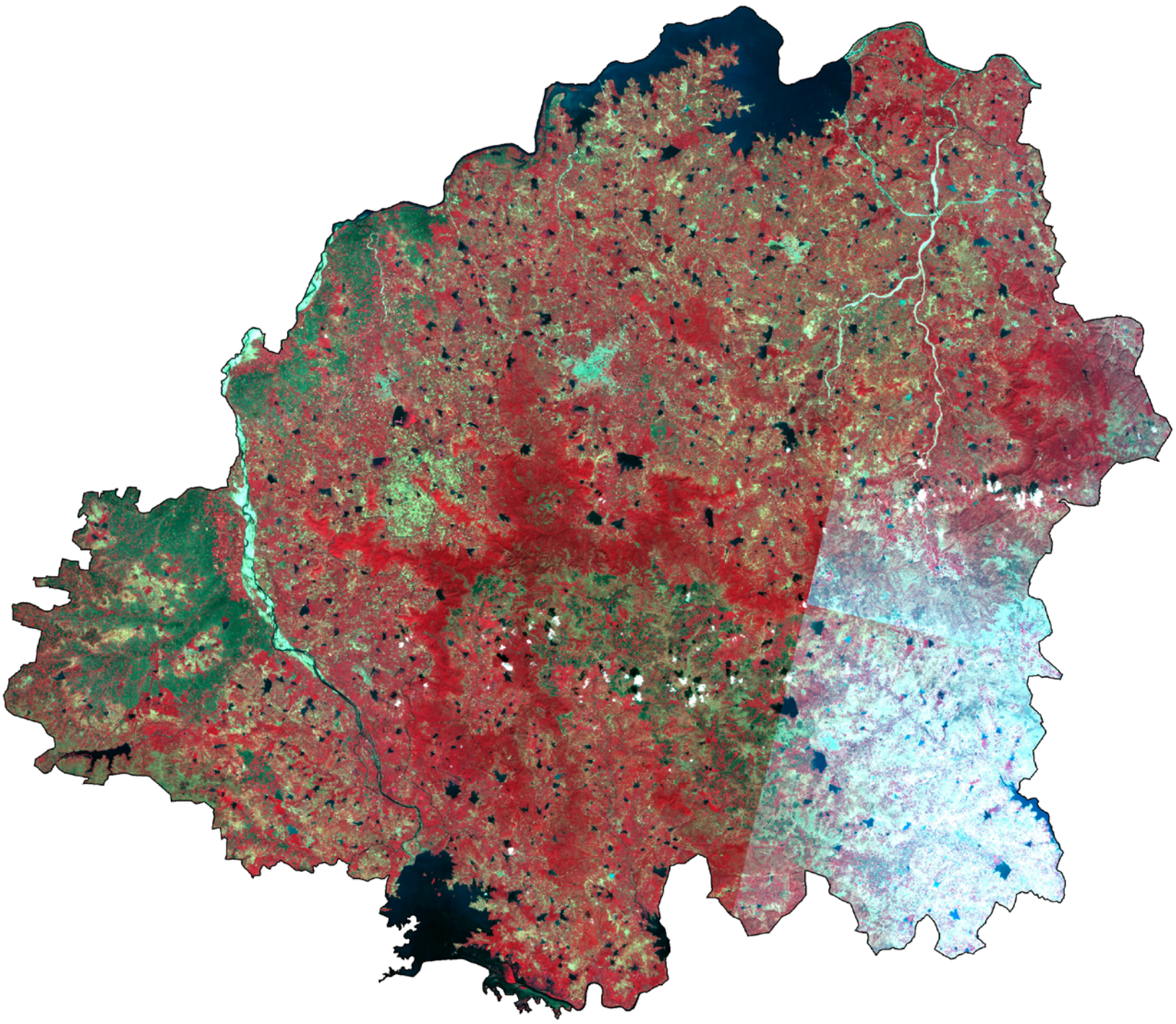
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Nizamabad



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

7.1.3 Karimnagar

Karimnagar district is situated between 78°40' and 80°00' east longitudes and 18°00' and 19°00' north latitudes. This district is bounded on the north by Adilabad district, on the east by Gadchiroli district of Maharastra, on the south by Warangal and Medak districts and on the west by Nizamabad district. The district can be divided physiographically into two regions viz., hills and plateau. Three ranges from Balughat are spread over the district while the rest is plateau. The river Godavari, the largest river in the peninsular India, enters the district at Kandukurthi village, runs for a distance of 283 km forming the northern and eastern boundary of the district and leaves the district at Muknur village. The entire district is mainly drained by Maneru River, a tributary of river Godavari. The climate of the district is characterized by hot summer and is generally dry except during the south-west monsoon season. The average annual rainfall of the district is 968.6 mm. The rainfall increases from south to northern part varying from 950 to 1100 mm. The southwest monsoon contributes about 83% of the annual rainfall. The relative humidity is high, generally during the south-west monsoon season and the air is generally dry during the rest of the year.

The district comprises of 1872 wetlands, out of which, the mapped ones are 1274 besides 598 small wetlands (<2.25 ha). These wetlands account for 67017 ha. Only three types encountered in the district (Table 9), which are River/Stream (30743 ha) followed by Reservoir/Barrages (25141 ha) and Tanks/Ponds (10535 ha). Aquatic vegetation has registered about 60 per cent increase from 4607 ha in post-monsoon to 11471 ha in pre-monsoon. Analysis of wetland status in terms of open water, shown that about 44 per cent seasonal reduction in open water from the post-monsoon (37710 ha) and pre-monsoon (21283 ha) out of 66419 ha (excluding wetlands <2.25 ha) of wetland extent. Qualitative turbidity of the open water dominated by moderate (33778 ha) followed high (3136 ha) and low turbidity (796 ha) in post-monsoon. The trend continued in pre-monsoon season also with area under moderate (16655 ha) followed by high (1454 ha) and low (174 ha).

Table 9: Area estimates of wetlands in Karimnagaar

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	1106	River/Stream	17	30743	45.87	7939	5213
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	565	25141	37.51	20969	12480
3	1202	Tanks/Ponds	692	10535	15.72	8802	3590
		Sub-Total	1274	66419	99.11	37710	21283
		Wetlands (<2.25 ha), mainly Tanks	598	598	0.89	-	-
		Total	1872	67017	100.00	37710	21283

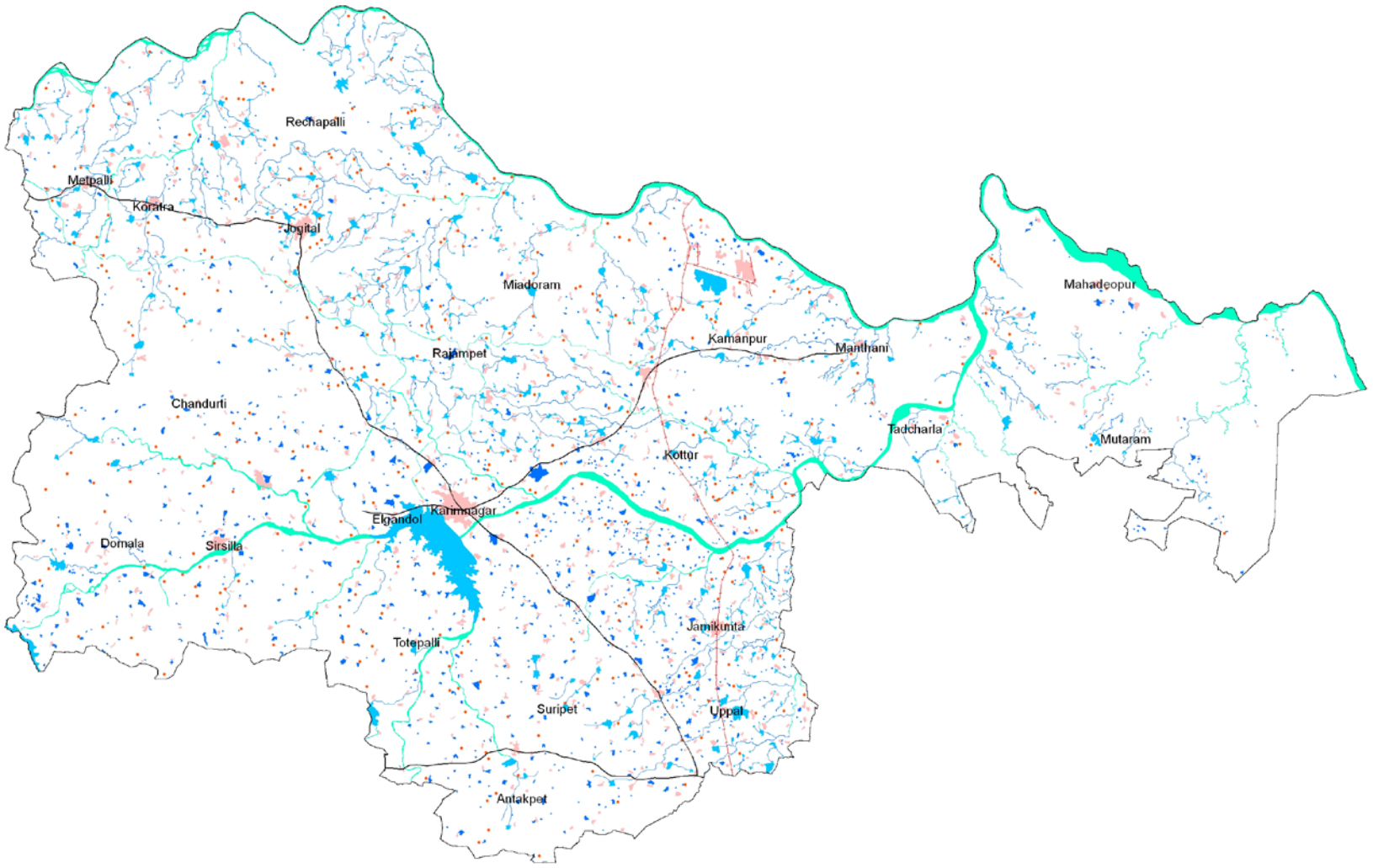
Area under Aquatic Vegetation	4607	11471

Area under turbidity levels		
Low	796	174
Moderate	33778	19655
High	3136	1454

State : Andhra Pradesh

WETLAND MAP

District : Karimnagar

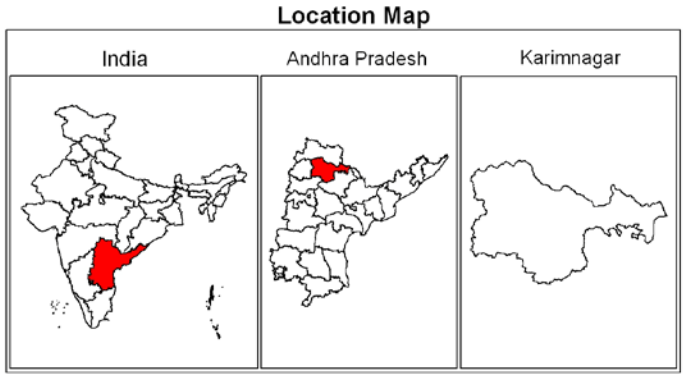


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

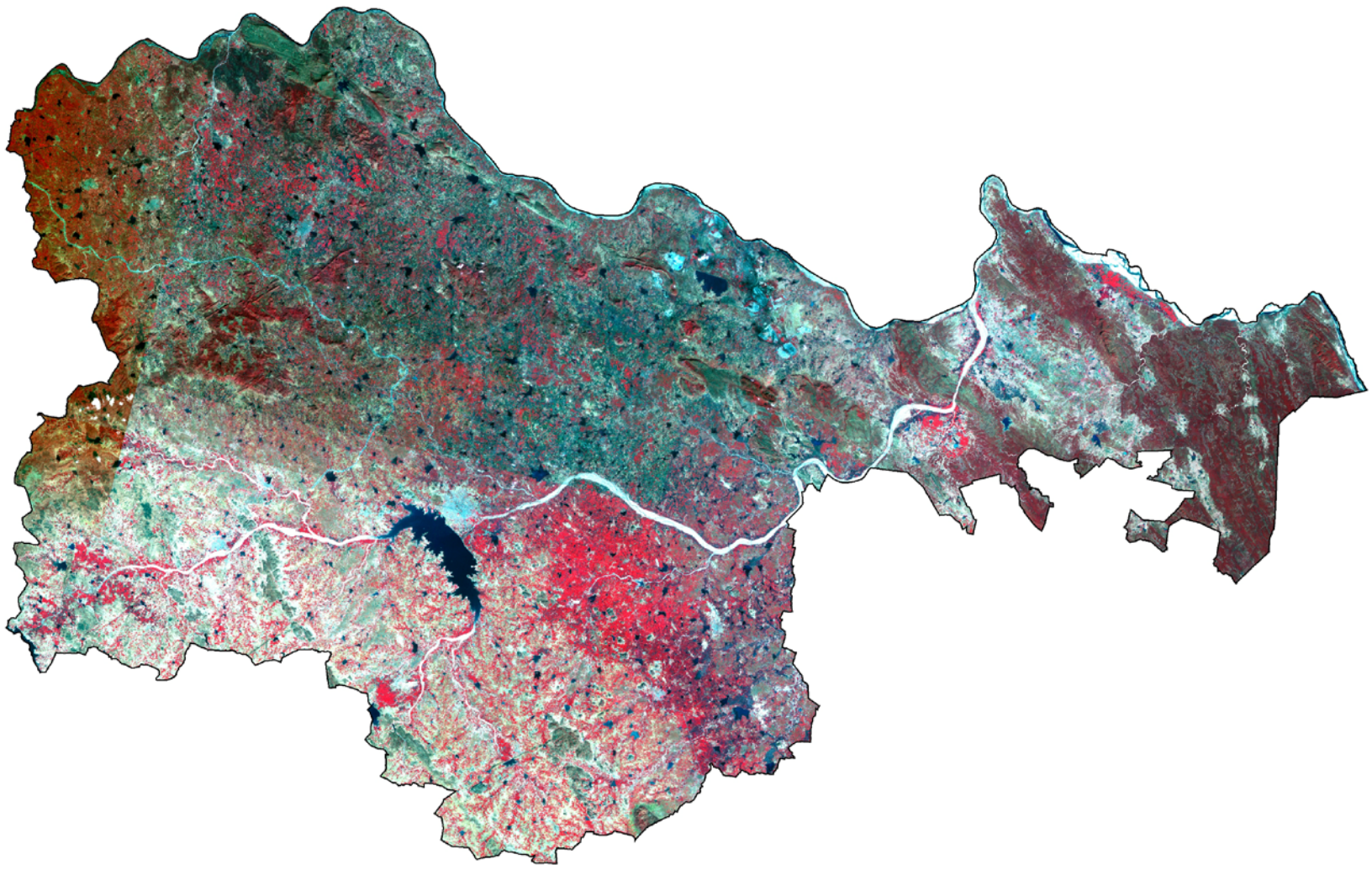
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Karimnagar



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

7.1.4 Medak

Medak district is situated between 77°28' and 79°10' East Longitudes and 17°27' and 18°19' North Latitudes. This district is bounded on the north by Nizamabad and Karimnagar districts on the east by Karimnagar and Warangal districts, on the south by Nalgonda and Rangareddy districts and on the west by Bidar district of Karnataka. The district has a population of 26,70,097 as per 2001 census. The population density of the district is 275 persons per sq. km. The major crops grown here are Rice, Jowar, Cotton, Turmeric, Maize, Arhar, Chillies, Sugarcane and Sesame. The district forms a part of the Deccan Plateau crossed by different hill ranges. Manjeera, the tributary of the river Godavari, Haldi (Pasupuyeru) and Kudliar the tributaries of Manjeera drain the district. Medak has tropical climate and the summer is very hot and dry. The summer season extends from March to May. From December to February it is winter. The mean maximum and minimum temperature vary from 40 ^{0} C to 26^0 C. The south-west monsoon brings heavy rains. The rainy season extends from June to September. The district receives an average rainfall of 873 mm.

The district comprises of 1756 wetlands, out of which, the mapped ones are 1092 besides 664 small wetlands (<2.25 ha). These wetlands occupy 47639 ha, which accounts for 4.9 per cent of the geographical area of the district. Only three types encountered in the district (Table 10), which are Reservoir/Barrages (22072 ha) followed by Tanks/Ponds (20116 ha) and River/Stream (4787 ha). Aquatic vegetation has registered about a threefold increase form 3483 ha in post-monsoon to 13563 ha in pre-monsoon. Open water has shown about 44 per cent seasonal reduction from the post-monsoon (39574 ha) and pre-monsoon (21476 ha) out of 46975 ha (excluding wetlands <2.25 ha) of wetland extent. Qualitative turbidity of the open water dominated by moderate (22257 ha) followed high (14308 ha) and low turbidity (3009 ha) in post-monsoon. The trend changed in pre-monsoon season with area under moderate (14896 ha) continued to dominate followed by low (6366 ha) and high (214 ha).

Table 10: Area estimates of wetlands in Medak

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	1106	River/Stream	15	4787	10.05	3014	1810
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	11	22072	46.33	20310	11655
3	1202	Tanks/Ponds	1066	20116	42.23	16250	8011
		Sub-Total	**1092**	**46975**	**98.61**	**39574**	**21476**
		Wetlands (<2.25 ha), mainly Tanks	664	664	1.39	-	-
		Total	**1756**	**47639**	**100.00**	**39574**	**21476**

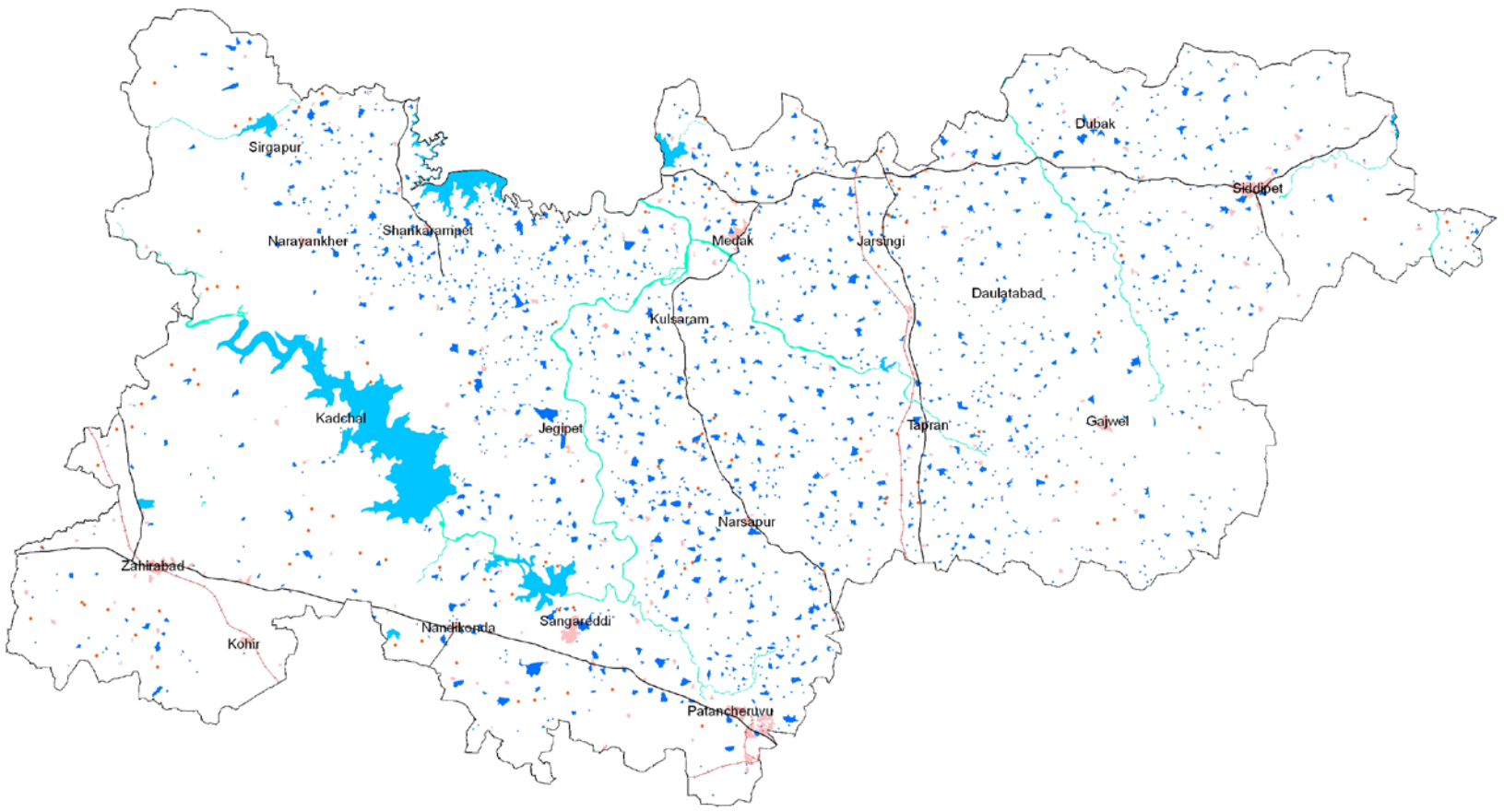
Area under Aquatic Vegetation	3483	13563

Area under turbidity levels		
Low	3009	6366
Moderate	22257	14896
High	14308	214

State : Andhra Pradesh

WETLAND MAP

District : Medak

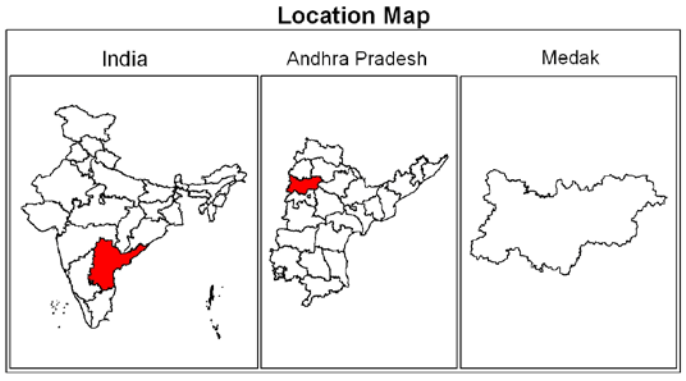


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

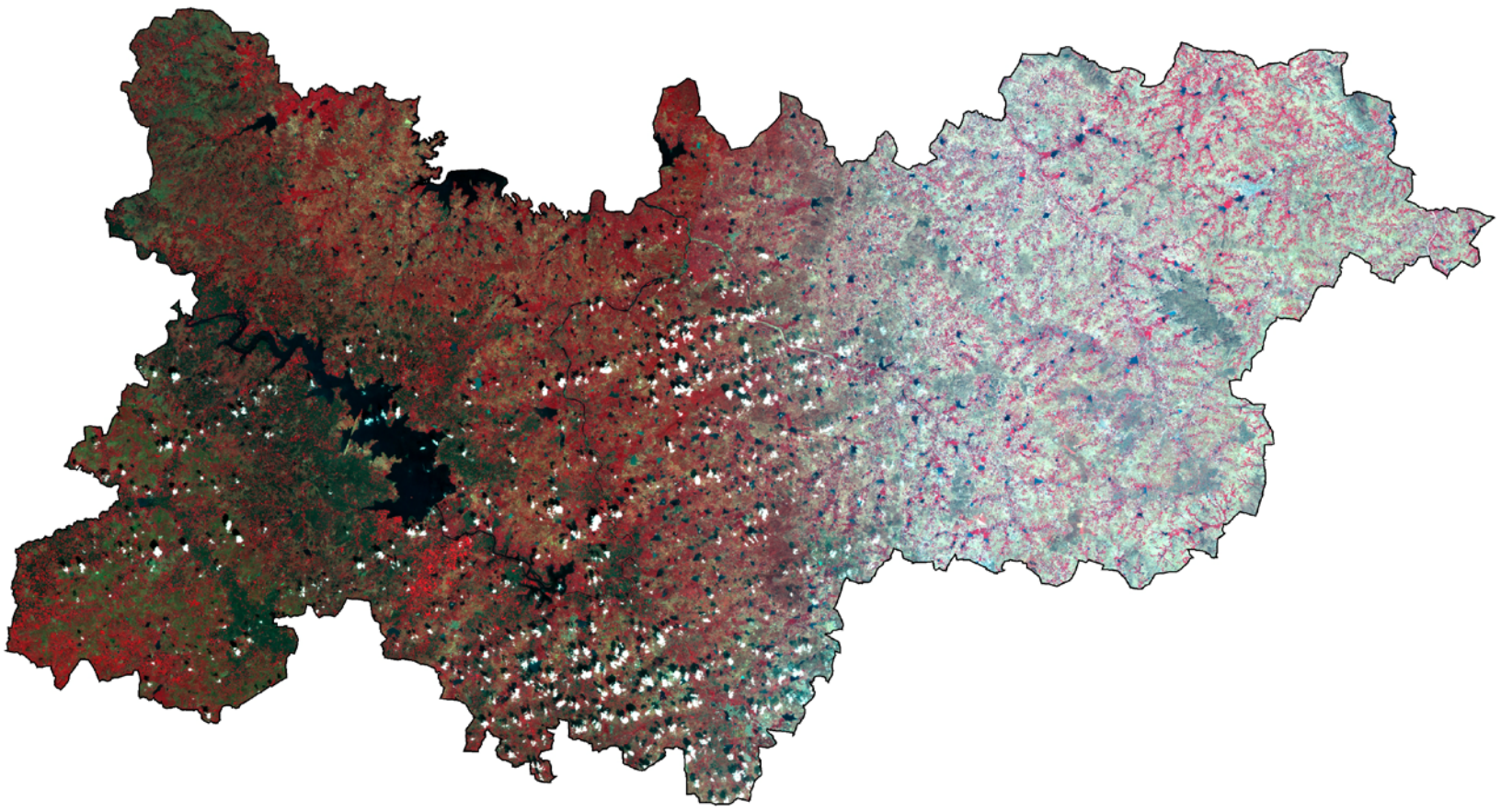
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Medak



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

7.1.5 Hyderabad

The geographical area of the district is 217 km^2, out of which wetlands constitute 4.31 per cent of area. The district comprises 31 wetlands, out of which, the mapped ones are 18 besides 13 small wetlands (<2.25 ha). These wetlands occupy an area 935 ha. Only three types encountered in the district (Table 11), which are Reservoir/Barrages (584 ha) followed by River/Stream (231 ha) and Tanks/Ponds (107 ha).

Aquatic vegetation has registered a decrease form 68 ha in post-monsoon to 49 ha in pre-monsoon. Open water has shown a nominal decrease of about 9 per cent seasonal reduction from the post-monsoon (685 ha) and pre-monsoon (626 ha) out of 922 ha (excluding wetlands <2.25 ha) of wetland extent. Qualitative turbidity of the open water dominated by moderate (623 ha) followed high (62 ha) and low turbidity has not been observed in post-monsoon. The trend changed in pre-monsoon season with area under low (495 ha) to dominate followed by moderate (131 ha) without high turbidity zones.

Table 11: Area estimates of wetlands in Hyderabad

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	1106	River/Stream	4	231	24.71	62	-
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	2	584	62.46	552	553
3	1202	Tanks/Ponds	12	107	11.44	71	73
		Sub-Total	**18**	**922**	**98.61**	**685**	**626**
		Wetlands (<2.25 ha), mainly Tanks	13	13	1.39	-	-
		Total	**31**	**935**	**100.00**	**685**	**626**

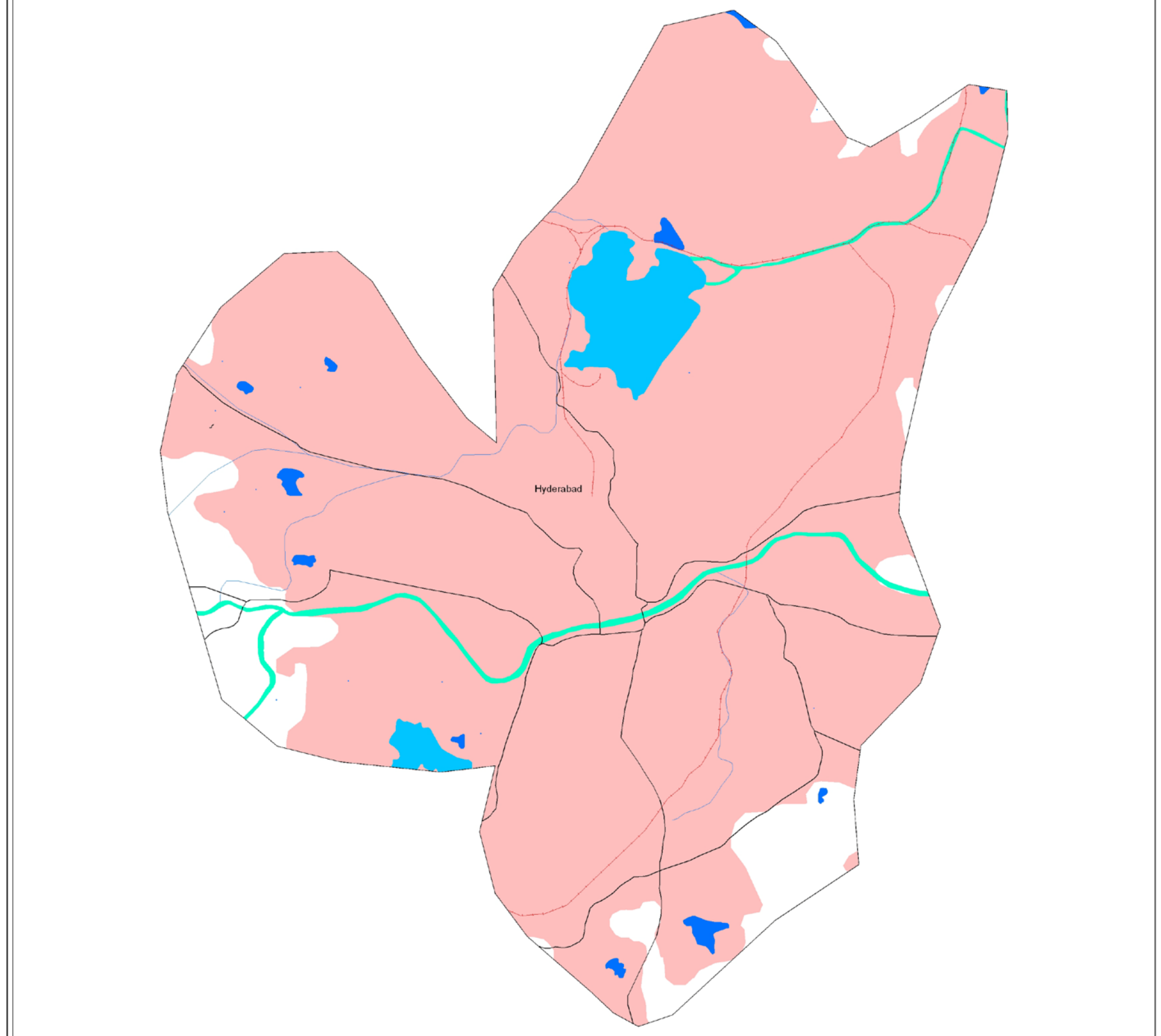
Area under Aquatic Vegetation	68	49

Area under turbidity levels		
Low	-	495
Moderate	623	131
High	62	-

State : Andhra Pradesh

WETLAND MAP

District : Hyderabad

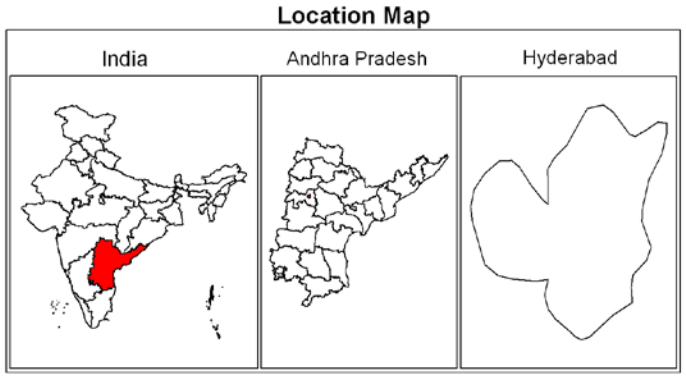


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



2 1 0 2 4 Kilometers

Data Source :

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

Prepared By :

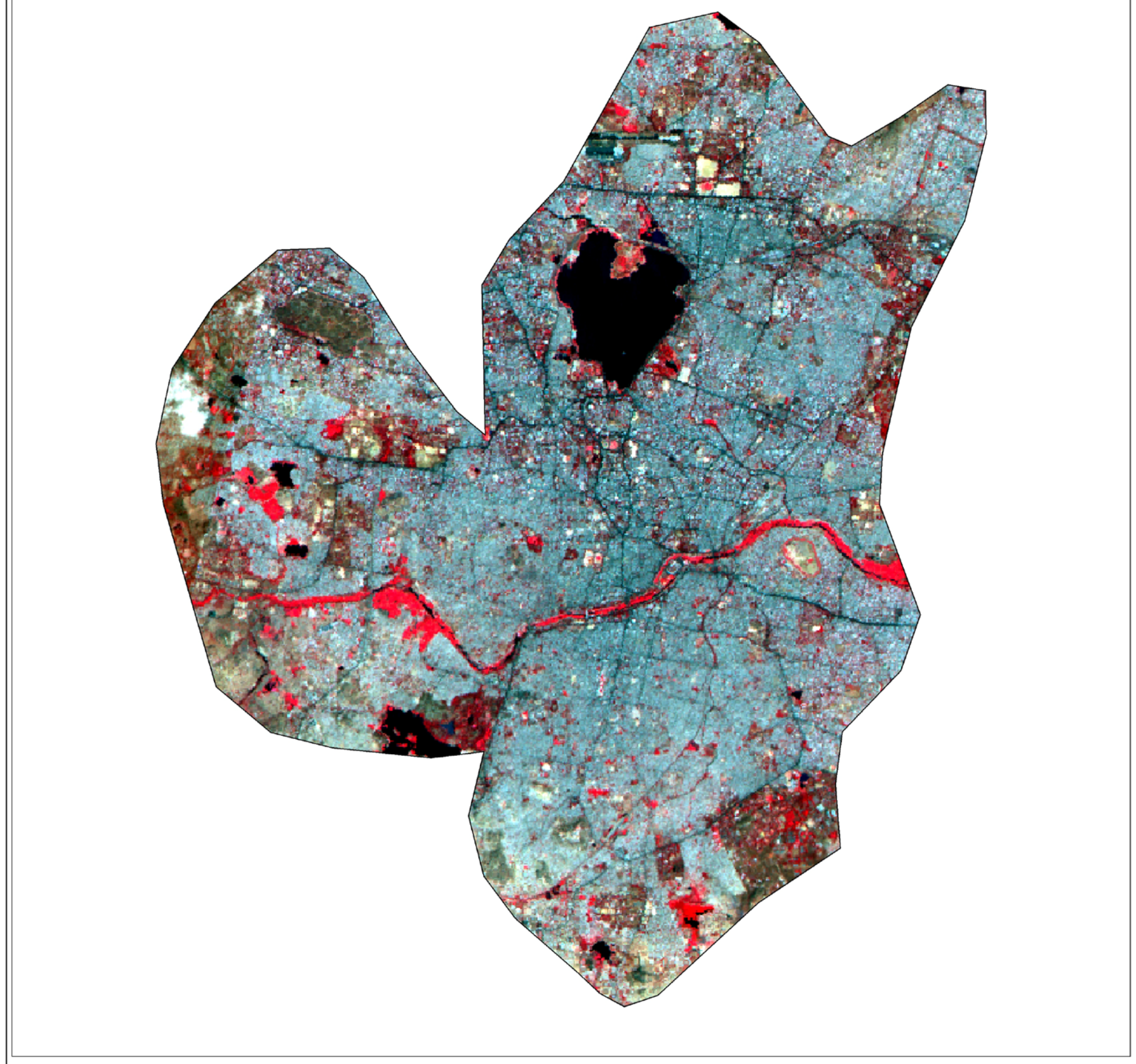
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Hyderabad



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

7.1.6 Rangareddi

The district is located at the heart of Dakshinapatha or the Deccan plateau of the Indian subcontinent and lies between 16^0 19' ad 18^0 20' North latitude and 77^0 30' East longitude bounded on the north by Medak district, on the east by Nalgonda District on the south by Mahaboobnagar District and on the west by Gulbarga District of Karnataka State. The district is situated at an elevation of 500-600 m above sea level in the Deccan Plateau. Scattered hillocks and outcrops of black stone are ubiquitous in the district. The general slope of the land is from west to east and south-east. Musi is the main river flowing from west to east in the district. The Climate of the district is characterized by hot summer and is generally dry except during the South west monsoon season. The year may be divided into four seasons. March to May is the summer season, June to September constitutes the South West monsoon season, October to December from the North East monsoon season and January to February is the winter season. The District has a normal rainfall of 781.5 MM. the bulk of which is received through the South West Monsoon during the period from June to September. The mean maximum temperature begins to rise from the middle of February and reaches a maximum of about 30^0C in May. December is the coldest month with the mean daily maximum temperature at 28.6^0 C and the mean daily minimum Temperature at 13.6^0 C.

Wetlands in this constitute 1.37 per cent of the geographical area. The number of wetlands in this district are 749 wetlands, out of which, the mapped ones are 348 besides 401 small wetlands (<2.25 ha). These wetlands account for an area of 10257 ha (Table 12). Reservoir/Barrages (4325 ha) constituting about 42 per cent of wetland extent followed by Tanks/Ponds (3287 ha) and River/Stream (2182 ha). Aquatic vegetation has registered about 2.3 times increase form 964 ha in post-monsoon to 2264 ha in pre-monsoon. Open water has shown a substantial decrease of about 36 per cent seasonal reduction from the post-monsoon (6914 ha) and pre-monsoon (4417 ha) out of 10257 ha (excluding wetlands <2.25 ha) of wetland extent. Qualitative turbidity of the open water dominated by moderate (5967 ha) followed high (673 ha) and low (274 ha) in post-monsoon. The trend remained unchanged in pre-monsoon season with area under moderate (3936 ha) to dominate followed by high (256 ha) and low (225 ha).

Table 12: Area estimates of wetlands in Rangareddi

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	1105	Waterlogged	2	62	0.60	19	-
2	1106	River/Stream	11	2182	21.27	596	-
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	54	4325	42.17	3571	2415
4	1202	Tanks/Ponds	281	3287	32.05	2728	2002
		Sub-Total	**348**	**9856**	**96.09**	**6914**	**4417**
		Wetlands (<2.25 ha), mainly Tanks	401	401	3.91	-	-
		Total	**749**	**10257**	**100.00**	**6914**	**4417**

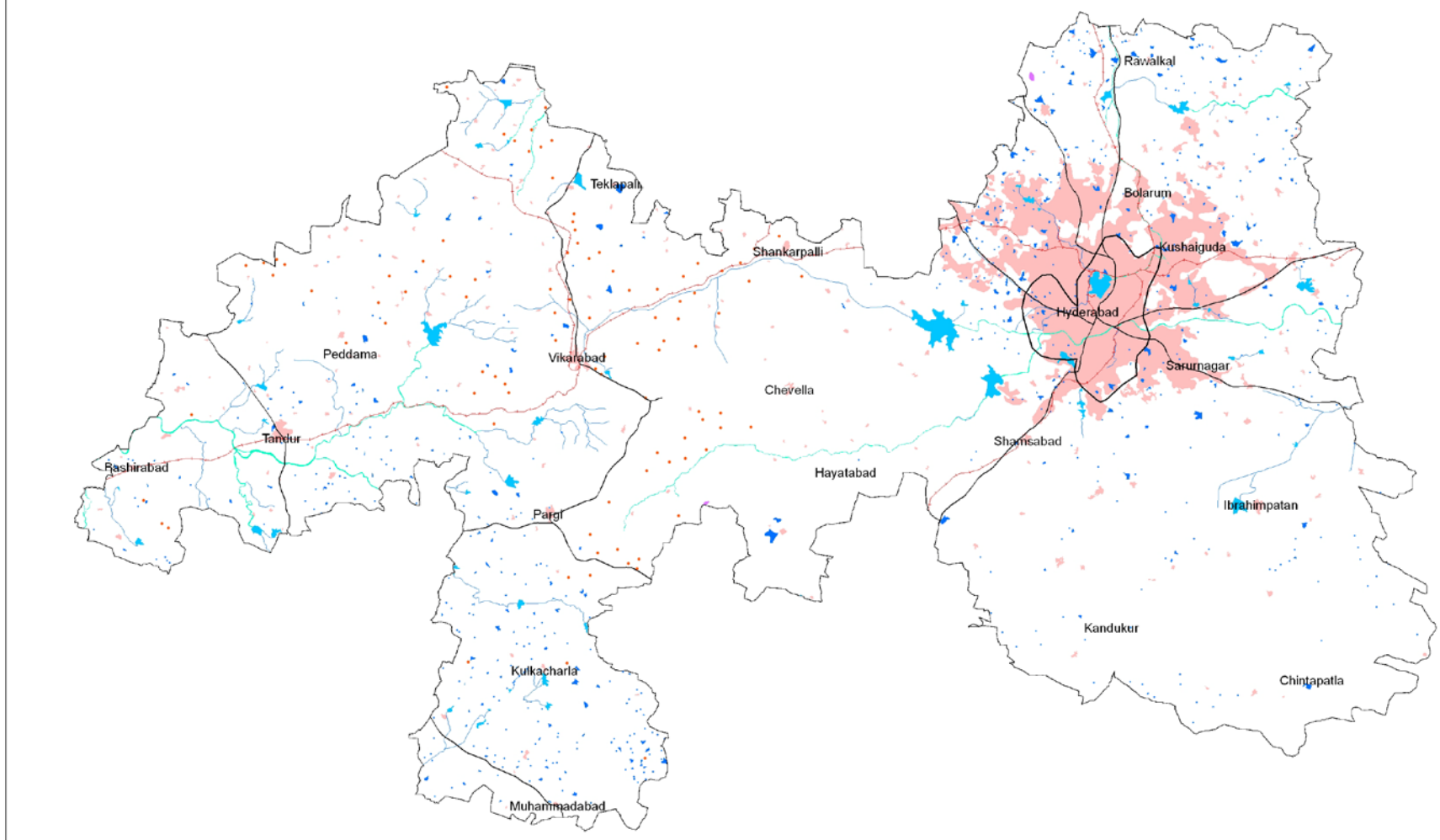
Area under Aquatic Vegetation	964	2264

Area under turbidity levels		
Low	274	225
Moderate	5967	3936
High	673	256

State : Andhra Pradesh

WETLAND MAP

District : Rangareddi

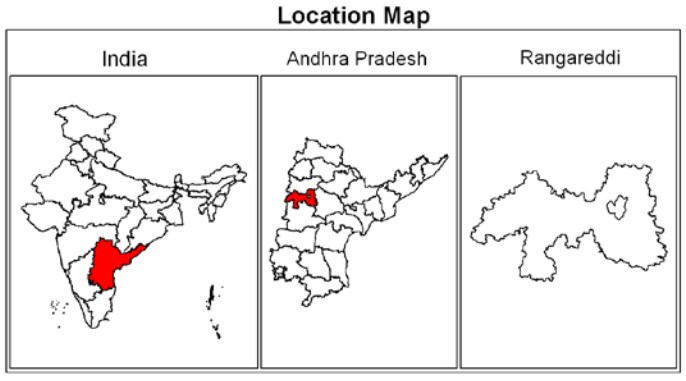


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

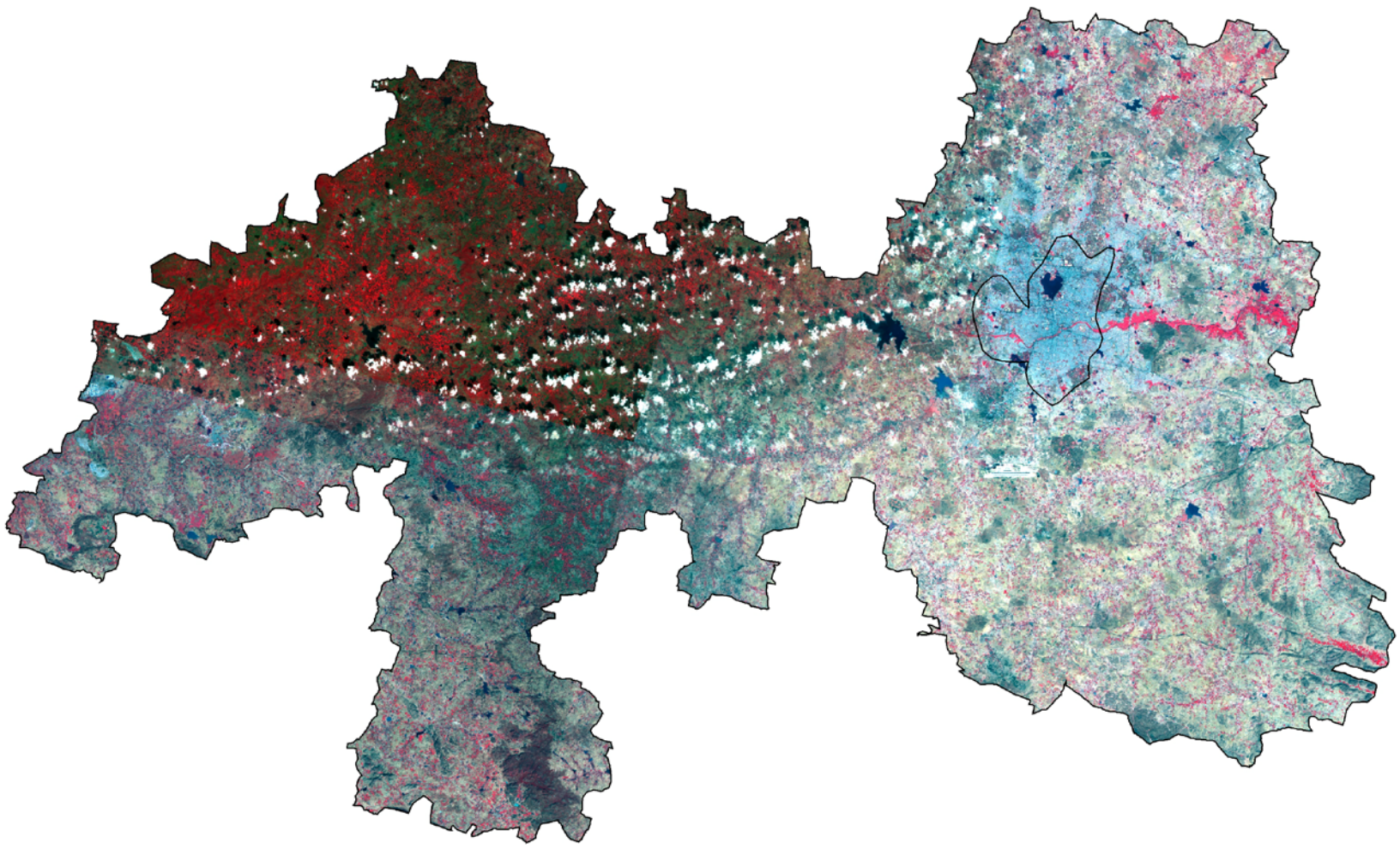
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Rangareddi



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

7.1.7 Mahbubnagar

Mahabubnagar is the largest district in Telangana Region and the second largest in Andhra Pradesh State. Mahbubnagar is located at 16.73° N 77.98° E. It is bounded on the north by Rangareddy and Nalgonda, on the east by Nalgonda and Guntur districts and on the south by rivers Krishna and Tungabhadra and on the west by Raichur and Gulbarga districts of Karnataka states. The district may be physiographically divided into more or less two distinct regions, the plain region with low lying scattered hills and the extensive Amarabad-Farhabad plateau, a continuous range of hills, of an average elevation of about 800 meters, extending more or less, east-west along the Krishna river on the southern boundary of the district. The hill range is interspersed by several deep valleys, which are almost inaccessible from the plains. Mahabubnagar district has abundant resources of many minerals like diamonds, gold, semiprecious stones, abrasive, asbestos, clays, quartz, limestones etc. Climate is Tropical. May and June are the hottest months with the highest maximum temperatures recorded. November, December and January months record low temperatures. The temperatures in summer are max 40 °C and min 26 °C and in winter max 28 °C and min 18 °C. Rains are heavy in the north of the district. Average rainfall is 754mm.

The geographical area of this district is 10257 km^2, out of which Wetlands constitute 2.84 per cent of area. The district comprises 1021 wetlands, out of which, the mapped ones are 595 besides 606 small wetlands (<2.25 ha). These wetlands account for an area of 52327 ha (Table 13). Reservoir/Barrages (31256 ha) ranked first constituting about 42 per cent of wetland extent followed by River/Stream (14136 ha) and Tanks/Ponds (5424 ha) and. Open water has shown a substantial decrease of about 24 per cent seasonal reduction from the post-monsoon (32655 ha) and pre-monsoon (20367 ha) out of 51721 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation has registered about 5 fold increase form 2623 ha in post-monsoon to 12516 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (21722 ha) followed low (9147 ha) and high (1786 ha) in post-monsoon. The trend remained unchanged in pre-monsoon season with area under moderate (15278 ha) to dominate followed by low (3449 ha) and low (1640 ha).

Table 13: Area estimates of wetlands in Mahbubnagar

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	1105	Waterlogged	15	356	0.68	109	139
2	1106	River/Stream	19	14136	27.01	4868	3794
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	210	31256	59.73	24163	13908
4	1202	Tanks/Ponds	340	5424	10.37	3509	2510
5	1203	Waterlogged	11	549	1.05	6	16
		Sub-Total	**595**	**51721**	**98.84**	**32655**	**20367**
		Wetlands (<2.25 ha), mainly Tanks	606	606	1.16	-	-
		Total	**1201**	**52327**	**100.00**	**32655**	**20367**

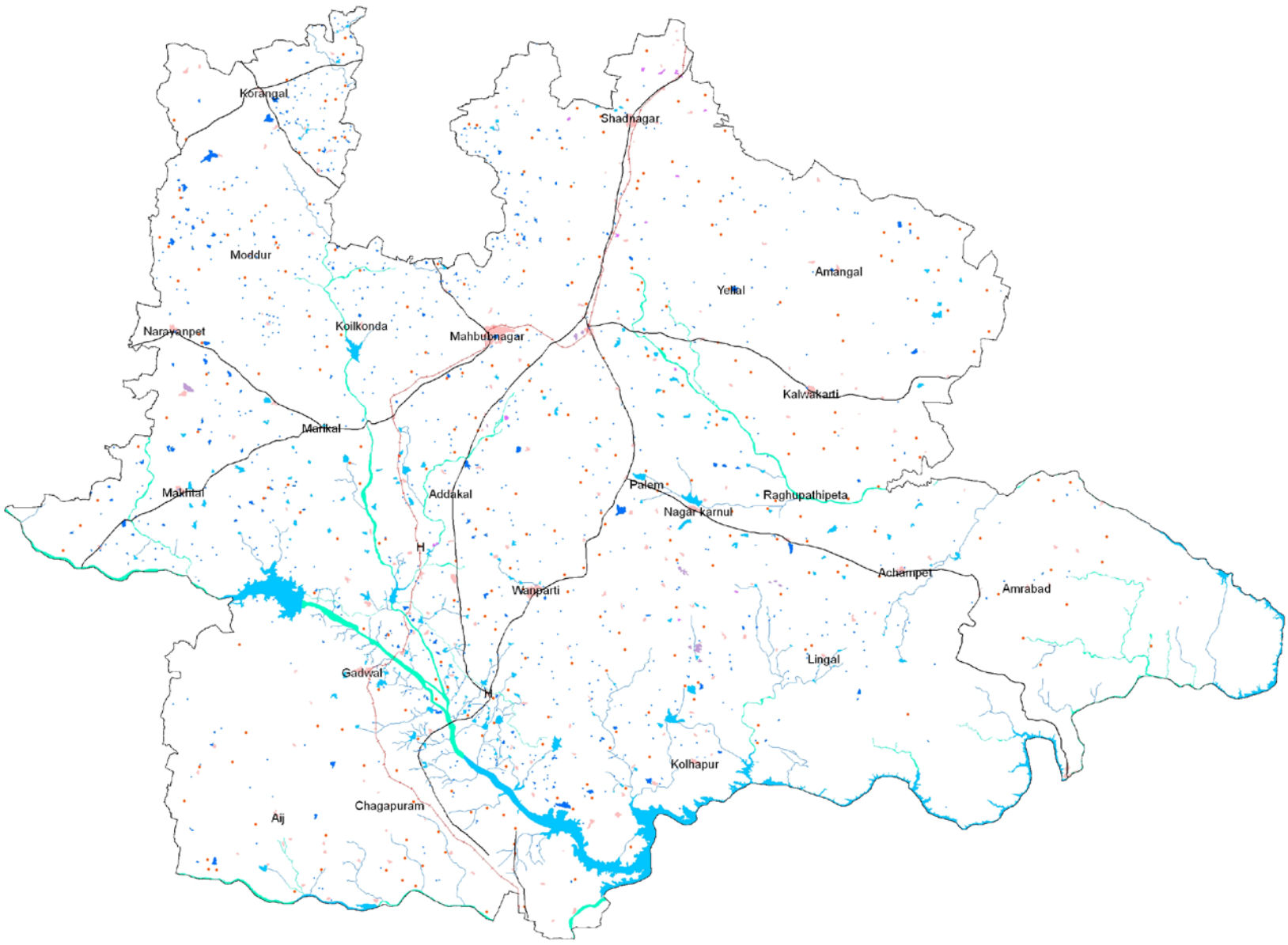
Area under Aquatic Vegetation	2623	12516

Area under turbidity levels		
Low	9147	3449
Moderate	21722	15278
High	1786	1640

State : Andhra Pradesh

WETLAND MAP

District : Mahbubnagar

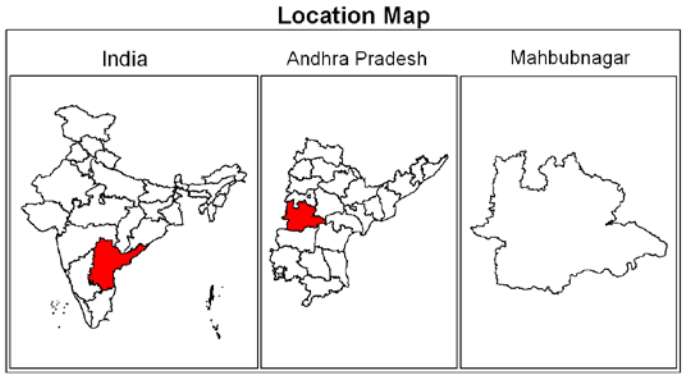


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

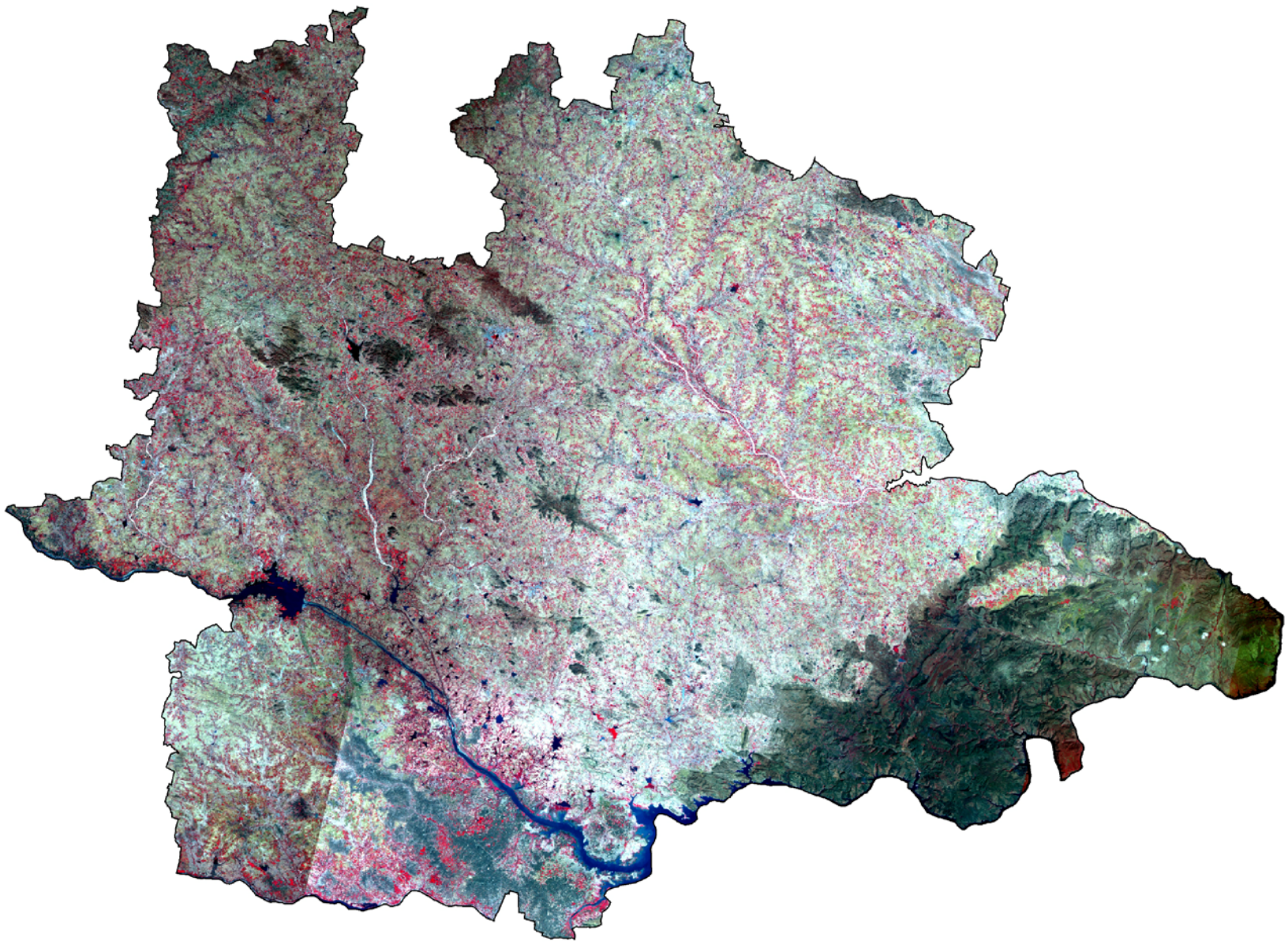
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Mahbubnagar



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

7.1.8 Nalgonda

The district is in the southern part of the Telangana region between $16^0$25' and 17^0-50' of the Northern Latitude and 78^0-40' and 80^0-05' of Eastern longitude. The District is bounded by Medak and Warangal districts in the North, Guntur and Mahabubnagar districts in the South, Khammam and Krishna districts in the East and Mahabubnagar and Rangareddy district in the West. The total population of the district is 32.48 lakhs and density of population is 229 per Sq. Km as per 2001 census. Agriculture is the main occupation for 70% of the population of the district. The major irrigation source is the Left Bank Canal of the Nagarjunasagar Reservoir. The district is undulating in terrain and the general slope of the terrain is from west and north-west to south-east. Apart from the four ranges of hills spanning across the district, there are a number of isolated hills. The main rivers draining the district are Krishna, Musi, Aler, Dindi, Hallia, Kongal and Peddavagu. The region experiences hot and dry summer throughout the year except during the South West Monsoon season. The year may broadly be divided into four seasons. It experiences cold season from December to mid February, summer season from mid February to first week of June. South West monsoon season from June to September and retreating monsoon or the past monsoon season during October to November. Cold season extending from December to February is followed by summer when both day and night temperatures increase sharply. May being the hottest month, the mean daily maximum temperature is about 40^0 C and the mean daily minimum is about 28^0 C sometimes the day temperature crosses 44^0 C during this period. December is the coldest month with the mean daily maximum and minimum temperatures being 35^0 C and 20^0 C respectively. The average rainfall in the district is 772 mm.

The geographical area of this district is 14240 km^2, out of which Wetlands constitute 4.68 per cent of area. The district comprises 1422 wetlands, out of which, the mapped ones are 886 besides 536 small wetlands (<2.25 ha). These wetlands account for an area of 66606 ha (Table 14). Reservoir/Barrages (39289 ha) ranked first constituting about 59 per cent of wetland extent followed by River/Stream (15039 ha) and Tanks/Ponds (11702 ha) and. Open water has shown a substantial decrease of about 27 per cent seasonal reduction from the post-monsoon (44338 ha) and pre-monsoon (32498 ha) out of 66070 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation has registered about 2 fold increase form 6892 ha in post-monsoon to 14128 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (38480 ha) followed low (4132 ha) and high (1726 ha) in post-monsoon. The trend changed in pre-monsoon season with area under moderate (30954 ha) continued to dominate followed by high (1323 ha) and low (221 ha).

Table 14: Area estimates of wetlands in Nalgonda

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	1106	River/Stream	17	15039	22.58	6111	2986
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	267	39289	58.99	29639	23615
3	1202	Tanks/Ponds	601	11702	17.57	8573	5857
4	1203	Waterlogged	1	40	0.06	15	40
		Sub-Total	**886**	**66070**	**99.20**	**44338**	**32498**
		Wetlands (<2.25 ha), mainly Tanks	536	536	0.80	-	-
		Total	**1422**	**66606**	**100.00**	**44338**	**32498**
		Area under Aquatic Vegetation				6892	14128
		Area under turbidity levels					
		Low				4132	221
		Moderate				38480	30954
		High				1726	1323

State : Andhra Pradesh

WETLAND MAP

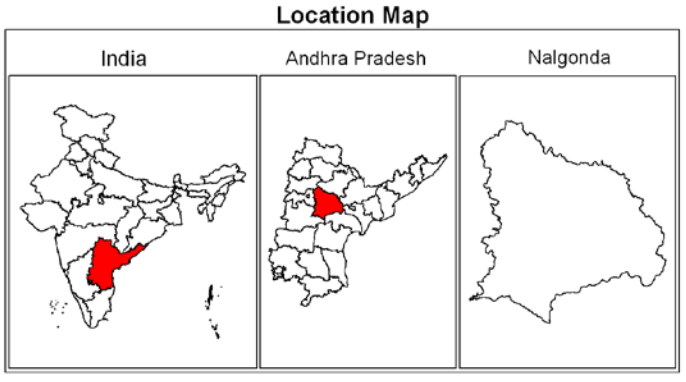
District : Nalgonda

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

Legend

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

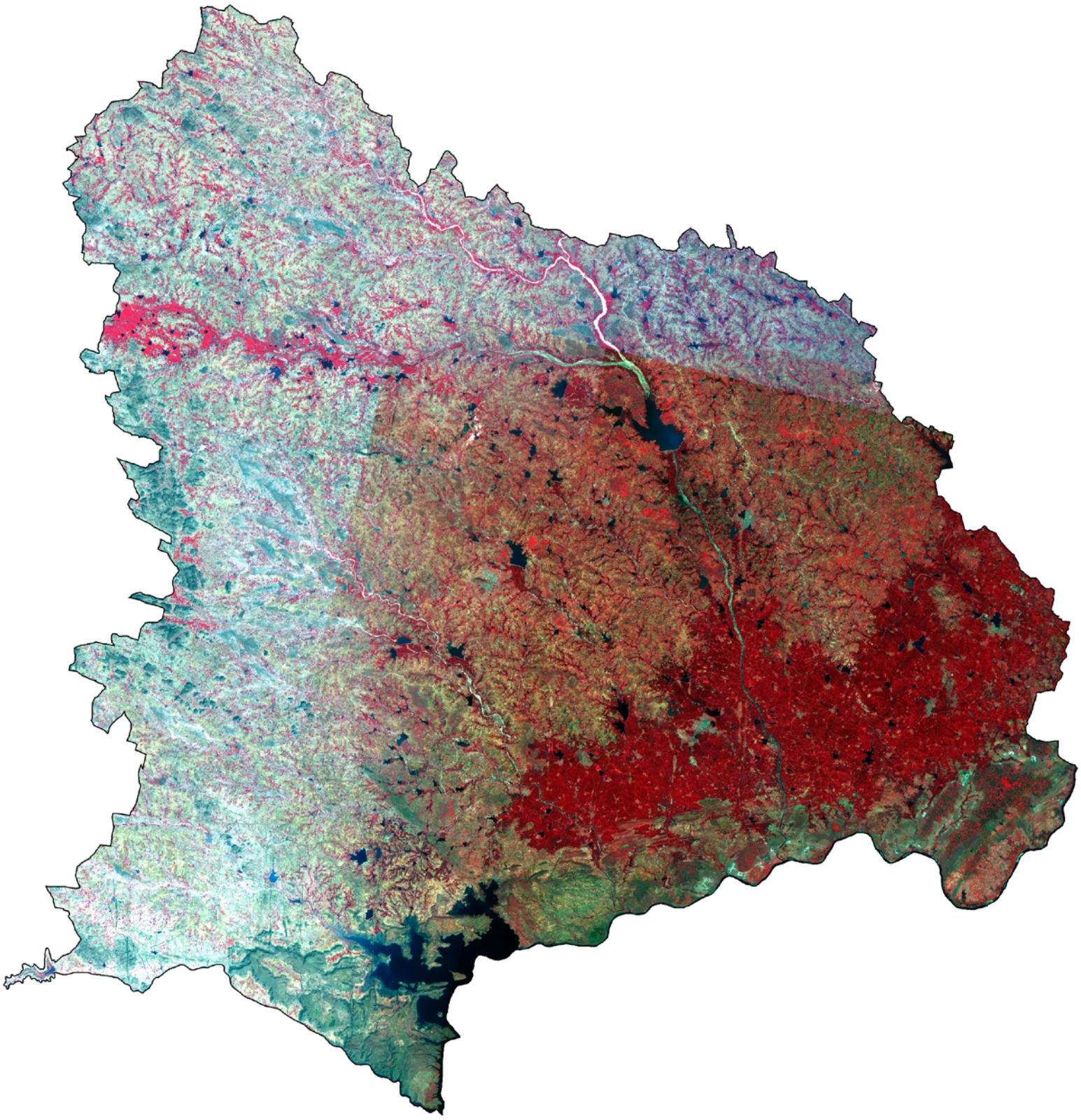
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Nalgonda



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

7.1.9 Warangal

Warangal district is situated between 78°49' and 80°43' east longitudes and 17°19' and 18°36' north latitudes. It is bounded on the north by Karimnagar district, on the east by Khammam district, on the south by Nalgonda and Khammam districts and on the west by Medak district. The population of the district according to 2001 census is 32, 46,004. The density of population per sq km is 252 persons. Warangal district falls in the drainage basins of both Godavari and Krishna rivers. The river Godavari, the largest river in the peninsular India flows through the eastern part of the district. Pedavagu and Lakhnavaram are the two main tributaries of the Godavari, which drain the district. In the southern and south-western part of the district, the tributaries of river Krishna namely Aleru, Paleru and Munneru flow towards southern direction.

The geographical area of this district is 12846 km^2, out of which Wetlands constitute 3.97 per cent of area. The district comprises 2085 wetlands, out of which, the mapped ones are 709 besides 606 small wetlands (<2.25 ha). These wetlands account for an area of 52327 ha (Table 15). Reservoir/Barrages (24875 ha) ranked first constituting about 49 per cent of wetland extent followed by River/Stream (14147 ha) and Tanks/Ponds (9462 ha) and. Open water has shown a substantial decrease of about 27 per cent seasonal reduction from the post-monsoon (35760 ha) and pre-monsoon (13092 ha) out of 50337 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation has registered about 6.5 fold increase form 2373 ha in post-monsoon to 15585 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (32083 ha) followed high (2256 ha) and low (1421 ha) in post-monsoon. The trend remained unchanged in pre-monsoon season with area under moderate (11165 ha) to dominate followed by high (1794 ha) and low (133 ha).

Table 15: Area estimates of wetlands in Warangal

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	1836	3.60	1578	754
2	1105	Waterlogged	1	17	0.03	17	-
3	1106	River/Stream	20	14147	27.71	3585	2071
	1200	**Inland Wetlands -Man-made**					
4	1201	Reservoirs/Barrages	694	24875	48.73	22147	7900
5	1202	Tanks/Ponds	659	9462	18.54	8433	2367
		Sub-Total	**1376**	**50337**	**98.61**	**35760**	**13092**
		Wetlands (<2.25 ha), mainly Tanks	709	709	1.39	-	-
		Total	**2085**	**51046**	**100.00**	**35760**	**13092**

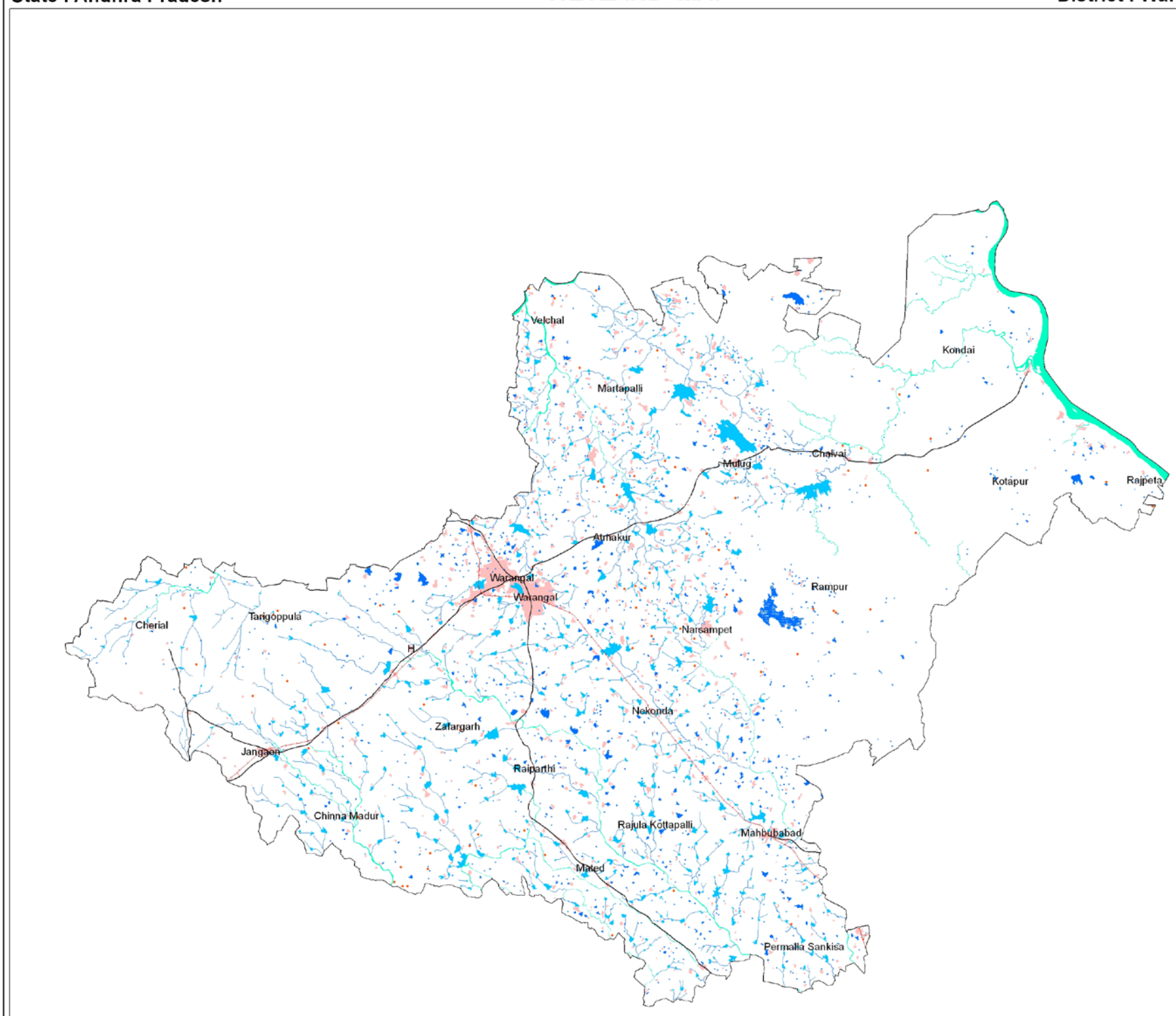
Area under Aquatic Vegetation	2373	15585

Area under turbidity levels		
Low	1421	133
Moderate	32083	11165
High	2256	1794

State : Andhra Pradesh

WETLAND MAP

District : Warangal

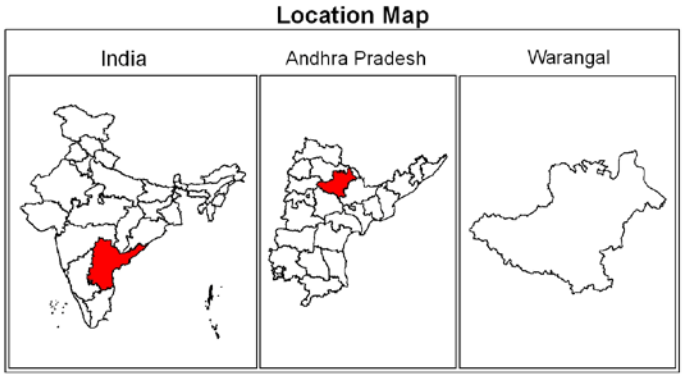


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

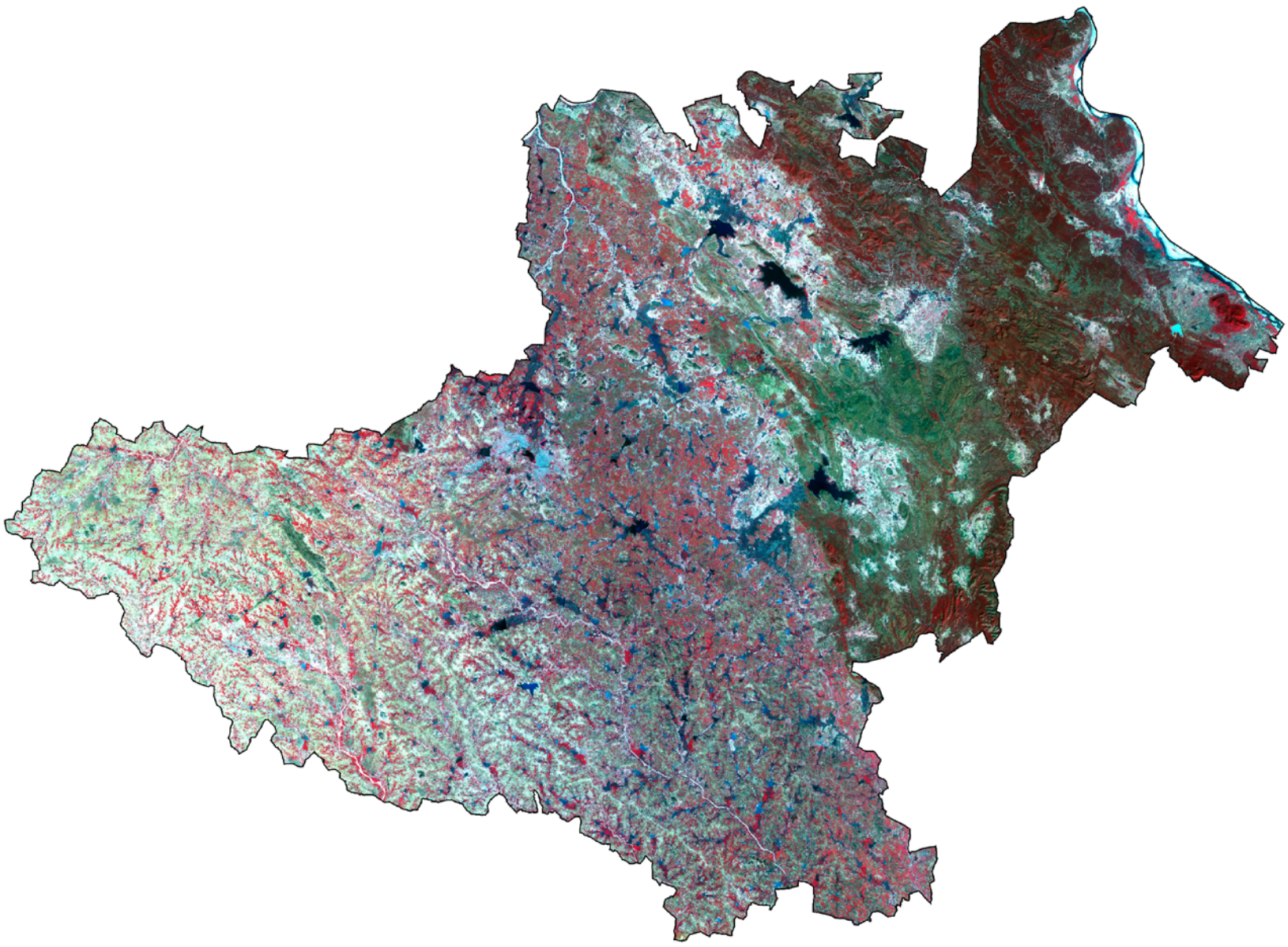
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Warangal



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

7.1.10 Khammam

Khammam district lies between 16^0 45' and 18^0 35' north latitudes and between 79^0 47' and $81^{0\ 47'}$ east longitudes. It is bounded on the north by Madhya Pradesh and Orissa States, on the south by Krishna district, on the east by East and west Godavari districts and on the west by Nalgonda and Warangal districts. The total population of the district as per 2001 census is 25.79 lakhs. The density of population per sq km is 161 persons. The district can be broadly divided into three physiographic units viz, hills, uplands, plains. A range of hill stretches from Singareni to Ashwaropet in the South east bounding the lower Godavari valley. The important rivers which flow through this district are the Godavari, Sabari, Kinnerasani, Muner (Muneru), Palleru, Akeru and Wira. The climate of this district is characterized by a hot summer and good seasonal rainfall. The summer season is from about the middle of February to about the first week of June. The temperature during summer shoots up to 43^0 C. The south-west monsoon season which follows, lasts up to the end of September. October and November constitute the post-monsoon season. December to the middle of February is the season of generally fine weather. The normal annual rainfall is 1157mm.

The geographical area of this district is 16029 km^2, out of which Wetlands constitute 3.96 per cent of area. The district comprises 1635 wetlands, out of which, the mapped ones are 743 besides 892 small wetlands (<2.25 ha). These wetlands account for an area of 63422 ha (Table 16). River/Stream (41381 ha) ranked first constituting about 65 per cent of wetland extent followed by Reservoir/Barrages (11371 ha) and Tanks/Ponds (8044 ha) and. Open water has shown a substantial decrease of about 35 per cent seasonal reduction from the post-monsoon (33552 ha) and pre-monsoon (21795 ha) out of 62530 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation has registered about 2 fold increase form 3159 ha in post-monsoon to 7026 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (23884 ha) followed low (6432 ha) and high (3236 ha) in post-monsoon. The trend remained unchanged in pre-monsoon season with area under moderate (18280 ha) to dominate followed by low (2045 ha) and low (1470 ha).

Table 16: Area estimates of wetlands in Khammam

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	1654	2.61	1411	1055
2	1105	Waterlogged	2	18	0.03	9	11
3	1106	River/Stream	18	41381	65.25	17276	12223
	1200	**Inland Wetlands -Man-made**					
4	1201	Reservoirs/Barrages	163	11371	17.93	9247	5690
5	1202	Tanks/Ponds	558	8044	12.68	5547	2762
6	1203	Waterlogged	1	62	0.10	62	54
		Sub-Total	**743**	**62530**	**98.59**	**33552**	**21795**
		Wetlands (<2.25 ha), mainly Tanks	892	892	1.41	-	-
		Total	**1635**	**63422**	**100.00**	**33552**	**21795**

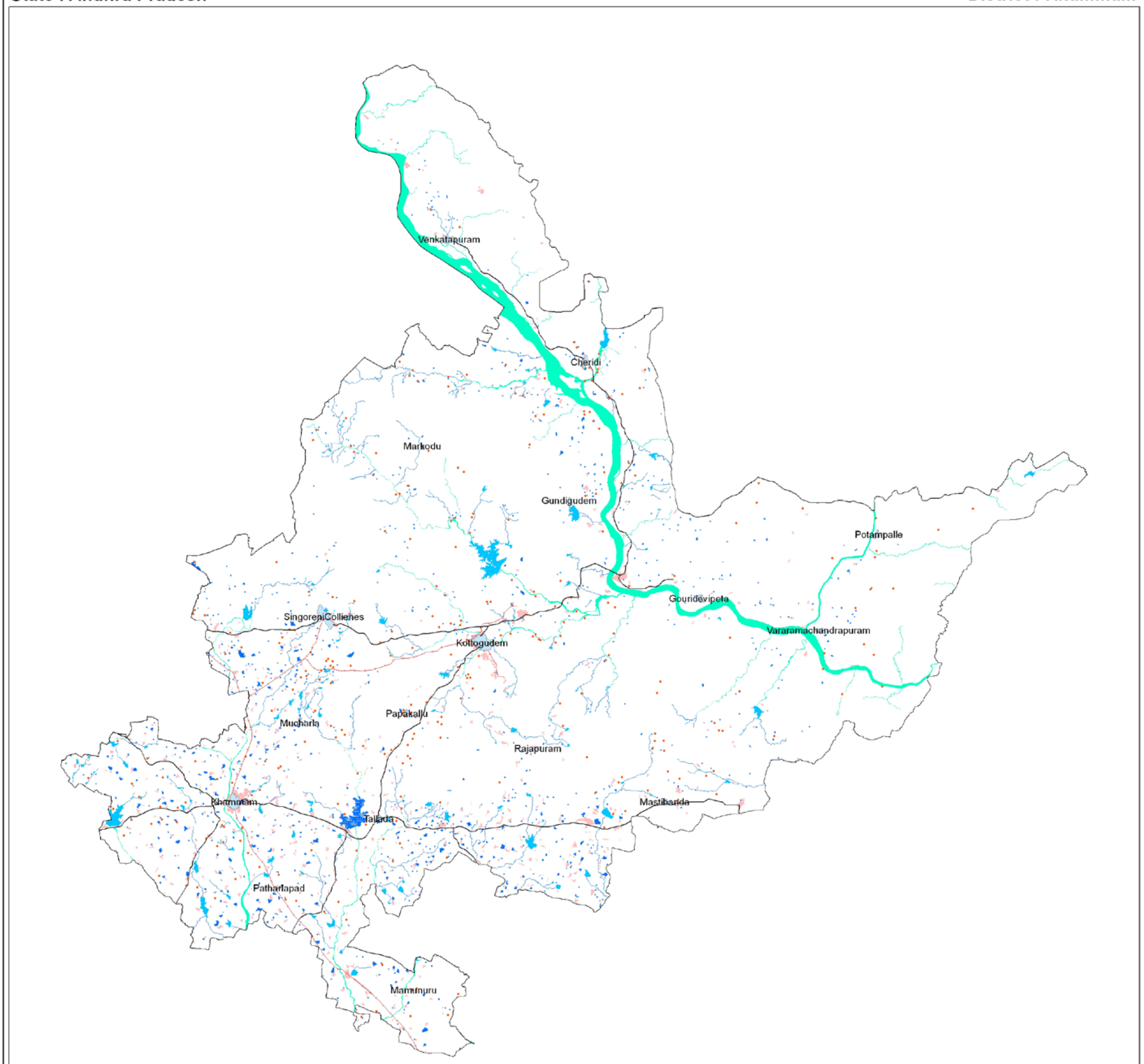
Area under Aquatic Vegetation	3159	7026

Area under turbidity levels		
Low	6432	2045
Moderate	23884	18280
High	3236	1470

State : Andhra Pradesh

WETLAND MAP

District : Khammam

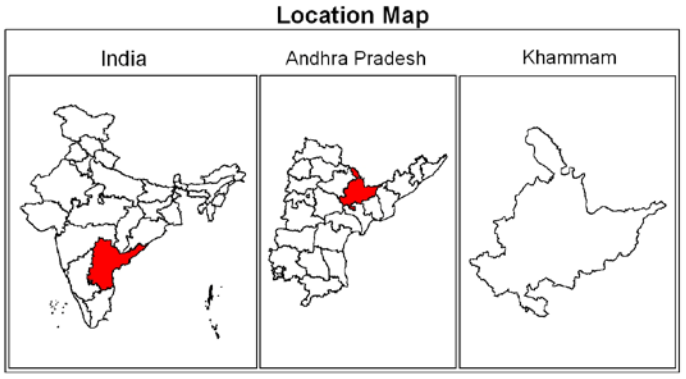


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

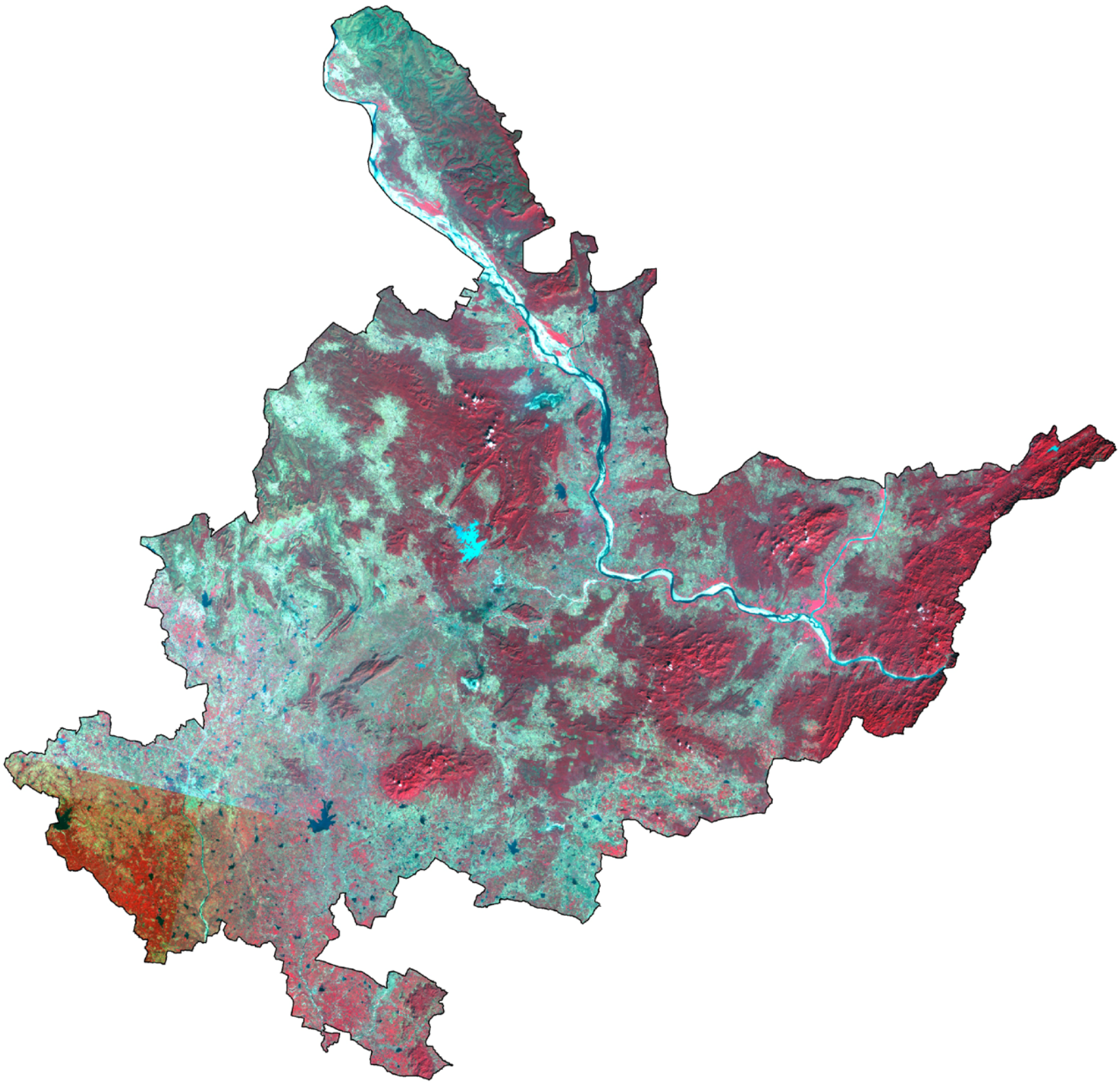
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Khammam



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

7.1.11 Srikakulam

Srikakulam district is the extreme North-eastern district of Andhra Pradesh situated within the geographic co-ordinates of 18° 20’ and 19° 10’ of Northern latitude and 83° 50’ and 84° 50’ of Eastern longitude. The district has varied landscape with hills, rivers, forests, tanks and a long coastline of 193 kms. The important rivers are Nagavalli, Vamsadhara, Mahendratanaya, Champavathi, Bahuda and Kumbikotagedda. The rivers have the origin in the Eastern Ghats of Orissa state. The climate in the district is characterized by humidity. April to June are the hottest months. The south-west-monsoon which follows the summer season lasts up to September. The north-east monsoon starts from October and extends up to end of November. The normal annual average rainfall in the district is 1162 mm.

The geographical area of this district is 5837 km^2, out of which Wetlands constitute 5.97 per cent of area. The district comprises 2063 wetlands, out of which, the mapped ones are 654 besides 1409 small wetlands (<2.25 ha). These wetlands account for an area of 34849 ha (Table 17). River/Stream (10959 ha) ranked first constituting about 31 per cent of wetland extent followed by Reservoir/Barrages (4938 ha) and Tanks/Ponds (4678 ha). Coastal wetlands form about 33 per cent dominated by salt pans (3934) and sand/beach (3733 ha) and intertidal mudflats (2591 ha). Mangroves have shown their presence with an area of 72 ha. Open water has shown a substantial decrease of about 35 per cent seasonal reduction from the post-monsoon (14645 ha) and pre-monsoon (11079 ha) out of 33440 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation has registered about 1.7 times increase form 3049 ha in post-monsoon to 5367 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (10892 ha) followed low (3213 ha) and high (540 ha) in post-monsoon. The trend remained unchanged in pre-monsoon season with area under moderate (8915 ha) to dominate followed by low (1475 ha) and low (689 ha).

Table 17: Area estimates of wetlands in Srikakulam

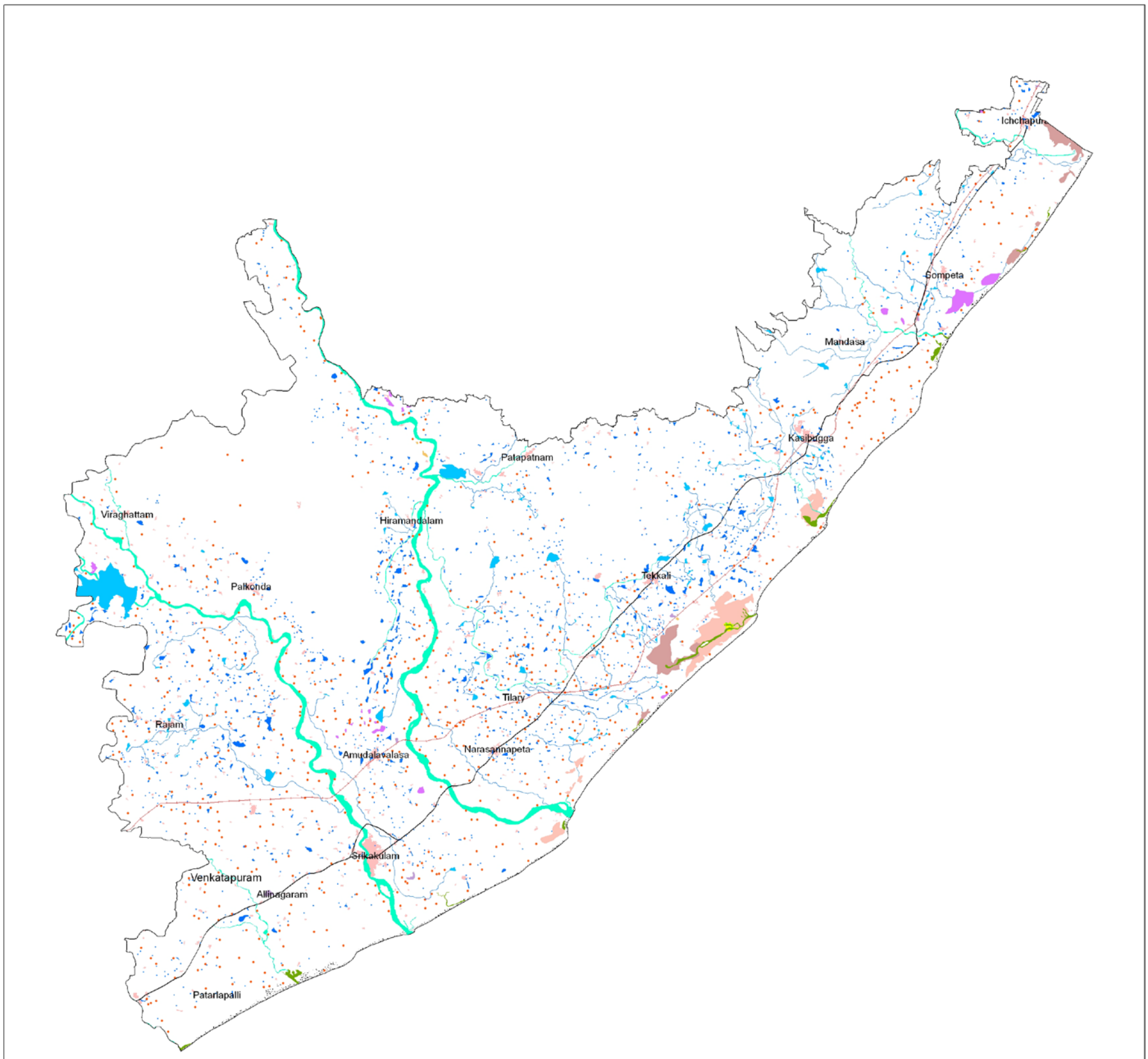
Area in ha

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	1105	Waterlogged	21	1293	3.71	124	66
2	1106	River/Stream	10	10959	31.45	5377	4692
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	116	4938	14.17	3696	2231
4	1202	Tanks/Ponds	460	4678	13.42	3260	1459
5	1203	Waterlogged	7	168	0.48	19	6
		Total - Inland	**614**	**22036**	**63.23**	**12476**	**8454**
	2100	**Coastal Wetlands - Natural**					
6	2102	Creeks	11	1033	2.96	911	845
7	2103	Sand/Beach	7	3733	10.71	-	-
8	2104	Intertidal mud flats	6	2591	7.43	-	-
9	2106	Mangroves	3	72	0.21	-	-
	2200	**Coastal Wetlands - Man-made**					
10	2201	Salt pans	10	3934	11.29	1224	1741
11	2202	Aquaculture ponds	3	41	0.12	34	39
		Total - Coastal	**40**	**11404**	**32.72**	**2169**	**2625**
		Sub-Total	**654**	**33440**	**95.96**	**14645**	**11079**
		Wetlands (<2.25 ha), mainly Tanks	1409	1409	4.04	-	-
		Total	**2063**	**34849**	**100.00**	**14645**	**11079**
		Area under Aquatic Vegetation				3049	5367
		Area under turbidity levels					
		Low				3213	1475
		Moderate				10892	8915
		High				540	689

State : Andhra Pradesh

WETLAND MAP

District : Srikakulam

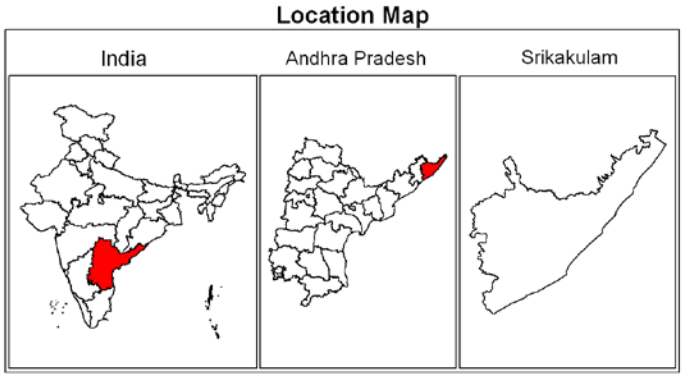


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

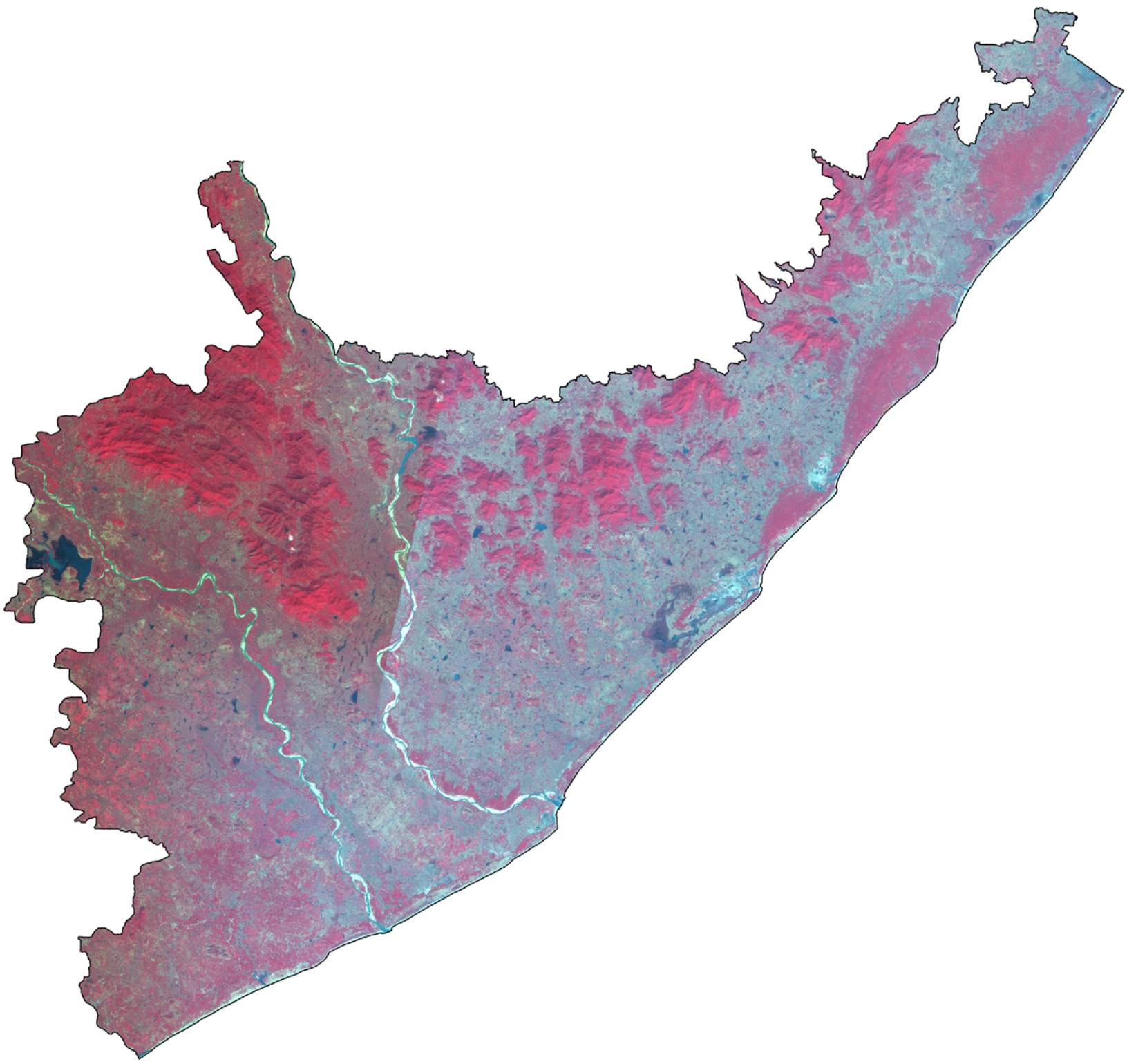
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Srikakulam



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

7.1.12 Vizianagaram

Vizianagaram district is one of the northern coastal districts of Andhra Pradesh. The district is situated within the geographical co-ordinates of 17° 15 ' and 19° 15' of the northern latitude and 83 00 ' and 83° 45 ' of the eastern longitude. The district is bounded on the east by Srikakulam District on the west and south by Visakhapatnam district, on the south east by the Bay of Bengal and North West by Orissa State. The areas transferred from Visakhapatnam district are mostly picturesque especially in the north. The agency track mostly consists of the hilly regions covered by the Eastern Ghats which run parallel to the coast from the North - East to the South West. The average height of these hills is over 914 meters, although there are several peaks of even 1,219 meters high. The climate of Vizianagaram district is characterized by high humidifies nearly all the year round with oppressive summer and good seasonal rainfall. The summer season is from March to May. This is followed by South West monsoon season, which continues up to September, October and November constitute the post monsoon or retreating monsoon season. December to February is the season of generally fine weather. The climate of the hill parts of the district is different from that of the plain. The normal rainfall of the district for the year is 1,131 mm. The district gets the benefit of both the South-west and North-east monsoon.

The geographical area of this district is 6539 km^2, out of which Wetlands constitute 3.62 per cent of area. The district comprises 3984 wetlands, out of which, the mapped ones are 1721 besides 2263 small wetlands (<2.25 ha). These wetlands account for an area of 23674 ha (Table 17). Tanks/Ponds (10567 ha) ranked first constituting about 31 per cent of wetland extent followed by River/Stream (5623 ha) and Reservoir/Barrages (4778 ha). Coastal wetlands form less than 2 per cent. Open water has shown a substantial decrease of about 56 per cent seasonal reduction from the post-monsoon (14741 ha) and pre-monsoon (6461 ha) out of 33440 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation has registered about 5 times increase form 961 ha in post-monsoon to 5222 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (11162 ha) followed low (3351 ha) and high (228 ha) in post-monsoon. The trend changed in pre-monsoon season with area under low (3218 ha) to dominate followed by moderate (2873 ha) and high (370 ha).

Table 18: Area estimates of wetlands in Vizianagaram

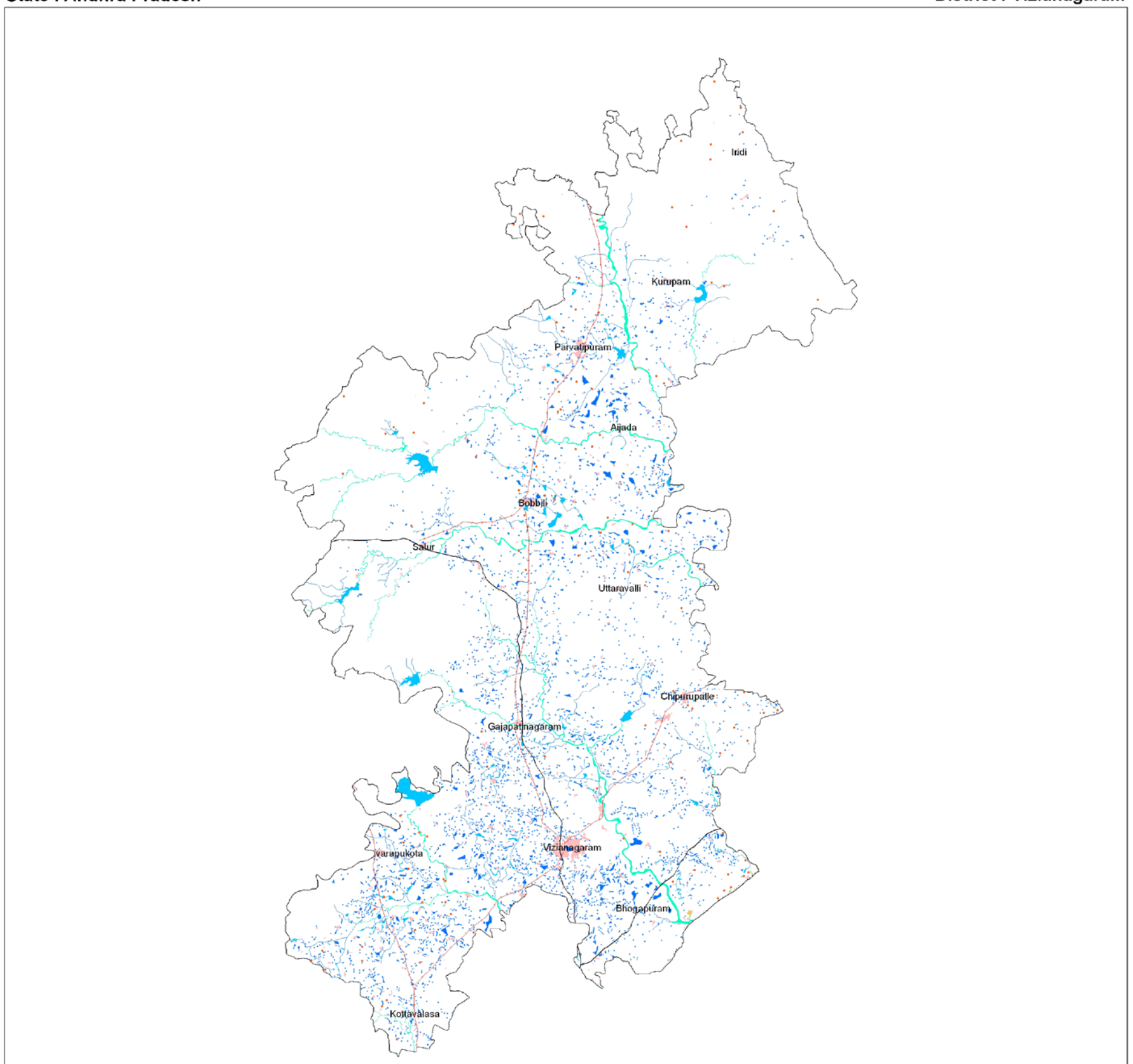
Area in ha

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	1106	River/Stream	23	5623	23.75	2995	2009
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	152	4778	20.18	3967	2119
3	1202	Tanks/Ponds	1539	10567	44.64	7724	2293
		Total - Inland	**1714**	**20968**	**88.57**	**14686**	**6421**
	2100	**Coastal Wetlands - Natural**					
4	2102	Creeks	3	21	0.09	15	9
5	2103	Sand/Beach	1	363	1.53	-	-
	2200	**Coastal Wetlands - Man-made**					
6	2201	Salt pans	1	12	0.05	7	12
7	2202	Aquaculture ponds	2	47	0.20	33	19
		Total - Coastal	**7**	**443**	**1.87**	**55**	**40**
		Sub-Total	**1721**	**21411**	**90.44**	**14741**	**6461**
		Wetlands (<2.25 ha), mainly Tanks	2263	2263	9.56	-	-
		Total	**3984**	**23674**	**100.00**	**14741**	**6461**
		Area under Aquatic Vegetation				961	5222
		Area under turbidity levels					
		Low				3351	3218
		Moderate				11162	2873
		High				228	370

State : Andhra Pradesh

WETLAND MAP

District : Vizianagaram

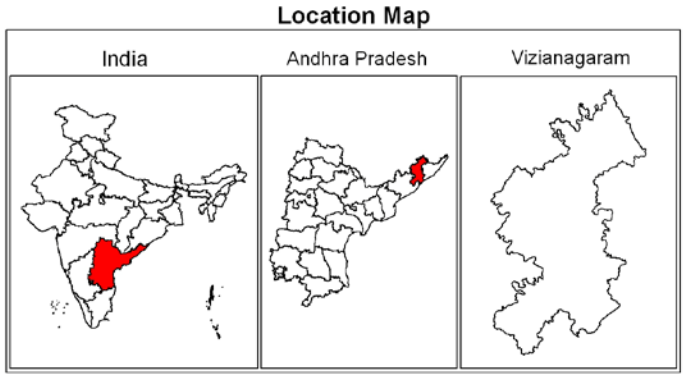


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

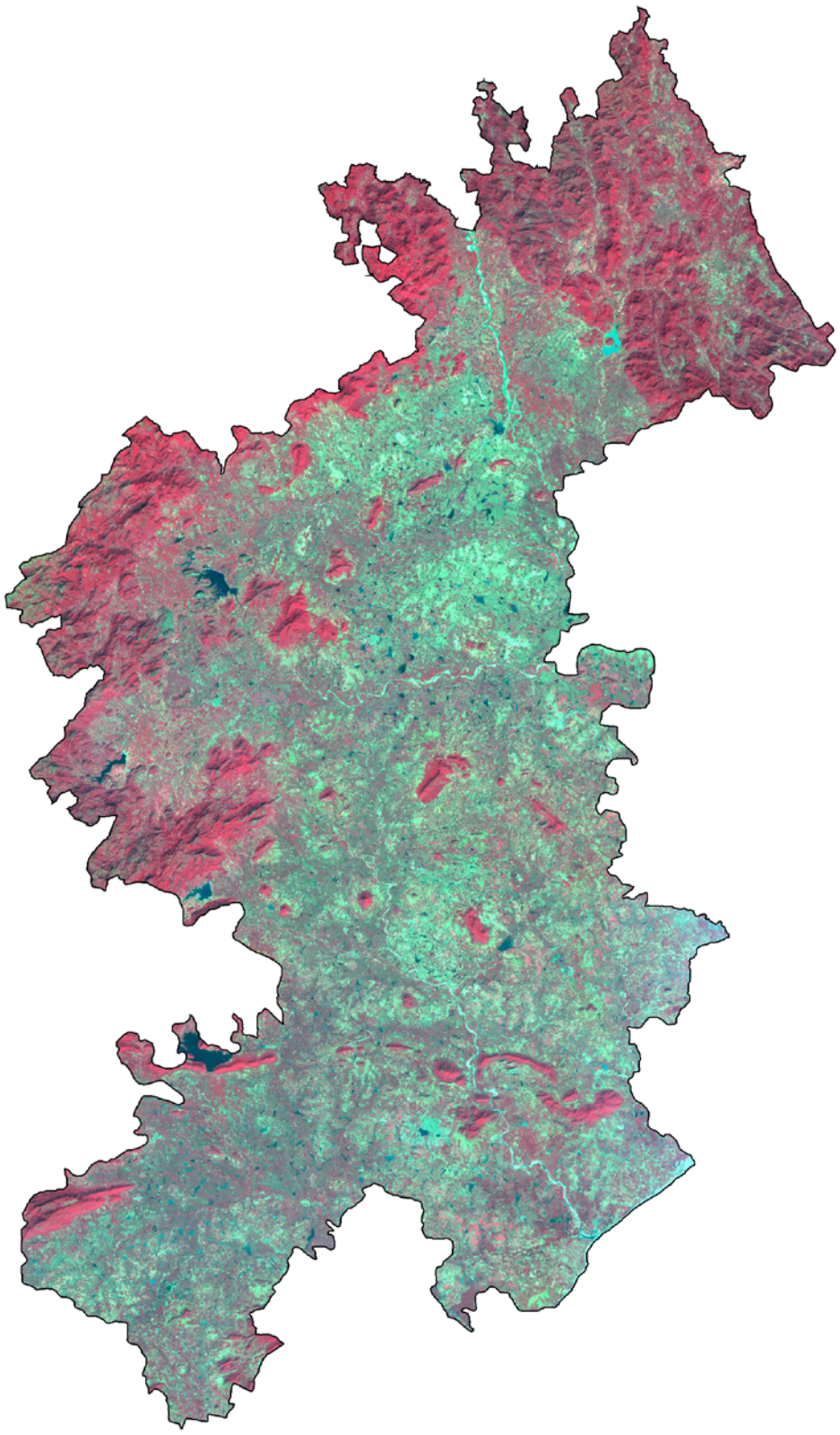
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Vizianagaram



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

7.1.13 Visakhapatnam

Visakhapatnam district is one of the North Eastern Coastal districts of Andhra Pradesh and it lies between 17^0 15' and 18^0 32' Northern latitude and 18^0 54' and 83^0 30' in Eastern longitude. It is bounded on the North partly by the Orissa State and partly by Vizianagaram District, on the South by East Godavari District, on the West by Orissa State and on the East by Bay of Bengal. Physiographically the district can be divided into two parts: coastal plains and hilly tracts of the Eastern Ghats. It is drained by rivers Sarada, Varaha, Tandava, Meghadrigedda and Gambhiramgedda. Along the shore lie a series of salt and sandy swamps. The coastline is broken by a number of bald head lands, the important of them being the Dolphin's Nose which had enabled the establishment of Natural Harbour at Visakhapatnam, Rushikonda, Polavaram Rock and the Narasimha Hill at Bheemunipatnam. The district has varied climatic conditions in across the area. Near the coast the air is moist, but gets warmer towards the interior and cools down in the hilly areas on account of elevation and vegetation. April to June is warmest period. The mean minimum and maximum temperatures recorded at Visakhapatnam airport are about 17.5^0 C and 34^0 C during January and May respectively. The district receives annual normal rainfall of 1202 mm. of which south-west monsoon accounts for 54% of the normal while North-East monsoon contributes 25 % and the rest is shared by summer showers and winter rains.

The geographical area of this district is 11161 km^2, out of which Wetlands constitute 2.24 per cent of area. The district comprises 1335 wetlands, out of which, the mapped ones are 678 besides 657 small wetlands (<2.25 ha). These wetlands account for an area of 24988 ha (Table 19). River/Stream (7424 ha) ranked first constituting about 30 per cent of wetland extent followed by Reservoir/Barrages (6666 ha) and Tanks/Ponds (4793 ha). Coastal wetlands form about 22 per cent dominated by sand/beach (2103 ha) and salt pans (2261 ha). Open water has shown a substantial decrease of about 35 per cent seasonal reduction from the post-monsoon (16984 ha) and pre-monsoon (11185 ha) out of 24331 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation has registered about 2.5 times increase form 1410 ha in post-monsoon to 3504 ha in pre-monsoon. Qualitative turbidity of the open water dominated by low (8220 ha) followed moderate (7774 ha) and high (990 ha) in post-monsoon. The trend remain unchanged in pre-monsoon season with area under low (4477 ha) followed by moderate (4451 ha) and high (2257 ha).

Table 19: Area estimates of wetlands in Visakhapatnam

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	1106	River/Stream	29	7424	29.71	6071	4171
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	79	6666	26.68	5064	4076
3	1202	Tanks/Ponds	543	4793	19.18	3409	1341
		Total - Inland	**651**	**18883**	**75.57**	**14544**	**9588**
	2100	**Coastal Wetlands - Natural**					
4	2102	Creeks	7	677	2.71	598	515
5	2103	Sand/Beach	6	2103	8.42	-	-
	2200	**Coastal Wetlands - Man-made**					
6	2201	Salt pans	9	2261	9.05	1718	751
7	2202	Aquaculture ponds	5	407	1.63	124	331
		Total - Coastal	**27**	**5448**	**21.80**	**2440**	**1597**
		Sub-Total	**678**	**24331**	**97.37**	**16984**	**11185**
		Wetlands (<2.25 ha), mainly Tanks	657	657	2.63	-	-
		Total	**1335**	**24988**	**100.00**	**16984**	**11185**

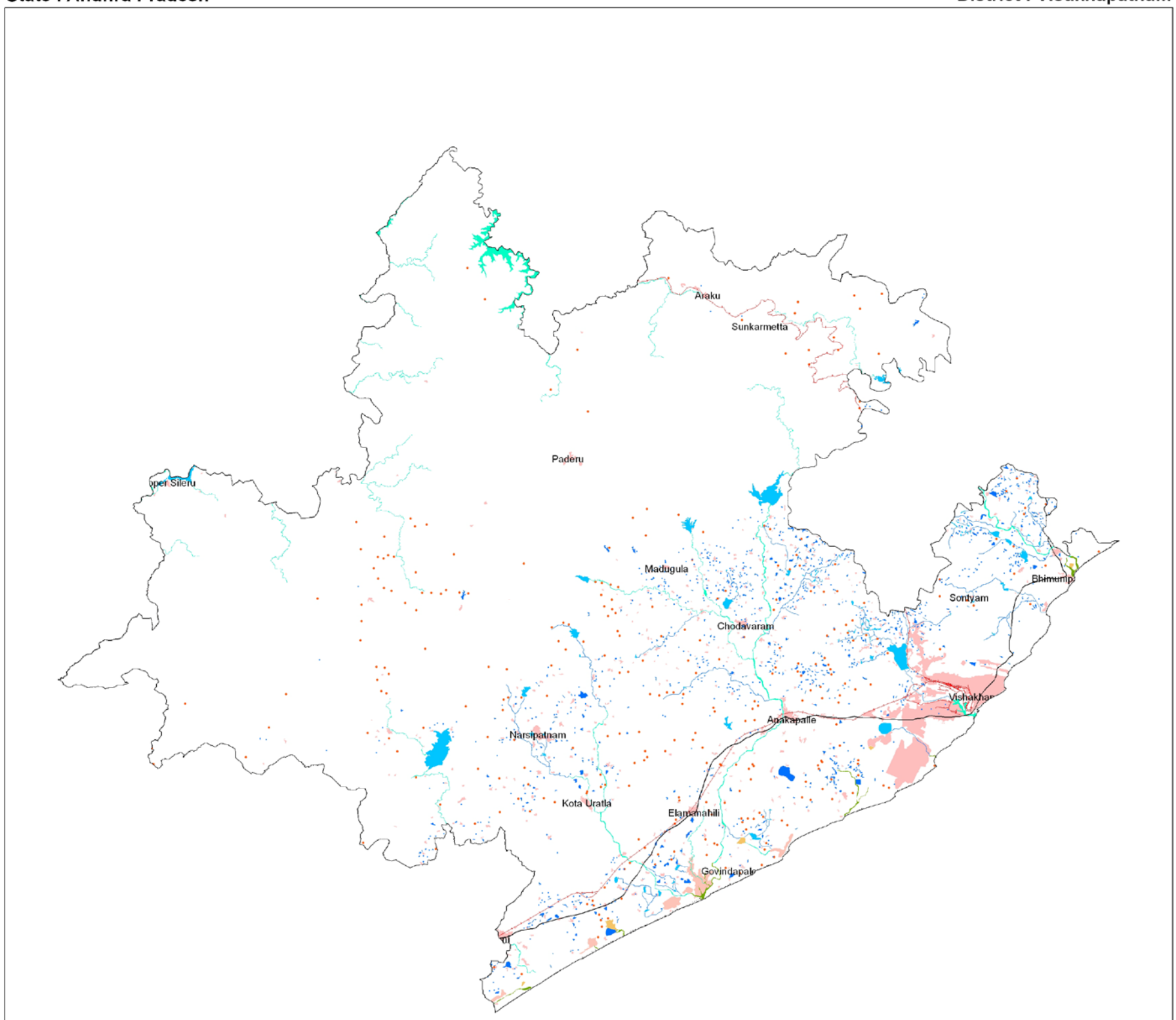
Area under Aquatic Vegetation	1410	3504

Area under turbidity levels		
Low	8220	4477
Moderate	7774	4451
High	990	2257

State : Andhra Pradesh

WETLAND MAP

District : Visakhapatnam

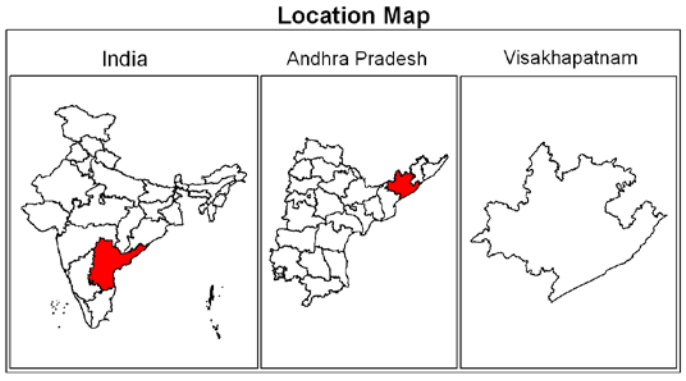


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

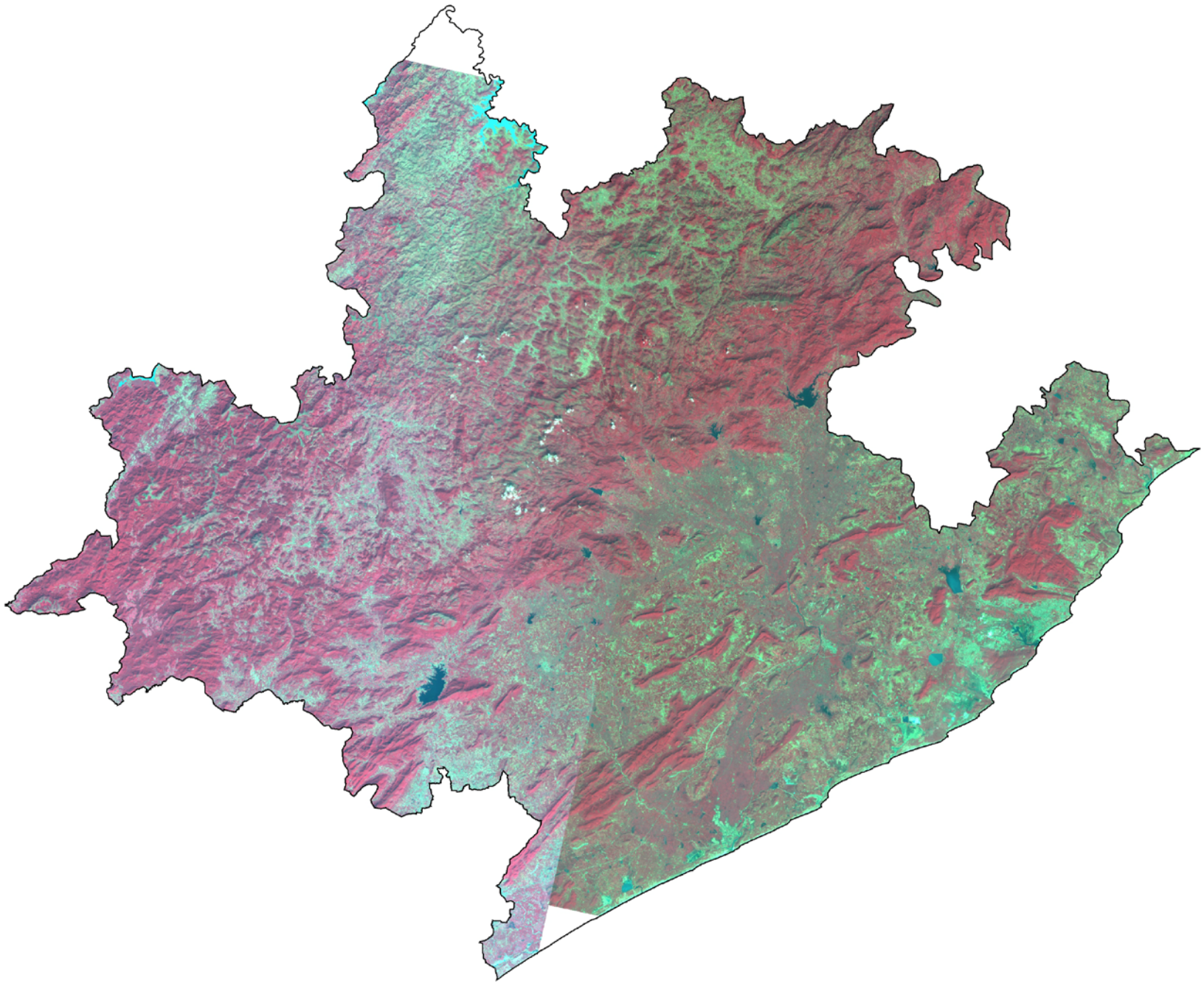
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Visakhapatnam



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

7.1.14 East Godavari

It is bounded by Visakhapatnam on the north, West Godavari on the south, Khammam on the west and Bay of Bengal on the east. The District is located between northern latitudes of 16^0 30' and 18^0 20' and between the eastern longitudes of 81^0 30' and 82^0 30'. The district can be broadly classified into three natural divisions, the delta, the upland, and hill tracts. Godavari is the major river draining the district. Yelleru is the second important river in the district. The temperature reaches a maximum of 48 degrees Celsius from April to June and is moderate the rest of the year. The average rainfall of the district is around 1280.0 mm. More than half of the rainfall is from southwest monsoons and the rest is from the northeast monsoon during October and November. The average annual rainfall in the district is 1076.20 mm. The rainfall during south-west monsoon season (June-September) contributes 64% of the annual rainfall, while the retrieving monsoon season accounts for about 36%.

The geographical area of this district is 10807 km^2, out of which Wetlands constitute 9.17 per cent of area. The district comprises 1972 wetlands, out of which, the mapped ones are 800 besides 1172 small wetlands (<2.25 ha). These wetlands account for an area of 99057 ha (Table 20). River/Stream (36135 ha) ranked first constituting about 36 per cent of wetland extent followed by Reservoir/Barrages (10042 ha) and Tanks/Ponds (4244 ha). Coastal wetlands form about 48 per cent dominated by Mangroves (18638 ha) and aquaculture ponds (18440 ha). Open water has shown a marginal decrease of about 5 per cent seasonal reduction from the post-monsoon (54716 ha) and pre-monsoon (52154 ha) out of 97885 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation also has marginally increased from 20245 ha in post-monsoon to 20742 ha in pre-monsoon. Qualitative turbidity of the open water dominated by low (32503 ha) followed moderate (19637 ha) and high (2576 ha) in post-monsoon. The trend remain unchanged in pre-monsoon season with area under low (28491 ha) followed by moderate (21220 ha) and high (2443 ha).

Table 20: Area estimates of wetlands in East Godavari

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	1106	River/Stream	11	36135	36.48	27877	26949
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	73	10042	10.14	8673	7352
3	1202	Tanks/Ponds	505	4244	4.28	3384	2764
4	1203	Waterlogged	1	102	0.10	10	19
		Total - Inland	**590**	**50523**	**51.00**	**39944**	**37084**
	2100	**Coastal Wetlands - Natural**					
5	2102	Creeks	13	2376	2.40	2364	2376
6	2103	Sand/Beach	11	2622	2.65	-	-
7	2104	Intertidal mud flats	19	4513	4.56	-	-
8	2106	Mangroves	69	18638	18.82	-	-
	2200	**Coastal Wetlands - Man-made**					
9	2201	Salt pans	3	773	0.78	366	223
10	2202	Aquaculture ponds	95	18440	18.62	12042	12471
		Total - Coastal	**210**	**47362**	**47.81**	**14772**	**15070**
		Sub-Total	**800**	**97885**	**98.82**	**54716**	**52154**
		Wetlands (<2.25 ha), mainly Tanks	1172	1172	1.18	-	-
		Total	**1972**	**99057**	**100.00**	**54716**	**52154**

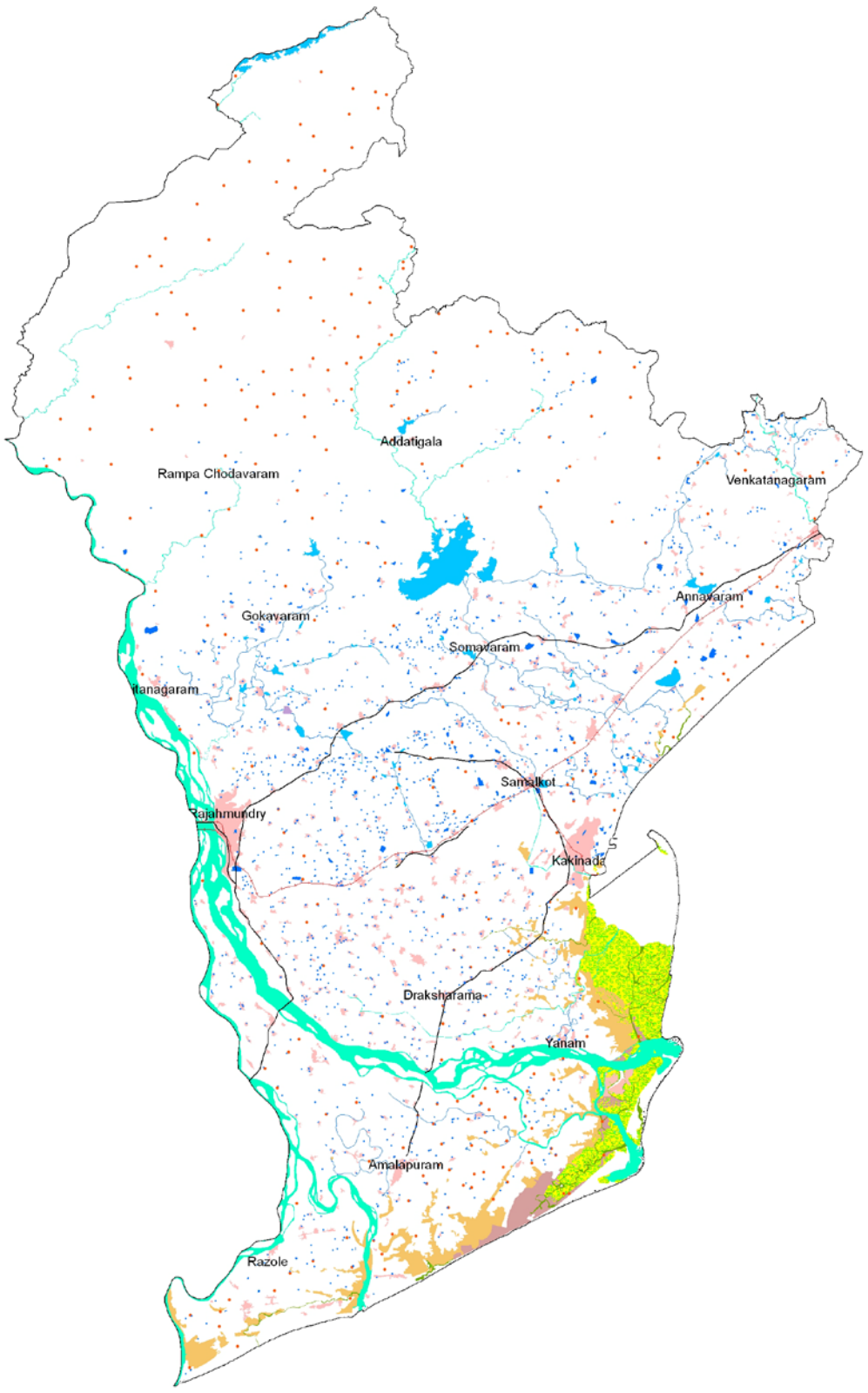
Area under Aquatic Vegetation	20245	20742

Area under turbidity levels		
Low	32503	28491
Moderate	19637	21220
High	2576	2443

State : Andhra Pradesh

WETLAND MAP

District : East Godavari

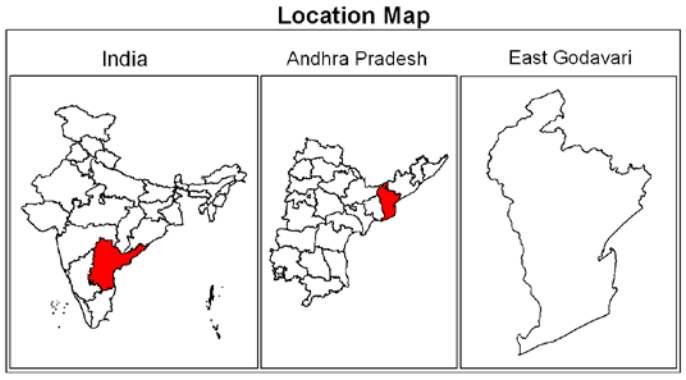


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

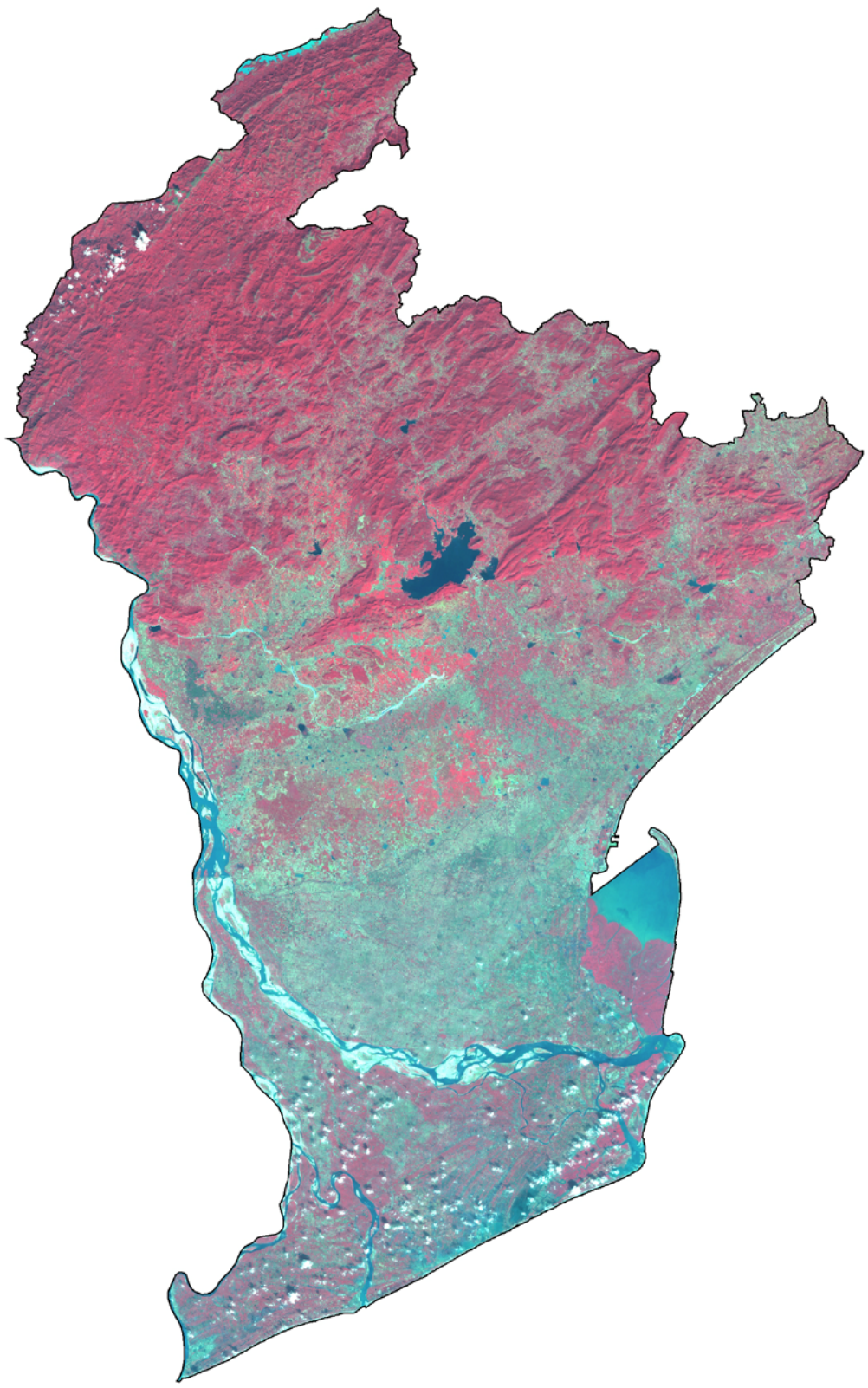
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : East Godavari



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

7.1.15 West Godavari

The district lies between 16^0 15'and$17^0$30' northern latitudes and $80^0$55' and 81^0 55' eastern longitudes. It is surrounded by Khammam district on the north, Krishna district and the Bay of Bengal on the south and on the east by river Godavari and Krishna district on the West. West Godavari is popular for its intensive agriculture and it is known as "Annapurna" of Andhra Pradesh. The irrigation system of the river Godavari irrigates a large part of the district. The district can be divided into three natural regions i.e. Delta, Upland and Agency areas. The soils are mostly composed of red sandy, red loamy and lateritic in the middle of the district and alluvial and sandy in coastal region.

The geographical area of this district is 7742 km^2, out of which Wetlands constitute 11.81 per cent of area. The district comprises 1743 wetlands, out of which, the mapped ones are 741 besides 1002 small wetlands (<2.25 ha). These wetlands account for an area of 91447 ha (Table 21). Lake/Ponds (12208) ranked first constituting about 13 per cent of wetland extent followed by River/Stream (9329 ha), Reservoir/Barrages (3420 ha) and Tanks/Ponds (3191 ha). Coastal wetlands form about 68 per cent dominated by aquaculture ponds (58845 ha). Open water has shown a substantial decrease of about 25 per cent seasonal reduction from the post-monsoon (67601 ha) and pre-monsoon (51421 ha) out of 90445 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation also has almost doubled from 12458 ha in post-monsoon to 23906 ha in pre-monsoon. Qualitative turbidity of the open water dominated by low (35717 ha) followed moderate (31773 ha) and high (111 ha) in post-monsoon. The trend remain unchanged in pre-monsoon season with area under low (44905 ha) followed by moderate (6426 ha) and high (91 ha).

Table 21: Area estimates of wetlands in West Godavari

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	6	12208	13.35	-	2267
2	1106	River/Stream	12	9329	10.20	6857	5800
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	36	3420	3.74	3022	1579
4	1202	Tanks/Ponds	334	3191	3.49	2409	1808
5	1203	Waterlogged	3	104	0.11	35	34
		Total - Inland	**391**	**28252**	**30.89**	**12323**	**11488**
	2100	**Coastal Wetlands - Natural**					
6	2102	Creeks	1	50	0.05	50	49
7	2103	Sand/Beach	1	329	0.36	-	-
8	2104	Intertidal mud flats	1	475	0.52	-	-
	2200	**Coastal Wetlands - Man-made**					
9	2201	Salt pans	8	2494	2.73	1632	1917
10	2202	Aquaculture ponds	339	58845	64.35	53596	37967
		Total - Coastal	**350**	**62193**	**68.01**	**55278**	**39933**
		Sub-Total	**741**	**90445**	**98.90**	**67601**	**51421**
		Wetlands (<2.25 ha), mainly Tanks	1002	1002	1.10	-	-
		Total	**1743**	**91447**	**100.00**	**67601**	**51421**

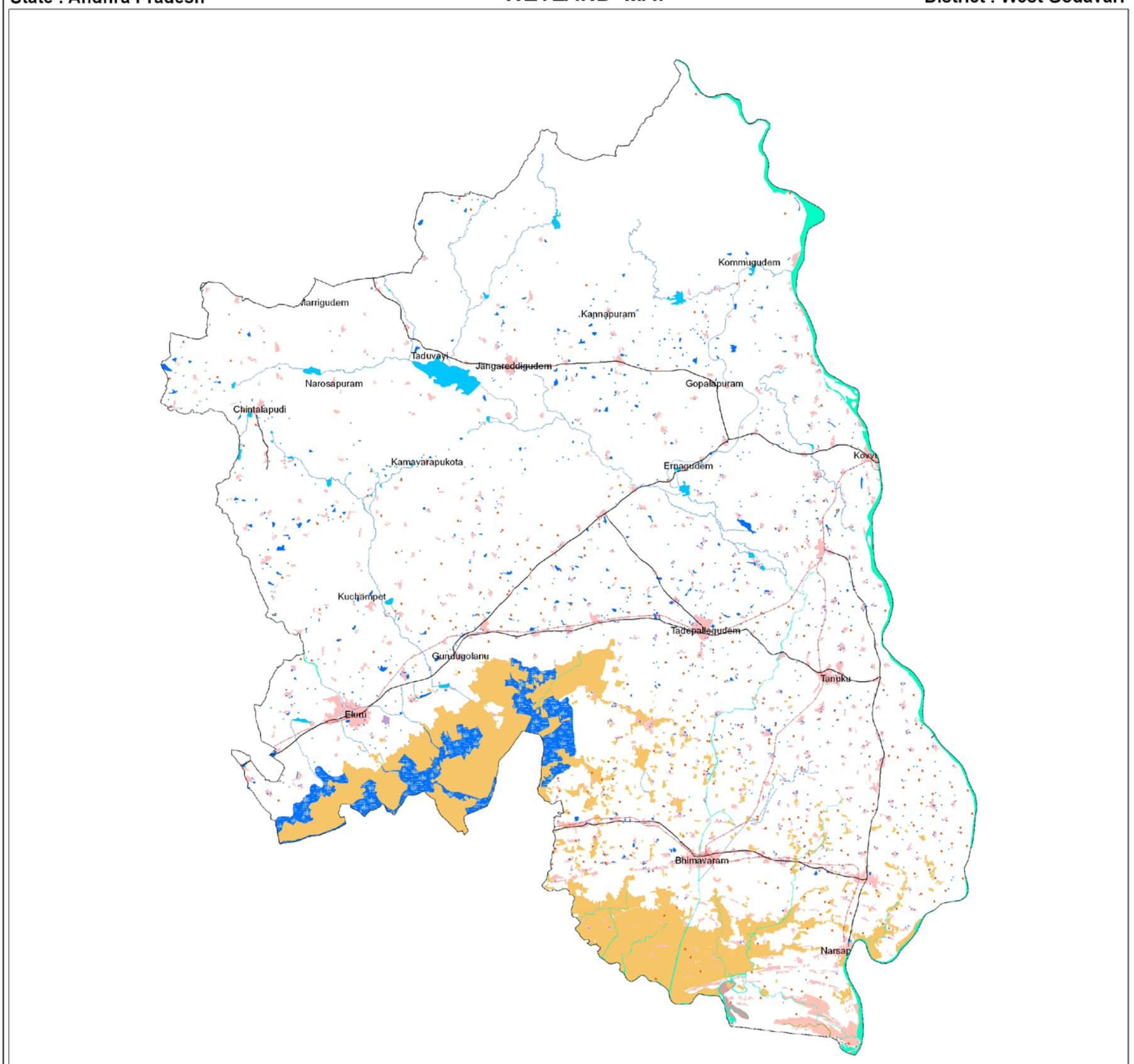
Area under Aquatic Vegetation	12458	23906

Area under turbidity levels		
Low	35717	44905
Moderate	31773	6426
High	111	91

State : Andhra Pradesh

WETLAND MAP

District : West Godavari

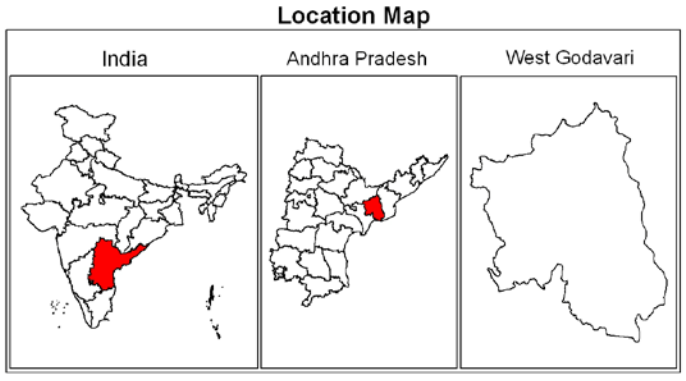


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

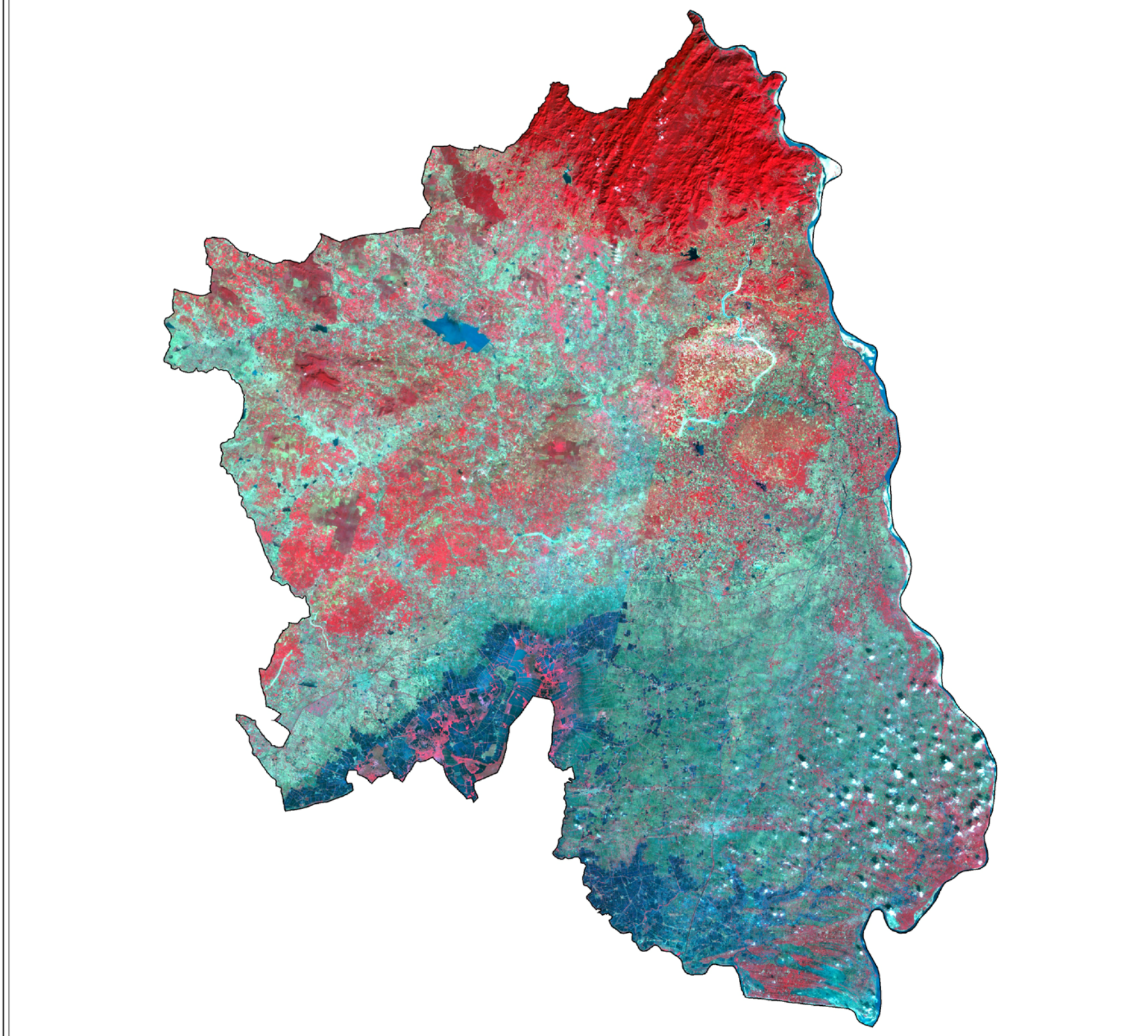
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : West Godavari



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

7.1.16 Krishna

Krishna district lies between 15° 43’ and 17° 10’ north latitudes and 80° 0’ and 81° 33’ east longitudes. It is bounded on the north by Khammam district, on the south by Bay of Bengal, on the east by Bay of Bengal and West Godavari district and on the west by Guntur and Nalgonda districts. The district is naturally divided into delta and upland zones. All the mandals existing in Bandar, Gudivada divisions and part of Vijayawada division comprise delta and all the Mandals existing in Nuzvid division and the remaining mandals of Vijayawada Division constitute upland. The upland consists of an undulating terrain broken by low ranges of Eastern Ghats. The climatic conditions of the district are of extreme kind with hot summers and cold winters and may be classified as tropical. April to June are the hottest months with high temperature in May. The monsoon usually breaks in the middle of June and bring good rains up to middle of October, The normal annual rainfall of this district is 1034 mm and 2/3rd of which is received in the south-west monsoon period.

The geographical area of this district is 8727 km^2, out of which wetlands constitute 19 per cent of area. The district comprises 1764 wetlands, out of which, the mapped ones are 831 besides 933 small wetlands (<2.25 ha). These wetlands account for an area of 165818 ha (Table 22). Coastal wetlands form about 73 per cent dominated by aquaculture ponds (88939 ha) and mangroves (14794). River/Stream (27379) ranked first in inland wetlands, constituting about 17 per cent of wetland extent followed by Tanks/Ponds (6312 ha) and Lake/Ponds (6145 ha). Open water has shown a decrease of about 14 per cent seasonal reduction from the post-monsoon (87097 ha) and pre-monsoon (74772 ha) out of 164885 ha (excluding wetlands <2.25 ha) of wetland extent. Aquatic vegetation also has shown about 1.5 times increase from 20371 ha in post-monsoon to 28352 ha in pre-monsoon. Qualitative turbidity of the open water dominated by low (50574 ha) followed moderate (35297 ha) and high (1226 ha) in post-monsoon. The trend remain unchanged in pre-monsoon season with area under low (39680 ha) followed by moderate (34789 ha) and high (303 ha).

Table 22: Area estimates of wetlands in Krishna

Area in ha

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	4	6145	3.71	379	258
2	1106	River/Stream	22	27379	16.51	14718	12235
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	85	3881	2.34	2686	1539
4	1202	Tanks/Ponds	511	6312	3.81	4452	2418
		Total - Inland	**622**	**43717**	**26.36**	**22235**	**16450**
	2100	**Coastal Wetlands - Natural**					
5	2102	Creeks	16	2817	1.70	2805	2644
6	2103	Sand/Beach	14	2129	1.28	-	-
7	2104	Intertidal mud flats	39	8315	5.01	-	-
8	2106	Mangroves	68	14794	8.92	-	-
	2200	**Coastal Wetlands - Man-made**					
9	2201	Salt pans	2	4174	2.52	1272	1073
10	2202	Aquaculture ponds	70	88939	53.64	60785	54605
		Total - Coastal	**209**	**121168**	**73.07**	**64862**	**58322**
		Sub-Total	**831**	**164885**	**99.44**	**87097**	**74772**
		Wetlands (<2.25 ha), mainly Tanks	933	933	0.56	-	-
		Total	**1764**	**165818**	**100.00**	**87097**	**74772**

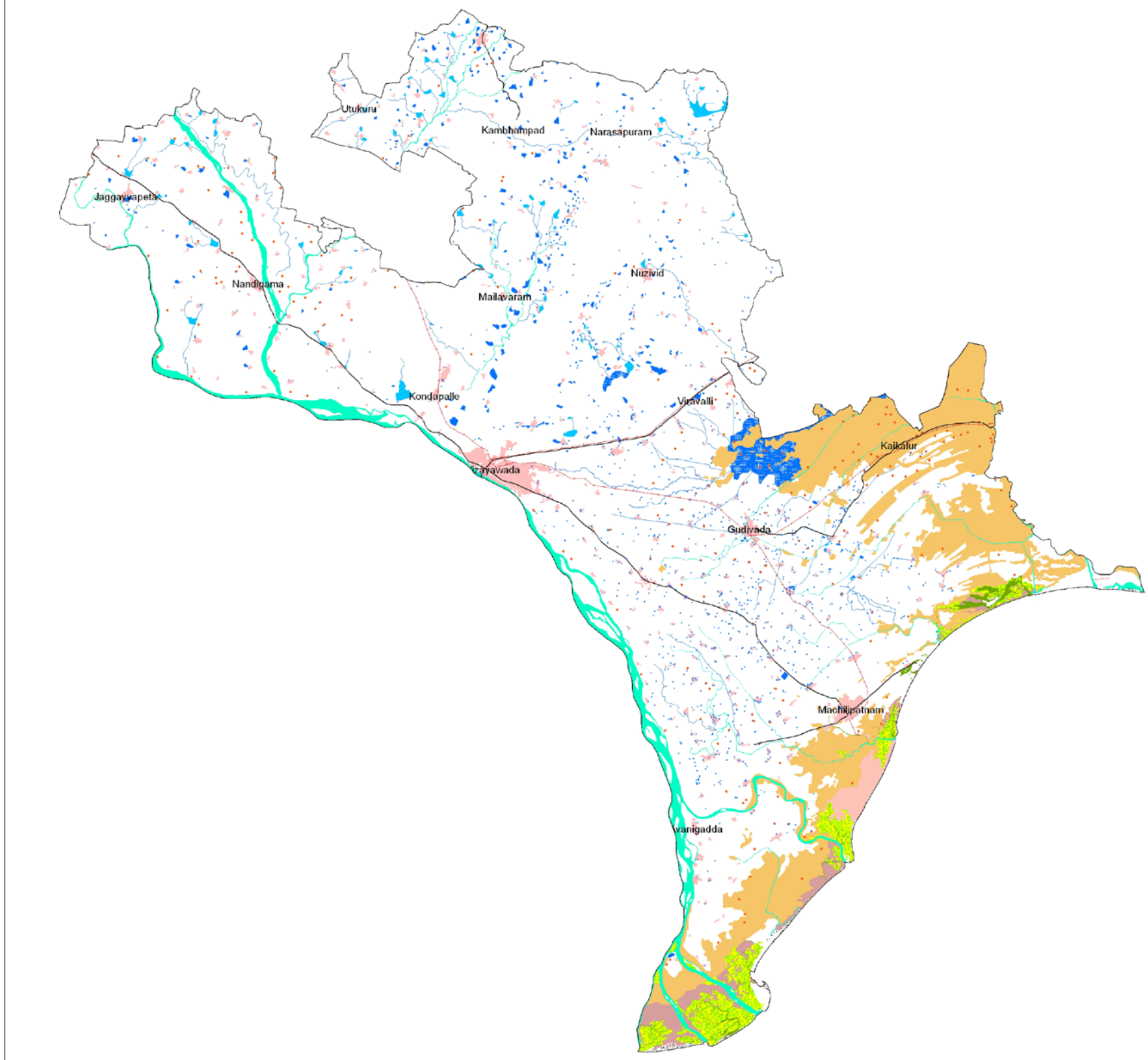
Area under Aquatic Vegetation	20371	28352

Area under turbidity levels		
Low	50574	39680
Moderate	35297	34789
High	1226	303

State : Andhra Pradesh

WETLAND MAP

District : Krishna

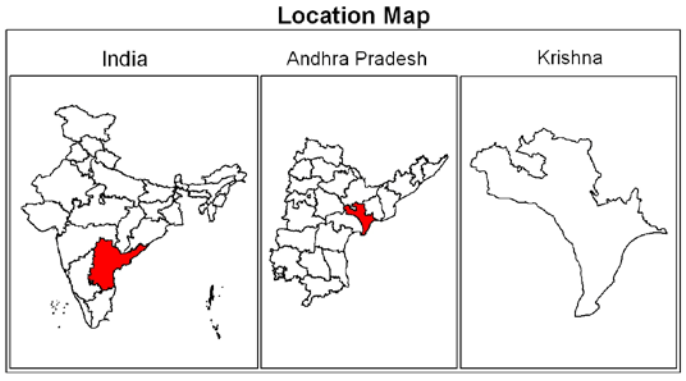


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



10 5 0 10 20 Kilometers

Data Source :

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

Prepared By :

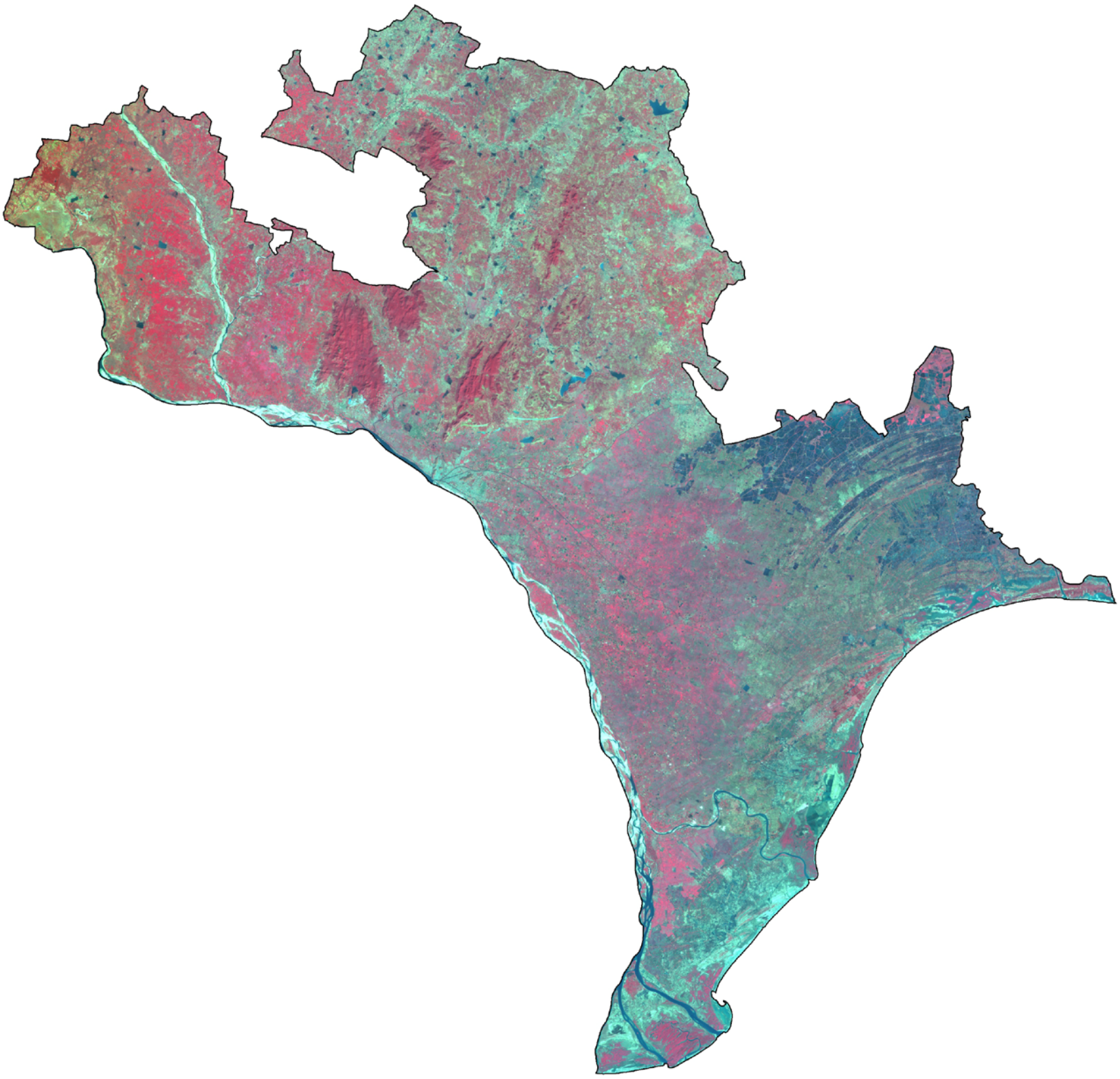
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Krishna



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

7.1.17 Guntur

Guntur District is situated between 15 18' and 16˚ 50' of the North Latitude is 79˚ 10' and 80˚ 55' of the Eastern Longitude. River Krishna bound it on the North. On the South by Prakasham Districts, on the East Bay of Bengal on the west by Mahabubnagar and Nalgonda districts. The district may be broadly divided into three regions: the delta, the stony upland and hills and the black cotton plains. River Krishna washes the northern and a portion of eastern boundaries of the district. The Gundlakamma, Naguleru and Chandravanka are the other important rivers in the district. The climate in this district is generally very warm in summer. The summer which is oppressive during April and May is severe in the upland areas especially in the tracks adjoining the hills.

The geographical area of the district is 11391 km^2, out of which wetlands constitute 5.94 per cent of area. The district comprises 1408 wetlands, out of which, the mapped ones are 639 besides 769 small wetlands (<2.25 ha). These wetlands account for an area of 67652 ha (Table 23). Coastal wetlands form about 45.6 per cent dominated by aquaculture ponds (20842 ha) and mangroves (6332 ha). River/Stream (22725) ranked first in inland wetlands, constituting about 33.6 per cent of wetland extent followed by Reservoirs (9799 ha) and Tanks/Ponds (3512 ha).

Open water has shown a decrease of about 6.9 per cent seasonal reduction from the post-monsoon (31185 ha) to pre-monsoon (29031 ha). Aquatic vegetation also has shown increase from 7726 ha in post-monsoon to 8902 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (27578 ha) in post-monsoon. The trend remain unchanged in pre-monsoon season with area under moderate (25600 ha).

Table 23: Area estimates of wetlands in Guntur

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	1105	Waterlogged	1	3	0.00	-	-
2	1106	River/Stream	26	22725	33.59	12319	11046
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	98	9799	14.48	8785	7919
4	1202	Tanks/Ponds	377	3512	5.19	2678	1939
5	1203	Waterlogged	1	6	0.01	6	6
		Total - Inland	**503**	**36045**	**53.28**	**23788**	**20910**
	2100	**Coastal Wetlands - Natural**					
6	2102	Creeks	6	561	0.83	493	561
7	2103	Sand/Beach	8	847	1.25	-	-
8	2104	Intertidal mud flats	17	2256	3.33	-	-
9	2106	Mangroves	51	6332	9.36	-	-
	2200	**Coastal Wetlands - Man-made**					
10	2202	Aquaculture ponds	54	20842	30.81	6904	7560
		Total - Coastal	**136**	**30838**	**45.58**	**7397**	**8121**
		Sub-Total	**639**	**66883**	**98.86**	**31185**	**29031**
		Wetlands (<2.25 ha), mainly Tanks	769	769	1.14	-	-
		Total	**1408**	**67652**	**100.00**	**31185**	**29031**

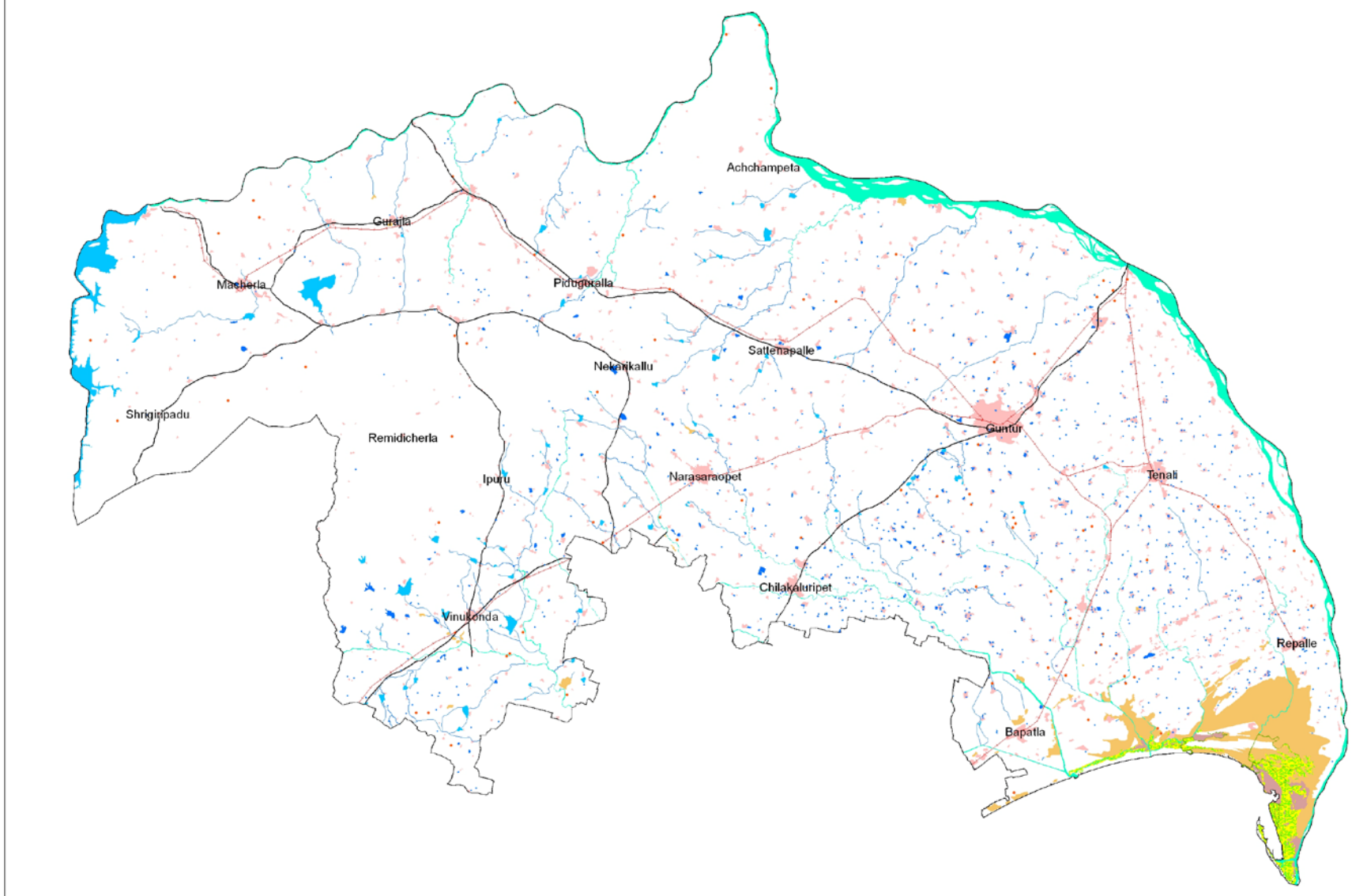
Area under Aquatic Vegetation	7726	8902

Area under turbidity levels		
Low	2476	3136
Moderate	27578	25600
High	1131	295

State : Andhra Pradesh

WETLAND MAP

District : Guntur

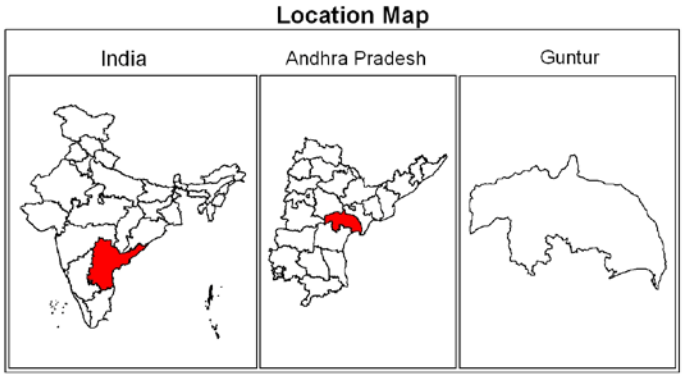


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

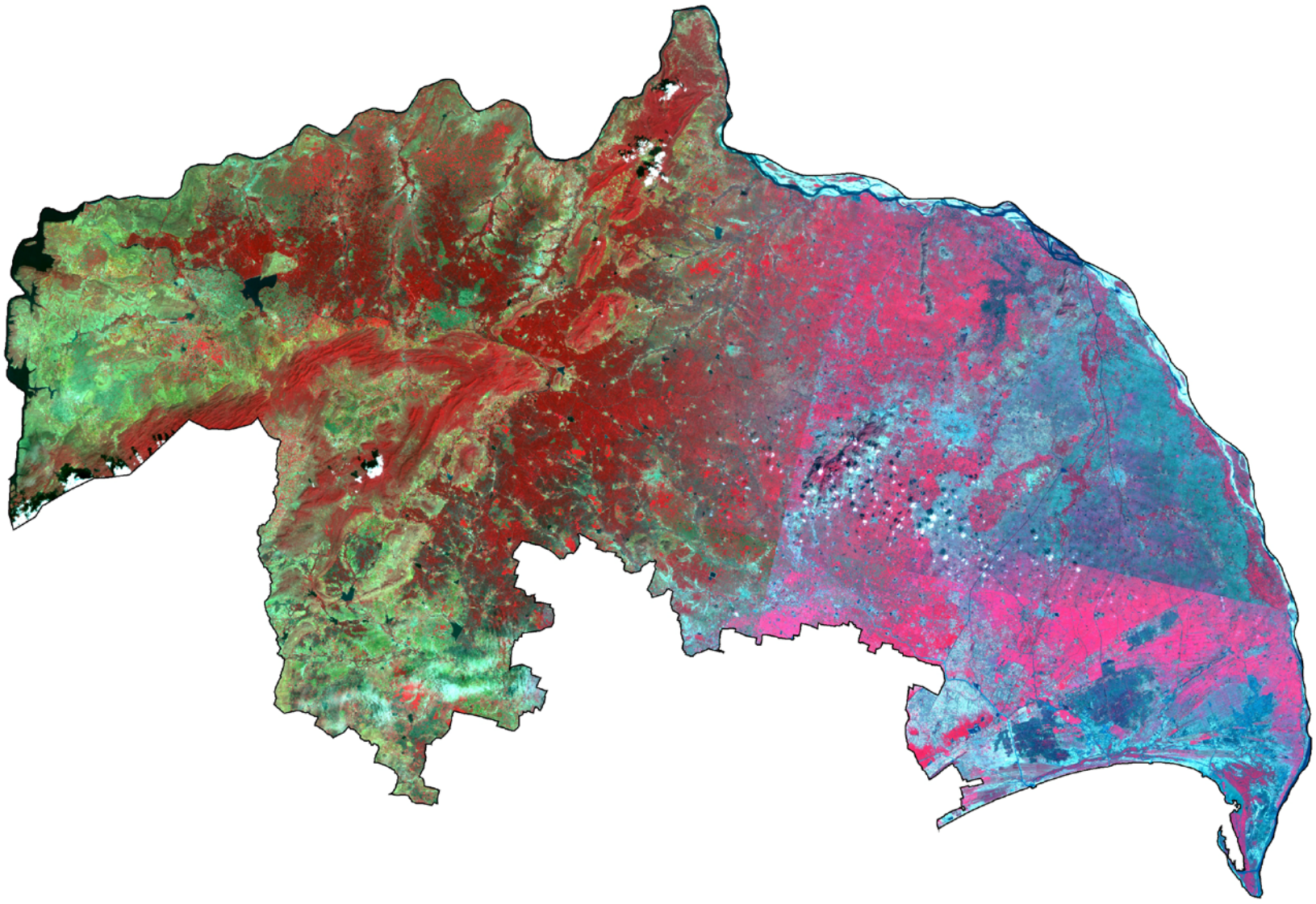
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Guntur



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

7.1.18 Prakasam

Prakasam district is situated in tropical region between 14˚ 57' and 16˚ 17' Northern latitude and 78˚ 43' and 80˚ 25' Eastern longitude. The district is bounded on East by Bay of Bengal, on the West by Kurnool district, on the North partly by Guntur and Mahaboobnagar Districts, on the south partly by Nellore and Kadapa district. The important hill ranges in the district are the Nallamalas and the Veligondas. These hills separate this district from Kurnool and kadapa districts. The district on the whole has a dry climate. The normal maximum and minimum temperature recorded in the district are 38.2 ^{0}C and 19.7 ^{0}C respectively. The district receives its rainfall mostly from South-West and North-East monsoon. The annual normal rainfall is 872 mm. Gundlakamma, Musi, Maneru and Paleru are the important principal rivers that watered the district. There are also other minor rivers like the Tammileru, Sagileru and Gudisaeru and streams like Vagara vagu, Nallavagu, Vedimangala vagu which flow in some parts of the district.

The geographical area of the district is 17626 km^2, out of which wetlands constitute 2.98 per cent of area. The district comprises 2126 wetlands, out of which, the mapped ones are 892 besides 1234 small wetlands (<2.25 ha). These wetlands account for an area of 52565 ha (Table 24). Coastal wetlands form about 33 per cent dominated by aquaculture ponds (9718 ha) and salt pans (4077 ha). River/Stream (13873 ha) ranked first in inland wetlands, constituting about 26.4 per cent of wetland extent followed by Reservoirs (12265 ha) and Tanks/Ponds (7490 ha).

Open water has shown a decrease of about 26.5 per cent seasonal reduction from the post-monsoon (25489 ha) to pre-monsoon (18743 ha). Aquatic vegetation also has shown increase from 2338 ha in post-monsoon to 9023 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (18580 ha) in post-monsoon. The trend remain unchanged in pre-monsoon season with area under moderate (13985 ha).

Table 24: Area estimates of wetlands in Prakasam

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	1105	Waterlogged	5	272	0.52	257	178
2	1106	River/Stream	40	13873	26.39	5038	3572
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	257	12265	23.33	8887	4212
4	1202	Tanks/Ponds	480	7490	14.25	5918	3572
		Total - Inland	**782**	**33900**	**64.49**	**20100**	**11534**
	2100	**Coastal Wetlands - Natural**					
5	2102	Creeks	10	471	0.90	364	471
6	2103	Sand/Beach	13	1221	2.32	-	-
7	2104	Intertidal mud flats	8	1335	2.54	-	-
8	2105	Salt Marsh	4	527	1.00	-	-
9	2106	Mangroves	8	82	0.16	-	-
	2200	**Coastal Wetlands - Man-made**					
10	2201	Salt pans	24	4077	7.76	1332	1347
11	2202	Aquaculture ponds	43	9718	18.49	3693	5391
		Total - Coastal	**110**	**17431**	**33.16**	**5389**	**7209**
		Sub-Total	**892**	**51331**	**97.65**	**25489**	**18743**
		Wetlands (<2.25 ha), mainly Tanks	1234	1234	2.35	-	-
		Total	**2126**	**52565**	**100.00**	**25489**	**18743**

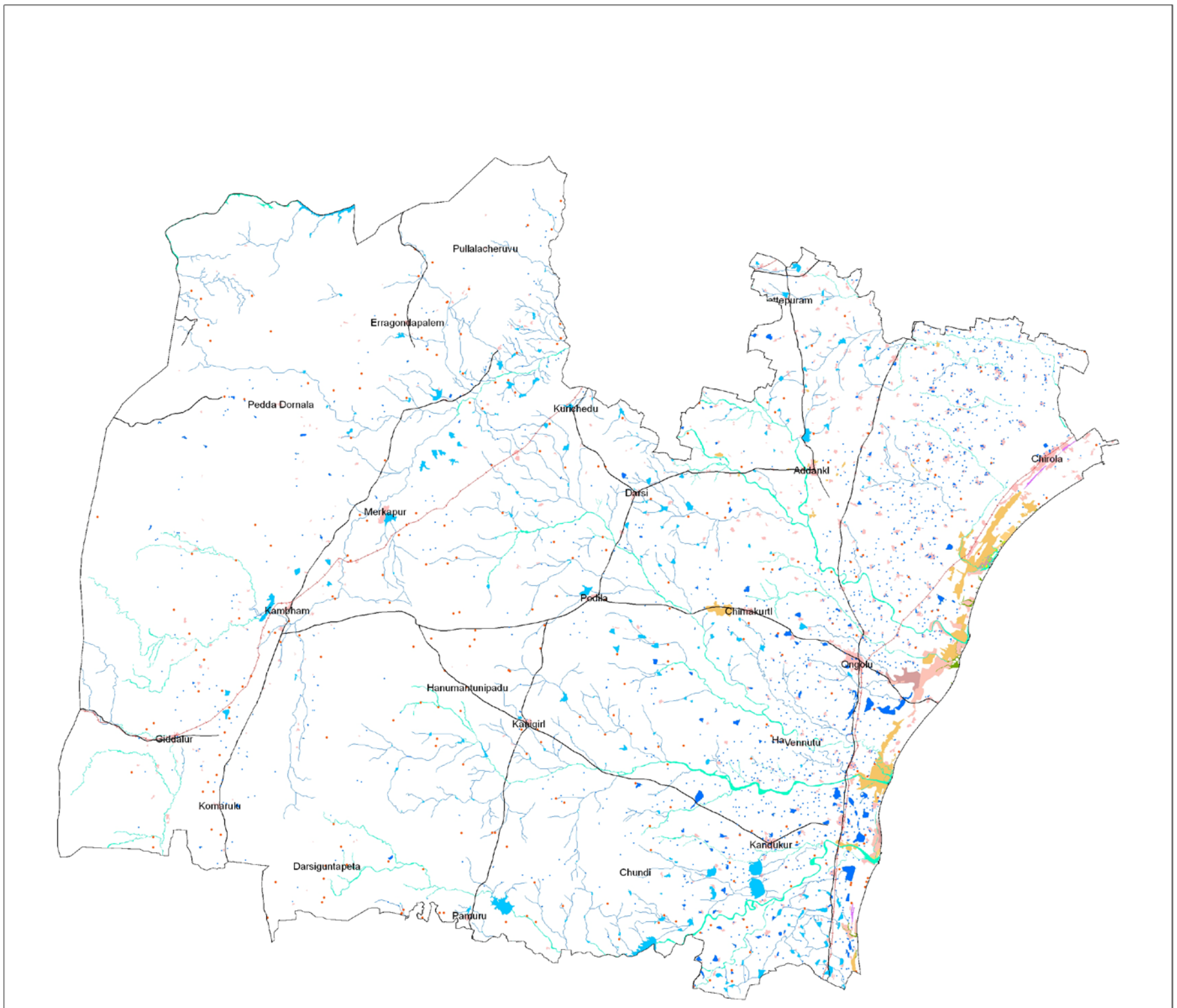
Area under Aquatic Vegetation	2338	9023

Area under turbidity levels		
Low	3469	3197
Moderate	18580	13985
High	3440	1559

State : Andhra Pradesh

WETLAND MAP

District : Prakasam

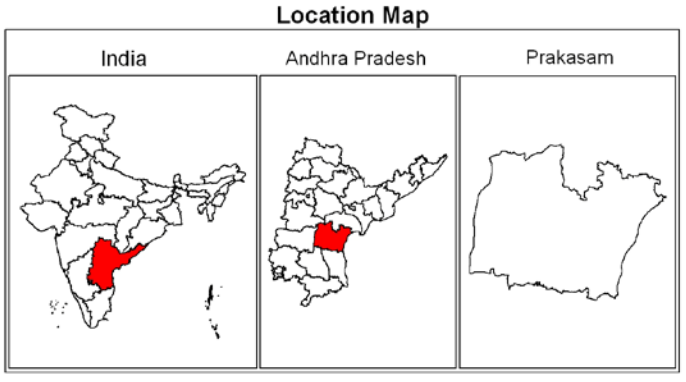


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

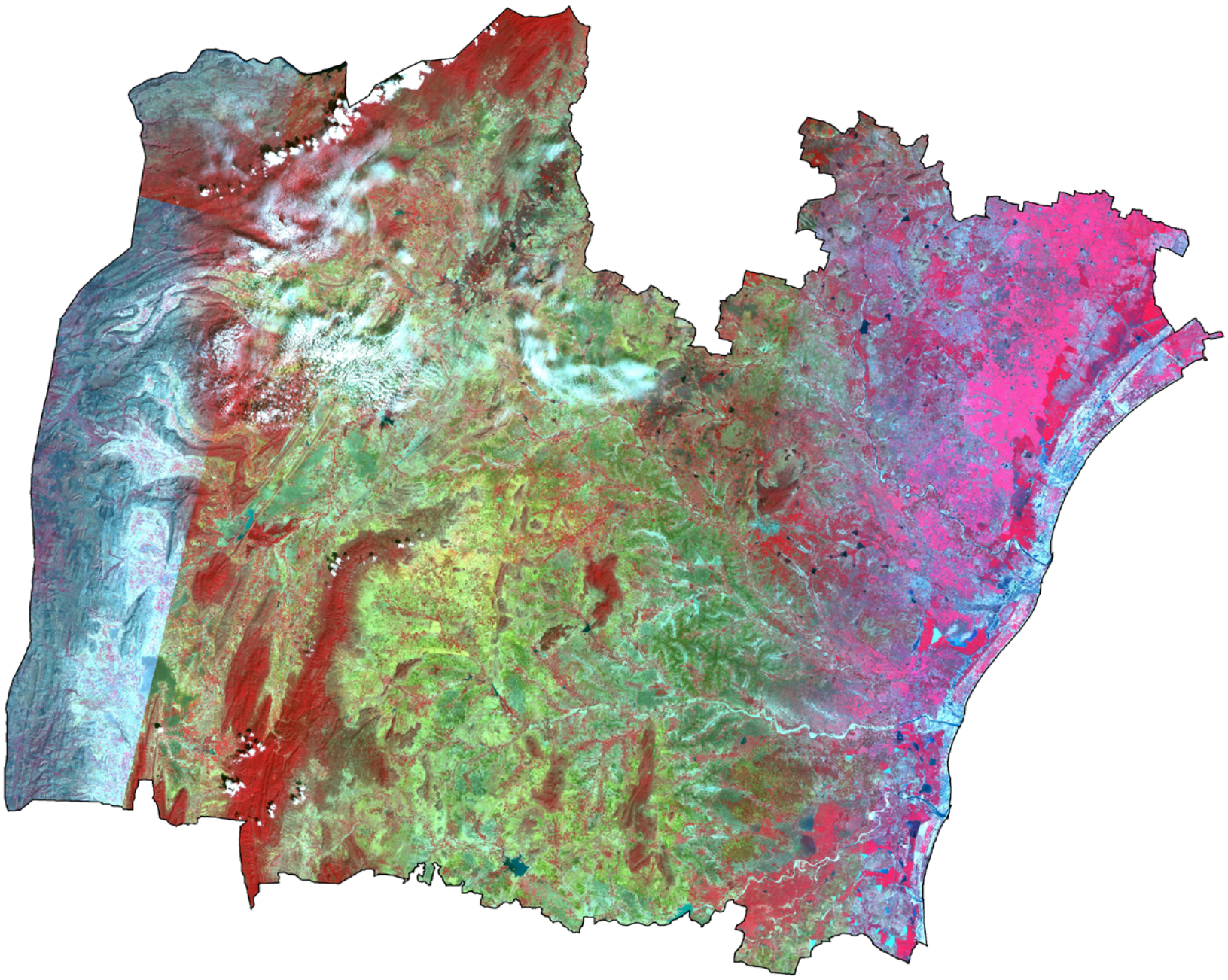
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Prakasam



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

7.1.19 Nellore

Nellore is the southern most coastal district of Andhra Pradesh. It lies between $13^0$25'and $15^0$55' N of the Northern latitude and $79^0$9'and 80^0 14' of the Eastern Longitude. It is bounded on the north by Prakasam District on the East by Bay of Bengal on the South by Chittoor District and Chengalpattu district of Tamilnadu and on the West by Veligonda Hills which separate it from Kadapa district. The eastern side consists of area of low lying land extending from the base of the Eastern Ghats to the sea. The west side of the district is separated from Kadapa district by Veligonda hills. The climate of the district is generally dry and salubrious. May and June are the hottest months with highest maximum temperature recorded at 39^0 C. The temperature is low in the months of November, December and January and the mean minimum temperature is above 20^0 C In January. The Annual Normal Rainfall of the District is 1080 mm. River Pennar flows from west to east and splits the district into two halves. The other rivers flowing in the district are Kandaleru and Swarnamukhi.

The geographical area of the district is 13076 km^2, out of which wetlands constitute 16.47 per cent of area. The district comprises 2998 wetlands, out of which, the mapped ones are 2318 besides 680 small wetlands (<2.25 ha). These wetlands account for an area of 215404 ha (Table 25). Coastal wetlands form about 52 per cent dominated by lagoons (47407 ha) and aquaculture ponds (43195 ha). Reservoirs (45715 ha) ranked first in inland wetlands, constituting about 21 per cent of wetland extent followed by Tanks/Ponds (27673 ha) and River/Stream (26826 ha).

Open water has shown a decrease of about 19 per cent seasonal reduction from the post-monsoon (141494 ha) to pre-monsoon (114398 ha). Aquatic vegetation also has shown increase from 8145 ha in post-monsoon to 25839 ha in pre-monsoon.

Table 25: Area estimates of wetlands in Nellore

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	1105	Waterlogged	6	369	0.17	358	80
2	1106	River/Stream	33	26826	12.45	9934	6946
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	469	45715	21.22	39903	23475
4	1202	Tanks/Ponds	1088	27673	12.85	24890	7151
5	1203	Waterlogged	16	2082	0.97	727	375
		Total - Inland	**1612**	**102665**	**47.66**	**75812**	**38027**
	2100	**Coastal Wetlands - Natural**					
6	2101	Lagoons	2	47407	22.01	47306	47407
7	2102	Creeks	14	1588	0.74	1503	1476
8	2103	Sand/Beach	15	2544	1.18	-	-
9	2104	Intertidal mud flats	41	12282	5.70	-	-
10	2105	Salt Marsh	24	3475	1.61	-	-
11	2106	Mangroves	55	1568	0.73	-	-
	2200	**Coastal Wetlands - Man-made**					
12	2202	Aquaculture ponds	555	43195	20.05	16873	27488
		Total - Coastal	**706**	**112059**	**52.02**	**65682**	**76371**
		Sub-Total	**2318**	**214724**	**99.68**	**141494**	**114398**
		Wetlands (<2.25 ha), mainly Tanks	680	680	0.32	-	-
		Total	**2998**	**215404**	**100.00**	**141494**	**114398**

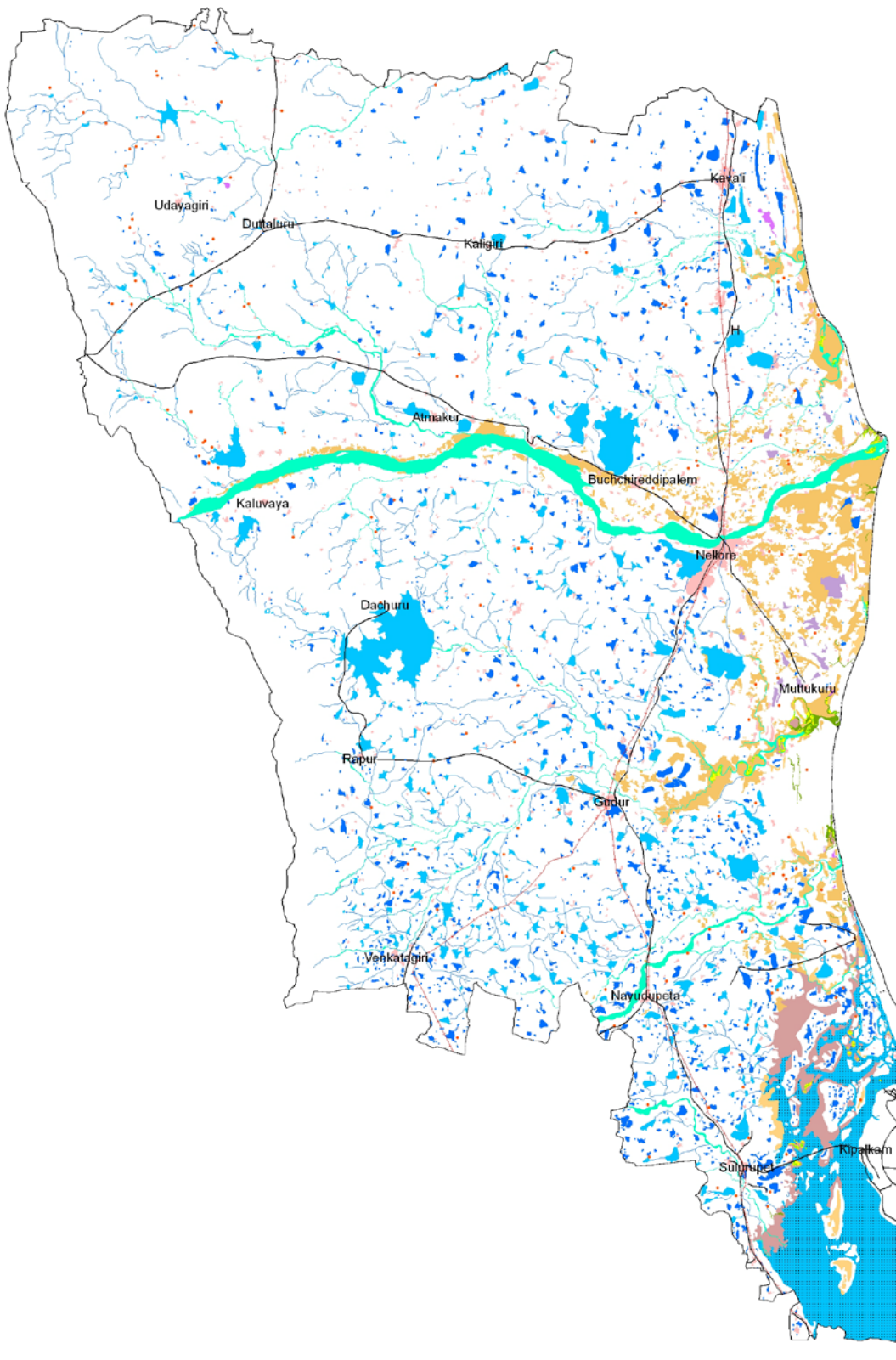
Area under Aquatic Vegetation	8145	25839

Area under turbidity levels		
Low	68956	57821
Moderate	67693	51748
High	4840	4830

State : Andhra Pradesh

WETLAND MAP

District : Nellore

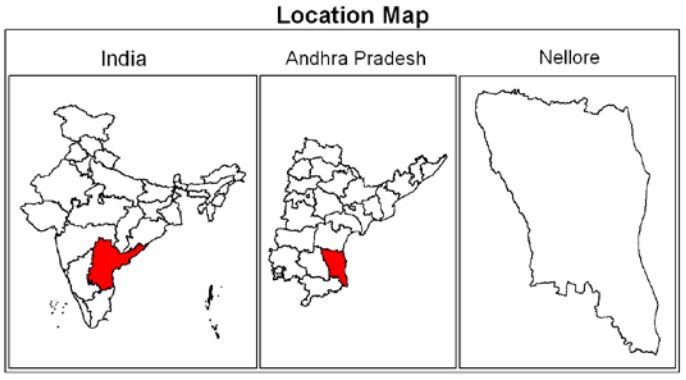


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

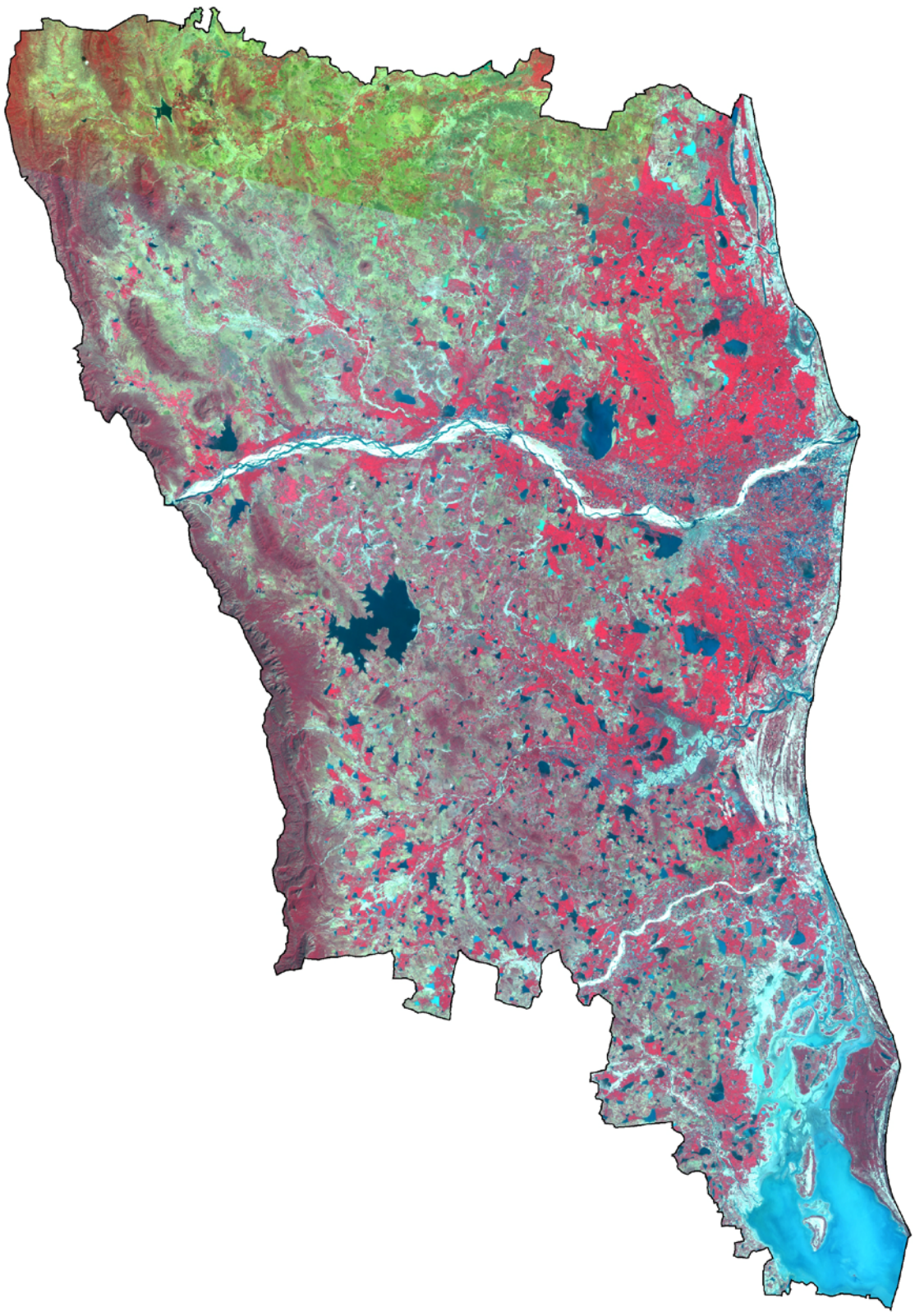
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Nellore



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

7.1.20 Cuddapah

The Cuddapah district is bounded by the Latitude 13° 43' to 15° 14'N and Longitude 77° 51'E to 79° 29'E The district is bounded by Kurnool on the north, Chittoor district on the south, Nellore on the east and Anantapur on the west. The district is said to be the heart of Rayalaseema as it is centrally located and well connected with the four districts of Rayalaseema. The area in general forms an undulating topography with hills and plains. The eastern, western and southern parts of the district form high hilly terrains with plains in between them. The area experiences humid tropical climate. The summer months are very hot and winter months are pleasant, when the night temperature is about 28^0 C to 30^0 C. The district falls under southern and scarce rainfall is mainly influenced by the South-west monsoon. The normal rainfall of the district is 700 mm as against the state average rainfall of 940 mm.

The geographical area of the district is 15359 km^2, out of which wetlands constitute 3.68 per cent of area. The district comprises 901 wetlands, out of which, the mapped ones are 541 besides 360 small wetlands (<2.25 ha). These wetlands account for an area of 56470 ha (Table 26). Reservoirs (29738 ha) ranked first in inland wetlands, constituting about 52.7 per cent of wetland extent followed by river/stream (22126 ha) and Tanks/Ponds (3584 ha).

Open water has shown a decrease of about 22.6 per cent seasonal reduction from the post-monsoon (34973 ha) to pre-monsoon (27073 ha). Aquatic vegetation also has shown increase from 2772 ha in post-monsoon to 5402 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (23599 ha) in post-monsoon.

Table 26: Area estimates of wetlands in Cuddapah

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	1106	River/Stream	18	22126	39.18	4424	3610
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	301	29738	52.66	27480	22005
3	1202	Tanks/Ponds	220	3584	6.35	3069	1458
4	1203	Waterlogged	2	662	1.17	-	-
		Sub-Total	**541**	**56110**	**99.36**	**34973**	**27073**
		Wetlands (<2.25 ha), mainly Tanks	360	360	0.64	-	-
		Total	**901**	**56470**	**100.00**	**34973**	**27073**

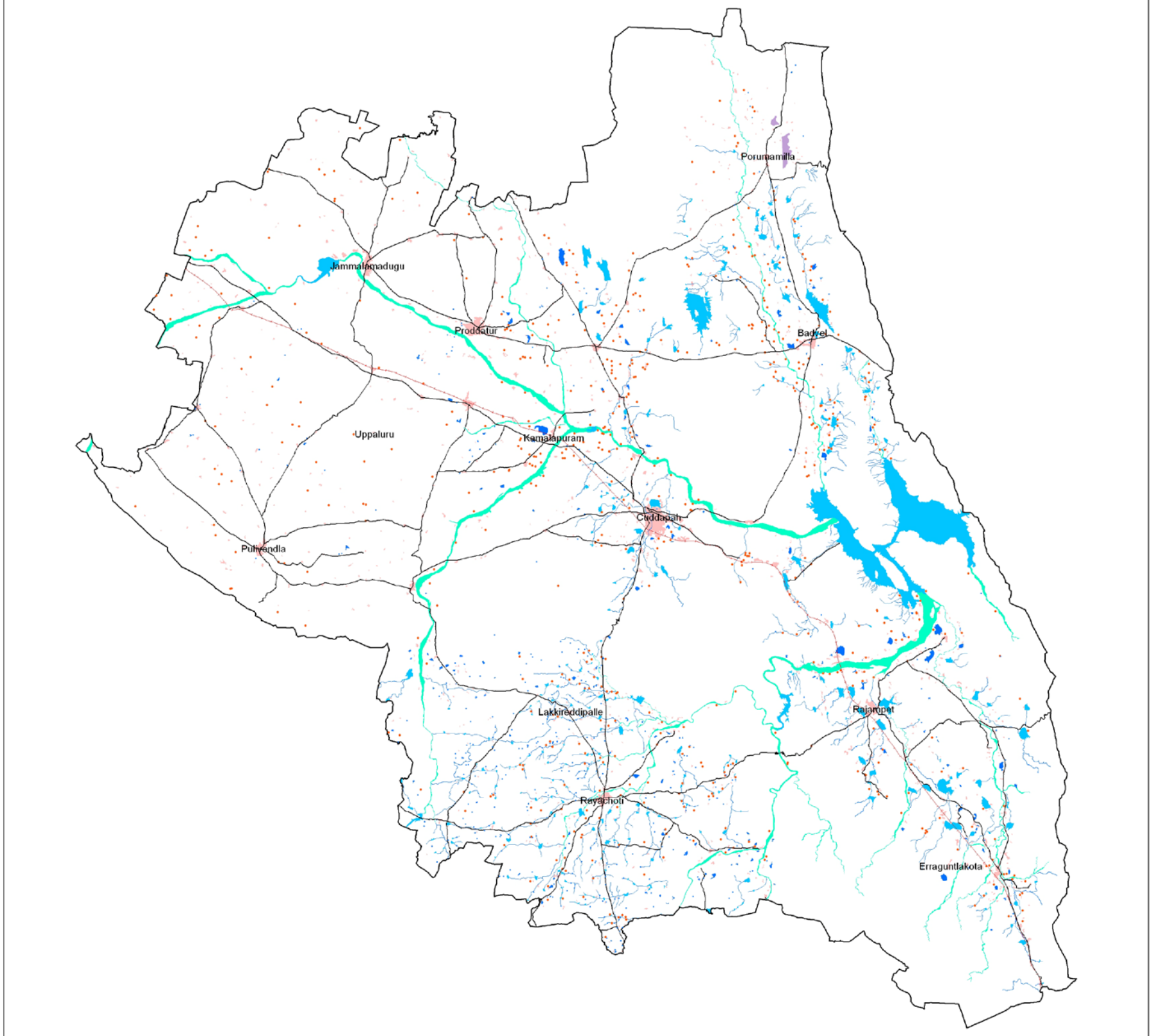
Area under Aquatic Vegetation	2772	5402

Area under turbidity levels		
Low	8109	12546
Moderate	23599	13122
High	3265	1405

State : Andhra Pradesh

WETLAND MAP

District : Cuddapah

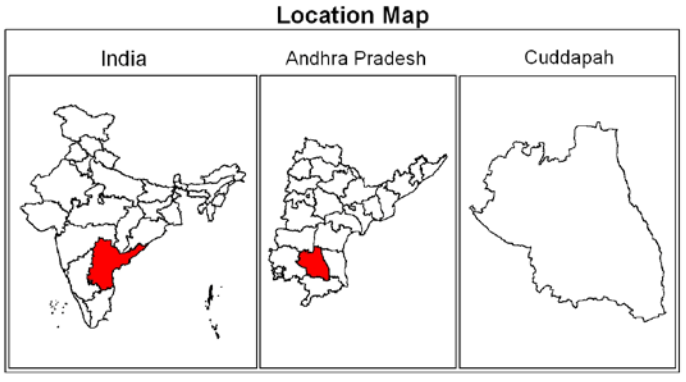


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Cuddapah

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

7.1.21 Kurnool

Kurnool district is situated on 14^0 15' - 16^0 11' Northern latitude and 76^0 58'-78^0 25' Eastern longitude and the altitude varies from 1000 m above sea level. The district is surrounded by Prakassam, Cuddapah, Ananthapur, Mahaboobnagar districts and Karnataka state. Nallamalas and Erramalas are the two important mountain ranges in the district running parallel from North to South. May and June are the hottest months with the highest maximum temperatures recorded. November, December and January months record low temperatures. The maximum temperature in summer is 46°C and minimum in winter 14°C. The normal rainfall in the district is 630 mm.

The geographical area of the district is 17658 km^2, out of which wetlands constitute 2.18 per cent of area. The district comprises 591 wetlands, out of which, the mapped ones are 302 besides 289 small wetlands (<2.25 ha). These wetlands account for an area of 38479 ha (Table 27). Reservoirs (24956 ha) ranked first in inland wetlands, constituting about 64.9 per cent of wetland extent followed by river/stream (11012 ha) and Tanks/Ponds (1887 ha).

Open water has shown a decrease of about 47.8 per cent seasonal reduction from the post-monsoon (26782 ha) to pre-monsoon (13972 ha). Aquatic vegetation also has shown increase from 2029 ha in post-monsoon to 11842 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (17750 ha) in post-monsoon. The trend remain unchanged in pre-monsoon season with area under moderate (11469 ha).

Table 27: Area estimates of wetlands in Kurnool

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	1106	River/Stream	29	11012	28.62	2772	2479
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	127	24956	64.86	22592	10683
3	1202	Tanks/Ponds	142	1887	4.90	1395	810
4	1203	Waterlogged	4	335	0.87	23	-
		Sub-Total	**302**	**38190**	**99.25**	**26782**	**13972**
		Wetlands (<2.25 ha), mainly Tanks	289	289	0.75	-	-
		Total	**591**	**38479**	**100.00**	**26782**	**13972**

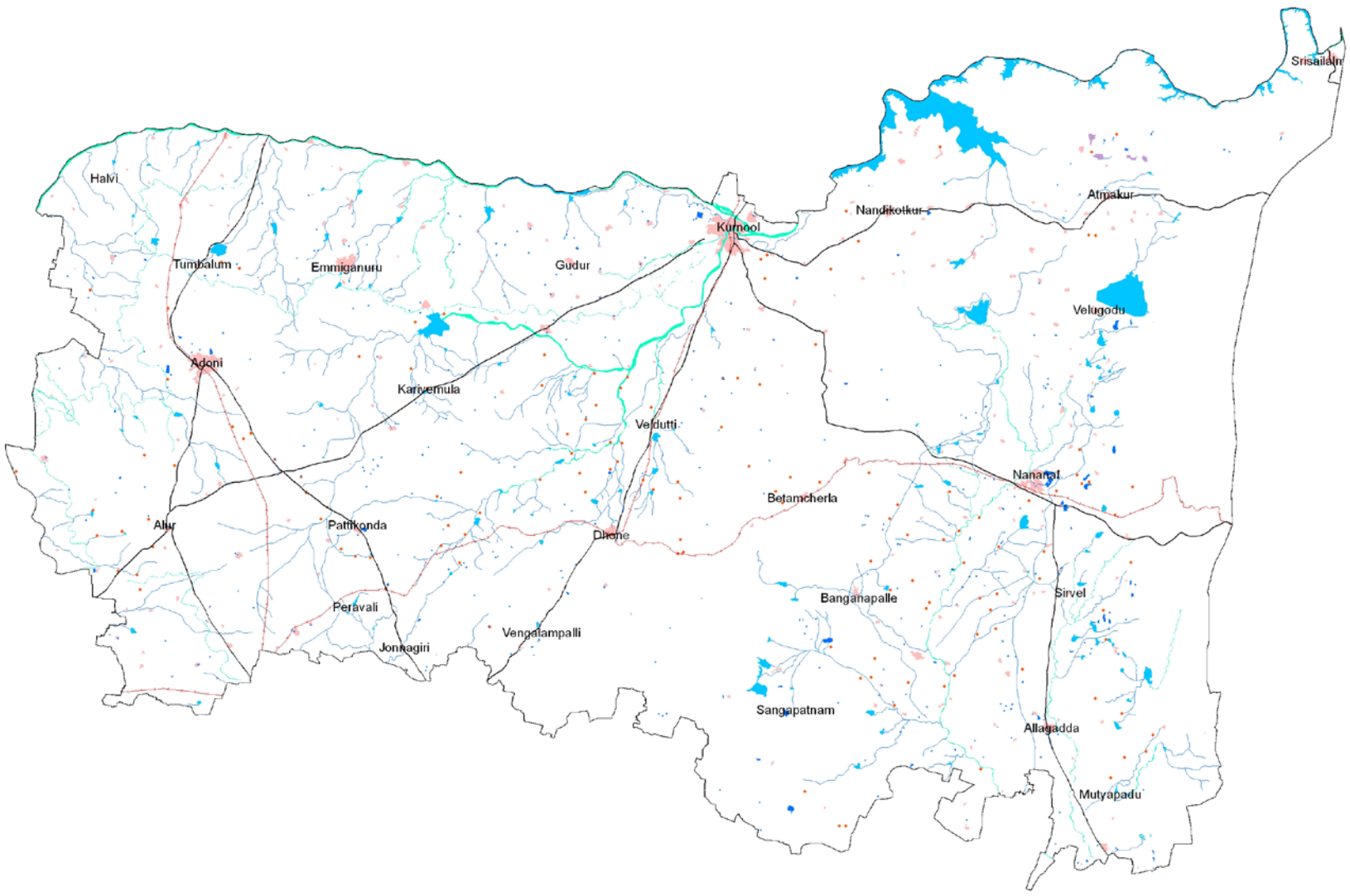
Area under Aquatic Vegetation	2029	11842

Area under turbidity levels		
Low	7476	1247
Moderate	17750	11469
High	1556	1256

State : Andhra Pradesh

WETLAND MAP

District : Kurnool

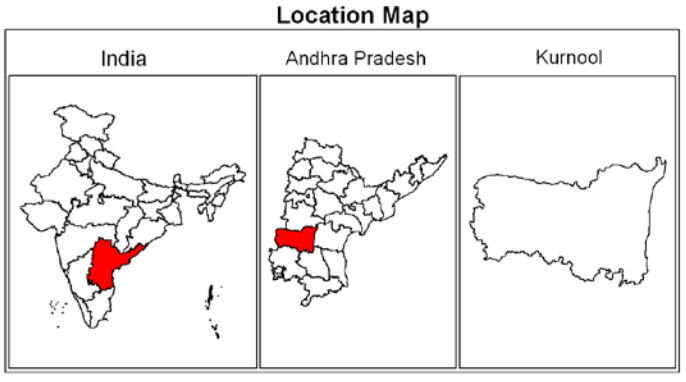


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

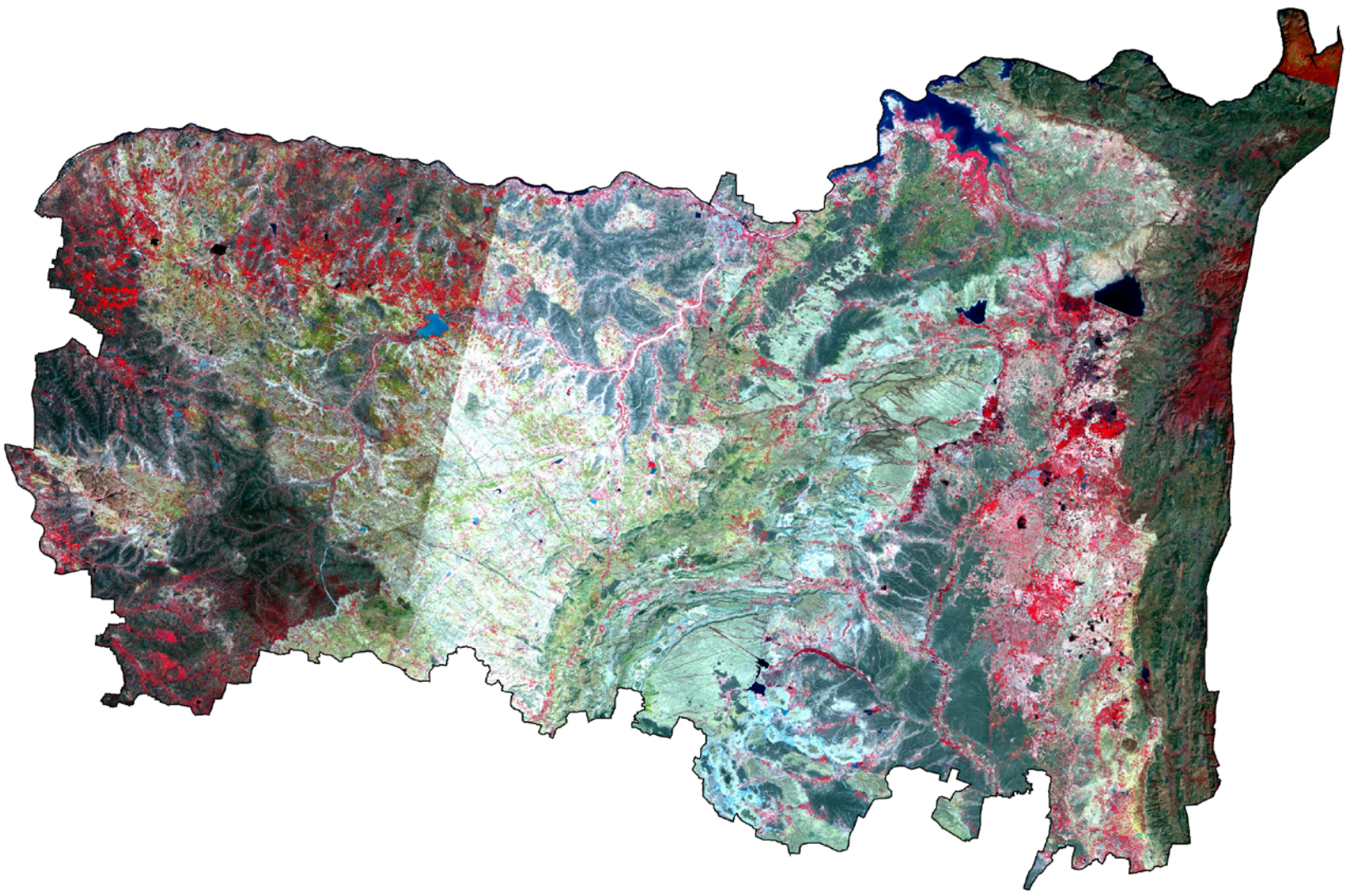
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Kurnool



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

7.1.22 Anantapur

The district lies between North Latitudes 13° 40’ and 15° 15’ and East Longitudes 76°50’ and 78°30’. While the northern boundary of the district is bound by Bellary (Karnataka) and Kurnool districts, the eastern, south eastern and south western boundaries are bound by Kadapa, Chittoor and Kolar districts respectively. The district can be divided into three natural regions, northern black cotton, central semi-arid with scarce vegetation and southern high level connecting Mysore plateau. In general the district has gradient from South to North with few hill ranges. Several major and minor rivers drain the district; most of them originating in Karnataka. Among them Pennar and its tributaries Chitravati, Kushavati, Jayamangala, Papagni are the main rivers flowing in the district. The months of March, April and May are dry and warm with daily temperature ranging between 29° C to 40° C. November, December and January are the cooler months with the temperatures falling to about 15° C. The average annual rainfall of the district is 553 mm.

The geographical area of the district is 19130 km^2, out of which wetlands constitute 2 per cent of area. The district comprises 1141 wetlands, out of which, the mapped ones are 641 besides 500 small wetlands (<2.25 ha). These wetlands account for an area of 38400 ha (Table 28). Reservoirs (13947 ha) ranked first in inland wetlands, constituting about 36.3 per cent of wetland extent followed by River/stream (13718 ha) and Tanks/Ponds (9896 ha).

Open water has shown a decrease of about 11 per cent seasonal reduction from the post-monsoon (10481 ha) to pre-monsoon (9334 ha). Aquatic vegetation also has shown increase from 6075 ha in post-monsoon to 8490 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (8216 ha) in post-monsoon.

Table 28: Area estimates of wetlands in Anantapur

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	1105	Waterlogged	1	278	0.72	-	117
2	1106	River/Stream	15	13718	35.72	45	-
	1200	**Inland Wetlands -Man-made**					
3	1201	Reservoirs/Barrages	175	13947	36.32	7299	5074
4	1202	Tanks/Ponds	447	9896	25.77	3131	4135
5	1203	Waterlogged	3	61	0.16	6	8
		Sub-Total	**641**	**37900**	**98.70**	**10481**	**9334**
		Wetlands (<2.25 ha), mainly Tanks	500	500	1.30	-	-
		Total	**1141**	**38400**	**100.00**	**10481**	**9334**

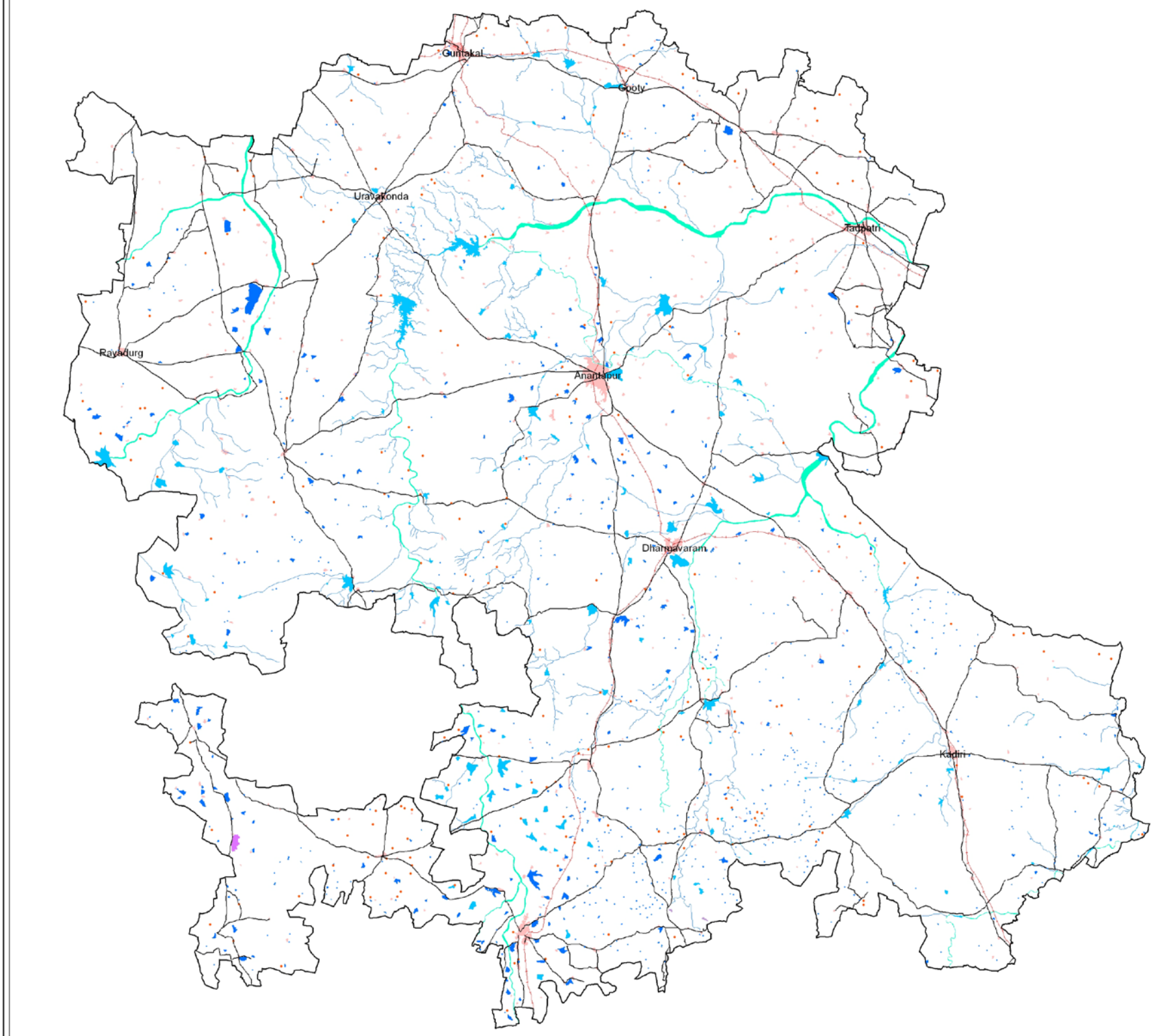
Area under Aquatic Vegetation	6075	8490

Area under turbidity levels		
Low	173	325
Moderate	8216	4717
High	2092	4292

State : Andhra Pradesh

WETLAND MAP

District : Anantapur

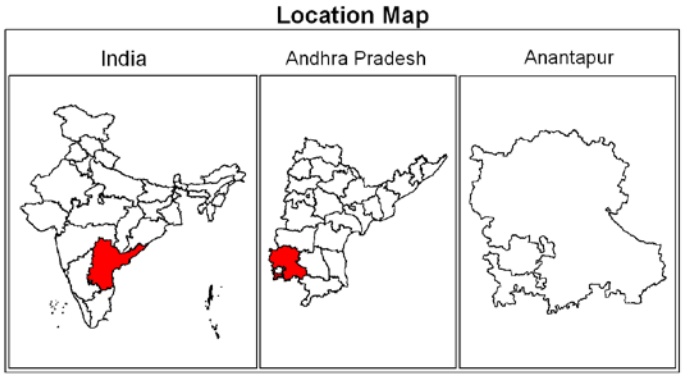


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

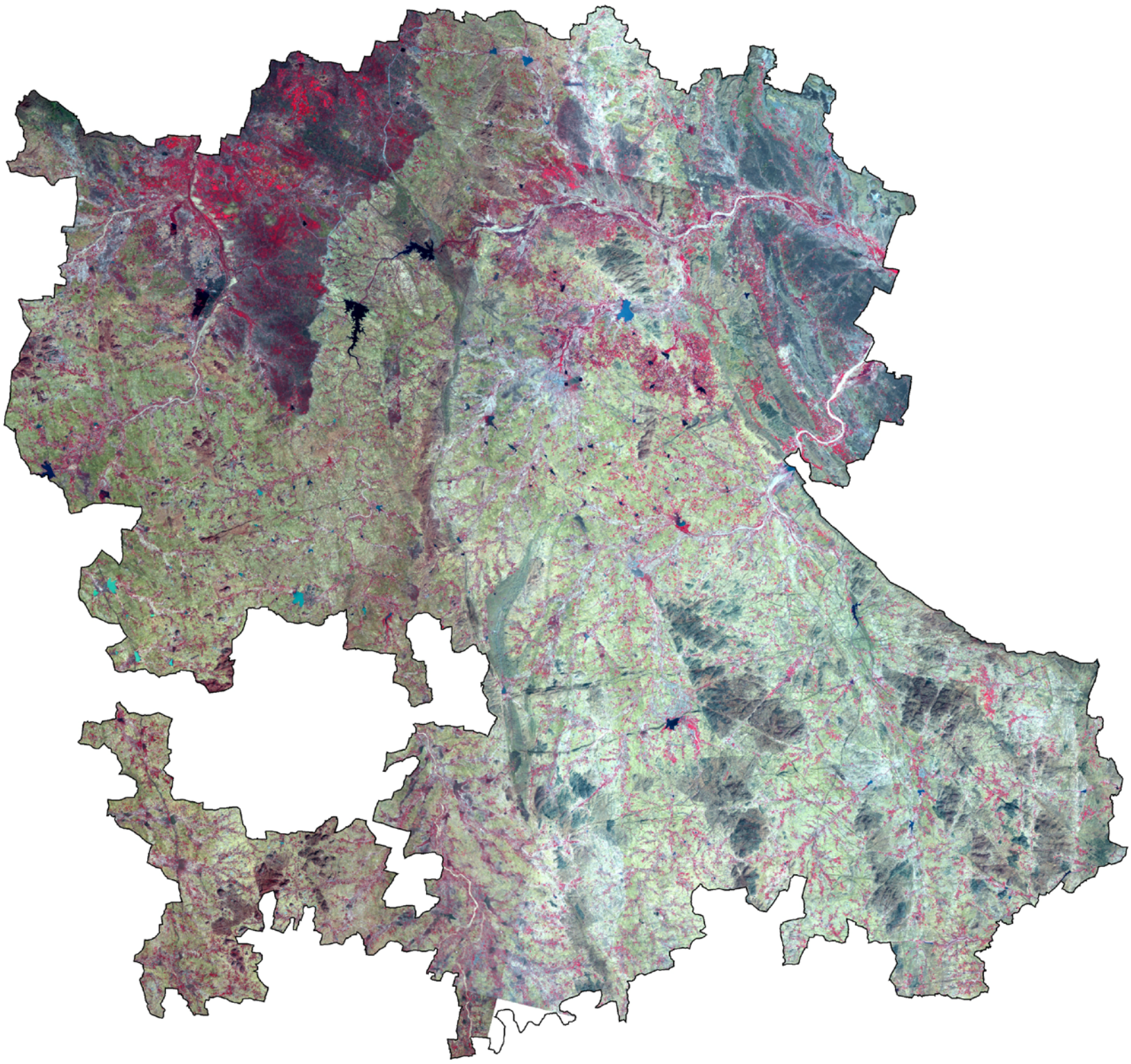
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Anantapur



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

7.1.23 Chittoor

Chittoor district which forms the southern most district of Andhra Pradesh lies between north Latitudes 12^0 37' and 14^0 08 and East longitudes 78^0 33' and 79^0 55'. The district is bound by Anantapur and Kadapa Districts on the north, Nellore District on the east, Chengalpattu and North Arcot and Dharmapuri Districts of Tamil Nadu in the south and Kolar District of Karnataka State on the West. The district can be broadly divisible into two parts: Hilly areas of western part comprising mainly the Eastern Ghats and eastern plains. Chittoor experiences a moderate climate. The average annual rainfall for the district is 934 mm.

The main rivers/streams flowing through the district are Ponnai a tributary of River Palar, Swarnamukhi, Arani, Bahuda and Pincha.

The geographical area of the district is 15152 km^2, out of which wetlands constitute 2.7 per cent of area. The district comprises 3191 wetlands, out of which, the mapped ones are 1732 besides 1459 small wetlands (<2.25 ha). These wetlands account for an area of 40961 ha (Table 29). Tanks/Ponds (18638 ha) ranked first in inland wetlands, constituting about 45.5 per cent of wetland extent followed by Reservoirs (12084 ha) and River/stream (8780 ha).

Open water has shown a decrease of about 76.6 per cent seasonal reduction from the post-monsoon (29451 ha) to pre-monsoon (6904 ha). Aquatic vegetation also has shown increase from 1222 ha in post-monsoon to 7139 ha in pre-monsoon. Qualitative turbidity of the open water dominated by moderate (22901 ha) in post-monsoon.

Table 29: Area estimates of wetlands in Chittoor

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	1106	River/Stream	31	8780	21.44	1570	302
	1200	**Inland Wetlands -Man-made**					
2	1201	Reservoirs/Barrages	310	12084	29.50	10681	3042
3	1202	Tanks/Ponds	1391	18638	45.50	17200	3560
		Sub-Total	**1732**	**39502**	**96.44**	**29451**	**6904**
		Wetlands (<2.25 ha), mainly Tanks	1459	1459	3.56	-	-
		Total	**3191**	**40961**	**100.00**	**29451**	**6904**

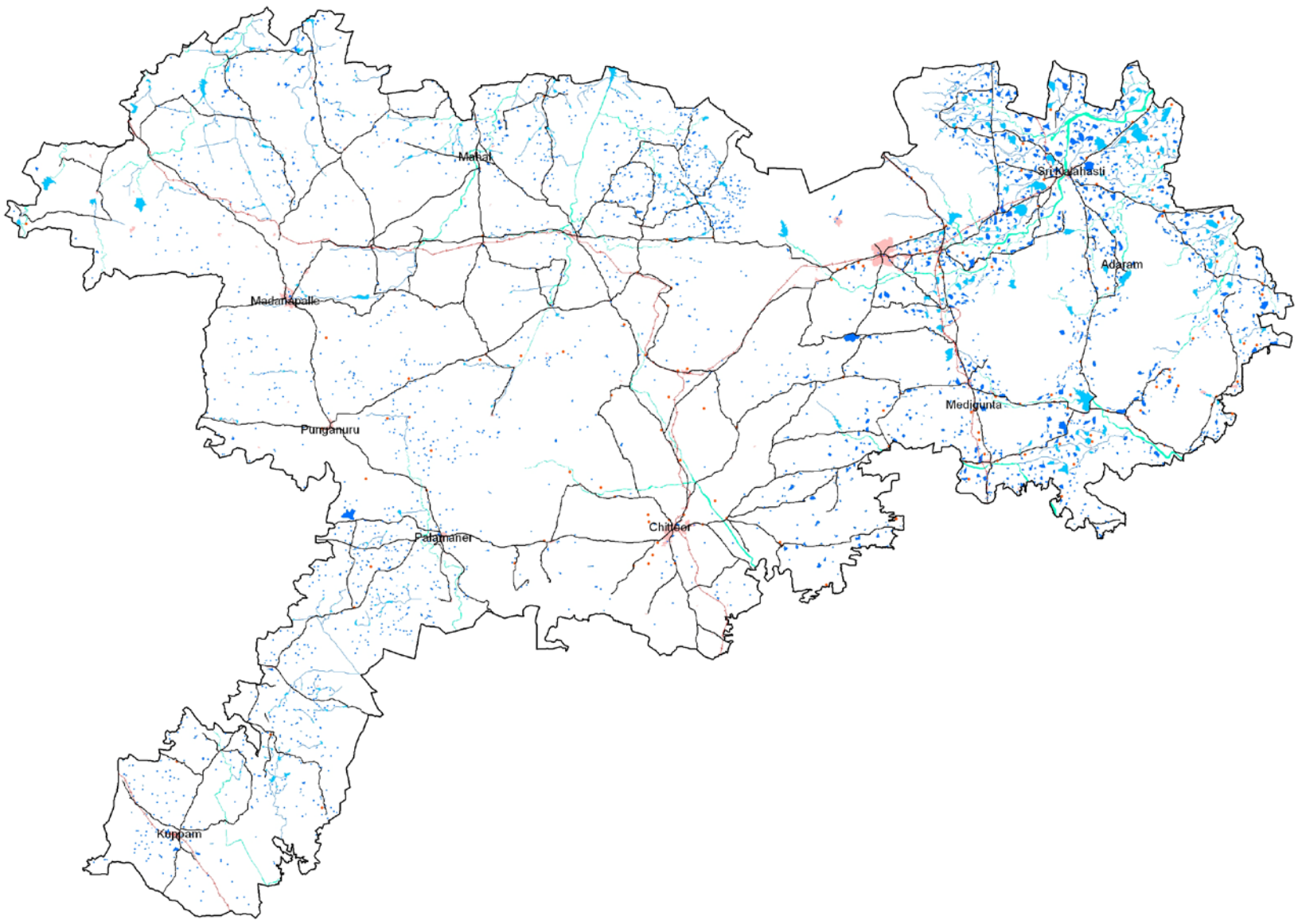
Area under Aquatic Vegetation	1222	7139

Area under turbidity levels		
Low	1370	147
Moderate	22901	3845
High	5180	2912

State : Andhra Pradesh

WETLAND MAP

District : Chittoor

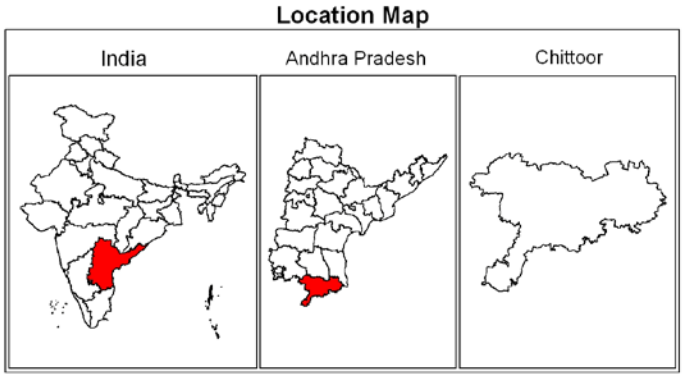


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



20 10 0 20 40 Kilometers

Data Source :

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

Prepared By :

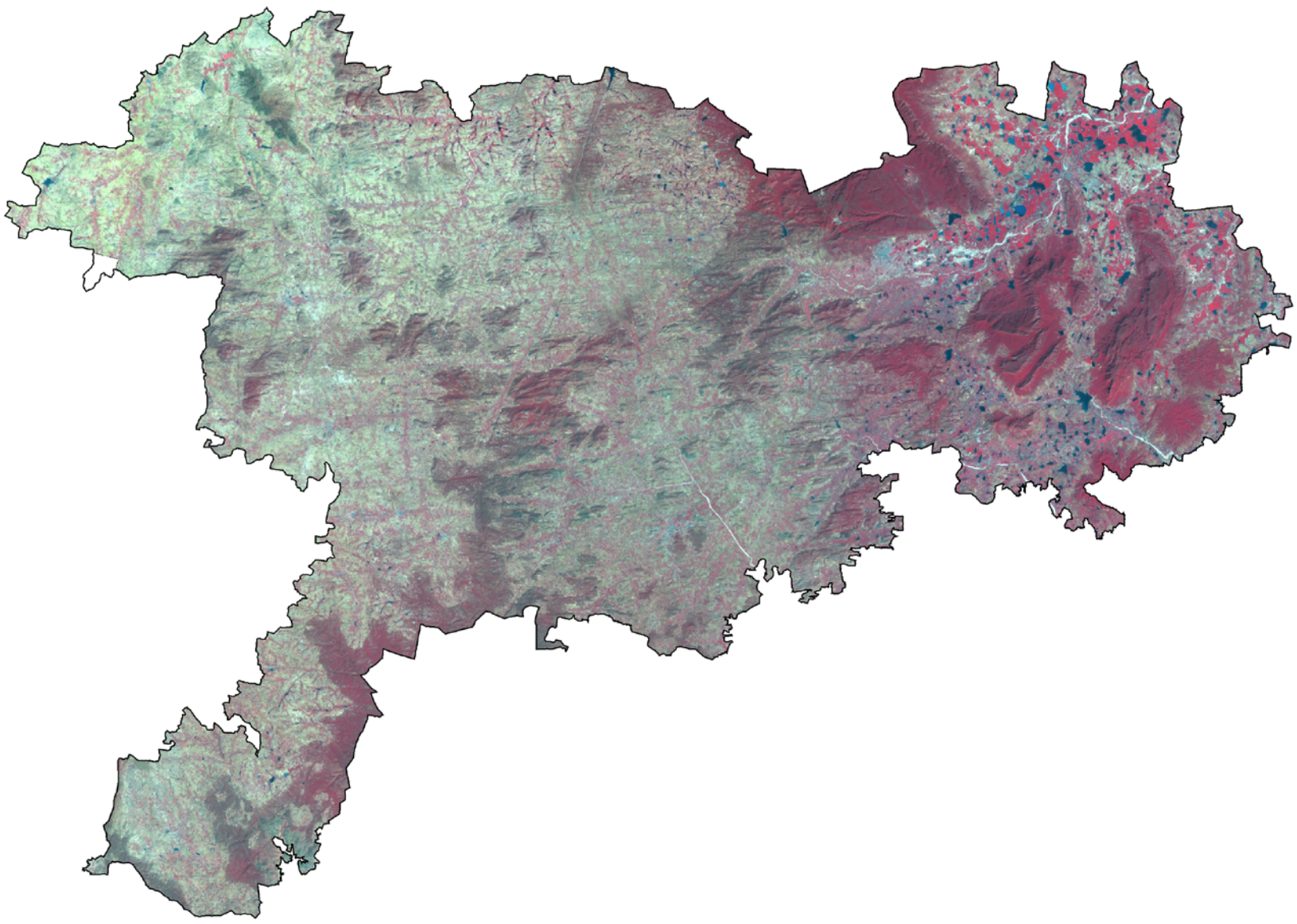
Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

Sponsored By:

Ministry of Environment and Forests
Government of India

State : Andhra Pradesh

District : Chittoor



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

MAJOR WETLAND TYPES

8.0 MAJOR WETLAND TYPES OF ANDHRA PRADESH

Major wetland types observed in the state are
Reservoirs/Barrages, River/Streams, Aquaculture ponds, Tanks/ponds and Lagoons. Details are given in Plate-1a and 1b. Ground truth data was collected for selected wetland sites. The standard Performa 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-2b..

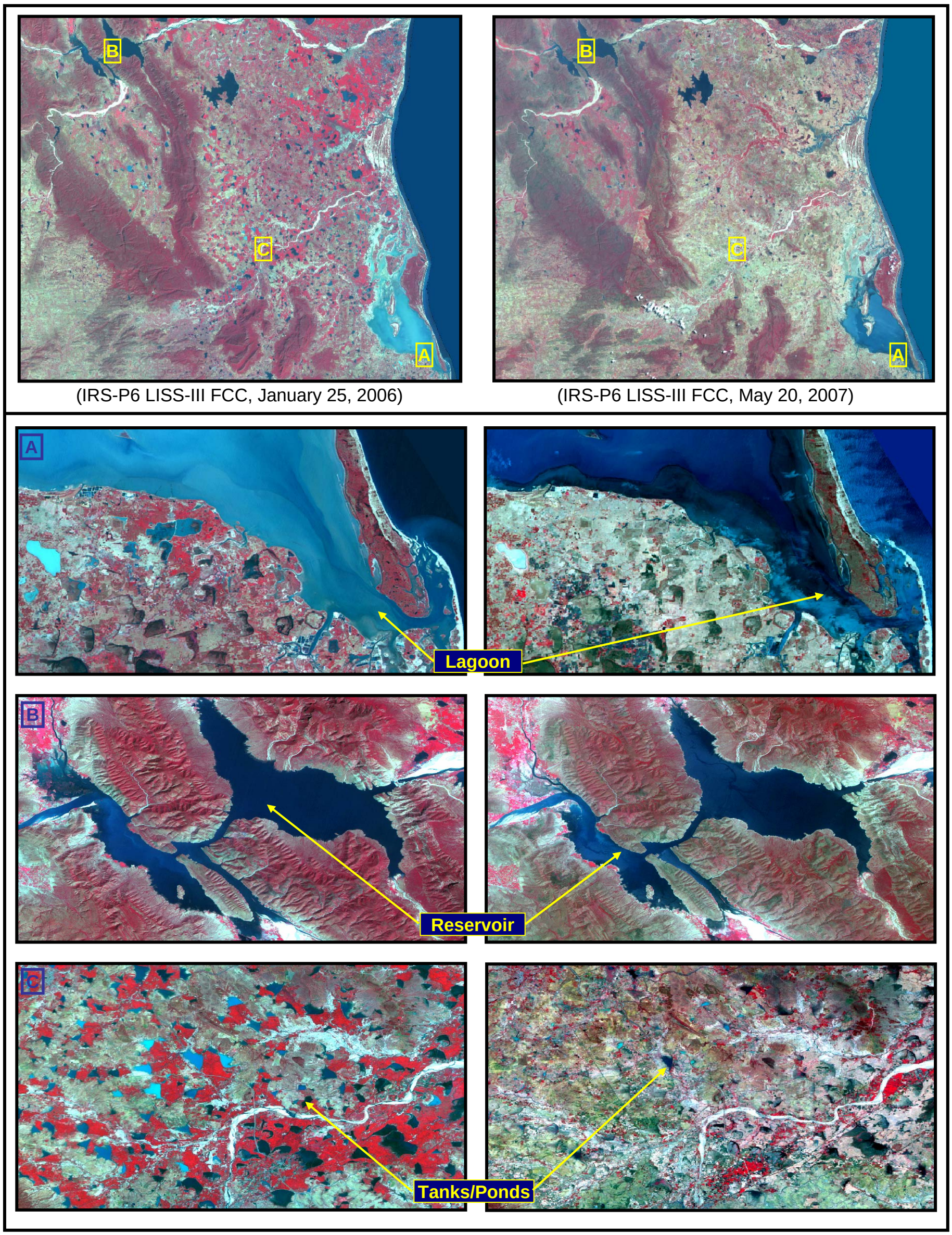


Plate 1a: Major wetland types of Andhra Pradesh

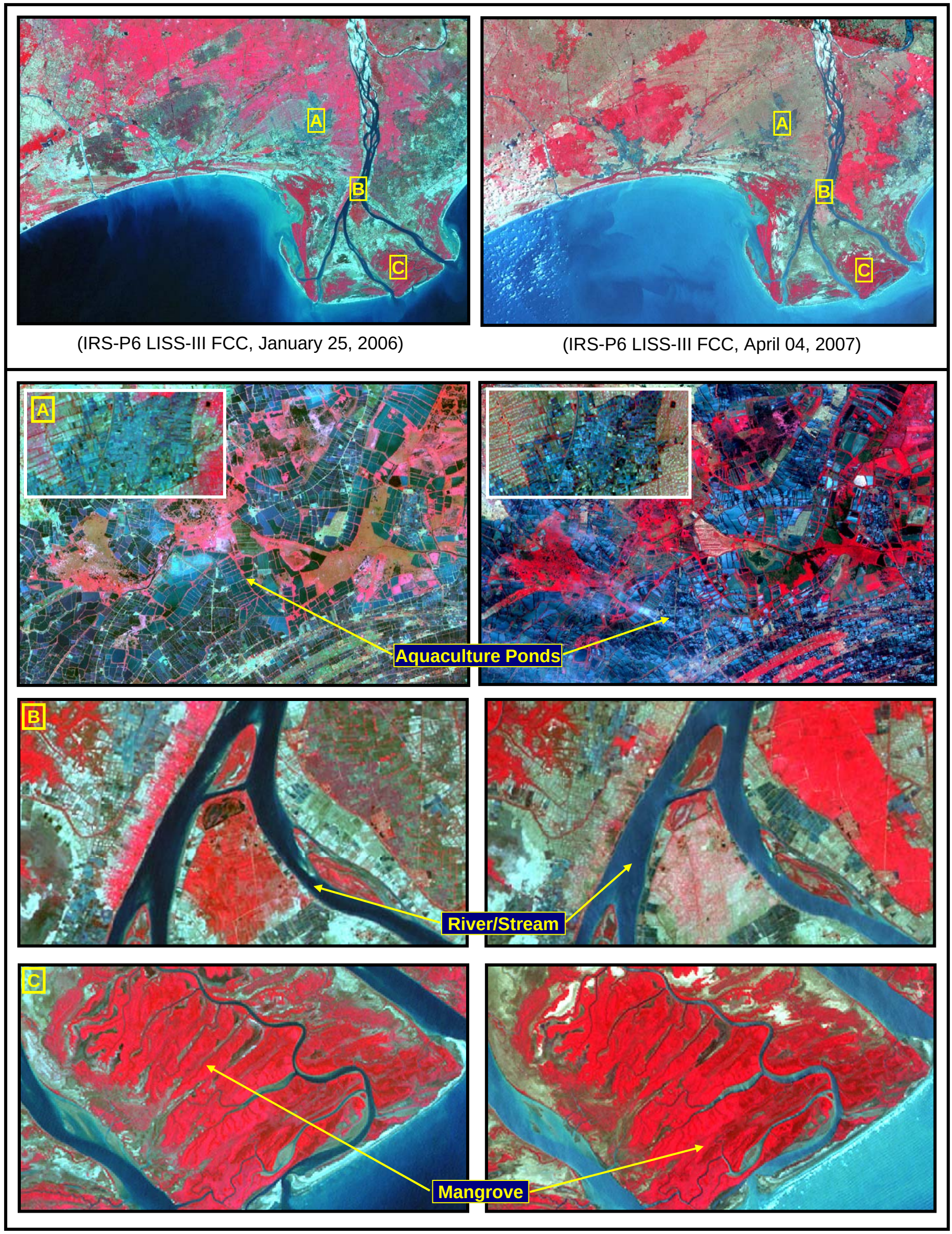


Plate 1b: Major wetland types of Andhra Pradesh

Sl. No.	Description	Field photograph
1.	Wetland Type : Reservoir (Musi Reservoir : Nalgonda) Location : Longitude: 79° 51' 53" E Latitude : 17° 23' 27" N	
2.	Wetland Type : Lake/Pond (Pakhal Lake) Location : Longitude: 79° 59' 59" E Latitude : 17° 57' 21" N	
3.	Wetland Type : Mangroves (Coringa mangroves) Location : Longitude: 82° 19' 41" E Latitude : 16° 49' 10" N	
4.	Wetland Type : River/Stream Location : Longitude: 80° 00' 36" E Latitude : 13° 40' 57" N	

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

Sl. No.	Description	Field photograph
5.	Wetland Type : Aquaculture Pond (West Godavari District) Location : Longitude: 81° 16' 43" E Latitude : 16° 40' 50" N	
6.	Wetland Type : Intertidal Mudflat Location : Longitude: 81° 06' 54" E Latitude : 15° 57' 28" N	
7.	Wetland Type : Lake/Pond (District : West Godavari) Location : Longitude: 81° 12' 46" E Latitude : 16° 38' 10" N	
8.	Wetland Type : Sand/Beach Location : Longitude: 81° 07' 00" E Latitude : 15° 57' 20" N	

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

IMPORTANT WETLANDS OF ANDHRA PRADESH

9.0 IMPORTANT WETLANDS OF ANDHRA PRADESH

Andhra Pradesh has large number of wetlands both in coastal and inland categories. The Krishna mangroves, Kolleru lake, Pulicat lake, Pakhal Lake, Hussain Sagar Lake and Nagarjuna Sagar Reservoirs are some of the important wetlands of Andhra Pradesh State. Extensive field work was carried out for these wetland areas. Wetland maps have been prepared for 5 km buffer area of each wetland sites. Details of each wetland and wetland map of 5 km buffer area are shown in plates 3 to 14.

9.1 Kolleru Lake

Kolleru Lake is located 60-km away from Vijayawada near Eluru, West Godavari district. It is the largest fresh Water Lake in the country. The lake is extends over 83501 ha (depending on water spread) of wetland and marshes surrounding the Kolleru Lake, between the Krishna and Godavari deltas. It is described as "Peerless Fisherman's Paradise and Birds heaven" in the Imperial Gazetteer. Geologically the lake is said to be formed by siltation from Krishna and Godavari Rivers the water spread of the lake is purely dependent upon the intensity of monsoon runoff. The maximum depth of lake is 3 m during monsoon period and the water spread in the lake goes upto 90,000 ha; at 2 m contour the water spread will be about 13,500 ha; over thirty canals and streams enter the lake from the adjoining cultivated farm lands. Major streams that contribute fresh water to the lake are (a) Budameru, (b) Thammileru, and (c) Ramileru. Upputeru is the only outlet which drains the lake waters into Bay of Bengal. The lake shows high values of total alkalinity, hardness, and nitrates as compared to similar water bodies located elsewhere in India.

The flora mainly consists of aquatic weeds like *Ipomoea aquatica, Scripus sp., Pharagmites sp., Ottelia sp., Typha sp.* etc. and certain trees species like Albezzia, Rain tree, Palmyrah, Prosopis and coconut. The lake supports a rich biodiversity and high biomass of fish, plankton that forms the source of food for birds.

Pelicans arrive here during the nesting season to raise their young. In winter great activity can be seen here. The babble of Pelicans can be heard a quarter of a mile away. Apart from pelicans, one can find grey herons, white ibis, pond herons, egrets and many migratory ducks and water birds. Birds like Teals and Pintails are the main species. Other species include painted storks, open bill storks, grey Herons, cormorants, white Ibises, glossy Ibises, egrets, Reef Herons, Ducks, Coots, Shovellers, Terns, Jacanas, Moorhens etc can be seen here. Migratory Birds from Australia, Siberia, Egypt and Philippines assemble near the Kolleru Lake in search of a suitable place for their survival. These birds include some of the exclusive varieties like the Open Billed Stork, Shovellers, Painted Stork, Pintails, Glossy Ibises, Teals and Red Chested Podchards. Numerous other varieties of birds are also found in the Kolleru Lake Bird Sanctuary.

Principal threat to the lake is from increased expansion of agricultural activities in the area. Further the lake is also being used as a dumping yard for industrial pollutants also, and a spurt in this activity is observed leading to severe eutrophication conditions in the lake. Water inlets into the lake are bonded thus reducing the inflows during summer and when water requirements for agriculture purpose are high and availability of water is low.

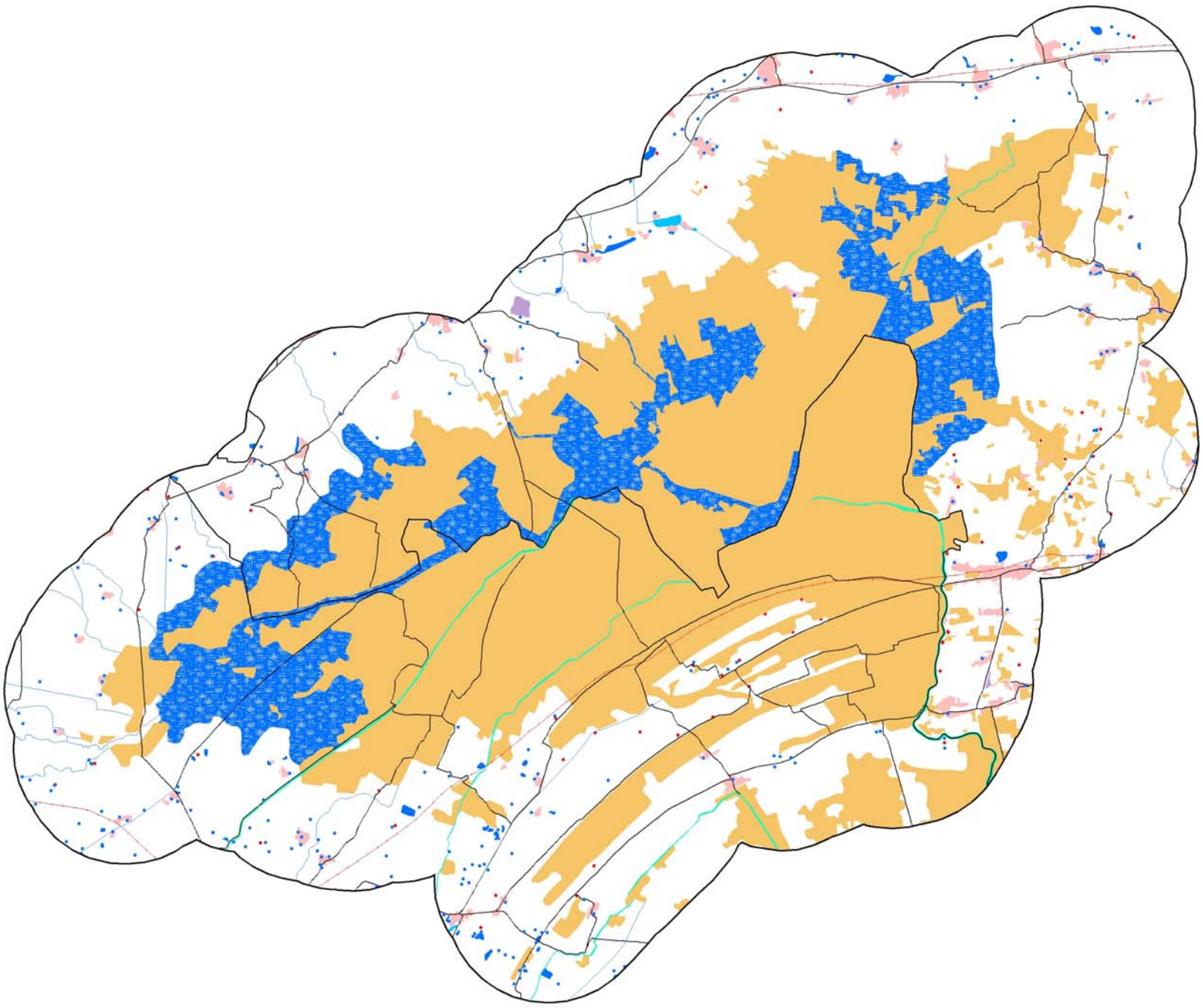
Field photographs of Kolleru lake

IRS P6 LISS-III image : Part of Kolleru lake

State : Andhra Pradesh

WETLAND MAP

Kolleru Lake

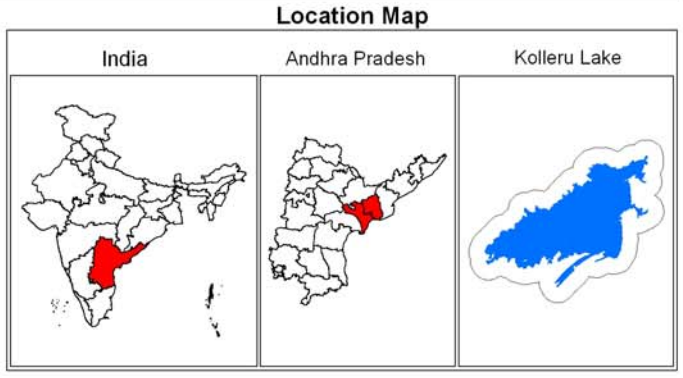


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

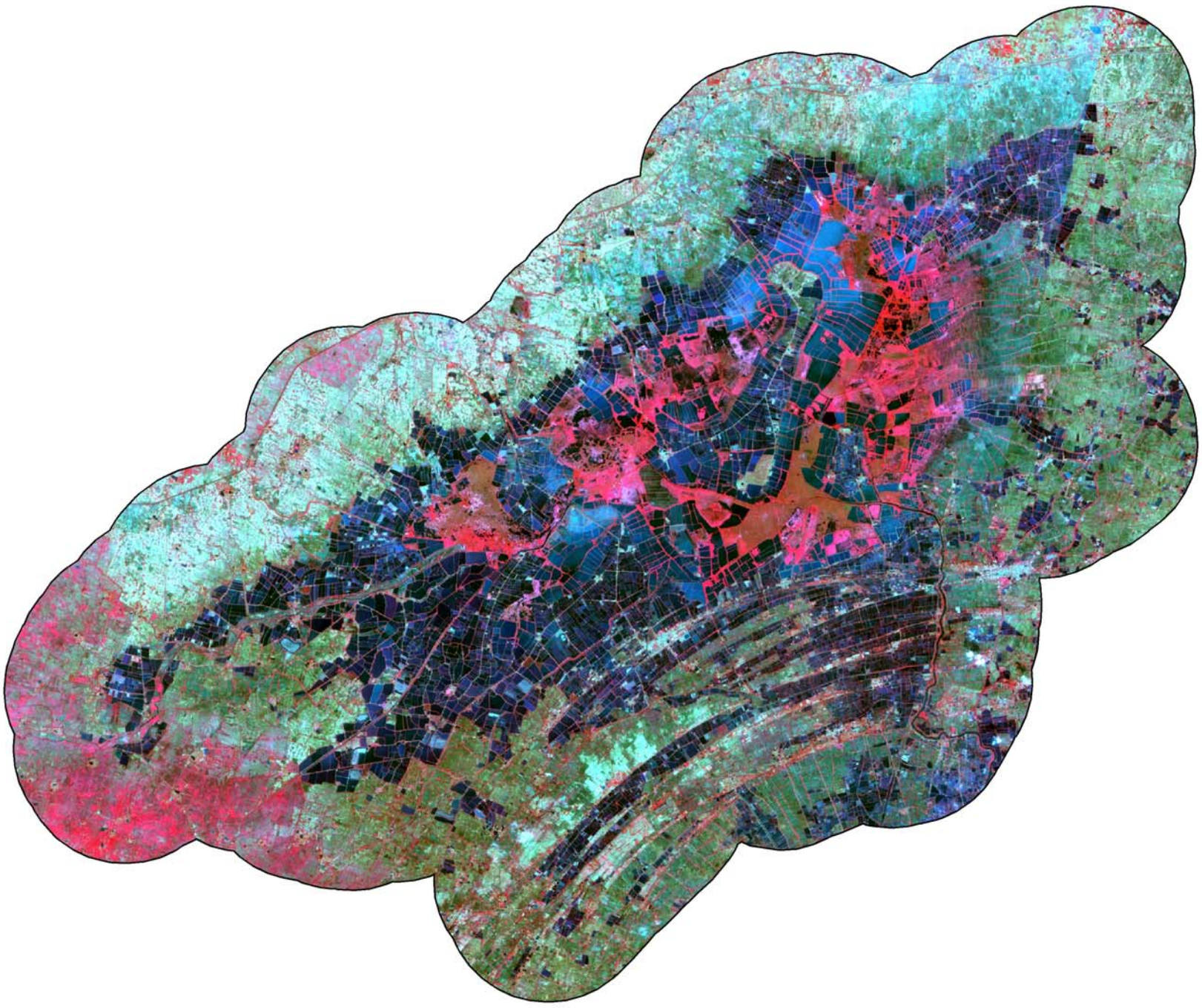
Sponsored By:

Ministry of Environment and Forests
Government of India

Plate 3: Wetland map - 5 km buffer area of Kolleru Lake

State : Andhra Pradesh

Kolleru Lake



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

Plate 4: IRS LISS-III FCC - 5 km buffer area of Kolleru Lake

9.2 Krishna Mangroves

The mangrove area lies between latitude 16° 0’ - 16° 15’N and Longitude 81° 10’ - 81°- 15’ E. The northern tributary of the Krishna river drains in this area and this tributary brings in a lot of sediments and freshwater which has enabled the luxuriant mangrove growth. Mangrove in Krishna delta includes numerous species that help maintain the balance of coastal ecosystem. The most notable of Mangrove are species of *Acanthaceae, Avicenniaceae* or *Verbenaceae* (Black mangrove), *Combretaceae* (Buttonwood, White mangrove), *Arecaceae* (Mangrove palm), *Rhizophoraceae* (Red mangrove), *Lythraceae* (Mangrove apple) etc. families. The families considered as the minor components of Mangrove in India include the *Acanthaceae, Bombacaceae, Cyperaceae, Euphorbiaceae, Lecythidaceae, Lythraceae, Meliaceae, Myrsinaceae, Myrtaceae, Pellicieraceae, Plumbaginaceae, Pteridaceae, Rubiaceae, Sterculiaceae,* etc.

The mangroves of Krishna delta occupy an area of around 27,661 ha. The second largest patch of mangroves in Andhra Pradesh, the Krishna River emerges from the hills at Vijayawada, flows for about 96 km downstream by forming a delta before it eventually empties into the sea. The Hamsaladevi distributary is the first to branch out 60 km downstream from Vijayawada near Avanigadda and flows northward into the sea near Machilipatnam. Mangroves have been reported to be less abundant there. The Gollamattapaya and Nadimeru distributaries branch out 25 km downstream from Avanigadda, and flow northward to join the sea. The main Krishna channel flows southward to join the sea near False Divi point. The abundance of mangroves is more along the main Krishna River than the other distributaries. Mangroves are mainly prevalent around these three distributaries in tidal creeks, channels, lagoons, tidal flats and mudflats. The area has a warm, humid and tropical climate with an annual rainfall of around 110 cm. Thirty two species of mangrove and mangrove-associated plants belonging to 26 genera and 18 families are recorded in Godavari and Krishna mangrove ecosystems. Two species i.e., *Scyphiphora hydrophyllacea* (Godavari mangroves) and *Aegialites rotundifolia* (Krishna mangroves) are regarded as rare species. The areas are rich in plankton, various types of benthic organisms.

Degraded Mangroves along Hamsaladeevi point

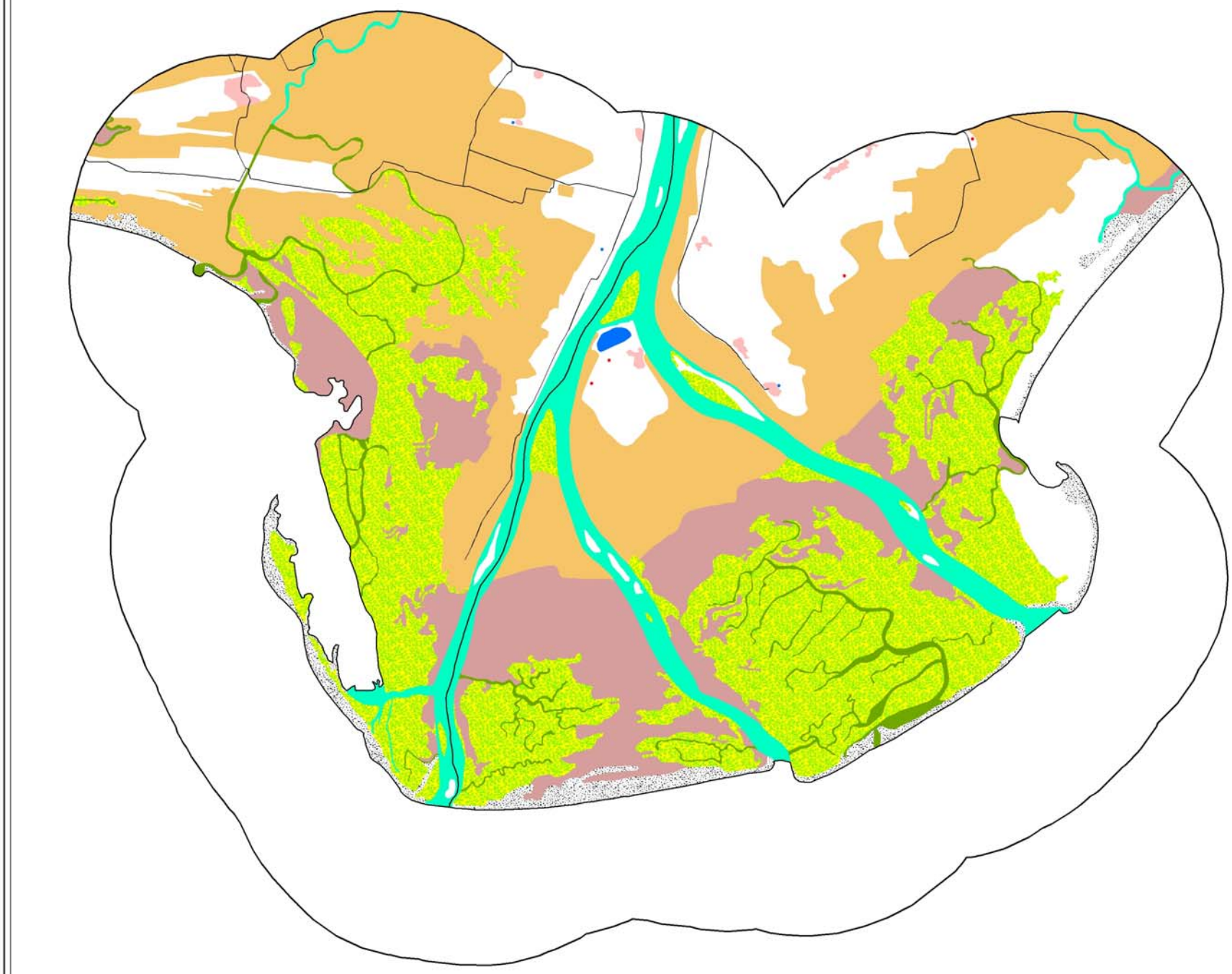
Degraded Mangroves along River Krishna

Mangroves along tidal creeks in Sorlagondi, Krishna District

State : Andhra Pradesh

WETLAND MAP

Krishna Mangroves



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

Legend

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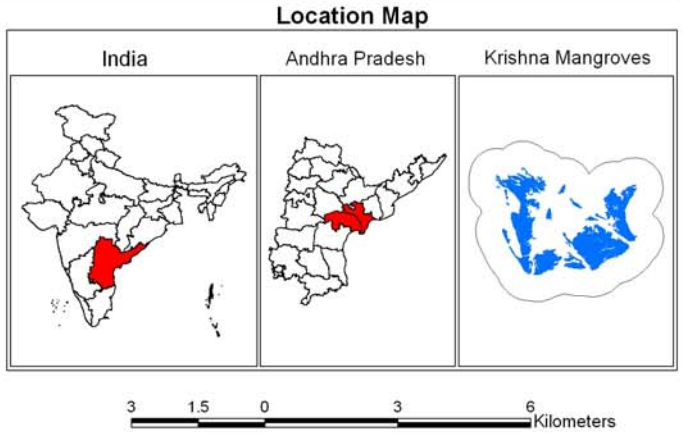
- International Boundary

Location Map



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

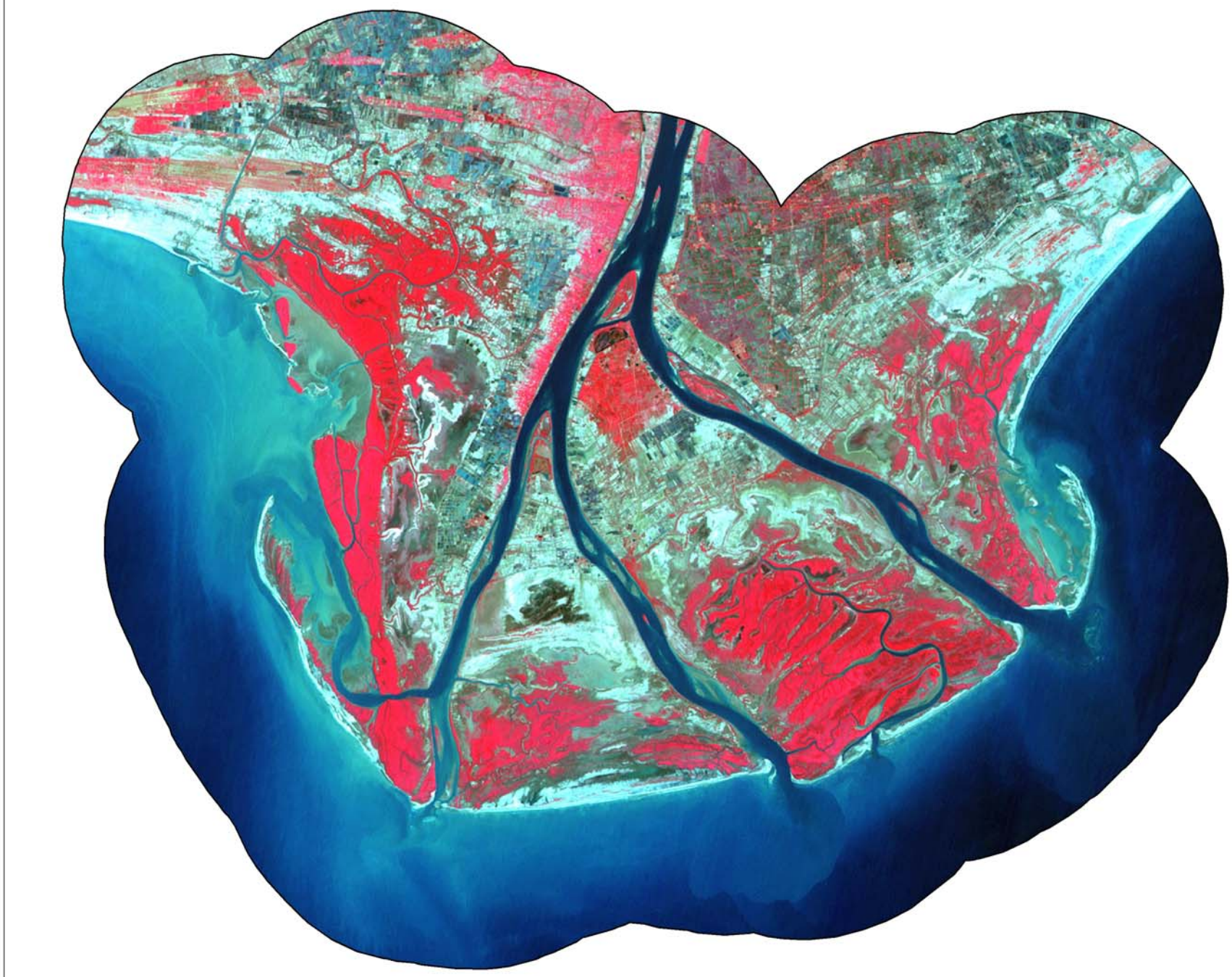
Sponsored By:

Ministry of Environment and Forests
Government of India

Plate 5: Wetland map - 5 km buffer area of Krishna Mangroves

State : Andhra Pradesh

Krishna Mangroves



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

Plate 6: IRS LISS-III FCC - 5 km buffer area of Krishna Mangroves

9.3 Pakhal Lake

Location: 79° 59' 59" E and 17° 57' 21" N

District: Warangal District

Area : 1836 ha

The Pakhal Lake is located in Pakhal village of Warangal District. The lake was built by the Kakateeya king for supporting irrigation activities in the region, the environment around the lake is very serene. The lake lies between hills and deep forest provides a picturesque environment. Keeping in view the above said environmental beauty the Tourism Department of Andhra Pradesh had converted and promoted this lake as Eco-tourism spot. Due to excess erosion in the catchment areas an increased siltation activity is noticed in the lake bed, resulting in poor storage levels. The lake receives its waters from the hills located in the Narsampet Reserve Forest. The lake is categorised as protected under the wild life act and an area of 86,205 ha falls under this act which was established in the year 1952. Tourist facilities are being provided by the Andhra Pradesh Forest Department under Eco-tourism concept which is represented in the picture given below.

Field photographs of Pakhal Wildlife Sanctuary

Pakhal Wildlife Sanctuary:

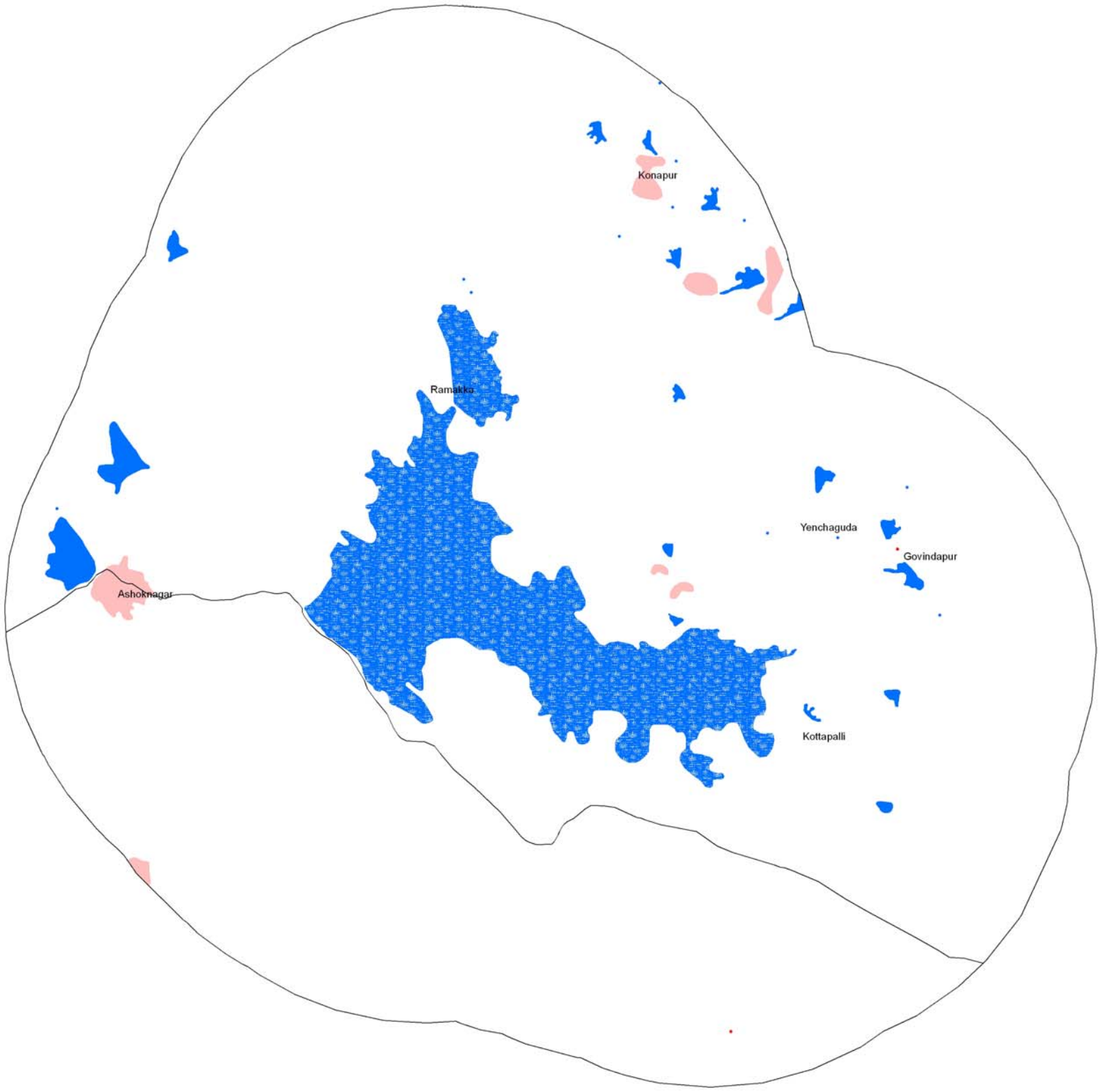
Pakhal Wildlife Sanctuary, covers an area of 860 sq. km. The natural beauty and the fresh ambience rejuvenate every visitor's mind. Bamboo, *Techtona grandis, Adina cordifolia, Bombax ceiba, Bridelia retusa, Flacourtia indica* and *Garuga pinnata* are the main vegetation. Tropical deciduous forest with evergreen species, woody herbs, climbers, shrubs and monsoon herbs are common in this sanctuary.

With respect to fauna, this evergreen forest is the home ground for animals like; Spotted Deer, Sambar, Bluebull, Wild Boar, Hyena, Sloth Bear, Panther, Tiger, Leopard, Teals, Spoon Bills and Storks are the common that can be located in this Sanctuary. During winter's season, migratory birds make their stay.

State : Andhra Pradesh

WETLAND MAP

Pakhal Lake



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
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			Natural	
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	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
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Legend

- Wetlands (<2.25ha)
- Drainage (line)
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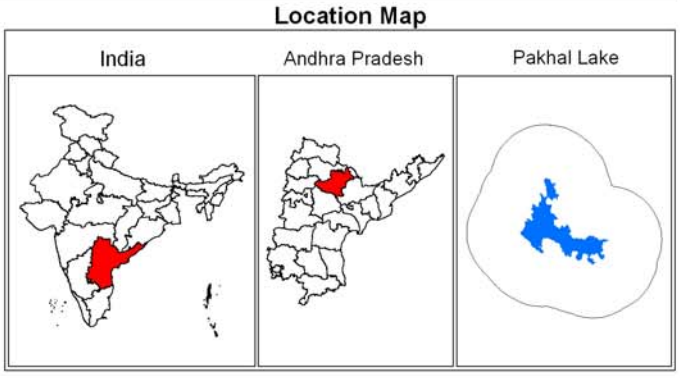
Location Map



2 1 0 2 4 Kilometers

Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
and
A.P. State Remote Sensing Applications Centre, Hyderabad

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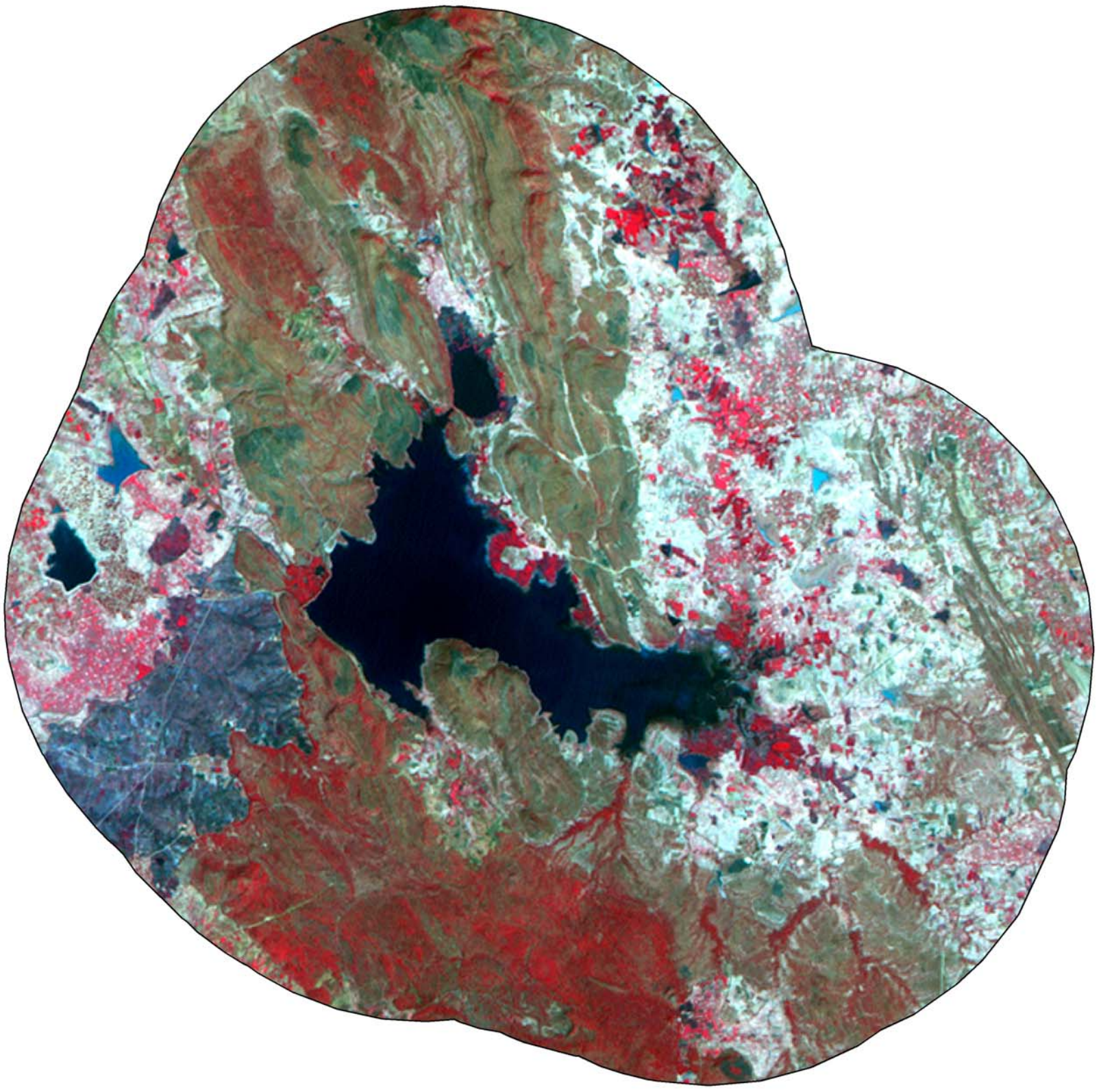
Plate 7: Wetland map - 5 km buffer area of Pakhal Lake

State : Andhra Pradesh

Pakhal Lake



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

Plate 8: IRS LISS-III FCC - 5 km buffer area of Pakhal Lake

9.4 Pulicat Lagoon

The lagoon's boundary limits range between 13.33° to 13.66° N and 80.23° to 80.25°E, with a dried part of the lagoon extending up to 14.0°N.; with about 84% of the lagoon in Andhra Pradesh and 16% in Tamil Nadu. The lagoon is aligned parallel to the coast line with its western and eastern parts covered with sand ridges. Area of the lake varies with the tide; 450 sq. km in high tide and 250 sq. km in low tide. Its length is about 60 km with width varying from 0.2 km to 17.5 km. Climate of the lagoon coast line is dominated by Tropical monsoons. Air temperature varies from 15 °C to 45 °C. The large spindle-shaped barrier island named Sriharikota separates the lake from the Bay of Bengal. The sandy barrier islands of Irkam and Venad and smaller islands in the north are aligned north–south and divide the lagoon into eastern and western sectors. The morphology of the lagoons is categorized under four types with large areas under mudflats and sandflats. The fishing village of Pulicat is at the south end of the lake. Three major rivers which feed the lagoon are the Arani River at the southern tip, the Kalangi River from the northwest and the Swarnamukhi River at the northern end, in addition to some smaller streams. The Buckingham Canal, a navigation channel, is part of the lagoon on its western side. The lagoon's water exchange with the Bay of Bengal is through an inlet channel at the north end of Sriharikota and out flow channel of about 200 m width at its southern end, both of which carry flows only during the rainy season.

The lagoon has rich flora and fauna diversity, which supports active commercial fisheries and a large and varied bird population. Fishing is the major occupation in the many villages located around the lake periphery and on the islands. The lake has rich fish diversity, mostly marine species, some truly brackish water and a few freshwater species. Mullets and Catfish are the major brackish water fish, which have supported sustenance fishing for the lake fishermen. The lake is a nursery for several species of fish. Two thirds of the settlements in the lake area are in Tamil Nadu and the balance in Andhra Pradesh. finfish and live lagoon Green crabs are also economic benefits from the lagoon. 168 total fish species are reported. The frequently found ones are the Mullets: *M. cunnesius*, *M. jerdoni*, *M. dussumieri*, *M. cephalus*, *M. bornensis* and Blowfish *T. nigropunctatus*, *T. leopardus*, *Barbus dorsalis*, Catfish *Macrones vittatus*, Sardines, *Sardinella fimbriata* and milk fish. Finfish, Green crabs, Clams and Prawns are the most commercially exploited fishes of the lagoon. Endangered Green sea turtles are found on the beaches of Sriharikota beach.

The shallow lake is known for its diversity of aquatic birds and is an important stopover on migration routes and is reported to be the third most important wetland on the eastern coast of India for migratory shorebirds, particularly during the spring and autumn migration seasons. Every year approximately 15,000 Greater Flamingos are reported to visit the lake along with pelicans, kingfishers, herons, painted storks, spoonbills and ducks. The highest concentrations of flamingo are found in the periphery of the lagoon where the water level is below 40 centimeters. The concentrations of flamingos are also associated with high algal, fish and benthic diversity. Other water birds in the area include Spot-billed Pelican, seven species of herons and egrets, Painted Stork, Greater Flamingos, ducks, 20 species of shorebirds, gulls, terns, Little Grebe, Indian Cormorant, Little Cormorant, Asian Openbill Stork, Black-headed Ibis, Eurasian Spoonbill, Lesser Whistling Teal, Spotbill Duck, Great Thick-knee and Stone Curlew. Several species of wintering waterfowl have been noted including Bar-headed Goose, Ruddy Shelduck, Eurasian Wigeon, Gadwall, Common Teal, Northern Pintail, Garganey, Northern Shoveler, Common Pochard, Brown-headed Gull, Black-headed Gull, Whiskered Tern, Gull-billed Tern and Caspian Tern. Birds of prey which appear in winter are the: White-bellied Sea Eagle, Osprey, Harriers and Peregrine Falcons. The largest concentrations of Flamingos occur in the Andhra Pradesh part of the sanctuary, around the islands of Vendadu and Irukkam.

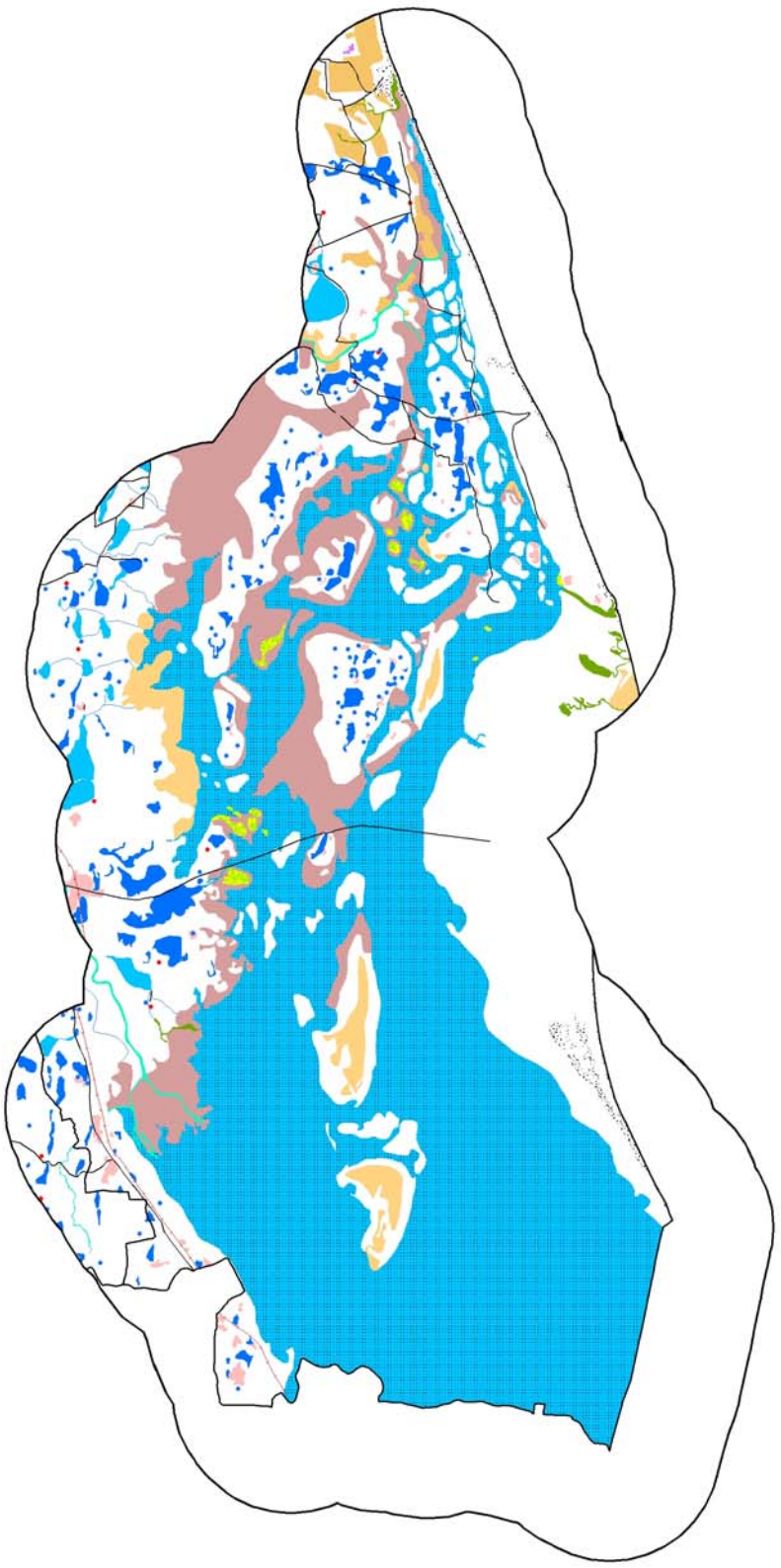
Aquatic vegetation reported is 59 species, including eight *Cyanophyceae*, seven *Chlorphyceae* and two *Rhodophyceae.* Patches of residual, dry, evergreen forest and large areas of littoral scrub in woodlands in fishing villages bordering the lagoon are seen. Invasive phytoplankton species of *Prosopis juliflora*, *Spirulina major*, *Oscillatoria spp.*, *Anabaena spp.*, *Rhizosolenia castracanei*, *Eucampia cornuta* and *Climacodium fravenfeldianum* in the plains on the periphery of the lake have been recorded.

Field photographs of Pulicat Lagoon

State : Andhra Pradesh

WETLAND MAP

Pulicat Lagoon

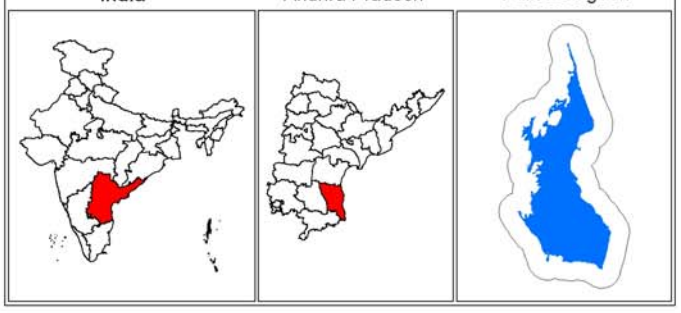


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



5 2.5 0 5 10 Kilometers

Data Source :

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

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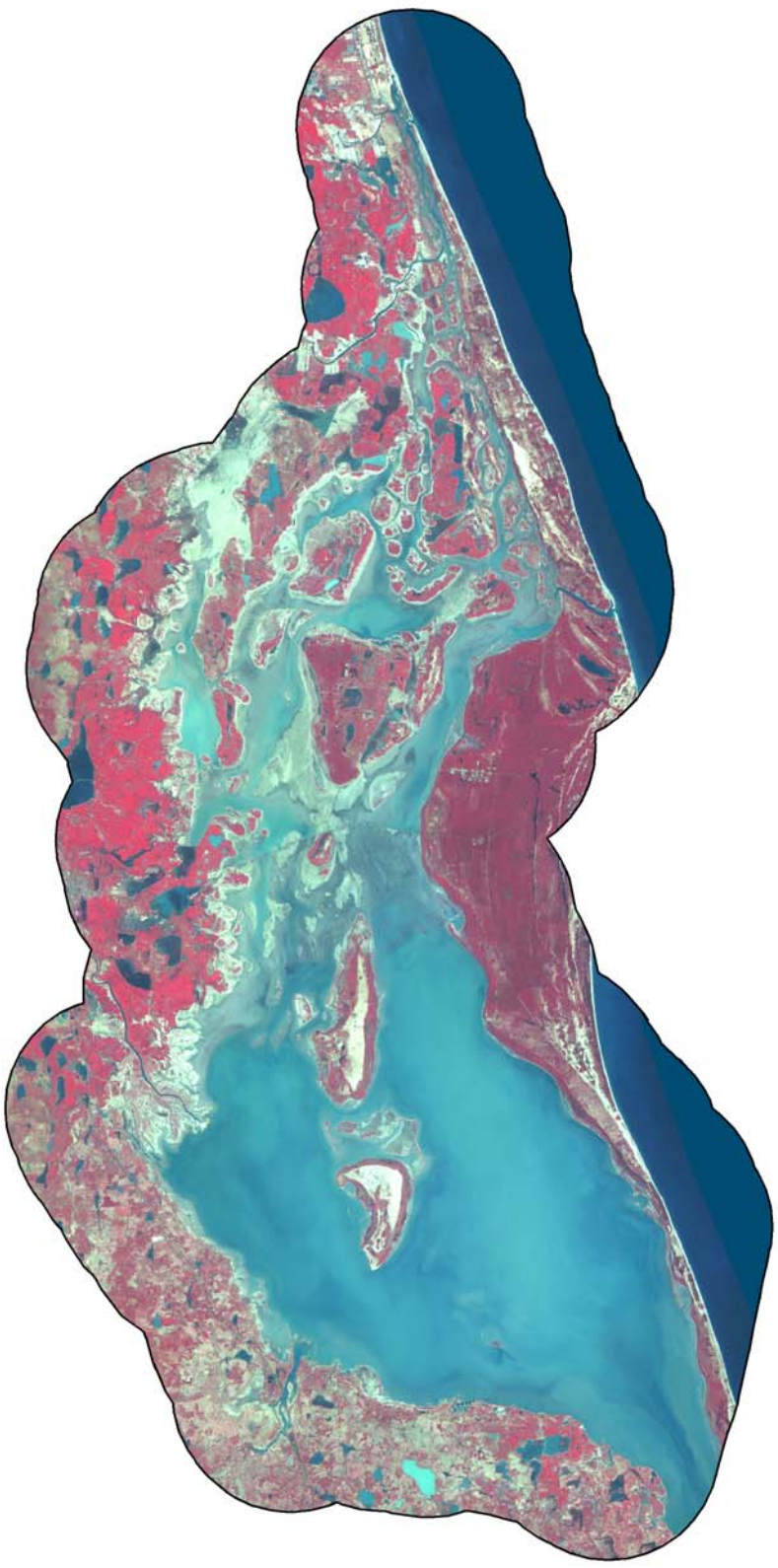
Plate 9: Wetland map - 5 km buffer area of Pulicat Lagoon

State : Andhra Pradesh

Pulicat Lagoon



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

Plate 10: IRS LISS-III FCC - 5 km buffer area of Pulicat Lagoon

9.5 Hussain Sagar Lake

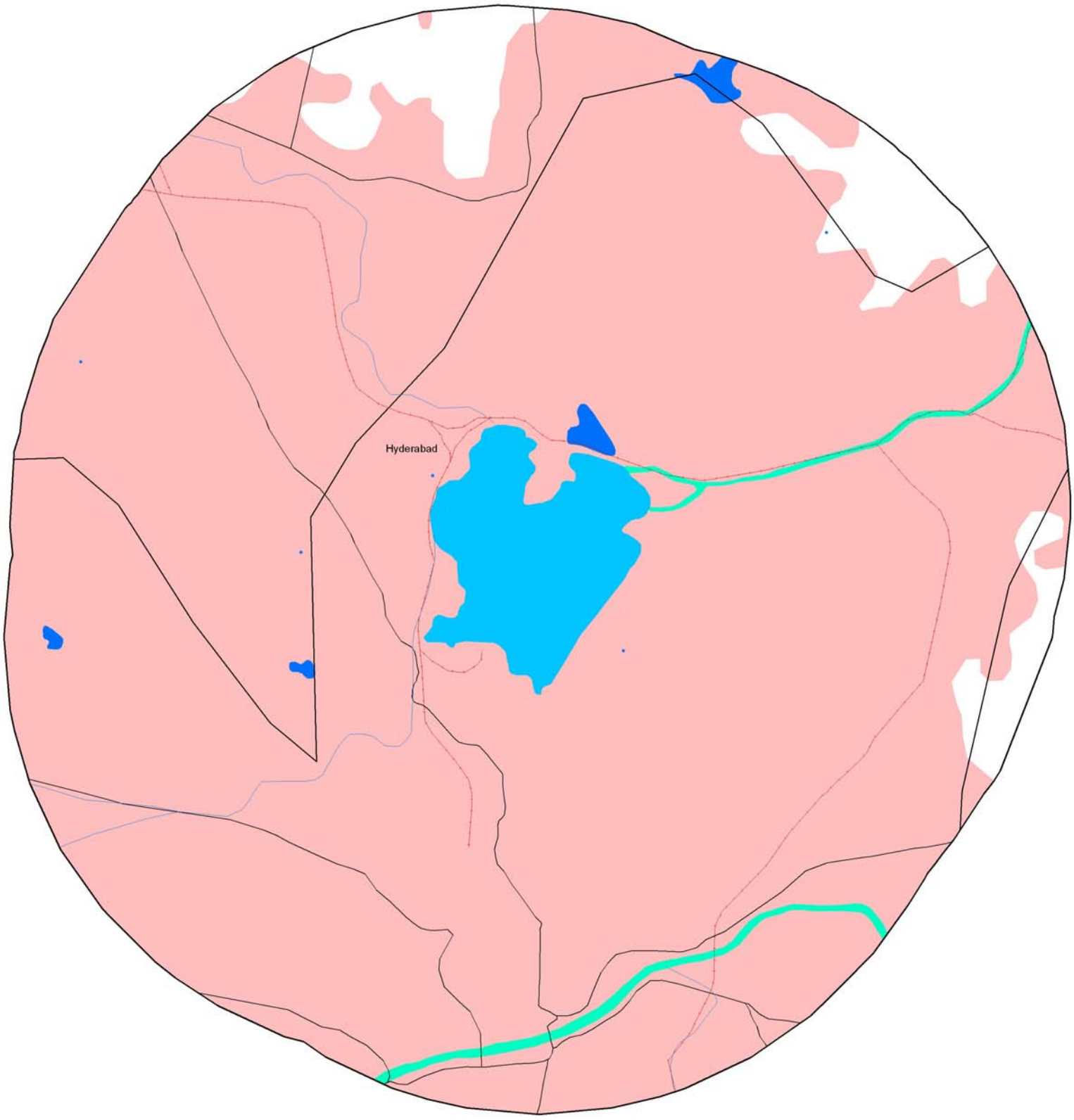
Hussain Sagar is one of the oldest man-made water-body constructed in mid-16th centaury. It is fed by streams originated by Musi river, Faulksagar and Kukatpally tanks. It was a quiet and placid lake of 497 ha. The lake was originally constructed to cater to supply drinking water but it is not used as a drinking water source since 1930. The lake protects the lives and properties in the low lying areas around the lake from floods. The water temperature ranges from 25^0 C to 35^0 C. The pH value range from 7.4 to 8.7. The lake is recorded for *Tendepis sp.* and molluscs like; *Bellamya bengalensis*, *Pila virens*, *Thiara scabra*, *T. lineate*, *Lymnaea acuminata* and *Indopolanorbis exustus*. The avifauna include, *Anas crecca, A. Penelope, A. poecilorhyncha, A. querquedula, Ardea cinera, A. gyayii, Aythya farina, Ceryle rudis, Cypsiurus parvus, Egretta alba, E. garzetta, Fulica atra, Hirundo rustica, Nettapus coromandelianus, Phalacrocorax niger* and *Podiceps ruficollis*. The main threat to the lake is encroachment by both private and public agencies. In addition to the encroachment the lake also faces the problem of pollution due to the continuous discharge of untreated domestic sewage and toxic industrial chemicals for several years. Although several Central Effluent Treatment Plant and Sewage Treatment Plant have grown up to restrict the pollution yet a considerable amount of sewage flows into the lake.

Field photograph of Hussain Sagar Lake

State : Andhra Pradesh

WETLAND MAP

Hussain Sagar Lake

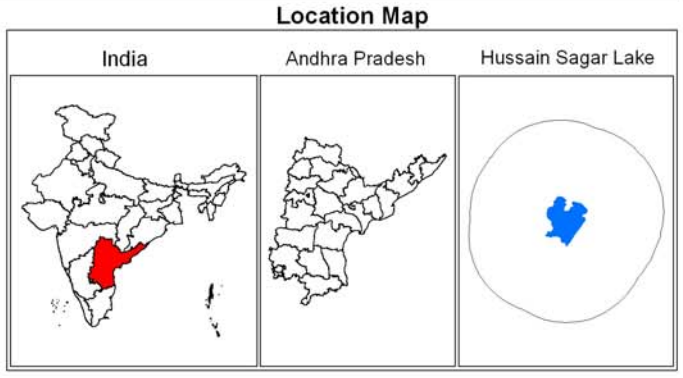


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Location Map



Data Source :

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

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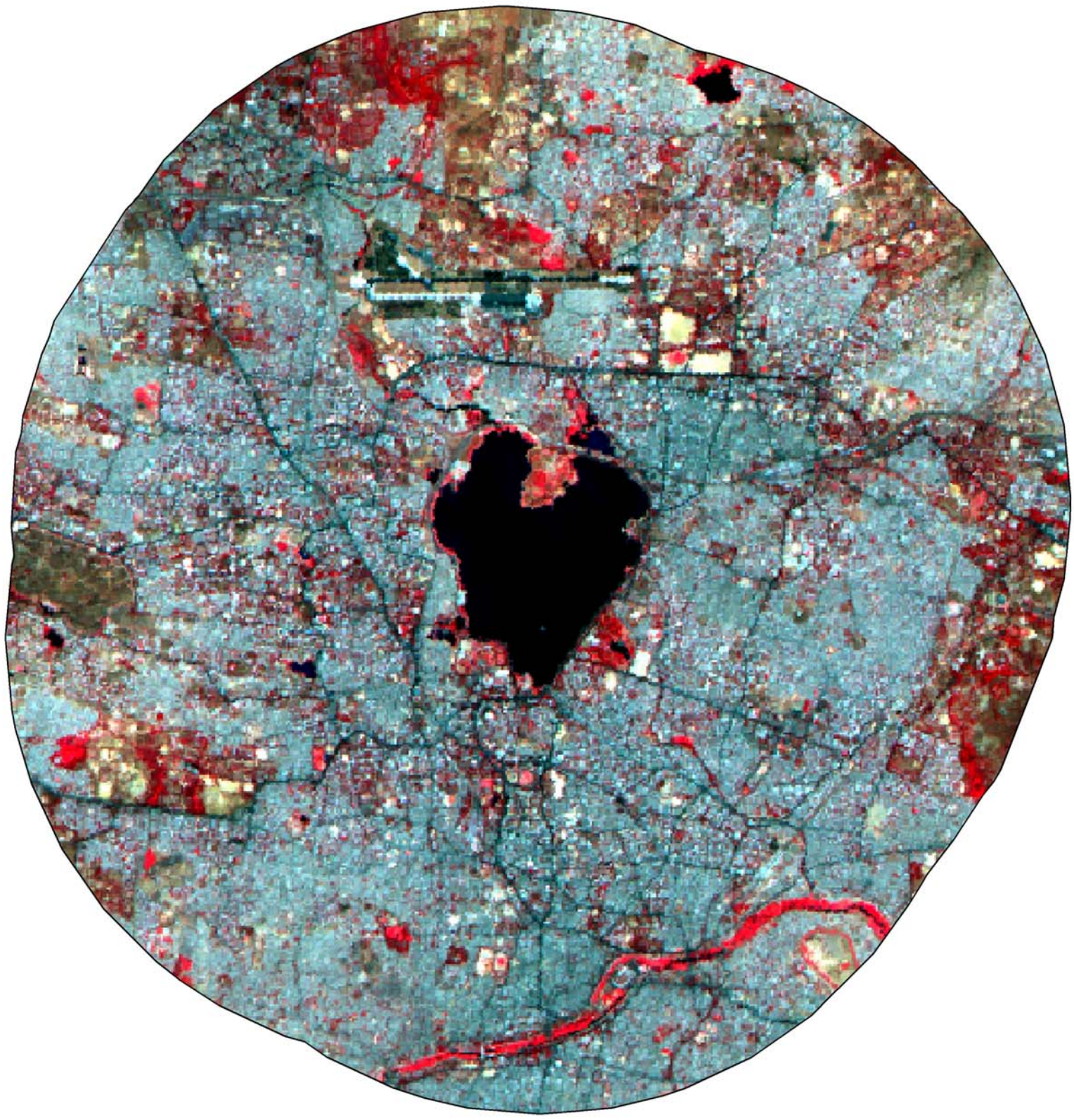
Plate 11: Wetland map - 5 km buffer area of Hussain Sagar Lake

State : Andhra Pradesh

Hussain Sagar Lake



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

Plate 12: IRS LISS-III FCC - 5 km buffer area of Hussain Sagar Lake

9.6 Nagarjuna Sagar Reservoir

Nagarjuna Sagar reservoir across the river Krishna is a major multipurpose river valley project built after the independence. Its major uses are irrigation and generation of electricity. It is located in the Nallamalai forests spanning across four districts (Nalgonda, Guntoor, Prakasam and Mahbubnagar) with central coordinates being 79°12' 33" E and 16° 32' 45" N covering an area of 28478 ha. The area came under protection and was declared as Nagarjunasagar Wildlife Sanctuary in 1973,. Later it came under the Tiger Project, during 1983. The Nagarjunasagar -Srisailam sanctuary was renamed the Rajiv Gandhi Wildlife Sanctuary in the year 1992, which include both Nagarjunasagar as well as Srisailam reservoir areas. The forest is mainly of Tropical Dry Deciduous type. It experience very hot summers with temperatures reaching as high as 40° C, especially during March and June. The winters are comparatively pleasant and cool. The winter temperatures fall down to 10 ° C. The area experiences heavy rainfall caused by the south west monsoons, from the months of June to October.

The Nagarjunasagar Tiger Reserve in Andhra Pradesh is the largest Tiger Reserve in India. It sprawls over an area of 3568 sq km. The flora in Nagarjunasagar is varied, with herbs, shrubs, trees and a few marshes with sedges. The scrubland and the climbers are mainly found at the foothills while the well drained hill slopes in the Nagarjunasagar supports the thorn forest vegetation of the region. The rare plants of the region are *Niebuhria apetala, Cissus vitiginea, Peterolobium indicum, Ziziphus xylopyrus*. Spread over an area of 6 sq km is the Rollerpadu grasslands near Srisailam. Dotted with dry, thorny bushes, a natural habitat for blackbucks. Other main species of flora in Nagarjunasagar are *Anogeissus latifolia, Cleisthanthus collinus, Terminalia, Pterocarpus marsupium, Hardwickia binata, Boswellia serrara, Tectona grandis* etc.

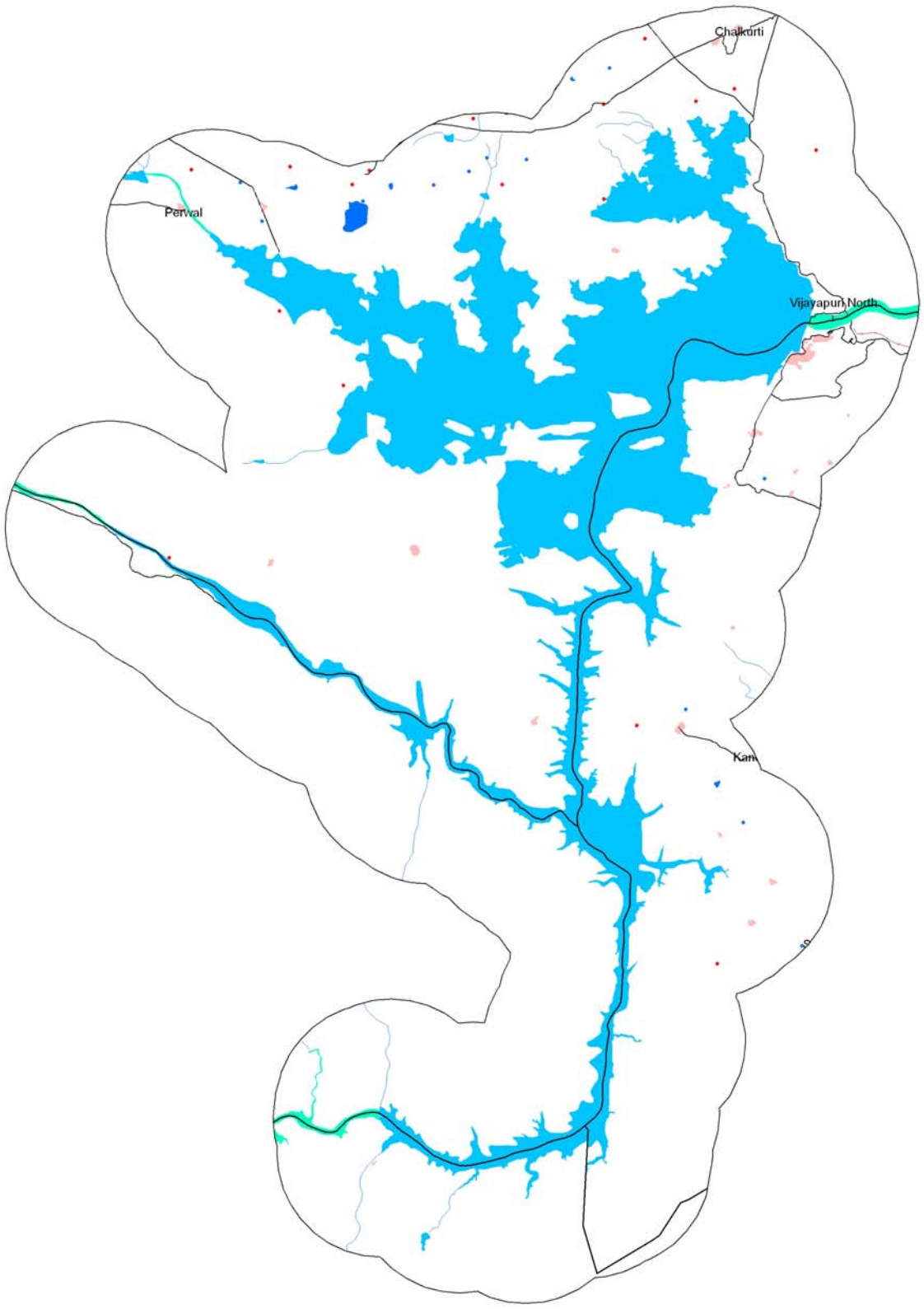
Tigers are an integral part of the fauna in Nagarjunasagar and otherwise also numerous and diverse. Apart from tigers, animals like leopard, jungle cat, wild dog, wolf, jackal, Bengal fox, sloth bear, four-horned antelope, sambar, spotted deer, bluebull, blackbuck, chinkara, Indian pangolin, langoor, bonnet macaque, smooth-coated otter, palm civet, striped hyena, wild boar, Indian spotted chevrotain, Indian muntjac, giant flying squirrel, Indian porcupine and Indian tree shrew at the sanctuary. Among the several reptiles, few are the Indian soft-shelled turtle, Indian python, cobra, monitor lizard, and the marsh crocodile.

Wildlife in Nagarjunasagar also includes nearly 150 species of avifauna. Common birds like the grey hornbill and peafowl. Other birds spotted by tourists in the sanctuary are Green Bee-eater, Hoopoe, White-bellied Drongo, Indian Treepie, etc.

State : Andhra Pradesh

WETLAND MAP

Nagarjuna Sagar Reservoir

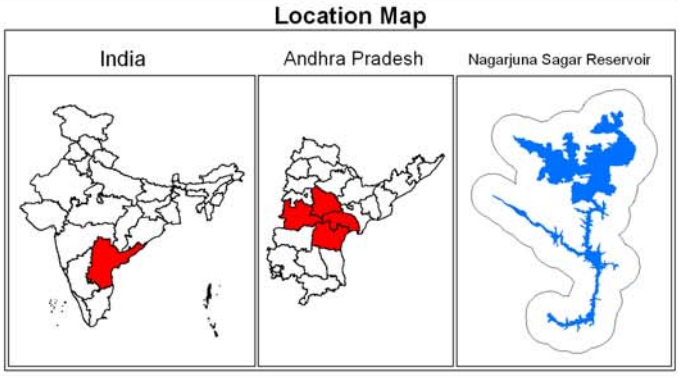


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Reverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



6 3 0 6 12 Kilometers

Data Source :

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Plate 13: Wetland map - 5 km buffer area of Nagarjuna Sagar Reservoir

State : Andhra Pradesh

Nagarjuna Sagar Reservoir

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

Plate 14: IRS LISS-III FCC - 5 km buffer area of Nagarjuna Sagar Reservoir

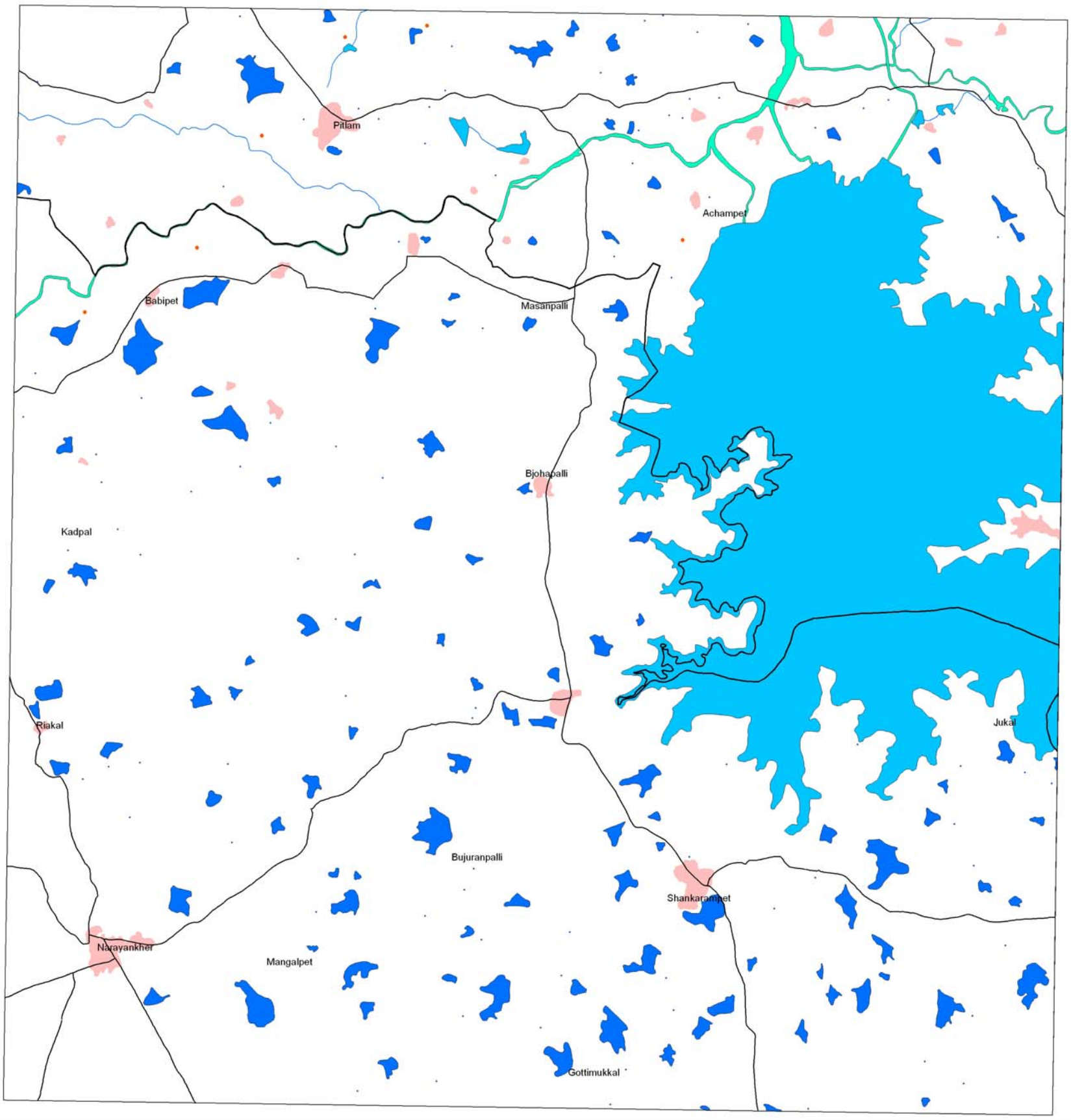
SOI MAP SHEET-WISE WETLAND MAPS

(Selected)

State : Andhra Pradesh

WETLAND MAP

Map No. : 56F/16



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	2201			Salt pans
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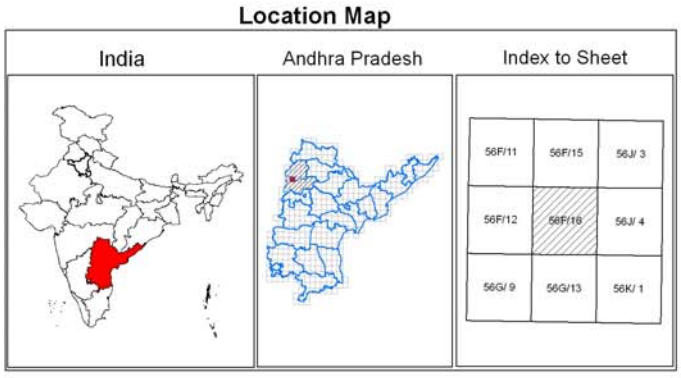
Legend

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

Location Map



Data Source :

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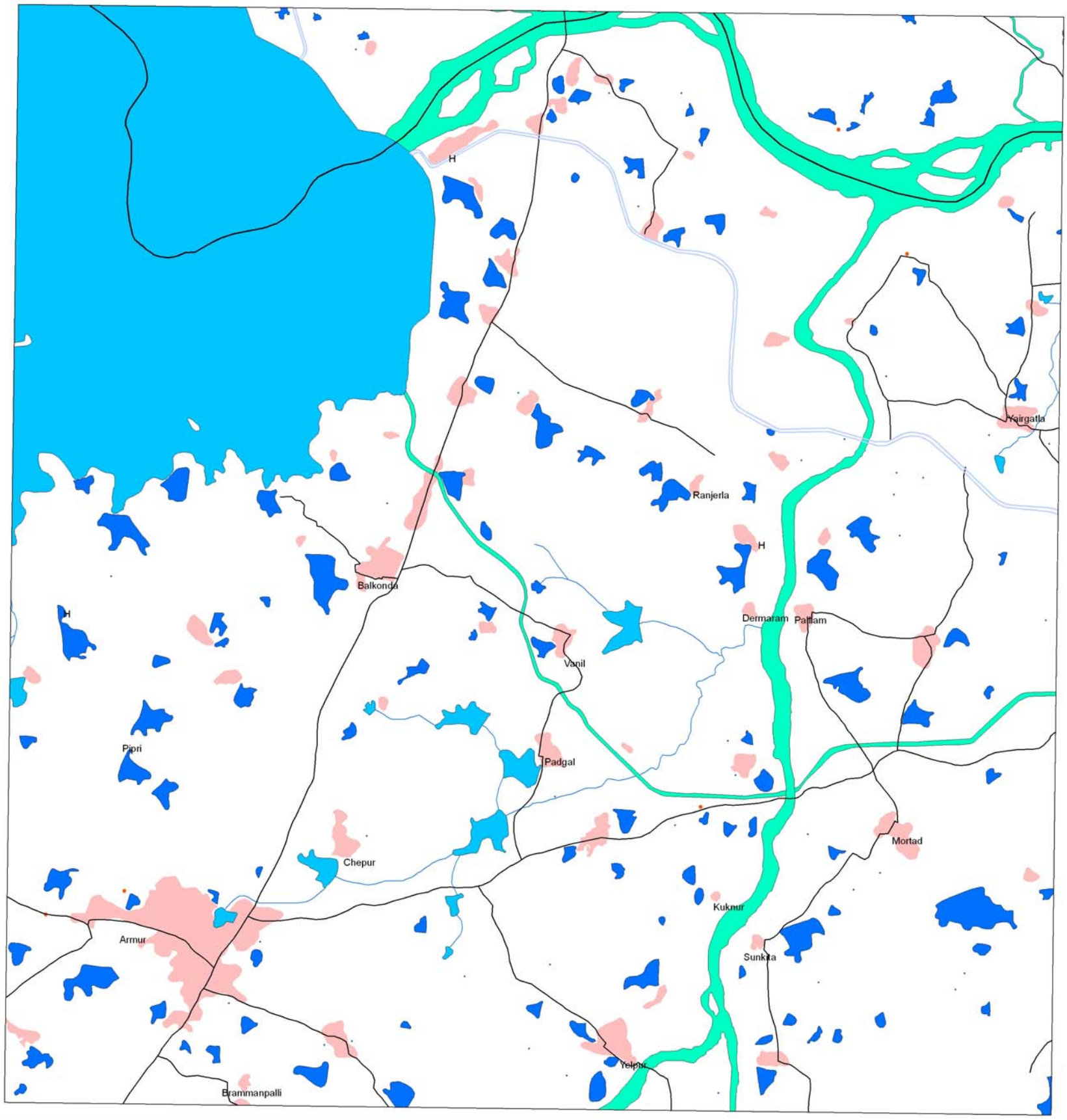
State : Andhra Pradesh

WETLAND MAP

Map No. : 56J/05



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Legend

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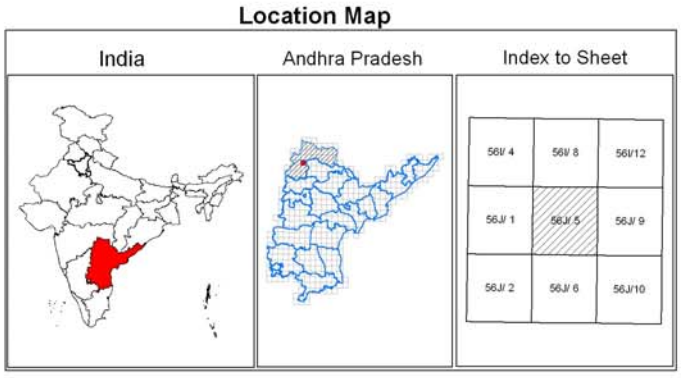
- International Boundary

Location Map



Data Source :

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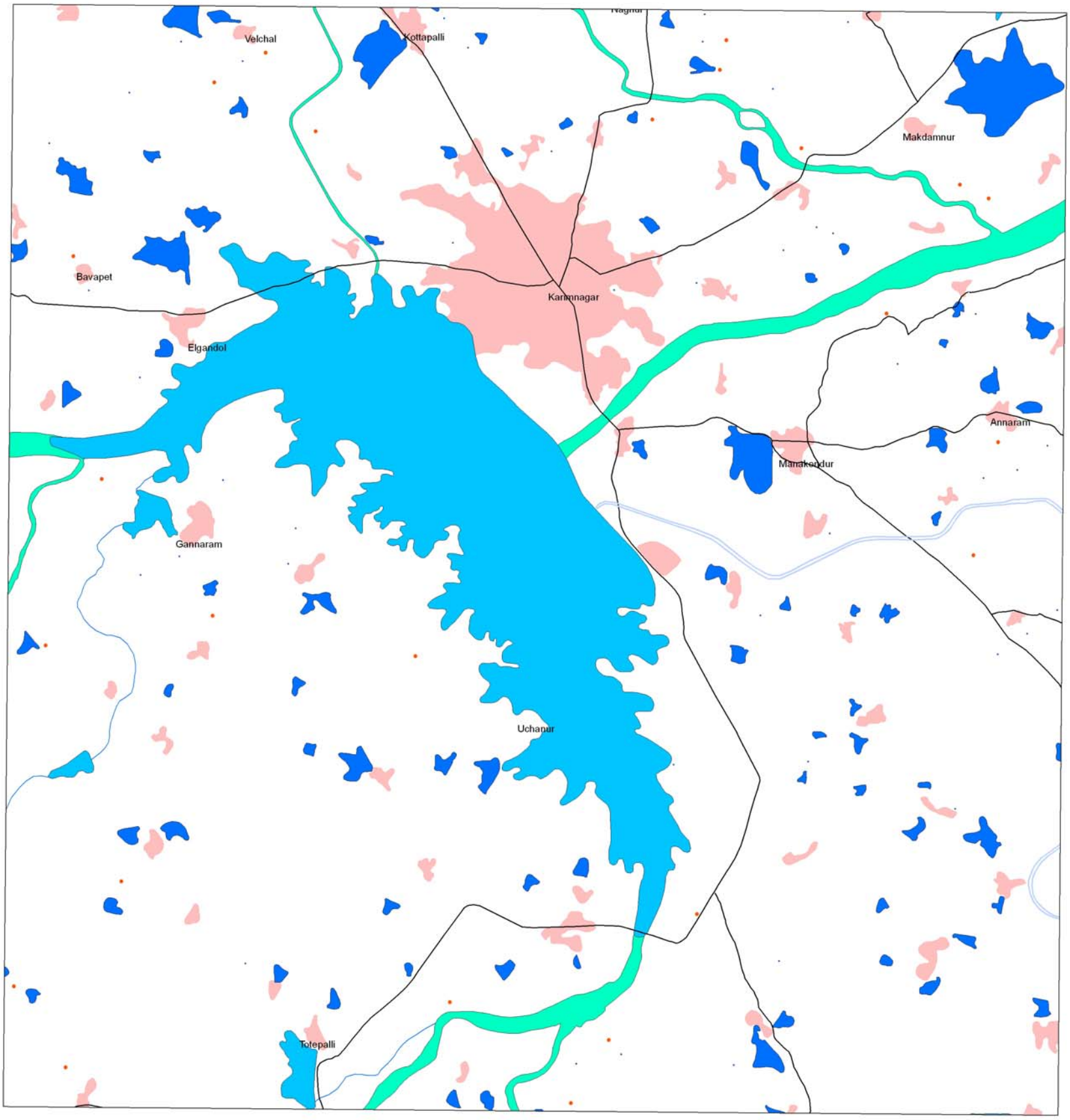
State : Andhra Pradesh

WETLAND MAP

Map No. : 56N/03



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Legend

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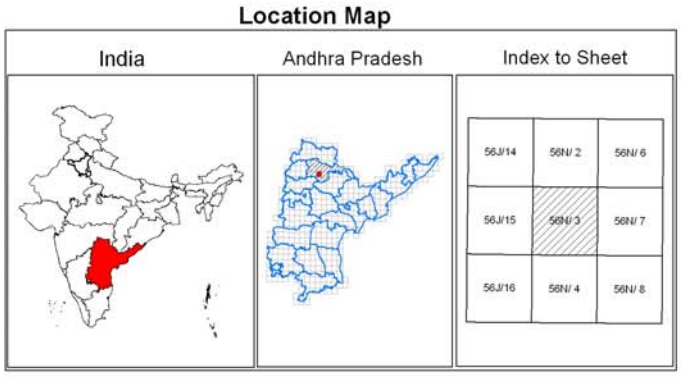
- International Boundary

Location Map



Data Source :

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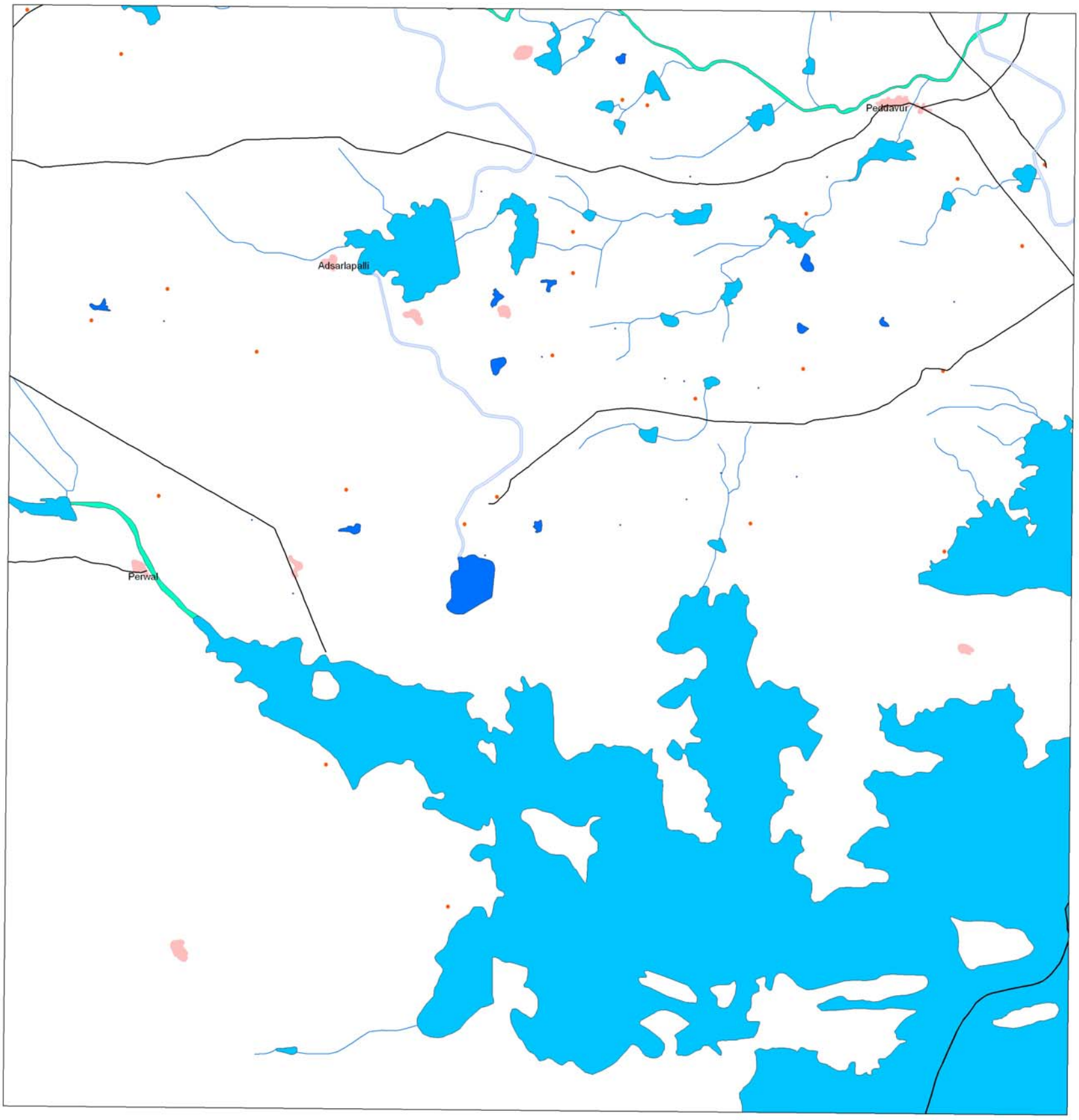
Government of India

State : Andhra Pradesh

WETLAND MAP

Map No. : 56P/02



Symbol	Typecode	Level I	Level II	Level III
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	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
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	2202			Aquaculture ponds

Legend

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- Settlements
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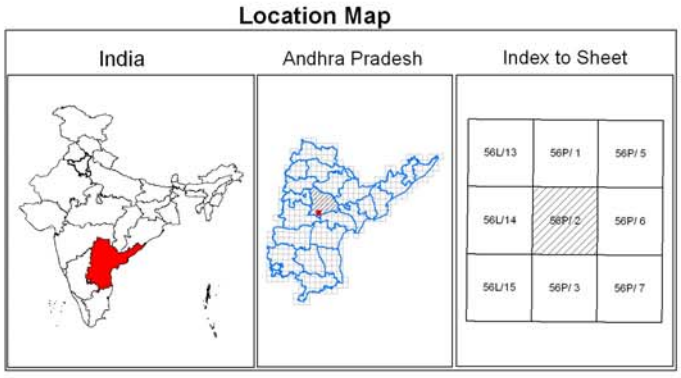
Location Map



Data Source :

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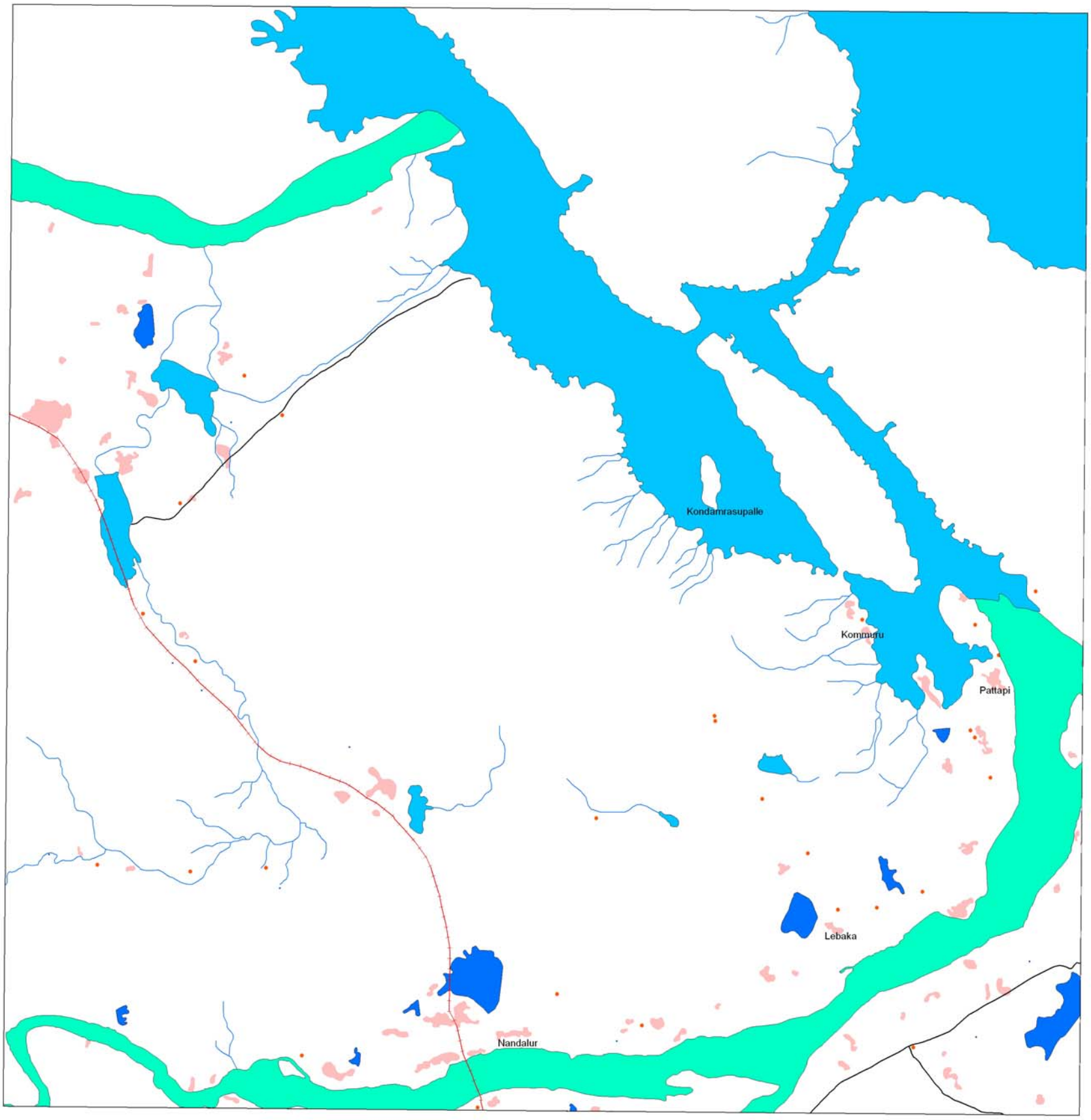
Government of India

State : Andhra Pradesh

WETLAND MAP

Map No. : 57N/03

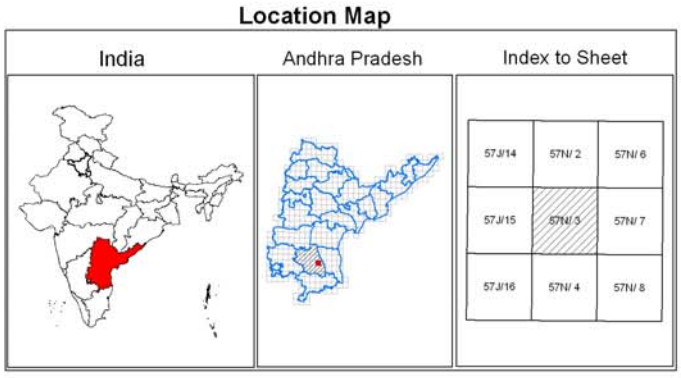


Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203		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

Legend

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

Location Map



Data Source :

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

Prepared By :

Space Applications Centre (ISRO), Ahmedabad
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A.P. State Remote Sensing Applications Centre, Hyderabad

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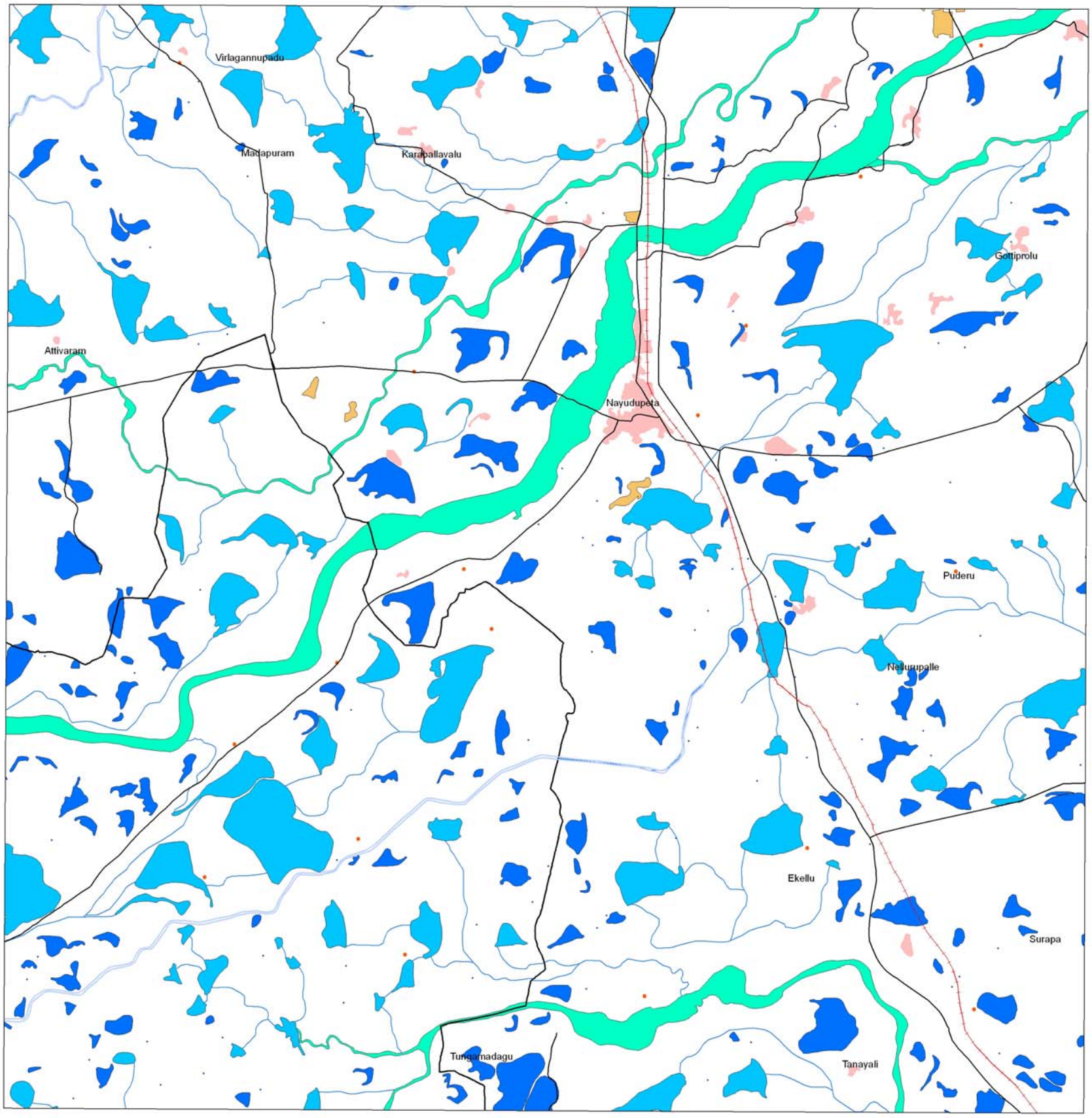
Government of India

State : Andhra Pradesh

WETLAND MAP

Map No. : 57O/13



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

Legend

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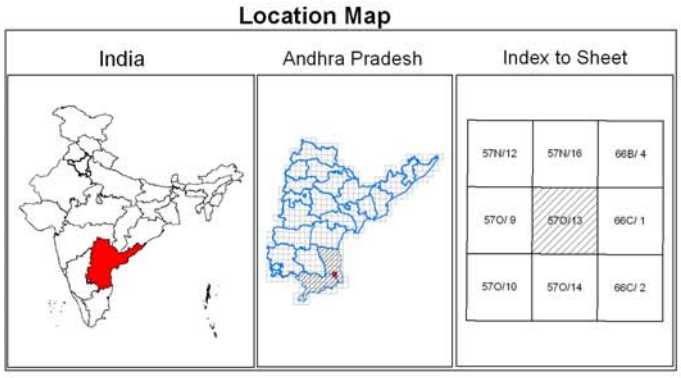
- Railways
- Town/Settlements
- District Boundary
- State Boundary
- International Boundary

Location Map



Data Source :

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

Prepared By :

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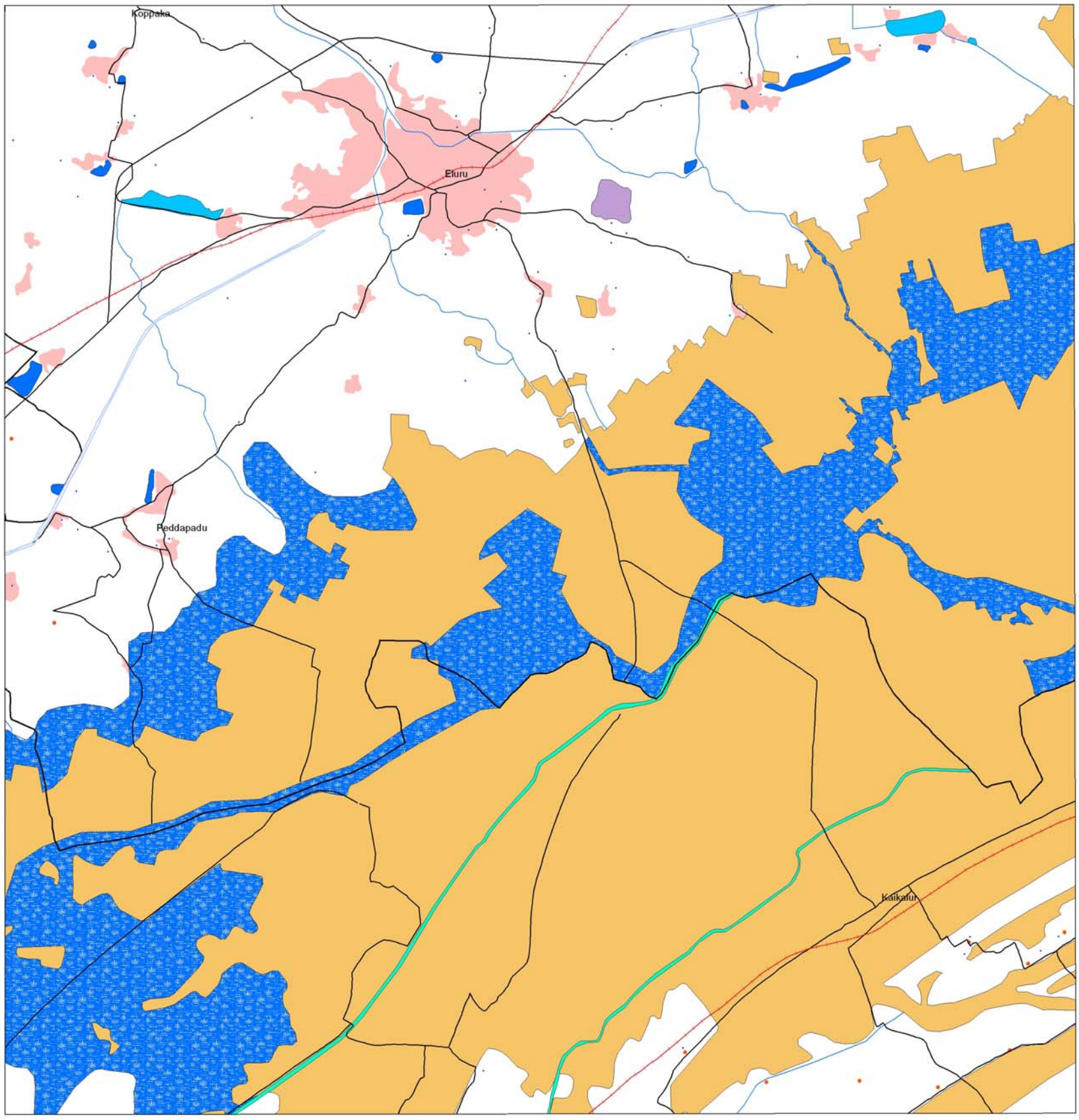
State : Andhra Pradesh

WETLAND MAP

Map No. : 65H/02



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
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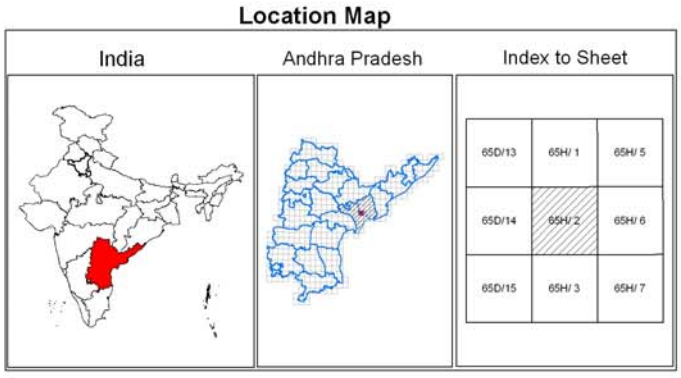
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Legend

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

Location Map



Data Source :

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

Prepared By :

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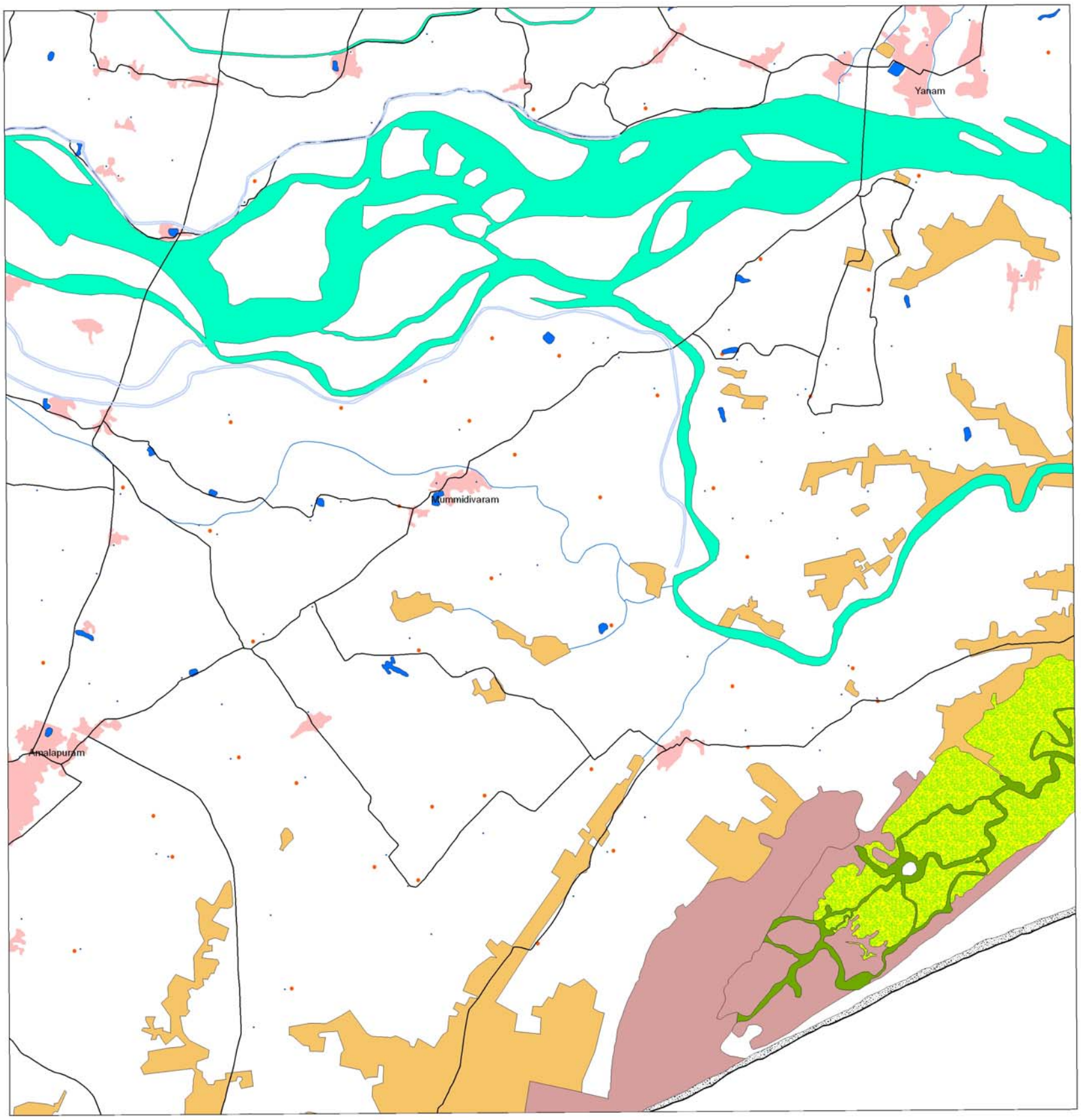
Government of India

State : Andhra Pradesh

WETLAND MAP

Map No. : 65L/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
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	2101			Lagoons
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	2106			Mangroves
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			Man-made	
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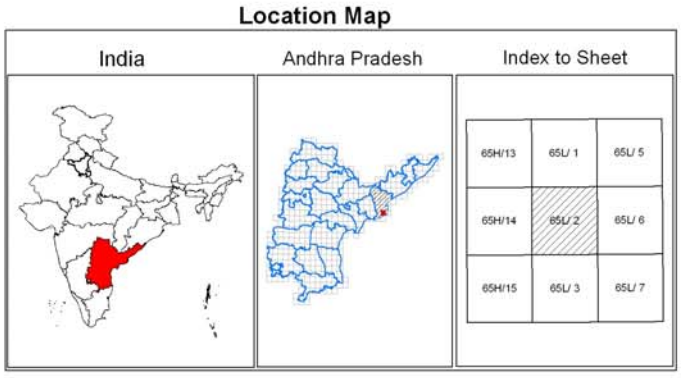
Legend

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

Location Map



Data Source :

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

Prepared By :

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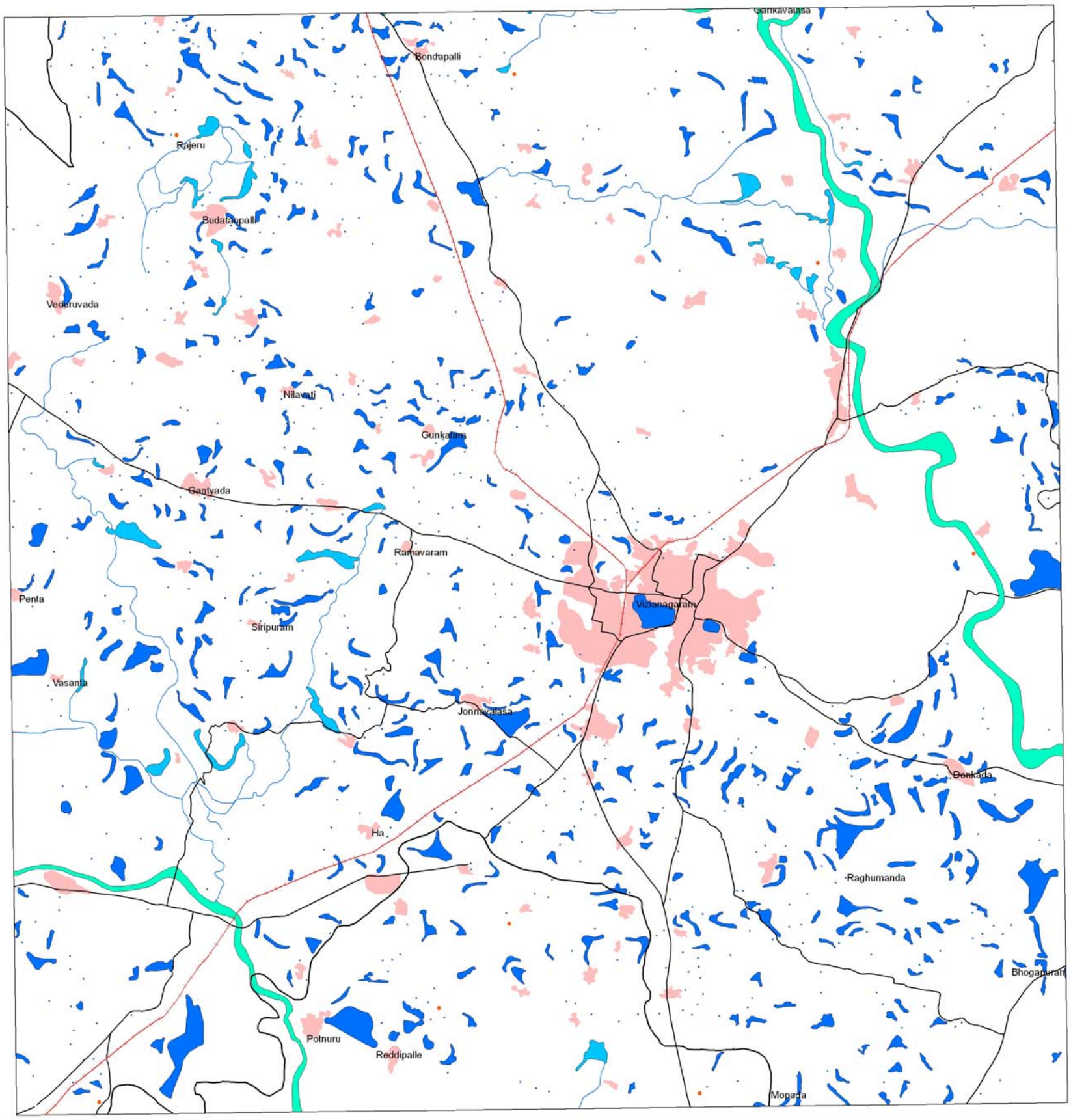
Government of India

State : Andhra Pradesh

WETLAND MAP

Map No. : 65N/08



Symbol	Typecode	Level I	Level II	Level III
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			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
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	2101			Lagoons
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Legend

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- Railways
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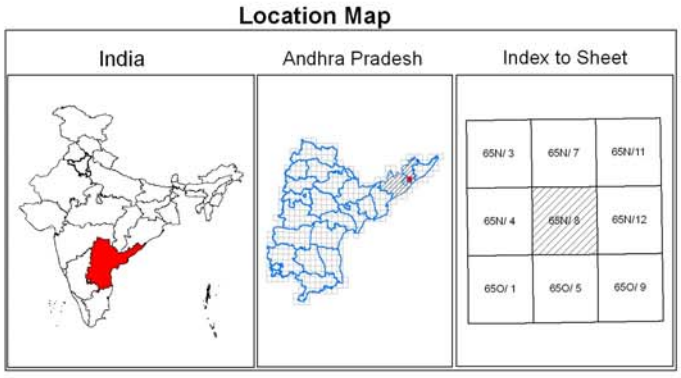
- International Boundary

Location Map



0 1 2 4 6 Kilometers

Data Source :

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

Prepared By :

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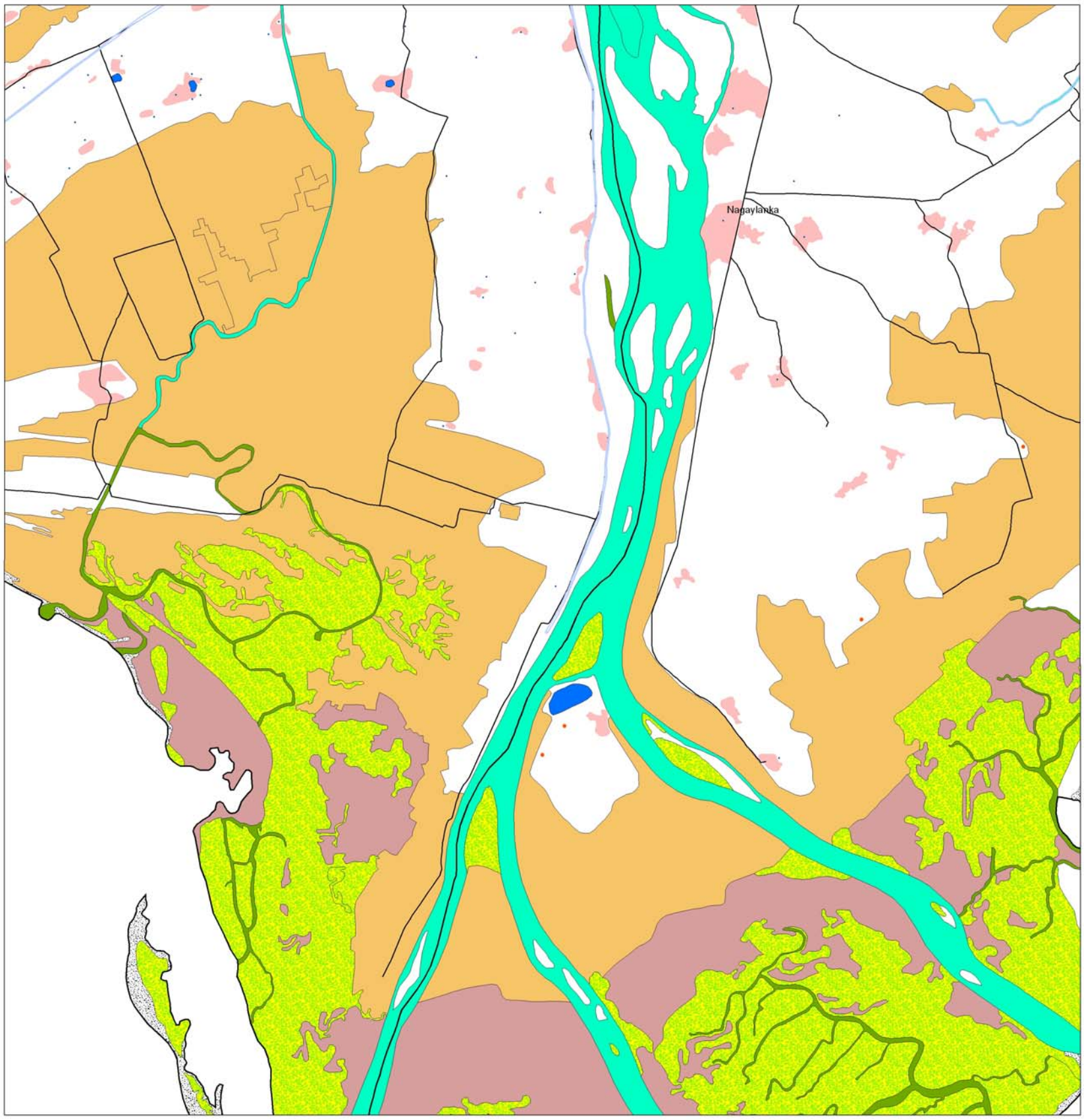
Government of India

State : Andhra Pradesh

WETLAND MAP

Map No. : 66A/13



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
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	1106			River/Stream
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	2107			Coral reefs
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Legend

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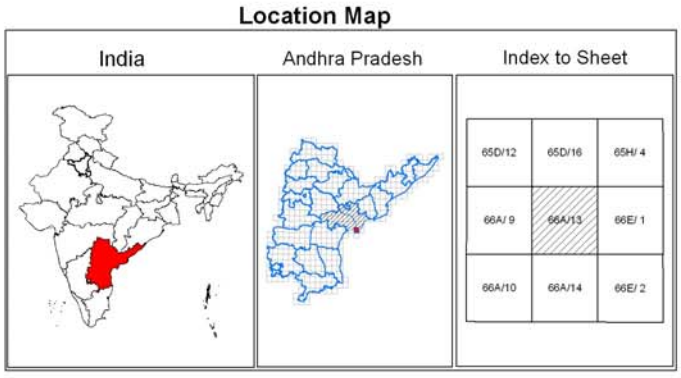
Location Map



Data Source :

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

Prepared By :

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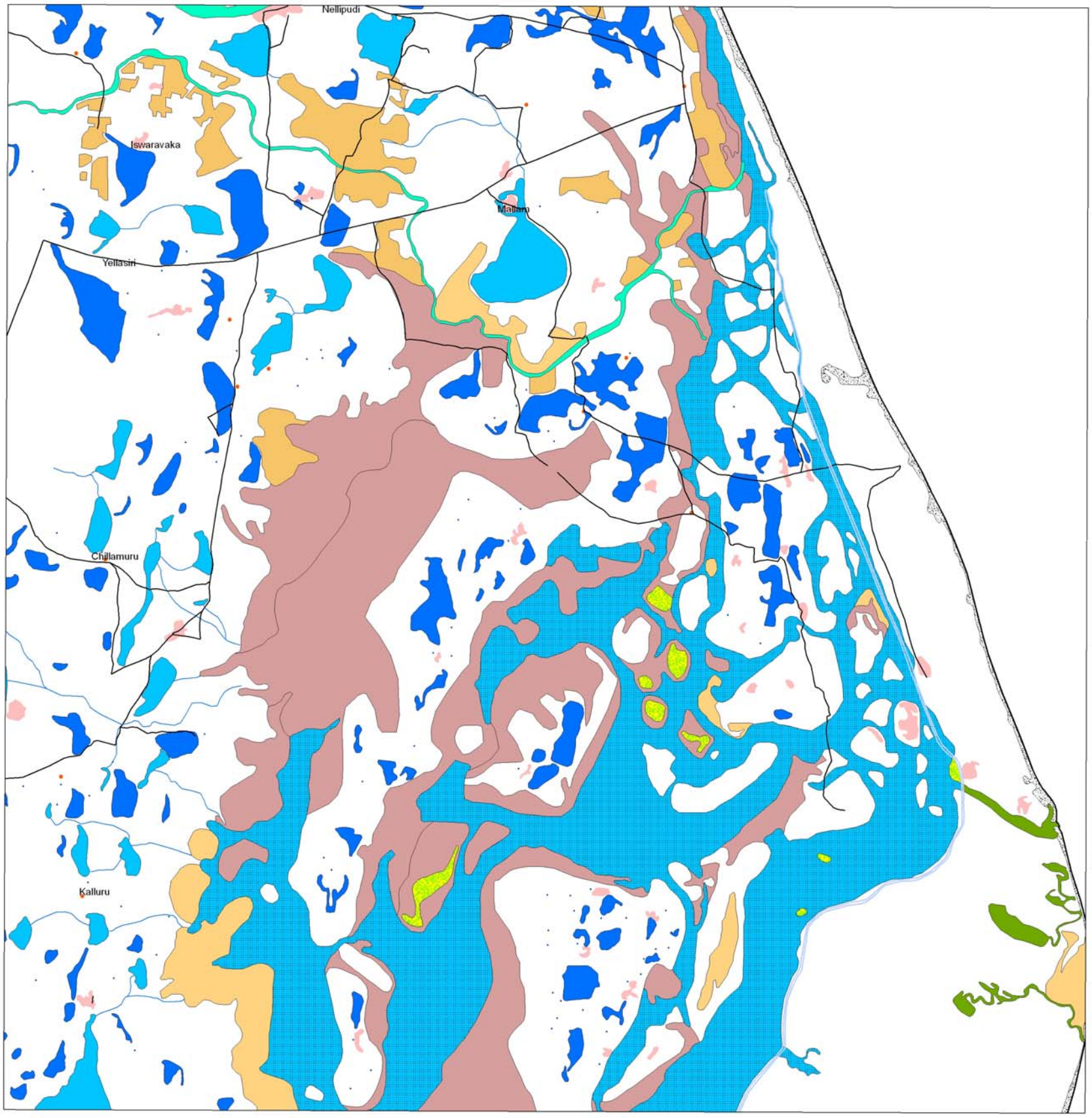
State : Andhra Pradesh

WETLAND MAP

Map No. : 66C/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			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
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	2107			Coral reefs
			Man-made	
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	2202			Aquaculture ponds

Legend

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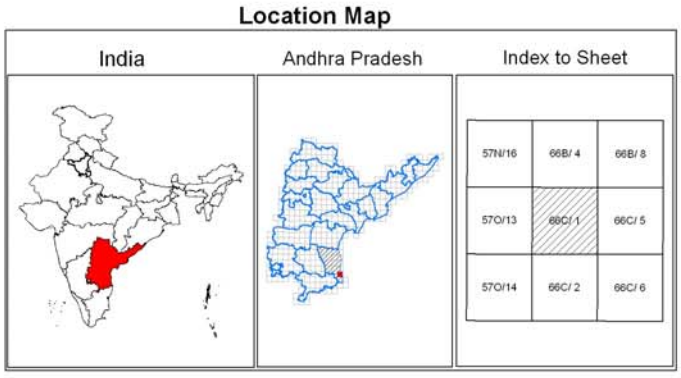
Location Map



Data Source :

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Ministry of Environment and Forests
Government of India

REFERENCES

1. Anon. 2005, NNRMS Standards. A National Standards for EO images, thematic & cartographic maps, GIS databases and spatial outputs. ISRO:NNRMS: TR:112:2005. A Committee Report: National Natural Resources Management System, Bangalore
2. Anon. 1993. Directory of Indian Wetlands, 1993. WWF India, New Delhi and AWB Kuala Limpur, xvi+264pp., 32 maps.
3. Clark, John R. (1977). *Coastal Ecosystem Management,* A Wiley Interscience Publication, John Wiley & Sons, New York,.
4. Cowardin, L.M., Carter, V., Golet, E.C. and La Roe (1979). *Classification of wetlands and deep water habitats*. USFWS/085-79/31, Office of the Biological Services, U.S. Fish and Wildlife Service, Washington, D.C.
5. *Encyclopaedic Directory of Environment (1*988). (Ed. By G.R. Chatwal, D.K. Pandey, and K.K. Nanda). Vol. I-IV, Anmol Publications, New Delhi.
6. Garg, J.K., Singh, T.S. and Murthy, T.V.R. (1998). *Wetlands of India*. Project Report: RSAM/sac/resa/pr/01/98, June 1998, 240 p. Space Applications Centre, Ahmedabad,
7. Garg J.K. and Patel J. G., 2007. National Wetland Inventory and Assessment, Technical Guidelines and Procedure Manual, Technical Report, SAC/EOAM/AFEG/NWIA/TR/01/2007, June 2007, Space Applications Centre, Ahmedabad,
8. *Glossary of Geology* (1974). (Ed. By Margarate G., Robbert, M. Jr. and Wolf, C.L), American Geological Institute, Washington, D.C..
9. Jensen, J.R. (1986). *Introductory Digital Image Processing: A Remote Sensing Perspective,* Prentice Hall, Englewoods Cliff, NJ.
10. Lacaux, J.P., Tourre, Y.M., Vignolles, C., Ndione, J.A. and Lafaye, M. 2007. Classification of ponds from high-spatial resolution remote sensing: Application to Rift valley fever epidemics in Senegal. *Remote Sensing of Environment*, 106, pp. 66-74
11. Lillesand, T.M. and Keifer, R.W. 1987. Remote Sensing and Image Interpretation. John Wliey and Sons, New York.
12. *Manorama Yearbook 2007*
13. *McGraw - Hill Encyclopaedia of Environmental Science* (1974). (Ed. Sybil P. Parkar), McGraw-Hill Book Company, New York.
14. McFeeters, S.K. 1996. The use of Normalised Difference Water Index (NDWI) in the delineation of open water features. *International Journal of remote Sensing*, 7, pp. 1425-1432.
15. Millennium Ecosystem Assessment. 2005, Ecosystems and Human Well-being: A Framework for Assessment, http://www.MAweb.org
16. Mitsch, William J. and Gosselink, James G. (1986). *Wetlands*, Van Nostrand Reinhold Company, New York.
17. Navalgund, R.R., Nayak, S.R., Sudarshana, R., Nagaraja, R. and Ravindran, S. 2002. Proceedings of the ISPRS Commission VII. Symposium on Resource and Environmental Monitoring, IAPRS & SIS, Vol.35, Part-7, NRSA, Hyderabad.
18. Patel J.G., Singh T.S., Garg J.K. et al, Wetland Information System, West Bengal, SAC/RSAM/RESA/FLPG/WIS/01/2003, A Technical report: Space Applications Centre, Ahmedabad
19. Ramsar Convention (2007). www.ramsar.org
20. Reid, George K and Wood, Richard D. (1976). *Ecology of Inland Waters and Estuaries*. D. Van Nostrand Company, New York.
21. SACON, 2004, Inland Wetlands of India : Conservation Atlas. Coimbatore, Salim Ali Centre for Ornithology and Natural History, 2004, ISBN 81-902136-1-X. ,Vedams eBooks (P) Ltd. Vardhaman Charve Plaza IV, Building # 9, K.P Block, Pitampura,
22. Singh T.S., Patel J.G., Garg J.K. et al. Loktak Lake Resources Information System (LRIS), SAC/RSAM/RESIPA/FLPG/WIS/02/2003, A Technical report: Space Applications Centre, Ahmedabad
23. Townshend, J.R., and Justice, C.O. 1986. Analysis of dynamics of African vegetation using the Normalised difference Vegetation Index. *International Journal of Remote Sensing, 7, pp. 1435-1445.*
24. Tucker, C.J. and Sellers, P.J. 1986. Satellite remote sensing of primary productivity. *International Journal of Remote Sensing, 7, pp. 1395-1416.*
25. Xu Hanqiu, 2006. Modification of normalised difference water index (NDWI) to enhance open water features in remotely sensed imagery. *International Journal of Remote Sensing, 7, pp. 3025-3033.*

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:

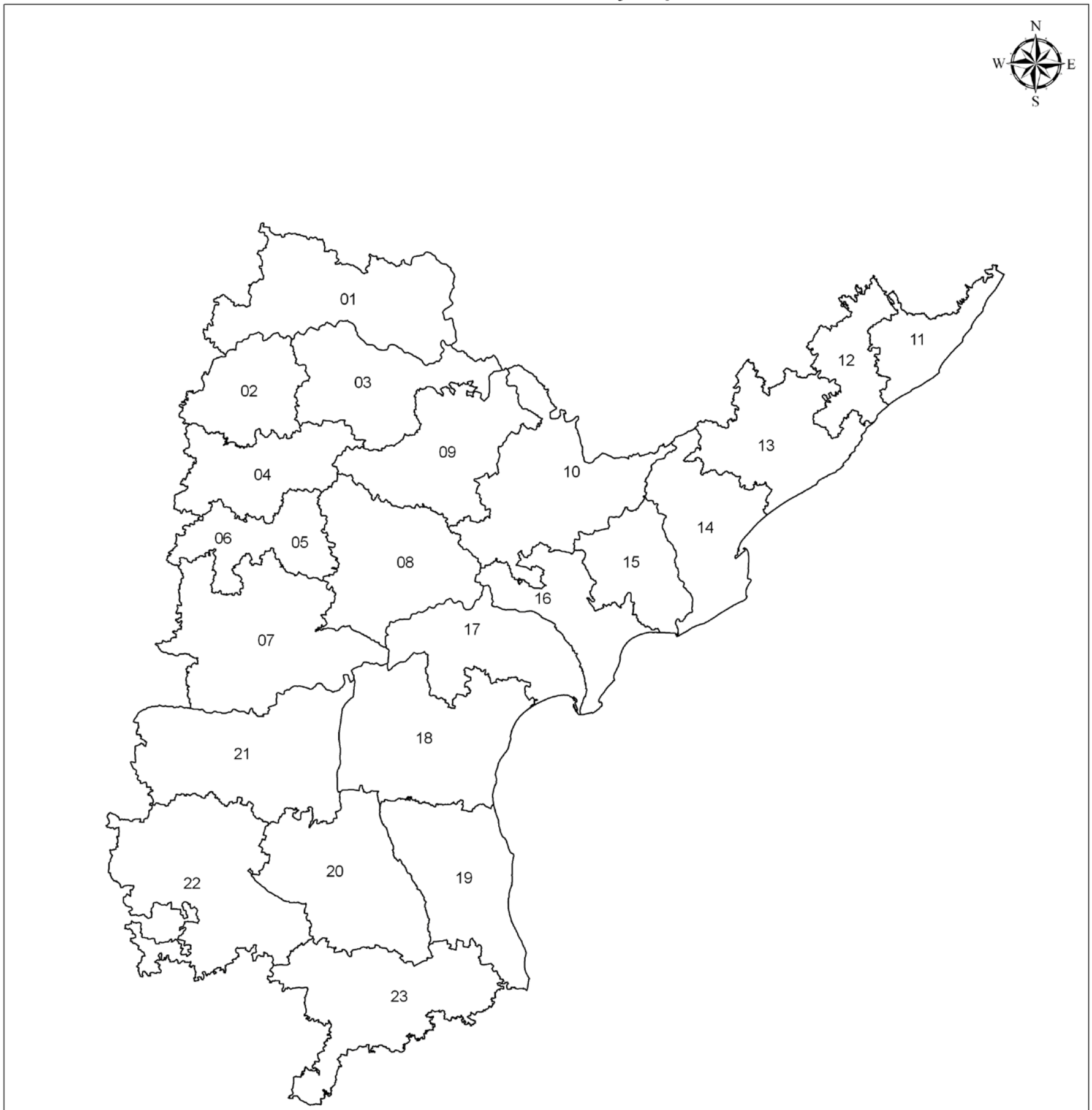
Wetland type code	Definition and description
1000	**Inland Wetlands**
1100	**Natural**
1101	**Lakes**: Larger bodies of standing water occupying distinct basins (Reid *et al*, 1976). These wetlands occur in natural depressions and normally fed by streams/rivers. On satellite images lakes appear in different 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 : Andhra Pradesh

District Boundary Map



List of Districts

District Code	District Name
01	Adilabad
02	Nizamabad
03	Karimnagar
04	Medak
05	Hyderabad
06	Rangareddi
07	Mahbubnagar
08	Nalgonda

District Code	District Name
09	Warangal
10	Khammam
11	Srikakulam
12	Vizianagaram
13	Visakhapatnam
14	East Godavari
15	West Godavari
16	Krishna

District Code	District Name
17	Guntur
18	Prakasam
19	Nellore
20	Cuddapah
21	Kurnool
22	Anantapur
23	Chittoor

Legend

State Boundary

District Boundary

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

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

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

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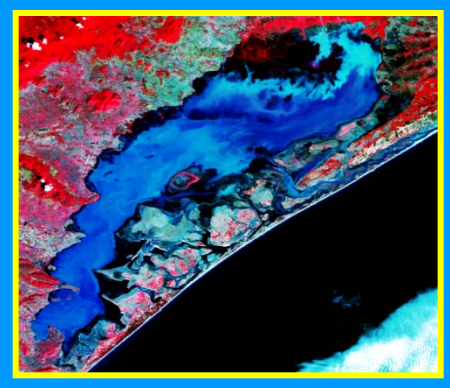

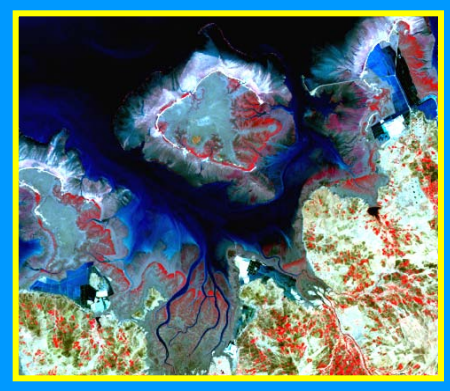

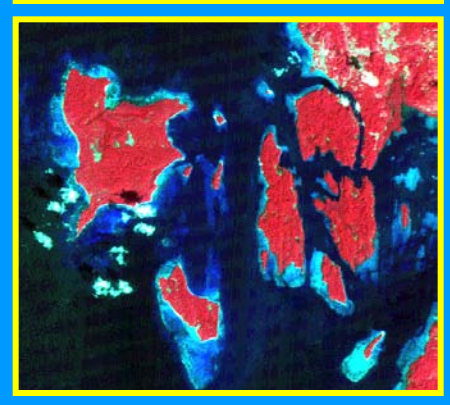

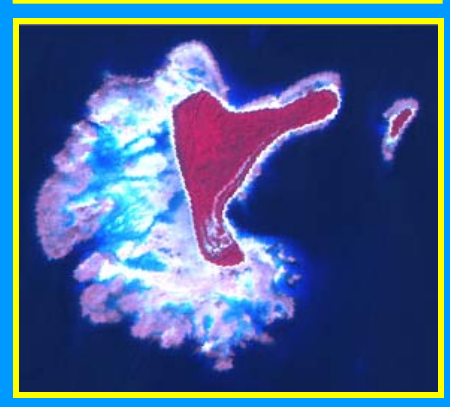

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