INLAND WETLANDS OF INDIA
Conservation Priorities

V.S. Vijayan
S. Narendra Prasad
Lalitha Vijayan
S. Muralidharan



SACON
SÁLIM ALI CENTRE FOR ORNITHOLOGY
AND NATURAL HISTORY

Inland Wetlands of India

Conservation Priorities

V S Vijayan
S Narendra Prasad
Lalitha Vijayan
S Muralidharan

with contributions from

Arun Kumar, Bharucha E, Bhattacharjee P C, Chaudhary V M, Choudhury A, Daniels R J R, Hussain S A, Jaggi A K, Kalsi R, Krishna Murthy Y V N, Kulshrestha M, Mookherjee K, Nageswara Rao P P, Pandey S, Parasharya B M, Pittie A, Rao R J, Sharma J R, Sinha A K, Srivastava D S, Tiwari A K, Wani A R

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Ministry of Environment & Forests, Govt. of India

UNDP India

United Nations Development Programme

SACON

SÁLIM ALI CENTRE FOR ORNITHOLOGY AND NATURAL HISTORY



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Phone : 91 422 2657101 to 2657103 Fax : 91 422 2657088
E-mail : salimali@vsnl.com Website : www.sacon.org

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E-mail : acedata@vsnl.net acedata@vsnl.com
Website : acedata-india.com

ஆ. இராசா
ए. राजा
A. RAJA

सत्यमेव जयते

मंत्री
पर्यावरण एवं वन
भारत सरकार
पर्यावरण भवन, सी. जी. ओ. काम्पलैक्स
नई दिल्ली-110003
MINISTER
ENVIRONMENT & FORESTS
GOVERNMENT OF INDIA
PARYAVARAN BHAWAN, C.G.O. COMPLEX
NEW DELHI-110003

13th OCTOBER, 2004



MESSAGE

India with its diversity of geography, people and biological wealth has held water as one of the most important and sacred elements of nature from time immemorial. However, this vital resource is becoming scarce and it is of great concern to people everywhere. Severity of water shortage is felt especially by the millions in the rural as well as urban India.

It is an enormous challenge to meet the accelerating demand of the ever-growing population while caring and nurturing our precious natural resources. Challenge is so great that apart from the government interventions, active involvement of civil society is urgently called for. However, such a collective effort would be successful, only if it is based on economically viable and ecologically sound policy founded on strong scientific understanding and information. The nation-wide project on wetlands supported by the UNDP and the Government of India is one such major national initiative to create a database on wetland resources for their conservation and sustainable use.

The Sàlim Ali Centre for Ornithology and Natural History (SACON) which undertook this national project has compiled the results in the form of a book "Inland Wetlands of India - Conservation Priorities". The most startling findings are the loss of wetlands and the amount of pollution in the remaining water resources. It is reported that the country has lost 38% of the wetlands in the last 10 years and, out of the 1700 fishes studied from 170 wetlands across the country, none was free from residual pesticides and heavy metals. My Ministry is committed to arrest further loss of wetlands and also try to reduce the pollution levels in the wetlands, especially where they are used for drinking water.

I congratulate SACON and all the agencies and individuals associated with this important national initiative. I am sure the different agencies of the government at the national and state level, and also the civil society would benefit from this publication.

(A. RAJA)



IUCN
The World Conservation Union

World Headquarters
Rue Mauverney 28
1196 Gland
Tel: +41 (0)22 999 00 00
Fax: +41 (0)22 999 00 02

MESSAGE

Lakes, floodplains, marshes and deltas are the wetlands, home of a wide variety of biodiversity and, they are in fact the most species-diverse habitats on earth. Wetlands are not only attractive but also extremely useful to humanity as they are the key to providing water, food and timber. In addition, they protect us against floods and droughts and offer space for recreation. In fact, freshwater ecosystems provide to society a quarter of the estimated USD 33 million value of all ecosystem goods and services combined.

However, the news is not all good. The IUCN Red List of Threatened Species has identified freshwater ecosystems as an habitat under particular threat from over-extraction of fresh water, overuse of their resources, drainage and pollution. They are blocked by dams or turned into agricultural land. Already 50% of the world's wetlands have been lost in the past century. The forthcoming Global Amphibian Assessment, a collaborative effort of IUCN and Conservation International, will report that as much as 30% of species in some freshwater habitats are currently under threat of extinction.

Given the urgent need to better understand and conserve the world's wetlands, IUCN welcomes this volume that provides much needed information on status and trends of wetlands throughout India. In particular, the emphasis placed on noting the socio-economic values is an important step towards forming the bridge between biodiversity conservation and sustainable livelihoods. The identification of 655 freshwater sites of high biodiversity value will be essential to assist in conservation planning and the 199 new areas to be declared Ramsar sites are a welcome addition to this important network.

The Sálim Ali Centre for Ornithology and Natural History is now 13 years old and we are very pleased that it joined IUCN as a member in December 2003. Sálim Ali, himself, said that "wildlife conservation is for down to earth practical purposes" and this is exactly the spirit of the IUCN mission - practical answers to enhance our world's biodiversity while improving livelihoods. We applaud the efforts that SACON is making to enhance the knowledge base for conservation in India and we look forward to a long and fruitful collaboration with them.

June 2004

Achim Steiner
Director General
IUCN - The World Conservation Union



Wetlands International
P.O. Box 471
6700 AL Wageningen
The Netherlands
Tel: +31 317 478854
Fax: +31 317 478850
E-mail: post@wetlands.org

Visiting Address:
Droevendaalsesteeg 3a
6708 PB Wageningen
Reg. No: 09099028

MESSAGE

Dear Dr Vijayan,

Wetlands International commends the Sálim Ali Centre for Ornithology and Natural History (SACON) for completing this nationwide project on inland wetlands of India – and the UNDP and Government of India for their support of this landmark initiative. This is a major achievement resulting from the coordination of participatory activities by a large number of research organisations, bird watchers, remote sensing centres, NGOs and other concerned agencies. Together, they have documented critical information on wetland status and prioritized 655 wetlands, located in different bio-geographical regions of India, for long-term conservation measures.

The study provides a valuable benchmark for assessing the biological and conservation status of wetlands in India. It reveals a rapid loss of wetlands over the last 10 years and draws attention to the continuing threats to the integrity of remaining wetlands from pollution caused by agricultural run-off and industrial effluents. The studies highlight the outstanding biodiversity of India's wetlands and their waterbird communities, which are important indicators of wetland ecosystem health. It is heartening to note that 199 wetlands fulfil the criteria as wetlands of international importance under the Ramsar Convention on Wetlands.

I congratulate SACON for the publication on **"Inland Wetlands of India – Conservation Priorities"**, which I am sure will be an excellent basis for the development of a national wetlands policy and action plan for conservation and management of wetlands. This publication will also be a valuable reference for all regional, national and international organisations and communities dedicated to the conservation, management and sustainable use of wetlands to benefit people's livelihoods and biodiversity.

Yours sincerely,

Jane Madgwick

Jane Madgwick
CEO, Wetlands International



UNDP India

PREFACE

As freshwater becomes a scarce resource, conflicts are emerging at various levels over access to this essential element for human sustenance. It is in this context that wetlands assume a special significance. Wetlands have the capacity to absorb floodwaters and thereby control floods. In the drier areas they provide fresh water for all forms of life. As part of the overall effort to ensure water sufficiency, conserving the ecology and hydrology of wetlands assumes great significance. Unfortunately, this is a fact not always fully appreciated, resulting in the neglect and degradation of numerous wetlands all over the world, including India.

This comprehensive publication, which is an outcome of the Government of India - UNDP initiative on the conservation and management of wetlands under the previous Country Programme (from 1997-2002), provides a detailed multi-parameter baseline for wetlands throughout India. The Geographical Information System (GIS) database for 232 districts of the country encapsulated in the book, has the potential to become a powerful planning tool for the government, local communities and the civil society for the conservation and sustainable use of these wetlands.

Two over-arching issues of immediate concern that the report brings out relate to the alarming loss of Indian wetlands - nearly 40 per cent over last ten years alone - and the contamination of the remaining ones.

The report calls for a determined, proactive National Wetland Conservation Strategy and Action Plan that needs to be implemented with priority to arrest further erosion of wetlands. Some of the concrete proposals include establishing state-level and Panchayat-level authorities for monitoring and management of wetlands, with full participation of women and, documentation of the wetland resources under a National Wetland Biodiversity Register.

With the publication of this study, it is now possible to access vital information related to wetlands in the public domain. UNDP is delighted to offer its support to this work, as a part of our work in natural resource management in India. I hope that the report will be widely used and discussed so as to raise awareness on these issues in a way that it helps develop a rational approach to the conservation and sustainable use of wetlands in India.

Maxine Olson
Resident Representative
United Nations Development Programme

55, Lodi Estate, Post Box No. 3059, New Delhi 110 003, India. Tel: 91-11-2462 8877 Fax: 91-11-2462 7615 http://www.undp.org.in

सत्यमेव जयते

प्रोदीप्त घोष, पी.एच.डी.
सचिव
PRODIPTO GHOSH, Ph. D.
Secretary



भारत सरकार
पर्यावरण एवं वन मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS

FOREWORD

Wetlands all over the globe are reckoned as key for water security, besides being an economic resource and providing wildlife habitats. Their enormous services to mankind have hitherto been taken for granted. The time has now come to realize how we have put the wetlands in jeopardy through poor planning of development activities.

India is a signatory to the Ramsar Convention and other international treaties, and is committed to sustainable development under Agenda 21. A number of proactive wetland conservation measures were taken up by the Government of India in the ninth and tenth five-year plans. At present, 19 wetlands are recognized as wetlands of international importance. Although the ecological and economic functions of wetlands are significant, the conservation of wetlands have not yet received sufficient attention, because of complexities of resource use, ownership, legal issues and, most importantly inadequate recognition of the economic value of the wetland ecosystem. The Ministry of Environment and Forests, Government of India is undertaking the formulation of a National Wetland Strategy involving various stakeholders for protecting the wetlands while retaining their ecological and economic benefits.

In order to safeguard the wetlands, we require quality information based on which alone informed decision-making is possible. Wetlands being dynamic ecosystems, one requires this information at frequent time intervals. India has advanced scientific and remote sensing capabilities which can be harnessed to these needs. The Government of India, along with the UNDP in its Country Cooperation Framework (CCF-1), executed a project "Inland Wetlands of India" through the Sàlim Ali Centre for Ornithology and Natural History (SACON) to identify and generate baseline information on wetlands and broad-basing wetland conservation by evolving a "National Network of Inland Wetland Conservation Areas" akin to the Protected Area Network for Wildlife and Forests. A paradigm shift required in the conservation areas is recognition that the primary stakeholders are the local communities.

I am particularly happy that SACON has carried out this challenging task with the active involvement of the Department of Space (Regional Remote Sensing Agencies) and more than 500 bird-watchers from all over the country.

(Prodipto Ghosh)

Dated : 25th May, 2004
Place : New Delhi

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वहाँ है खुशहाली।।

पर्यावरण भवन, सी. जी. ओ. काम्पलैक्स, नई दिल्ली-110003 फोन : 24360721, 24361896, फैक्स : (011) 24362746
PARYAVARAN BHAWAN, C.G.O. COMPLEX, LODHI ROAD, NEW DELHI-110003 TEL. : 24360721, 24361896 FAX : (011) 24362746
E-mail : prodipto_ghosh@nic.in

ACKNOWLEDGEMENTS

An extremely important and topical national project of this magnitude would never have been successful but for the whole-hearted support, active participation and cooperation of a large number of committed conservationists and well-wishers of both wetlands and SACON.

It is extremely gratifying to place on record our deep sense of gratitude to the Ministry of Environment and Forests, Government of India for choosing SACON to be the executing agency of this important landmark project. Needless to emphasize, various key functionaries were very cooperative despite, a large flux of many of them during the project.

We record our sincere thanks to the following officers who have been of great help to us right from the beginning till the very end of the project. Mr Viswanath Anand, the then Secretary, MoEF and his successors Messrs P V Jayakrishnan and K C Misra and, Dr Prodipto Ghosh; Mr Vinod Vaish, the then Special Secretary and his successor Mr A K Kundra; Mr A M Gokhale, Additional Secretary and his successor Ms Veena Chhotray; Mr R H Khwaja, Joint Secretary and Chairperson of the Steering Committee and his successors Mr D D Verma and Ms Veena Upadhyaya; Mr Ujjwal Choudhary, the then Director (IC Division) and his successor Mr S K Joshi and their colleagues. Dr Siddharth Kaul, Director, MoEF who was the National Sub-Programme Director of the project is to be thanked specially for the keen interest he showed during the entire project period.

We record our heartfelt gratitude to the UNDP for making this project possible through some exceptional enthusiasm of several key officials. In particular, we are indebted to Mr Keshav Desi Raju, the then Assistant Resident Representative, and his successors Messrs Pradeep Monga, and P Venkataramana; Messrs Tor Skudal and Sudarshan Rodriguez, Dr Ravi Chellam, Mr Sunil Arora, and Ms Usha Rao (Programme Officers) and Ms Manju Narang, Division Assistant.

We owe our thanks to the officials of the Forest Departments, especially the Principal Chief Conservators of Forests, Chief Wildlife Wardens and the local Conservators of Forests/ District Forest Officers/ Wildlife Wardens of all the states for extending whole-hearted support.

Image processing of select districts would not have been possible but for the involvement of the scientists of the Department of Space. We particularly thank Dr M L Manchanda, the then Head and his colleagues, Drs A K Tiwari, M Kudrat, Mr Sudhir Kumar, Mr H S Srivastava and Ms Sujimol of Regional Remote Sensing Service Centre (RRSSC), Dehra Dun; Dr P P Nageshwara Rao, formerly Head, Regional Remote Sensing Service Centre, Bangalore; Dr J R Sharma, Head and his colleagues Dr Dibyendu Dutta and Mr Rajendra N Gaikwad of RRSSC, Jodhpur; Dr A Jayaraman, Head, RRSSC, Kharagpur; Dr Y V N Krishnamurthy, Head and his colleagues Drs Subratha N Das, S Srinivasa Rao and A O Varghese and, Mr Ashish Kumar Sharma of the RRSSC, Nagpur; the late Dr R S Ayyangar, the then Head, Maharashtra Remote Sensing Application Centre (MRSAC), Nagpur, his successor Dr A K Sinha and their colleagues Drs Shirish A Ravan, S S Tikekar, V M Ghare, Ms Tutu Sengupta; Dr P S Roy, Dy Director, NRSA, Hyderabad and Dr S P S Kushwaha and Mr C Jeganathan of IIRS, Dehra Dun.

We are grateful to Dr R R Navalgund, Director NRSA and his colleague Dr R Sudarshana and, Dr C B S Dutt and Dr V Jayaraman of ISRO, Bangalore for their keen interest in the project. A special note of thanks to Dr J K Garg of SAC, Ahmedabad for helping us in obtaining the earlier state reports on wetlands.

Dr Arun Kumar, Additional Director and his colleagues at the Regional Centre of Zoological Survey of India, Dehra Dun have been of great help to us. Dr Rema Devi, Scientist, ZSI at its Regional Station in Chennai was of immense help to us for the painstaking scrutiny of the checklist of freshwater fishes of India compiled by us from literature. Dr N P Singh, the then Director, Botanical Survey of India (BSI) and his successor Dr M Sanjappa and their colleagues at the headquarters (Kolkata) and Regional Stations in Coimbatore and Pune extended full cooperation in using their invaluable herbarium collections without which we could not have completed the checklist of freshwater angiosperms. Special thanks are due to Dr V P Prasad (BSI, Pune) who was with SACON for a short duration for helping us in the preparation of the checklist of endemic aquatic plants (angiosperms). We also appreciate the cooperation of the Director and staff of the Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore; staff of the Department of Botany, Calicut University; and the staff of Rapinat Herbarium, Tiruchirapalli for according permission to refer plant specimens in their respective herbarium.

The fieldwork would have been impossible, especially within a short time frame, but for the active, enthusiastic and willing cooperation of the 15 State Coordinators whose names have been given under team members (Page xvi). The Resource Personnel and participants of the waterfowl census were more than 500 (partial list in appendix 11). We record our sincere thanks to all of them individually for the contribution they made for the success of this project. The success of the Regional Workshops held at the beginning and also at the end of the project was largely because of the interest and involvement of local coordinators and participants, especially Dr B M Parasharya and Mr Uday Vora (Gujarat); Dr Kulshreshtha and Harsh Vardhan (Rajasthan); Dr R J Rao (Madhya Pradesh and Chhattisgarh); Dr Erach Bharucha, his team and Mr M G Gogate, Principal Chief Conservator of Forests and his colleagues (Maharashtra); Dr Arun Kumar and his colleagues, ZSI, Dehra Dun (Uttar Pradesh and Uttaranchal); Drs P C Bhattacharjee and Anwaruddin Choudhury (Assam and Northeast); Messrs Kushal Mookherjee, Sujan Chatterjee and Dipankar Ghosh (West Bengal); Drs R J Ranjit Daniels and Jayashree Vencatesan (Tamil Nadu); Mr S A Hussain, Dr T V Ramachandra and Dr S Subramanya (Karnataka); Mr Aasheesh Pittie and, Mr Hitesh Malhotra, Chief Wildlife Warden and his colleagues from the Wildlife Department (Andhra Pradesh).

Dr Robert B Grubh (Director, Institute for Restoration of Natural Environment) and Mr S A Hussain (Biodiversity Initiative Trust) were of immense help to the project in many ways. Dr U K Gopalan, Retired Scientist, National Institute of Oceanography helped us getting the data on the freshwater wetlands of Kerala. Dr O P Nameer, Faculty of Forestry, Kerala Agricultural University willingly shared the waterfowl data for Kerala while Dr A B Shanbhag of Goa University did not have any hesitation to provide us with data on the freshwater wetlands of Goa. We were benefited by the discussions we had with Dr U Sridharan, Additional Director, MoEF and Dr Sudhakar Kar as both of them have a thorough knowledge about waterfowl status and distribution in Orissa. Mr B C Choudhury, Drs S A Hussain and G S Rawat of Wildlife Institute of India, Dehradun were of help to us at various stages of the project.

The entire staff of SACON both at the headquarters in Coimbatore and at the field station, Dehra Dun were extremely cooperative. The Senior Finance Officer Ms Jayashree Muralidharan, holding both the NEX Guidelines of the UNDP in one hand and rule book of SACON in the other, efficiently managed the project both administratively and financially without interrupting the steady progress of work.

The final phase of the report writing was something akin to a festive event in a family. All investigators and their students, staff of the Director (Mr V Vaidiyanathan and Mr N Santhana Raj) and, the Computer Assistant (Mr K K Ramakrishnan) did not find any difference between day and night, working days and holidays. Absolute willing cooperation! The students especially Ms J Umamaheshwari, Ms N Sheeba and Messrs S Somasundaram, R Easwaran, K S Anoop Das, Debanic Mukherjee, P Balakrishnan, R Jayakumar, V Dhananjayan and R Sankardoss were of great help in various ways – checking bibliography, tables and figures. The checklist of freshwater aquatic plants was compiled by Ms K Anitha and Mr Sudheer. The final checking of figures, tables and their reference in the text was done by Ms Manjari Jain and Ms Rupa Simon.

We are grateful to Dr V J Nair, Emeritus Scientist, Botanical Survey of India for the laborius job of verifying the checklist of freshwater angiosperms and for "viewing" the manuscript through his 'pollen analysis lens' and giving valuable editorial comments. It is indeed our honour that Mr J C Daniel, a father figure of conservation in the country who, of late, is greatly worried about the fast decline of village ponds and tanks, willingly undertook the painstaking job of editing the massive text. We also had the benefit of Prof M K Prasad of Kerala Sastra Sahitya Parishad and retired Pro-Vice Chancellor of Calicut University, and Dr K P S Chauhan, (formerly Director, MoEF) going through parts of the text.

Last but not least, our sincere thanks are to the Chairman (Dr J R B Alfred, Director, ZSI) and all members of the Research, Monitoring and Advisory Committee and, to all the Chairmen, Governing Council of SACON during the period, for the unstinted support given for the project from conceptual level to production of this publication.

INLAND WETLAND PROJECT TEAM

Investigators:

V S Vijayan
S Narendra Prasad
Lalitha Vijayan
S Muralidharan

Coordinators for mapping:

Dr A K Tiwari (RRSSC, Dehra Dun)
Dr V M Chaudhary (RRSSC, Kharagpur)
Dr Y V N Krishna Murthy (RRSSC, Nagpur)
Dr J R Sharma (RRSSC, Jodhpur)
Mr P P Nageswara Rao (RRSSC, Bangalore)
Dr A K Sinha (MRSAC, Nagpur)

Steering Committee:

Chairman: Joint Secretary, MoEF
(Mr R H Khwaja, IAS, succeeded by
Mr D D Verma, IAS and
Ms Veena Upadhyaya, IAS)
National sub-programme coordinator:
Dr S N Prasad, SACON
Director, IC-Division, MoEF:
Mr U K Choudhury succeeded by
Mr S K Joshi
National sub-programme Director:
Dr S Kaul, Director, MoEF
Director, SACON : Dr V S Vijayan

State Coordinators for field work:

Mr Aasheesh Pittie (Andhra Pradesh)
Dr Anwarudin Choudhury (Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Sikkim and Tripura)
Dr P C Bhattacharjee (Assam)
Dr D S Srivastava (Bihar & Jharkhand)
Dr R J Rao (Chhattisgarh and Madhya Pradesh)
Dr B M Parasharya (Gujarat)
Dr Rajiv Kalsi (Haryana and Punjab)
Mr Sanjeeva Pandey, IFS (Himachal Pradesh)
Mr A R Wani (Jammu & Kashmir)
Mr S A Hussain (Karnataka)
Dr Erach Bharucha (Maharashtra)
Mr Manoj Kulshresthra (Rajasthan)
Dr R J Ranjit Daniels (Tamil Nadu)
Dr Arun Kumar (Uttar Pradesh and Uttaranchal)
Mr Kushal Mookherjee (West Bengal)

(List of participants: Appendix 11)

Project personnel

SACON Headquarters

Dr G Srinivasan, Research Associate (July 2001-March 2002)
Ms J Umamaheshwari, JRF (July 2001 – October 2001)
Mr Amlan Dutta, JRF (August 2000 – December 2000)
Mr C M Sabapathy, JRF (June 2001-January 2002)
Mr P Sivakumar, JRF (March 2002-March 2003)
Mr M Mahendiran, JRF (April 2002-March 2003)
Ms Manjula Menon, JRF (June 2002 – December 2002)
Ms K Mathumitha, Tech. Asst. (July 2002 - March 2003)
Mr R Jayakumar, JRF (August 2001-March 2003)
Mr V Dhananjayan, JRF (October 2001-March 2003)
Mr P Selvam, Technical Assistant (June 2002-March 2003)
Mr S Patturajan, Laboratory Attendant (May 2001 - March 2003)

SACON field station, Dehra Dun

Mr Alok Kumar Jaggi (August 2000-March 2003)
Mr T Praveen Kumar (August 2001-March 2003)
Ms Priti Kaushik (June 2002-March 2003)
Ms Tanushree Sengupta (March 2000 to January 2002)
Mr Sunil Thakur (November 2000 to July 2001)
Ms Pallavi Yadav (July 2001to January 2002)
Mr Bilal Habib (February 2002 to May 2002)
Mr Shashank S Rai (February 2002 to May 2002)
Mr Nikhil V Lele (June 2002 to December 2002)
Mr Anil K Jamwal (January 2003-March 2003)

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Abbreviations used

BCPP	-	Biodiversity Conservation Prioritization Project
BSI	-	Botanical Survey of India
DDD	-	dichlorodiphenyldichloroethane
DDE	-	dichlorodiphenyldichloroethylene
DDT	-	dichlorodiphenyltrichloroethane
EASI/PACE	-	A Remote Sensing software of PCI Geomatics, Canada
ECD	-	Electron Capture Detector
FDA	-	Food and Drug Administration
FAO	-	Food and Agricultural Organization
FCC	-	False Colour Composite
GNU	-	Gnu's Not Unix
HCH	-	hexachlorocyclohexane
Health Canada	-	Provisional Tolerable Dietary Intake, Health Canada
IBAs	-	Important Bird Areas
ICAR	-	Indian Council of Agricultural Research
IARC	-	International Agency for Research on Cancer
MIDCs	-	Mumbai Industrial Development Corporations
NCC	-	National Cadet Corps
NDC	-	National Documentation Centre
NDVI	-	Normalized Difference Vegetation Index
NGO	-	Non-Governmental Organization
NRIS	-	Natural Resource Information System
NRSA	-	National Remote Sensing Agency
NSS	-	National Service Scheme
PAs	-	Protected Areas
RSPB	-	Royal Society for the Protection of Birds, USA
SAC	-	Space Application Centre, Ahmedabad
SACON	-	Sálim Ali Centre for Ornithology and Natural History
SGI	-	Silicon Graphics India
SOI	-	Survey of India
UN Committee	-	Joint Expert Committee on Food and Agriculture of United Nations and World Health Organization
USEPA	-	United States Environmental Protection Agency
WHO	-	World Health Organization
WIFS	-	WIde Field Sensor
ZSI	-	Zoological Survey of India

EXECUTIVE SUMMARY

There has been an inseparable relationship between the rural economy and wetland resources, as wetlands are integral and key components in food and water security. Man has been living on the wetland resources for ages, rather harmoniously, devising indigenous methods in safeguarding and augmenting water resources. The disharmony arose due to the over use of resources. The rapidly expanding human population, large scale changes in land use/land cover, the burgeoning development projects, dumping of industrial effluents and solid wastes and improper use of watersheds have led to the decline of wetland resources of the country. The alarming pace of disappearance of wetlands from the landscape is of great concern. It is estimated that by 2050, the freshwater biodiversity will have a drastic decline relative to other biomes. Reliable and updated information on the extent of wetlands, their biodiversity values, ecosystem service values and socioeconomic importance are vital for evolving long-term conservation policy, legislation and administrative interventions. Currently, neither we have such information available with us nor have a system in place to generate and update them periodically. Moreover, only a few of the ecologically sensitive regions are protected by the Wildlife Protection Act while the rest are becoming an easy target for anthropogenic exploitation.

The National Wetland Committee of the Ministry of Environment and Forests (MoEF), Govt. of India, has recommended a number of proactive steps, one of which is inventory of wetlands in the country. Following this and realizing the importance of wetlands in rural economy and biodiversity conservation, the United Nations Development Programme under the PDF initiative along with the Government of India entrusted SACON with a project to develop a comprehensive inland wetland inventory, mapping and classification on a large spatial scale using existing and also by generating additional information.

The primary objective was to prioritize the freshwater wetlands for conservation action. The task involves mapping the wetlands and collecting data on the wetland biodiversity.

The Space Applications Centre (SAC), Ahmedabad at an earlier initiative, mapped the wetlands using remote sensing data mostly of 1992-93. Some of the states were mapped at 1:2,50,000 scale while others at 1:50,000, covering the wetlands of the size 56.25 ha and above and 2.25 ha and above respectively. It was found that wetlands below 56.25 ha are more numerous than those above 56.25 ha. Moreover, smaller wetlands play a vital role in landscape ecology, hydrology of local areas and biodiversity conservation. The effort, although laudable, provides only physical delineation of the wetlands, and a description of vegetation and turbidity as 'low', 'medium' or 'high'. These information, although useful, by themselves are inadequate for long-term planning of conservation initiatives.

We made use of the data generated by SAC and also generated primary data at a higher resolution wherever necessary, although we were aware that generating the same set of data on physical dimensions would have given excellent opportunities to examine the loss/ gain of wetlands during the past 10 years. We mapped the wetlands which are 2 ha and above from select districts of those states where SAC had covered the wetlands of 56.25 ha and above in size. These two efforts of SAC and SACON together provide maps for the wetlands of the size 2.25 ha and above for most districts in the country.

Biodiversity values were assessed using primary and secondary data. Checklists of aquatic plants, fishes and reptiles were prepared for each state through an exhaustive literature survey and finally verifying them with experts in the field concerned. Primary data were collected on wetland birds by a coordinated effort of more than 500 personnel from various states organized through 15 State Coordinators. A broad classification of wetlands based on use values was also attempted. Contamination (organochlorine pesticides and heavy

metals) profile of wetlands of 14 states using fishes as indicators has been brought out. Temporal changes indicating the loss/ gain in the wetland cover could be worked out using the SAC's data of early 1990s and the present set.

Although this study, perhaps, is the most comprehensive of the kind till date in the country, we are aware that there are enormous scopes for improvement for a wider coverage of wetland and collection of data on biodiversity. However, in spite of all its shortcomings, we feel the present report is adequate to help initiate conservation planning of the wetlands on a national scale; fulfilling the task entrusted to us.

The salient features of the findings and achievements are listed below:

1. Prioritization of 655 wetlands in the country for conservation at three levels; wetlands of international, national and local significance.
2. Projection of 199 wetlands for recognition at international level as Ramsar sites
3. A GIS database on the nation-wide distribution of wetlands for 232 districts of the country
4. A spatial database on the wetlands 2 ha and above for the select 72 districts from 10 states covering land use classification at level I, and wetland attributes at levels II and III.
5. Broad characteristics such as turbidity level and vegetation of all the wetlands (2 ha and above) in 72 districts.
6. Species richness and abundance of waterfowl in the major wetlands in all the states, except Andaman and Nicobar, and Lakshadweep islands.
7. Site records of Threatened and Near Threatened species of wetland birds in various states.
8. Georeferenced distribution of 29 species of Anatidae, in Arc/info coverage.
9. Georeferenced distribution of 109 endemic aquatic plant species in the country in Arc/info coverage.
10. A broad classification of wetlands on socioeconomic use values
11. Pattern in the levels of heavy metals and, organochlorine pesticides in the fishes of select wetlands of 14 states in India.
12. Creation of a comprehensive database on the major groups of Threatened wetland animals (birds, turtles, fishes) and endemic wetland plants of each state.
13. A comprehensive Inland Wetland Conservation Atlas with value added spatial data on distribution of wetlands in over 232 districts spanning almost all states. Other thematic details include classification of wetlands above 2 ha for 72 districts, distribution of bird and endemic aquatic plant species, and levels of environmental contamination.
14. Creation of an easily accessible public domain database for all the data created and compiled.
15. An outline for a National Wetland Conservation Strategy and Action Plan for 2004-2020.
16. Establishment of a strong network of field personnel in the country.
17. An outreach and awareness campaign on conservation among various stakeholders across a wide cross section.

1. INTRODUCTION

"First, there is life in the water, by which everything else is made green"

- 14 Aasaa Guru Nanak Dev

"Our task must be to widen our circle of compassion to embrace all living creatures and the whole of nature in its beauty"

- Albert Einstein

The two great and eminent masters of spirituality and science, Guru Nanak and Einstein, thus essentially, exhorted humanity to save and nourish our environment. The beginning of the new millennium poses an enormous and unprecedented environmental challenge of providing and safeguarding the sources of clean and safe water to billions of human beings. There is also a great urgency in balancing the galloping needs for food, energy and materials to the burgeoning population and the seriously threatened and impaired vital functions of our fragile ecosystems of which water is an integral component. There has been a rising global concern on the diminishing freshwater supplies and wanton destruction of the freshwater ecosystems; our very life-supporting system. It is well known that wetland is an integral and key component of the hydrological cycle to maintain the freshwater supplies. Thus, it is our long-term best-bet for water and food security. This is more so in countries like India, where the ecosystem people, have over ages evolved sustainable use of water and wetlands. The sustainable practices seem to be coming under increasing pressures with a direct threat to wetlands. These wetlands are also highly productive.

India with its annual rainfall of over 1,300 mm, varied topography and climatic regimes support and sustain diverse and unique wetland habitats. Natural wetlands in India consist of the high-altitude Himalayan lakes, followed by wetlands situated in the flood plains of the major river systems, saline and temporary wetlands of the arid and semi-arid regions, coastal wetlands such as lagoons, backwaters and estuaries, mangrove swamps, coral reefs and marine wetlands. With the exception of bogs, fens and typical salt marshes, Indian wetlands cover the whole range of wetland ecosystem types found elsewhere. In addition to the various types of natural wetlands, a large number of man-made wetlands also contribute in sustaining the faunal and floral diversity. These man-made wetlands, resulted from the needs of irrigation, water supply, electricity, fisheries and flood control, cover larger area than the natural wetlands. The various reservoirs, shallow ponds and innumerable tanks support aquatic biodiversity and add to the country's wetland wealth. Majority of the inland wetlands are directly or indirectly dependent on the major rivers such as the Ganga, Brahmaputra, Narmada, Godavari, Krishna, Cauvery, and Tapti. Most of the wetlands occur in the hot arid regions of Gujarat and Rajasthan, deltaic regions of the east and west Coast, highlands of central India, and the wet humid zones of southern peninsular India. The estimated number of inland wetlands in the country is 23,444 covering an area of 3.56 million ha (SAC, 1998).

Wetlands in India, as elsewhere are increasingly facing several anthropogenic pressures. Thus, the rapidly growing human population, large scale changes in land use/land cover, burgeoning development projects and the improper use of watersheds have all caused a substantial decline of wetland resources of the country. Significant losses have resulted from its conversion for industrial, agricultural and various urban developments. These have led to hydrological perturbations, pollution and their effects. Unsustainable levels of grazing and fishing activities have also resulted in degradation of wetlands. Only a few of the ecologically sensitive regions are protected by the Wildlife Protection Act, whereas several wetlands are becoming an easy target for anthropogenic exploitation. Survey of 140 major sites across various agro-climatic zones

identified anthropogenic interference as the main cause of wetland degradation (The Directory of Indian Wetlands, Anon., 1993).

The wetland loss in India can be divided into two broad groups, namely acute and chronic losses. The filling up of wetlands with soil constitutes acute loss, whereas the gradual elimination of forest cover and, or, soil-unfriendly practices in the catchment areas leading to erosion and sedimentation of the wetlands over a period of time is termed as chronic loss. The current loss rates in India can lead to serious consequences, where 74% of the human population is rural (World Development Report, 1994) and, many of these people are wetland resource dependent. Healthy wetlands are essential for sustainable food production and potable water for humans and livestock. Moreover, wetlands play a vital role in maintaining the overall cultural, economic and ecological health of the environment. The alarming pace of their disappearance from the landscape is of great concern.

India is already facing a water crisis. Nearly 40% of the urban population in India has no access to water. The scenario in rural India is even more frightening: 750 villages were without water resources in 1985, and the number increased to 65,000 villages in 1996. It is projected that, the total requirement of water will leapfrog to 1,050 billion cubic meters from the present consumption of 750 billion cubic meters (Rao, 1997). Investigating into the downward transition of India's water-sustainability since 1947, TERI projects a dismal scenario for India in 2047. It states: "Annual per capita water availability in India fell by 62% in the first fifty years of independence, a trend that is likely to worsen in the next fifty years with a projected 67% decline...". Therefore, wetlands, a key and critical component of the freshwater cycle, are of utmost importance for survival.

Wetlands are also necessary for the continued existence of India's diverse populations of wildlife and plant species; a large number of endemic species are wetland dependent. Most problems pertaining to India's wetlands are related to human population. India contains 16% of the world's population, and yet constitutes only 2.42% of the earth's surface. Indian landscape has contained quite a few natural wetlands over a period of time. Restoration of the original wetlands from the reclaimed area is quite difficult, once these sites are occupied for non-wetland uses. Hence, the demand for wetland products (e.g., water, fish, food, fiber, medicinal plants) will increase with increase in population. Wetland loss refers to physical loss in the spatial extent or loss in the wetland function. The loss of one km^2 of wetlands in India will have much greater impacts than the loss of one km^2 of wetlands in low population areas of abundant wetlands (Foote *et al.*, 1996).

It is all the more serious that most of the remaining wetlands, irrespective of the extent and number, are contaminated either by pesticides or industrial effluents or by both. It may be noted that the consumption of pesticide in India has crossed more than 1,00,000 mt from a mere 5,000 mt of 1960s. These pesticides find their way to the wetlands either through runoff or seepage and inflict deleterious effects on the entire wetland system. Worst still is that contaminants even make their way to the nearby drinking water sources also. Estimates show that three million people around the world suffer from pesticide poisoning every year, of which 2,00,000 die, mostly in countries such as India (Sahgal, 2003). Yet, we have no clue on the quantum and characteristics of the contaminants in the commonly used wetland resources.

The National Wetland Committee of the Ministry of Environment and Forests (MoEF), Govt. of India, has recommended a number of proactive steps. Accordingly, 27 wetlands have been declared tentatively as wetlands of national and international significance for long-term conservation. The committee recommended a nation wide inventory of wetlands to be undertaken under the guidance of National Wetland Committee with the support of the Standing Committee on Bioresources of the National Natural Resourc Management

System (NNRMS) and MoEF. The Space Applications Center (SAC) Ahmedabad, of the Indian Space Research Organization (ISRO) had undertaken, in collaboration with various State Remote Sensing Application Centers, a nation wide mapping of wetlands. This was done on a reconnaissance scale and was completed during 1997. This represents the first ever comprehensive spatial inventory of the water bodies / wetlands in the country - a commendable initiative indeed.

The SAC had mapped the wetlands at 1:2,50,000 scale in the mainland as well as in the islands, using the visual interpretation of coarse resolution satellite data. The states of Sikkim, West Bengal, Goa, Punjab, Haryana, Himachal Pradesh, Chandigarh, Delhi, and the Union Territories of Andaman and Nicobar, Lakshadweep, Dadra and Nagerhaveli were mapped at 1:50,000 scale which covered all wetlands of the size 2.25 ha and above. However, in the rest of the country, only wetlands of 56.25 ha and above in size could be mapped. It is indisputable that a vast majority of wetlands, in their number, extent and conservation importance, are below 50 ha in size (for example, those in the Indo-Gangetic plains and in the Deccan peninsula). It is reported that there are about 39,000 village tanks in Tamil Nadu alone (Vaidyanathan, 2001). Yet most of these could not be captured on 1:2,50,000 scale mapping. Thus, the inventory covered only a small number of wetlands. Moreover, the conservation values of these wetlands are not known, even after completing their inventory. The data merely indicate the location of wetlands; the classification of wetlands on 1:2,50,000 scale is geomorphologic in nature (such as oxbow lakes, playas, lakes and ponds) and do not have any information on biodiversity conservation values. By itself, it is a pioneering effort, the first ever attempt to locate the wetlands, but the information is useful only to a limited extent for conservation of wetlands. The study recommended mapping at a larger spatial scale as wetlands below 56.25 ha in size could not be delineated.

Most studies on wetlands in India are confined to limnological aspects, productivity, nutrient dynamics, vegetation; often each aspect studied in different ponds and lakes. Migratory movement of waterfowl was extensively studied by the Bombay Natural History Society (BNHS) focussing on Point Calimere in the South, Bharatpur and Harike in the North. The BNHS also earns the distinction of conducting a decade-long, multidisciplinary integrated study on the ecology of the Keoladeo National Park, Bharatpur (Vijayan, 1991); one of the best waterfowl areas in the country. It was the first ever study on a wetland ecosystem in totality in India, perhaps in the world.

Remarkable contributions have been made by Brij Gopal and his associates of the Jawaharlal Nehru University to the Indian wetland ecology, especially, aquatic vegetation studies. The classification system based on aquatic vegetation suggested by him is the first ever for our wetlands (Gopal and Sah, 1995). The only nation-wide survey of any particular species of wetland was made by Choudhary *et al.*, (2000) on fresh water turtles. Although there is a wealth of information on the freshwater fishes of India (Jhingran, 1991), it deals mainly with commercially important species of larger water bodies, such as dams and lakes. Check lists of freshwater fishes of India have been brought out by Talwar and Jhingran (1991), Jayaram (1999), Menon (1999) and Daniels (2002). Yet, fish fauna of the numerous ponds and tanks in the country is not covered completely. And, status of the habitat use is undetermined in many cases. Again, conservation status of many species of fishes is "fishy".

There were three major attempts to inventorize the wetlands in the country. Scott (1989) gave an inventory of 90 wetlands, WWF-India and AWB (Anon., 1993) covered 140 wetlands, and Samant (2000), as part of the Biodiversity Conservation Priorities for India, prioritized 158 wetlands. Choudhury and Raghuram (2002) emphasized the need for having a Protected Area Network of Wetlands, while Parikh and Datye (2002) proposed a national wetland strategy.

However, there has been no systematic attempt to cover wetlands on a national scale on various ecological and socioeconomic criteria. Such information is obviously important and crucial for prioritizing wetlands to create a National Network of Inland Wetland Conservation Areas in the country for long-term conservation. It may also be added that the biogeographical classification evolved for terrestrial ecosystems based on the distribution of mammals and a few other groups would perhaps be inadequate for classifying aquatic biodiversity.

The Inland Wetland Project, sponsored by the UNDP-MoEF, is the first of its kind in India, where two distinct groups of talents; space base remote sensing technologists and hardcore field biologists of Sálim Ali's mould were brought together to document mankind's most invaluable resource on earth, the wetlands. Scientists from Regional Remote Sensing Centres under the leadership of Dr A K Tiwari took special care in bringing together a workable methodology and coordinating constantly in handling spatial data of higher resolutions to meet the requirements of the project. Wetlands of the size 2 ha and above in 72 districts from 10 states have been mapped along with the land use pattern.

An extensive field programme, covering 655 wetlands as well as museum data collection on birds, plants and fishes was undertaken in a very actively participated programme comprising over 500 individuals across the length and breadth of the country. We also attempted profiling of socioeconomic dimensions in wetland conservation in a qualitative fashion to gauge the magnitude of the conservation task at hand. One of the unique features of this project is profiling of the environmental contamination in select wetlands across the country, as many as 173 wetlands from 14 states. Pesticides, reported to be affecting three million people around the world in a year, and heavy metals notorious for its pernicious toxicity have been documented in 1700 fishes belonging to 66 species.

We also realized that the traditional modes of data collection and reporting would be of little use unless there is an extensive outreach programme for accessing the information. Hence, this vast data and information generated during the project period is brought together in a computer assisted Geographic Information System (GIS) domain for a wider dissemination and for the benefit of various stakeholders in wetland conservation (Prasad *et al.*, 2002).

Keeping in view of the objective of the project, to develop a comprehensive inland wetland inventory, mapping and classification using the existing and generating additional information, we have tried our level best to put together all the existing information on the extent and number of wetlands in each state. The enormous data generated by us have been condensed as much as possible and only those which are required to highlight the salient features are given in the report.

All the 28 states have been covered. However, the newly formed states, namely the Chhattisgarh, Uttaranchal and Jharkhand have been treated along with the original respective states. The information available on the number and extent of wetlands, turbidity levels and, details of vegetation, fishes, turtles and birds and, the contamination levels of fishes have been provided for most of the states. The quantum of data varies for various states. Bihar and north-eastern states do not have as much data as the other states.

The present report is not a treatise on the wetland resources of the country. It is only the first step of our endeavour to document and monitor the wetland resources. It is a sample demonstrating the richness of the wetland resources and the speed at which they disappear even before documenting the resources they contain. However, it is hoped that the present attempt would help enhance conservation attention that wetlands, our major life-supporting system, so urgently require. We fervently hope that a proactive action plan, involving all stakeholders, would soon be in place, before the issue of diminishing clean and sustained water supplies drown humanity in chaos.

Ecosystem services of wetlands

- Retain water from precipitation and surface run off
  - maintain ground water table
  - direct source for drinking and irrigation
- Mitigate flood: contain deluge, protecting properties in the down stream
- Coastal Guard: guard against storm and soil erosion
- Sediment trapping: suspended sediments are deposited at the bottom, 80-90%, hence the load is reduced in the water that flows out
- Nutrient removal: reduce nitrogen and phosphorus in the water, even up to 90%, by the uptake of plants
- Reduction of Biological Oxygen Demand (BOD) from surface water: By decomposition of organic matter or oxidation of inorganics, wetlands remove BOD even up to 100%
- Removal of toxic residues: wetland vegetation absorbs and retains 20-100% of metals in water
- Removal of pathogens: Faecal coliform bacteria and protozoan attached to the suspended solids are trapped by wetland vegetation, thereby avoiding threat to human health
- Waste processing: by high primary productivity rates, sedimental rates and bacterial action in the sediments
- Fish and other fauna: it appears 60-65% of the world's fish are caught in the wetlands
- Plant resources: edible, medicinal and other economic uses
- Habitat: for a wide variety of plants and animals; especially waterfowl
- Non-consumptive values: scenic, recreational, aesthetic, scientific

(Compiled from various sources)

Ecosystem goods and service values of wetlands

Wetland /per ha : US $ 14,785 (Costanza *et al.*, 1997)
Forest /per ha : US $ 2,007

Total goods and service values of wetland : US $ 8,700 billion/ per year

This is much above the combined GDP of several countries !!

This means, if there are no wetlands around, humanity has to spend this much more amount of money to keep going and not to be an extinct species on earth



Erach Bharucha

Flamingos in Bhigwan

Wetland definition

Ramsar:

"the 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 6 m"

Popular one:

"lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water" - Cowardin *et al.*, (1979)

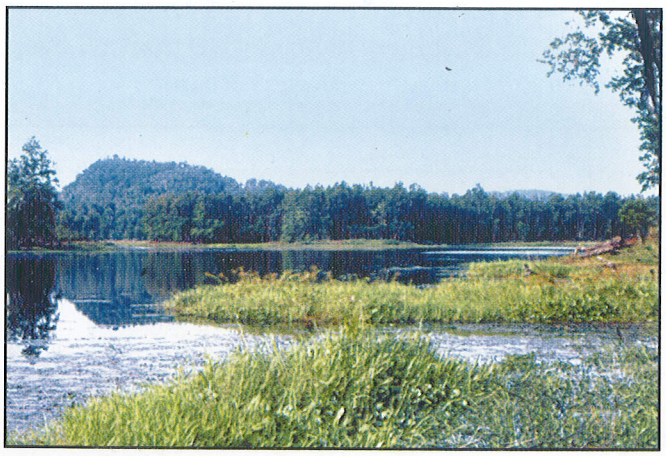
The extent of wetlands

In the world

5.6 million sq km (Aselmann and Crutzen, 1989)
6 million sq km (Maltby and Turner, 1983)

In India

MoEF (1990)	:	4.1 million ha (above 100 ha in size); 67,429 wetlands
WWF-India-AWB (Anon., 1993)	:	10.8 million ha ; (excluding paddy fields and fisheries)
SAC, Ahmedabad (1998)	:	7.58 million ha (all types of wetlands); 3.56 million ha (freshwater wetlands)
SACON's estimate of freshwater wetlands	:	7 million ha



Anwaruddin Choudhury

Chandubi beel; one of the IBAs in Assam

2. OBJECTIVES & METHODOLOGY

In the fast deteriorating scenario of the wetland wealth of the country, the utmost priority, as already indicated by the National Wetland Committee of the MoEF, should be given to document the existing wetland resources. Hence, the project was envisaged to develop a **'comprehensive inland wetland inventory, mapping and classification on a large spatial scale using existing and also by generating additional information'**.

Under this major direction, the specific objective of the project was fixed at prioritizing the Inland Wetlands on a multi-criteria for long-term conservation. The following three components were identified to achieve the same.

1. Mapping of the wetlands and the select group of flora and fauna using remote sensing /GIS data,
2. Collection of data on major biodiversity, economic utilization of the wetlands and conservation issues, and
3. Evaluation of the environmental contamination in select wetlands.

The methodology adopted for achieving each of the above specific goals is given below:

1. Mapping of the wetlands and their major biodiversity using remote sensing data

Specific tasks identified were :

a. Map wetlands, 2 ha and above, in selected districts of the following states using the digital image processing of remote sensing data
   - Andhra Pradesh
   - Bihar including Jharkhand
   - Gujarat
   - Jammu & Kashmir
   - Karnataka
   - Madhya Pradesh including Chhattisgarh
   - Maharashtra
   - Rajasthan
   - Tamil Nadu
   - Uttar Pradesh including Uttaranchal

b. Evaluate the status of turbidity and aquatic vegetation in wetlands

c. Map the status of land use around the wetlands

d. Make a complete inventory of wetlands of 2 ha and above

e. Prepare the distribution maps of wetlands of 56.25 ha and above in size, using the existing information

f. Prepare distribution maps of selected waterfowl species and endemic wetland plants of India

g. Map the prioritized wetlands of India for conservation

Methodology for mapping

Remote sensing

A method was developed for the project using digital image processing (Anon ,2000). The digital image processing was carried out on IBM workstation using EASI/PACE and SGI workstation using ERDAS-IMAGINE software. The digital data processed from NDC, NRSA pertain to 1999-2001 period. The methodology is summarised below:

i. Geometric corrections

Geometric corrections of IRS LISS III digital data have been carried out using SOI toposheets at 1:2,50,000 scale. The projection defined for the district was followed as per NRIS standard.

Projection Type : Polyconic
Datum : Everest and central co-ordinates (approximate) of the district.

ii. Classification

Land use classification has been carried out to map various land use categories. The ground truth was collected during field trips. Special care was taken to classify 'marshy' and 'swampy' areas, as these constitute important components of the wetlands, but could not be separated along with the 'water bodies' which are being separated independently. Interactive help from topographic maps and ground truth was taken for locating swampy areas.

iii. Extraction of water bodies

Band 4 of IRS LISS III image data were 'density sliced' to separate the water bodies. Threshold values for water mask were obtained interactively. A bit map was generated for the water bodies as mask which was used for further classification of water bodies into turbidity pattern and aquatic vegetation.

iv. Classification of water bodies based on area criteria

The water bodies were interactively classified into sub- classes, namely reservoirs, ponds /lakes, oxbow/ cut-offs. This was performed by identifying the Area of Interest (AOI) in ERDAS-IMAGINE.

v. Turbidity patterns

Turbidity patterns are best reflected by the band 2 LISS III image data. Higher the DN value in band 2, greater the turbidity. The turbidity classification is essentially qualitative in nature. Determination of the threshold for different turbidity levels had to be verified with the major (large sized) water bodies in the area. The density slicing of the band 2 data was carried out within the water body mask generated in step iii. Finally, the image was segregated to obtain three turbidity levels. The recoded values being:

Low turbidity : 1
Moderate : 2
High : 3

vi. Aquatic vegetation

Aquatic vegetation was classified within the water body mask that was generated using band 4 of LISS III data. The Normalised Difference Vegetation Index (NDVI) was obtained for water bodies. The NDVI values of less than zero were considered as nil or negligible vegetation. The positive values were subjectively divided into three vegetation levels, namely low, moderate and high vegetation coverage. Recoding of the NDVI image was done to obtain an image classified into three aquatic vegetation classes.

Suggested recoded values were:

Nil/Negligible/Low coverage	:	1
Moderate	:	2
High	:	3

vii. Integration of wetlands on the basis of the turbidity and aquatic vegetation

The turbidity classified image (having coded values 1, 2 and 3) and the aquatic vegetation classified image (coded as 1, 2 and 3) were added using arithmetic operators to obtain an image having 9 classes, (coded as 11, 12, 13, 14, 15, 16, 17, 18, 19) which show the vegetation classes amongst the three turbidity levels.

The image obtained above was then recoded to yield new values to the different classes. The classification codes for aquatic vegetation and turbidity classes are:

Class	Ponds/Lakes/Tanks	Reservoirs
Low turbidity - Low vegetation	11	21
Low turbidity-Moderate vegetation	12	22
Low turbidity- High vegetation	13	23
Moderate turbidity - Low vegetation	14	24
Moderate turbidity - Moderate vegetation	15	25
Moderate turbidity - High vegetation	16	26
High turbidity - Low vegetation	17	27
High turbidity - Moderate vegetation	18	28
High turbidity - High vegetation	19	29

viii. Integration of land use classification with turbidity and aquatic vegetation

The classified and recoded land use map was combined with that of recoded aquatic vegetation cum turbidity output. A further recoding of the various classes was carried out to match the final legend according to the classification scheme. Print outs for the districts were taken at A4 size and verified in the field.

ix. Refinements of classification

Necessary refinements were carried out on the classified (integrated) output to enable easy map reading.

x. Analysis of selected wetlands at 1:50,000

After selection of one quadrant area, wetlands of the LISS III data in each district (by SACON), the IRS LISS III data of post-monsoon (April/May data) are georeferenced with reference to 1:50,000 scale topographic

maps. The corresponding area from the classified outputs generated earlier was reprojected as per 1:50,000 scale topo maps. The image processing for the post-monsoon data was carried out using the similar method as described for district level mapping.

xi. Output generation

Outputs were generated for each district as well as for identified wetlands on A1 size paper, and soft copy outputs involving all aspects were given in a composite fashion on CD in ERDAS compatible format. The soft copy outputs are :

- Land use map with wetlands classified up to level two,
- Wetland class with turbidity and aquatic vegetation combined classes,
- Turbidity classification,
- Aquatic vegetation,
- Integrated map of land use, turbidity and aquatic vegetation,
- FCC of the district and,
- Pre-monsoon and Post-monsoon water spread.

Since these composite maps are difficult for field level use, these were segregated for specific components, such as wetland types, turbidity and vegetation and, a new and simple colour coding was done by the SACON team on remote sensing and GIS. Final map composition was done by this team from SACON.

xii. GIS layers on wetlands (above 56 ha), bird and plant distribution

An extensive programme of generating GIS layers consisting of tabular data from the earlier inventory and value addition process was taken up by the SACON team on remote sensing/GIS over the project period. A GIS database of wetlands for 246 districts of most states, except Tamil Nadu, Gujarat and West Bengal was developed. No data were available for these states for generating similar database. Data on select species of waterfowl were obtained from the Asian Waterfowl Census over the last 10 years and, GIS layers were generated. Similarly, data on 114 endemic aquatic plant species were used to generate the distribution maps. A comprehensive Conservation Atlas of Inland Wetlands is being produced separately.

An overall distribution of wetlands as point location was done for a number of states. The data were obtained from various State Remote Sensing Service Centres (Kumar *et al.*, 2002). The field data and museum/ herbarium pertaining to birds, plants, vegetation and socioeconomic attributes were entered into ARC Info 8.2 for spatial analyses and mapping. Wetland sites prioritized were shown in relation to other data such as Biodiversity Conservation Prioritization Project (BCPP), Important Bird Areas (IBAs), PAs, Ramsar sites.

xiii. Temporal changes in the wetland cover

An attempt was made to analyze the loss/gain of wetland cover in the select districts during the past 10 years. The satellite data generated by Space Applications Centre, Ahmedabad during the period between 1992-93 (SAC, 1998) and those generated by SACON during 2001 are used for comparison.

The major caveats for this analysis are: (1) the spatial resolution used in two different data sets are 56.25 ha and 2 ha for the SAC and SACON data respectively, (2) the precise dates of acquisition of satellite data for the two time periods vary and, (3) the variation in rainfall. Despite these handicaps, the bottom line of such

a comparison is that there would be no expected decrease in wetland extent, as all wetlands of the size 2 ha and above are taken into consideration in the data set of 2001.

Such an analysis was done for the wetlands of the districts selected for intensive studies from 10 states and the results are given under respective state report.

2. Collection of data on major biodiversity and economic utilization of the wetlands and conservation issues

i. Selection of wetlands

The earlier work on coarse scale mapping using LISS-I data by SAC, Ahmedabad formed the basis for the selection of sampling sites. The selection process, initially, was based on the size of wetland and the number of smaller wetlands surrounding the bigger wetland. In each state, approximately 30–50 sites were selected. The size of selected wetlands ranged from several thousand hectares to a few tens of hectares. Subsequently, the sites were confirmed in consultation with the state coordinators/ consultants based on the field information that they had. Secondary and primary data were collected on select wetlands.

ii. Compilation of secondary data

a. Birds

A list of wetland birds, comprising 417 species (Vijayan, 1986), as compiled from Ali & Ripley (1983) and the major species were incorporated in the data sheet prepared for collecting data from selected sites.

Information on more than 300 wetland birds were compiled from various sources. The references were screened to collect information on the wetland sites. More than 400 sites were recorded from different parts of the country, which were sorted out state-wise. Special attention was given to collect records on the rare species, occurrence of which is one of the criteria for deciding the important sites. Site information was also compiled from the field data of the Asian Waterfowl Census of earlier years (1990s) obtained from Bombay Natural History Society (BNHS), and Wetlands International – Asia Pacific (formerly Asian Wetland Bureau) and other sources to help identify the important sites. However, there were limitations in these data, as they were not available uniformly from different states.

b. Plants

A list of species of aquatic angiosperms was compiled from literature, mainly Cook (1996) and Flora volumes (BSI). Special attention was given to identify the endemics and, site records were collected from various herbaria of Botanical Survey of India (Coimbatore, Kolkata and Pune); Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore; Calicut University and Rapinat Herbarium, Tiruchirapalli. All the site records were combined, coordinates found out and mapped to identify important wetland sites and also to get the distribution map of each species.

c. Fishes

Information on the freshwater fishes were compiled by screening 545 references which include Talwar and Jhingran (1991), Menon (1999), Jayaram (1999), National Bureau of Fish Genetic Resources & Zoo Outreach

Camp Workshop (1997), Chhapgar and Manakadan (2000), Daniels (2002) and Vishwanath (2002). A total of 4,231 records were obtained. A list of Threatened species was compiled following Menon (1999), and distribution of these species is given in the respective states.

d. Herpetofauna

Information on all the 24 species of freshwater turtles (Choudhury *et al.*, 2000) were compiled by screening 105 references covering 1,545 records in 448 sites in 29 states (Bhupathy and Menon, 2003). Details of the wetlands were also recorded. A list of the freshwater turtles present in each state is reported.

iii. Collection of field data

Original data from select wetlands were collected on waterfowl, aquatic vegetation and socioeconomics. Fish samples were collected for assessing contamination.

Since the project had to cover the entire country, it was envisaged in the conceptual stage itself that local expertise should be involved in the project for collecting primary data. Such an involvement, it was thought, would go a long way in establishing a network of expertise from all parts of the country to lay a foundation for future monitoring programme. Moreover, a project of such a high magnitude covering the entire country, calls for enormous manpower to collect data within a very limited time. Hence, a participatory programme among various institutions and individuals from all over the country was designed.

iv. National workshops for state coordinators

State coordinators and a few consultants were identified and a workshop for the coordinators was conducted to deliberate on the project, methodology, work plan, modalities, time schedule and preparation of the report. Methodologies for collecting data on birds, vegetation, environmental contamination and socioeconomic aspects of the wetland were presented and discussed.

v. State-level workshops for local resource personnel

Workshops were conducted for the resource personnel, identified by the respective state coordinators, and the methodologies for collecting data were explained and demonstrated in the field. Illustrations of 109 common aquatic plants and some common fishes and, a list of Threatened and Near Threatened birds (Appendix 2) from the Threatened Birds of Asia (BirdLife International, 2001) were circulated to the field persons for reference. 30-50 wetlands / wetland complex were identified for each state. In all, 655 wetlands were prioritized and selected for field studies. The work-plan and format for report were also finalized. Twelve such state-level workshops were conducted during August-December 2001 for the 25 states selected for detailed studies. A total of about 250 local resource persons along with the local coordinators participated in the workshops, and above 500 persons were involved in the fieldwork.

vi. Regional workshops

Six regional workshops, one each in Guwahati, Pune, Ahmedabad, Jaipur, Coimbatore and Hyderabad were conducted after the field work to discuss the report of the field study compiled by the respective coordinators. These were attended to by, apart from the participants of field survey, officials of the Forest Department and also other NGOs of the area. Hence, the state reports had a consensus of the concerned people.

vii. Conservation criteria

Major criteria identified for prioritizing the wetlands (Ramsar Convention Bureau, 1997) were birds, fishes, plants, hydrology, size of the wetland and socioeconomic uses (listed below). However, many of these criteria, except birds, size and socioeconomic uses, could not be used as data were not available. Data on the individual criteria were categorized in the following way.

a. Birds
- Total number of species
- Total count of waterfowl
- 1% Biogeographic population
- Threatened and Near Threatened species
- Population of Threatened and Near Threatened birds
- Resident and breeding birds
- Raptors
- Stop over migration/flyway

b. Fishes
- Endemic species/Endangered species
- List of fishes

c. Vegetation
- Endemic species/ Endangered species
- List of plants

d. Hydrology
- Flood control
- Drinking water (Crucial irrigation sources)
- Ground water recharge
- Seasonal/Perennial source

e. Socioeconomics
- Dependence of local people
- Cultural values
- Food/Fodder
- Eco-tourism value

vii. Methodology for bird census

The method followed for bird census was "total count" wherever possible, walking round the wetlands or from specific vantage points (Vijayan, 1991). If not completely covered, the per cent of coverage was marked, and if possible a rough estimate given taking into consideration of the habitats available as in stratified sampling. In each area three counts in two days, covering morning and evening were done in most cases and the maximum number is taken for the area. Whenever species identification was found to be difficult, the group-wise data were provided, so that the total number could be considered. Wetlands, which fall within 5 km radius of a major one, are grouped together as a complex and considered as a unit. The counts were made during December 2001-February 2002 except for the high altitude areas where it was done during May-June 2002.

Most of the resource persons were experienced, as they have been involved in the Asian Waterfowl Census for quite some time. However, in the case of Bihar, Jammu and Kashmir and in some states in the Northeast, such resources were scanty.

Data were analyzed for species richness, abundance in total, group-wise, (taxonomical) and species-wise for each wetland or wetland complex and for the whole state. Status-wise distribution of resident, migrant and threat categories such as Threatened, Near-Threatened was also considered as these are of special significance for assigning conservation value to the wetland. Species above the threshold population of the biogeographic region were also categorized based on Rose and Scott (1994) and Important Bird Area Criteria given by BNHS & RSPB (Jhunjhunwala *et al.*, 2001).

viii. Plants

Wetland vegetation is broadly classified as emergent, floating and submerged depending on the structure and habit, the first one stands out of the surface of water and can exist in partly wet soils while the other two exist only in water. Any wetland may have one or more of these vegetation types as well as areas with open water. The plants exhibit various patterns of distribution and densities. They may be locally dense or scattered, in patches or in expanses. The data sheet was designed to simultaneously record the density and spread of the different vegetation types in the wetland. This would give a picture of the type of wetland and habitats, which would clearly indicate the bird community.

ix. Fishes

Primary data on fishes were collected only for contamination studies and evaluating the socioeconomic values of the wetland.

x. Socioeconomic data

Since wetland resources have been used traditionally by the people living around the wetlands and, since the studies have shown that the economic benefit of the wetlands could be utilized without compromising the biodiversity values of the wetlands (Dugan, 1988,1990; Vijayan, 1991, 1994; Ramsar Convention Bureau, 1997), it was envisaged to collect data on the level of dependence of people on the wetlands. Such data would be required while prioritizing each wetland and, while determining the kind of protection to be given; Community Reserve/ Sanctuary/ National Park. It is also understood that the use of the resource would affect the habitat diversity in a wetland impacting some of the wetland birds (Weller, 1999). Hence, a regular monitoring of the resource use is essential for the conservation of the wetland biodiversity. A questionnaire was prepared for collecting information on the socioeconomic aspects of the wetlands from the people living around. It included physical details such as extent of area, status, values and uses, details of the people living around and using the resources, their attitude, dependency, contamination profile and other conservation issues of the site.

3. Environmental contamination

The study on environmental contamination was focussed to (i) assess the contamination profile, heavy metals and organochlorine pesticides, of fishes of inland wetlands of India; (ii) generate a database and (iii) evaluate the possible toxic impact on the consumers (man and piscivorous birds).

Materials and methods

The procedure for collecting, packing and forwarding fish samples to the laboratory at Sálim Ali Centre for Ornithology and Natural History was explained at the coordinators' meet at Delhi, as well as at the state-level workshops where all the key resource persons were present. A special kit containing a polymer was developed for protecting the fishes while on transit.

Eight species of commonly occurring fishes, namely *Cyprinus carpio, Labeo rohita, Anabas testudineus, Oreochromis mossambicus, Clarias batrachus, Heteropneustes fossilis, Cirrhinus mrigala* and *Channa orientalis* were chosen for the study, based on their abundance, distribution and trophic status. Desired size and weight range were also specified. However, these specifications could not be adhered to, because of the practical difficulties, and the fishes were received irrespective of the size classes. Samples on arrival were transferred to deep freezers till processing.

Samples were processed for pesticides and heavy metals adopting different procedures. While extraction and clean up were the major steps involved in pesticide studies, digestion of samples using various acids in Microwave Digestion System was the tedious step in heavy metal quantification. Advanced instruments, namely Gas Chromatograph fitted with ECD and Atomic Absorption Spectrophotometer were used for the study. Although, innumerable pesticides are being used in various parts of the country and a variety of heavy metals are present in the inland wetlands, the present investigation is largely confined to the following most common ones:

Pesticides: *p,p'*-DDT, *p,p'*-DDE, *p,p'*-DDD, alpha-HCH, beta-HCH, gamma-HCH, delta-HCH, heptachlor, heptachlor epoxide, dieldrin, endosulfan I, endosulfan II, and endosulfan sulphate.

Heavy metals: Copper, lead, zinc, cadmium and chromium.

The results are expressed in ppm wet weight. Along with the results, suitability of the fish for human consumption as per the permissibility levels fixed by Joint Expert Committee on Food and Agriculture of United Nations and World Health Organization (WHO, 1989, 1993) for metals, and Provisional Tolerable Dietary Intake, Health Canada (1996) for organochlorine pesticides are also given for each state. Abbreviations used in the text are of WHO (1989, 1993) and Health Canada (1996) respectively. The contaminants input into human beings is calculated based on the assumption that the average consumption per-week is 250 gm.

4. Prioritization of wetlands for long-term conservation

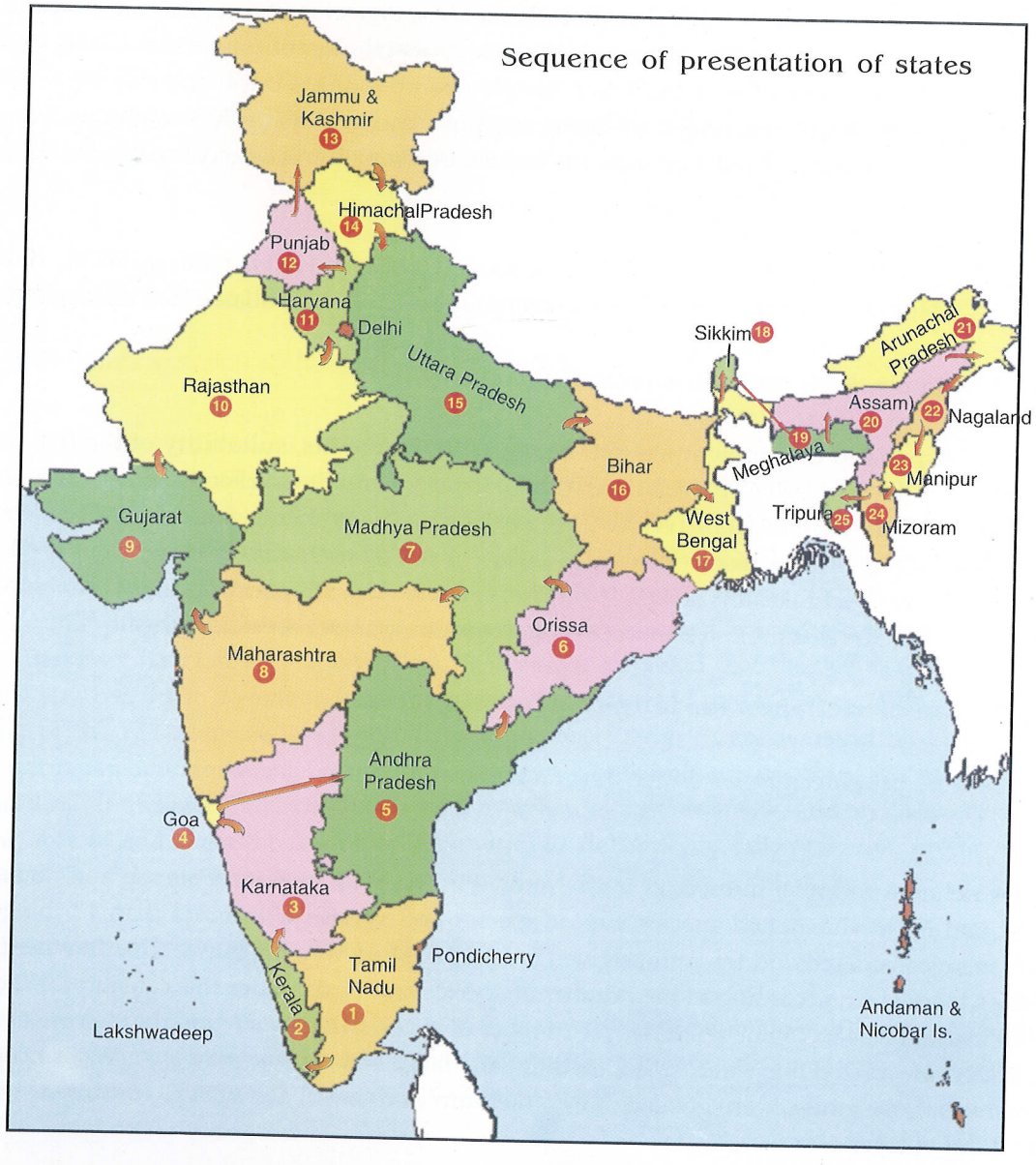
The wetlands were prioritized based on the data on birds, and size and socioeconomic use of the particular wetlands.

The species richness and total number of birds counted in the peak migratory season and, the number of Threatened and Near Threatened species, raptor species and species with more than 1% biogeographic population were considered and the ratings given from 1-10. More weightage was given to the Threatened birds (ratings were given according to the number of species and birds under this category). Wherever, the data on number of birds were not available, the number of species alone was used. In the case of the size of wetland, it was categorized into three; small, medium and large and ratings were given accordingly. For the socioeconomic use, the grades were given as 'low', 'medium' and 'high', according to the intensity of the use pattern by local villagers.

The ratings for birds and size of the wetland were added together while use grade was taken separately. Rank was given according to the rating obtained, those with top ratings were given first rank. This was followed by second, third and fourth ranks. Those in the first rank were again examined to see whether they qualify the criteria specified for declaration as Ramsar sites (Ramsar Convention, 1997). In case, even if the sites are in the second rank, but still qualify the Ramsar criteria, they are also recommended to be declared as Ramsar sites. However, all of them would become part of the National Network of Inland Wetland Conservation Areas. Specific action for each wetland, whether to be declared as Community Reserve or Protected Area, is to be decided depending on the use value and richness of biodiversity.

Sequence of presentation of the state reports

The report for each state is presented on geographical basis, starting from the southern tip (Tamil Nadu) covering adjacent states, moving towards Jammu & Kashmir and then towards Himachal Pradesh and passing through Uttar Pradesh, Bihar and finally ending up with Tripura as shown in the figure below.



TAMIL NADU

Tamil Nadu, endowed with bountiful and benign nature, has a tradition of preserving the ponds and tanks, dating back to the 4th and 5th centuries. With its long coast lines, alluvial plains, and hill chain of the Western Ghats, the state offers a wide variety of habitats. Situated on the southeast of the Indian Peninsula, Tamil Nadu can be divided physiographically into: i) the eastern coastal plain and , ii) the hilly region along the north and the west. The coastal plain is further divided into (a) the coromandel plain in the north (b) the alluvial plain of the Cauvery delta and (c) the dry southern plains. Along the whole length of the western part, at a distance from the sea varying from 80 to 150 km runs the range of Western Ghats, a steep and rugged landmass averaging 1,220 m above the sea level and rising up to 2,440 m at the highest point.

The state has a number of rivers, all flowing from west to east, the Western Ghats to the Bay of Bengal. The rivers are entirely rain fed and short in length. The main river of the state is Cauvery which flows across Tamil Nadu cutting the state into two halves. Some of the major rivers are Amaravathi, Bhavani, Tamaraparani and Vaigai.

The climate of Tamil Nadu is of tropical type, summers are not too hot and winters not too cold. The temperature varies from 21.5 to 37.7°C. Rainfall is fairly widespread throughout the year. The state gets full benefit of the north-east monsoon, which brings rainfall in October to November and sometimes in December also. The south-west monsoon also serves the state from June to September. The average annual rainfall varies from 670 to 1,200 mm.

Status of wetlands

It may be noted that the land use statistics of the state does not indicate wetlands which are possibly classified under some other categories (Table 3.1). Studies by SAC (1998) show that the wetland area of the state was 1.24% of the total area in 1991. The total number of wetlands of the size 56.25 ha and above for the whole state was estimated at 1,175 covering an area of 1,615.12 sq km (Table 3.2). The number and area of wetlands of the size 2 ha and above in eight select districts in 2001 were 4,779 and 731.72 sq km respectively (Table 3.3).



State at a glance	
State capital	Chennai
Area	1,30,058 sq km
Population (2001)	62,110,839
Total number of districts	30
Major rivers	Cauvery, Amaravathi
Total forest area	21,400 sq km
Population density (2001)	478/sq km
Ramsar site	1
Proposed Ramsar sites	5
Total sites proposed for conservation	49

Table 3.1. Land use pattern in Tamil Nadu

Land use category	Area in sq km
Total geographic area	1,30,058
Forests	21,400
Not available for cultivation	24,450
Other uncultivated land excluding fallow land	7,110
Fallow land	20,660
Net area sown	56,350
Area sown more than once	9,930
Total cropped area	66,270
Cultivable area	84,120

Source: www.indiastat.com

The wetlands in Tamil Nadu comprise lakes, ponds, reservoirs and seasonally waterlogged areas (Table 3.2).

Table 3.2. Distribution of various categories of inland wetlands in Tamil Nadu

Wetland category	Area (sq km)	No. of wetlands
Lakes/ponds	938.67	773
Oxbow lakes	5.48	1
Waterlogged (seasonal)	74.41	31
Reservoirs	220.73	29
Tanks	375.92	341
Total	1,615. 12	1,175

Source: SAC (1998)

Habitat analyses of wetlands in select districts

Eight districts, namely Vellore, Cuddalore, Pudukkottai, Thanjavur, Ramanathapuram, Tirunelveli, Kanyakumari and Chengalpet were chosen to map wetlands at finer resolution (23.5 m) and to capture wetlands above 2 ha in size and study them in detail along with the land use in the catchment area. Turbidity, vegetation and seasonal changes in water level in the wetlands of these eight districts were studied. The land use pattern as well as the seasonal changes in water levels varies greatly among the wetlands of different districts (Table 3.4-3.27).

Wetlands

The area under wetlands in the eight districts studied ranged between 0.42% (Tirunelveli) and 5.11% (Pudukkottai) of the geographical area of the respective districts (Fig. 3.1). Three categories of wetlands were found, namely ponds/lakes, reservoirs and waterlogged areas. Oxbow lakes were not recorded from the districts studied in Tamil Nadu. Waterlogged land was the dominant type of wetland in Thanjavur district, whereas it was reservoir in Kanyakumari district. All other districts had more ponds/lakes (Fig. 3.2; Table 3.3).

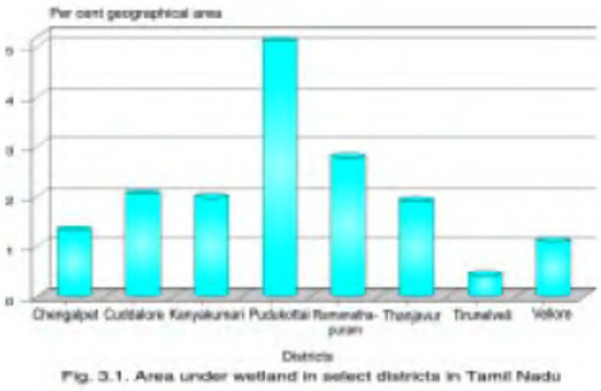


Fig. 3.1. Area under wetland in select districts in Tamil Nadu

It is striking that all the districts had smaller wetlands (smaller than 56.25 ha) several times more numerous than the larger ones (Fig. 3.3).

Table 3.3. Area (in sq km) under different classes of wetlands in select districts of Tamil Nadu

Districts	Ponds/lakes/tanks		Reservoirs		Waterlogged		Total no. of wetlands	Total area of wetlands
	No.	Area	No.	Area	No.	Area		
Chengalpet	550	94.88	2	19.21	-	-	552	114.09
Vellore	363	65.48	-	-	-	-	363	65.48
Cuddalore	110	73.47	-	-	-	-	110	73.47
Pudukkottai	1,810	232.25	-	-	-	-	1,810	232.25
Thanjavur	311	22.75	-	-	479	43.36	790	66.11
Ramanathapuram	887	116.37	-	-	-	-	887	116.37
Tirunelveli	170	20.86	3	7.29	-	-	173	28.15
Kanyakumari	88	9.7	6	26.1	-	-	94	35.8
Total	4,289	635.76	11	52.6	479	43.36	4,779	731.72

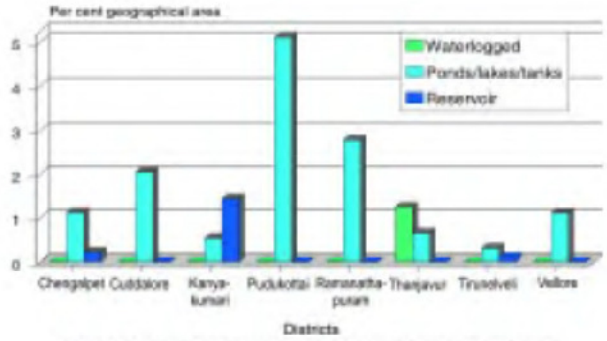


Fig. 3.2. Area under different wetland classes in select districts in Tamil Nadu

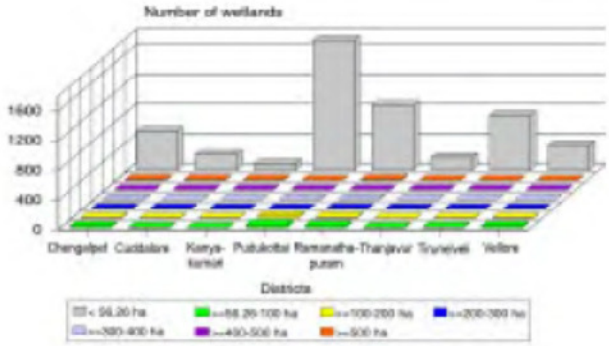


Fig. 3.3. Size class distribution of wetlands in select districts in Tamil Nadu

Turbidity

The reservoirs in the three districts had low turbidity while the ponds/ lakes in all the districts showed moderate to high turbidity, except in the case of those in Tirunelveli and Vellore, where it was low and low/ moderate respectively. (Fig. 3.4,3.5; Table 3.28).

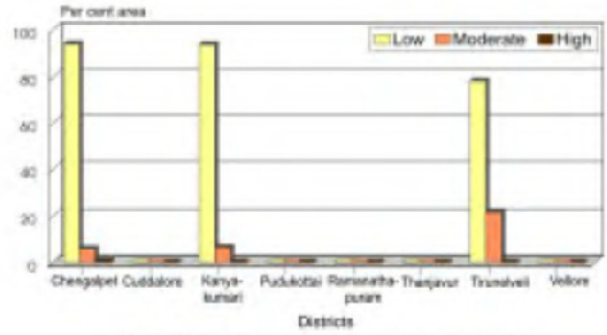


Fig. 3.4. Turbidity pattern of reservoirs in select districts in Tamil Nadu

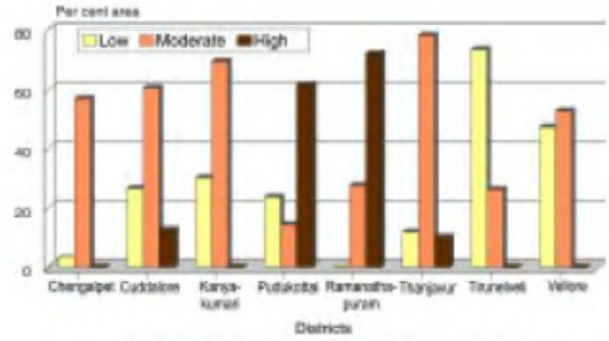


Fig. 3.5. Turbidity pattern of ponds/lakes/waterlogged areas in select districts in Tamil Nadu

Summer recession

Summer (pre-monsoon) recession of wetland area varied from 0.56% in Kanyakumari to 100% in Pudukkottai (Fig. 3.6). In all other districts, the recession is between 35% and 75%. Such a landscape level recession of water will affect the aquatic birds and other fauna, especially those fully dependent on wetlands.

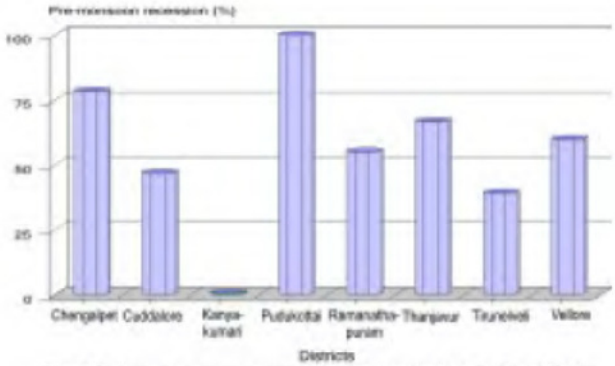


Fig. 3.6. Average summer recession in select districts in Tamil Nadu

Wetlands and land use pattern in the catchment areas

Integrated land use maps of all the eight districts show that catchment areas of most of the wetlands in the plains are covered mainly by agricultural land. In the case of reservoirs, the catchment areas are covered by forests or agricultural lands (Fig. 3.7-3.14).

Temporal changes in wetland cover

A comparison of the wetland cover, between the SAC's data of 1991 and SACON's data of 2000-2001 for the eight select districts shows that there is a considerable decrease in the wetland area between these two periods in all the districts, except in Kanyakumari where there is an increase in wetland area, about 20.82%. Maximum loss was in Cuddalore; 88.32% followed by Tirunelveli; 84.90% (Table 3.29; Fig. 3.15). It appears for the eight districts, there is a total loss of 950.74 sq km.

Table 3.29. Changes in the wetland area (in sq km) in select districts

District	SAC (1991)	SACON (2001)	Variation	% Variation
Chengalpet	223.67	114.09	-109.58	-48.99
Cuddalore	629.17	73.47	-555.70	-88.32
Pudukkottai	251.55	232.25	-19.30	-7.67
Kanyakumari	29.63	35.80	6.17	20.82
Thanjavur	116.20	66.11	-50.09	-43.11
Tirunelveli	186.38	28.15	-158.23	-84.90
Ramanathapuram	132.17	116.37	-15.80	-11.96
Vellore	132.99	65.48	-67.51	-50.76

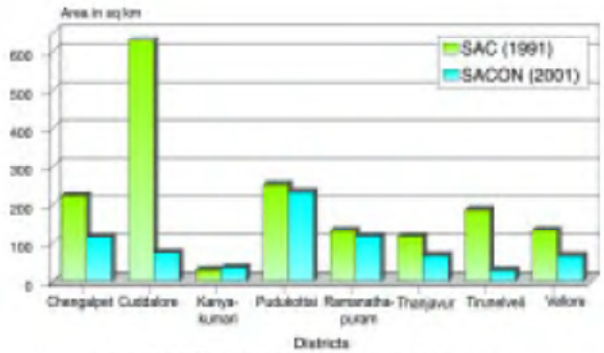


Fig. 3.15. Difference in total wetland area in Tamil Nadu

Biodiversity

Vegetation

The proportion of the area of vegetative cover is low in almost all the wetlands mapped in the eight districts. However, moderately thick growth of aquatic plants was noticed in the wetlands of Ramanathapuram, Vellore and Pudukkottai.

Plants most widely represented in the wetlands of Tamil Nadu are non-native introductions. The exotic plant *Ipomoea fistulosa* is one among them; reported from 24 of the 51 wetlands surveyed. No species of plant reported from the wetlands in the present study can be treated as rare or endangered except *Oryza rufipogon*, which is an important genetic resource. This species, present in extensive patches in the Mapedu Peria Eri, is not widely known in the state. Altogether 46 species of endemic aquatic plants belonging to 14 families were reported from Tamil Nadu (Table 3.30).

The detailed satellite data analyses on different classes of aquatic vegetation as well as cross classification of turbidity and vegetation across different types show that all the reservoirs had consistently low turbidity (Table 3.28), whereas the lakes/ ponds had moderate turbidity in six districts which indicate that the sedimentation is higher in the ponds/ lakes. However, spread of vegetation is almost the same both in the reservoirs and ponds/ lakes ie. low in both (Fig. 3.16, 3.17).

Table 3.28. Summary of turbidity and aquatic vegetation in wetlands of select districts

Wetland class	No. of wetlands*	Area sq km	% of wetland type area					
			Turbidity level			Aquatic vegetation		
			Low	Moderate	High	Low	Moderate	High
Chengalpet								
Ponds/lakes/tanks	2	19.21	3.15	56.85	00.00	100.0	00.00	00.00
Reservoirs	550	94.88	93.83	5.69	0.47	100.0	00.00	00.00
Vellore								
Ponds/lakes/tanks	363	65.48	47.30	52.70	00.00	56.90	43.1	00.00
Cuddalore								
Ponds/lakes/tanks	110	73.47	26.64	60.75	12.62	86.24	12.98	0.78
Pudukkottai								
Ponds/lakes/tanks	1810	232.25	23.81	14.29	61.90	76.19	23.81	0.00
Thanjavur								
Ponds/lakes/tanks	311	22.75	0.00	100.0	0.00	88.61	9.94	1.45
Waterlogged	479	43.36	23.55	56.23	20.23	100.0	0.00	0.00
Ramanathapuram								
Ponds/lakes/tanks	887	116.37	00.00	27.69	72.31	59.17	40.83	0.00
Tirunelveli								
Reservoirs	3	7.29	78.19	21.81	00.00	100.0	00.00	00.00
Ponds/lakes/tanks	170	20.86	73.63	26.37	00.00	86.43	13.57	00.00
Kanyakumari								
Reservoirs	6	26.1	93.64	6.36	0.00	84.52	15.48	0.00
Ponds/lakes/tanks	88	9.7	30.31	69.69	0.00	92.89	7.11	0.00

* wetlands of size 2 ha and above only

Table 3.30. List of endemic aquatic plants of Tamil Nadu

S.#.	Species	Family
1	*Tonningia cucullata*	Commelinaceae
2	*Aponogeton appendiculatus*	Aponogetonaceae
3	*Lagenandra meeboldii*	Araceae
4	*Cryptocoryne spiralis*	Araceae
5	*Cryptocoryne consobrina*	Araceae
6	*Cyanotis papilionacea*	Commelinaceae
7	*Eleocharis swamyii*	Cyperaceae
8	*Eriocaulon richardianum*	Eriocaulaceae
9	*Eriocaulon ritchieanum*	Eriocaulaceae
10	*Eriocaulon robusto-brownianum*	Eriocaulaceae
11	*Farmeria indica*	Podostemaceae
12	*Fimbristylis crystallina*	Cyperaceae
13	*Fimbristylis woodrowii*	Cyperaceae
14	*Fuirena swamyii*	Cyperaceae
15	*Fuirena trilobites*	Cyperaceae
16	*Fuirena wallichiana*	Cyperaceae
17	*Geissaspis tenella*	Fabaceae
18	*Hoppea dichotoma*	Gentianaceae
19	*Hygrophila serpylla*	Acanthaceae
20	*Hygrophila pinnatifida*	Acanthaceae
21	*Indotristicha ramosissima*	Podostemaceae
22	*Indotristicha tirunelveliana*	Podostemaceae
23	*Isachne elegans*	Poaceae
24	*Ischaemum nilagiricum*	Poaceae
25	*Limnophila polystachya*	Scrophulariaceae
26	*Lindernia minima*	Scrophulariaceae
27	*Lipocarpha raynaliana*	Cyperaceae
28	*Murdannia lanuginosa*	Commelinaceae
29	*Murdannia pauciflora*	Commelinaceae
30	*Myriophyllum oliganthum*	Haloragaceae
31	*Najas marina ssp.*	Haloragaceae
32	*Paspalum canarae*	Poaceae
33	*Podostemum barberi*	Podostemaceae
34	*Polypleurum dichotomum*	Podostemaceae
35	*Ramphicarpa longiflora*	Scrophulariaceae
36	*Rotala ritchei*	Scrophulariaceae
37	*Rotala fimbriata*	Lythraceae
38	*Rotala illecebroides*	Lythraceae
39	*Rotala macrandra*	Lythraceae
40	*Sesbania procumbens*	Fabaceae
41	*Utricularia albocaerulea*	Lentibulariaceae
42	*Utricularia arcuata*	Lentibulariaceae
43	*Utricularia praeterita*	Lentibulariaceae
44	*Utricularia smithiana*	Lentibulariaceae
45	*Utricularia wightiana*	Lentibulariaceae
46	*Willisia selaginoides*	Podostemaceae

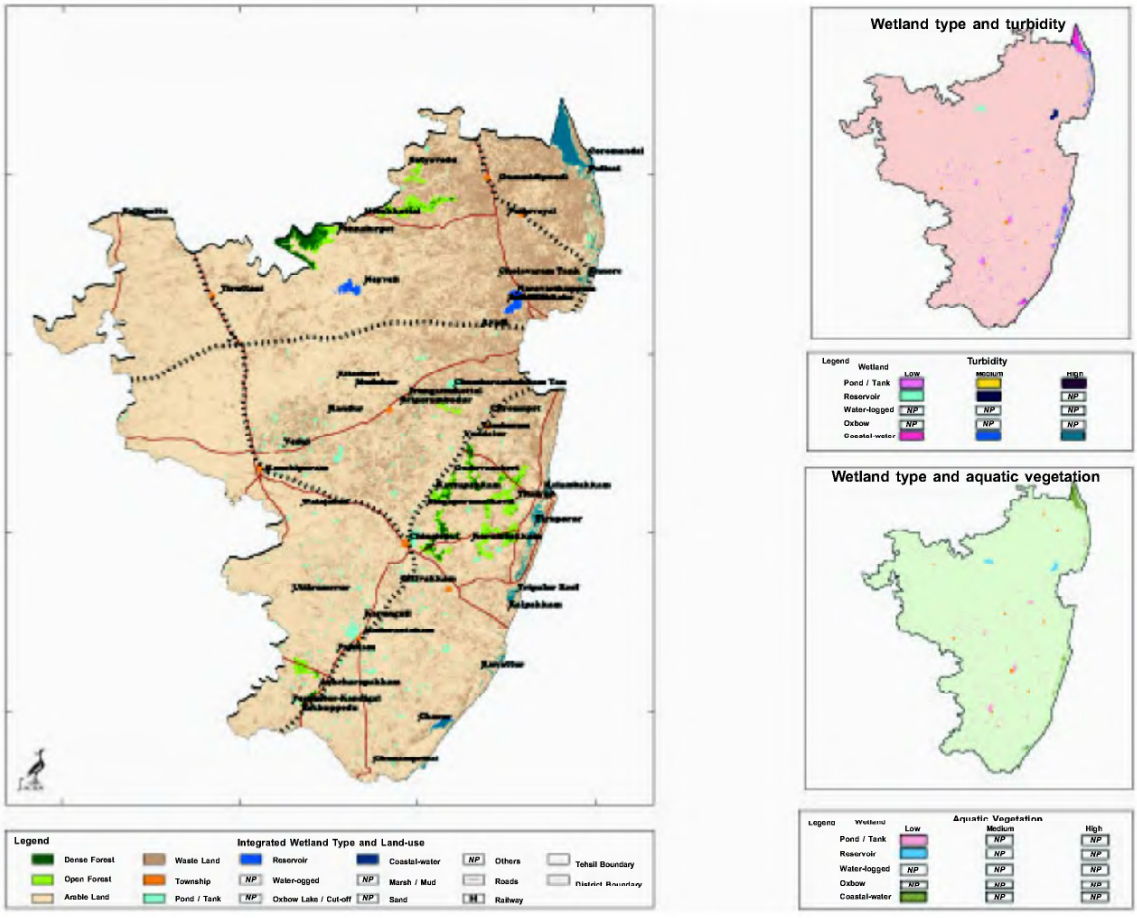


Fig. 3.7. Land use and wetland categories of the district of Chengalpet

Table 3.4. Area under different land use and wetland categories in the district of Chengalpet

Land use classes	Area (sq km)	Area (%)
Dense forest	68.21	0.80
Open forest	124.59	1.45
Arable land	5,884.96	68.68
Wasteland	2,150.14	25.09
Ponds/tanks/lakes/rivers	94.88	1.11
Reservoirs	19.21	0.22
Others	226.39	2.64

Table 3.5. Area under different turbidity clsses in the district of Chengalpet

Turbidity classes	Area (sq km)	Area (%)
Low	97.32	85.30
Moderate	16.32	14.30
High	0.45	0.40

Table 3.6. Seasonal pattern of wetland area in the district of Chengalpet *

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/ponds/ lakes/tanks	44.16	9.46	34.70	78.58

* Only about 25% of the district area is covered for the pre-monsoon data

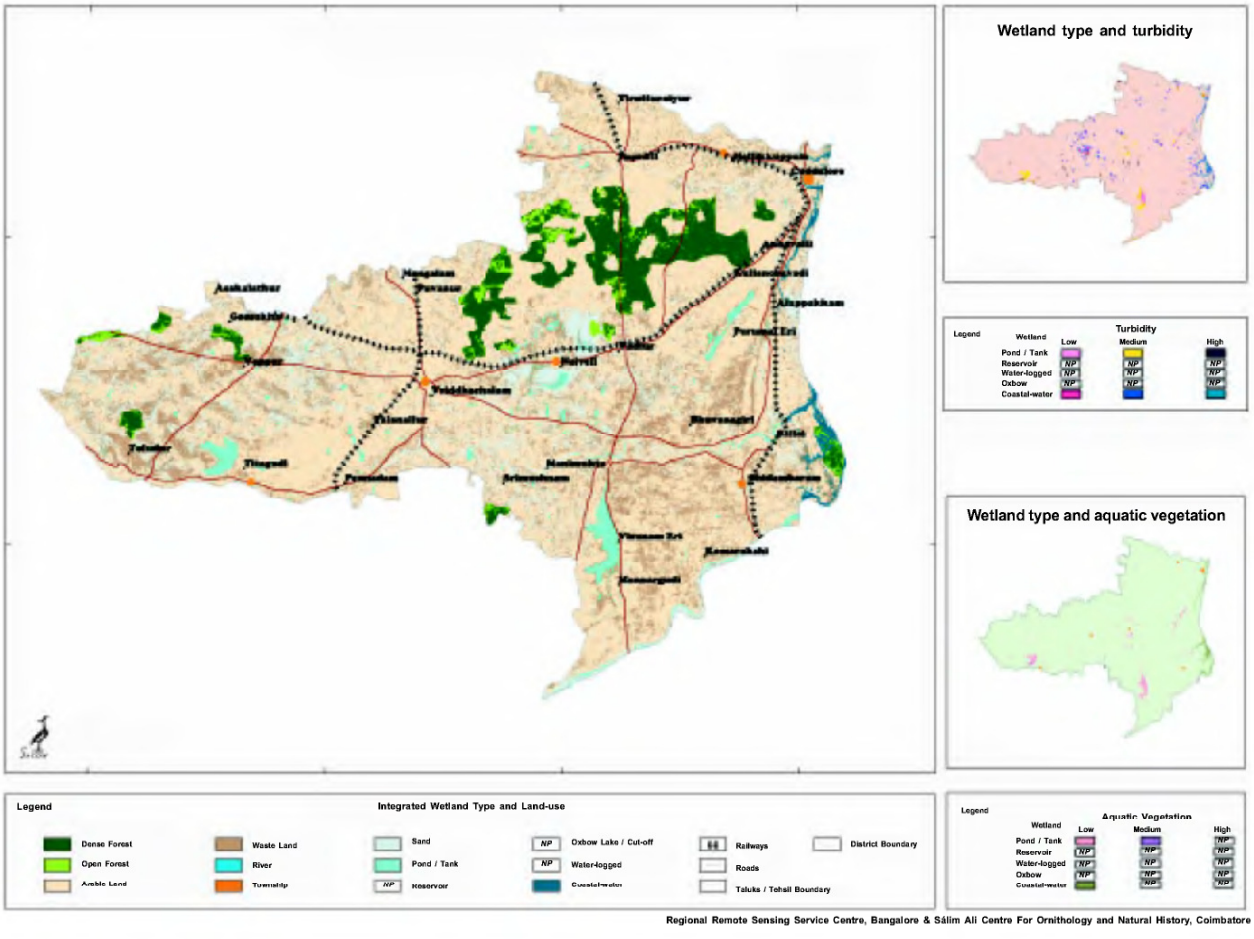


Fig. 3.8. Land use and wetland categories in the district of Cuddalore

Table 3.7. Area under different land use and wetland categories in the district of Cuddalore

Land use classes	Area (sq km)	Area (%)
Dense forest	220.00	6.12
Open forest	50.82	1.41
Arable land	2,036.00	56.65
Wasteland	578.09	16.08
Ponds/tanks/lakes/rivers	73.47	2.04
Others	635.82	17.69

Table 3.8. Area under different turbidity classes in the district of Cuddalore

Turbidity classes	Area (sq km)	Area (%)
Low	19.57	26.64
Moderate	44.63	60.75
High	9.27	12.62

Table 3.9. Seasonal pattern of wetland area in the district of Cuddalore *

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Rivers/ponds/ lakes/tanks	115.36	61.43	53.93	46.75

* About 95% of the district area is covered for the pre-monsoon data

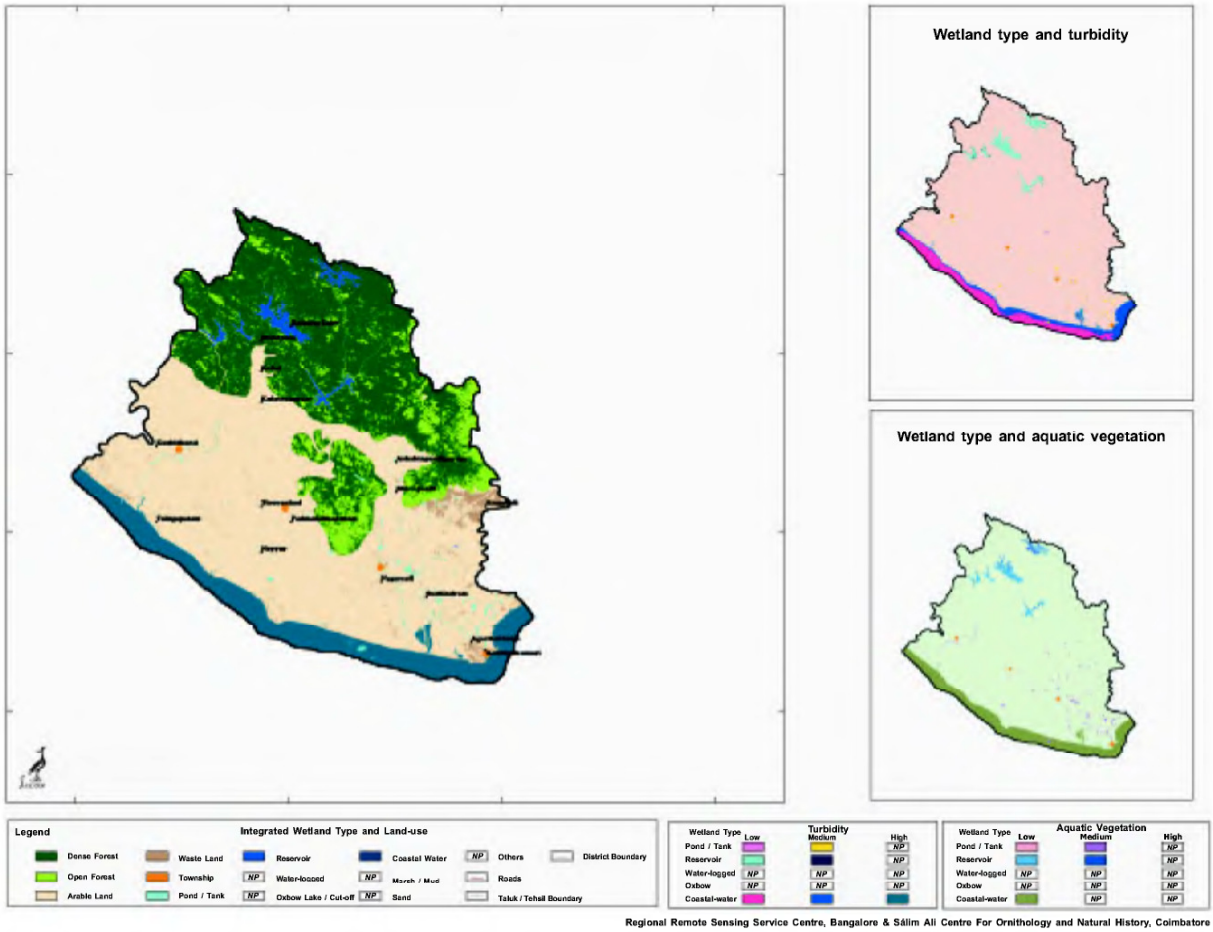


Fig. 3.9. Land use and wetland categories in the district of Kanyakumari

Table 3.10. Area under different land use and wetland categories in the district of Kanyakumari

Land use classes	Area (sq km)	Area (%)
Dense forest	501.51	27.57
Open forest	176.34	9.70
Arable land	855.25	47.02
Wasteland	38.49	2.12
Ponds/tanks/lakes/rivers	9.70	0.53
Reservoir	26.10	1.44
Others	211.36	11.62

Table 3.11. Area under different turbidity classes in the district of Kanyakumari

Turbidity classes	Area (sq km)	Area (%)
Low	27.38	76.48
Moderate	8.42	23.52
High	0.00	0.00

Table 3.12. Seasonal pattern of wetland area in the district of Kanyakumari *

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Rivers/ponds/lakes/ tanks/reserviors	37.12	36.91	0.21	0.57

*Only about 20% of the district area is covered for the pre-monsoon data

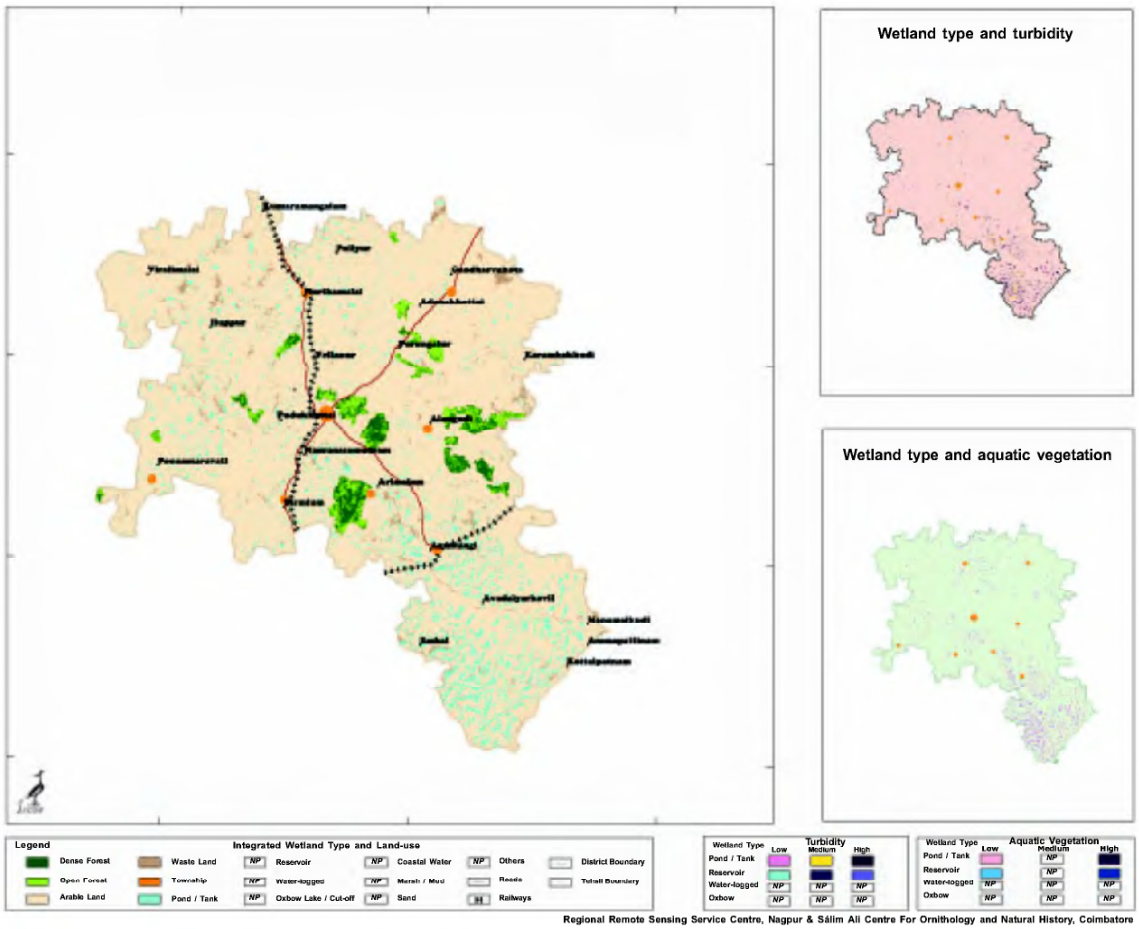


Fig. 3.10. Land use and wetland categories in the district of Pudukkottai

Table 3.13. Area under different land use and wetland categories in the district of Pudukkottai

Land use classes	Area (sq km)	Area (%)
Dense forest	88.47	1.95
Open forest	114.28	2.51
Arable land	3,914.96	86.13
Wasteland	121.65	2.68
Ponds/tanks/lakes/rivers	232.25	5.11
Others	73.73	1.62

Table 3.14. Area under different turbidity classes in the district of Pudukkottai

Turbidity classes	Area (sq km)	Area (%)
Low	55.30	23.81
Moderate	33.18	14.29
High	143.77	61.90

Table 3.15. Seasonal pattern of wetland area in the district of Pudukkottai *

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Rivers/ponds/ lakes/tanks	95.85	0.00	95.85	100.00

*Only about 60% of the district area is covered for the pre-monsoon data

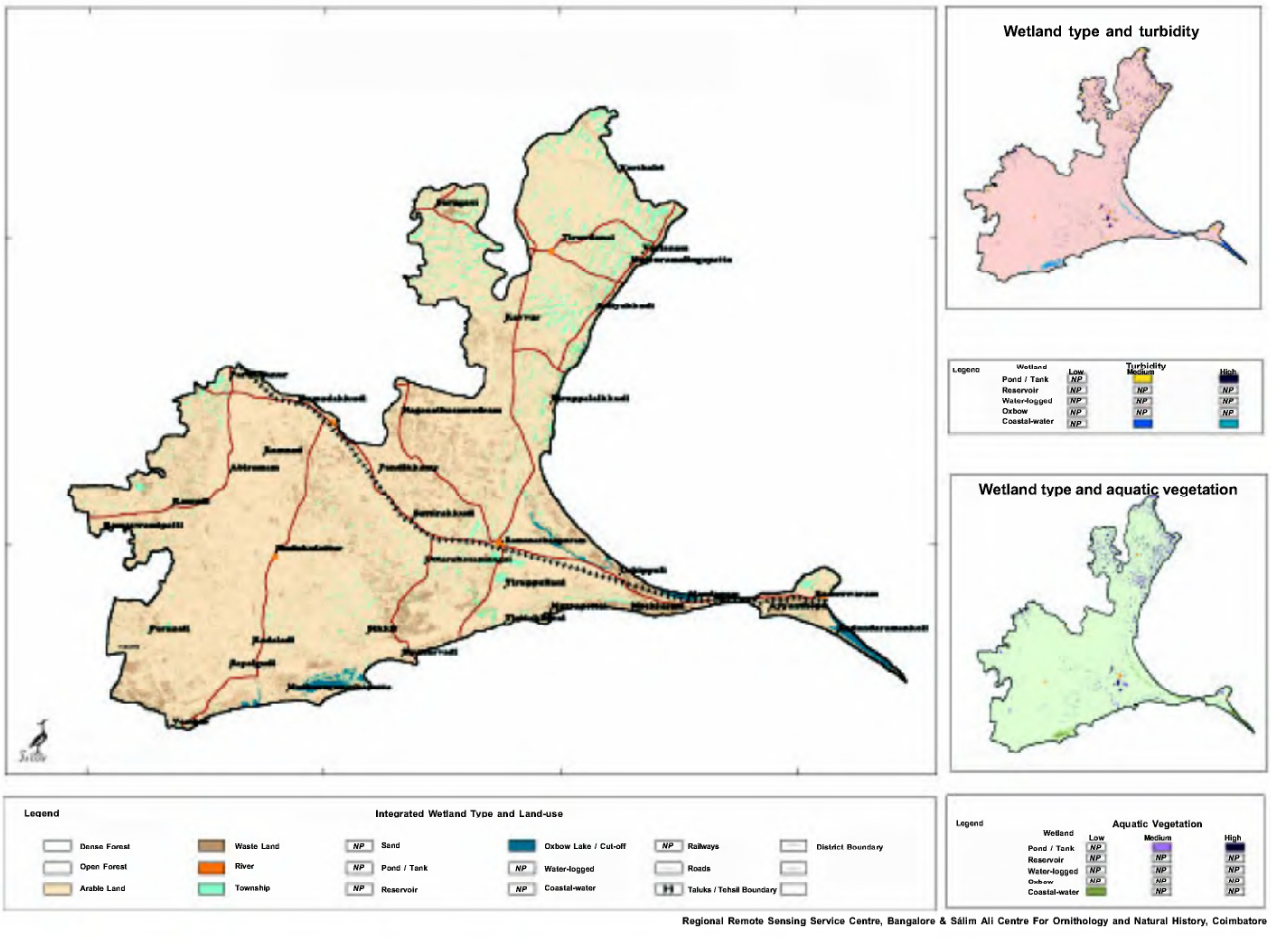


Fig. 3.11. Land use and wetland categories in the district of Ramanathapuram

Table 3.16. Area under different land use and wetland categories in the district of Ramanathapuram

Land use classes	Area (sq km)	Area (%)
Dense forest	0.00	0.00
Open forest	0.00	0.00
Arable land	3,263.13	78.00
Wasteland	504.21	12.05
Ponds/tanks/lakes/rivers	116.37	2.78
Others	299.94	7.17

Table 3.17. Area under different turbidity classes in the district of Ramanathapuram

Turbidity classes	Area (sq km)	Area (%)
Low	0.00	0.00
Moderate	32.22	27.69
High	84.15	72.31

Table 3.18. Seasonal pattern of wetland area in the district of Ramanathapuram *

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Rivers/ponds/ lakes/ tanks	104.21	46.62	57.59	55.26

* About 90% of the district area is covered for the pre-monsoon data

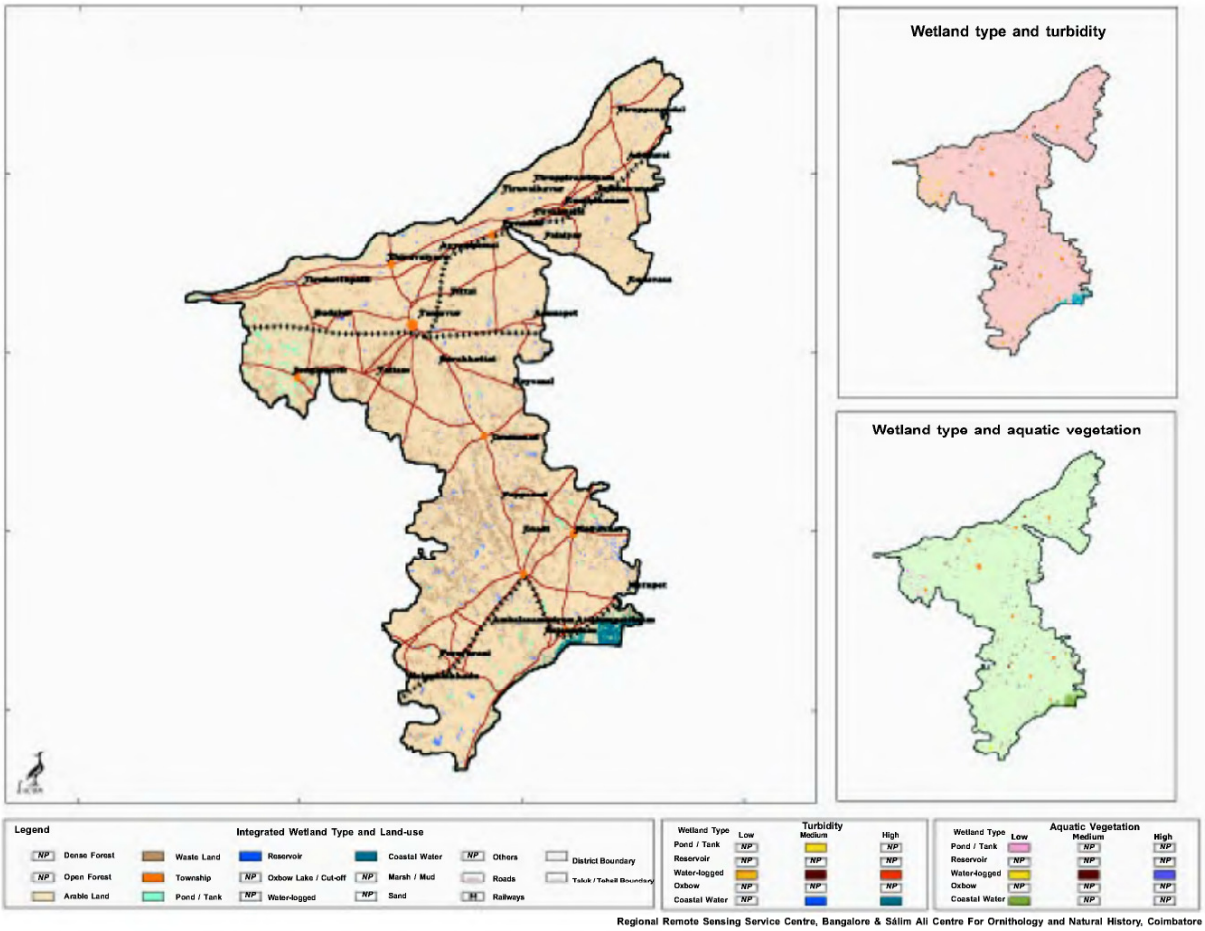


Fig. 3.12. Land use and wetland categories in the district of Thanjavur

Table 3.19. Area under different land use and wetland categories in the district of Thanjavur

Land use classes	Area (sq km)	Area (%)
Dense forest	0.00	0.00
Open forest	0.00	0.00
Arable land	2,557.99	73.63
Wasteland	343.89	9.90
Ponds/tanks/lakes/rivers	22.75	0.65
Waterlogged	43.36	1.25
Others	506.25	14.57

Table 3.20. Area under different turbidity classes in the district of Thanjavur

Turbidity classes	Area (sq km)	Area (%)
Low	10.21	15.44
Moderate	47.13	71.29
High	8.77	13.27

Table 3.21. Seasonal pattern of wetland area in the district of Thanjavur *

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Rivers/ponds/lakes/ tanks/reservior	121.65	40.55	81.10	66.67

*100% of the district area is covered for the pre-monsoon data

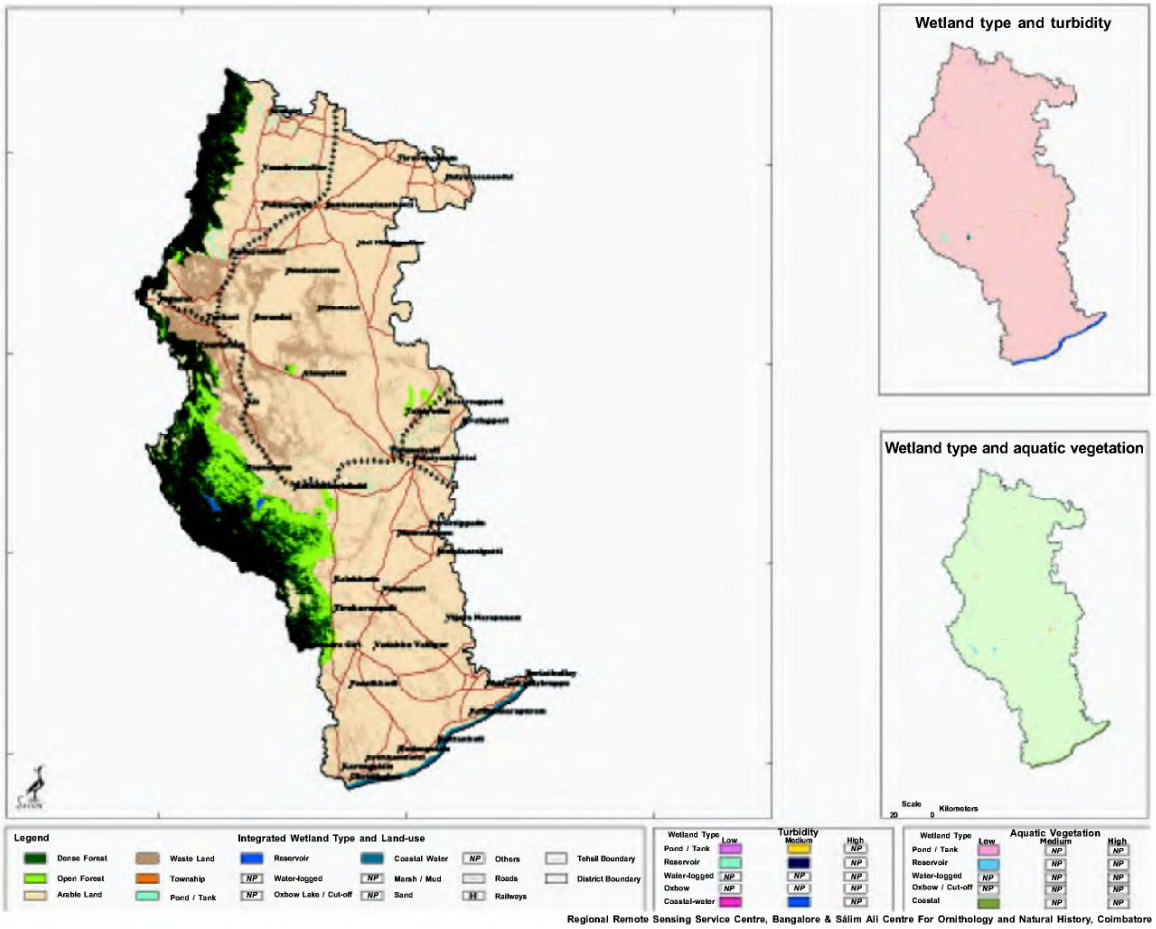


Fig. 3.13. Land use and wetland categories in the district of Tirunelveli

Table 3.22. Area under different land use and wetland categories in the district of Tirunelveli

Land use classes	Area (sq km)	Area (%)
Dense forest	879.68	13.05
Open forest	359.99	5.34
Arable land	4,174.81	61.93
Wasteland	695.22	10.31
Ponds/tanks/lakes/rivers	20.86	0.31
Reservoir	7.29	0.11
Others	603.86	8.96

Table 3.23. Area under different turbidity classes in the district of Tirunelveli

Turbidity classes	Area (sq km)	Area (%)
Low	21.06	74.81
Moderate	7.09	25.19
High	0.00	0.00

Table 3.24. Seasonal pattern of wetland area in the district of Tirunelveli *

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Rivers/ponds/lakes/ tanks/reserviors	2.98	1.81	1.17	39.26

*Only about 10% of the district area is covered for the pre-monsoon data

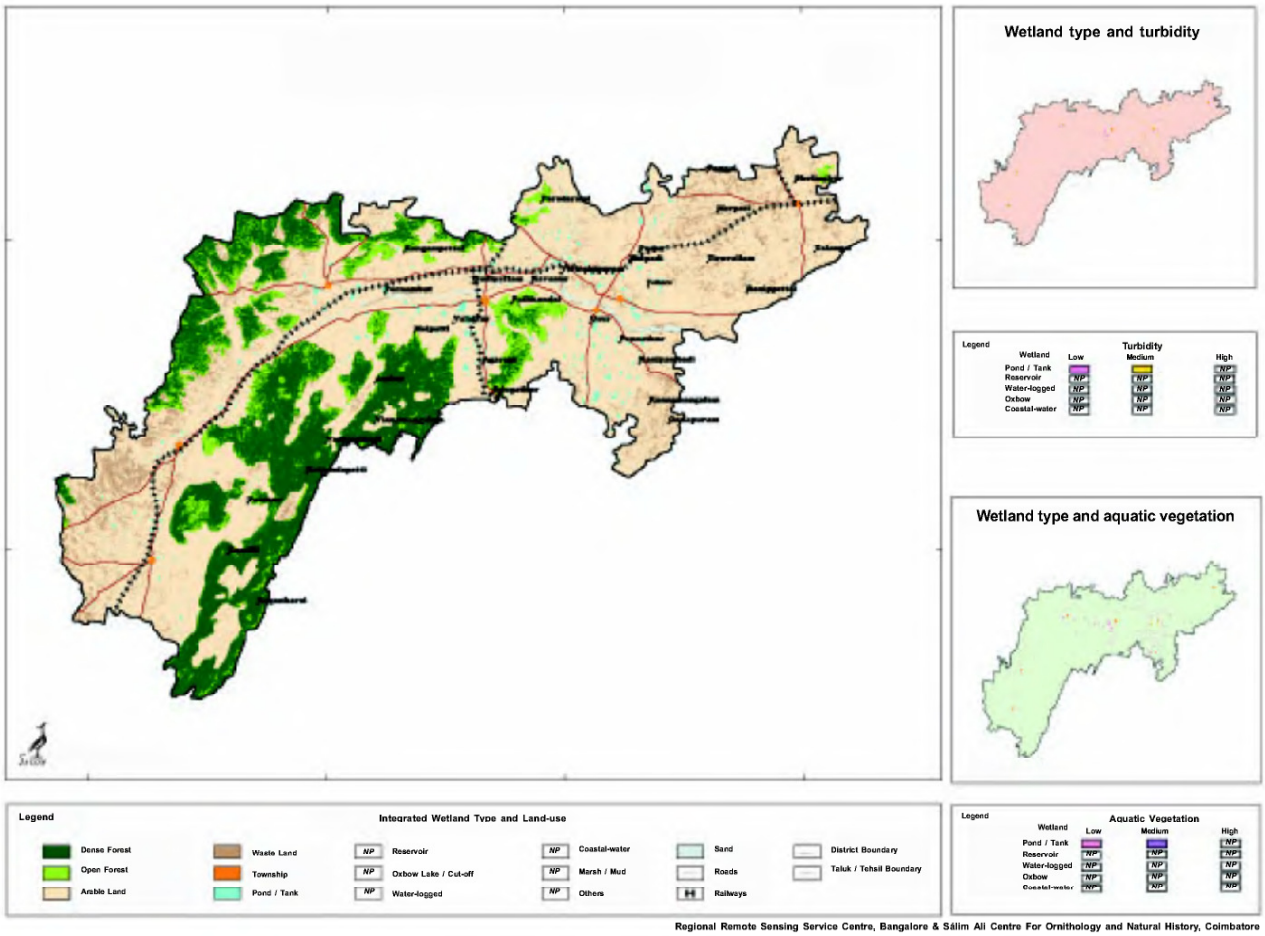


Fig. 3.14. Land use and wetland categories of the district of Vellore

Table 3.25. Area under different land use and wetland categories in the district of Vellore

Land use classes	Area (sq km)	Area (%)
Dense forest	1,216.06	20.37
Open forest	458.81	7.68
Arable land	3,688.21	61.78
Wasteland	435.47	7.29
Ponds/tanks/lakes/rivers	65.48	1.10
Others	106.25	1.78

Table 3.26. Area under different turbidity classes in the district of Vellore

Turbidity classes	Area (sq km)	Area (%)
Low	30.97	47.30
Moderate	34.51	52.70
High	0.00	0.00

Table 3.27. Seasonal pattern of wetland area in the district of Vellore *

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Rivers/ponds/ lakes/tanks	61.39	24.56	36.83	59.99

*Only about 60% of the district area is covered for the pre-monsoon data

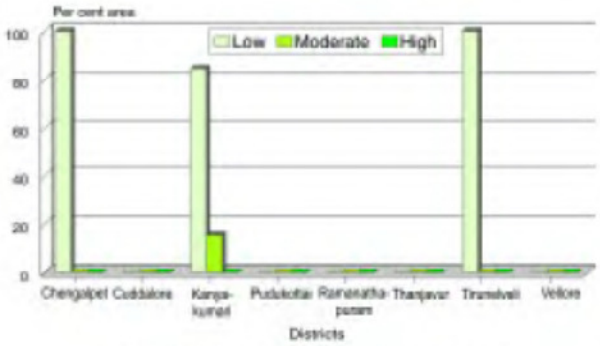


Fig. 3.16. Aquatic vegetation in reservoirs in select districts in Tamil Nadu

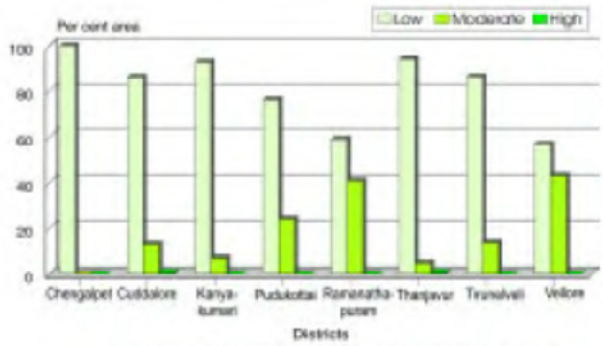


Fig. 3.17. Aquatic vegetation in the ponds/lakes/waterlogged areas in select districts in Tamil Nadu

Fishes

Data on fishes are limited to sight records without any information on their abundance. The pattern of distribution is striking that the species of fish most widely represented in the wetlands of Tamil Nadu are exotics. For instance, Tilapia *Oreochromis mossambicus* is reported from 31 of the 51 wetlands surveyed. The alien species cause much damage to the native species and the ecosystem.

Of the 72 species of freshwater fishes reported from Tamil Nadu, 35 are Threatened with three Critical, 14 Endangered and 18 Vulnerable species (Table 3.31).

Turtles

Of the six species of freshwater turtles reported from Tamil Nadu, three are Endangered and one each is Near Threatened, Vulnerable and of Least Concern (Table 3.32).

Birds

In all, 1,76,277 birds belonging to 125 species including both migratory and resident that depend on wetlands fully or partly and 28 other species found in the vicinity of wetlands were enumerated during the survey covering 51 wetlands (Table 3.33); 62% of the birds enumerated were ducks. Three Threatened species with 145 birds, and five Near Threatened with 1,085 birds were observed (Table 3.34). More than 1% of the biogeographic population of six species were present in five wetlands; the Painted Stork (1 site), Pintail and Shoveller (1 site), Openbill and Cotton Teal (2 sites), and Indian Shag (1 site).

Table 3.31. Endangered and Vulnerable species of freshwater fishes reported in Tamil Nadu

S.#	Name of the species	Status
1	*Pangasius pangasius*	CR
2	*Proeutropiichthys taakree*	CR
3	*Puntius arulius tambiraparniei*	CR
4	*Anguilla bengalensis*	EN
5	*Bhavania australis*	EN
6	*Garra gotyla stenorhynchus*	EN
7	*Garra hughi*	EN
8	*Hypselobarbus dubius*	EN
9	*Hypselobarbus kurali*	EN
10	*Nemacheilus keralensis*	EN
11	*Nemacheilus monilis*	EN
12	*Ompok bimaculatus*	EN
13	*Pseudeutropius atherinoides*	EN
14	*Puntius arulius*	EN
15	*Puntius dorsalis*	EN
16	*Puntius melanampyx sp.nov.*	EN
17	*Puntius melanostigma*	EN
18	*Anabas testudineus*	VU
19	*Bagarius bagarius*	VU
20	*Barbodes sarana*	VU
21	*Barilius bakeri*	VU
22	*Catla catla*	VU
23	*Channa orientalis*	VU
24	*Cirrhinus cirrhosus*	VU
25	*Cirrhinus reba*	VU
26	*Clarias batrachus*	VU
27	*Glyptothorax madraspatanum*	VU
28	*Heteropneustes fossilis*	VU
29	*Labeo dero*	VU
30	*Mystus vittatus*	VU
31	*Nemacheilus semiarmatus*	VU
32	*Puntius chola*	VU
33	*Puntius vittatus*	VU
34	*Rhinomugil corsula*	VU
35	*Tor khudree*	VU

CR=Critically Endangered; EN=Endangered; VU=Vulnerable

Table 3.32. List and status of turtle species reported from Tamil Nadu

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretus leithii*	VU	-	IV
2	*Chitra indica*	EN	-	IV
3	*Geoemyda silvatica*	EN	-	I
4	*Lissemys punctata*	NT	II	I
5	*Melanochelys trijuga*	LC	-	-
6	*Pelochelys cantorii*	EN	-	I

VU=Vulnerable; EN=Endangered; NT=Near Threatened; LC=Least Concern

Interestingly, all these are resident birds. The Pond Heron is the most widely distributed bird in the wetlands of Tamil Nadu.

The most widespread birds such as the Pintail, Shoveller and other ducks are not the most numerous in the state. They tend to be rather localized in their distribution suggesting that they prefer certain types of wetlands with specific habitats and water depth requirements.

Among the wetlands surveyed, Thennampattu had the maximum number of species and birds (Table 3.33). Vakkadai also had >20,000 birds while four more wetlands had >10,000 birds. Five wetlands had 40 or more species while 11 wetlands had 25-40 species and 14 wetlands had <10 species. There were no birds in two of the wetlands surveyed.

Environmental contamination

Samples were analyzed for persistent pesticides and metals.

Twenty-four species of birds had a total population of not below 1,000 in the 51 wetlands surveyed. Of these, the Pintail, Shoveller and Cotton Teal turned out to be the three most numerous waterfowl. While the first two are winter migrants to the state, the third is a common resident.

At least nine species of birds, namely the Pond Heron, Little Cormorant, Little Egret, Cattle Egret, Little Grebe, Coot, Grey Heron, Large Egret, and Whitebreasted Kingfisher occurred in 50% of the wetlands surveyed.

Table 3.33. Major wetlands of Tamil Nadu with species and number of birds

S.No	Name of the wetland	No.of Spp.	No.of birds
1	Thennampattu	46	34,745
2	Vakkadai	44	20,387
3	Thirumeni	38	16,755
4	Uthiramerur	43	12,415
5	Ponnur	35	11,909
6	Kappalur	36	10,009
7	Periakanmoi and Sakkarakottai	17	9,567
8	Wellington lake	19	6,294
9	Chemabarambakkam	11	6,027
10	Parandur	41	5,705
11	Vandiyoor	21	5,164
12	Uthirakosamangai	13	3,704
13	Veeranam tank	27	3,011
14	Suchindram kulam complex	31	2,957
15	Kaliveli	12	2,756
16	Theroor wetland complex	33	2,490
17	Koonthankulam sanctuary	22	2,470
18	Vellode	40	2,137
19	Pallikarnai	18	2,136
20	Udayamarthandapuram	31	1,816
21	Dusimamandoor	26	1,714
22	Koothapar big tank	22	1,528
23	Vaduvoor lake	19	1,179
24	Kallaperamber	17	1,035
25	Kunnathur	14	930
26	Ousteri	25	872
27	Kovaipudur	20	723
28	Ariyakulam	9	604
29	R S Mangalam	5	464
30	Gundur big tank	27	455
31	Vembanur wetland complex	25	402

Contd...

Table 3.33. Contd...

S.No	Name of the wetland	No.of Spp.	No.of birds
32	Seidunganallur kulam	13	384
33	Govindavadi	11	372
34	Sulur	6	361
35	Mapedu periaeri	3	355
36	Manavalakurichi kulam	24	338
37	Arapakkam big and small tanks	6	329
38	Chitrangudi	7	326
39	Vetangudi	3	243
40	Aval poondarai	23	229
41	Chathirampudukulam	3	200
42	Singanallur	7	169
43	Poondi reservoir	15	158
44	Kooram	14	146
45	Uthukadu	6	114
46	Melakulam	5	100
47	Thirupulivanam	7	46
48	Magarel	8	35
49	Bahur	3	12
50	Perur kulam	0	0
51	Sivakalai kulam	0	0
	Total	125	1,76,277

Table 3.34. Frequency of sightings of Threatened and Near Threatened birds in Tamil Nadu

S.#	Species	Status	No.of sites	No.of birds
1	Spotbilled Pelican	T	8	142
2	Dalmatian Pelican	T	1	2
3	Spotted Greenshank	T	1	1
4	Darter	NT	15	202
5	Painted Stork	NT	12	148
6	White Ibis	NT	14	629
7	Lesser Flamingo	NT	1	100
8	Blackbellied Tern	NT	1	6

T=Threatened; NT=Near Threatened

Heavy metals

Among all the wetlands in Tamil Nadu, Ariyakulam of Tirunelveli district recorded the highest concentrations of lead (15.97±30.01 ppm) followed by Singanallur, Coimbatore (10.65±0.75 ppm) (Fig. 3.18). The other metals detected were within the tolerable limits. Significant differences were observed in the contamination level of copper, zinc, lead and cadmium among the wetlands ($P<0.005$).

Among the 10 species studied, *Heteropneustes fossilis* recorded the maximum concentrations of lead (11.16±21.75 ppm) followed by *Oreochromis mossambicus* (6.17±1.87 ppm) and *Channa punctatus* (5.81±2.13 ppm) (Fig. 3.19). Even though significantly varying ($P<0.005$) levels of zinc, copper, lead and cadmium were recorded in all the species, except in *Catla catla*, they are not expected to cause any ill effects at the present levels.

Wetlands such as Pallikaranai, Vandiyoor, Singanallur, Aval poondarai do suffer from domestic sewage intrusion which may account for the elevated metal concentrations. However, no data exist on the quantum of effluent discharged and solid wastes dumped, except for Pallikaranai where 3,500 tonnes of municipal wastes are dumped and 33 million litres of untreated domestic sewages are discharged every day.

Pesticides

Pesticide residues among the wetlands of Tamil Nadu revealed that fishes from Kappalur (0.143 ppm) of Tiruvannamalai district recorded the maximum load of total organochlorine residues followed by Gundur big tank (0.136 ppm) of Tiruchirapalli district and Vaduvoor (0.089 ppm) of Mannarkudi. The least concentrations were recorded in Theroor complex (0.008 ppm) in Kanyakumari district (Fig. 3.20).

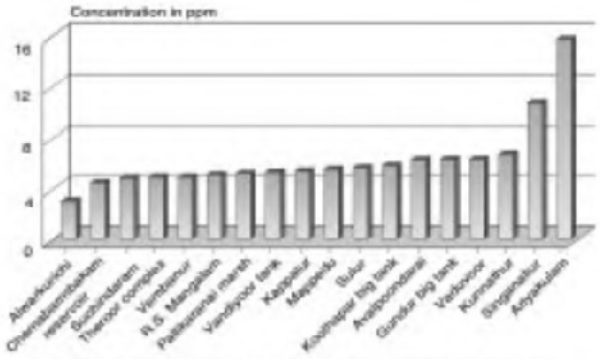


Fig. 3.18. Lead contamination in select wetlands of Tamil Nadu

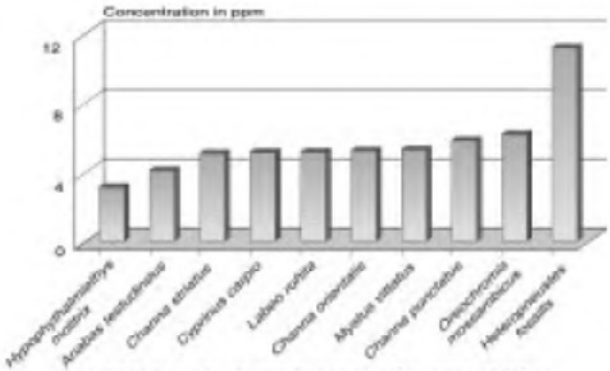


Fig. 3.19. Lead contamination in select species of fishes in Tamil Nadu

Of the various species analyzed for organochlorine residues, *Hypophthalmicthys molitrix* (0.179 ppm) recorded the maximum residues followed by *Mystus vittatus* (0.131 ppm), while the least was in *Anabas testudineus* (0.019 ppm) and *Channa striatus* (0.018 ppm) (Fig. 3.21). Variation in organochlorine residues among the wetlands appears to be significant ($P<0.05$).

Although the pesticide concentrations detected are below the FAO/ WHO limits for fish and wildlife, it may be noted that 77 % of fishes from Tamil Nadu are contaminated with HCH followed by DDT (66%), dieldrin (58%) and endosulfan (55%). According to the recent reports, Tamil Nadu seems to be consuming approximately 1,685 mt of pesticides every year. It is alarming to note that Tamil Nadu is the highest consumer of pesticides (1120 g/ha), followed by Andhra Pradesh (1050 g/ha) and Haryana (900 g/ha).

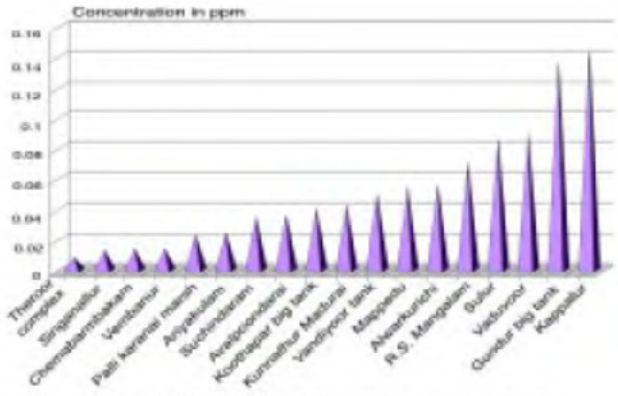


Fig. 3.20. Total organochlorine residues among various wetlands of Tamil Nadu

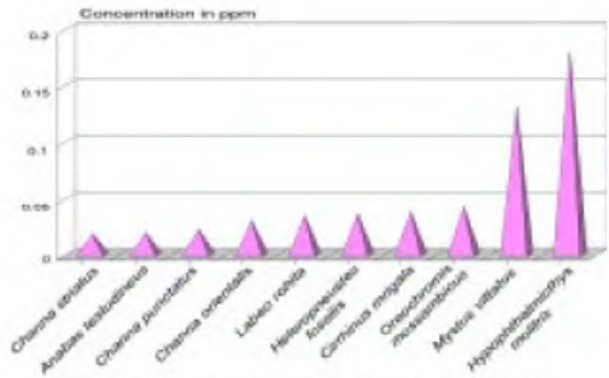


Fig. 3.21. Total organochlorine residues among various species of fishes in Tamil Nadu

Suitability for human consumption

The values recorded in the species like *Heteropneustes fossilis* for lead are indicative of physiological disturbances to the fish (Abbasi *et al.*, 1998; Misra *et al.*, 2002).

An analysis of the daily dietary intake of metals and pesticides by humans through fish shows that the levels of all the metals, except for lead, are within the limits suggested by various statutory agencies. Concentrations of lead are high in *Heteropneustes fossilis* (0.40mg), *Oreochromis mossambicus* (0.22 mg) and *Channa punctatus* (0.21 mg) compared to the levels prescribed by UN Committee (WHO, 1989, 1993) which is 0.21mg/day for 60 kg of adult. It is to be noted that these species are stocked in many of the

wetlands for commercial purpose. Regular consumption of these fishes may create physiological complications in the consumers. Further, the recorded levels of lead can create physiological disturbances in the fishes themselves, particularly, *Heteropneustes fossilis.*

Pesticide concentrations detected in the present samples appear to be safe for human consumption, as the values are within the statutory limits given by UNEP/FAO/WHO (1989) and Health Canada (1996). However, 25 % decline in fish catch has been reported in the wetlands, namely Kappalur and R S Mangalam of Ramnathapuram district. Although various reasons could be attributed for the same, impact of the use of pesticides on agriculture in the catchment areas could be a serious one. It is suggested that Kappalur of Tiruvannamalai district, Gundur big tank of Tiruchirapalli and Vadavoor of Mannargudi may be viewed with concern as the contamination levels are higher.

Socioeconomic values

Socioeconomic values have been assigned based on the sum of the ranks of the various use values of the wetlands. Depending on the ranks, they are considered as of high, medium and low use values. Areas with higher biodiversity values had low to medium use values (Table 3.35). Most of the sites had medium use values. In the case of wetlands, even if it is protected, the local people make use of the resources to a certain extent.

Prioritization of wetlands

Fourty-nine wetlands have been evaluated and prioritized, assigning grades for different criteria, especially of birds as explained under methods. Size of the wetland, earlier bird counts, records of breeding and roosting colonies were also considered for giving ranks of priority. The total grades are ranked into four. The first five came in the first rank, followed by 10 in the second rank, 19 in the third rank and 15 in the fourth rank. The top ranking sites are Periakanmoi- Sakkarakottai and Kaliveli in the East Coast, Uthiramerur and Thennampattu in the Deccan Peninsula and Suchindram kulam complex in the Western Ghats. The next 10, namely Vakkadai, Theroor wetland complex, Ponnur, Thirumeni, Koonthankulam sanctuary, Veeranam tank, Parandur, Gundur big tank, Wellington lake, and Chemabarambakkam came in the second rank. Only when the area was also considered as a criterion, did Kaliveli and Uthiramerur come up in the first rank and similarly Veeranam, Wellington lake, Chemabarambakkam to the second rank and Dusimamandoor, Ousteri, and Pallikarnai to the third rank.

In the Western Ghats, Suchindram kulam complex gets high priority. The Suchindram kulam complex along with Theroor wetland complex has already been considered for protected status by the State Government. Kaliveli does not strictly qualify as an inland wetland. Further, it enjoys certain amount of legal protection, as it is well known as a sanctuary for migratory birds. Action has already been initiated for further studies and proposing Pallikarnai as a protected area, which is in the immediate vicinity of the city of Chennai. This site has already been identified as a potential Conservation Area based on a study conducted by Care Earth with the support of the Tamil Nadu Pollution Control Board. Based on the earlier studies, it is found that a few wetlands with breeding colonies of birds, namely Vettangudi, Magarel, Kooram and Chitrangudi would have got better biodiversity values, if they were surveyed during the breeding season of birds. Hence, they are also given higher rank. Of these, Vettangudi is already protected as a bird sanctuary.

The top ranking five wetlands qualify to be declared as Ramsar sites. Spatial distribution of the prioritized wetlands, along with those identified by the BCPP, IBA programme and the Protected Areas of Tamil Nadu is given (Fig. 3.22).

Table 3.35. Prioritized list of the major wetlands of Tamil Nadu

No.	Name of the wetland	Rank	Use
1	Periakanmoi and Sakkarakottai	1	M
2	Thennampattu	1	M
3	Suchindram kulam complex	1	M
4	Kaliveli	1	M
5	Uthiramerur	1	M
6	Vakkadai	2	M
7	Theroor wetland complex	2	M
8	Ponnur	2	M
9	Thirumeni	2	M
10	Koonthankulam sanctuary	2	M
11	Parandur	2	M
12	Gundur big tank	2	M
13	Veeranam tank	2	H
14	Wellington Lake	2	M
15	Chemabarambakkam	2	H
16	Kappalur	3	M
17	Uthirakosamangai	3	M
18	Vembanur wetland complex	3	M
19	Vetangudi	3	M
20	Vellode	3	L
21	Chitrangudi	3	M
22	Manavalakurichi kulam	3	M
23	Vaduvoor lake	3	M
24	Vandiyoor	3	M
25	Aval poondarai	3	L
26	Seidunganallur kulam	3	M
27	Dusimamandoor	3	M
28	Kunnathur	3	M
29	Ousteri	3	M
30	Pallikarnai	3	M
31	Govindavadi	3	M
32	Kooram	3	M
33	Bahur	3	M
34	Magarel	3	M
35	Kovaipudur	4	L
36	Udayamarthandapuram	4	M
37	Ariyakulam	4	M
38	Koothapar big tank	4	M
39	Melakulam	4	M
40	R S Mangalam	4	M
41	Chathirampudukulam	4	L
42	Kallaperamber	4	M
43	Mapedu periaeri	4	M
44	Poondi reservoir	4	H
45	Arapakkam big and small tanks	4	M
46	Singanallur	4	L
47	Sulur	4	M
48	Thirupulivanam	4	M
49	Uthukadu	4	M

Summary

- The total number of wetlands of the size 56.25 ha and above in Tamil Nadu during 1992-'93 was 1,175, covering an area of 1,615.17 sq km (SAC, 1998).
- The number of wetlands of the size 2 ha and above, as interpreted from 1999 satellite data, in the eight select districts is 4,685, covering an area of 731 sq km.
- Ponds/ lakes outnumber all other types of wetlands. However, reservoirs cover larger extent of land area.
- Turbidity was low in the reservoirs, whereas it was moderate to high in ponds/ lakes.
- There is an estimated loss of 12% to 88% of wetland area in the seven districts; total loss for the seven districts amounts to 950.74 sq km.
- Vegetation was low in most of the wetlands.
- Tamil Nadu has 46 species of aquatic endemic plants belonging to 14 families; three Critical, 14 Endangered, and 18 Vulnerable species of fishes; and three Endangered, one each of Near Threatened, Vulnerable and Least Concern species of freshwater turtles.
- In the 51 wetlands surveyed, 1,76,277 birds of 125 species were recorded.
- The Pintail, Shoveller and Cotton Teal were the most abundant species.
- The Pond Heron is the most widely distributed species of wetland bird.
- Three Threatened species with 145 birds and five Near Threatened with 1,085 birds were recorded.
- Two hundred fishes comprising 15 species from 18 wetlands were analyzed for environmental contamination.

- Seventy-seven per cent of the fish sampled from Tamil Nadu are contaminated with HCH; 66% with DDT, 58% with dieldrin and 55% with endosulfan.

- Kappalur in Tiruvannamalai, Gundur big tank in Tiruchirapalli and Vaduvoor in Mannarkudi had higher levels of organochlorine pesticides.

- Fifty one wetlands have been prioritized; five have come in the first rank of priority followed by 10 in the second, 19 in the third and 15 in the fourth rank.

- The five in the first rank in the list, namely Periakanmai, Thennampattu, Suchindram kulam complex, Kaliveli and Uthiramerur are qualified to be declared as Ramsar sites.



R.J. Ranjit Daniels

Pallikarnai wetland : rich in biodiversity including a wild variety of rice

R.J. Ranjit Daniels



Pallikarnai : a wetland under serious threat from municipal dumping

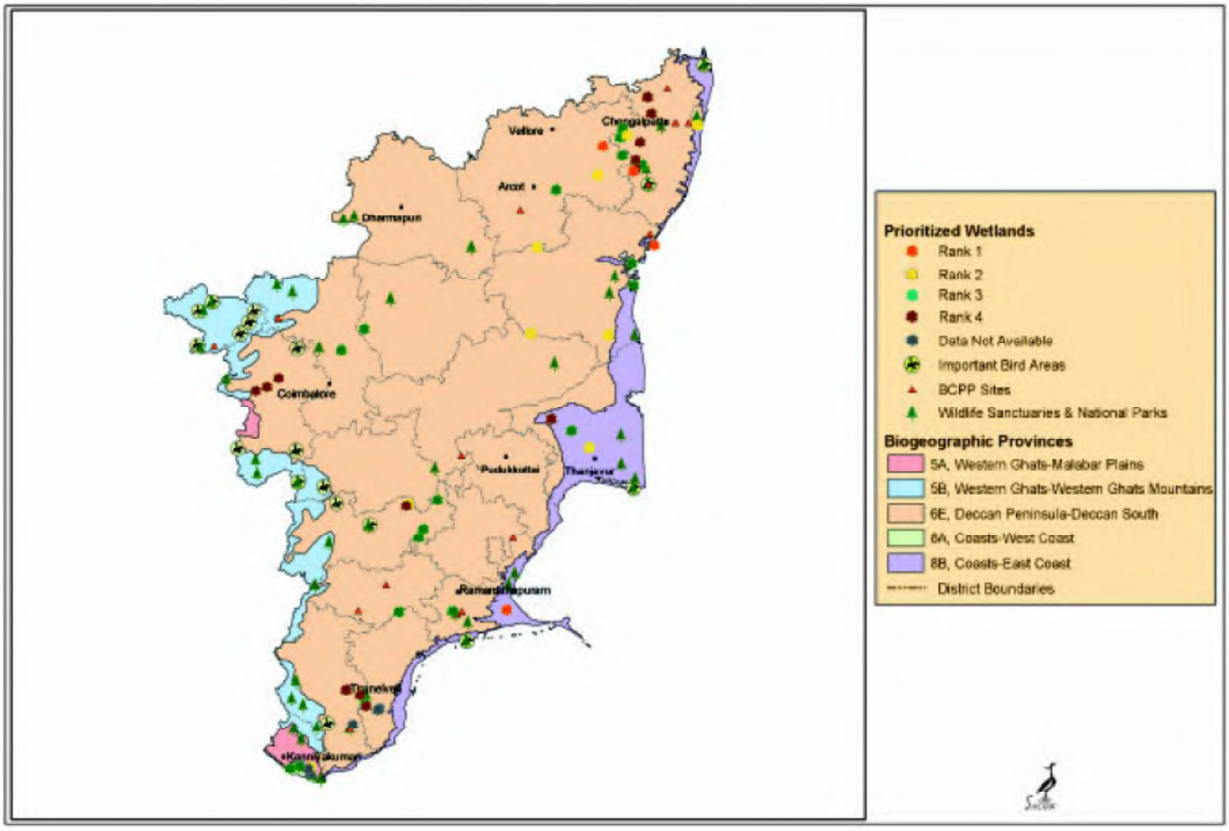


Fig. 3.22. Prioritized wetlands along with other conservation areas in Tamil Nadu

Ramsar sites of India

S.No.	Name of the wetland	State	Area	Coordinates
1.	Ashtamudi Wetland	Kerala	61,400 ha	08°57'N 076°35'E
2.	Bhitarkanika Mangroves	Orissa	65,000 ha	20°39'N 086°54'E
3.	Bhoj Wetland	Madhya Pradesh	3,201 ha	23°14'N 077°20'E
4.	Chilika Lake	Orissa	116,500 ha	19º42'N 085º21'E
5.	Deepor Beel	Assam	4,000 ha	26°08'N 091°39'E
6.	East Calcutta Wetlands	West Bengal	12,500 ha	22°27'N 088°27'E
7.	Harike Lake	Punjab	4,100 ha	31º13'N 075º12'E
8.	Kanjli	Punjab	183 ha	31°25'N 075°22'E
9.	Keoladeo National Park	Rajasthan	2,873 ha	27º13'N 077º32'E
10.	Kolleru Lake	Andhra Pradesh	90,100 ha	16°37'N 081°12'E
11.	Loktak Lake	Manipur	26,600 ha	24º26'N 093º49'E
12.	Point Calimere Wildlife and Bird Sanctuary	Tamil Nadu	38,500 ha	10°19'N 079°38'E
13.	Pong Dam Lake	Himachal Pradesh	15,662 ha	32°01'N 076°05'E
14.	Ropar	Punjab	1,365 ha	31°01'N 076°30'E
15.	Sambhar Lake	Rajasthan	24,000 ha	27º00'N 075º00'E
16.	Sasthamkotta Lake	Kerala	373 ha	09°02'N 076°37'E
17.	Tsomoriri	Jammu & Kashmir	12,000 ha	32°54'N 078°18'E
18.	Vembanad-Kol Wetland	Kerala	151,250 ha	09°50'N 076°45'E
19.	Wular Lake	Jammu & Kashmir	18,900 ha	34º16'N 074º33'E

Source: www.ramsar.org



KERALA

Kerala, "the garden state of India" as depicted by Jawaharlal Nehru, with its verdant forest clad mountains along the east, extensive palm groves interspersed with a variety of crops in the mid plains and, large stretches of backwaters or estuarine lagoons along the west, besides being picturesque and unrivalled in beauty, is an abode of a variety of life forms. In contrast with the size of the state, it is endowed with one of the richest and varied avifauna, almost one-fifth of the total forms recorded in India. Physiographically the state is divisible into three well-defined zones: the hills (Western Ghats) along the east, the plains and the sea board. The state, a narrow stretch of land, 35 to 120 km in width, is blessed with as many as 44 rivers, owing to the mountainous terrain and heavy rains.



State at a Glance	
State capital	Thiruvananthapuram
Area	38,863 sq km
Population (2001)	3,18,38,619
Major rivers	Bharatapuzha
Total number of districts	14
Total forest area	30% of total area
Population density (2001)	819/sq km
Ramsar sites	3
Proposed Ramsar sites	Nil
Total sites proposed for conservation	4

The climate is equable. The monthly temperature varies from 24° to 31°C. Kerala gets both the monsoons but more from the southwest. Average annual rainfall is about 2,500 mm.

Status of wetlands

The land use classification of the state has not included wetlands as a separate unit of land; probably it would have been clubbed with some other types (Table 4.1). The SAC (1998) has mapped the wetlands of Kerala using the satellite imageries of 1988-1990 at 1:2,50,000 scale. The wetlands of the size 56.25 ha and above were estimated at 64, covering an area of 342 sq km (Table 4.2). It includes 29 reservoirs, 16 waterlogged areas, and the remaining ponds/

Table 4.1. Land use pattern in Kerala

Land use type	Area in sq km
Total geographic area	38,863
Forests	10,820
Not available for cultivation	3,620
Other uncultivated land excluding fallow land	840
Fallow land	1,000
Net area sown	22,690
Area sown more than once	6,580
Total cropped area	29,170
Cultivable area	24,430

Source: www.indiastat.com

Table 4.2. Distribution of various categories of inland wetlands in Kerala

Type of inland wetland	No. of wetlands
Lakes/ponds	9
Waterlogged (seasonal)	15
Reservoirs	29
Tanks	1
Waterlogged (man-made)	1
Abandoned quarries	9
Total	64

Source: SAC (1998)

Table 4.3. Inland water resources (for the development of Inland Fisheries) in Kerala

Sl No	Item	No.	Area (sq km)
1	Private ponds	35,763	219.86
2	Panchayat ponds	6,848	14.87
3	Manmade quarry ponds	879	3.41
4	Holy ponds	2,689	4.80
5	Village ponds & other water holes	185	4.96
6	Irrigation tanks	852	28.35
7	Public sector fresh water fish farms	13	0.85
8	Freshwater springs	7	–
9	Freshwater lakes	9	16.20
10	Reservoirs	53	428.90
11	Check dams	80	2.59
	Total	47,378	724.79

Source: Master *Panfish* Book. Dept. of Fisheries, Kerala (2002)

lakes. However, this does not cover one of the internationally significant wetlands in the state; the Kole wetlands in Trichur and Malappuram. Moreover, there are numerous small wetlands in the state. In a recent survey conducted by the Department of Fisheries, Kerala, as many as 47,378 wetlands including 53 reservoirs, covering an area of 724.79 sq km were recorded (Table 4.3). All ponds of the size 0.02 ha and above were included.

Biodiversity

Aquatic vegetation

Most of the wetlands studied had aquatic weeds; some of them had thick growth and covered larger areas. *Eichhornia* sp. *Salvinia* sp. and *Pistia* sp. were the major species.

Sixty-five species of endemic aquatic angiosperms belonging to 19 families have been reported from Kerala (Table 4.4), according to the literature and herbaria records of BSI and other institutions as given under methods. Two Families, namely *Podostemaceae* and *Eriocaulaceae* were represented by 10 species each.

Fishes

Thirty seven species of Threatened fishes (Menon, 1999) comprising four Critical, 16 Endangered and 17 Vulnerable were recorded from Kerala (Table 4.5).

Turtles

Five species of freshwater turtles were recorded, out of which two are Endangered (EN), one each is Vulnerable (VU), Near Threatened (NT) and of Least Concern (LC) (Table 4.6).

Table 4.4. Endemic aquatic angiosperms reported from Kerala

S#	Species	Family
1	*Aponogeton appendiculatus*	Aponogetonaceae
2	*Cladopus hookerianus*	Podostemaceae
3	*Cryptocoryne consobrina*	Araceae
4	*Cryptocoryne cognatoides*	Araceae
5	*Lagenandra meeboldii*	Araceae
6	*Cryptocoryne spiralis*	Araceae
7	*Cyathocline lutea*	Asteraceae
8	*Cyanotis papilionacea*	Commelinaceae
9	*Eriocaulon cuspidatum*	Eriocaulaceae
10	*Eriocaulon eurypeplon*	Eriocaulaceae
11	*Eriocaulon fysonii*	Eriocaulaceae
12	*Eriocaulon heterolepis*	Eriocaulaceae
13	*Eriocaulon lanceolatum*	Eriocaulaceae
14	*Eriocaulon parviflorum*	Eriocaulaceae
15	*Eriocaulon richardianum*	Eriocaulaceae
16	*Eriocaulon robusto-brownianum*	Eriocaulaceae
17	*Eriocaulon sivarajanii*	Eriocaulaceae
18	*Eriocaulon stellulatum*	Eriocaulaceae
19	*Fuirena wallichiana*	Cyperaceae
20	*Farmeria indica*	Podostemaceae
21	*Fimbristylis dauciformis*	Cyperaceae
22	*Fimbristylis hirsutifolia*	Cyperaceae
23	*Geissaspis tenella*	Fabaceae
24	*Heliotropium keralense*	Boraginaceae
25	*Hoppea dichotoma*	Gentianaceae
26	*Hydrobryopsis sessilis*	Podostemaceae
27	*Hygrophila serpylla*	Acanthaceae

Contd...

Table 4.4. Contd...

S#	Species	Family
28	*Indotristicha ramosissima*	Podostemaceae
29	*Ischaemum jayachandranii*	Poaceae
30	*Ischaemum nilagiricum*	Poaceae
31	*Ischaemum travancorense*	Poaceae
32	*Ischaemum vembanadense*	Poaceae
33	*Lagenandra nairii*	Araceae
34	*Limnophila glandulifera*	Scrophulariaceae
35	*Limnopoa meeboldii*	Poaceae
36	*Lindernia estaminodiosa*	Scrophulariaceae
37	*Lindernia manilaliana*	Scrophulariaceae
38	*Lipocarpha raynaliana*	Cyperaceae
39	*Murdannia lanuginosa*	Commelinaceae
40	*Murdannia pauciflora*	Commelinaceae
41	*Myriophyllum oliganthum*	Haloragaceae
42	*Nymphoides krishnakesara*	Menyanthaceae
43	*Nymphoides macrosperma*	Menyanthaceae
44	*Nymphoides sivarajanii*	Menyanthaceae
45	*Paspalum canarae*	Poaceae
46	*Podostemum barberi*	Podostemaceae
47	*Podostemum munnarense*	Podostemaceae
48	*Pogostemon erectum*	Lamiaceae
49	*Polypleurum dichotomum*	Podostemaceae
50	*Polypleurum filifolium*	Podostemaceae
51	*Ramphicarpa longiflora*	Scrophulariaceae
52	*Rotala cookii*	Lythraceae
53	*Rotala fimbriata*	Lythraceae
54	*Rotala illecebroides*	Lythraceae
55	*Rotala macrandra*	Lythraceae
56	*Rotala malabarica*	Lythraceae
57	*Rotala malampuzhensis*	Lythraceae
58	*Utricularia albocaerulea*	Lentibulariaceae
59	*Utricularia cecilii*	Lentibulariaceae
60	*Utricularia praeterita*	Lentibulariaceae
61	*Utricularia smithiana*	Lentibulariaceae
62	*Utricularia wightiana*	Lentibulariaceae
63	*Wiesneria triandra*	Alismataceae
64	*Willisia selaginoides*	Podostemaceae
65	*Zeylanidium maheshwarii*	Podostemaceae

Table 4.5. Threatened freshwater fishes reported from Kerala

S#	Species	Status
1	*Lepidopygopsis typus*	CR
2	*Osteochilichthys longidorsalis*	CR
3	*Silurus wynaadensis*	CR
4	*Travancoria elongata*	CR
5	*Anguilla bengalensis*	EN
6	*Bhavania australis*	EN
7	*Garra hughi*	EN
8	*Garra surendranathanii*	EN
9	*Hypselobarbus kurali*	EN
10	*Hypselobarbus thomasi*	EN
11	*Mystus malabaricus*	EN
12	*Nemacheilus keralensis*	EN
13	*Ompok bimaculatus*	EN
14	*Osteobrama bakeri*	EN
15	*Puntius arulius*	EN
16	*Puntius denisonii*	EN
17	*Puntius melanampyx*	EN
18	*Puntius melanostigma*	EN
19	*Puntius parrah*	EN
20	*Tetraodon travancoricus*	EN
21	*Anabas testudineus*	VU
22	*Bagarius bagarius*	VU
23	*Barbodes sarana*	VU
24	*Barilius bakeri*	VU
25	*Catla catla*	VU
26	*Channa orientalis*	VU
27	*Cirrhinus reba*	VU
28	*Clarias batrachus*	VU
29	*Garra menoni*	VU
30	*Heteropneustes fossilis*	VU
31	*Macrognathus guentheri*	VU
32	*Mystus vittatus*	VU
33	*Nemacheilus semiarmatus*	VU
34	*Parambassis thomassi*	VU
35	*Puntius chola*	VU
36	*Puntius conchonius*	VU
37	*Puntius vittatus*	VU

Table 4.6. Freshwater turtles recorded from Kerala

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes leithii*	VU	-	IV
2	*Geoemyda silvatica*	EN	-	I
3	*Lissemys punctata*	NT	II	I
4	*Melanochelys trijuga*	LC	-	-
5	*Pelochelys cantorii*	EN	-	I

VU=Vulnerable; EN=Endangered; NT=Near Threatened; LC=Least concern

Birds

Data on birds available from nine freshwater wetlands were considered (Nameer, 2002; Jayson, 2002) and the following four have been short-listed on the basis of the abundance and number of species of birds; Kole wetlands, Ambalamedu lake, Kattampally and Madakkara. The last two could be considered as 90% freshwater wetland. Excluding Ambalamedu, in the remaining three wetlands, 97,222 birds belonging to 73 species were recorded. Kole wetlands had the highest number of species as well as birds (Table 4.7). There were two Near Threatened species; the Darter and White Ibis, 28 and 72 respectively. Ambalamedu lake had 30,003 birds belonging to six species during 1996, whereas it was only eight birds of seven species in 2003. The reason for such a drastic decline is not clear. However, it was reported that contamination could be one of the major reasons.

Table 4.7. Major wetlands of Kerala with species and number of birds during 2003

S.#	Wetland	No. of species	No. of birds
1	Kole wetlands	57	78,840
2	Kattampally	24	14,729
3	Madakkara	14	3,653
	Total	73	97,222

Prioritization of wetlands

All the nine wetlands were evaluated for priority conservation as done for other states. Kole wetlands falls in the first rank followed by Kattampally, Madakkara and Ambalamedu in the second rank (Table 4.8). Kole wetlands has already been declared as a Ramsar site. The other three sites although internationally important as migratory bird habitats, do not meet the Ramsar criteria. They could be considered under the proposed National network of Inland Wetland Conservation Areas. Ambalamedu lake needs immediate attention, as the waterfowl have almost totally disappeared from the area during 2003.

Table 4.8. Prioritized wetlands of Kerala

S.#	Name of the wetland	Rank
1	Kole wetlands	1
2	Kattampally	2
3	Madakkara	2
4	Ambalamedu	2

Summary

- Kerala, according to the satellite data of 1988-1990 (SAC, 1998), has 64 freshwater wetlands of the size 56.25 ha and above, covering an area of 342 sq km .
- A recent study conducted by the Department of Fisheries, Kerala, shows that the state has 47,378 wetlands of the size 0.02 ha and above, covering an area of 724.79 sq km.
- Kerala has, according to published literature, sixty-five species of endemic aquatic flowering plants; four Critical, 16 Endangered and 17 Vulnerable species of fishes; two Endangered and one each of Vulnerable, Near Threatened and Least Concern species of freshwater turtles; and three Near Threatened species of wetland birds.
- Data available from nine wetlands were analysed; four short-listed and prioritized.
- One falls in the first rank (Kole wetlands) and three in the second rank.
- Kole wetlands has already been declared as Ramsar sites; the other three sites are proposed for long-term conservation.

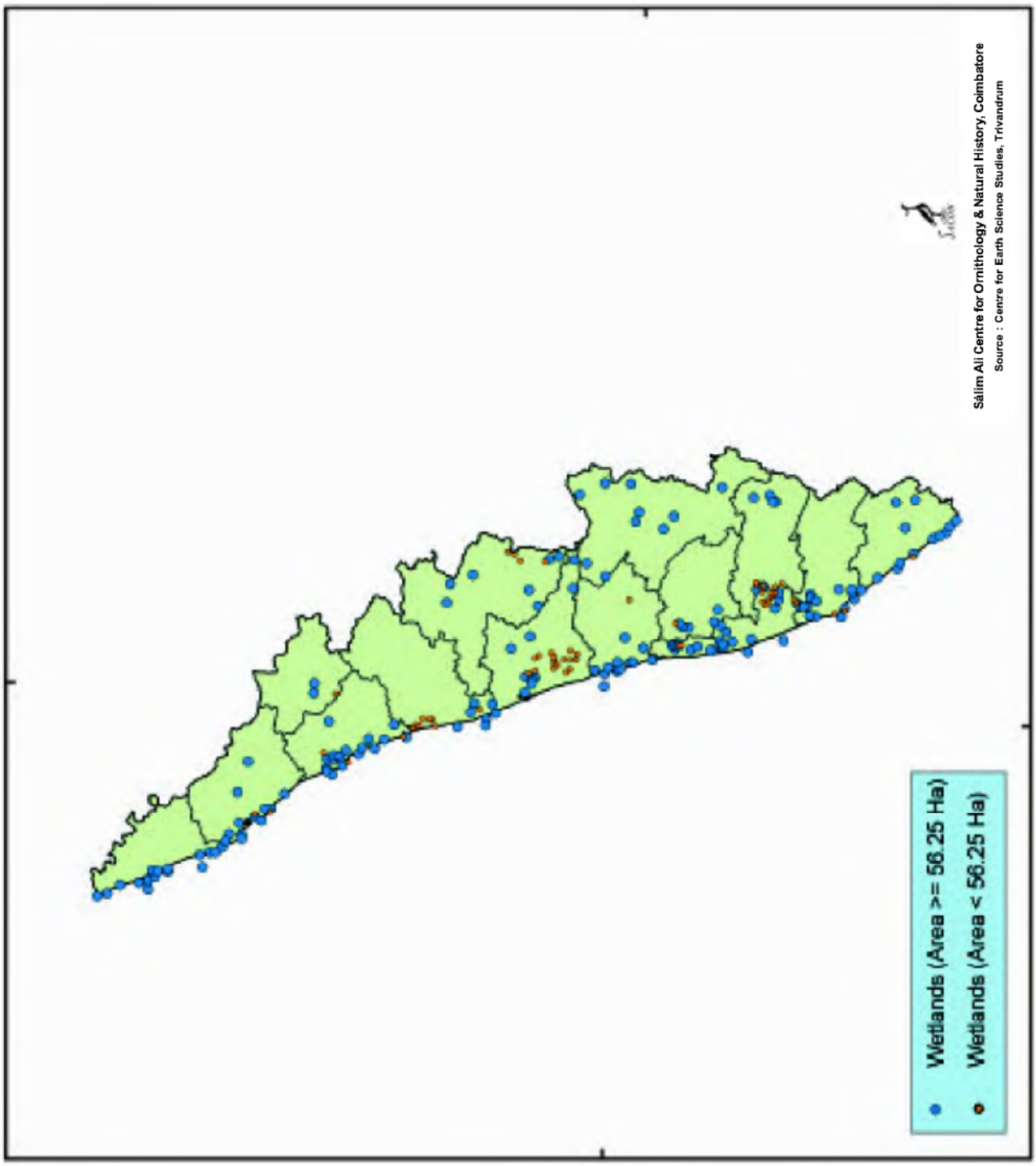


Fig. 4.1. Distribution of wetlands in Kerala (all types of wetlands 56.25 ha and above are included)



V.S. Vijayan



V.S. Vijayan

Kole wetlands near Thrissur, Kerala

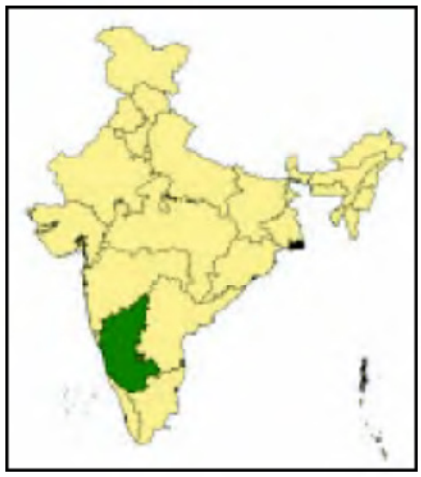


V.S. Vijayan

Chinese net: a traditional fishing gear, in the backwaters of Kerala

KARNATAKA

Karnataka, is a land of unparalleled natural beauty and bounty. It is situated on the western edge of the Deccan plateau with Maharashtra and Goa to its north, Kerala and Tamil Nadu to its south, Andhra Pradesh to its east and the Arabian Sea to its west. Based on the soil characteristics, elevation and rainfall pattern, the state can be classified into the following ten agro-climatic zones; according to Dept. of Agriculture, UAS, Karnataka: North eastern transition zone, North eastern dry zone, Northern dry zone, Central dry zone, Eastern dry zone, Southern dry zone, Southern transition zone, Northern transition zone, Hilly zone and Coastal zone.



State at a glance	
State capital	Bangalore
Area	1,91,791 sq km
Population (2001)	52,733,958
Total number of districts	27
Major rivers	Krishna, Cauvery
Total forest area	30,630 sq km
Population density (2001)	275/sq km
Ramsar site	--
Proposed Ramsar sies	21
Total sites proposed for conservation	75

The state exhibits sub-regional climatic variations within tropical monsoonal zone. The average rainfall in the mainland is 2,000-2,540 mm while parts of the Kanara coast accounts for 7,620 mm and the Maidan North remains the driest with below 700 mm. Average temperature varies from 15.1 to 33.9°C.

Status of wetlands

The routine land use statistics of the state does not indicate wetlands as a separate category (Table 5.1). However, 1.19% (2,288.16 sq km) of the land area in Karnataka is covered by inland wetlands of the size above 56.25 ha (SAC, 1998). The total number of inland wetlands was estimated at 622 in the entire state (Table 5.2). However, SACON's estimate of the wetlands of the size 2 ha and above in seven districts shows that there are 1,647 wetlands covering an area of 2,049.17 sq km (Table 5.3). It may also be emphasised that the wooded/forested wetlands as a category was not amenable to interpretation from satellite data.

Table 5.1. Land use pattern in Karnataka

Land use type	Area in sq km
Total geographic area	1,91,791
Forests	30,630
Not available for cultivation	20,950
Other uncultivated land excluding fallow land	17,350
Fallow land	16,680
Net area sown	1,04,890
Area sown more than once	18,220
Total cropped area	1,23,120
Cultivable area	1,38,920

(Source www.indiastat.com)

Table 5.2. Distribution of various categories of inland wetlands in Karnataka

Inland wetland	Area (sq km)	No. of wetlands
Lake/pond	4.37	5
Oxbow lake	0.56	1
Swamp/marsh	0.87	1
Reservoir	1,672.68	53
Tank	609.12	561
Waterlogged	0.56	1
Total	2,288.16	622

Source: SAC (1998)

A variety of wetland types are encountered in Karnataka, ranging from huge reservoirs to village tanks and occasional oxbow lakes (Table 5.2).

It is interesting to note that while the districts in the Western Ghats with heavy rainfall have fewer number of wetlands, the districts which are relatively drier have higher number of wetlands. Thus Tumkur with a rainfall of less than 700 mm has 125 wetlands, while Dakshina Kannada district with an excess of 2,000 mm rainfall has only 23 wetlands. The spatial distribution of wetlands for the entire state (Fig. 5.1) shows a skewed distribution of wetlands in the drier districts. This has a substantial bearing in the distribution and abundance of wetland birds and other aquatic species. However, it may be noted that all these wetlands are 56.25 ha and above in size.

Habitat analyses of wetlands in select districts

The districts of Belgaum, Bellary, Chickmagalur, Chitradurga, Uttara Kannada, Raichur and Shimoga were mapped for the wetlands of the size 2 ha and above. The land use patterns along with wetland types and wetland size classes and the related statistics are given (Tables 5.4, 5.7, 5.10, 5.13, 5.16, 5.19, 5.22).

In the seven districts studied, the number of wetlands as well as area of wetlands is the highest in the districts of Raichur, followed by Shimoga. Chickmagalur had the lowest number of wetlands (Table 5.3). The wetland area of the seven districts in relation to the total geographical area of the district varied from 1.6% to 3.96% (Fig. 5.2). Only two categories of wetlands were recorded, namely ponds/lakes and reservoirs (Fig. 5.3). Except for Chitradurga in all other districts, reservoirs formed the major part of the wetland area. Size

Table 5.3. Types, number and extent (sq km) of wetlands in select districts

Districts	Ponds/lakes/tanks		Reservoirs		Total no. of wetlands	Total area of wetlands
	No.	Area	No.	Area		
Belgaum	229	63.08	3	154.19	232	217.27
Bellary	224	88.32	2	318.57	226	406.89
Chickmagalur	129	42.93	1	108.73	130	151.66
Chitradurga	351	147.45	1	25.8	352	173.25
Uttara Kannada	135	90.01	4	107.43	139	197.44
Raichur	233	124.85	2	362.06	235	486.91
Shimoga	331	119.92	2	295.83	333	415.75
Total	1,632	676.56	15	1,372.61	1647	2,049.17

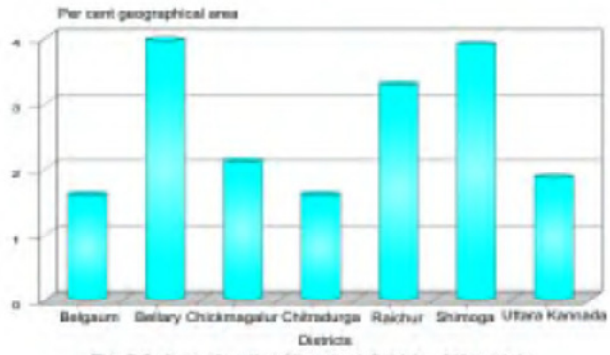


Fig. 5.2. Area of wetland in select districts of Karnataka

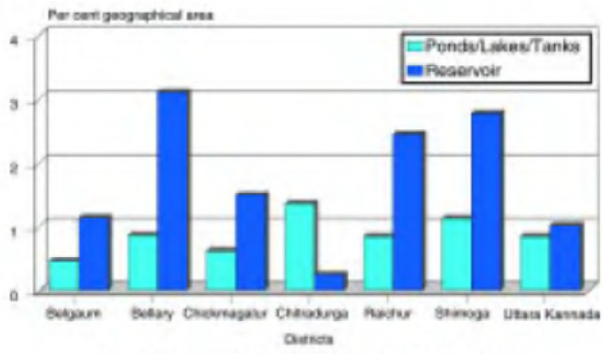


Fig. 5.3. Area of different types of wetland in select districts of Karnataka

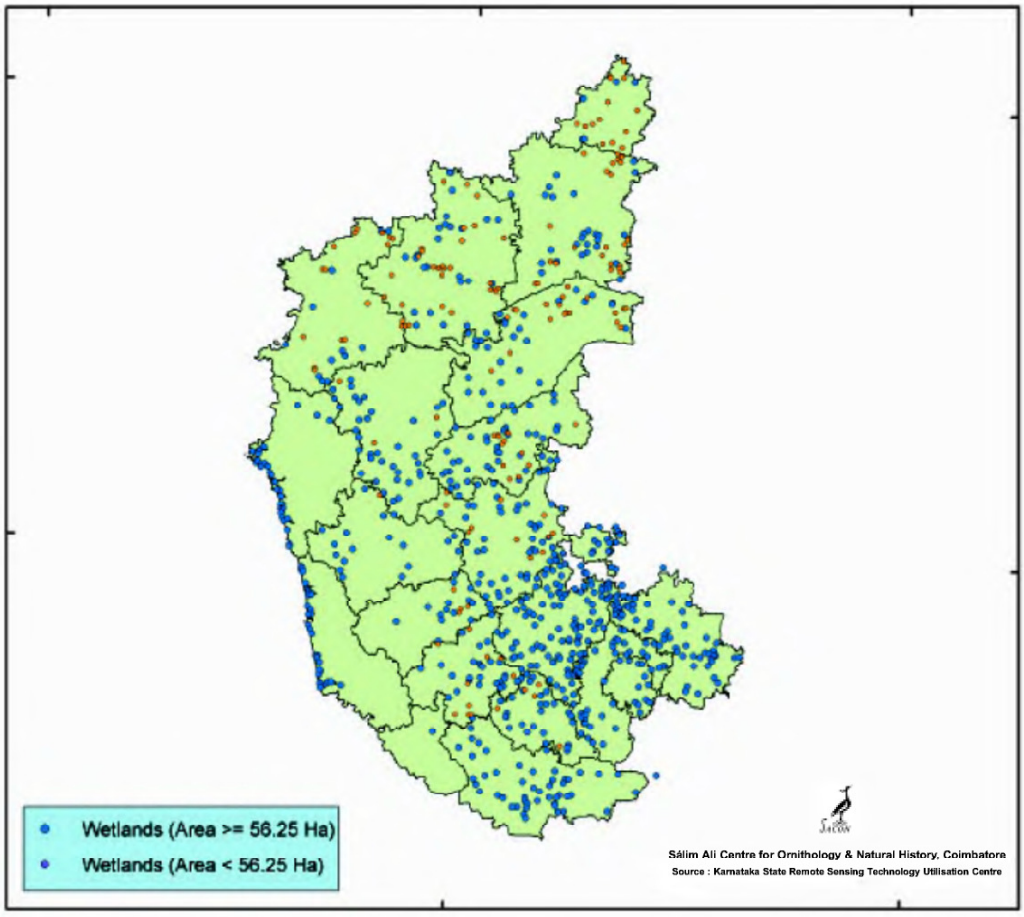


Fig. 5.1. Distribution of wetlands in Karnataka

class distribution of wetlands indicated that there are large number of smaller wetlands below the size of 56.25 ha than larger wetlands above 56.25 to 100 ha (Fig. 5.4).

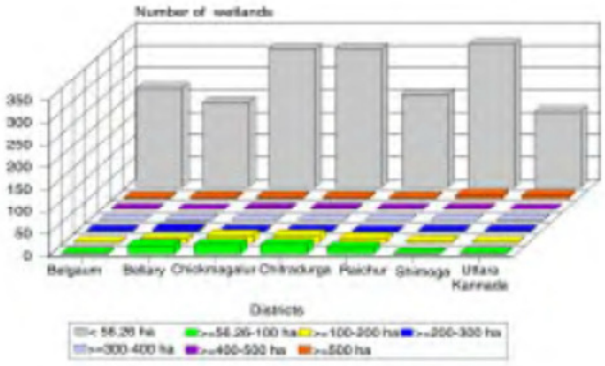


Fig. 5.4. Size class distribution of wetlands in select districts of Karnataka

Turbidity

Turbidity of the reservoirs was low in all the districts (Fig. 5.5). In the case of ponds/ lakes/ tanks, it was low in the districts of Belgaum, Chickmagalur, Chitradurga, Uttara Kannada and Shimoga, while those in the other districts studied it was either moderate or high (Fig. 5.6; Table 5.5, 5.8, 5.11, 5.14, 5.17, 5.20, 5.23).

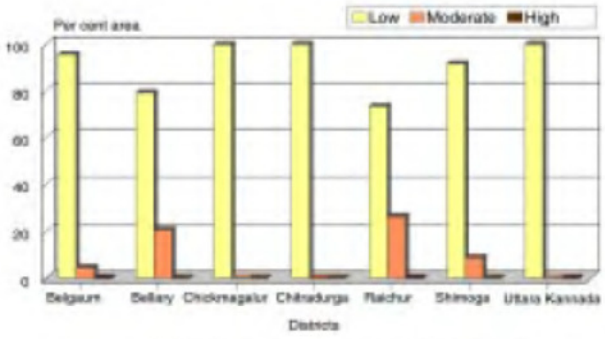


Fig. 5.5. Turbidity pattern of reservoirs in select districts of Karnataka

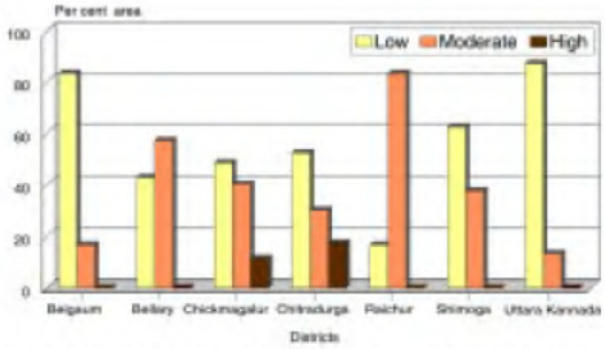


Fig. 5.6. Turbidity pattern of ponds/tanks/lakes in select districts of Karnataka

Summer recession

Summer (pre-monsoon) recession of wetland area in different districts is shown in Fig. 5.7. Uttara Kannada district has exhibited the maximum summer season recession (68.51%). Minimum recession was found in Chickmagalur and Shimoga districts where forest cover is comparatively larger. However, this does not appear to hold true for Uttara Kannada, where forest cover is quite high (38%), still it has the highest summer recession.

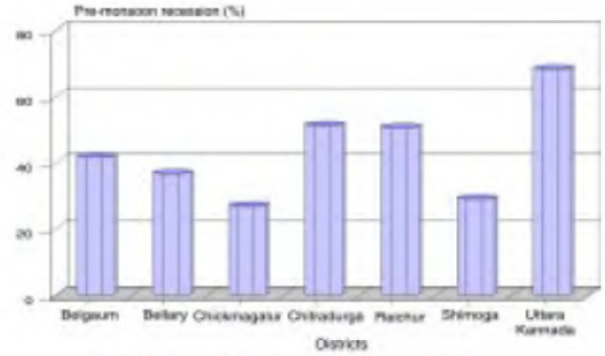


Fig. 5.7. Average summer recession in the wetlands in select districts in Karnataka

Wetlands and land use pattern in the catchment areas

The land use pattern in the select districts shows that crop lands are more in four districts while forests dominate in Chickmagalur, Uttara Kannada and Shimoga (Fig. 5.8-5.14; Tables 5.4, 5.7, 5.10, 5.13, 5.16. 5.19, 5.22). In most cases the wetlands are surrounded by crop lands.

Table 5.25. Summary of wetland statistics for the select districts of Karnataka

Wetland class	No. of wetlands	Area* (sq km)	% Wetland type area					
			Turbidity levels			Aquatic vegetation		
			Low	Moderate	High	Low	Moderate	High
Belgaum								
Reservoirs	3	154.19	95.45	4.55	0.00	100.00	0.00	0.00
Ponds/lakes/tanks	229	63.08	83.34	16.66	0.00	100.00	0.00	0.00
Bellary								
Reservoirs	2	318.57	79.21	20.79	0.00	100.00	0.00	0.00
Ponds/lakes/tanks	224	88.32	42.86	57.14	0.00	100.00	0.00	0.00
Chickmagalur								
Reservoirs	1	108.73	99.9	0.10	0.00	100.00	0.00	0.00
Ponds/lakes/tanks	129	42.93	48.6	40.25	11.08	100.00	0.00	0.00
Chitradurga								
Reservoirs	1	25.80	100.00	0.00	0.00	100.00	0.00	0.00
Ponds/lakes/tanks	351	147.45	52.50	30.00	17.50	100.00	0.00	0.00
Uttara Kannada								
Reservoirs	4	107.43	100.0	0.00	0.00	100.00	0.00	0.00
Ponds/lakes/tanks	135	90.01	87.10	12.90	0.00	100.00	0.00	0.00
Raichur								
Reservoirs	2	362.06	73.56	26.44	0.00	100.00	0.00	0.00
Ponds/lakes/tanks	233	124.85	16.66	83.33	0.00	100.00	0.00	0.00
Shimoga								
Reservoirs	2	295.83	91.37	8.63	0.00	100.00	0.00	0.00
Ponds/lakes/tanks	331	119.92	62.44	37.56	0.00	100.00	0.00	0.00

* Wetlands of size 2.0 ha and above only

Temporal changes in wetland cover

The wetland area during 1991-92 and 1998-'99 in the seven districts studied shows that there is a loss of wetland cover in the districts of Shimoga and Chickmagalur. It is ironic to note that such a loss of wetlands has happened in high rainfall districts. The only reason for the loss appears to be conversion of wetlands into other forms of land use. This needs to be verified. All other districts showed an increase in wetland cover (Table 5.26, Fig. 5.15).

Table 5.26. Changes in the wetland area in each district (in sq km)

District	SAC (1991-'92)	SACON (1998-'99)	Variation	%Variation
Uttara Kannada	151.13	197.44	46.32	30.65
Shimoga	457.57	415.75	-41.82	-9.14
Belgaum	197.33	217.27	19.94	10.10
Chickmagalur	197.76	151.66	-46.46	-23.49
Chitradurga	130.88	173.25	42.38	32.38
Bellary	353.00	406.89	53.89	15.27
Raichur	30.06	486.91	456.86	1,520.06

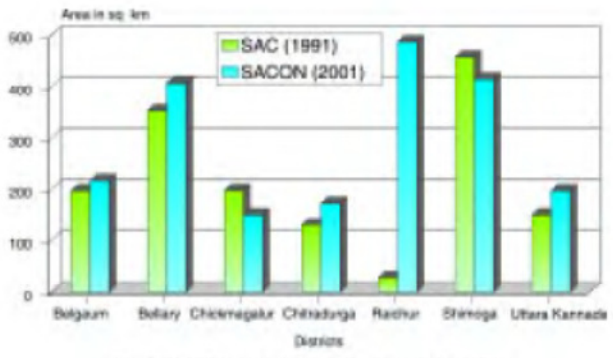


Fig. 5.15. Difference in total wetland area in Karnataka

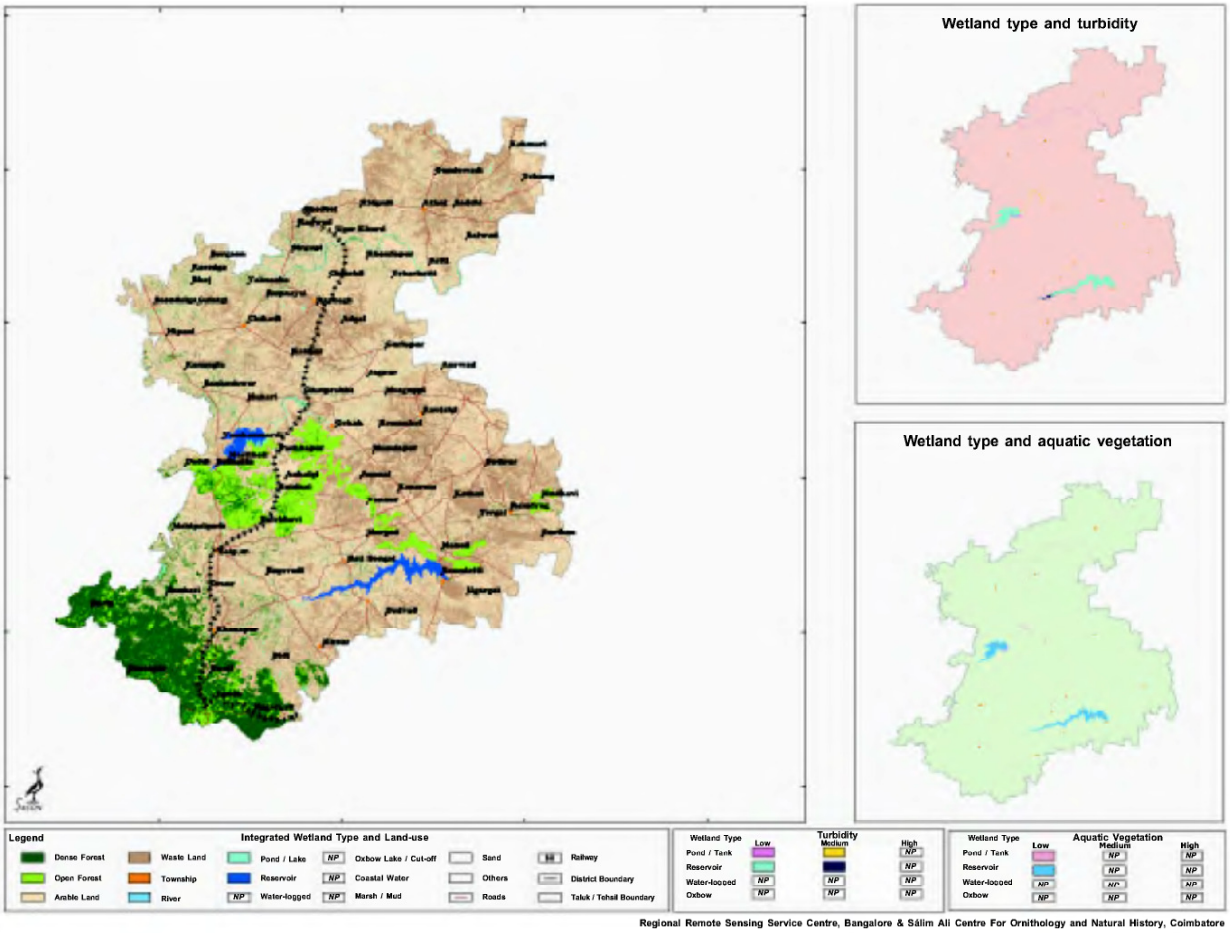


Fig. 5.8. Land use and wetland categories of the district of Belgaum

Table 5.4. Area under different land use and wetland categories in the district of Belgaum

Land use class	Area (sq km)	Area (%)
Forest-dense	1,401.75	10.27
Forest-open	799.00	5.86
Arable land	6,970.22	51.09
Wasteland	3,995.00	29.28
Ponds/lakes/tanks/rivers	63.08	0.46
Reservoirs	154.19	1.13
Others	259.33	1.90

Table 5.5. Area under different turbidity classes in the district of Belgaum

Turbidity class	Area (sq km)	Area (%)
Low	199.75	91.94
Moderate	17.52	8.06
High	0.00	0.00

Table 5.6. Seasonal pattern of wetland area in the district of Belgaum

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/ponds/ lakes/tanks/rivers	102.39	59.71	42.68	41.68

* Only 72% of the district area is covered for the pre-monsoon data

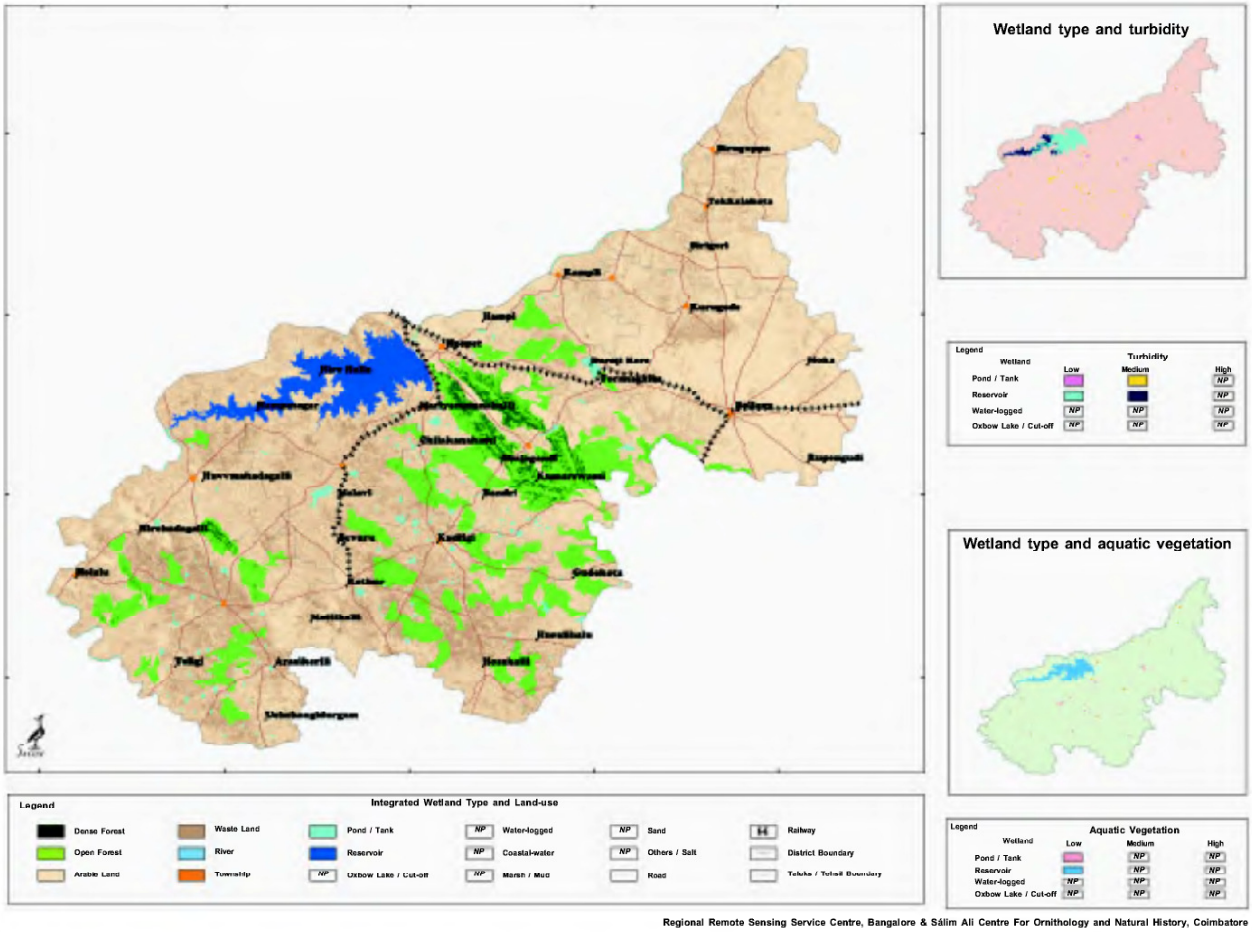


Fig. 5.9. Land use and wetland categories of the district of Bellary

Table 5.7. Area under different land use and wetland categories in the district of Bellary

Land use class	Area (sq km)	Area (%)
Forest-dense	129.32	1.26
Forest-open	1,208.05	11.74
Arable land	6,141.18	59.69
Wasteland	2,144.84	20.85
Cloud affected	78.10	0.76
Ponds/lakes/tanks/rivers	88.32	0.86
Reservoirs	318.57	3.10
Others	179.79	1.75

Table 5.8. Area under different turbidity classes in the district of Bellary

Turbidity class	Area (sq km)	Area (%)
Low	290.18	71.32
Moderate	116.71	28.68
High	0.00	0.00

Table 5.9. Seasonal pattern of wetland area in the district of Bellary

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/ponds/ lakes/tanks/rivers	374.91	236.95	137.96	36.80

* Only 54% of the district area is covered for the pre-monsoon data

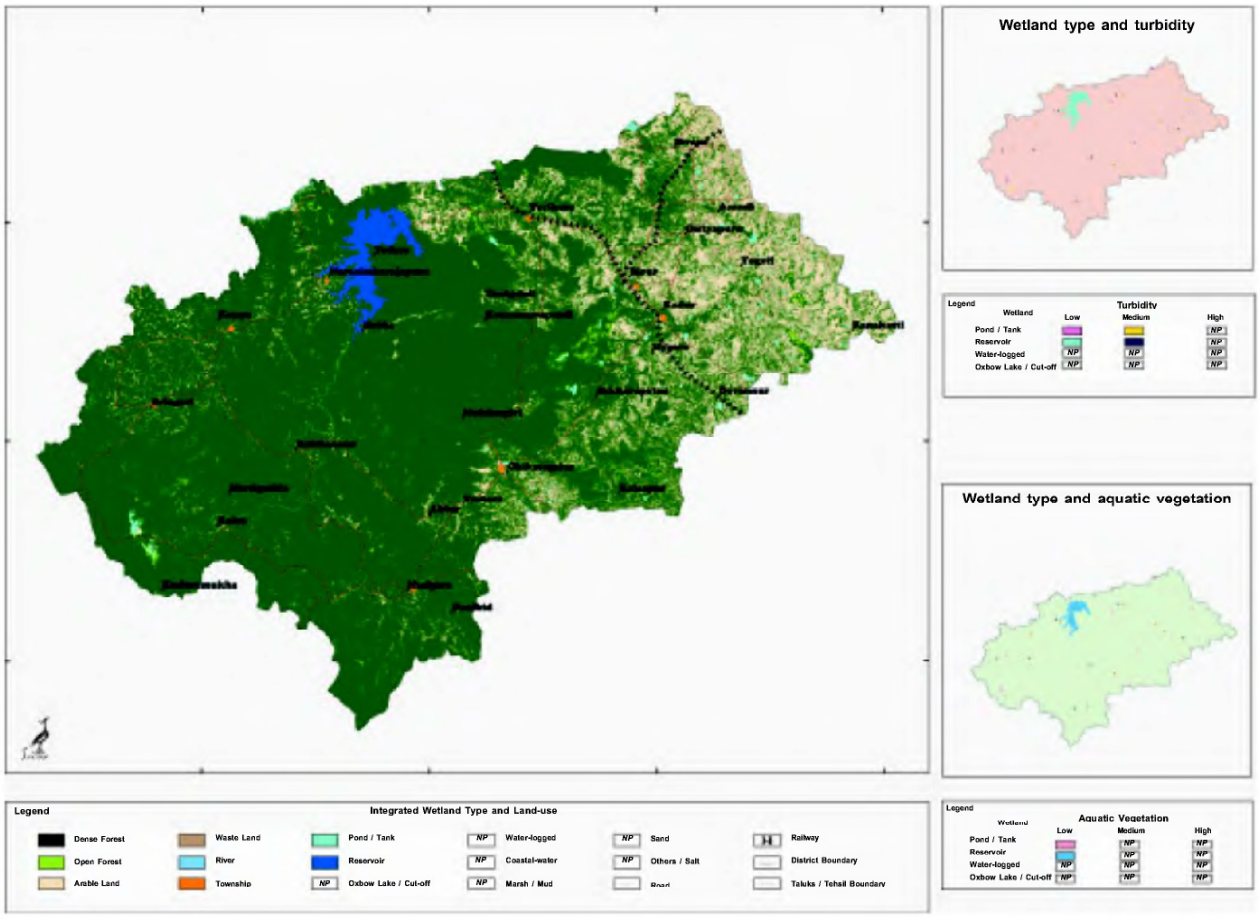


Fig. 5.10. Land use and wetland categories of the district of Chickmagalur

Table 5.10. Area under different land use and wetland categories in the district of Chickmagalur

Land use class	Area (sq km)	Area (%)
Forest-dense	5,588.76	76.52
Forest-open	49.45	0.68
Arable land	1,340.78	18.36
Wasteland	77.69	1.06
Ponds/lakes/tanks/rivers	42.93	0.62
Reservoirs	108.73	1.49
Others	94.11	1.29

Table 5.11. Area under different turbidity classes in the district of Chickmagalur

Turbidity class	Area (sq km)	Area (%)
Low	129.59	85.45
Moderate	17.30	11.41
High	4.76	3.13

Table 5.12. Seasonal pattern of wetland area in the district of Chickmagalur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/ponds/ lakes/tanks/rivers	148.93	108.45	40.48	27.18

* Only 86% of the district area is covered for the pre-monsoon data

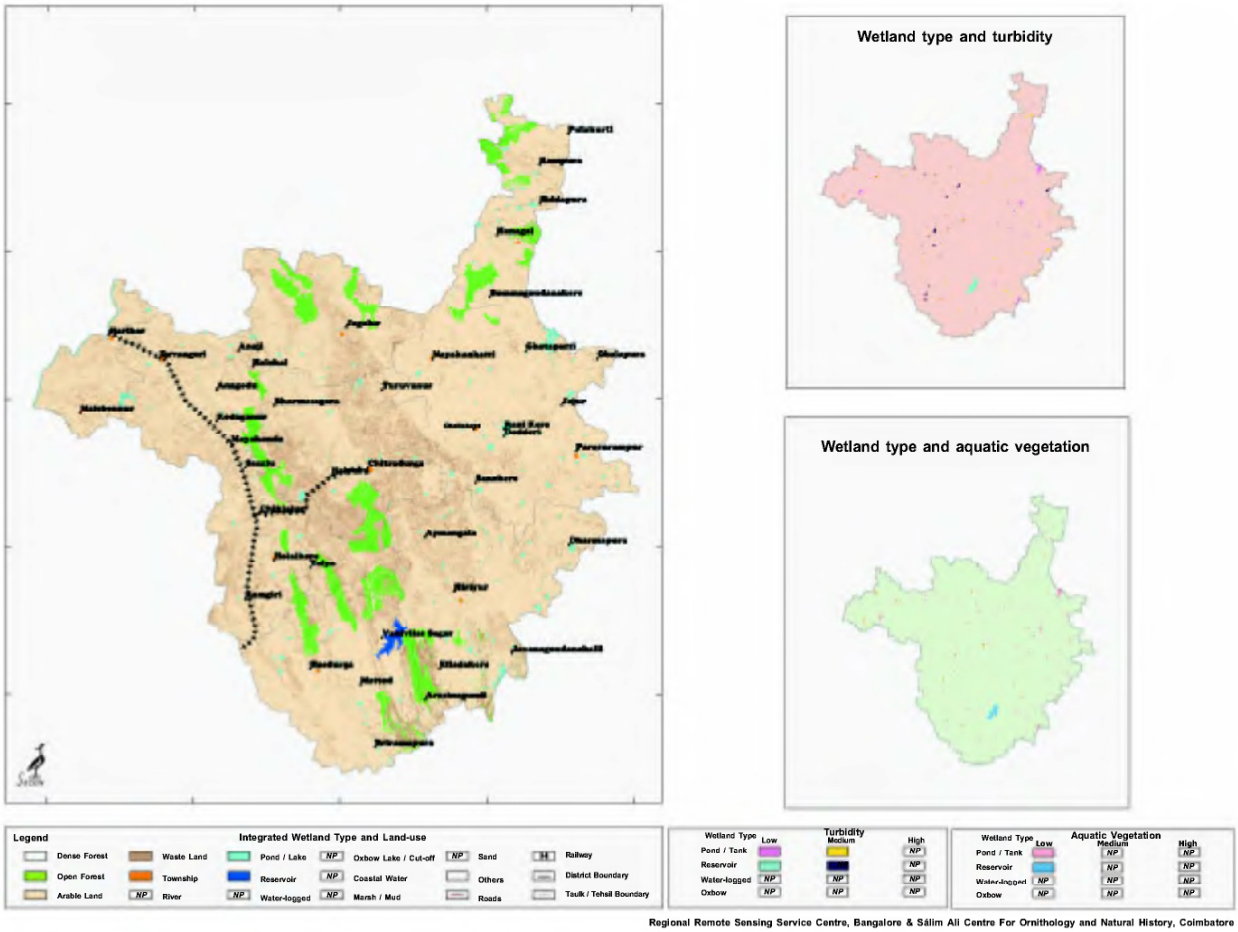


Fig. 5.11. Land use and wetland categories of the district of Chitaradurga

Table 5.13. Area under different land use and wetland categories in the district of Chitradurga

Land use class	Area (sq km)	Area (%)
Forest-dense	0.00	0.00
Forest-open	667.24	6.10
Arable land	8,460.29	77.40
Wasteland	1,452.44	13.29
Ponds/lakes/tanks/rivers	147.45	1.35
Reservoirs	25.80	0.24
Others	176.95	1.62

Table 5.14. Area under different turbidity class in the district of Chitradurga

Turbidity class	Area (sq km)	Area (%)
Low	103.21	59.57
Moderate	44.24	25.54
High	25.80	14.89

Table 5.15 Seasonal pattern of wetland area in the district of Chitradurga

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/ponds/ lakes/tanks/rivers	68.76	33.46	35.30	51.34

* Only 65% of the district area is covered for the pre-monsoon data

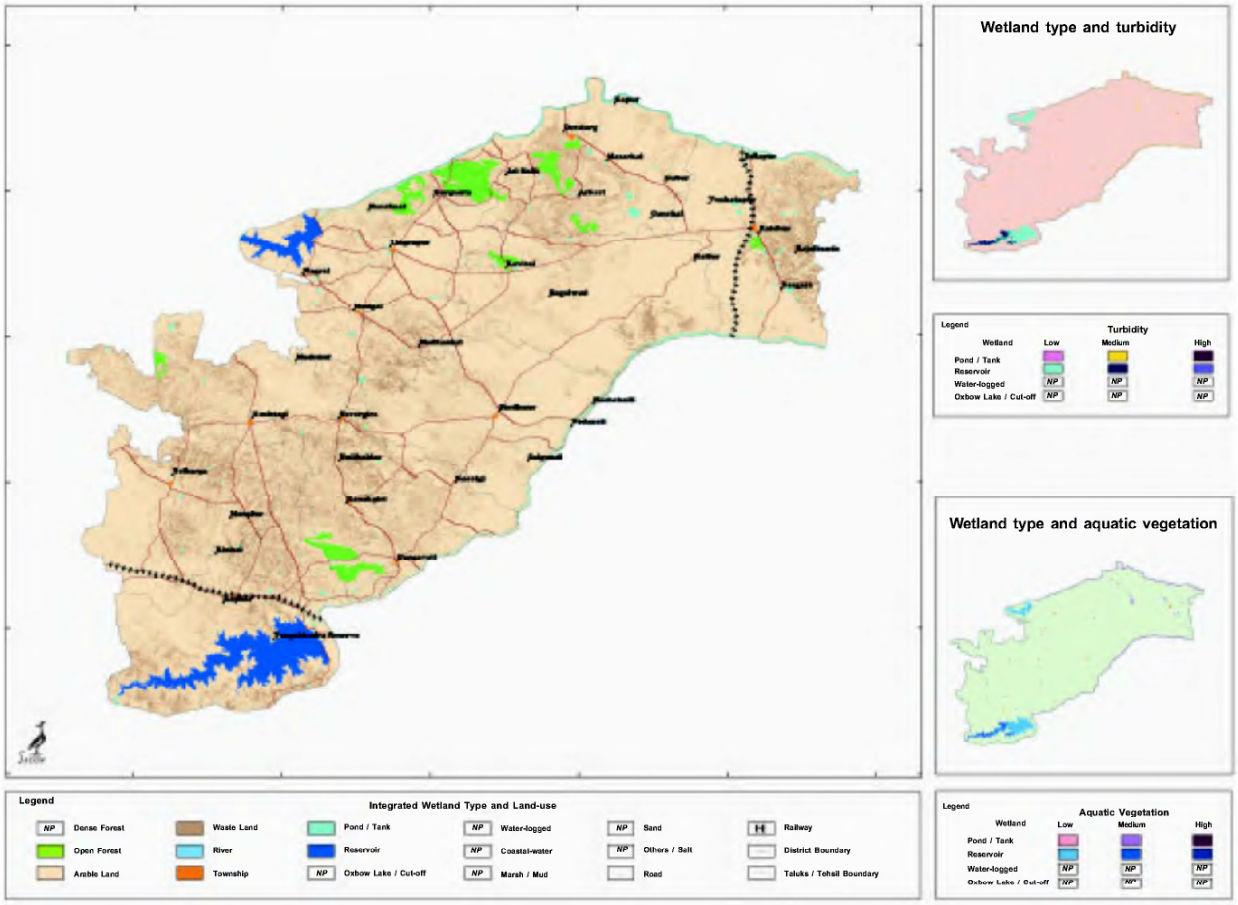


Fig. 5.12. Land use and wetland categories of the district of Raichur

Table 5.16. Area under different land use and wetland categories in the district of Raichur

Land use classes	Area (sq km)	Area (%)
Forest-dense	0.00	0.00
Forest-open	287.15	1.94
Arable land	11,502.66	77.66
Wasteland	2,209.81	14.92
Ponds/lakes/tanks/rivers	124.85	0.84
Reservoirs	362.06	2.44
Others	324.50	2.19

Table 5.17. Area under different turbidity classes in the district of Raichur

Turbidity class	Area (sq km)	Area (%)
Low	287.15	58.97
Moderate	199.76	41.03
High	0.00	0.00

Table 5.18. Seasonal pattern of wetland area in the district of Raichur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/ponds/ lakes/tanks/rivers	31.66	15.61	16.05	50.69

* Only 36% of the district area is covered for the pre-monsoon data

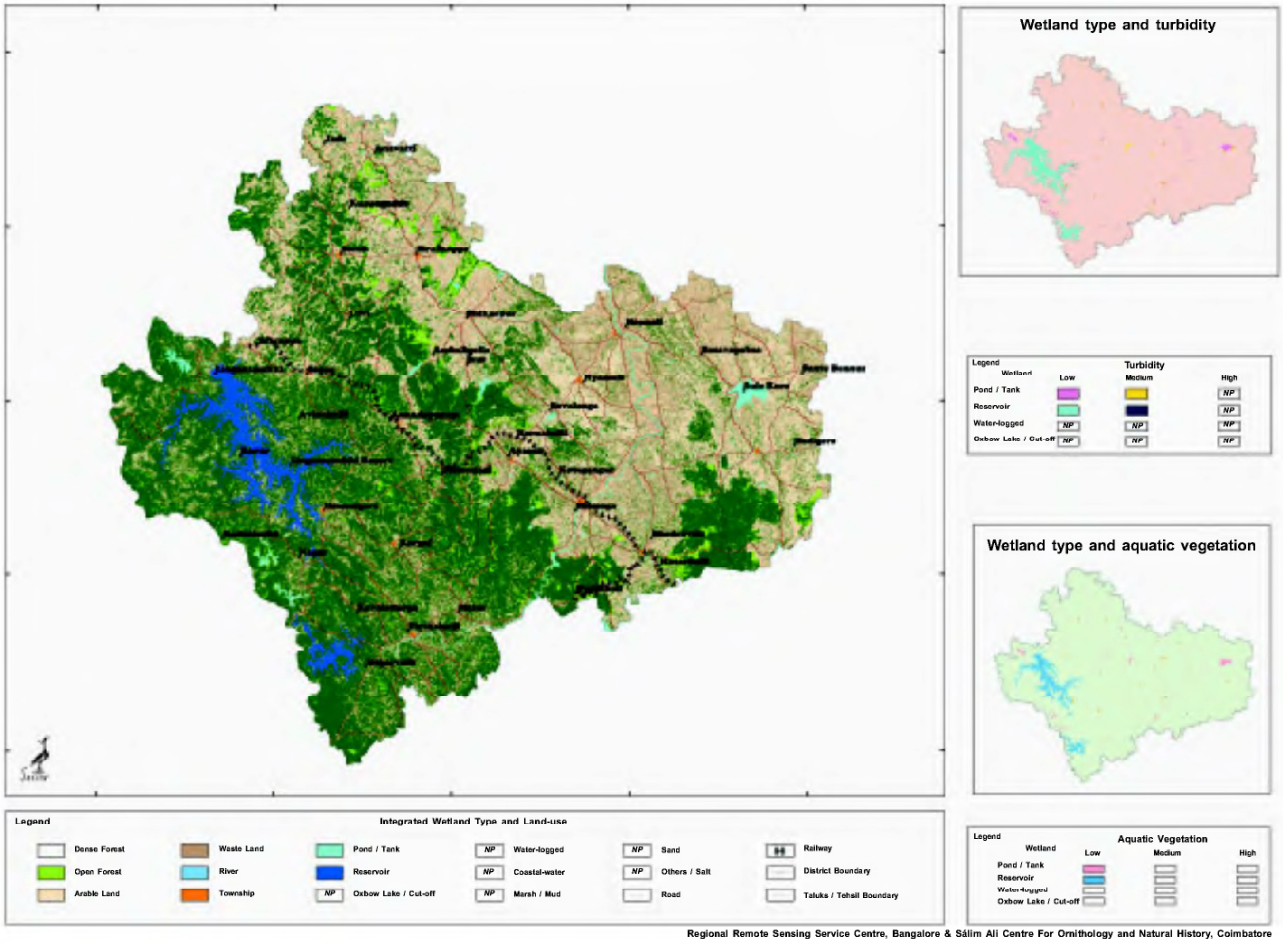


Fig. 5.13. Land use and wetland categories of the district of Shimoga

Table 5.19. Area under different land use and wetland categories in the district of Shimoga

Land use class	Area (sq km)	Area (%)
Forest-dense	4,650.59	43.55
Forest-open	291.25	2.73
Arable land	3,509.67	32.86
Wasteland	1,475.48	13.81
Ponds/lakes/tanks/rivers	119.92	1.12
Reservoirs	295.83	2.77
Others	335.13	3.13

Table 5.20. Area under different turbidity classes in the district of Shimoga

Turbidity class	Area (sq km)	Area (%)
Low	345.17	83.02
Moderate	70.59	16.98
High	0.00	0.00

Table 5.21. Seasonal pattern of wetland area in the district of Shimoga

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/ponds/ lakes/tanks/rivers	356.54	252.48	104.06	29.19

* Only 95% of the district area is covered for the pre-monsoon data

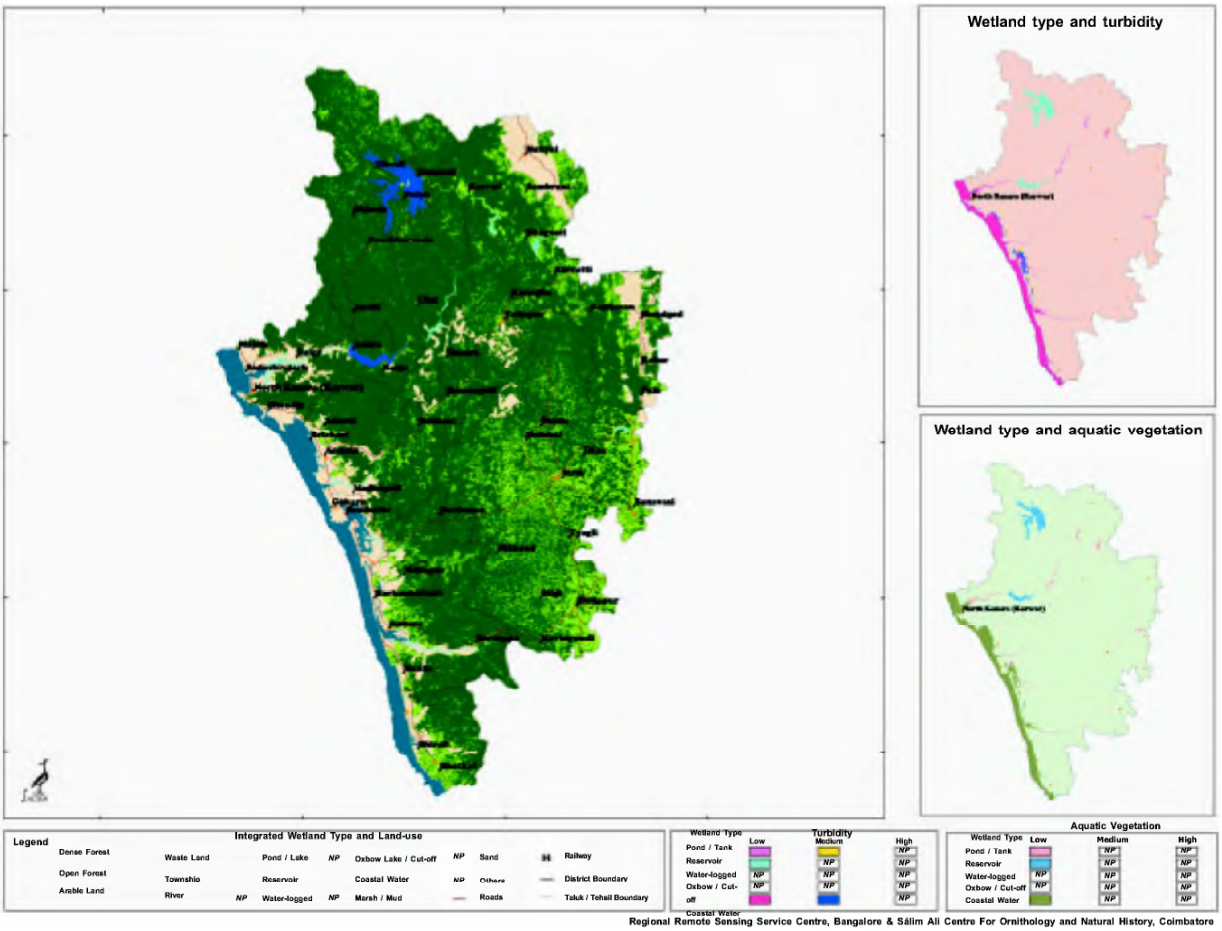


Fig. 5.14. Land use and wetland categories of the district of Uttara Kannada

Table 5.22. Area under different land use and wetland categories in the district of Uttara Kannada

Land use classes	Area (sq km)	Area (%)
Forest-dense	7,288.08	68.26
Forest-open	1,626.02	15.23
Arable land	914.64	8.57
Wasteland	23.23	0.22
Ponds/lakes/tanks/rivers	90.01	0.84
Reservoirs	107.43	1.01
Other water body	627.18	5.87

Table 5.23. Area under different turbidity classes in the district of Uttara Kannada

Turbidity class	Area (sq km)	Area (%)
Low	185.83	94.12
Moderate	11.61	5.88
High	0.00	0.00

Table 5.24. Seasonal pattern of wetland area in the district of Uttara Kannada

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/ponds/ lakes/tanks	47.04	14.81	32.23	68.52

* Only 21% of the district area is covered for the pre-monsoon data

Biodiversity

Aquatic vegetation

In the districts mapped, the aquatic vegetation seemed to be low in most part of the wetlands (Table 5.25; Fig. 5.16). However, some of the specific wetlands studied for waterfowl contained thick growth of *Eichhornia* sp.. The endemic aquatic plants of Karnataka (Cook, 1966; Flora Volumes, BSI) comprise 64 species belonging to 17 families. Family Eriocaulaceae has the highest representatives; 14 species (Table 5.27).

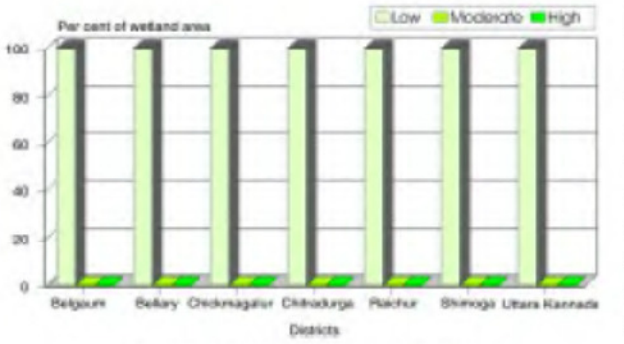


Fig. 5.16. Aquatic vegetation in wetlands of select districts of Karnataka

Fishes

Of the 15 species of fishes reported from Karnataka (Table 5.28), three are Critically Endangered and 12 Endangered (Menon, 1999).

Turtles

Of the 23 species of freshwater turtles in India, four are reported from Karnataka. Out of these one each is Endangered, Vulnerable, Near Threatened and one is rather safe ie. of Least Concern (Table 5.29).

Birds

Seventy five wetlands in 12 districts representing the three major biogeographic zones of the state, namely the West Coast, Deccan Plateau and Western Ghats were surveyed for waterfowl. The total area of the wetlands covered is more than 300 km sq km.

Table 5.27. List of endemic plants reported from Karnataka

S.No.	Species	Family
1	*Tonningia cucullata*	Commelinaceae
2	*Cladopus hookerianus*	Podostemaceae
3	*Cryptocoryne cognata*	Araceae
4	*Cryptocoryne consobrina*	Araceae
5	*Cryptocoryne cognatoides*	Araceae
6	*Lagenandra meeboldii*	Araceae
7	*Cryptocoryne spiralis*	Araceae
8	*Eriocaulon breviscapum*	Eriocaulaceae
9	*Eriocaulon cuspidatum*	Eriocaulaceae
10	*Eriocaulon dalzellii*	Eriocaulaceae
11	*Eriocaulon eurypeplon*	Eriocaulaceae
12	*Eriocaulon fysonii*	Eriocaulaceae
13	*Eriocaulon heterolepis*	Eriocaulaceae
14	*Eriocaulon lanceolatum*	Eriocaulaceae
15	*Eriocaulon parviflorum*	Eriocaulaceae
16	*Eriocaulon richardianum*	Eriocaulaceae
17	*Eriocaulon ritchieanum*	Eriocaulaceae
18	*Eriocaulon robusto-brownianum*	Eriocaulaceae
19	*Eriocaulon sedgwickii*	Eriocaulaceae
20	*Eriocaulon stellulatum*	Eriocaulaceae
21	*Fimbristylis woodrowii*	Cyperaceae
22	*Fuirena trilobites*	Cyperaceae
23	*Fuirena tuwensis*	Cyperaceae
24	*Fuirena wallichiana*	Cyperaceae
25	*Geissaspis tenella*	Fabaceae
26	*Hoppea dichotoma*	Gentianaceae
27	*Hubbardia heptaneuron*	Poaceae
28	*Hydrobryopsis sessilis*	Podostemaceae
29	*Hygrophila pinnatifida*	Acanthaceae
30	*Hygrophila serpylla*	Acanthaceae
31	*Indotristicha ramosissima*	Podostemaceae
32	*Isachne meeboldii*	Poaceae
33	*Isachne elegans*	Poaceae
34	*Ischaemum nilagiricum*	Poaceae
35	*Isachne veldkampii*	Poaceae
36	*Limnophila polystachya*	Scrophulariaceae
37	*Limnopoa meeboldii*	Poaceae
38	*Lindernia estaminodiosa*	Scrophulariaceae
39	*Murdannia pauciflora*	Commelinaceae
40	*Myriophyllum oliganthum*	Haloragaceae
41	*Paspalum canarae*	Poaceae
42	*Podostemum barberi*	Podostemaceae
43	*Pogostemon erectum*	Lamiaceae
44	*Trithuria konkanensis*	Hydatellaceae
45	*Utricularia smithiana*	Lentibulariaceae
46	*Utricularia wightiana*	Lentibulariaceae
47	*Wisneria triandra*	Alismataceae
48	*Pogostemon salicifolius*	Lamiaceae

Contd...

Table 5.27. Contd...

S.No.	Species	Family
49	*Utricularia cecilii*	Lentibulariaceae
50	*Cyanotis papilionacea*	Commelinaceae
51	*Cyathocline lutea*	Asteraceae
52	*Eriocaulon barbeyanum*	Eriocaulaceae
53	*Murdannia lanuginosa*	Commelinaceae
54	*Ramphicarpa longiflora*	Scrophulariaceae
55	*Rotala fimbriata*	Lythraceae
56	*Rotala illecebroides*	Lythraceae
57	*Rotala macrandra*	Lythraceae
58	*Rotala malampuzhensis*	Lythraceae
59	*Rotala ritchei*	Lythraceae
60	*Sesbania procumbens*	Fabaceae
61	*Utricularia albocaerulea*	Lentibulariaceae
62	*Utricularia arcuata*	Lentibulariaceae
63	*Utricularia lazulina*	Lentibulariaceae
64	*Utricularia praeterita*	Lentibulariaceae

Table 5.28. Threatened freshwater fishes reported from Karnataka

S.No.	Species	Status
1	*Proeutropiichthys taakree*	CR
2	*Puntius narayani*	CR
3	*Silurus wynaadensis*	CR
4	*Anguilla bengalensis*	EN
5	*Bhavania australis*	EN
6	*Garra gotyla stenorhynchus*	EN
7	*Hypselobarbus curmuca*	EN
8	*Hypselobarbus jerdoni*	EN
9	*Hypselobarbus kurali*	EN
10	*Hypselobarbus thomasi*	EN
11	*Mystus malabaricus*	EN
12	*Puntius dorsalis*	EN
13	*Puntius melanampyx sp.nov.*	EN
14	*Rita pavimentatus*	EN
15	*Tetraodon travancoricus*	EN

CR=Critially Endangered; EN=Endangered

Table 5.29. Distribution and status of turtle in Karnataka

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes leithii*	VU	-	IV
2	*Geoemyda silvatica*	EN	-	I
3	*Lissemys punctata*	NT	II	I
4	*Melanochelys trijuga*	LC	-	-

VU=Vulnerable; NT=Near Threatened; LC=Least Concern; EN=Endangered

In all, 3,08,434 birds belonging to 139 species of migratory and resident birds that depend fully or partly on wetlands were enumerated (Table 5.30). Seven of them were terrestrial. Of the 75 sites surveyed, nine sites had 67 % of the total birds counted and each of these sites had more than 16,000 birds. The top five wetlands, namely Byramangla reservoir, Krishnaraja sagar, Hoskote tank, Manslapura tank and Yelibechali tank had more than 20,000 birds qualifying them to be considered as internationally important wetlands (Ramsar sites). Manslapura tank, Samunder talab, and Yelibechali tank had more than 50% of the total species recorded, (77, 71 and 73 respectively).

Fifteen species of raptors including two Threatened and three Near Threatened were recorded. Majority of the birds (about 60%) were ducks. 45 species had a total population of more than 1,000 in the 75 wetlands surveyed. Of these, six species, namely the Pintail, Shoveller, Garganey, Common Teal, Coot and Cattle Egret were abundant with more than 10,000 birds. All these, except the last, are winter migrants to the state.

Distribution of the species shows that four species, namely the Pond Heron, Cattle Egret, Little Cormorant and Little Grebe were the most widely spread, occurring in more than 75% of the sites counted, while 18 species were found in more than 50% of the wetlands surveyed. These include the abundant species such as the Pintail, Shoveller, Garganey, Coot and Cattle Egret. The most widely distributed birds in the wetlands are all resident species breeding in the state.

Table 5.30. Major wetlands of Karnatakawith species and number of birds

Sl. #	Name of the wetland	No.of. species	No.of birds
1	Agara tank (Yelandur cluster)	17	840
2	Amanakatte	35	244
3	Arakere	41	1,190
4	Attivery Bird Sanctuary	37	1,729
5	Badane kere	32	14,121
6	Bannur Heggere	27	615
7	Belikere	43	2,336
8	Bellandur	11	1,583
9	Bethamangala tank	20	1,965
10	Byramangala reservoir	38	36,729
11	Chikka Hoskote	12	256
12	Chikkaballi	41	497
13	Chikkajala tank	23	230
14	Dalavay tank	30	1,428
15	Daroji tank	35	9,129
16	Doddajala tank	16	370
17	Duggatti tank (Yelandur cluster)	24	449
18	Gende Hosalli	36	612
19	Gudavi Bird Sanctuary	20	2,097
20	Hebbur Ammanikere	14	139
21	Heche tank	14	59
22	Heggari (Haveri) tank	27	1,150
23	Hennagara tank	25	308
24	Hirekere tank (Yelandur cluster)	41	3,302
25	Hoskote tank	33	27,295
26	Irsawadi tank (Yelandur cluster)	58	16,819
27	Isloor Village tank	30	306
28	Jigni tank	17	201
29	Kabini river	35	533
30	Kaggaladu Chikkakere	10	105
31	Kaggalipura kere	27	3,331
32	Kaggalladu Dodda kere	10	166
33	Kalkere tank	20	3,837
34	Kalambellan tank	11	296
35	Kallur lake (Yelandur cluster)	34	8,606
36	Kamasamudram kere	25	739
37	Karanji tank	46	4,156
38	Karigala kere	30	1,583
39	Kenchana kere	9	178
40	Kesthur lake (Yelandur cluster)	35	1,117
41	Kolar Ammanikere	28	1,838
42	Koppa	47	954
43	Kothagere kere	3	12
44	Krishnarajasagar dam	67	32,650
45	Kukkarahalli tank	30	6,371
46	Kunigal Chikkakere	21	766
47	Kunigal doddakere	9	911
48	Kunthur lake (Yelandur cluster)	33	8,030

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Six hundred and sixteen birds of five Threatened species and 5,729 birds of seven Near Threatened species were reported during the survey (Table 5.31). More than 1% of the biogeographic population of six species were present in five wetlands; the Painted Stork (1 wetland), Pintail and Shoveller (each in one wetland) Openbill Stork and Cotton Teal (each in two wetlands) and Indian Shag (1 wetland).

Environmental contamination

Contamination levels in 162 fishes comprising nine species collected from 13 wetlands in Karnataka are discussed below.

Heavy metal contamination

Among the wetlands studied, almost equal concentrations of lead were recorded in Tumkur Amanikare (5.51 $\pm$0.92 ppm) and Heche tank (5.50$\pm$0.57 ppm) of Shimoga district (Fig. 5.17). Although appreciable concentrations of copper, cadmium and chromium were also recorded, their levels are lower than the levels reported to be harmful.

Among the nine species of fishes received from Karnataka, *Cirrhinus mrigala* had the maximum concentrations of lead (5.89$\pm$1.26 ppm), while *Channa striatus* had maximum of zinc (17.78$\pm$9.05 ppm) and cadmium (0.79$\pm$0.29 ppm) (Fig. 5.18). Metal levels in surface dwellers such as *Cyprinus carpio* and *Catla catla*, and subsurface dwellers, namely *Labeo rohita* were much lower than those in a bottom dweller, *Channa striatus*. Significant variation in contamination ($P<0.005$) could be related to their feeding habits.

Heche tank of Shimoga is said to be under a process of eutrophication and that the fishes of this wetland are reported to suffer from an undefined infectious disease to the extent of wiping

Table 5.30. Contd...

Sl. #	Name of the Wetland	No. of species	No.of birds
49	Lingambudhi tank	64	3,719
50	Maddur kere (Deshalli)	41	629
51	Maddur tank (Yelandur cluster)	30	1,481
52	Magadi tank	40	4,504
53	Malagi Dharma dam	42	1,082
54	Mansalapura tank	77	25,040
55	Maralur Ammanikere	7	43
56	Marehallikere	19	779
57	Mullur tank (Yellandur cluster).	24	277
58	Nagavalli tank	10	961
59	Narasambudi tank	9	768
60	Neregal tank	28	3,082
61	Rampura tank	17	4,387
62	Ravanduru kere	52	1,177
63	Salagaon tank	39	578
64	Samunder talab	71	23,438
65	Shidlaghatta Ammanikere	32	8,681
66	Shimsha river stretch	36	436
67	Sulekere	52	1,344
68	Tailur tank	43	1,133
69	Tumkur Ammanikere	10	103
70	Yelibechali tank	73	18,848
71	Uranganahalli tank	19	204
72	Varthur tank	12	128
73	Yelandur tank (Yelandur cluster)	17	1,254
74	Yellamallappa	10	1,532
75	Yeriyru tank (Yelandur cluster)	24	648
	Total	139	3,08,434

Table 5.31. Frequency of sightings of Threatened and Near Threatened birds in the wetlands of Karnataka

S.#	Species	Status	No. of wetlands where sighted	Total birds sighted
1	Greater Spotted Eagle	T	10	14
2	Lesser Adjutant	T	2	3
3	Spotbilled Pelican	T	28	585
4	Spotted Greenshank	T	1	12
5	Whitebacked Vulture	T	1	2
6	Blacknecked Stork	NT	1	1
7	Darter	NT	24	76
8	Greyheaded Fishing Eagle	NT	1	2
9	Painted Stork	NT	30	1,438
10	Pale Harrier	NT	12	20
11	White Ibis	NT	37	4,189
12	Blackbellied Tern	NT	1	3
	Total no. of T : 616; Total no. of NT: 5,729			
	Total			6,345

T=Threatened; NT=Near Threatened

out certain species. Since *Channa striatus* is a bottom dweller, it is affected faster than other species.

Pesticide contamination

Annual consumption of pesticides in Karnataka is estimated at 3,127 mt. It is reported that 17.7% of bovine milk samples had pesticides above tolerable limits. Further studies by ICAR (1999) revealed that about 30 % of vegetables and fruits from Karnataka had organochlorine residues. However, surprisingly organochlorine concentrations in Karnataka wetlands are comparatively lower than that in the other states. It ranked 12th in terms of total average organochlorine residues. The maximum load of total concentration of organochlorine residues was recorded in Karigala kere (0.08 ppm) of Mysore district and Marchalli kere (0.077 ppm) of Mandya district followed by Ravanduru kere (0.059 ppm) of Mysore district. The minimum concentrations were recorded in Heche tank (0.013 ppm) of Shimoga district and Mandakhalli (0.009 ppm) of Mysore district (Fig. 5.19).

Among the various species analyzed, *Anguilla bicolor bicolor* (0.10 ppm), recorded the highest load of total organochlorine residues followed by *Labeo rohita* (0.06 ppm) and *Clarias batrachus* (0.052 ppm), whereas *Heteropneustes fossilis* (0.011 ppm) recorded the minimum (Fig. 5.20). Among the different organochlorine residues analyzed, HCH and heptachlor epoxide were the most frequently detected chemicals in majority of the fishes. The variation in concentration, particularly HCH, DDT and dieldrin is significant ($P<0.05$) among the species studied.

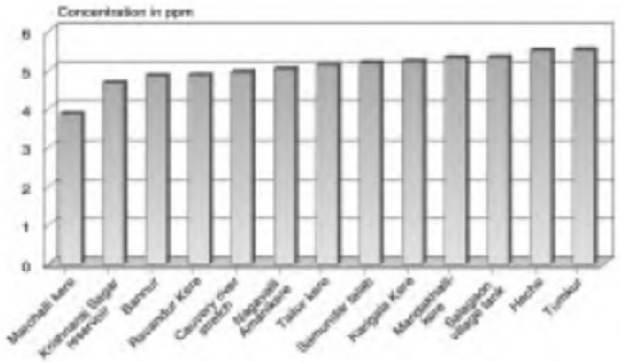


Fig. 5.17. Lead contamination in select wetlands in Karnataka

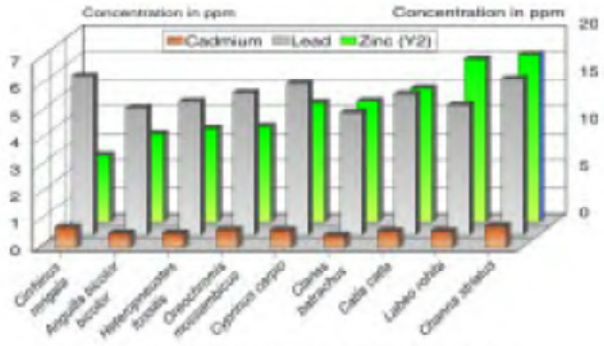


Fig. 5.18. Heavy metal contamination in select species of fishes in Karnataka

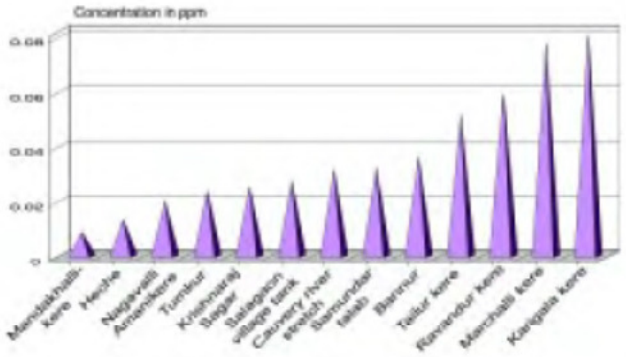


Fig. 5.19. Total organochlorine residues among various wetlands of Karnataka

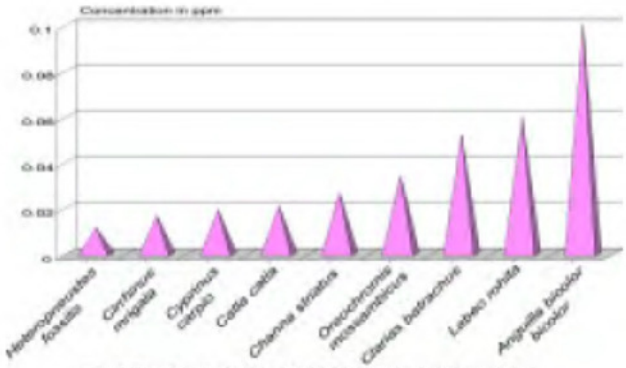


Fig. 5.20. Total organochlorine residues among various species of fishes in Karnataka

Suitability for human consumption

It may be noted that although varying levels of metals were recorded in the fishes from Karnataka, on the whole the concentrations appear to be safe for human consumption. However, the levels of lead are almost at the permissible levels prescribed by UN Committee (WHO, 1989, 1993). Further, as per the guidelines of UNEP/FAO/WHO (1989) and Health Canada (1996), the daily dietary intake of dieldrin, endosulfan, heptachlor epoxide, HCH and DDT is 6µg, 450µg, 60µg, 18µg and 300µg respectively. Although pesticide residues have been detected in the fishes of Karnataka, the levels do not appear to be higher than the allowable limits recommended for human consumption. However, if the per capita consumption increases, the levels may turn toxic.

Socioeconomic values

Thirteen sites had high use values (≥ 10) for various purposes while 37 sites had medium (6-9) and others (<6) had low values.

Prioritization of wetlands

Seventy five wetlands have been evaluated and prioritized for long-term conservation, by assigning grades for different criteria, especially of birds. The total grades are ranked into three; 11 with ratings >15 are considered in the first rank, the next 21 with 10-14 ratings as second rank and other 20 as third rank (Table 5.32).

It is to be noted that Bellandur had the maximum count of birds in 1994 (56,339), which has declined drastically

Table 5. 32. Prioritized list of wetlands in Karnataka

Sl.No	Name	Rank	Use grade
1	Narasambudi tank	1	M
2	Krishnarajasagar dam	1	H
3	Irsawadi tank (Yelandur cluster)	1	M
4	Samunder talab	1	M
5	Karanji tank	1	L
6	Mansalapura tank	1	M
7	Yelibechali tank	1	H
8	Lingambudhi tank	1	L
9	Hirekere tank (Yelandur cluster)	1	L
10	Byramangala reservoir	1	M
11	Gende Hosalli	1	M
12	Badane kere	2	M
13	Tailur tank	2	H
14	Kesthur lake (Yelandur cluster)	2	L
15	Kukkarahalli tank	2	L
16	Sulekere	2	H
17	Malagi Dharma dam	2	H
18	Shidlaghatta Ammanikere	2	M
19	Yelandur tank (Yelandur cluster)	2	H
20	Attivery Bird Sanctuary	2	L
21	Hoskote tank	2	H
22	Kallur lake (Yelandur cluster)	2	M
23	Koppa	2	M
24	Maddur kere (Deshalli)	2	M
25	Magadi tank	2	M
26	Ravanduru kere	2	H
27	Arakere	2	M
28	Chikkaballi	2	H
29	Kenchana kere	2	H
30	Kunthur lake (Yelandur cluster)	2	M
31	Neregal tank	2	L
32	Yellamallappa	2	L
33	Kamasamudram kere	3	H
34	Salagaon tank	3	H
35	Amanakatte	3	M
36	Belikere	3	H
37	Daroji tank	3	H
38	Duggatti tank (Yelandur cluster)	3	M
39	Shimsha river stretch	3	M
40	Dalavay tank	3	L
41	Isloor village tank	3	H
42	Kabini river	3	H
43	Kaggalipura kere	3	H
44	Maddur tank (Yelandur cluster)	3	H
45	Heggari (Haveri) tank	3	L
46	Hennagara tank	3	H
47	Kolar Ammanikere	3	M
48	Marehallikere	3	M
49	Agara tank (Yelandur cluster)	3	M

Contd...

in 2001-'02 (1,583) giving a low biodiversity value, probably because of the eutrophication and, pollution from the inflow of domestic and industrial waste. Although, Attivery Bird Sanctuary is a protected area, it needs to be monitored and managed to maintain the biodiversity.

The 11 top ranking sites qualify to be declared under Ramsar sites. Rest of the wetlands should be considered as Conservation Areas and the conservation programme should be decided separately according to the individual case. The prioritized sites along with BCPP sites, Important Bird Areas and Wildlife Sanctuaries are given in Fig. 5.21.

It may be noted that the sites selected for the present study were based mainly on the earlier data on birds from the Asian Waterfowl Census (Anon., 1988, 1990, 1994, 1995, 1996; Perennou *et al.*, 1994; Lopez and Mundkur, 1997). Hence, the lower conservation values for some sites based on the present data may have to be rechecked in subsequent years, as these sites had good bird population in earlier years.

Summary

- Karnataka, according to the satellite data of 1991-'93 has 622 wetlands of the size 56.25 ha and above, covering an area of 2,288.16 sq km (SAC, 1998).
- In recent estimates, in seven select districts alone, the number of wetlands of 2 ha and above is 1,647 covering an area of 2,049.17 sq km.
- The districts of Shimoga and Chickmagalur had a decrease in the wetland area compared to that in 1991-'92.
- Number of wetlands below 2 ha in size is more common in all the districts studied.

Table 5.32. Contd...

Sl.No	Name	Rank	Use grade
50	Bannur Heggere	3	M
51	Bethamangala tank	3	M
52	Doddajala tank	3	
53	Hebbur Ammanikere	3	
54	Kunigal doddakere	3	
55	Uranganahalli tank	3	H
56	Kalkere tank	4	H
57	Bellandur	4	M
58	Chikkajala tank	4	
59	Gudavi Bird Sanctuary	4	H
60	Heche tank	4	H
61	Jigni tank	4	L
62	Kalambellan tank	4	
63	Karigala kere	4	H
64	Mullur tank (Yellandur cluster)	4	H
65	Nagavalli tank	4	
66	Rampura tank	4	M
67	Vartur tank	4	M
68	Yeriyru tank (Yelandur cluster)	4	
69	Chikka Hoskote	4	
70	Kaggaladu Chikkakere	4	
71	Kothagere kere	4	
72	Kunigal Chikkakere	4	
73	Maralur Ammanikere	4	
74	Tumkur Ammanikere	4	
75	Kaggalladu Dodda kere	4	

- Turbidity level, as shown by satellite imageries, was low in all the reservoirs except in those of Chitradurga where it was high. In the case of ponds/ lakes, the turbidity level varied from low to high.
- In most of the wetlands, the aquatic vegetation is not dense as shown by satellite imageries.
- Karnataka has 64 endemic species of aquatic plants; three Critically Endangered and 12 Endangered species of fish; and one each of Endangered, Near Threatened, Vulnerable, and Least Concern species of freshwater turtles.
- In 75 wetlands, 3,08,434 birds belonging to 139 species were recorded.
- Ducks were the most abundant, while the Pond Heron, Cattle Egret, Little Cormorant, and Little Grebe were the most widely distributed species.
- Five wetlands had more than 20,000 birds and three wetlands had high species richness.
- Six hundred and sixteen birds of five Threatened and 5,729 birds of seven Near Threatened species were recorded.
- One hundred and sixty two fishes of nine species from 13 wetlands were analysed for heavy metals and organochlorine pesticides.
- Lead level was high in Tumkur-Ammanikere and Heche tank. *Cirrhinus mrigala* had a high concentration of lead.
- Levels of pesticides in the fishes are not higher than the permissible limits, but regular consumption will be a risk for human health.
- Seventy five wetlands have been prioritized according to their biodiversity values and socioeconomic uses.
- Twenty one wetlands qualify to be brought under Ramsar sites.

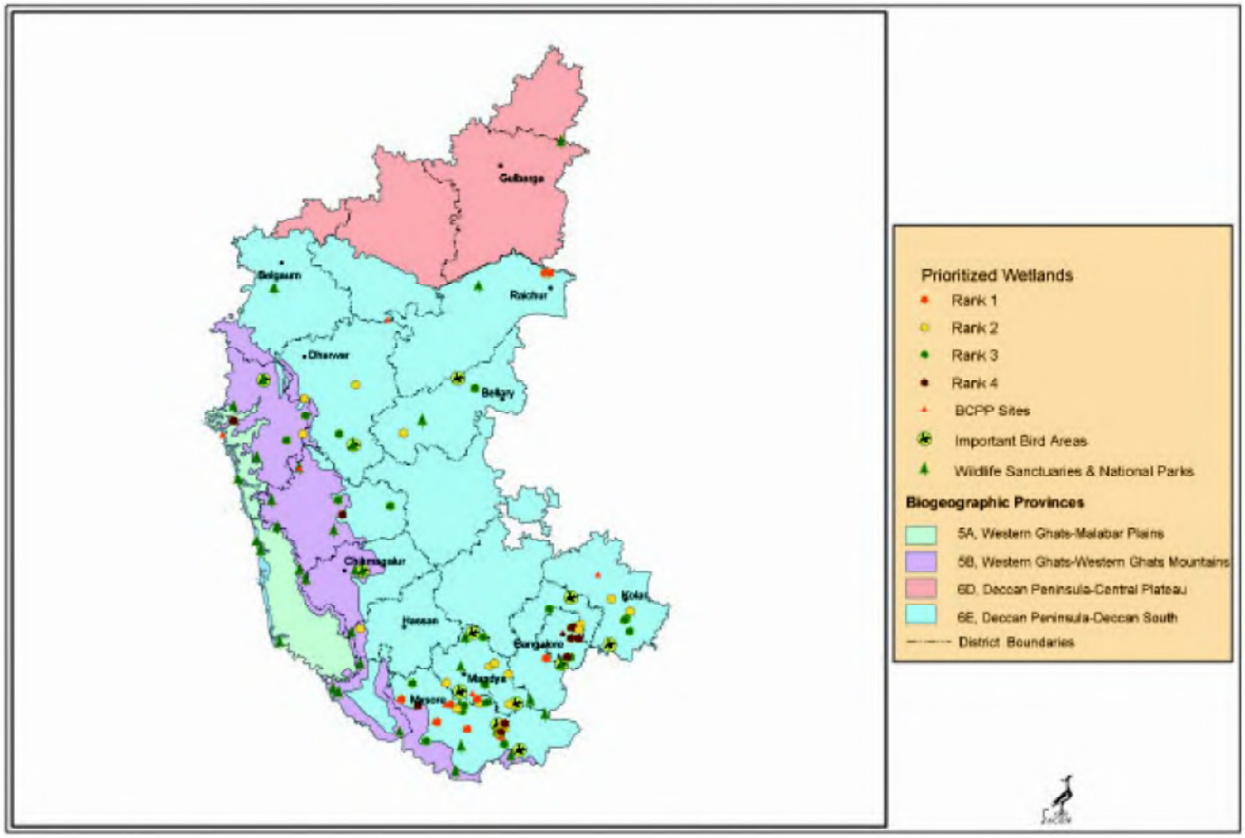


Fig. 5.21. Prioritized wetlands and other conservation areas in Karnataka



Vivek R. Sinha

Spotbilled Pelican at the nest



K. Ramachandran

Painted Stork at the nest

GOA

Goa, cradled between the rugged mountain ranges of the Western Ghats and the Arabian Sea, is the smallest state in India. The coastal plains of extensive palm groves, the still and endless beaches, estuaries and tidal creeks and the verdant forests make the tiny state rich in biodiversity. Topographically, the state can be divided into three distinct regions: the coastal plains covering 22 per cent of the total area of the state, intermediate sub-mountainous region with undulating uplands covering 35 percent of the area and, the interior hilly region ranging from 300 to 1,200 m in elevation covering 43 per cent of the area. Mandovi and Zuari are the two main rivers.



The climate is tropical humid with the annual mean precipitation varying from 3,000 to 5,000 mm. Most of the rainfall is from southwest monsoon. The mean annual maximum and minimum temperatures are 32 and 22^{0}C respectively.

State at a glance	
State capital	Panaji
Area	3,702 sq km
Population (2001)	13,43,998
Total number of districts	2
Major rivers	Tere Khol, Mandovi, Zuari, Chapora, Betul
Total forest area	39% of total area
Population density (2001)	363/sq km
Ramsar site	Nil
Proposed Ramsar site	1
Total sites proposed for conservation	2

Status of wetlands

The land use statistics of Goa, as in other states does not identify the wetlands as a separate category (Table 6.1). SAC (1998) has mapped the wetlands of the size 2.25 ha and above during 1992-1993 and reported the presence of 18 wetlands covering 21.45 sq km km i.e. about 0.56% of the total land area of the state (Table 6.2).

There are two reservoirs which cover about 45.59% of the total wetlands area, while tanks cover about 18.23%. The most prominent wetlands are Carambolim and Curtorim.

Table 6.1. Land use pattern in Goa

Land use type	Area in sq km
Total geographic area	3,702
Forests	1,250
Not available for cultivation	370
Other uncultivated land excluding fallow land	570
Fallow land	–
Net area sown	1,420
Area sown more than once	290
Total cropped area	1,710
Cultivable area	1,990

Source: www.indiastat.com

Table 6.2. Distribution of various categories of inland wetlands in Goa

Type of inland wetland	Area sq km	No. of wetlands
Lakes/ponds	1.59	3
Oxbow lakes/cut-off meander	1.95	1
Waterlogged (seasonal)	0.90	1
Reservoirs	9.78	2
Tanks	3.91	5
Waterlogged (man-made)	1.66	3
Abandoned quarries	1.66	3
Total	21.45	18

Source: SAC (1998)

Biodiversity

Aquatic vegetation

Aquatic macrophytes cover 60-70 per cent area of both the wetlands reported, namely Carambolim and Curtorim. Major species were *Hydrilla* sp. *Utricularia* sp. *Nymphaea* sp. and *Nymphoides* sp. *Oryza rufipogon* is reported from Carambolim.

Seventeen species of endemic aquatic plants belonging to nine Families were reported from Goa. Species of the Family Eriocaulaceae were more common (Table 6.3).

Table 6.3. Endemic aquatic plants from Goa

S.#	Species	Family
1	*Cladopus hookerianus*	Podostemaceae
2	*Eriocaulon cuspidatum*	Eriocaulaceae
3	*Eriocaulon dalzellii*	Eriocaulaceae
4	*Eriocaulon eurypeplon*	Eriocaulaceae
5	*Eriocaulon heterolepis*	Eriocaulaceae
6	*Eriocaulon robusto-brownianum*	Eriocaulaceae
7	*Fimbristylis woodrowii*	Cyperaceae
8	*Ramphicarpa longiflora*	Scrophulariaceae
9	*Rotala fimbriata*	Lythraceae
10	*Trithuria konkanensis*	Hydatellaceae
11	*Utricularia arcuata*	Lentibulariaceae
12	*Eriocaulon sedgwickii*	Eriocaulaceae
13	*Hydrobryopsis sessilis*	Podostemaceae
14	*Fuirena wallichiana*	Cyperaceae
15	*Geissaspis tenella*	Fabaceae
16	*Hygrophila serpylla*	Acanthaceae
17	*Utricularia praeterita*	Lentibulariaceae

Fishes

Four species of fishes, namely *Heteropneustes fossilis, Barbus amphibius, Rasbora daniconius* and *Aorichthys seenghala* were reported from Carambolim lake, while 10 species including *Barbus stigma, Rasbora daniconius* and *Clarias batrachus*, were reported from Curtorim lake. (Source: Description of vegetation and fish at the two lakes: Dr. A.B. Shanbhag).

Table 6.4. Threatened species of freshwater fishes reported from Goa

S.#	Species	Status
1	*Ompok bimaculatus*	EN
2	*Puntius melanampyx sp.nov.*	EN
3	*Pseudeutropius atherinoides*	EN
4	*Anabas testudineus*	VU
5	*Bagarius bagarius*	VU
6	*Barbodes sarana*	VU
7	*Catla catla*	VU
8	*Cirrhinus reba*	VU
9	*Clarias batrachus*	VU
10	*Heteropneustes fossilis*	VU
11	*Labeo dero*	VU
12	*Mystus vittatus*	VU
13	*Osteobrama cotio*	VU
14	*Puntius chola*	VU
15	*Puntius vittatus*	VU

Altogether 15 Threatened species of fish were reported from Goa (Menon, 1999), out of which three are Endangered and the rest Vulnerable (Table 6.4).

Turtles

Only one species of freshwater turtle, *Lissymes punctata*, which is included in the Near Threatened status, was reported from Goa.

Birds

Census data of birds in Carambolim for 1989 to 1991 (Perennou *et al.*, 1994) and for 2001 (Shanbhag, Per. Comm.) show that the total population of wetland birds varied from 48,000 to 25,640 during 1989-91 and 2001 respectively. There is a decline of over 50% in 10 years. 106 species including both migratory and resident were reported. The Pintail and Gargeney were the most abundant species.

In Curtorim lake, total birds counted were 15,500 during December 2002, and 14,800 during January 2003. The number of species recorded was 120. Most abundant species was the Garganey, followed by Lesser Whistling Teal, Pintail and White-eyed Pochard. (A.B. Shambhag, Pers. Comm.).

One Threatened (the Lesser Adjutant) and, three Near Threatened species, namely the White-eyed Pochard, White Ibis and Darter were reported from Carambolim.

Prioritization of wetlands

Carambolim falls in the first rank and Curtorim in the second, based on the abundance of birds and the number of species.

Carambolim qualifies to be declared as a Ramsar site, based on the abundance of birds and the number of Threatened and Near Threatened species.

Summary

- Goa has 18 wetlands of the size 2.25 ha and above, covering an area of 21.45 sq km according to a survey in 1992-93 (SAC, 1998).
- The two reservoirs cover about 46% of the total wetland area of the state.
- Tanks and lakes are much smaller in size.
- Goa has 17 species of endemic aquatic plants; three Endangered and 12 Vulnerable species of fishes; one Near Threatened freshwater species of turtle; and one Threatened and three Near Threatened species of birds.
- The two major freshwater wetlands in the state are Carambolim and Curtorim.
- Carambolim had 48,000 birds in 1990 and 25,640 in 2001. Curtorim had 14,800 birds belonging to 120 species during January 2003.
- Carambolim falls in the first rank of priority, whereas Curtorim in the second rank.
- Carambolim qualifies to be declared as a Ramsar site.



Ameen Ahmed

Vegetation cover in Kunigal Chikkakere



Ameen Ahmed

A view of Tumkur Ammanikere with the main catchment area;
the hills of Devarayana Durga state forest at the back



V.S. Vijayan

Eichhornia: a major threat to most wetlands in the country

ANDHRA PRADESH

Andhra Pradesh, the ricebowl of South India, has one of the most magnificent wetlands in the country, the Kolleru. The state is broadly divided into three regions, namely the Circars or Coastal districts, Rayalaseema close to the coastal districts and the Telengana region close to Maharashtra's Marathwada region and some parts of Karnataka. The broad physiographic divisions made using remote sensing data of the state are: Deccan plateau, hill ranges and, coastal plains. The Eastern Ghats in Andhra Pradesh are much less in elevation than the Western Ghats, and are also discontinuous. The hills between the Godavari and Krishna rivers in the coastal areas, for a distance of about 150 km are scattered. To the south of Krishna river, the Ghats have an elevation from 300 to 1,500 m.



State at a glance	
State capital	Hyderabad
Area	2,75,068 sq km
Population (2001)	75,727,541
Population density (2001)	275/sq km
Total Number of districts	23
Major rivers	Godavari, Krishna, Pennar & Tunga Bhadra
Total forest area	61,990 sq km
Ramsar site	1
Proposed Ramsar sites	20
Total sites proposed for conservation	55

The climate of Andhra Pradesh presents a transition from tropical to sub-tropical monsoon climate of semi-arid to arid in Telengana to Rayalaseema regions and humid to sub-humid in the coastal region. The average rainfall of the state is 830 mm, which varies considerably from 690 mm in Rayalaseema to 860 mm in Telengana and 950 in coastal region. Temperature varies from 22 to 42°C.

Status of wetlands

The routine land use statistics of the state does not indicate wetlands as a separate category (Table 7.1). However, 1.33% of the land area in Andhra Pradesh is covered by wetlands of the size 56.25 ha and above (SAC, 1998) and the number of wetlands was estimated at 1,493 (Table 7.2). It may be noted that wetlands of the size 2 ha and above in nine out of the 23 districts of Andhra Pradesh alone come to 4,553 covering 3,457.17 sq km (Table 7.3). The spatial distribution of wetlands for the entire state (Fig. 7.1) shows that the low rainfall districts have a large number of wetlands, while, the relatively wet districts have fewer number of them. Such a clustered distribution of wetlands in the drier localities will have a substantial bearing in the status, distribution and abundance pattern of birds and other fauna and flora.

Table 7.1. Land use pattern in Andhra Pradesh

Land use type	Area in sq km
Total geographic area	2,75,068
Forests	61,990
Not available for cultivation	47,010
Other uncultivated land excluding fallow land	17,010
Fallow land	38,610
Net area sown	1,09,780
Area sown more than once	26,470
Total cropped area	1,36,250
Cultivable area	1,65,400

(Source: www.indiastat.com)

Of the different kinds of wetlands in the state (Table 7.2), village tanks followed by reservoirs constitute a large proportion of them. It may be reemphasized that the present data represent only a fraction of the potential extent of wetlands in the state.

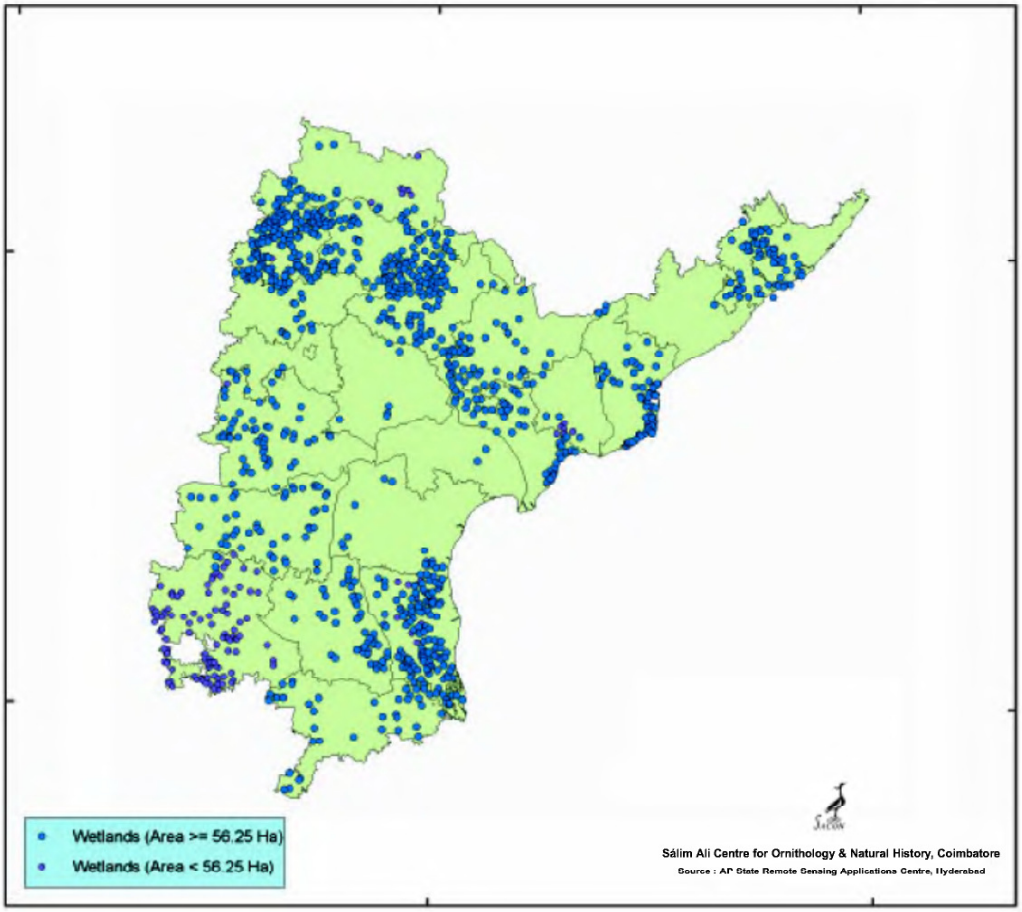


Fig. 7.1. Distribution of wetlands in Andhra Pradesh

Habitat analyses of wetlands in select districts

In order to obtain a more comprehensive picture on the status of wetlands, nine districts, namely Adilabad, Anantapur, Cuddapah, Nellore, Nizamabad, Prakasam, Warrangal, Guntur and Visakhapatnam were analysed. An indepth habitat analysis was carried out for all the wetlands above 2 ha. Area covered by wetlands with other land uses, turbidity, a cross classification of wetlands and turbidity, and finally seasonal changes in water levels for each of the nine districts were studied (Tables 7.4 to 7.30).

Table 7.2. Distribution of various categories of inland wetlands in Andhra Pradesh

Type of inland wetland	Area (sq km)	No. of wetlands
Lakes/ponds	33.25	5
Waterlogged (seasonal)	91.23	20
Reservoirs	1,281.85	53
Tanks	2,254.30	1,412
Waterlogged (man-made)	1.31	1
Ash/cooling pond	4.12	2
Total	3,666.06	1,493

Source: SAC (1998)

Wetlands

Total area under wetlands in the nine select districts is 3,457.17 sq km and, it varied from 106.45 sq km in the district of Visakhapatnam to 1,026.38 sq km in the district of Nellore (Table 7.3). In terms of the percentage of the total district area it varied from 0.90% (Visakhapatnam) to 9.89% (Nellore) (Fig. 7.2). Two major categories of wetlands, namely reservoirs and, ponds and lakes were identified in these districts. Nellore, Nizamabad and Adilabad districts had a large area under reservoirs. All the other districts had more of ponds and lakes, except Guntur and Visakhapatnam which had more waterlogged areas (Fig. 7.3).

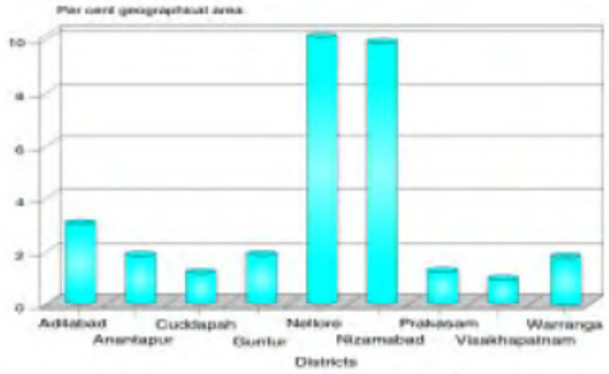


Fig. 7.2. Area under wetland in select districts of Andhra Pradesh

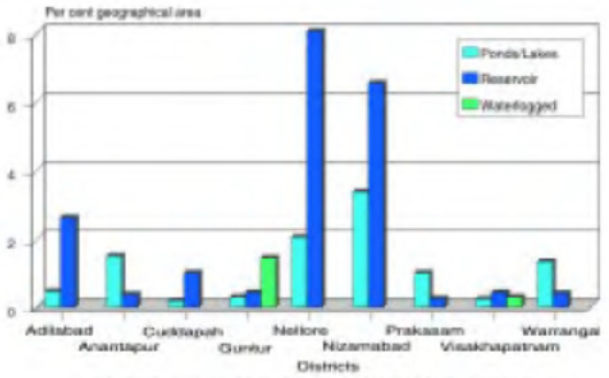


Fig. 7.3. Area under different wetland classes in Andhra Pradesh

It is very interesting to note that wetlands smaller than 56.25 ha are much more numerous in all the districts studied (Fig. 7.4). Therefore, the earlier data on wetlands above 56.25 ha in size are largely useful for reconnaissance surveys and are perhaps of marginal value in the field based wetland conservation planning for larger landscapes.

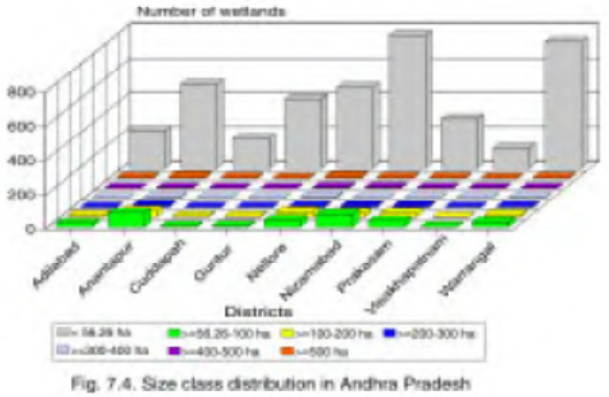


Fig. 7.4. Size class distribution in Andhra Pradesh

The estimated wetland area in Andhra Pradesh, including 2 ha size wetland, amounts to 6,744 sq km in contrast to 3,555 sq km estimated by SAC (1998). This estimate was obtained by a statistically significant ($p<0.03$) linear regression model between SAC estimate of wetlands (x) and that of

Table 7.3. Area (in sq km) under different classes of wetlands in select districts of Andhra Pradesh

Districts	Ponds/lakes/tanks		Reservoir		Waterlogged		Total no.	Total area
	No.	Area	No.	Area	No.	Area	of wetlands	of wetlands
Adilabad	247	66.01	5	367.35	-	-	252	433.36
Anantapur	622	260.87	6	64.41	-	-	628	325.28
Cuddapah	182	26.34	4	135.22	-	-	186	161.56
Nellore	557	208.84	11	817.54	-	-	568	1,026.38
Guntur	438	49.11	-	-	54	162.32	492	211.43
Visakhapatnam	179	26.89	10	47.62	196	31.94	385	106.45
Nizamabad	885	267.78	5	522.71	-	-	890	790.49
Prakasam (Ongole)	355	145.2	4	37.5	-	-	359	182.7
Warrangal	788	161.01	5	58.51	-	-	793	219.52
Total	4,253	1,212.05	50	2,050.86	250	194.26	4,553	3,457.17

SACON/RRSSC estimate (y). A comparative analysis of changes in total extent of wetlands in the select districts between two time periods (1992-93 and 2000-2001) revealed that there are two to four fold increase in the number of wetlands. One would consequently expect increase in the extent of wetlands. However, in the case of one district there is a net loss of wetlands.

Turbidity

Reservoirs had moderate to high turbidity in all the districts except in Warrangal and partly in Nizamabad where it was low. In the reservoirs in Adilabad, the turbidity was low to moderate. In the case of ponds/ lakes and waterlogged wetlands the turbidity was moderate/ high in all the districts except in Warrangal and Cuddapah where it was low (Fig. 7.5 & Fig. 7.6).

Moderate to high level of turbidity is obviously a cause for concern for the long-term maintenance of the habitat, as it indicates high levels of sediments. More concerted efforts for soil water conservation is therefore urgently required.

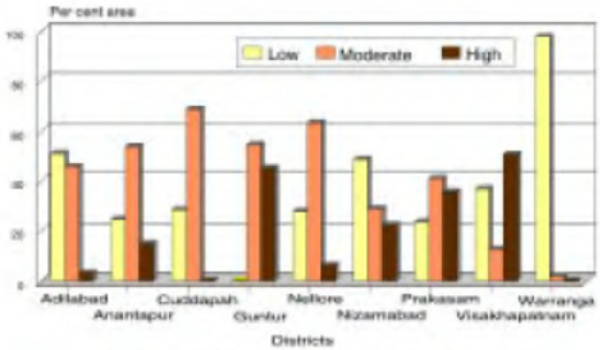


Fig. 7.5. Turbidity pattern of reservoirs in Andhra Pradesh

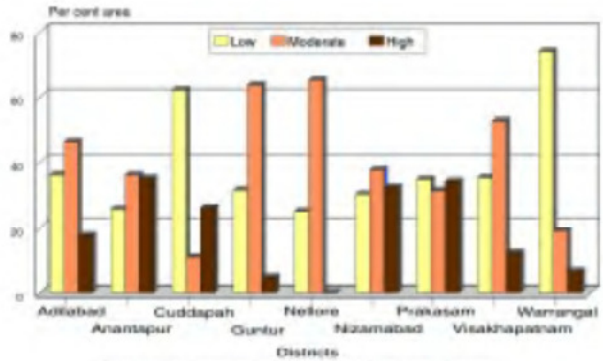


Fig. 7.6. Turbidity pattern of ponds/lakes/waterlogged areas in Andhra Pradesh

Summer recession

The summer recession among the wetlands (Fig. 7.7) varied from less than 10% to almost 100%. Adilabad, Warrangal and Cuddappah districts had minimum recession, whereas Anantapur district had the highest summer recession.

Wetlands and land use pattern in the catchment areas

The integrated land use and wetland maps of all the nine districts (Fig. 7.8-7.16) show that almost all the wetlands are embedded in a landscape dominated by agriculture. The only minor exceptions are the reservoirs having forests and, or agricultural land in their catchment areas.

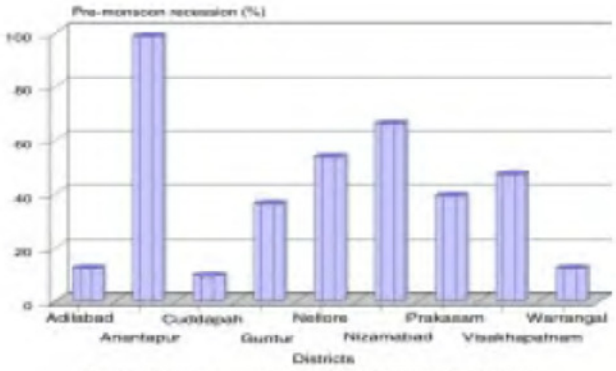


Fig. 7.7. Average summer recession in the wetlands of select districts in Andhra Pradesh

Temporal changes in wetland cover

An analysis of the changes in wetland cover between 1992-'93 and 2000-'01, in the nine select districts shows that, as expected, in all the districts compared, except in Prakasam, there is an increase of wetland (Table 7.31). The largest increase was found in Nellore, Nizamabad and Adilabad. Part of the increase is attributed to the spread of aquaculture in Nellore, construction of impoundments and finally due to scale difference in the data used (Fig. 7.17).

Table 7.31. Changes in the wetland area (sq km) in select districts of Andhra Pradesh

District	SAC (1992-'93)	SACON (2000-'01)	Variation	% Variation
Adilabad	149.15	433.20	284.05	190.45
Anantapur	241.35	325.28	83.93	34.78
Cuddapah	121.78	161.20	39.41	32.36
Guntur	185.25	211.43	26.18	14.13
Nellore	303.55	1,026.38	722.83	238.13
Nizamabad	434.25	789.83	355.58	81.88
Prakasam	218.00	182.64	-35.36	-16.22
Visakhapatnam	81.75	106.45	24.70	30.21
Warrangal	185.25	218.50	33.25	17.95

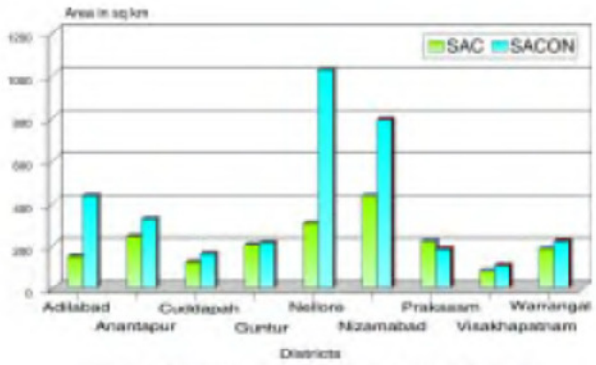


Fig. 7.17. Difference in total wetland area in select districts in Andhra Pradesh

Biodiversity

Aquatic vegetation

The aquatic vegetation was low in the reservoirs as well as in all other wetlands in the districts of Adilabad, Guntur and Visakhapatnam. In Anantapur, the reservoirs had more of low vegetation, whereas ponds/ lakes and waterlogged areas had both low and high vegetation (Fig. 7.18 & 7.19). Reservoirs in all other districts had either moderate or high vegetation, while all other wetlands had low/ moderate vegetation. The low incidence of vegetation cover could be due to the one time snapshot view of satellite pass. In order to get a temporal dimension of the vegetation dynamics, one would, therefore, require data at least from two satellite passes. The detailed satellite data analysis on different classes of aquatic vegetation as well as a cross classification of turbidity and vegetation in different wetland types shows that there appears to be no detectable correlation between turbidity levels and density of vegetation (Table 7.32). One would perhaps require temporal satellite data and extensive field data to relate the two variables.

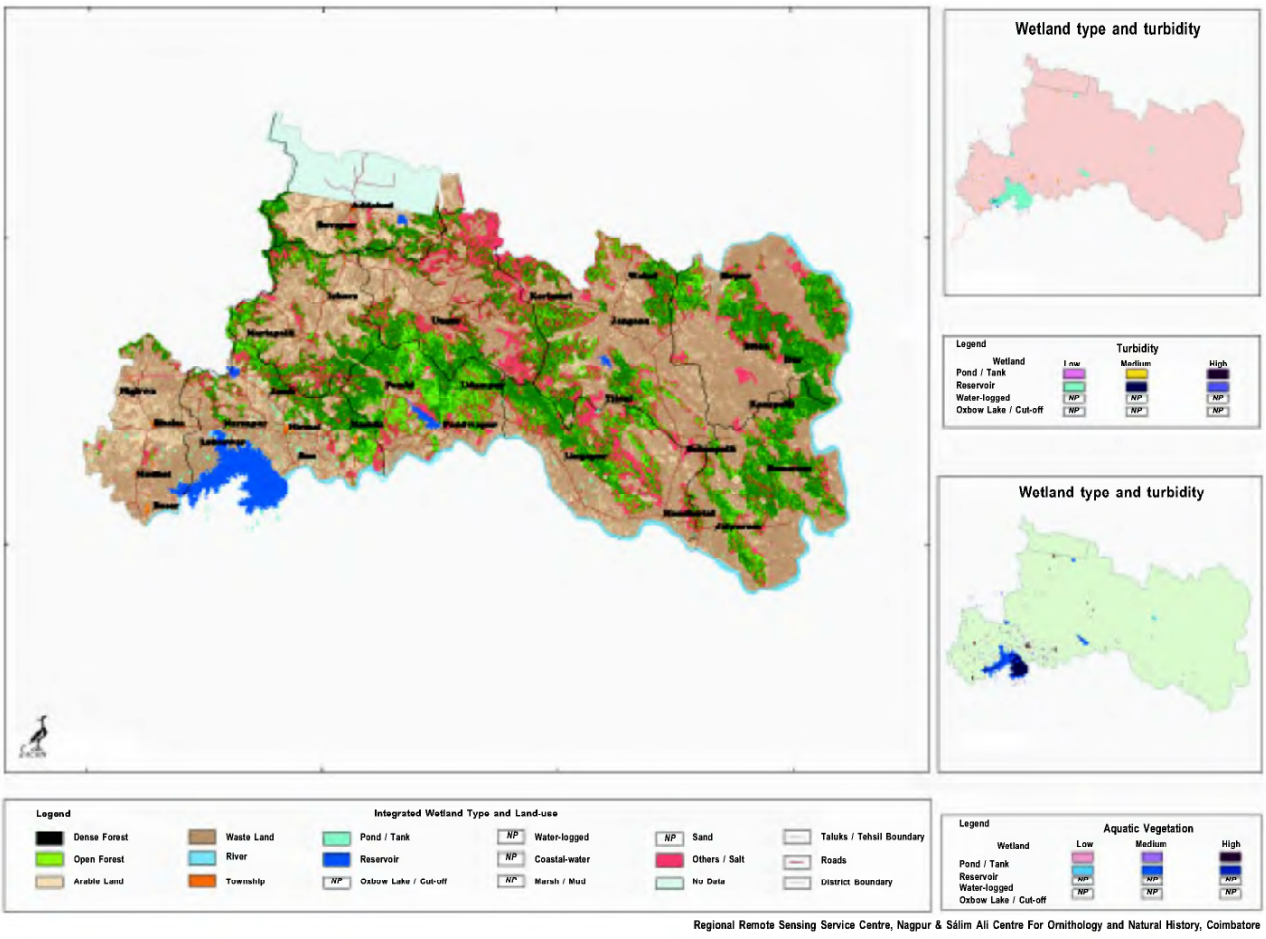


Fig. 7.8. Land use and wetland categories of the district of Adilabad

Table 7.4. Area under different land use and wetland categories in the district of Adilabad

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	2,875.39	20.45
Forest-open	1,452.50	10.33
Arable land	2,013.78	14.32
Wasteland	6,127.24	43.59
Wetland-ponds/lakes/tanks	65.90	0.46
Wetland-reservoirs	367.28	2.61
Township	32.41	0.23
Other water body/river	436.91	3.10
Others (area for which satellite data not available)	683.02	4.85

Table 7.5. Area under different turbidity classes in the district of Adilabad

Turbidity level	Area (sq km)	% of total wetland area
Low	23.71	5.47
Moderate	198.00	45.70
High	211.50	48.82

Table 7.6. Seasonal pattern of wetland areas in the district of Adilabad

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/ lakes/ tanks	66.01	46.11	19.90	
Reservoirs	367.74	334.66	33.08	
Total	433.75	380.77	52.98	12.21

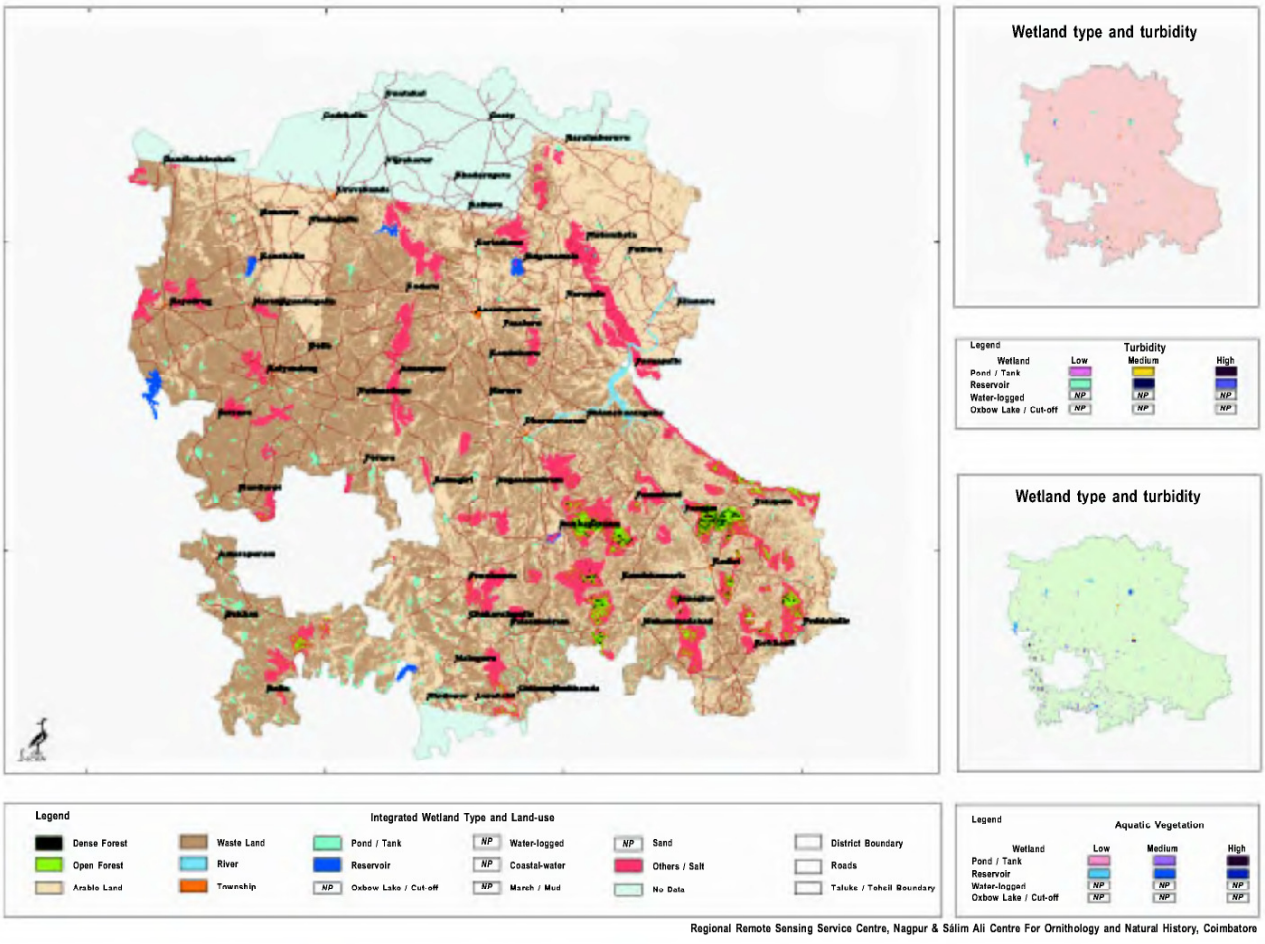


Fig. 7.9. Land use and wetland categories of the district of Anantapur

Table 7.7. Area under different land use and wetland categories in the district of Anantapur

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	32.57	0.18
Forest-open	210.90	1.20
Arable land	6,197.00	35.13
Wasteland	8,471.94	48.03
Wetland-ponds/lakes/tanks	260.87	1.48
Wetland-reservoirs	64.41	0.37
Township	9.41	0.05
Other water body/river	55.45	0.31
Others (area for which satellite data not available)	2,335.61	13.24

Table 7.8. Area under different turbidity classes in the district of Anantapur

Turbidity level	Area (sq km)	% of total wetland area
Low	125.94	40.41
Moderate	76.00	24.39
High	109.73	35.21

Table 7.9. Seasonal pattern of wetland areas in the district of Anantapur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	49.97	0.71	49.26	98.58

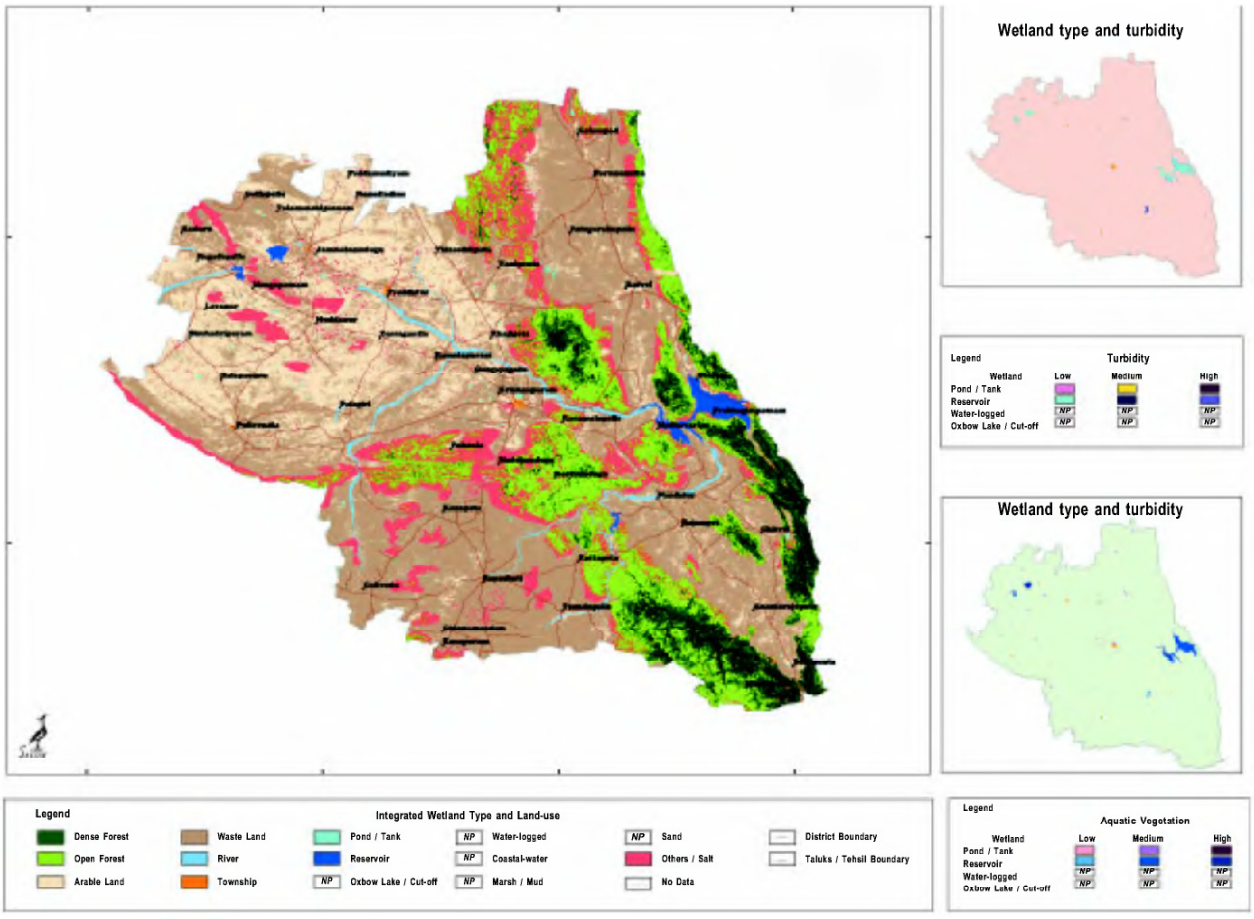


Fig. 7.10. Land use and wetland categories of the district of Cuddapah

Table 7.10. Area under different land use and wetland categories in the district of Cuddapah

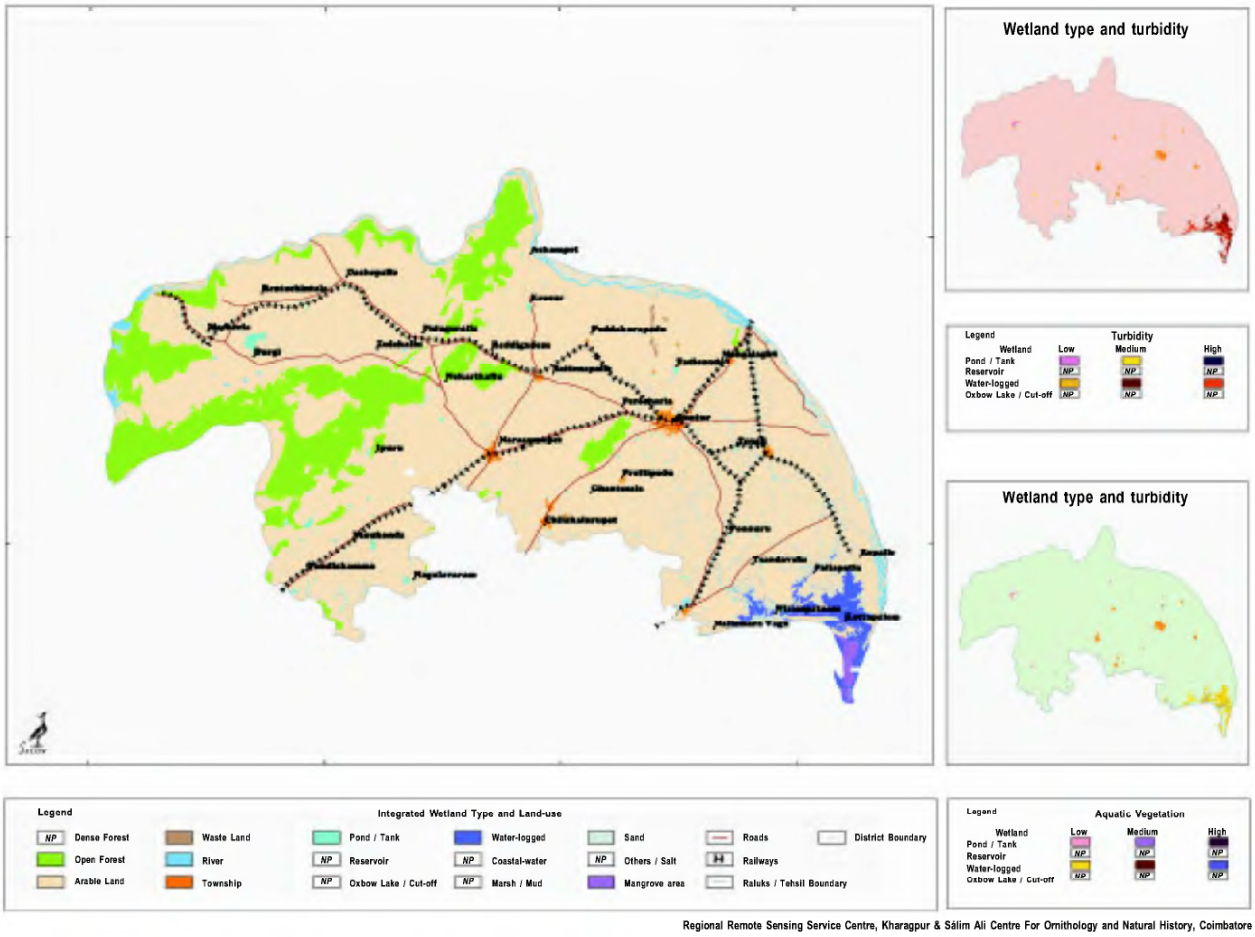
Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	1,037.52	7.66
Forest-open	2,250.95	16.62
Arable land	3,282.33	24.24
Wasteland	6,607.04	48.8
Wetland-ponds/lakes/tanks	26.13	0.19
Wetland-reservoirs	135.07	0.99
Township	11.95	0.08
Other water body /river	186.36	1.37
Others (area for which satellite data not available)	-	-

Table 7.11. Area under different turbidity classes in the district of Cuddapah

Turbidity level	Area (sq km)	% of total wetland area
Low	5.96	4.00
Moderate	97.86	65.67
High	45.19	30.33

Table 7.12. Seasonal pattern of wetland areas in the district of Cuddapah

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	19.62	18.86	0.76	
Reservoirs	115.88	104.22	11.66	
Total	135.50	123.08	12.42	9.17



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Fig. 7.11. Land use and wetland categories of the district of Guntur

Table 7.13. Area under different land use and wetland categories in the district of Guntur

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-open	1,708.55	15.0
Arable land	9,001.66	79.02
Wasteland	8.37	0.07
Rivers/water bodies	303.55	2.66
Township	60.63	0.53
Sand	63.39	0.56
Mangrove forest	33.32	0.29
Ponds/lakes	49.11	0.43
Waterlogged area	162.32	1.42

Table 7.14. Area under different turbidity classes in the district of Guntur

Turbidity level	Area (sq km)	% of total wetland area
Low	52.66	7.61
Moderate	119.83	56.68
High	75.5	35.71

Table 7.15. Seasonal pattern of wetland area in the district of Guntur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Water spread	26.22	16.75	9.47	36.12

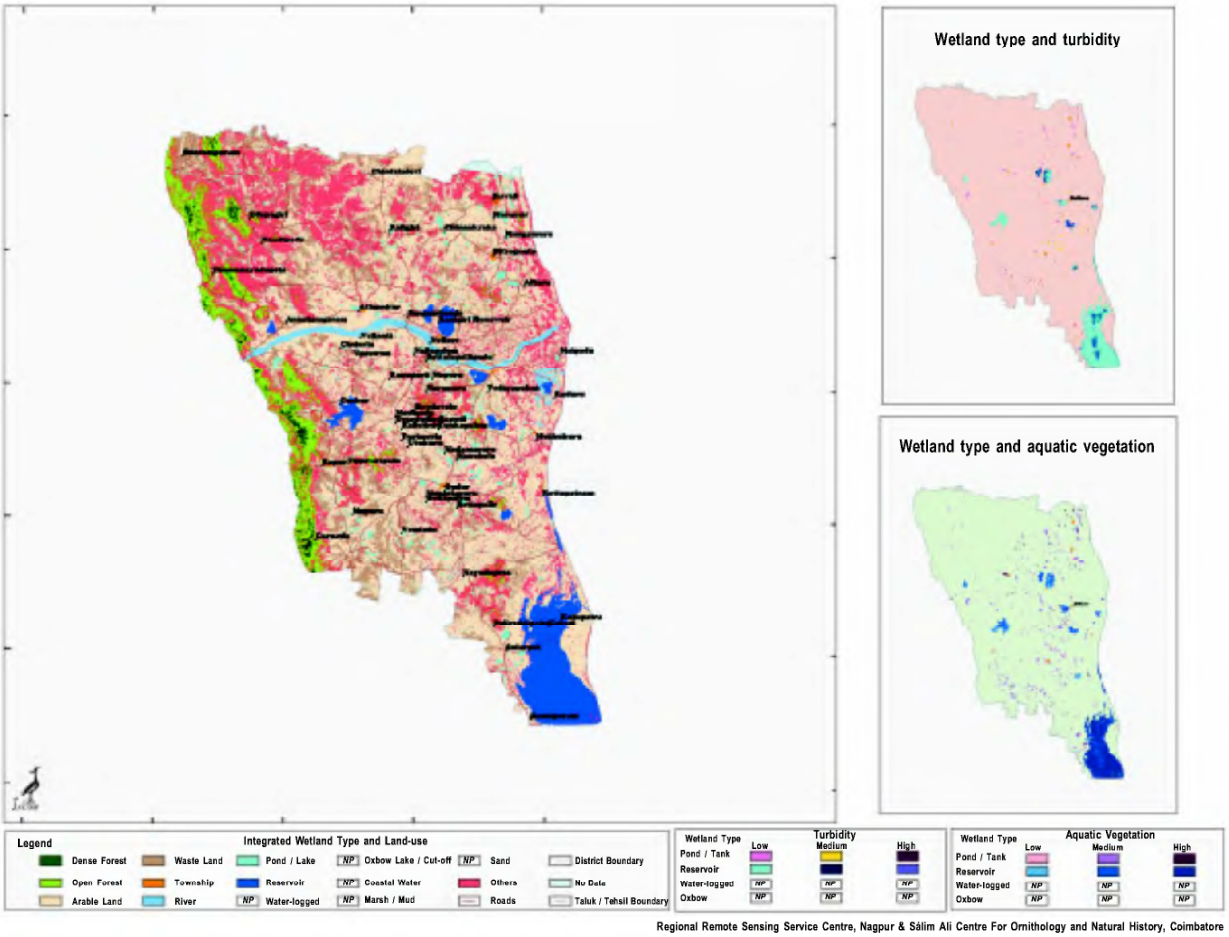


Fig. 7.12. Land use and wetland categories of the district of Nellore

Table 7.16. Area under different land use and wetland categories in the district of Nellore

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	102.05	1.00
Forest-open	735.48	7.24
Arable land	6,169.13	60.72
Wasteland	1,866.43	18.37
Wetland-ponds/lakes/tanks	208.55	2.05
Wetland-reservoirs	817.54	8.05
Township	18.70	0.18
Other water bodies/rivers	206.14	2.03
Others (area for which satellite data not available)	36.42	0.36

Table 7.17. Area under different turbidity classes in the district of Nellore

Turbidity level	Area (sq km)	% of total wetland area
Low	71.91	7.16
Moderate	362.9	36.14
High	569.48	56.7

Table 7.18. Seasonal pattern of wetland areas in the district of Nellore

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs	811.00	409.00	402.00	
Ponds/lakes /tanks	192.91	58.74	134.17	
Total	1,003.91	467.74	536.17	53.41

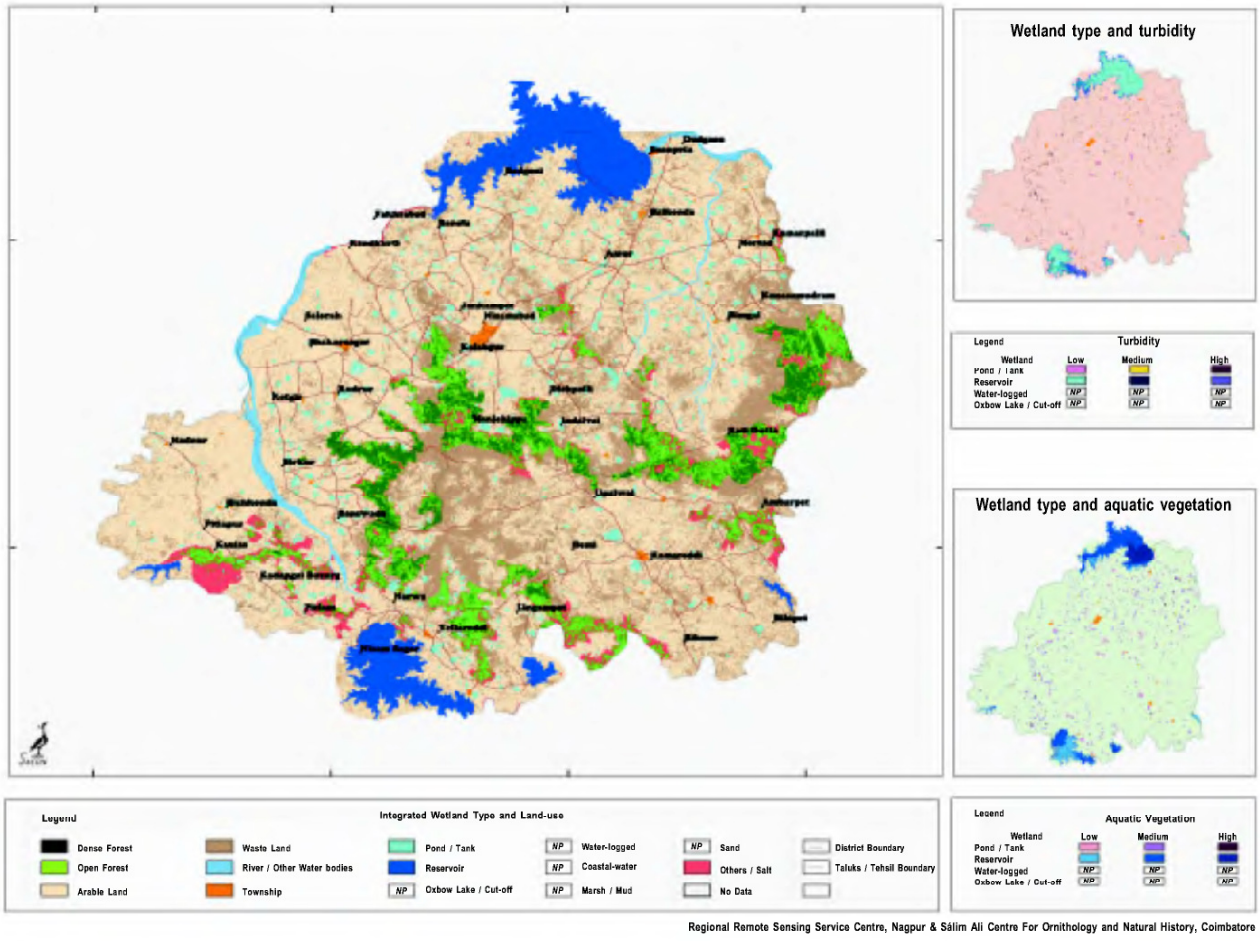


Fig. 7.13. Land use and wetland categories of the district of Nizamabad

Table 7.19. Area under different land use and wetland categories in the district of Nizamabad

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	323.36	4.04
Forest-open	483.74	6.05
Arable land	4,453.97	55.68
Wasteland	1,794.74	22.44
Wetland-ponds/lakes/tanks	267.37	3.34
Wetland-reservoirs	522.46	6.53
Township	26.87	0.34
Other water bodies/river s	127.00	1.59
Others (area for which satellite data not available)	-	-

Table 7.20. Area under different turbidity classes in the district of Nizamabad

Turbidity level	Area (sq km)	% of total wetland area
Low	203.39	25.75
Moderate	355.45	45.00
High	230.99	29.25

Table 7.21. Seasonal pattern of wetland areas in the district of Nizamabad

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs	182.85	77.28	105.57	
Ponds/lakes/tanks	116.88	24.53	92.35	
Total	299.73	101.81	197.92	66.03

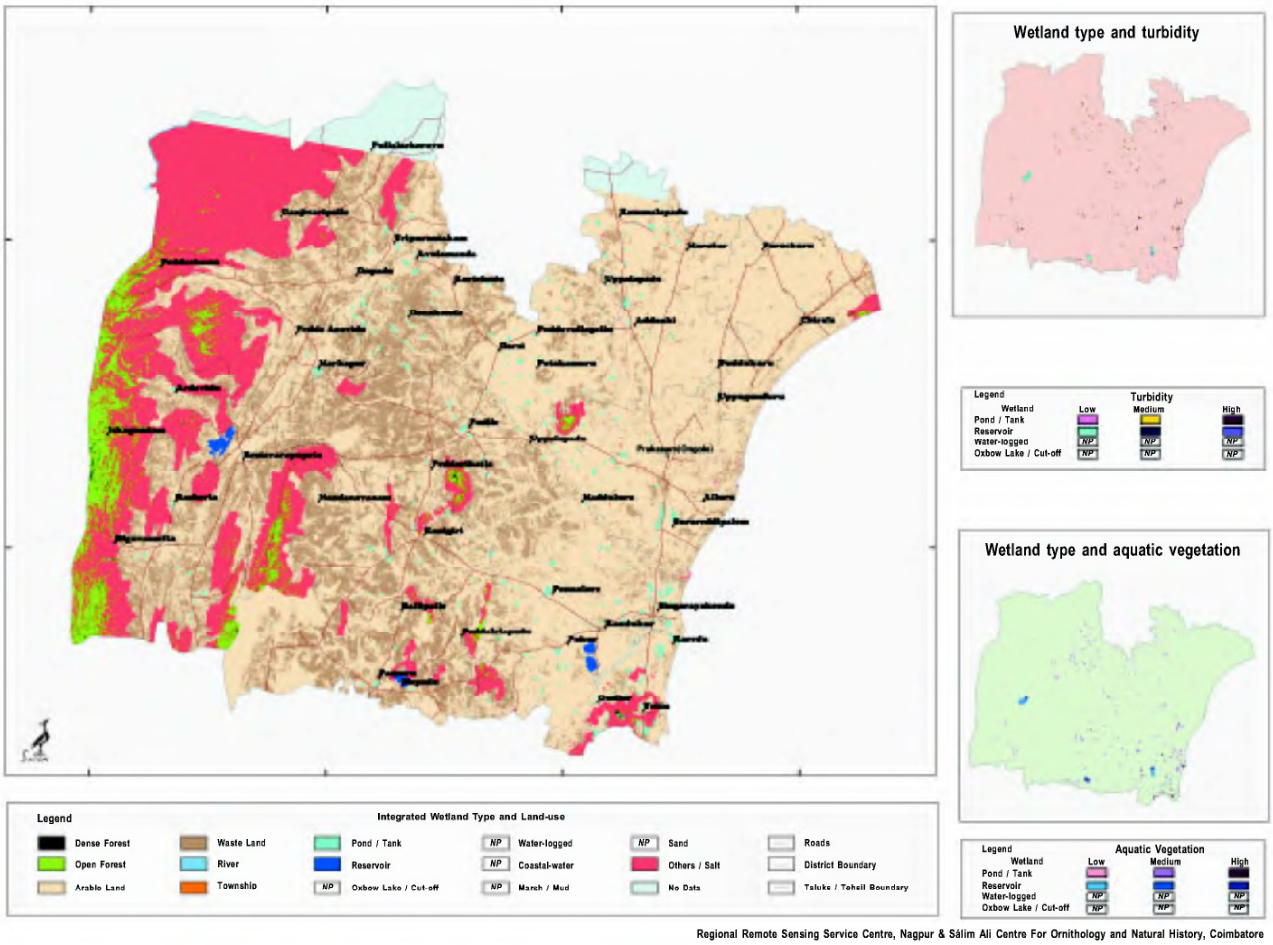


Fig. 7.14. Land use and wetland categories of the district of Prakasam (Ongole)

Table 7.22. Area under different land use and wetland categories in the district of Prakasam (Ongole)

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	14.00	0.10
Forest-open	608.57	4.13
Arable land	9,747.14	66.17
Wasteland	3,629.17	24.64
Wetland- ponds/lakes/tanks	145.15	0.99
Wetland-reservoirs	37.49	0.25
Township	0.67	0.00
Other water body/river	12.99	0.09
Others (area for which satellite data not available)	535.86	3.64

Table 7.23. Area under different turbidity classes in the district of Prakasam (Ongole)

Turbidity level	Area (sq km)	% of total wetland area
Low	62.83	34.4
Moderate	65.71	35.98
High	54.09	29.62

Table 7.24. Seasonal pattern of wetland areas in the district of Prakasam (Ongole)

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs	19.99	19.82	0.17	
Ponds/ lakes/ tanks	145.20	80.71	64.49	
Total	165.19	100.53	64.66	39.14

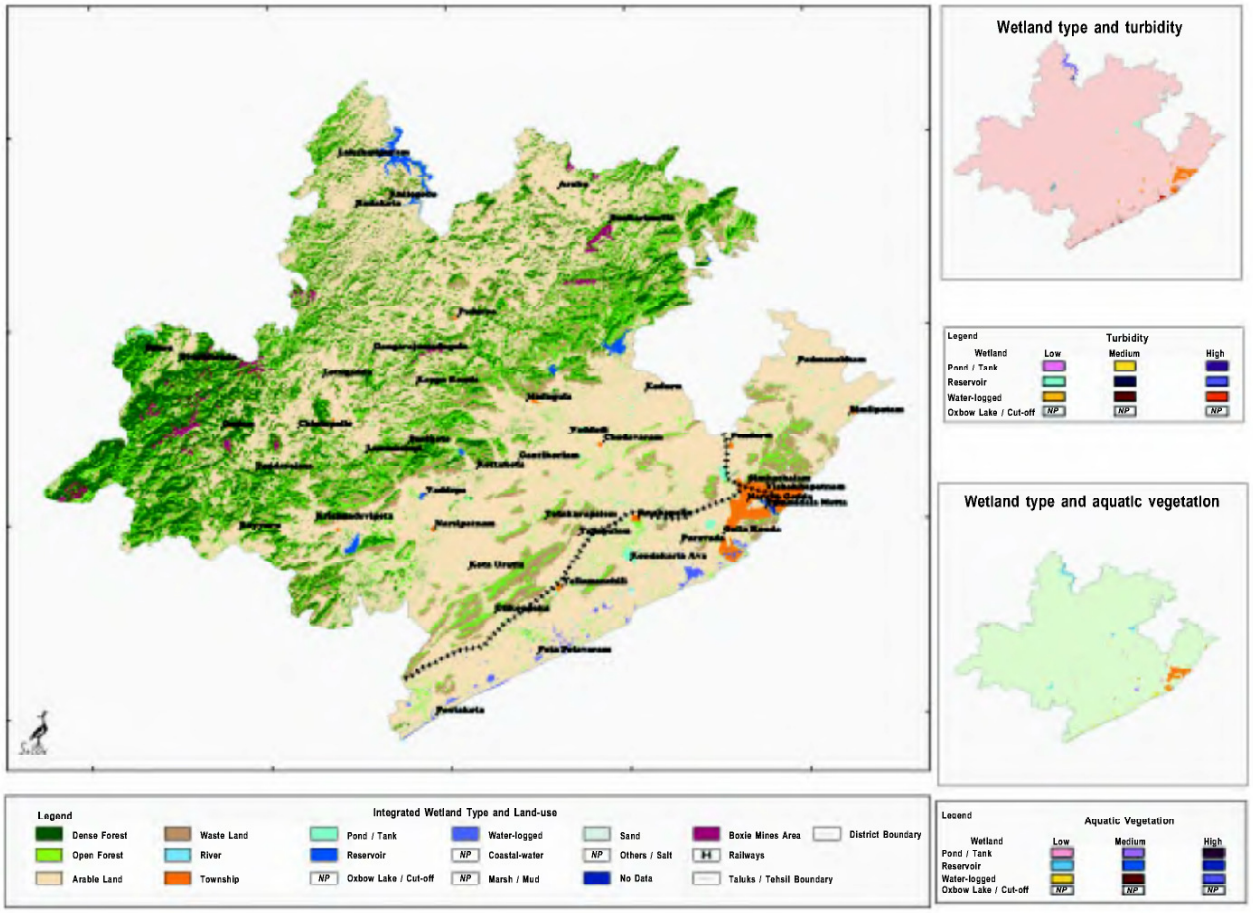


Fig. 7.15. Land use and wetland categories of the district of Visakhapatnam

Table 7.25. Area under different land use and wetland categories in the district of Visakhapatnam

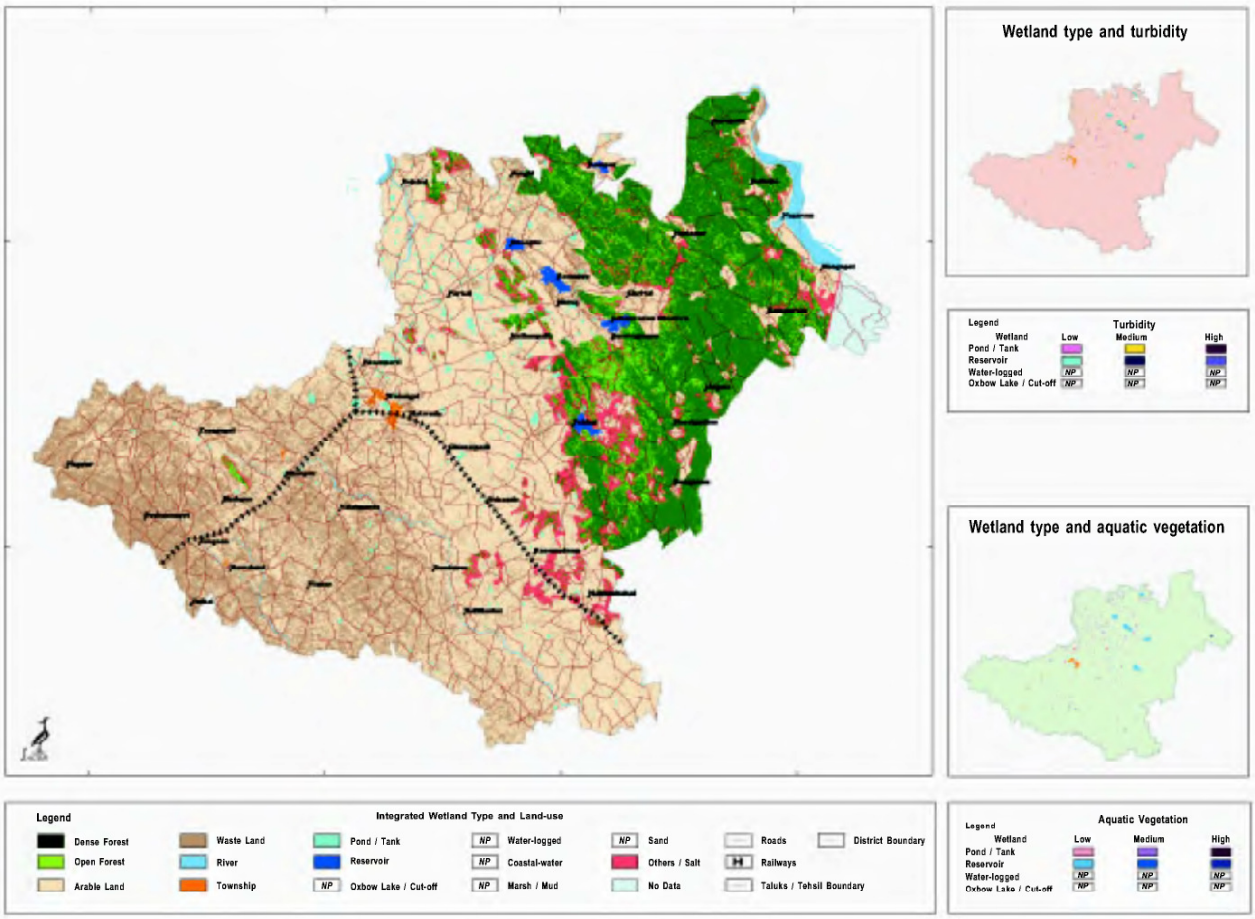
Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	1,563.00	14.00
Forest-open	986.00	8.83
Arable land	6,550.00	58.65
Wasteland	1,692.00	15.15
Settlement	104.00	0.93
Rivers/canals/water bodies	48.00	0.43
Sand	39.00	0.35
Harbour	4.00	0.04
Bauxite area	75.00	0.67
Ponds/lakes	26.89	0.24
Reservoir	47.62	0.43
Waterlogged	31.94	0.29

Table 7.26. Area under different turbidity classes in the district of Visakhapatnam

Turbidity level	Area (sq km)	% of total wetland area
Low	37.07	34.83
Moderate	37.4	35.13
High	31.98	30.04

Table 7.27. Seasonal pattern of wetland area in the district of Visakhapatnam

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Waterspread	24.59	13.07	11.52	
Waterlogged	0.29	0.12	0.17	
Total	24.88	13.19	11.69	46.99



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Fig. 7.16. Land use and wetland categories of the district of Warrangal

Table 7.28. Area under different land use and wetland categories in the district of Warrangal

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	2,363.53	19.46
Forest-open	501.95	4.13
Arable land	6,127.26	50.44
Wasteland	2,574.02	21.19
Wetland- ponds/lakes/tanks	160.01	1.32
Wetland-reservoirs	58.48	0.48
Township	21.68	0.18
Other water body/river	159.83	1.32
Others (area for which satellite data not available)	179.83	1.48

Table 7.29. Area under different turbidity classes in the district of Warrangal

Turbidity level	Area (sq km)	% of total wetland area
Low	176.04	80.57
Moderate	31.44	14.39
High	11.02	5.04

Table 7.30. Seasonal pattern of wetland areas in the district of Warrangal

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs	58.51	56.93	1.58	
Ponds /lakes/tanks	161.01	135.87	25.14	
Total	219.52	192.80	26.72	12.17

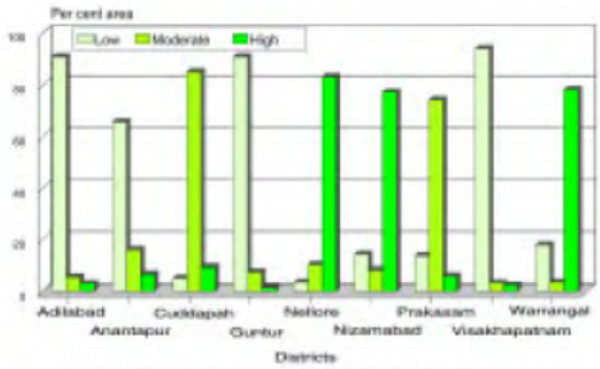


Fig. 7.18. Aquatic vegetation of reservoirs in Andhra Pradesh

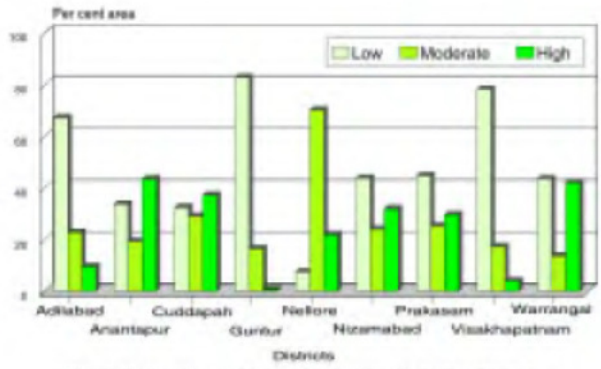


Fig. 7.19. Aquatic vegetation of ponds/ lakes in Andhra Pradesh

Table 7.32. Summary of turbidity and aquatic vegetation in the wetlands of select districts of Andhra Pradesh

Wetland class	No. of wetlands	Area sq km	Tudbidity levels			Aquatic vegetation		
			Low	Moderate	High	Low	Moderate	High
Adilabad								
Ponds/lakes/tanks	247	66.01	36.08	46.33	17.44	67.19	22.88	9.78
Reservoirs	5	367.35	51.09	45.57	3.32	90.8	5.92	3.26
Anantapur								
Ponds/lakes/tanks	622	260.87	25.51	36.01	34.98	33.75	19.32	43.43
Reservoirs	6	64.41	24.52	53.85	14.68	65.57	16.07	6.96
Cuddapah								
Ponds/lakes/tanks	182	26.34	62.12	11.01	26.04	32.63	29.37	37.17
Reservoirs	4	135.22	28.39	68.35	0.11	5.31	85.07	9.5
Nellore								
Ponds/lakes/tanks	557	208.84	24.88	65.16	0.14	7.71	70.17	21.99
Reservoirs	11	817.54	27.74	63.3	6.29	3.79	10.39	83.15
Guntur								
Ponds/lakes	438	49.11	31.38	63.66	4.95	82.92	16.56	0.52
Waterlogged	54	162.32	0.42	54.57	45.01	90.78	7.81	1.41
Visakhapatnam								
Ponds/lakes	179	26.89	55.63	42.82	1.54	70.94	22.89	6.17
Reservoirs	10	47.62	36.66	12.62	50.72	93.89	3.46	2.65
Waterlogged	196	31.94	14.58	62.23	23.19	85.83	11.83	2.34
Nizamabad								
Ponds/lakes/tanks	885	267.78	30.12	37.49	32.23	43.7	24.05	32.1
Reservoirs	5	522.71	48.8	28.76	22.4	14.36	8.43	77.17
Prakasam (Ongole)								
Ponds/lakes/tanks	355	145.20	34.72	31.17	34.08	44.71	25.21	30.04
Reservoirs	4	37.50	23.58	40.81	35.60	13.88	73.89	6.22
Warrangal								
Ponds/lakes/tanks	788	161.01	73.83	18.82	6.73	43.48	13.86	42.04
Reservoirs	5	58.51	97.72	1.93	0.04	17.92	3.88	78.17

Thirteen species of endemic aquatic plants belonging to nine families have been recorded from the wetlands of Andhra Pradesh (Table 7.33).

Table 7.33. Endemic aquatic plants recorded in Andhra Pradesh

S.No.	Species	Family
1	*Tonningia cucullata*	Commelinaceae
2	*Eleocharis swamyii*	Cyperaceae
3	*Eriocaulon ritchieanum*	Eriocaulaceae
4	*Fuirena trilobites*	Cyperaceae
5	*Fuirena wallichiana*	Cyperaceae
6	*Hoppea dichotoma*	Gentianaceae
7	*Pogostemon griffithii*	Lamiaceae
8	*Rotala fimbriata*	Lythraceae
9	*Rotala illecebroides*	Lythraceae
10	*Najas marina ssp.*	Najadaceae
11	*Sesbania procumbens*	Fabaceae
12	*Hydrobryopsis sessilis*	*Podostemaceae*
13	*Myriophyllum oliganthum*	Haloragaceae

Fishes

Nineteen species of fishes were reported from Andhra Pradesh (Table 7.34) as Threatened, of which two are Critically Endangered, five Endangered and 12 Vulnerable (Menon, 1999).

Table 7.34. Threatened freshwater fishes in Andhra Pradesh

No.	Species	Status
1	*Pangasius pangasius*	CR
2	*Proeutropiichthys taakree*	CR
3	*Hypselobarbus curmuca*	EN
4	*Anguilla bengalensis*	EN
5	*Pseudeutropius atherinoides*	EN
6	*Puntius dorsalis*	EN
7	*Rita pavimentatus*	EN
8	*Tor khudree*	VU
9	*Puntius chola*	VU
10	*Osteobrama cotio*	VU
11	*Mystus vittatus*	VU
12	*Labeo dero*	VU
13	*Heteropneustes fossilis*	VU
14	*Cirrhinus reba*	VU
15	*Clarias batrachus*	VU
16	*Catla catla*	VU
17	*Barbodes sarana*	VU
18	*Bagarius bagarius*	VU
19	*Anabas testudineus*	VU

CR=Critically Endangered; EN=Endngered; VU=Vulnerable

Turtles

Only five species of freshwater turtles were reported from Andhra Pradesh. Out of which one each is Endangered, Vulnerable and of Least Concern and two are Near Threatened (Table 7.35).

Table 7.35. Freshwater turtles reported from Andhra Pradesh

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes leithii*	VU	-	IV
2	*Chitra indica*	EN	-	IV
3	*Kachuga tentoria*	NT	-	-
4	*Lissemys punctata*	NT	II	I
5	*Melanochelys trijuga*	LC	-	-

VU=Vulnerable; EN=Endangered; NT=Near Threatened; LC=Least Concern

Birds

Wetland birds were studied from 55 wetlands covering most of the districts; 18 out of the 22. These sites represent the three major biogeographic zones of the state, namely East Coast, Deccan Plateau and the Eastern Ghats. The total area covered was around 1,200 sq km wherein 5,41,120 birds were enumerated (Table 7.36). These represent 122 species, both migratory and resident, that depend on wetlands fully or partly. 53% of all birds enumerated were ducks (Table 7.37). More than 1 % of the biogeographic population of 19 species were present in many wetlands.

Of the 122 species of birds observed in the 55 wetlands surveyed, 44 species had a total population of more than 1,000. The Little Egret was the most abundant species followed by the Pintail, Openbill Stork, Little Stint, Garganey, Tufted Duck, Lesser Whistling Teal, Cattle Egret and Shoveller. While the first is a resident, the second is a winter migrant to the state. Ducks and teals

Table 7.36. Major wetlands of Andhra Pradesh with species and number of birds

S.No.	Name of the wetland	# of species	# of birds
1	Alisagar	20	309
2	Anantaram	41	4,282
3	Banswada	22	835
4	Bellal tank	25	2,689
5	Bhadrakali tank	1	30
6	Chikkadpally	35	10,545
7	Chinna Thumbalam	54	20,902
8	Dali tank	16	5,423
9	Damercharla	27	557
10	Doulatabad lake	24	6,969
11	Draksharama : Gowthami	28	22,524
12	Gangayapuram pedda tank	24	1,829
13	Godavari river	28	19,236
14	Gudur tank	4	560
15	Hussain sagar	32	3,490
16	Ibrahimpur	27	1,213
17	Issalpet	7	79
18	Jamukuladinne	5	759
19	Jankampet tank	32	1,578
20	Jataprole tank	28	1,314
21	Kaligiri reservoir	12	176
22	Katakshapur tank	24	862
23	Kodad lake	27	448
24	Kolleru lake	18	1,673
25	Kondakarla	36	17,266
26	Kotpalli	23	28,599
27	Laknapur	51	35,375
28	Mittekoduru	49	11,860
29	Nandalur tank	17	2,803
30	Nandyal tank	46	2,068
31	Nasrullabad	10	91
32	Navipet tank	8	112
33	Nellore tank	3	2,500
34	Nirukula	16	184
35	Nizamsagar reservoir	27	60,732
36	Nowpada swamps	20	7,147
37	Palem	13	3,175
38	Patha-kotha cheruvu	43	5,873
39	Pavumanchala	57	2,445
40	Peddatippa samudram	20	733
41	Pocharam	57	14,156
42	Punyakshetram	1	6,000
43	Rangasamudram	13	1,025
44	Rudrur	30	7,342
45	Sangameshwara backwaters	70	1,53,519
46	Sasanam	9	139
47	Singoor dam	39	11,311

Contd...

formed the most abundant group (2,88,913) with more than half the population of all the wetland birds counted. The dominant ones were the Pintail, Garganey, Tufted Duck, Lesser Whistling Teal and Shoveller.

Distribution of birds in the wetlands surveyed showed that 10 species occur more widely; in more than 50% of the wetlands. These are the Pond Heron, Little Cormorant, Little Egret, Cattle Egret, Little Grebe, Pintail, Grey Heron, Shoveller, Coot and Smaller (Median) Egret. Most of these are residents with the exception of Pintail and Shoveller. The Pond Heron is the most widely distributed bird in the wetlands of Andhra Pradesh.

There were 598 birds of six Threatened species and 5,699 birds of eight Near Threatened species in the wetlands surveyed. While the Threatened species were confined to one to three localities, the Near Threatened were noted from one to 19 sites (Table 7.37). The maximum population of Threatened species was of Spotbilled Pelican, 489 birds.

Environmental contamination

One hundred and twenty nine fishes comprising 20 species were collected from 13 wetlands in Andhra Pradesh. Since some species were commercially insignificant and inadequate in numbers, only 10 species from nine wetlands have been examined for heavy metal and pesticide contamination.

Heavy metals

Among the wetlands, Draksharama of East Godavari district recorded the maximum concentration of zinc (23.54±28.23 ppm) followed by Jankampet tank (Fig. 7.20). The levels of lead, cadmium, copper and chromium were below the permissible limit. While agricultural activities are expected to be the reason for the increased level in Draksharama, sea water intrusion and sand mining seem to contribute at Jankampet tank.

Table 7.36. Contd...

S.No.	Name of the wetland	# of species	# of birds
48	Somasila	14	3,438
49	Tamadapalli tank	49	936
50	Telineelapuram	2	694
51	Telikunchi	1	6,000
52	Thattipudi	19	44,535
53	Thummalaguda	37	1,408
54	Uppalapadu	7	1,364
55	Warrangal	2	8
	Total	122	5,41,120

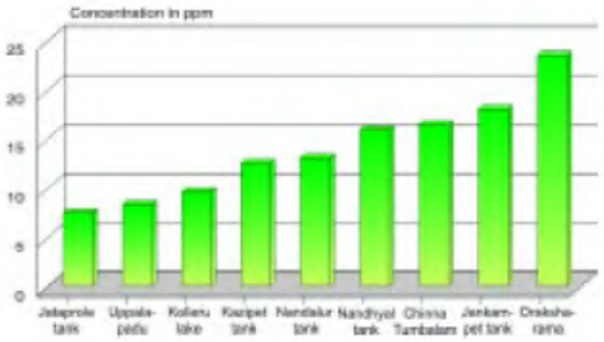


Fig. 7.20. Zinc contamination in select wetlands of Andhra Pradesh

Table 7.37. Frequency of sightings of Threatened and Near Threatened birds in Andhra Pradesh

S.#	Species	Status	No. of wetlands	Total birds sighted
1	Spotbilled Pelican	T	3	489
2	Baer's Pochard	T	1	78
3	Spotted Green Shank	T	1	20
4	Masked Finfoot	T	1	8
5	Indian Skimmer	T	1	2
6	Whitebacked Vulture	T	1	1
7	White Ibis	NT	19	3,438
8	Painted Stork	NT	12	1,687
9	Darter	NT	5	82
10	White-eyed Pochard	NT	6	42
11	Pale Harrier	NT	4	8
12	Greyheaded Fishing Eagle	NT	1	1
13	Blackbellied Tern	NT	8	101
14	Lesser Flammingo	NT	1	340

T = Threatened; NT = Near Threatened

On an average, among the species, *Channa striatus* recorded the maximum concentration of lead (5.35±0.72) which was twice higher than that in *Cirrhinus mrigala*. The minimum was in the latter species (2.14±1.72 ppm). Detectable concentrations of other metals were observed but they were well below the toxicity levels. The variation in contamination among the wetlands and species was significant for lead and zinc ($P<0.005$).

Pesticides

Among the nine wetlands, fishes of Draksha-rama of East Gohavari district recorded the maximum load (0.044 ppm) of total average organochlorine residues followed by Jankampet tank (0.038 ppm) of Nizamabad district and Uppalapadu (0.032 ppm) of Guntur district. All other wetlands recorded less than 0.02 ppm of total pesticide concentration while Nandhyal tank (0.002 ppm) in Kurnool district, Nandalur tank of Cuddapah district and Chinna Tumbalam of Kurnool district recorded the lowest; 0.001 ppm (Fig. 7.21). These variations were not statistically significant ($p>0.05$). It is to be noted that enormous amount of organophosphate and carbamate pesticides is being used indiscriminately in Andhra Pradesh. Residue levels of these chemicals could not be estimated as they degrade fast in the environment and do not get accumulated through food chain.

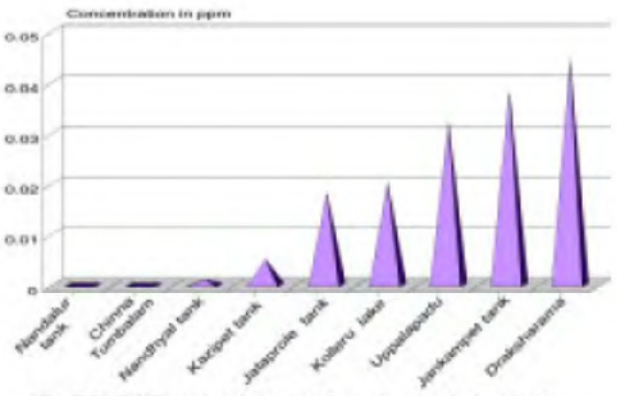


Fig. 7.21.Total organochlorine residues among select wetlands of Andhra Pradesh

Interestingly, Andhra Pradesh wetlands show less organochlorine residue concentration compared to other states.

Among all the fish species, *Cirrhinus mrigala* (0.032 ppm), *Heteropneustes fossilis* (0.026 ppm) and *Channa orientalis* (0.021 ppm) recorded higher load of total organochlorine concentration. *Labeo rohita* and *Clarias batrachus* recorded comparatively lower concentrations of total organochlorines; 0.009 and 0.008 ppm respectively (Fig. 7.22). Collectively, the findings indicate low levels of organochlorine residue influx into the wetlands of Andhra Pradesh.

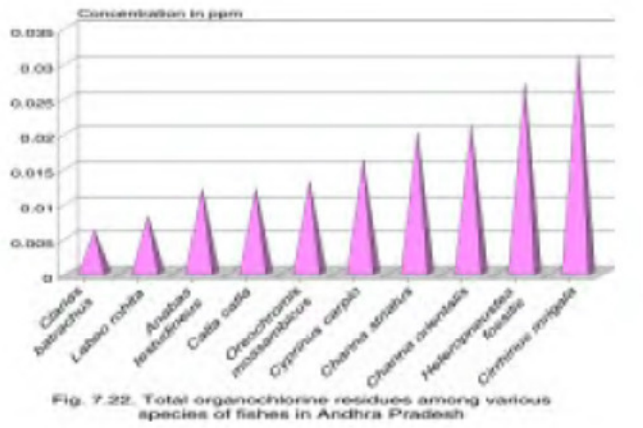


Fig. 7.22. Total organochlorine residues among various species of fishes in Andhra Pradesh

Suitability for human consumption

The levels of heavy metals and pesticides recorded appear to be safe for human consumption. According to the UN Committee (WHO, 1989, 1993) the allowable daily intake of lead and cadmium is 0.21 mg and 0.12 mg respectively for a 60 kg adult per day. Further as per the guidelines of UNEP/FAO/WHO (1989) and Health Canada (1996), the daily dietary intake of dieldrin, endosulfan, heptachlor epoxide, HCH and DDT is 6µg, 450µg, 60µg, 18µg and 300µg respectively. However, regular and high consumption may inflict serious physiological perturbations. Wetlands such as Jankampet tank and Draksharama require continuous monitoring to track the changes in the contamination pattern and propose effective conservation measures whenever required.

Socioeconomic values

Out of the 55 wetlands, 18 had very low socioeconomic use value, while 15 and 13 had medium and high use values respectively. Five among the 10 top ranking sites have a low use value and hence, they may be declared as Protected Areas or Community Reserves. These are Jamukuladinne, Pocharam, Telineelapuram, Thattipudi and Uppalapadu (Table 7.38). The sites with medium and high use values with high biodiversity values would obviously require immediate conservation actions.

Prioritization of wetlands

Conservation values of 55 wetlands have been evaluated and they were prioritized by assigning grades for different criteria, especially of birds as explained in the section on methods. The total grades were ranked into three; the first 10 with grades ≥15 were considered in the first rank, next 10 with 10-14 grades as second rank and, 16 with ranks 5-9 as third rank and others in the fourth rank. The first eight, namely Sangameshwara backwaters, Chinna Thumbalam, Uppalapadu, Telineelapuram, Pocharam, Nizamsagar reservoir, Thattipudi and Mittekoduru came in the first rank because of the high biodiversity value with respect to birds (Table 7.38). When the size of the wetland was considered, Anantaram and Jamukuladinne also came in the first priority. Similarly, Rudrur and Thummalaguda came up in the rank, so also Somasila and Kolleru. Sangameshwara backwaters, Nizamsagar reservoir, Thattipudi, Laknapur, Kotpalli, Draksharama:Gowthami, and Chinna Thumbalam had more than 20,000 birds which is the first criterion for considering the importance of a wetland as a Ramsar site. Laknapur, Kotpalli and Draksharama: Gowthami came down in the rank because of the lower number of Threatened and Near Threatened species. The spatial distribution of the prioritized wetlands and the same in relation to the BCPP and terrestrial Protected Areas are given in Fig. 7.23.

Table 7.38. Prioritized wetlands of Andhra Pradesh

S.No.	Name of the wetland	Rank	Use grade
1	Sangameshwara backwaters	1	H
2	Chinna Thumbalam	1	H
3	Uppalapadu	1	L
4	Telineelapuram	1	L
5	Pocharam	1	L
6	Nizamsagar reservoir	1	M
7	Thattipudi	1	L
8	Mittekoduru	1	M
9	Anantaram	1	DD
10	Jamukuladinne	1	L
11	Rudrur	2	H
15	Chikkadpally	2	M
12	Draksharama : Gowthami	2	DD
16	Thummalaguda	2	DD
13	Somasila	3	L
17	Godavari river	2	L
14	Kolleru lake	3	L
18	Kondakarla	2	L
19	Kotpalli	2	M
20	Laknapur	2	L
21	Patha-kotha cheruvu	2	M
22	Pavumanchala	2	H
23	Alisagar	3	H
24	Damercharla	3	DD
25	Doulatabad lake	3	H
26	Hussain sagar	3	DD
27	Ibrahimpur	3	M
28	Jankampet tank	3	H
29	Jataprole tank	3	L
30	Katakshapur tank	3	DD
31	Nandalur tank	3	M
32	Nandyal tank	3	H
33	Nowpada swamps	3	H
34	Peddatippa samudram	3	H
35	Singoor dam	3	M
36	Tamadapalli tank	3	H
37	Banswada	4	M
38	Bellal tank	4	H
39	Bhadrakali tank	4	DD
40	Dali tank	4	L
41	Gangayapuram pedda tank	4	M
42	Gudur tank	4	L
43	Issalpet	4	H
44	Kaligiri reservoir	4	L
45	Kodad lake	4	M
46	Nasrullabad	4	M
47	Navipet tank	4	M
48	Nellore tank	4	L
49	Nirukula	4	DD
50	Palem reservoir	4	M
51	Punyakshetram	4	L
52	Rangasamudram	4	M
53	Sasanam	4	L
54	Telikunchi	4	L
55	Warrangal	4	DD

L=Low; M=Medium; H=High; D=Data deficient

It may be noted that although Kolleru is an internationally important wetland and a Ramsar site, its diversity value has gone down. It is a matter of great concern and action needs to be taken on priority, to protect its biodiversity.

It is to be mentioned that the wetlands selected for study were based mainly on the earlier data on birds, mostly from the Asian Waterfowl Census and also from Bird Watchers' Society of Andhra Pradesh. Hence, the observed lower conservation scores for some wetlands during this study should be examined in the coming years as the low population of this year might be because of the local climatic factors, mainly rainfall.

The 10 top-ranking sites and 10 from the second rank fulfill the criteria to declare them as Ramsar sites and are proposed accordingly.

Summary

- Andhra Pradesh has 1,493 wetlands of the size 56.25 ha and above, covering an area of 3,666.06 sq km, as per the satellite imageries of 1992-93 SAC (1998).
- In the nine districts of Andhra Pradesh, assessed by SACON, 4,526 wetlands of the size 2 ha and above, covering 3,456 sq km have been reported.
- Small wetlands, 2 ha and above, are more in abundance than the larger wetlands.
- Most of the wetlands had low or moderate turbidity, except those in Nellore district which had larger areas with high turbidity.
- Satellite imageries of most of the wetlands showed low vegetation.
- Andhra Pradesh has 13 endemic species of aquatic plants; five Endangered, two Critically Endangered and 12 Vulnerable species of fishes; two Near Threatened and one each of

Endangered, Vulnerable and Least Concern species of freshwater turtles and, six Threatened and eight Near Threatened species of birds.

- In the 55 select wetlands, 5,41,120 wetland birds, belonging to 122 species were recorded.
- Ducks and Teals, mainly the Pintail, Garganey, Tufted Duck, Lesser Whistling Teal and Shoveller were the most abundant group
- Five hundred and ninety eight birds of six Threatened and 5699 birds of eight Near Threatened species were recorded during the survey.
- One hundred twenty nine fishes belonging to 10 species from 9 wetlands were analysed for pesticides and heavy metals.
- Two wetlands, namely Draksharama and Janakampet tank have comparatively high concentration of metals (zinc) and pesticides and therefore fishes from these are not advisable for regular consumption.
- *Channa striatus* had higher levels of lead while *Cirrhinus mrigala* had higher levels of organochlorine pesticides.
- 55 wetlands have been prioritized from Andhra Pradesh.
- 20 wetlands are recommended to be declared as Ramsar sites.



Vivek R. Sinha

Spoonbill at the nest

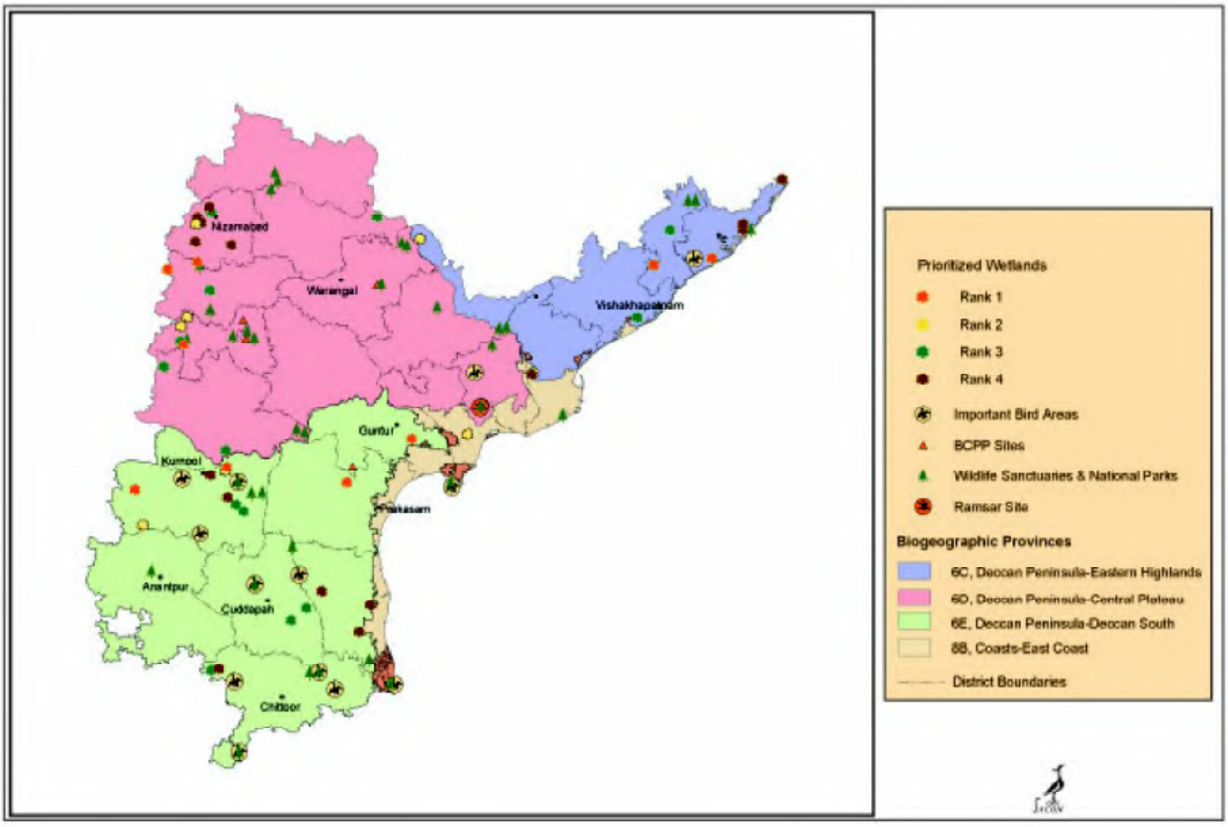


Fig. 7.23. Prioritised wetlands and other conservation areas in Andhra Pradesh



Lalitha Vijayan

Pelican in a city tank at Jamnagar, Gujarat

ORISSA

Orissa, inspite of its hill tracts and coastal belts, rivers and rivulets, tidal creeks and riverine islands, is known more for the Chilka, the largest brackish water lake in Asia and also for Bhitarkanika mangroves, one of the finest stretches of mangroves in the country. Geographically the state can be divided into four distinct areas; the northern plateau, central river basin, eastern hills and coastal plains. The state has a large number of rivers. The climate of the state is neither too hot nor cold. The rainfall varies from 1,010 mm to 1,810 mm. Most of the rainfall is from southwest monsoon. Temperature varies from 7 to 40°C.



Status of wetlands

As in other states, the routine land use statistics of the state does not show wetlands as a separate unit (Table 8.1). However, based on the data of 1992-'93, SAC (1998) has reported 234 inland wetlands of the size 56.25 ha and above, covering a total area of 1627.75 sq km (Table 8.2). Out of this, 88.8% of the area is covered by 86 reservoirs. Although lakes/ponds, waterlogged areas, marshes and tanks add up to 148, the total area covered by them is very small; only 181.7 km^2. There appears to be a large number of small ponds and tanks; some of them quite old. Overall distribution of wetlands in Orissa is given in Fig. 8.1.

State at a glance	
State capital	Bhubaneswar
Area	1,55,707 sq km
Population (2001)	36,706,920
Total number of districts	30
Major rivers	Mahanadi, Baitarani, Brahmani
Total forest area	56,060 sq km
Population density (2001)	236/sq km
Ramsar sites	2
Proposed Ramsar sites	4
Total sites proposed for conservation	7

Table 8.1. Land use pattern in Orissa

Land use type	Area in sq km
Total geographic area	1,55,707
Forests	56,060
Not available for cultivation	14,560
Other uncultivated land excluding fallow land	17,530
Fallow land	7,080
Net area sown	60,480
Area sown more than once	23,770
Total cropped area	84,250
Cultivable area	85,090

Source: www.indiastat.com

Table 8.2. Distribution of various categories of inland wetlands in Orissa

Inland wetlands	Number	Area (sq km)
Lakes	4	7.07
Oxbow lakes/cut-off meander	13	10.25
Waterlogged (seasonal)	77	98.07
Marsh vegetation (Inland)	6	24.63
Reservoirs	86	1,446.00
Tanks	5	4.88
Waterlogged	21	18.02
Abandoned quarries	19	15.13
Ash ponds/cooling ponds	3	3.70
Total	234	1,627.75

Source: SAC (1998)

Biodiversity

Aquatic vegetation

The endemic aquatic plants reported from Orissa, according to the compiled information, are only six species belonging to five Families (Table 8.3).

Table 8.3. Endemic aquatic angiosperms recorded from Orissa

S.#	Species	Family
1	*Eriocaulon breviscapum*	Eriocaulaceae
2	*Pogostemon griffithii*	Lamiaceae
3	*Eriocaulon duthiei*	Eriocaulaceae
4	*Hygrophila serpylla*	Acanthaceae
5	*Hoppea dichotoma*	Gentianaceae
6	*Rotala fimbriata*	Lythraceae

Fishes

Twenty-two species of Threatened freshwater fishes were recorded from Orissa (Menon, 1999), comprising one Critical, six Endangered and 15 Vulnerable species (Table 8.4).

Table 8.4. Threatened freshwater fishes reported from Orissa

S.#	Species	Status
1	*Pangasius pangasius*	CR
2	*Anguilla bengalensis*	EN
3	*Chitala chitala*	EN
4	*Eutropiichthys vacha*	EN
5	*Ompok bimaculatus*	EN
6	*Pseudeutropius atherinoides*	EN
7	*Puntius dorsalis*	EN
8	*Ailia coila*	VU
9	*Anabas testudineus*	VU
10	*Bagarius bagarius*	VU
11	*Barbodes sarana*	VU
12	*Catla catla*	VU
13	*Cirrhinus reba*	VU
14	*Clarias batrachus*	VU
15	*Heteropneustes fossilis*	VU
16	*Mystus bleekeri*	VU
17	*Mystus vittatus*	VU
18	*Osteobrama cotio*	VU
19	*Puntius chola*	VU
20	*Raiamas bola*	VU
21	*Rhinomugil corsula*	VU
22	*Sicamugil cascasia*	VU

Turtles

Nine species of freshwater turtles were reported from Orissa (Table 8.5), of which one is Critical, two Endangered, three Vulnerable and three Near Threatened. *Batagur baska,* the most Endangered species occurs only in Orissa and West Bengal.

Table 8.5. Freshwater turtles recorded from Orissa

S.#	Species	Threat categories		
		IUCN	CITES	IWP Act
1	*Aspideretes gangeticus*	VU	-	I
2	*Aspideretes hurum*	VU	I	I
3	*Aspideretes leithii*	VU	-	IV
4	*Batagur baska*	CR	I	I
5	*Chitra indica*	EN	-	IV
6	*Kachuga tecta*	NT	I	I
7	*Kachuga tentoria*	NT	-	-
8	*Lissemys punctata*	NT	II	I
9	*Pelochelys cantorii*	EN	-	I

VU=Vulnerable; CR=Critically Endangered;
EN=Endangered; NT=Near Threatened

Birds

Orissa is known for its large congregations of wetland birds in the coastal areas, especially, in Chilka lake and the massive heronries in Bitharkanika. It is also to be noted that a large number of waterfowl have been reported from a few reservoirs and lakes, although the numbers were not as high as those from Chilka. Data are available for seven such areas (Table 8.6).

Only three of the wetlands were covered completely, while the remaining areas were covered only 50-75% for censusing the birds (Lopez & Mundkur 1997). The total number of birds for the seven wetlands was 1,99,690. The highest species richness was in Ansupa lake while the highest number of birds was in Kumarkunthi reservoir. Although, Mancha Kund reservoir had only 16 species, it had a total of 18,755 birds.

Table 8.6. Major wetlands of Orissa with species and number of birds

S#	Wetlands	No. of birds	No. of species	Per cent covered
1	Kumarkunthi reservoir–(Chandka Wildlife Sanctuary)	74,616	30	100
2	Hirakud reservoir	44,719	29	100
3	Rengali reservoir	39,540	34	50-75
4	Machakund reservoir	18,755	16	50-75
5	Ansupa lake	11,860	42	100
6	Balimela	7,239	26	50-75
7	Mahanadi (Satkosia to Munduli)	2,967	32	50-75
	Total	1,99,696	-	-

Source: Lopez & Mundkur (1997), Dr. U. Sridharan (Pers. Comm.), Dr. Sudhakar Kar (Pers. Comm.)

Prioritization of wetlands

The first four came in the first rank, followed by one in the second and two in the third rank (Table 8.7). Distribution of the prioritized wetlands along with other conservation areas is given in Fig. 8.2.

Table 8.7. Prioritized wetlands of Orissa

S#	Wetlands	Rank
1	Kumarkunthi reservoir (Chandka Wildlife Sanctuary)	1
2	Hirakud reservoir	1
3	Rengali reservoir	1
4	Machakund reservoir	1
5	Ansupa lake	2
6	Balimela	3
7	Mahanadi (Satkosia to Munduli)	3

All the top ranking wetlands are qualified to be declared as Ramsar sites, considering the number of species and total number of birds. The remaining three also should be considered for long-term conservation programmes considering the species richness. Apart from the data available from Asian Waterfowl Census, information gathered from experts of the area (Dr U Sridharan and Dr Sudhakar Kar) were also made use of while prioritizing the wetlands for conservation.

Summary

- Orissa has 234 inland wetlands of the size 56.25 ha and above, covering an area of 1,627.75 sq km, according to the satellite data of 1992-'93 (SAC, 1998).
- Eighty-eight per cent of the wetland area is covered by 86 reservoirs.
- Tanks/ ponds amount only to 148.
- Orissa has according to the compiled information, six species of endemic aquatic plants; one Critical, six Endangered and 15 Vulnerable species of fishes; one Critical, two Endangered, three Vulnerable and three Near Threatened species of freshwater turtles.
- From the seven select wetlands, 1,99,690 birds were recorded.
- Four wetlands come in the first rank, one in the second and two in the third ranks of priority.
- All the four wetlands in the first rank are qualified to be declared as Ramsar sites.

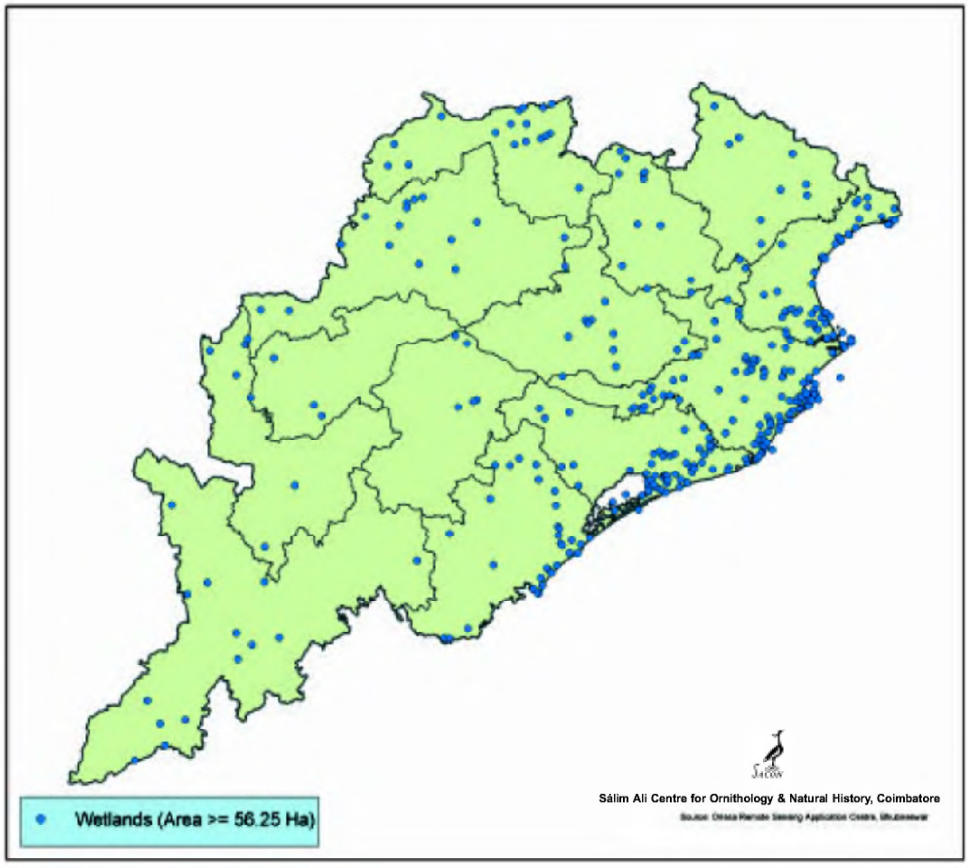


Fig. 8.1. Distribution of wetlands in Orissa

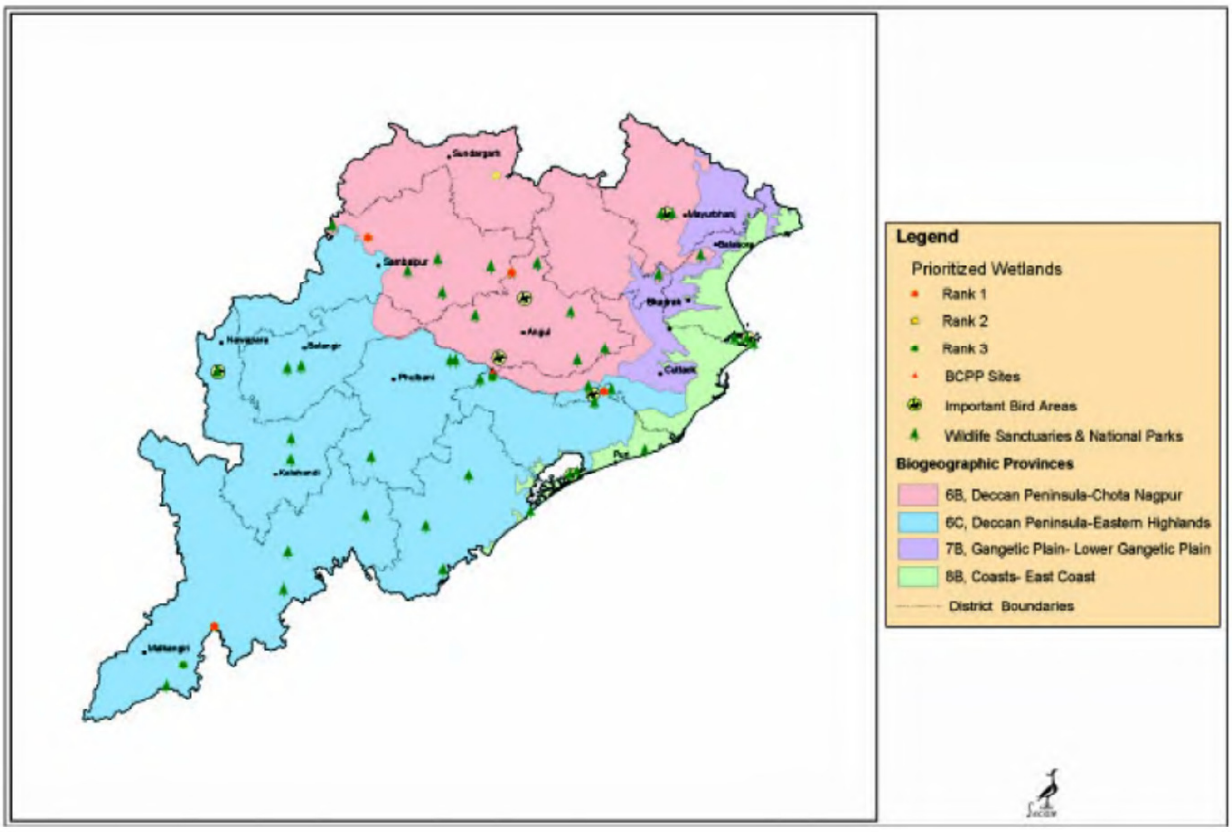


Fig. 8.2. Prioritized wetlands along with other conservation areas in Orissa



B.C. Choudhury

Congregation of resident and migrant waterfowl in the Bhoj wetland, Bhopal, Madhya Pradesh - a Ramsar site

MADHYA PRADESH and CHHATISGARH

Madhya Pradesh, the southernmost bastion of the Swamp Deer and Wild Buffalo, consists largely of a plateau, and has gorgeous mountain ranges, meandering rivers and large stretches of forests. The state can be divided into the following three major physiographic regions: (1) the central plateau – situated in between the Narmada-Son valley and the Vindhyan hills, (2) the Satpura range – in between the Narmada and the Tapti rivers; the region extends east to west and parallel to the Vindhyan range, and (3) the eastern plateau – the region extends over the eastern districts of Madhya Pradesh.



Average rainfall in different regions of the state ranges from 450 to 900 mm. The climate is extreme in the north, temperate and breezy in the plateau and generally hot and humid in the eastern and southern plains. The average temperature varies from 9.8 to 40.2°C.

Chhattisgarh

Chhattisgarh, situated to the east of Madhya Pradesh, is only 1,35,194 sq km in area. The state is divided into two major parts - the river valley of Mahanadi and the hilly regions. The eastern and southeastern parts of the state consist of hilly regions. The state has good forests; about 44 per cent of the total land area.

State at a glance	
State capital	Bhopal
Area	3,08,252 sq km
Population (2001)	60,385,118
Total number of districts	45
Major rivers	Chambal, Narmada, Tapi, Mahanadi, Indravati
Total forest area	1,47,080 sq km
Population density (2001)	196/sq km
Ramsar site	1
Proposed Ramsar sites	Madhya Pradesh: 6 Chattisgarh : Nil
Total sites proposed for conservation	Madhya Pradesh: 30 Chattisgarh : 18

Status of wetlands

The land use pattern of Madhya Pradesh does not indicate the presence of wetlands (Table 9.1). Space Applications Centre (SAC, 1998) also reports that the wetland area for the entire state is only 0.66% of the total area. The total number of wetlands of the size 56.25 ha and above was estimated at 407 and the total area covered by wetlands is 2,941.18 sq km (Table 9.2). SACON's estimate of the wetlands of 2 ha and above in eight select districts shows that there are 4,767 wetlands covering an area of 1,978.90 sq km (Table 9.3). Spatial distribution of wetlands above 56.25 ha in the state (Fig. 9.1) shows that the evenly spaced out wetlands are far fewer in number relative to the land mass. There are apparently no wetlands in the south-east and south-west regions of the state.

Table 9.1. Land use pattern in Madhya Pradesh and Chhattisgarh

Land use type	Area in sq km
Total geographic area	4,43,335
Forests	1,47,080
Not available for cultivation	42,170
Other uncultivated land excluding fallow land	40,900
Fallow land	14,940
Net area sown	1,98,390
Area sown more than once	61,720
Total cropped area	2,60,110
Cultivable area	2,54,230

(Source: www.indiastat.com)

The wetlands in Madhya Pradesh consist of reservoirs, lakes, tanks, and ash/cooling ponds (Table 9.2). Reservoirs are more in number and they cover a larger area followed by tanks and lakes.

Table 9.2. Distribution of various categories of inland wetlands in Madhya Pradesh

Inland wetland	Area (sq km)	No. of wetlands
Lakes	54.09	22
Reservoirs	2,668.64	227
Tanks	216.55	157
Ash/cooling ponds	1.90	1
Total	2,941.18	407

Source: SAC (1998)

Table 9.3. Types, number and extent (sq km) of wetlands (2 ha and above) in select districts

Districts	Ponds/lakes/tanks		Reservoirs		Total no. of wetlands	Total area of wetlands
	No.	Area	No.	Area		
Bilaspur	1,703	121.79	4	229.73	1,707	351.52
Datia	22	5.10	1	121.00	23	126.10
Durg	1,232	104.44	4	176.56	1,236	281.00
Jabalpur	368	61.38	2	233.78	370	295.16
Mandsaur	104	26.73	1	366.89	105	393.62
Morena	70	19.65	5	61.08	75	80.73
Raipur	1,176	143.60	6	201.75	1,182	345.35
Raisen	66	22.4	3	83.02	69	105.42
Total	4,741	505.09	26	1473.81	4,767	1,978.90

Habitat analyses of wetlands in select districts

Eight districts, namely Datia, Mandsaur, Morena, Jabalpur and Raisen from Madhya Pradesh and, Bilaspur, Durg and Raipur from Chhattisgarh were chosen to map wetlands at finer resolution (23.5 m) to capture wetlands above 2 ha in size along with the land use pattern, turbidity and aquatic vegetation. Area covered by wetlands and other land use, turbidity, a cross classification of wetlands and turbidity and, finally seasonal changes in water levels for the eight districts were studied. The land use pattern, seasonal changes in the water levels and turbidity vary greatly among the districts (Table 9.4-9.27). All the districts studied had more arable lands. Raisen and Morena had comparatively more forest land.

Total area occupied by wetlands in the eight districts is 1,978.9 sq km, out of which the reservoirs occupy 1,473.81 sq km and the rest by ponds/ lakes (Table 9.3). Although the wetlands occupy a very small percent of the total geographical area of each district, the difference among the districts is discernible (Fig. 9.2), the variation being 0.69 (Morena) and 5.48 (Datia). The larger extend of wetland in Datia is due to the large area under reservoir (Fig. 9.3).

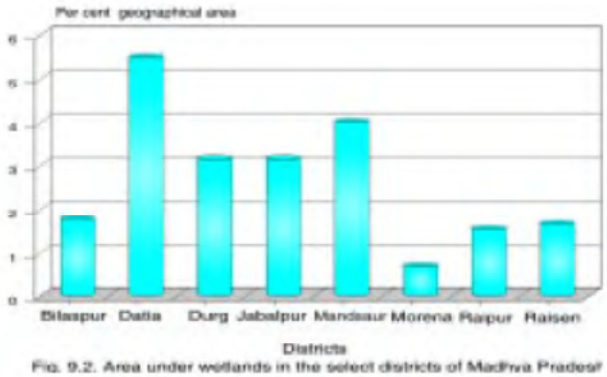


Fig. 9.2. Area under wetlands in the select districts of Madhya Pradesh

It is to be noted that the number of wetlands below 56.25 ha in size is substantially high in three of the eight districts studied (Table 9.3; Fig. 9.4) from 1,176 to 1,703. One of the reasons could be the comparatively higher

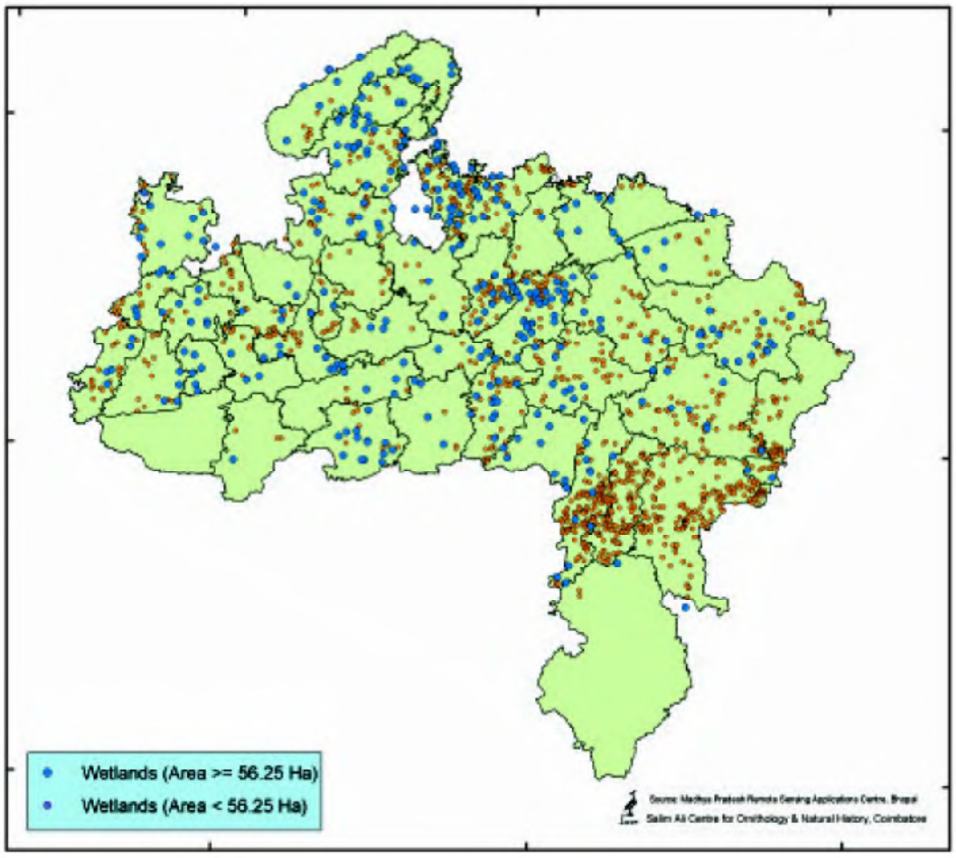


Fig. 9.1. Distribution of wetlands in Madhya Pradesh

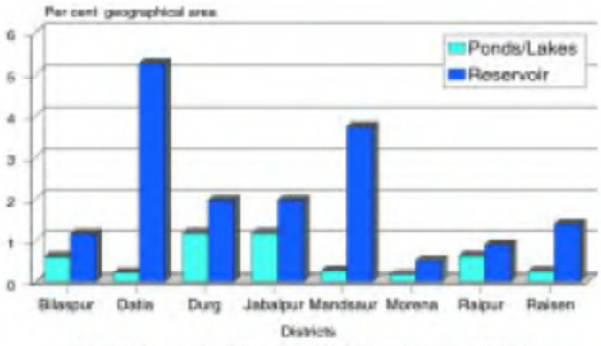


Fig. 9.3. Area under different wetland classes in select districts in Madhya Pradesh

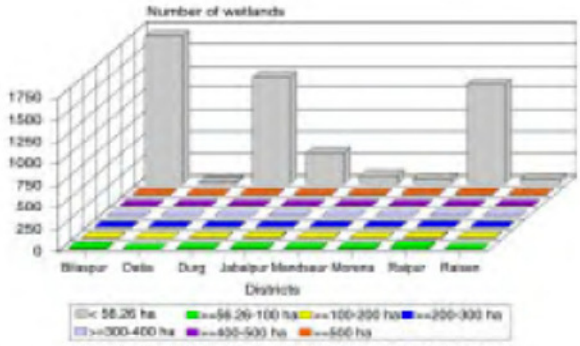


Fig. 9.4. Size class distributionof the wetlands in select districts of Madhya Pradesh

rainfall, above 1,200 mm, and the maintenance of ponds/lakes in these districts, namely Bilaspur, Durg and Raipur. However, the district Raisen seems to be an exception to this, where although the rainfall is above 1,200 mm, the number of smaller wetlands is negligible.

Turbidity

The turbidity of reservoirs, and ponds/ lakes shows a different pattern. The reservoirs had low turbidity in the districts of Bilaspur, Datia, Raipur, whereas in Durg and Morena it was high. In the other districts it was moderate to high or low to moderate (Fig. 9.5). In the case of ponds/ lakes, turbidity is high in the wetlands of Bilaspur, Jabalpur, Mandsaur, whereas it was moderate in Datia, moderate to high in Bilaspur, moderate and low in Durg (Fig. 9.6).

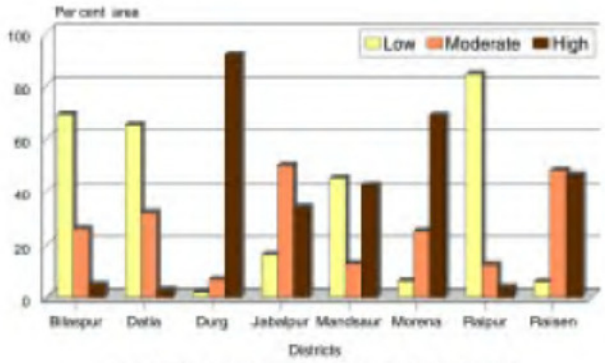


Fig. 9.5. Turbidity pattern of reservoirs in Madhya Pradesh

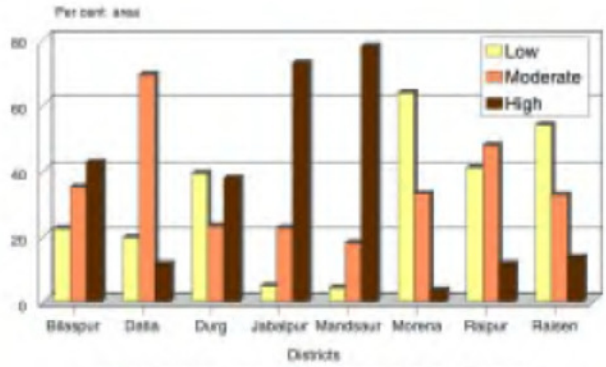


Fig. 9.6. Turbidity pattern of ponds/lakes in Madhya Pradesh

Summer recession

Summer (pre-monsoon) recession among the wetlands varied from 32.84% in Mandsaur district to 77.17% in Morena (Fig. 9.7).

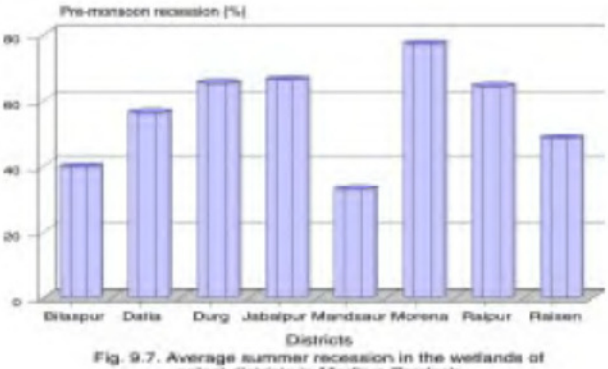


Fig. 9.7. Average summer recession in the wetlands of select districts in Madhya Pradesh

Wetlands and land use pattern in the catchment areas

Integrated land use maps of all the districts studied show that as in the other states, the wetlands, especially ponds/ lakes, are by and large surrounded by agricultural land. The reservoirs have forests or agricultural land in the catchment areas (Fig. 9.8-9.15).

Temporal changes in wetland cover

A comparison of the wetland area of the select districts between 1992-93 and 2000-2001 shows that while five districts had a total gain of 501.7 sq km, three districts had a total loss of 365.51 sq km. The loss was in the districts of Datia, Jabalpur and Morena between 35% and 86% (Table 9.29; Fig. 9.16). A detailed comparison with the past land use pattern would alone reveal the causes of decrease in the extent of wetland.

Table 9.29. Changes in the wetland area (in sq km) in select district

District	SAC (1992-'93)	SACON (2000-2001)	Variation	%Variation
Bilaspur	198.31	352.44	154.13	77.72
Datia	95.62	12.61	-83.01	-86.81
Durg	139.52	281.13	141.61	101.50
Jabalpur	455.28	293.63	-161.65	-35.51
Mandsaur	317.55	394.27	76.72	24.16
Murena	201.58	80.73	-120.85	-59.95
Raisen	106.03	141.09	35.06	33.07
Raipur	250.77	344.95	94.18	37.56

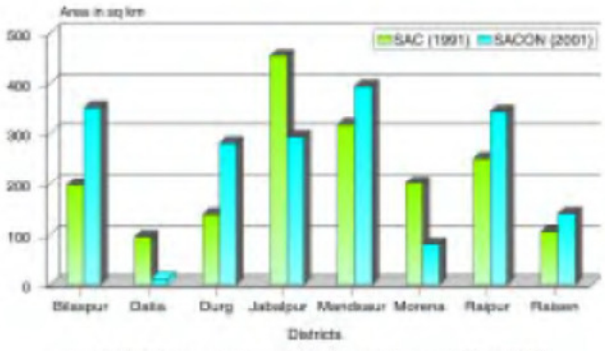


Fig. 9.16. Difference in total wetland area between 1992 and 2001 in Madhya Pradesh

Biodiversity

Aquatic vegetation

In the eight districts studied, aquatic vegetation in the reservoirs was low in five districts, whereas in the remaining three districts it was quite dense (Fig. 9.17). In the case of ponds/ lakes it was low in two districts, while moderate in one and high in five districts (Table 9.28; Fig. 9.18).

Twenty species of endemic plants belonging to 15 families are reported from the wetlands of Madhya Pradesh (Table 9.30).

Fishes

Sixteen Threatened species of fishes are reported from Madhya Pradesh and Chhattisgarh. Of these four are Endangered and 12 Vulnerable (Table 9.31).

Turtles

In Madhya Pradesh and Chhattisgarh, together there are 10 species of freshwater turtles, of which two are Endangered, four Vulnerable, one is Critically Endangered and three are Near Threatened (Table 9.32).

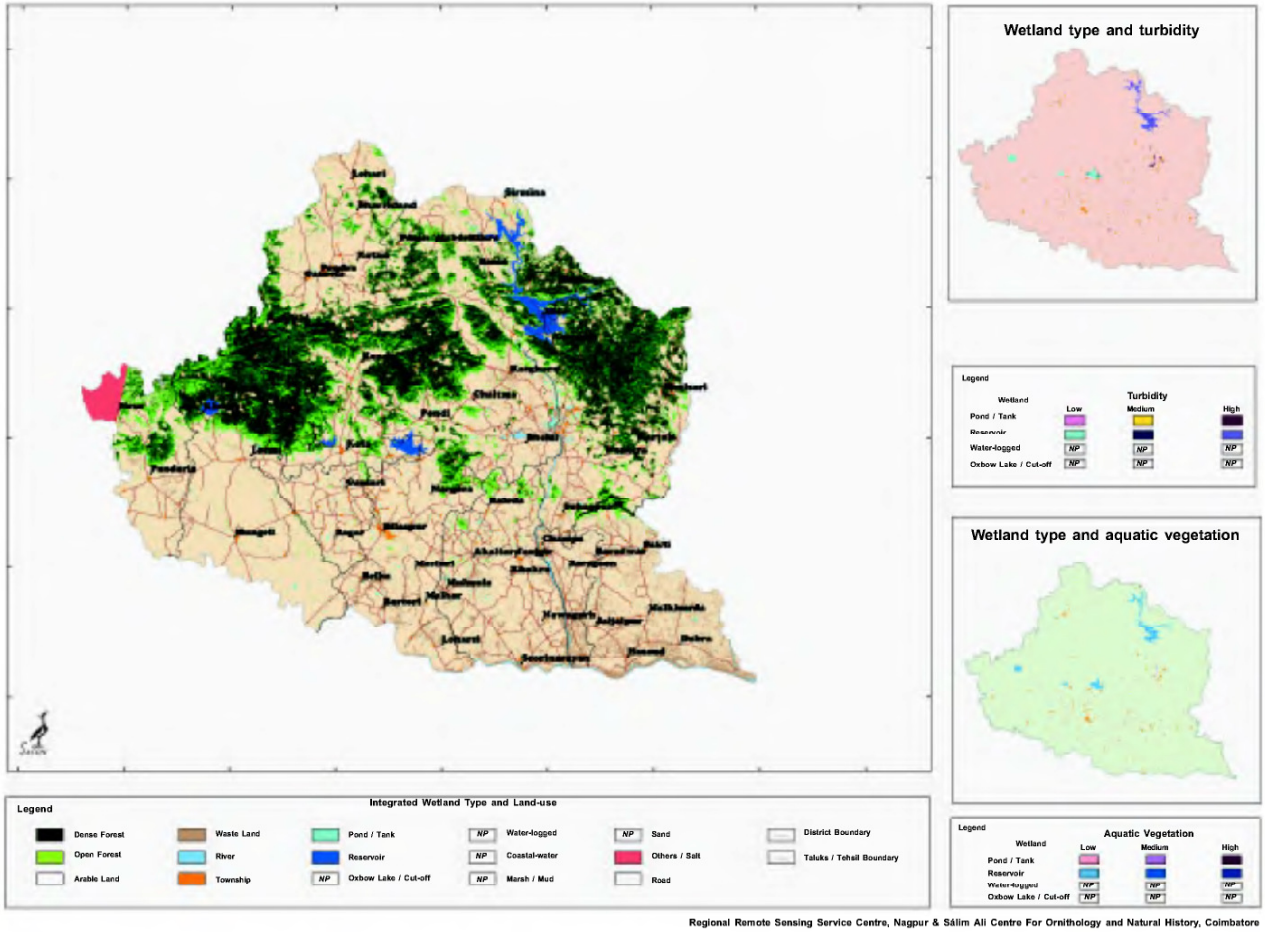


Fig. 9.8. Land use and wetland categories in the district of Bilaspur

Table 9.4. Area under different land use and wetland categories in the district of Bilaspur

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	3,827.55	19.12
Forest-open	1,528.29	7.64
Arable land	12,828.69	64.09
Wasteland	1,056.72	5.28
Wetland-ponds/lakes/tanks	121.81	0.61
Wetland-reservoirs	230.63	1.15
Township	133.76	0.67
Other water body/river	153.29	0.77
Others (area for which satellite data not available)	135.22	0.68

Table 9.5. Area under different turbidity classes in the district of Bilaspur

Turbidity class	Area (sq km)	% of total wetland area
Low	111.53	31.74
Moderate	38.04	10.83
High	201.78	57.43

Table 9.6. Seasonal pattern of wetland areas in the district of Bilaspur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	27.44	12.27	15.17	
Reservoirs	62.75	42.09	20.66	
Total	90.19	54.36	35.83	39.73

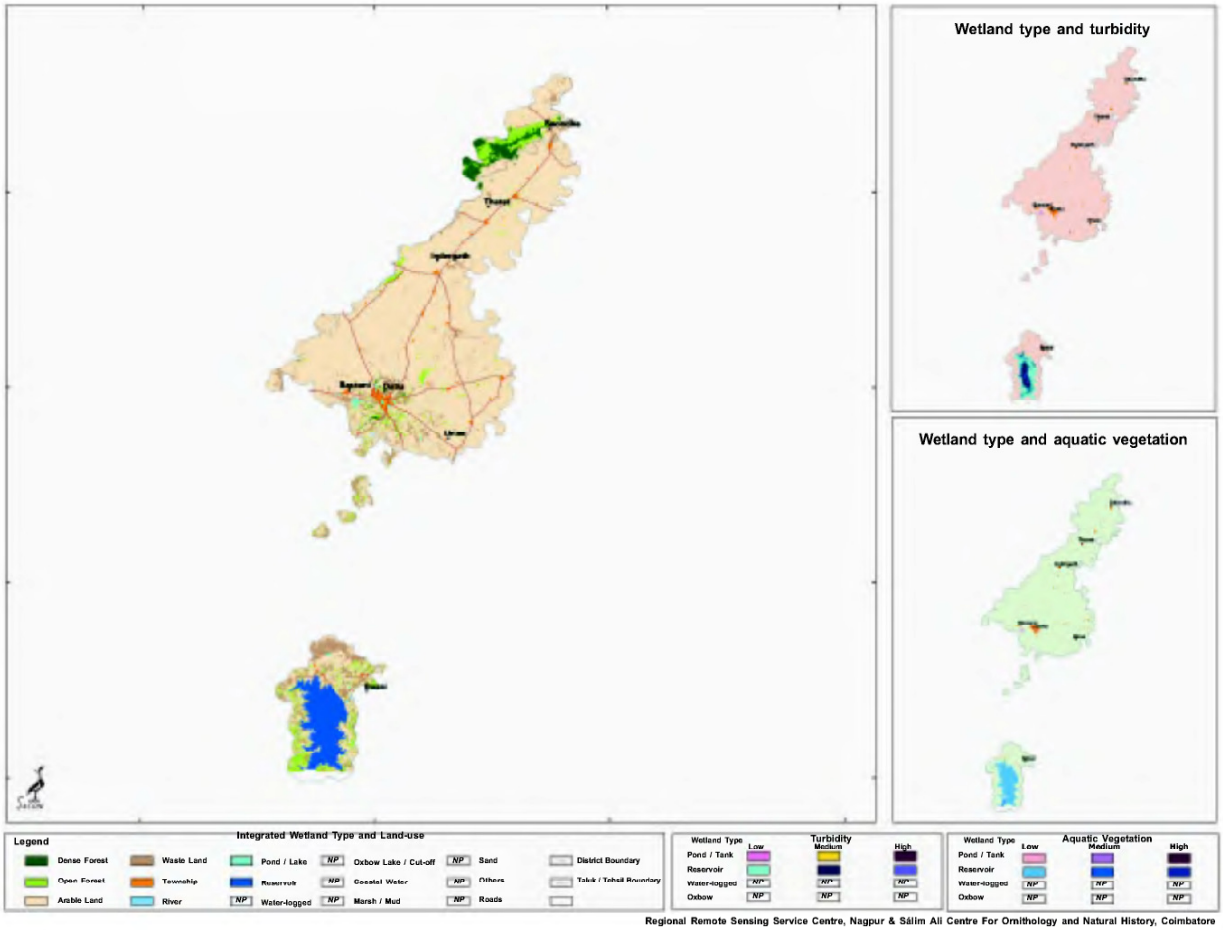


Fig. 9.9. Land use and wetland categories in the district of Datia

Table 9.7. Area under different land use and wetland categories in the district of Datia

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	41.72	1.81
Forest-open	112.94	4.91
Arable land	1,794.37	78.06
Wasteland	179.63	7.81
Wetland-ponds/lakes/tanks	5.10	0.22
Wetland-reservoirs	121.00	5.26
Township	24.28	1.06
Other water body /river	19.60	0.85
Others (area for which satellite data not available)	0.00	0.00

Table 9.8. Area under different turbidity classes in the district of Datia

Turbidity class	Area (sq km)	% of total wetland area
Low	82.58	65.48
Moderate	39.57	31.38
High	3.96	3.14

Table 9.9. Seasonal pattern of wetland areas in the district of Datia

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	4.14	1.81	2.33	56.28

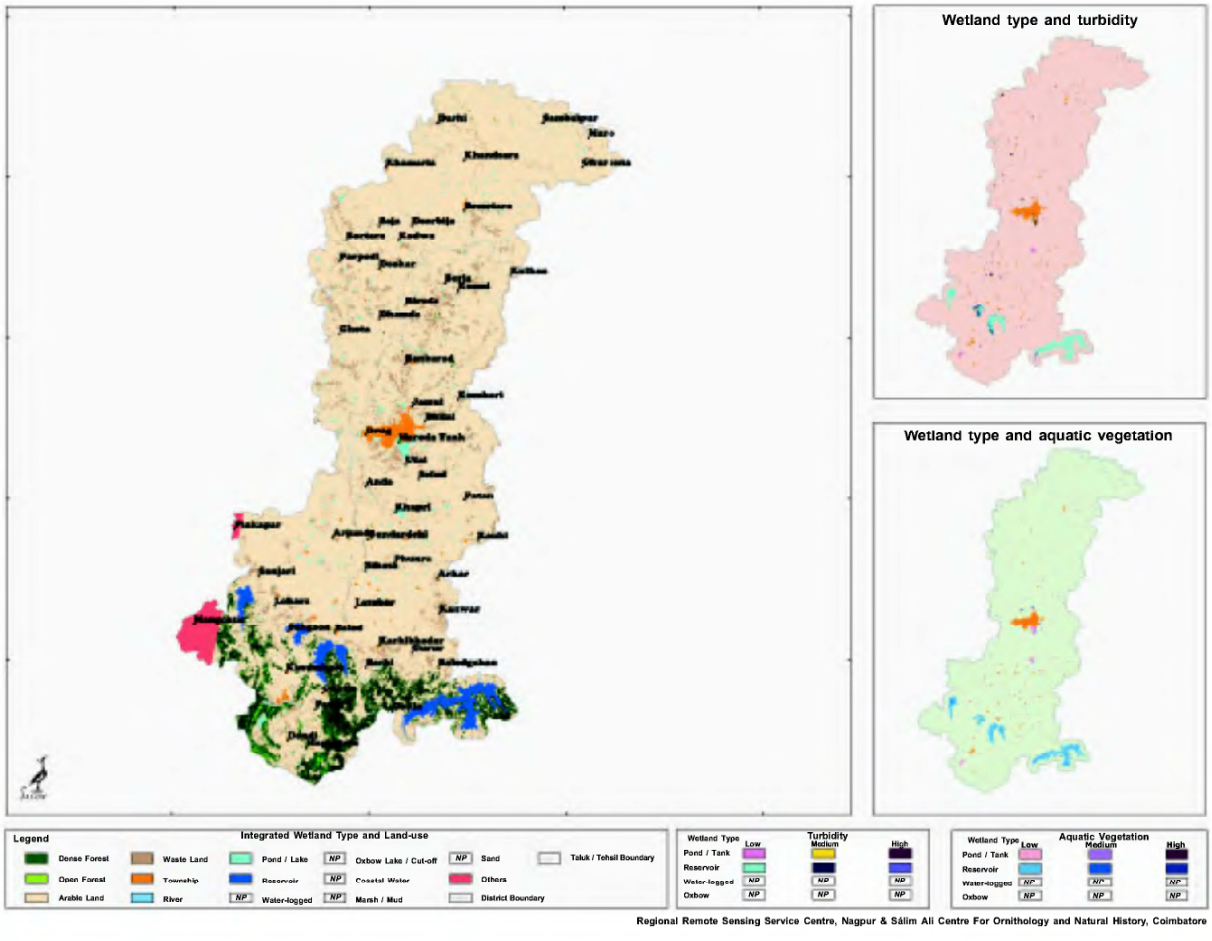


Fig. 9.10. Land use and wetland categories in the district of Durg

Table 9.10. Area under different land use and wetland categories in the district of Durg

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	521.71	5.83
Forest-open	43.35	0.48
Arable land	7,248.81	81.06
Wasteland	569.17	6.36
Wetland-ponds/lakes/tanks	104.51	1.17
Wetland-reservoirs	176.62	1.97
Township	102.72	1.15
Other water body /river	47.45	0.53
Others (area for which satellite data not available)	128.42	1.44

Table 9.11. Area under different turbidity classes in the district of Durg

Turbidity class	Area (sq km)	% of total wetland area
Low	201.27	71.63
Moderate	35.64	12.68
High	44.09	15.69

Table 9.12. Seasonal pattern of wetland areas in the district of Durg

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	30.75	10.74	20.01	65.07

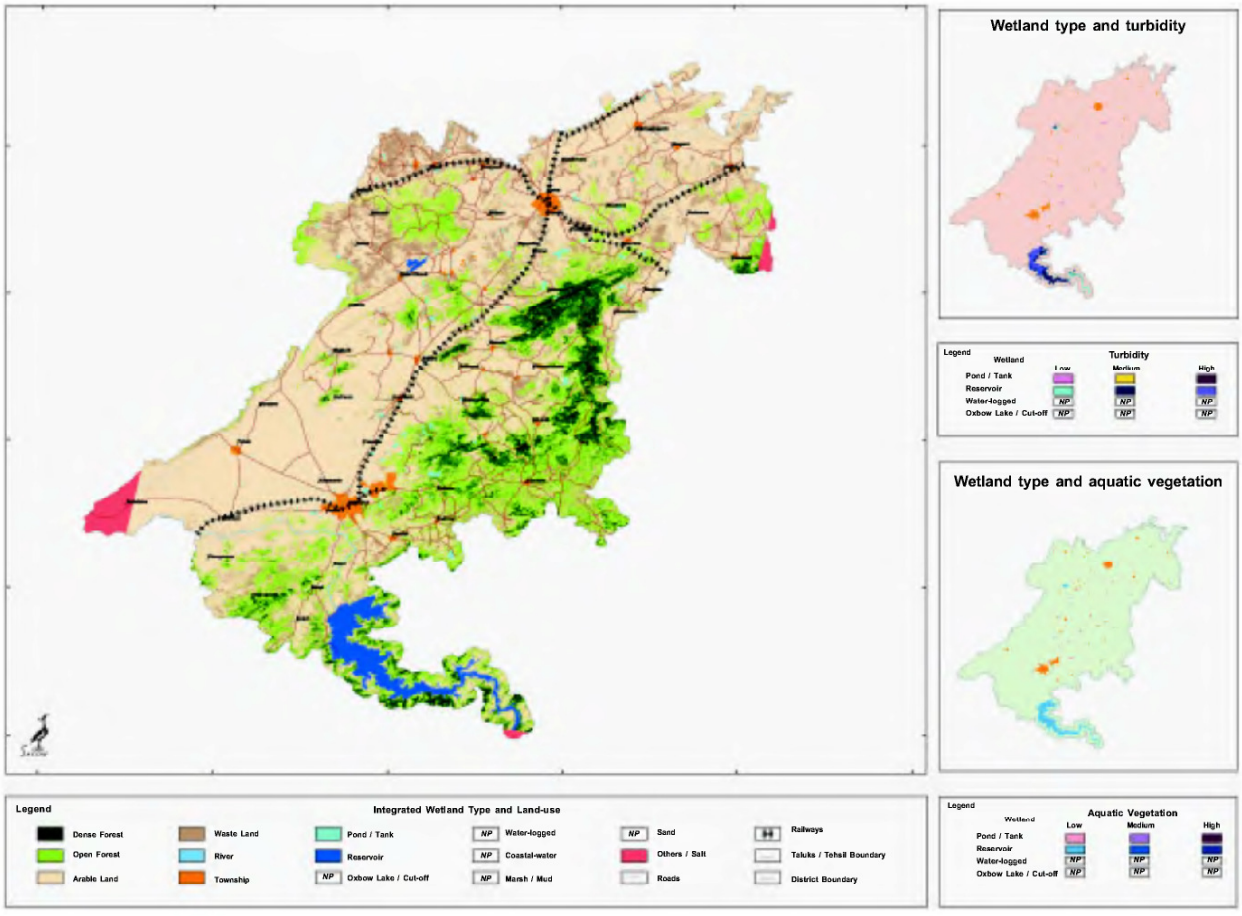


Fig. 9.11. Land use and wetland categories in the district of Jabalpur

Table 9.13. Area under different land use and wetland categories in the district of Jabalpur

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	575.94	5.35
Forest-open	1,950.64	18.11
Arable land	6,436.20	59.74
Wasteland	1,217.37	11.30
Wetland-ponds/lakes/tanks	59.63	0.55
Wetland-reservoirs	234.00	2.17
Township	132.99	1.23
Other water body/river	38.99	0.36
Others (area for which satellite data not available)	127.58	1.18

Table 9.14. Area under different turbidity classes in the district of Jabalpur

Turbidity class	Area (sq km)	% of total wetland area
Low	130.22	44.12
Moderate	82.18	27.84
High	82.76	28.04

Table 9.15. Seasonal pattern of wetland areas in the district of Jabalpur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs	7.02	1.13	5.89	
Ponds/lakes /tanks	37.79	14.05	23.74	
Total	44.81	15.18	29.63	66.12

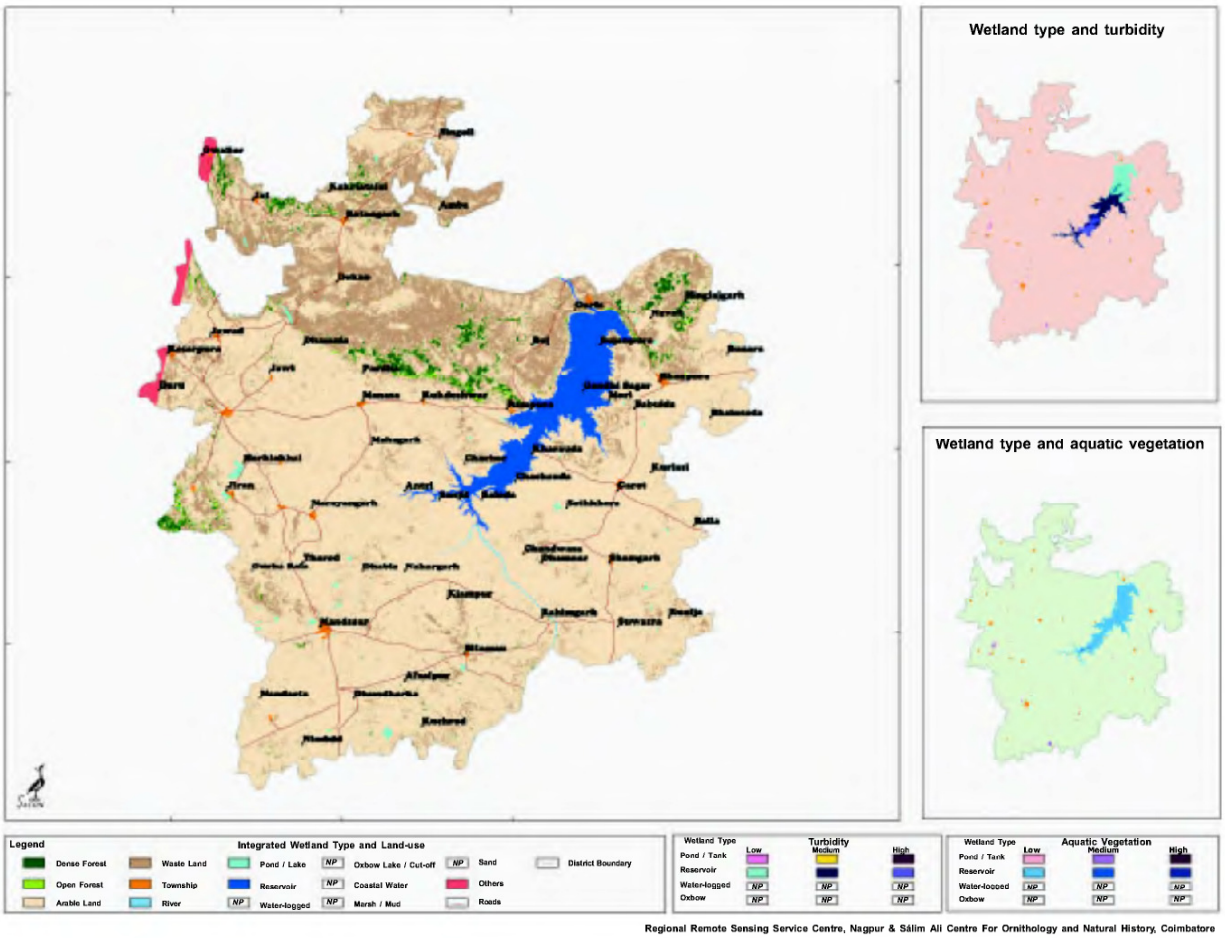


Fig. 9.12. Land use and wetland categories in the district of Mandsaur

Table 9.16. Area under different land use and wetland categories in the district of Mandsaur

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	176.77	1.80
Forest-open	28.97	0.29
Arable land	7,448.75	75.65
Wasteland	1,683.39	17.10
Wetland- ponds/lakes/tanks	27.02	0.27
Wetland-reservoirs	367.25	3.73
Township	39.45	0.40
Other water body/river	14.06	0.14
Others (area for which satellite data not available)	60.09	0.61

Table 9.17. Area under different turbidity classes in the district of Mandsaur

Turbidity class	Area (sq km)	% of total wetland area
Low	160.17	40.69
Moderate	47.07	11.96
High	186.41	47.35

Table 9.18. Seasonal pattern of wetland areas in the district of Mandsaur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs	366.89	256.22	110.67	
Ponds/lakes/tanks	21.28	4.46	16.82	
Total	388.17	260.68	127.49	32.84

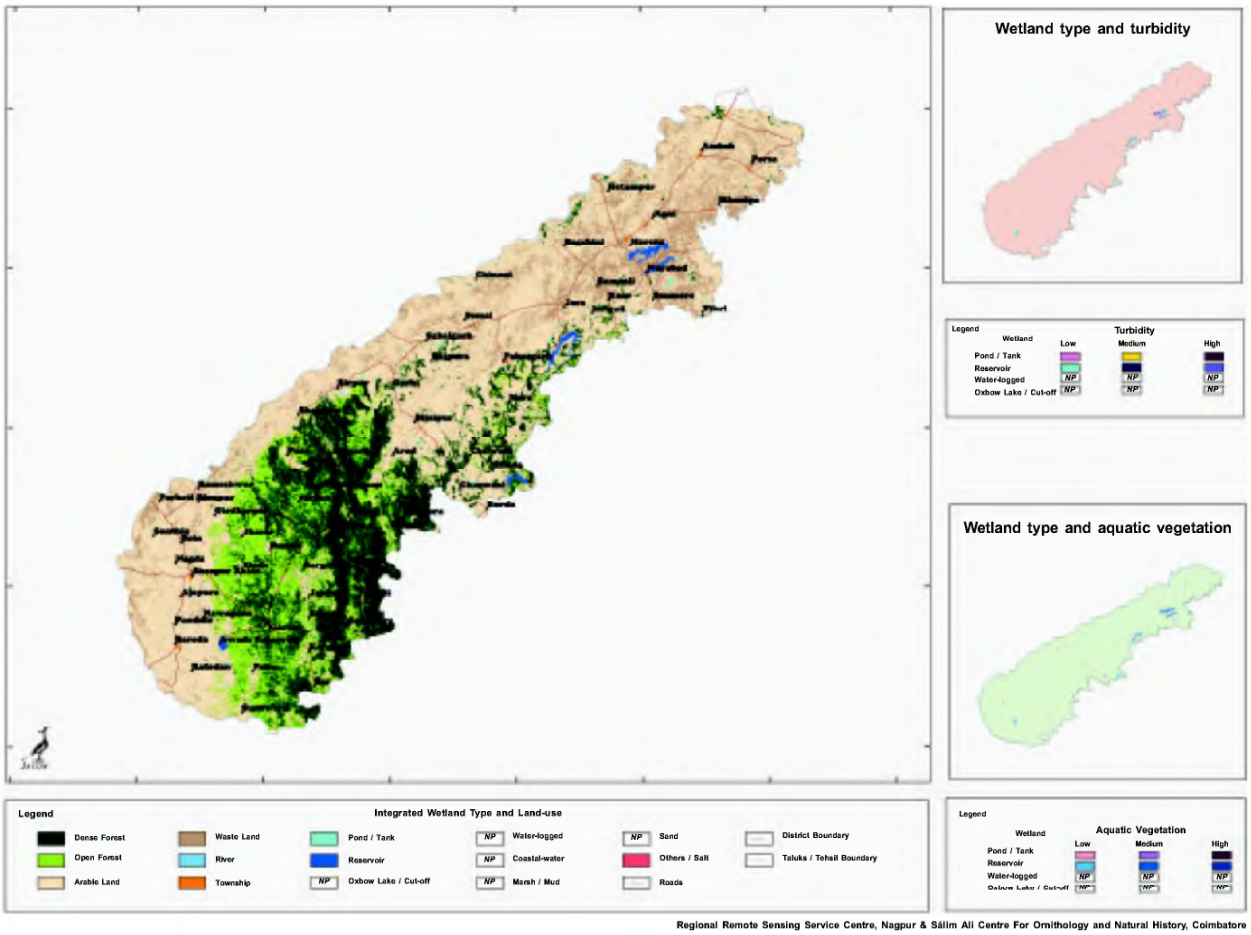


Fig. 9.13. Land use and wetland categories in the district of Morena

Table 9.19. Area under differentt land use and wetland categories in the district of Morena

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	2,354.88	20.11
Forest-open	1,400.97	11.96
Arable land	6,096.91	52.06
Wasteland	1,656.35	14.14
Wetland-ponds/lakes/tanks	19.65	0.17
Wetland-reservoirs	61.08	0.52
Township	14.13	0.12
Other water body/river	54.62	0.47
Others (area for which satellite data not available)	51.60	0.44

Table 9.20. Area under different turbidity classes in the district of Morena

Turbidity class	Area (sq km)	% of total wetland area
Low	21.79	26.99
Moderate	54.55	67.57
High	4.39	5.43

Table 9.21. Seasonal pattern of wetland areas in the district of Morena

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs	45.22	11.18	34.04	
Ponds/ lakes/ tanks	8.65	1.11	7.54	
Total	53.87	12.29	41.58	77.19

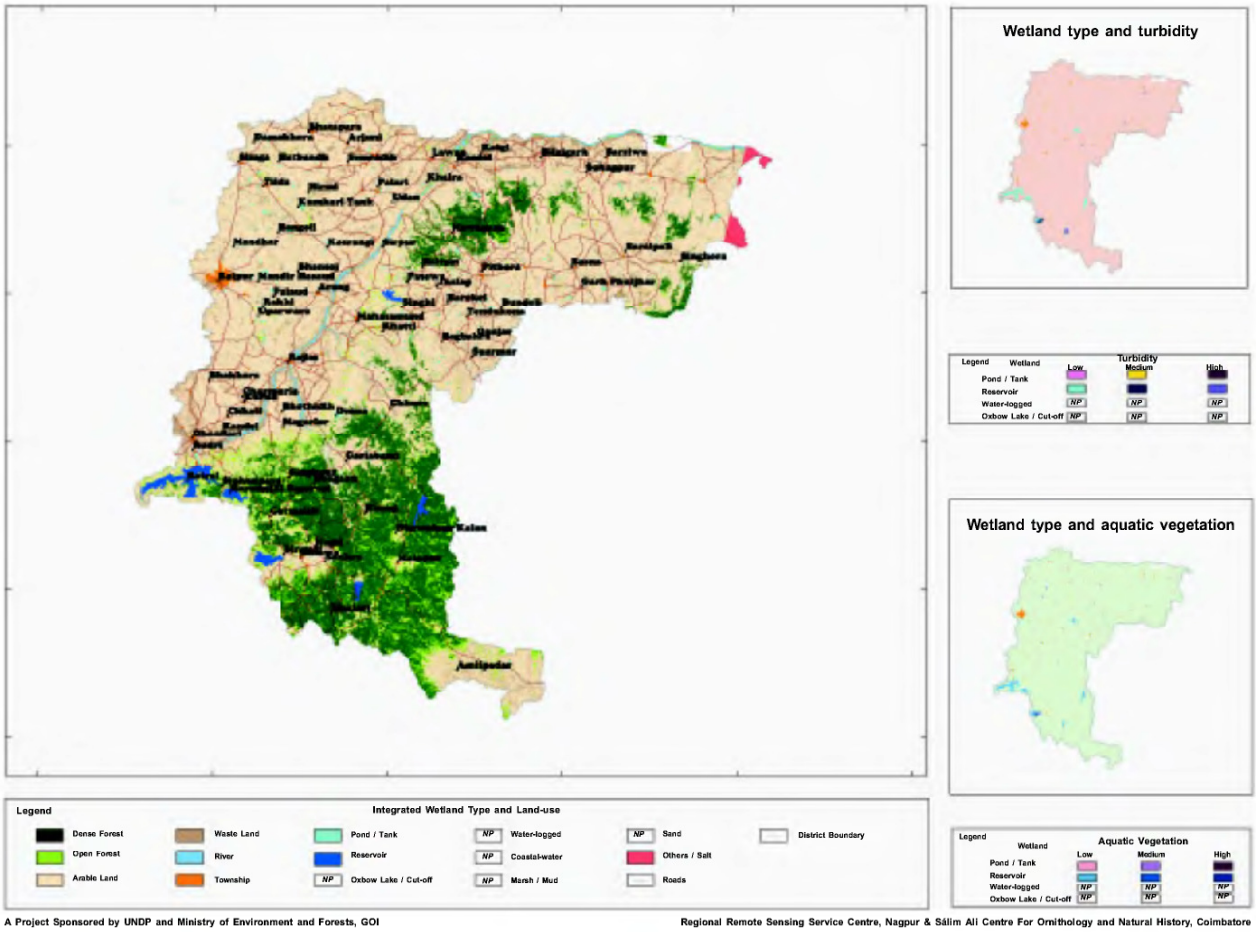


Fig. 9.14. Land use and wetland categories in the district of Raipur

Table 9.22. Area under different land use and wetland categories in the district of Raipur

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	3,877.95	17.01
Forest-open	1,310.05	5.75
Arable land	14,487.82	63.56
Wasteland	2,290.81	10.05
Wetland-ponds/lakes/tanks	142.98	0.63
Wetland-reservoirs	201.97	0.89
Township	139.76	0.61
Other water body /river	244.46	1.07
Others (area for which satellite data not available)	97.27	0.43

Table 9.23. Area under different turbidity classes in the district of Raipur

Turbidity class	Area (sq km)	% of total wetland area
Low	238.02	68.92
Moderate	83.41	24.15
High	23.92	6.93

Table 9.24. Seasonal pattern of wetland areas in the district of Raipur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	82.03	26.74	55.29	
Reservoirs	13.23	7.42	5.81	
Total	95.26	34.16	61.10	64.14

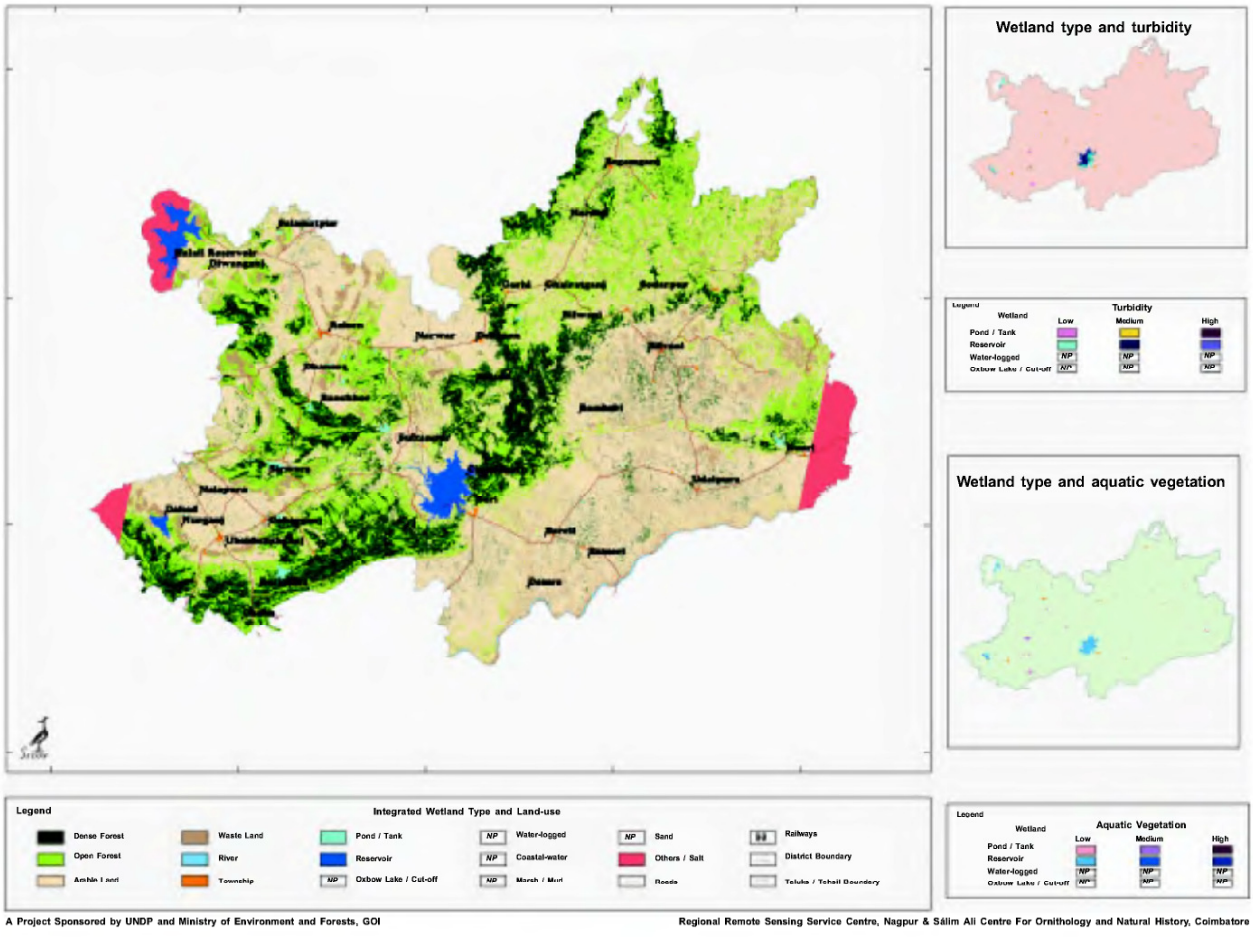


Fig. 9.15. Land use and wetland categories in the district of Raisen

Table 9.25. Area under different land use and wetland categories in the district of Raisen

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	1,258.92	14.66
Forest-open	1,722.36	20.06
Arable land	4,491.68	52.30
Wasteland	680.52	7.92
Wetland-ponds/lakes/tanks	22.40	0.26
Wetland-reservoirs	118.69	1.38
Township	13.99	0.16
Other water body/river	21.13	0.25
Others (area for which satellite data not available)	258.01	3.00

Table 9.26. Area under different turbidity classes in the district of Raisen

Turbidity class	Area (sq km)	% of total wetland area
Low	47.16	44.73
Moderate	50.5	47.9
High	7.77	7.37

Table 9.27. Seasonal pattern of wetland areas in the district of Raisen

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs	74.00	42.53	31.47	
Ponds/lakes/tanks	19.77	6.00	13.77	
Total	93.77	48.53	45.24	48.25

Table 9.28. Summary of wetland wise turbidity and aquatic vegetation statistics of the districts of Madhya Pradesh

Wetland class	No. of wetlands	Area sq km	% of wetland type area					
			Turbidity levels			Aquatic vegetation		
			Low	Medium	High	Low	Medium	High
Bilaspur								
Ponds/lakes/tanks	1,703	121.79	22.3	35.03	42.54	10.8	5.07	83.99
Reservoirs	4	229.73	69.26	25.99	4.74	95.57	2.36	2.06
Datia								
Ponds/lakes/tanks	22	5.1	19.54	69.05	11.41	3.99	19.25	76.75
Reservoirs	1	121	65.33	31.88	2.79	98.82	1.03	0.16
Durg								
Ponds/lakes/tanks	1,232	104.44	39.17	23.02	37.81	16.8	6.35	76.85
Reservoirs	4	176.56	1.8	6.57	91.63	94.97	3.31	1.73
Jabalpur								
Ponds/lakes/tanks	368	61.38	4.72	22.43	72.85	85.47	8.98	5.55
Reservoirs	2	233.78	16.27	49.81	33.91	99.29	0.34	0.37
Mandsaur								
Ponds/lakes/tanks	104	26.73	4.14	17.94	77.92	81.45	10.34	8.21
Reservoirs	1	366.89	45.13	12.53	42.34	99.05	0.63	0.32
Morena								
Ponds/lakes/tanks	70	19.65	63.58	32.96	3.47	29.53	10.07	60.4
Reservoirs	5	61.08	6.07	25.08	68.85	21.87	25.96	52.17
Raipur								
Ponds/lakes/tanks	1,176	143.6	40.97	47.56	11.47	27.05	67.34	5.61
Reservoirs	6	201.75	84.13	12.18	3.69	5.75	6.24	88.01
Raisen								
Ponds/lakes/tanks	66	22.4	53.87	32.51	13.62	11.6	16.36	72.03
Reservoirs	3	83.02	5.68	48.03	46.29	4.49	1.34	94.16

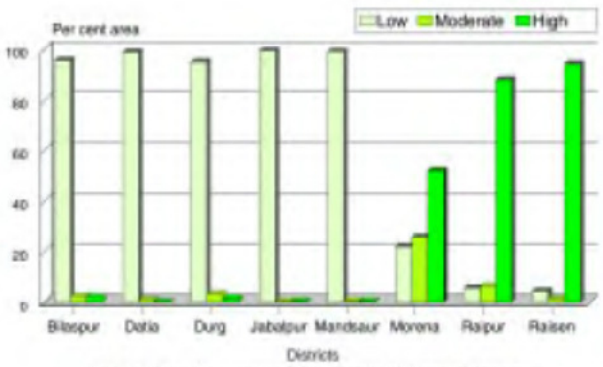


Fig. 9.17. Aquatic vegetation of reservoirs in Madhya Pradesh

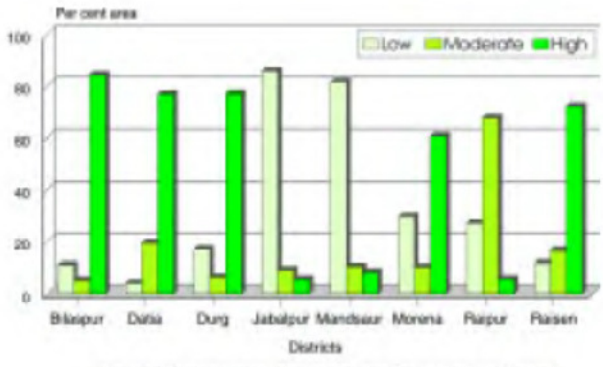


Fig. 9.18. Aquatic vegetation of ponds/lakes in Madhya Pradesh

Table 9.30. List of endemic aquatic plants of Madhya Pradesh

S. #	Species	Family
1	*Tonningia cucullata*	Commelinaceae
2	*Cyathocline jacquemontii*	Asteraceae
3	*Eriocaulon breviscapum*	Eriocaulaceae
4	*Eriocaulon cuspidatum*	Eriocaulaceae
5	*Eriocaulon duthiei*	Eriocaulaceae
6	*Eriocaulon martianum*	Eriocaulaceae
7	*Eriocaulon parviflorum*	Eriocaulaceae
8	*Fuirena wallichiana*	Cyperaceae
9	*Hoppea dichotoma*	Gentianaceae
10	*Hygrophila serpylla*	Acanthaceae

S. #	Species	Family
11	*Myriophyllum oliganthum*	Haloragaceae
12	*Najas kurziana*	Najadaceae
13	*Najas marina ssp.*	Najadaceae
14	*Paspalum canarae*	Poaceae
15	*Podostemum barberi*	Podostemaceae
16	*Ramphicarpa longiflora*	Scrophulariaceae
17	*Rotala illecebroides*	Lythraceae
18	*Utricularia praeterita*	Lentibulariaceae
19	*Wiesneria triandra*	Alismataceae
20	*Sesbania procumbens*	Fabaceae

Table 9. 31. Threatened freshwater fishes reported in Madhya Pradesh and Chhattisgarh

S.No	Species	Status
1	*Anguilla bengalensis*	EN
2	*Hypselobarbus curmuca*	EN
3	*Pseudeutropius atherinoides*	EN
4	*Ompok bimaculatus*	EN
5	*Anabas testudineus*	VU
6	*Bagarius bagarius*	VU
7	*Barbodes sarana*	VU
8	*Catla catla*	VU
9	*Cirrhinus reba*	VU
10	*Clarias batrachus*	VU
11	*Garra gotyla gotyla*	VU
12	*Heteropneustes fossilis*	VU
13	*Labeo dero*	VU
14	*Mystus vittatus*	VU
15	*Osteobrama cotio*	VU
16	*Puntius chola*	VU

EN=Endangered; VU=Vulnerable

Birds

In the 30 wetlands in Madhya Pradesh and 18 in Chhattisgarh surveyed, 85,083 birds of 99 species were recorded of which two were mostly terrestrial. Seven wetlands in Madhya Pradesh had no birds as they were dry because of the drought during the year. The highest number of species (60) and birds (26,806) were found at Gandhisagar dam. The only other wetland which had >20,000 birds is Halali dam. Five wetlands had 40 or more species while eight had 25 to 40 species and only one had < 10 species (Table 9.33).

About 40 % of the birds were ducks/teals (Anatidae). The most abundant was the Coot (19,269) followed by the Pintail (8,271), Red-crested Pochard (8,213), Common Teal (5,361), and Ruff (5,352). All are migratory. There were nine more species which had more than 1,000 birds.

Distribution of wetland birds shows that, most of them, except the Coot, were found only in a few wetlands. The most widespread species were the Little Cormorant found at 36 wetlands followed by the Redwattled Lapwing (32 wetlands), Pond Heron (30 wetlands), Coot (28 wetlands), Little Egret (27 wetlands) and Grey Heron (25 wetlands). Altogether, 12 species were found in more than 20 wetlands and 35 species in fewer than five wetlands. More widespread and common species are resident as found in other states. Many species are confined to a few wetlands mainly because of the habitat specificity.

Five globally Threatened species with 381 birds and, six Near Threatened species with 295 birds were found during the survey. The number of wetlands where they were sighted and the frequency of their sightings were quite limited (Table 9.34).

Environmental contamination

Ninety fishes comprising 12 species from 13 wetlands from Madhya Pradesh were studied. However, to have uniformity and comparison with other states, information on only five species of fishes from seven wetlands are discussed here.

Heavy metals

On an average, among the wetlands, Ramsagar (5.66±1.38 ppm) of Datia district and Barua reservoir (5.65±0.97 ppm) of Raipur district recorded the highest concentrations of lead (Fig. 9.19). Gandhisagar recorded the maximum concentration of chromium (2.83±1.64 ppm) which is higher than the level recorded in other states. Although detectable concentrations of zinc and cadmium were recorded, they fall within the permissible limits.

On an average, among the species, *Cyprinus carpio* ranked high in the concentration of lead (6.58±2.30 ppm) and chromium (1.38±1.22 ppm) (Fig. 9.20). Although significantly varying levels ($P<0.005$) of lead, zinc and copper were recorded in other species, the levels were not harmful at least for the time being.

Table 9.32. Status of freshwater turtles in Madhya Pradesh and Chhattisgarh

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
	Madhya Pradesh			
1	*Aspideretes gangeticus*	VU	-	I
2	*Aspideretes hurum*	VU	I	I
3	*Chitra indica*	EN	-	IV
4	*Hardella thurjii*	VU	-	-
5	*Kachuga dhongoka*	EN	-	-
6	*Kachuga kachuga*	CR	-	I
7	*Kachuga tecta*	NT	I	I
8	*Kachuga tentoria*	NT	-	-
9	*Lissemys punctata*	NT	II	I
	Chhattisgarh			
10	*Aspideretes gangeticus*	VU	-	I
11	*Aspideretes leithii*	VU	-	IV
12	*Kachuga tecta*	NT	I	I
13	*Kachuga tentoria*	NT	-	-
14	*Lissemys punctata*	NT	II	I

VU=Vulnerable; EN=Endangered; CR=Critical; NT=Near Threatened

Pesticides

The maximum load of total organochlorine residues was detected in Narmada (0.217ppm) of Bhopal and Gandhisagar reservoir (0.045 ppm) of Mandsaur district, whereas the minimum concentrations were in Tighara reservoir (0.013 ppm) followed by Gohad talab (0.006 ppm) of Bhind district (Fig. 9.21).

Among the various species of fishes analyzed, *Cyprinus carpio* (0.109 ppm) recorded the maximum load of total organochlorine residues followed by *Cirrhinus mrigala* (0.089 ppm) and *Labeo rohita* (0.06 ppm). *Notopterus notopterus* was the least (0.038 ppm) contaminated species (Fig. 9.22).

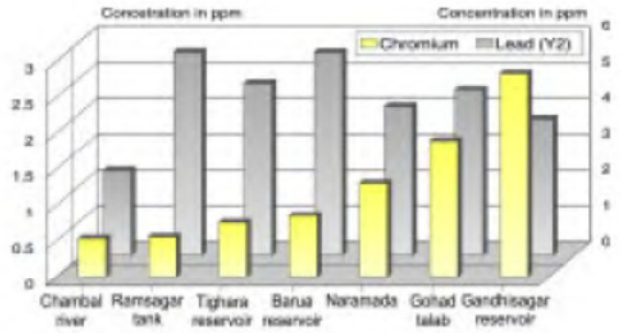


Fig. 9.19. Lead and Chromium contamination among select wetlands of Madhya Pradesh

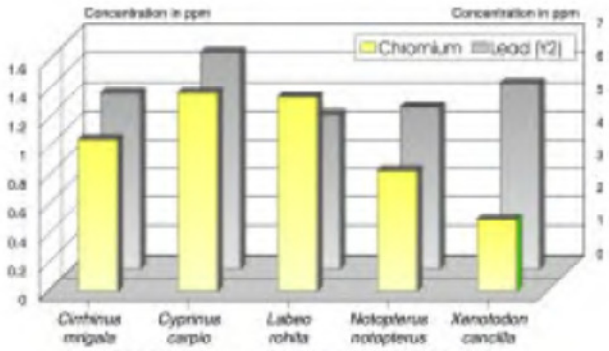


Fig. 9.20. Lead and Chromium contamination among fishes in Madhya Pradesh

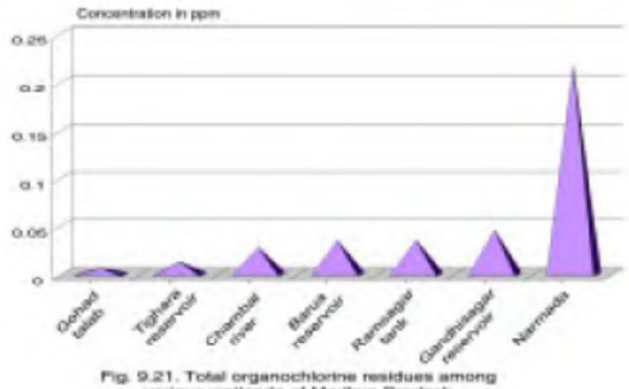


Fig. 9.21. Total organochlorine residues among various wetlands of Madhya Pradesh

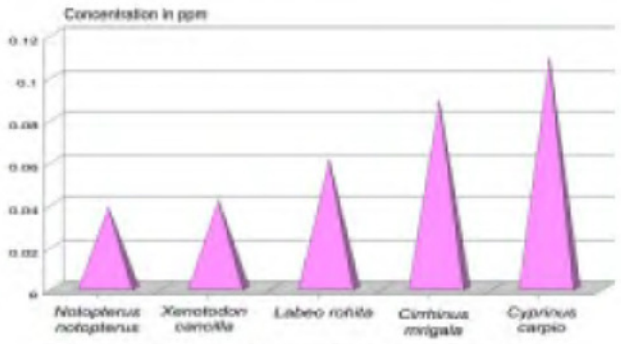


Fig. 9.22. Total organochlorine residues among various species of fishes in Madhya Pradesh

Table 9.33. Major wetlands of Madhya Pradesh & Chhattisgarh with species and number of birds

S.No	Name of the wetland	# of spp	# of birds
	Madhya Pradesh		
1	Barrusot	43	1,051
2	Barua reservoir	34	4,568
3	Besala tank	24	184
4	Chicklod	26	671
5	Gandhisagar dam	60	26,806
6	Gohad talab	19	666
7	Govindgarh	42	580
8	Halali dam	31	23,062
9	Icchawar lake	26	1,571
10	Indergarh dam	19	1,158
11	Kolar barrage	18	2,725
12	Kothadi tank	13	301
13	Kotri tank	27	1,230
14	Mod sagar	35	1,678
15	Nai talab	24	1,344
16	Phoolgavadi talab	22	677
17	Ramaowa	8	151
18	Sanwat tank	30	677
19	Sirpur talab	12	518
20	Tawa reservoir	43	3,554
21	Tighra	31	2,069
22	Upper lake	41	7,379
23	Yashwant sagar	11	127
	Chhattisgarh		
1	Bijapur tank	2	7
2	Bolar bandh	17	317
3	Deogaon	23	196
4	Dongam dam	8	65
5	Dugoli talab	10	69
6	Gajgidhni tank	25	649
7	Gangrel	7	57
8	Ghongha reservoir	13	80
9	Kuenar tank	2	8
10	Kutru	5	68
11	Kutru Irrigation tank	7	45
12	Madamsilli	9	55
13	Maniyari reservoir	10	51
14	Phersegarh	5	32
15	Pithapur dam	10	51
16	Rudri baraj	10	51
17	Sondur	10	68
18	Tappa tank	25	467

Table 9.34. Frequency of the sightings of Threatened and Near Threatened birds in Madhya Pradesh and Chhattisgarh

S#	Species	Status of species	No. of wetlands	Total birds sighed
1	Spotbilled Pelican	T	1	3
2	Whitebacked Vulture	T	4	186
3	Longbilled Vulture	T	3	122
4	Greater Spotted Eagle	T	1	4
5	Sarus Crane	T	12	66
6	Darter	NT	7	56
7	Painted Stork	NT	5	72
8	White Ibis	NT	5	50
9	White-eyed Pochard	NT	1	100
10	King Vulture	NT	1	12
11	Blackbellied Tern	NT	2	5

T=Threatened; NT=Near Threatened

The variations in organochlorine residues among the wetlands were not significant (P>0.05). Of the various pesticide residues analyzed, DDT was recorded in 93 % of the fishes sampled. It may be noted that reduction in fish harvest in the scale of 10-50% has been reported in most of the wetlands of Madhya Pradesh over the past five-six years.

Suitability for human consumption

Of all the metals, lead levels recorded in *Cyprinus carpio* (0.24 mg) are higher than the permissible levels stipulated by UN Committee (WHO, 1993) ie. 0.21 mg for 60 kg adult daily. On regular consumption, this may create adverse impacts on the vital organs such as liver and kidney.

There seems to be less organochlorine input into the aquatic environment. No data on organophosphorus, carbamate and other pesticides are available. The recorded concentrations of organochlorine are less than the levels expected to produce ecological risk to fish and avian wildlife (USEPA, 1980). However, it may be noted that, the point sources of industrial pollution and city sewage intrusion in most of the wetlands as they exist today enhance these levels. It is also reported that the pesticide consumption in Madhya Pradesh is

about 1,544 mt per year. Moreover, it is alarming to note that about 21.7 % of the bovine milk tested in Madhya Pradesh exceeded the tolerance limits for DDT.

Based on the present data, it is proposed that Ramsagar tank and Barua reservoir require continuous monitoring since the fishes collected from these wetlands show higher concentration of metals.

Socioeconomic values

Most of the wetlands surveyed are used primarily for irrigation and also for fishing. With the technical cooperation of the State Fisheries Department, the members of the fisheries cooperative are allowed to do commercial fishing operations.

Nine types of major uses were recorded in the wetlands surveyed, those with six and above uses were considered as of high use, with four and five uses as of medium and less than four as of low use. The high biodiversity areas (I & II rank) have high or medium socioeconomic uses (Table 9.35).

Prioritization of wetlands

Out of the 30 wetlands studied in Madhya Pradesh, seven had no birds as they were dry, being affected by the severe drought during the year. However, they were also considered in the list, based on the earlier records.

The wetlands are arranged in the order of ranks they received (Table 9.35). The first six came in first rank considering the total rating and size of the wetlands, as done in the other states. The top ranking sites are Gandhisagar dam, Sanwat tank, Upper lake, Halali dam, Govindgarh and Mod sagar. The last two were ranked top because of the large size. The next six, namely Barua reservoir, Tawa reservoir, Barrusot, Nai talab, Yashwant sagar and Phoolgavadi talab are in the second rank; here also the last three came up because of the size. Similarly, another six are in the third rank with four being large and the rest in the fourth rank. The top ranking six sites qualify to be declared as Ramsar sites.

Table 9.35. Prioritized list of the major wetlands of Madhya Pradesh and Chhattisgarh

S.#	Site	Rank	Use
	Madhya Pradesh		
1	Gandhisagar dam	1	H
2	Sanwat tank	1	DD
3	Upper lake	1	H
4	Halali dam	1	H
5	Govindgarh	1	M
6	Mod sagar	1	M
7	Barua reservoir	2	H
8	Tawa reservoir	2	M
9	Barrusot	2	M
10	Nai talab	2	M
11	Yashwant sagar	2	M
12	Phoolgavadi talab	2	M
13	Chicklod	3	H
14	Besala tank	3	DD
15	Indergarh dam	3	DD
16	Gohad talab	3	H
17	Sirpur talab	3	DD
18	Tighra	3	L
19	Kolar barrage	4	H
20	Icchawar lake	4	H
21	Kotri tank	4	DD
22	Kothadi tank	4	DD
23	Ramaowa	4	M
24	Arnia	DD	M
25	Chandpata	DD	L
26	Chhonda	DD	DD
27	Gambhir	DD	M
28	Narmada	DD	DD
29	Saiheb Khedi	DD	H
30	Undasa	DD	M
	Chhattisgarh	-	**DD**
1	Tappa tank	1	H
2	Deogaon	1	M
3	Gajgidhni tank	1	H
4	Bolar bandh	1	M
5	Ghongha reservoir	1	L
6	Maniyari reservoir	2	H
7	Gangrel	2	M
8	Dugoli talab	2	L
9	Kutru	2	L
10	Dongam dam	2	L
11	Kuenar tank	2	DD
12	Phersegarh	3	DD
13	Madamsilli	3	M
14	Pithapur dam	3	L
15	Sondur	3	M
16	Bijapur tank	3	DD
17	Kutru irrigation tank	3	DD
18	Rudri baraj	3	M

DD=Data deficient

In the case of Chhattisgarh the ratings with regard to birds was very poor in most of the wetlands. However, five wetlands having the highest number of species and birds were considered in the first rank, namely Tappa tank, Deogaon, Gajgidhni tank, Bolar bandh and Ghongha reservoir. For the remaining wetlands, those with larger size were taken into the second rank and the rest into third rank (Table 9.35).

In Madhya Pradesh, many of the wetlands surveyed, are protected partially or fully. Out of the first 12 wetlands, five were fully protected and one partly while the rest are not protected. The wetland with high biodiversity values, although protected, have high socioeconomic use values and hence, conservation measures have to be taken up only after detailed study and participation of the stakeholders. In the case of Chhattisgarh, none of the sites is protected and hence, immediate attention is needed to protect the top ranking ones with high or medium use as Community Reserves and the five with low use as Protected Areas.

It may be noted that many of the important wetlands were totally dry or had very little water because of drought and hence, have not figured in the prioritized list. These areas need to be surveyed/ resurveyed for including these in the priority list. Distribution of the prioritized wetlands along with other conservation sites are given in Fig. 9.23.

Summary

- The undivided Madhya Pradesh, during 1992-93, had 407 wetlands of the size 56.25 ha and above, covering an area of 2,941.18 sq km (SAC, 1998).

- In the eight districts studied by SACON recently, the number of wetlands of the size 2 ha and above is estimated at 4,767 covering an area of 1,978.90 sq km.

- Reservoirs have comparatively low turbidity while the ponds/ lakes had mostly either moderate or high turbidity.

- Density of vegetation, as per the satellite imageries, was low in the reservoirs of five districts, whereas it was moderate in one and high in two districts. In the ponds/ lakes, the vegetation was dense in five districts, moderate in one and low in two districts.

- Madhya Pradesh and Chhattisgarh together, had 20 species of endemic aquatic plants; four Endangered and 12 Vulnerable species of fishes; and two Endangered, one Critically Endangered, four Vulnerable and three Near Threatened species of freshwater turtles.

- In the 30 wetlands in Madhya Pradesh and 18 in Chhattisgarh surveyed, 85,083 birds belonging to 99 species were recorded.

- Five globally Threatened species with 381 birds and six Near Threatened species with 295 birds were recorded.

- The most abundant waterfowl species was the Common Coot, followed by the Pintail, Red-crested Pochard, Common Teal and Ruff.

- Ninety fishes comprising 5 species from 7 wetlands were analyzed for pesticides and heavy metals.

- Ramsagar of Datia district and Barua reservoir of Raipur district had high concentration of lead.
- DDT was present in 93% of the fishes analysed.
- Thirty wetlands in Madhya Pradesh and 18 in Chhattisgarh were prioritized.
- Six wetlands in Madhya Pradesh qualify to be declared as Ramsar sites.



K. Ramachandran

White Ibis

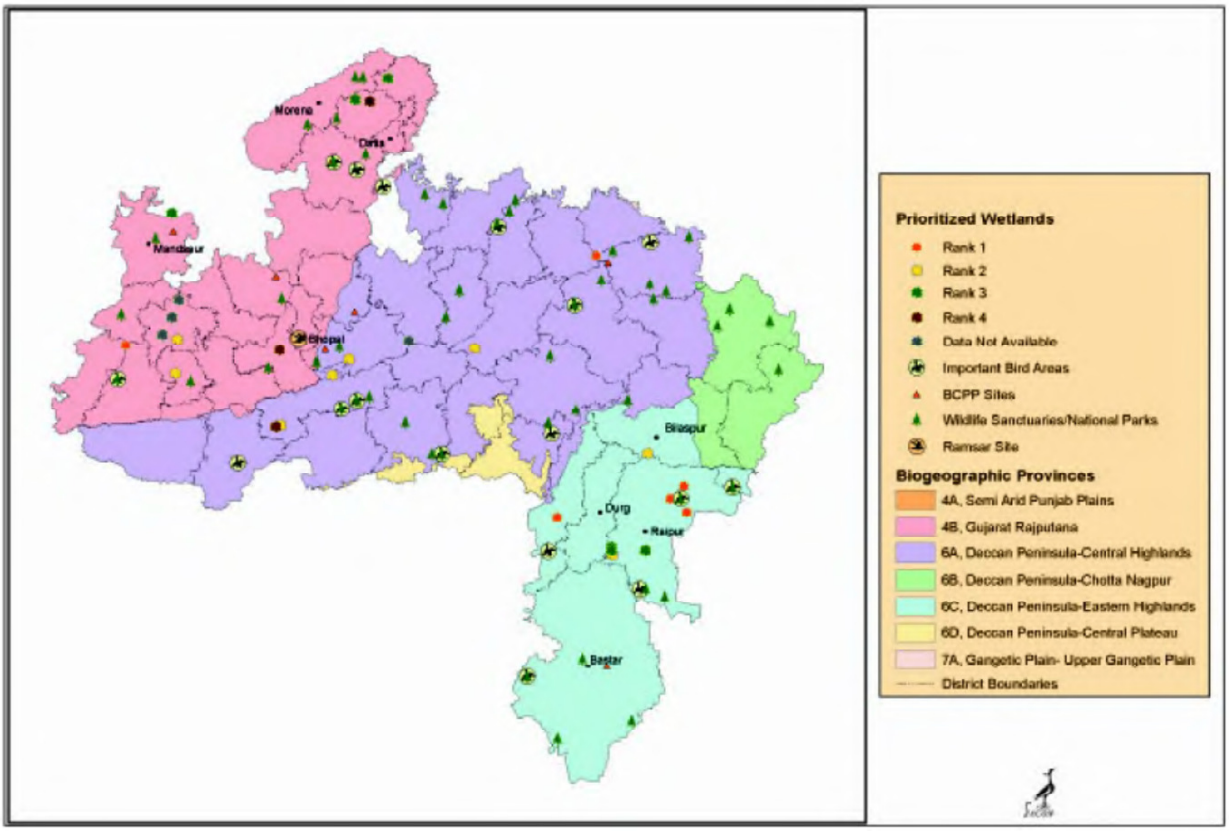


Fig. 9.23. Prioritized wetlands and other conservation areas in Madhya Pradesh (undivided)

Threats to wetlands

Dumping of toxic wastes from hospitals



Ameen Ahmed

Industrial effluents



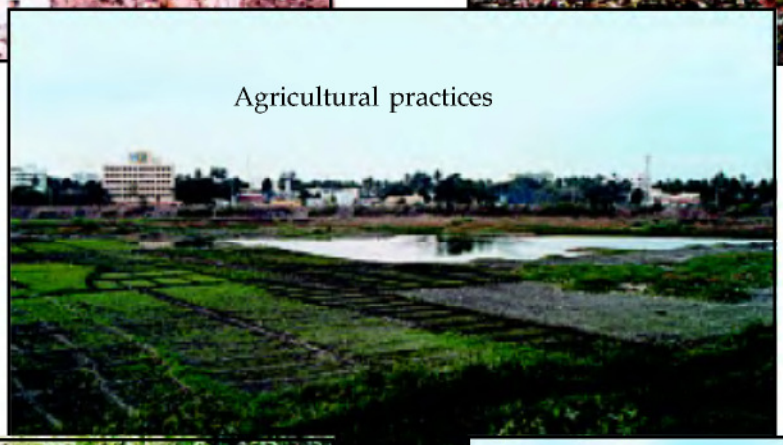
Bharathidasan

Garbage dumping



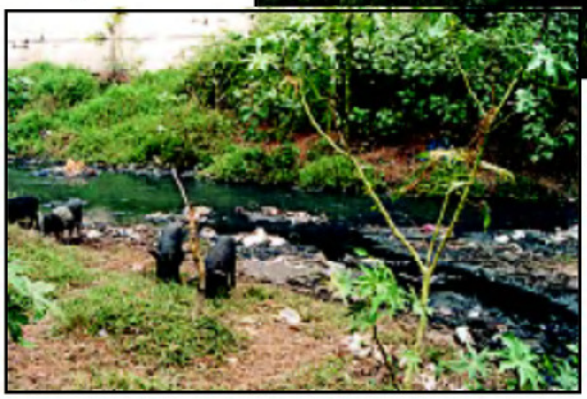
Bharathidasan

Agricultural practices



Bharathidasan

Sewage



Bharathidasan

Human settlement



Bharathidasan

MAHARASHTRA

Maharashtra, literally meaning the great state, with its rich biodiversity, is a huge irregular triangle with its base facing the Arabian sea. Physiographically the state may be divided into four natural divisions - the coastal strip (the Konkan), the Sahyadri or the Western Ghats, the Deccan plateau, and the forests of north Maharashtra. The Konkan consisting of undulating coastal low lands is 720 km long and 30-80 km broad. North Konkan has vast stretch of hinterlands. The Western Ghats run almost parallel to the sea coast. The average height of the Sahyadri is 1,200 meters.



Maharashtra receives its rainfall mainly from south-west monsoon, and it varies considerably in the coastal region (2000 mm), scanty rains in rain shadow areas in the central part (500 mm) to moderate rains in eastern parts (1,000 mm) of the state. The average temperature varies from 20.1 to 33.3°C.

State at a glance	
State capital	Mumbai
Area	3,07,713 sq km
Population (2001)	96,752,247
Total number of districts	35
Major rivers	Tapi, Godavari, Krishna, Bhima and Wardha
Total forest area	53,660 sq km
Population density (2001)	314/sq km
Ramsar sites	Nil
Proposed Ramsar sites	11
Total sites proposed for conservation	33

Status of wetlands

The routine land use statistics of the state does not indicate wetlands as a separate category (Table 10.1). However, 0.93% of the land area in Maharashtra is covered by wetlands of the size 56.25 ha and above (SAC, 1998). The total number of wetlands was estimated at 609 which cover an area of 2,849.42 sq km for the entire state (Table 10.2). However, the study conductd by SACON in seven districts shows that there are 1,874 wetlands of the size 2 ha and above, covering a total of 2,229.96 sq km (Table 10.3).

Table 10.1. Land use pattern in Maharashtra

Land use type	Area in sq km
Total geographic area	3,07,713
Forests	53,660
Not available for cultivation	29,400
Other uncultivated land excluding fallow land	24,510
Fallow land	22,700
Net area sown	1,77,320
Area sown more than once	44,230
Total cropped area	2,21,550
Cultivable area	2,24,530

(Source: www.indiastat.com)

Table 10. 2. Distribution of various categories of inland wetlands in Maharashtra

Inland wetlands	Wetland area (sq km)	No. of wetlands
Lakes/ponds	1.25	1
Reservoirs	1,301.19	26
Tanks	1,540.13	575
Aband. quarries	6.23	6
Ash/cooling pond	0.62	1
Total	2,849.42	609

Source: SAC (1998)

Table 10.3. Types, number and extent (sq km) of wetlands in select districts

Districts	Tanks/ponds/lakes		Reservoir		Total no.	Total area
	No.	Area	No.	Area	of wetlands	of wetlands
Aurangabad	239	61.49	1	399.75	240	461.24
Beed	376	109.13	3	121.39	379	230.51
Nagpur	276	99.60	6	176.67	282	276.28
Nasik	450	94.83	9	194.25	459	289.09
Pune	93	47.68	15	442.67	108	490.35
Satara	154	129.84	4	100.35	158	230.19
Yavatmal	244	91.92	4	160.39	248	252.30
Total	1,832	634.49	42	1,595.47	1874	2,229.96

The spatial distribution of wetlands for the entire state (Fig. 10.1) shows that the wetlands are clumped. Such a clustered distribution of wetlands will have a substantial bearing on the status, distribution and abundance pattern of birds and other fauna and also the flora.

Of the different kinds of wetlands in the state (Table 10.2), tanks/ ponds followed by reservoirs cover a large proportion of the wetlands (SAC, 1998). It may be noted that out of the 609 wetlands, 94% were tanks and only 4% were reservoirs, and that too tanks of the size only above 56.25 ha.

Habitat analyses of wetlands in select districts

In order to obtain a more comprehensive picture on the status of wetlands, as mentioned in the methodology, seven districts, namely Aurangabad, Beed, Nagpur, Nasik, Pune, Satara, and Yavatmal were selected. Area covered by wetlands, other land uses in the catchment areas, vegetation, turbidity, and finally seasonal changes in water levels for each of the seven districts were analysed (Table 10.4-10.24).

Wetlands

Total number of wetlands in the select districts come to 1,874 covering an area of 2,229.96 sq km. The wetland area in terms of the geographical area of the districts varied from 1.82% to 4.52% in Nasik and Aurangabad respectively (Fig. 10.2). Two major categories of wetlands, namely reservoirs and, ponds and lakes were identified in these districts. The former were more in area while the latter much more numerous (Table 10.3).

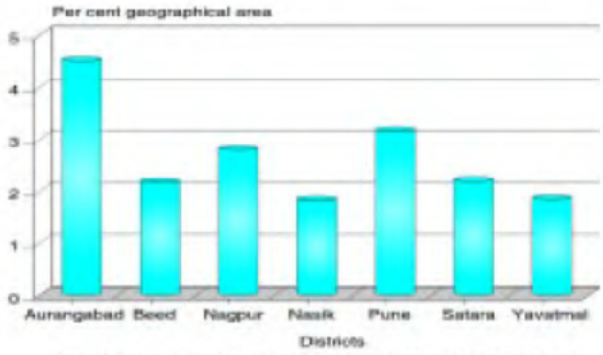


Fig. 10.2. Area under wetlands in select districts of Maharashtra

It is very instructive to learn that wetlands smaller than 56.25 ha are more numerous in all the districts studied (Fig. 10. 4).

Turbidity

Reservoirs of four districts (Beed, Nagpur, Nasik, Satara) had low turbidity while those in three districts, namely Aurangabad, Pune and Yavatmal had moderate, moderate/high and low/moderate levels of turbidity (Fig. 10.5). The ponds/tanks also had low turbidity except in Aurangabad and Beed where it was high (Fig. 10.6).

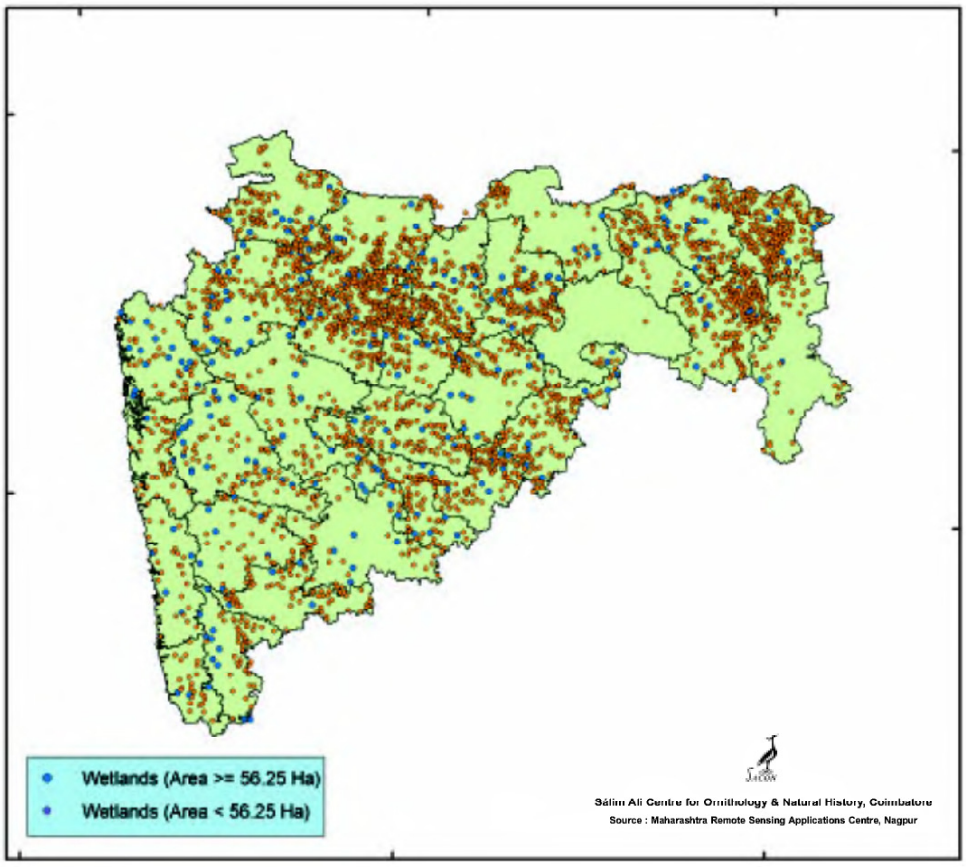


Fig. 10.1. Distribution of wetlands in Maharashtra

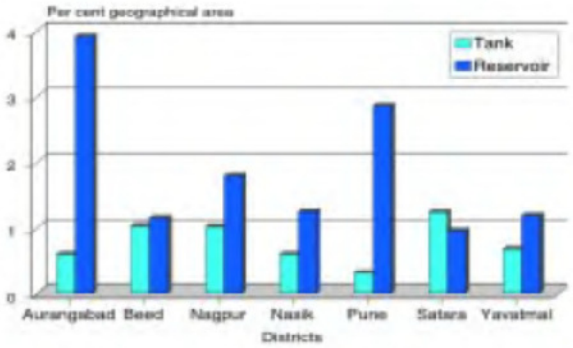


Fig. 10.3. Area under different wetland classes in select districts of Maharashtra

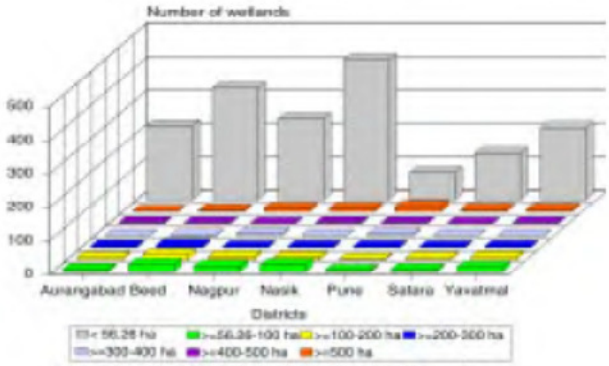


Fig. 10.4. Size class distribution of wetlands in select districts of Maharashtra

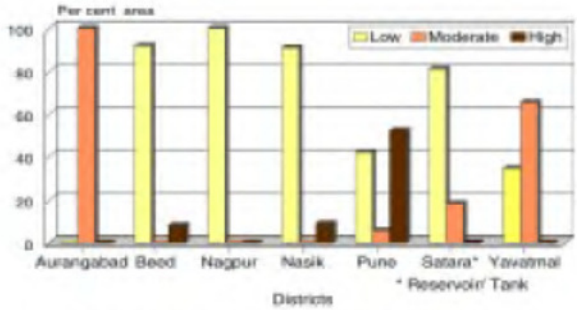


Fig. 10.5. Turbidity pattern of reservoirs in Maharashtra

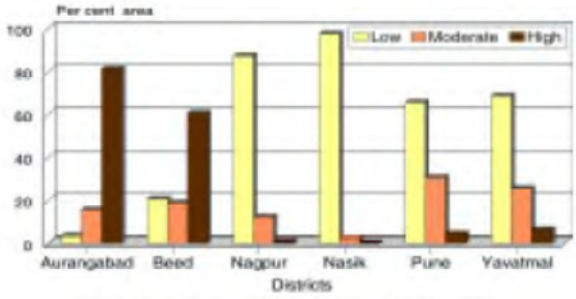


Fig. 10.6. Turbidity pattern of tanks in Maharashtra

Summer recession

The summer recession among the wetlands (Fig. 10.7) varied from 14.87% (Beed) to 86.22% (Nasik). It appears that the degree of recession is smaller in tanks than in reservoirs. Actual use of water in the reservoir may be a better indicator of the extent of recession. Thus, the reservoirs in Pune substantially cater to the generation of power, whereas the reservoirs in Aurangabad are used for irrigation.

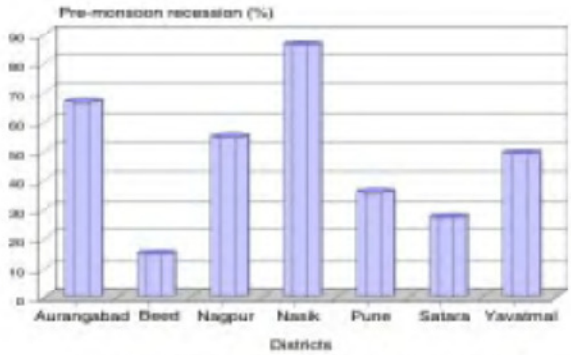


Fig. 10.7. Average summer recession in the wetlands of select districts in Maharashtra

Wetlands and land use pattern in the catchment areas

The integrated land use and wetland maps of all the seven districts show that almost all the wetlands are embedded in agricultural land. The only minor exception is for the reservoirs which have forests, and or agricultural land in their catchment areas (Fig. 10.8-10.14). The district Pune has the largest area under wetlands, while waste land is more in the districts of Satara and Nasik.

Table 10.25. Turbidity pattern in the wetlands of select districts of Maharashtra

District	Area sq km	Per cent area Low	Moderate	High
Aurangabad				
Reservoirs	399.75	0.00	100.00	0.00
Tanks	61.49	3.32	15.31	81.37
Beed				
Reservoirs	121.39	91.97	0.00	8.03
Tanks	109.13	20.61	18.91	60.48
Nagpur				
Reservoirs	176.67	100.00	0.00	0.00
Tanks	99.60	87.33	12.01	0.66
Pune				
Reservoirs	442.67	41.95	5.62	52.43
Tanks	47.67	65.40	30.51	4.09
Yavatmal				
Reservoirs	160.39	34.55	65.45	0.00
Tanks	91.92	68.43	25.44	6.13
Nasik				
Reservoirs	194.25	91.14	0.00	8.86
Tanks	94.83	97.50	2.32	0.18
Satara				
Reservoirs/Tanks	230.19	81.36	18.57	0.07

Table 10.26. Changes in the wetland area (sq km) in select districts of Maharashtra

District	SAC (1992-'93)	SACON (2000-'01)	Variation	%Variation
Aurangabad	321.74	461.24	139.50	43.36
Beed	135.43	230.51	95.08	70.21
Nagpur	204.86	276.28	71.42	34.86
Nasik	211.20	289.09	77.89	3688
Pune	528.67	490.34	-38.33	-7.25
Satara	218.71	230.19	11.48	5.24
Yavatmal	85.58	252.30	166.72	194.82

Temporal changes in wetland cover

A comparison of the wetland cover of 1992-'93 and 2000-'01 for the eight districts studied shows that all the districts, except Pune, had a gain in the wetland area (Fig. 10.15). Pune had a net loss of 7.25% ie. 38.33 sq km (Table 10.26).

Biodiversity

Vegetation

Habitat survey in relation to vegetation cover showed that nine wetlands had mainly shallow water, 15 wetlands with relatively large areas of deep water and most of them with emergent vegetation belts, ranging from nil to a high of 35%. Floating vegetation is either the exotic weed, water hyacinth or indigenous floating plants in 12 sites; covering 0% to 20%. Submerged vegetation was also present in many sites, but to a less extent. There were eight wetlands with open water spreads of over 90%. Satellite imageries show that most of the wetlands have 'low' vegetative cover (Fig. 10.16).

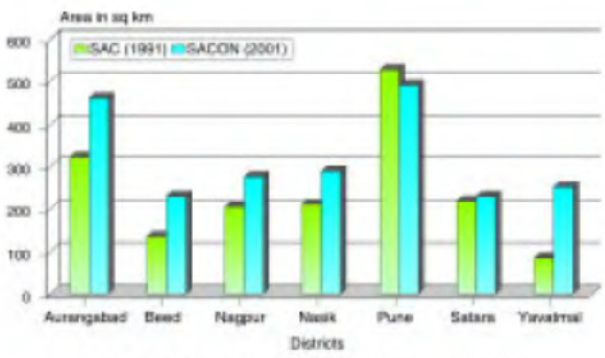


Fig. 10.15. Difference in the total area of wetlands in select districts of Maharashtra

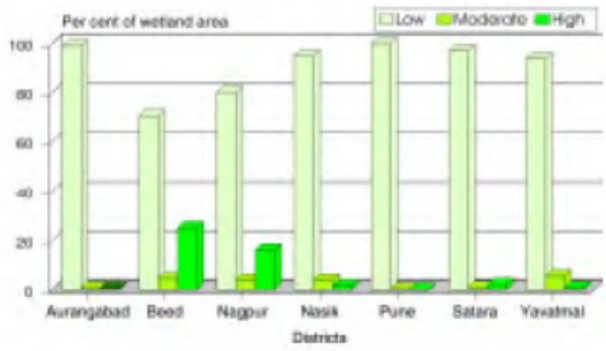


Fig. 10.16. Aquatic vegetation in wetlands of select districts of Maharashtra

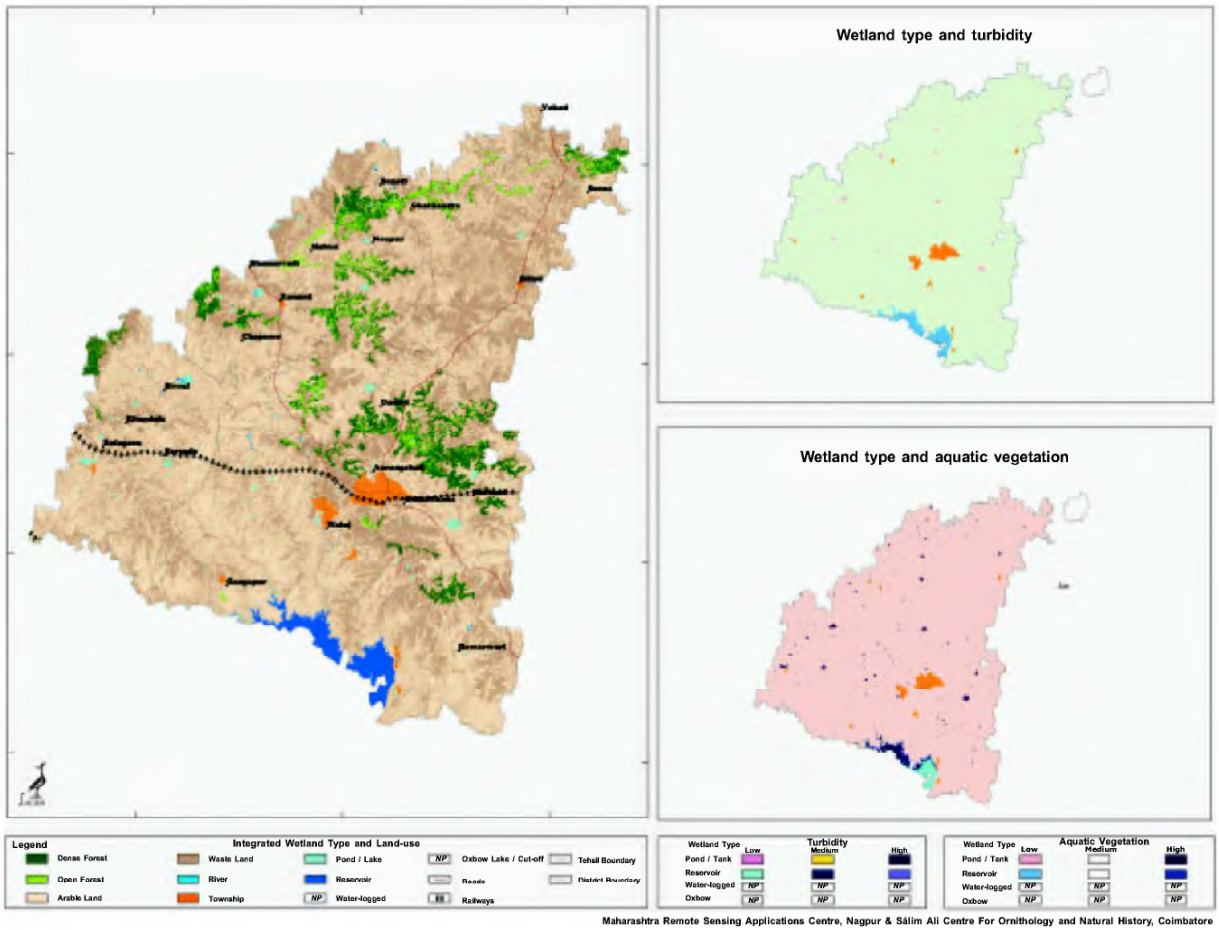


Fig. 10.8. Land use and wetland categories of the district of Aurangabad

Table 10.4. Land use and land cover statistics of the district of Aurangabad

Land use categories	Area (sq km)	Area(%)
Dense forest	460.66	4.51
Open forest	227.57	2.23
Arable land	5,008.46	49.05
Wasteland	4,003.11	39.20
Wetlands (reservoirs & tanks)	461.24	4.52
Others	50.47	0.49

Table 10.5. Area under different turbidity classes in the district of Aurangabad

Turbidity classes	Area (sq km)	Area (%)
Low	242.07	62.35
Moderate	80.12	20.64
High	66.03	17.01

Table 10.6. Seasonal pattern of wetland areas in the district of Aurangabad

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/tanks	51.43	17.18	34.25	66.60

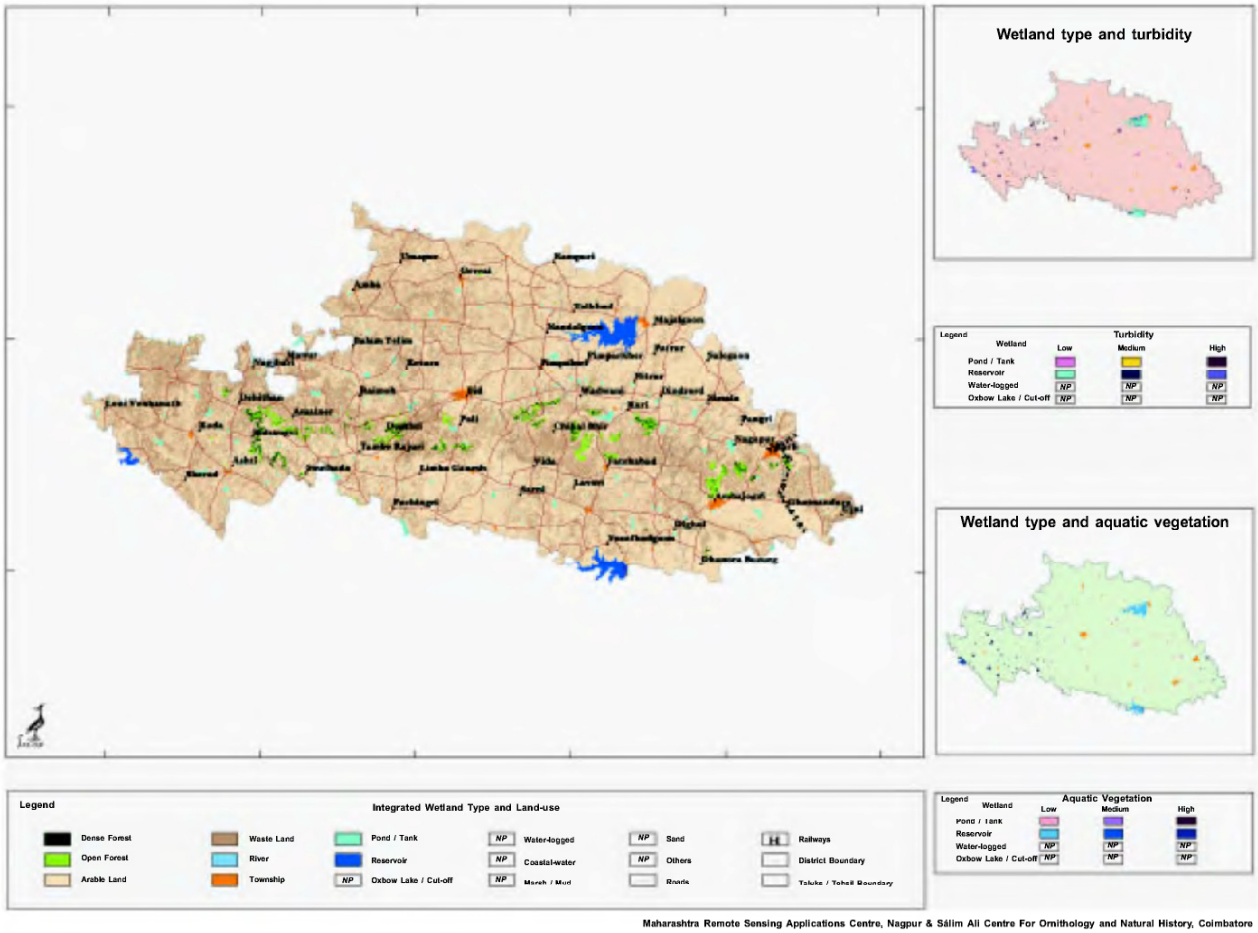


Fig. 10.9. Land use and wetland categories of the district of Beed

Table 10.7. Area under different land use and wetland types in the district of Beed

Land use categories	Area (sq km)	Area(%)
Dense forest	55.68	0.52
Open forest	139.15	1.31
Arable land	7,029.86	66.14
Wasteland	3,125.65	29.41
Wetlands (tanks and reservoirs)	230.51	2.17
Others	48.03	0.45

Table 10.8. Area under different turbidity levels in the district of Beed

Turbidity classes	Area (sq km)	Area (%)
Low	114.29	49.58
Moderate	49.42	21.44
High	66.80	28.98

Table 10.9. Seasonal pattern of wetland areas in the district of Beed

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/tanks	59.92	51.01	8.91	14.87

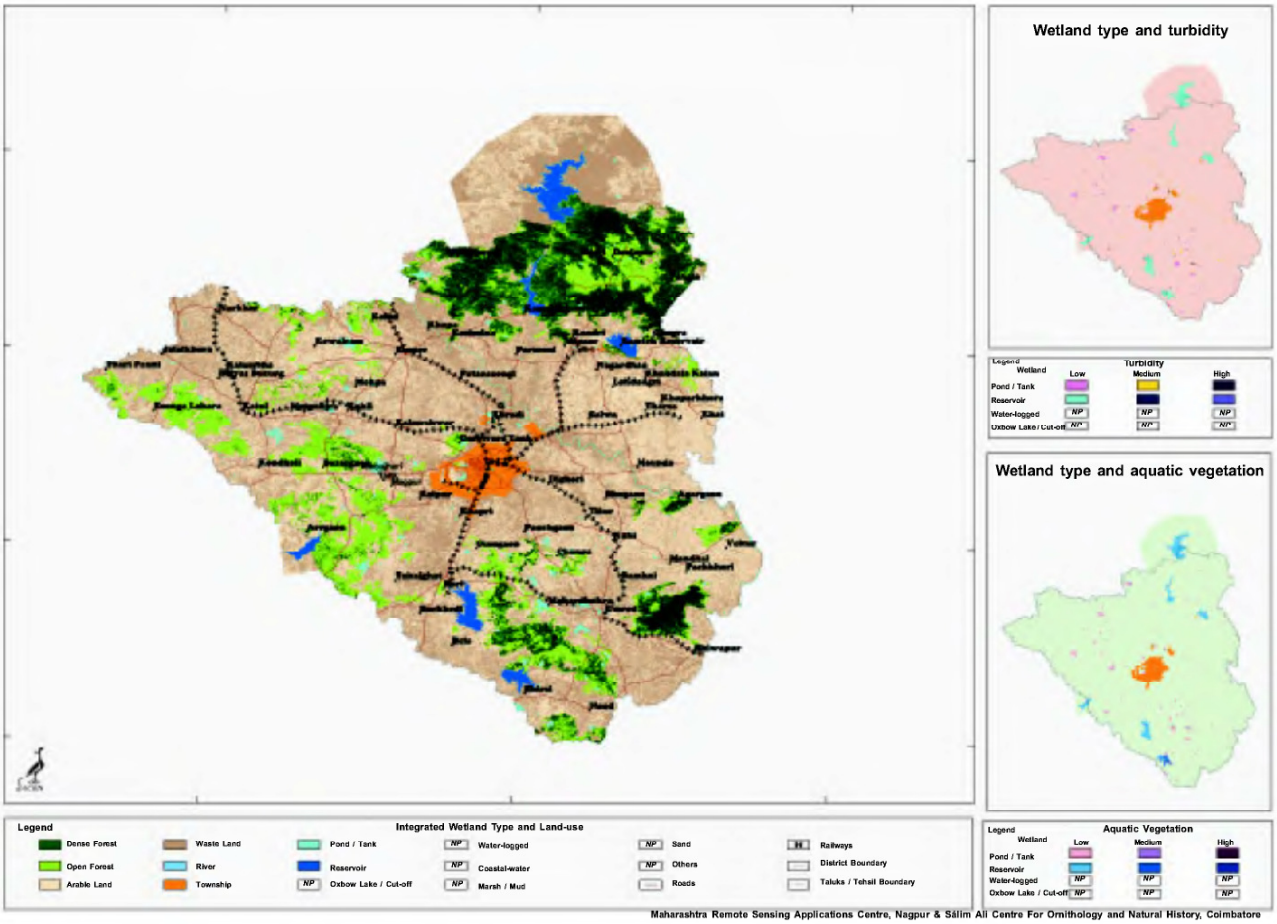


Fig. 10.10. Land use and wetland categories of the district of Nagpur

Table 10.10. Area under different land use classes in the district of Nagpur

Land use categories	Area (sq km)	Area(%)
Dense forest	1,093.28	11.047
Open forest	1,373.24	13.876
Arable land	3,605.24	36.43
Wasteland	3,379.50	34.15
Wetland	276.27	2.79
Others	169.12	1.709

Table 10.11. Area under different turbidity classes in the district of Nagpur

Turbidity classes	Area (sq km)	Area(%)
Low	508.98	82.54
Moderate	47.70	17.27
High	5.34	0.19

Table 10.12. Seasonal pattern of wetland areas in the district of Nagpur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/tanks	122.73	55.39	67.34	54.87

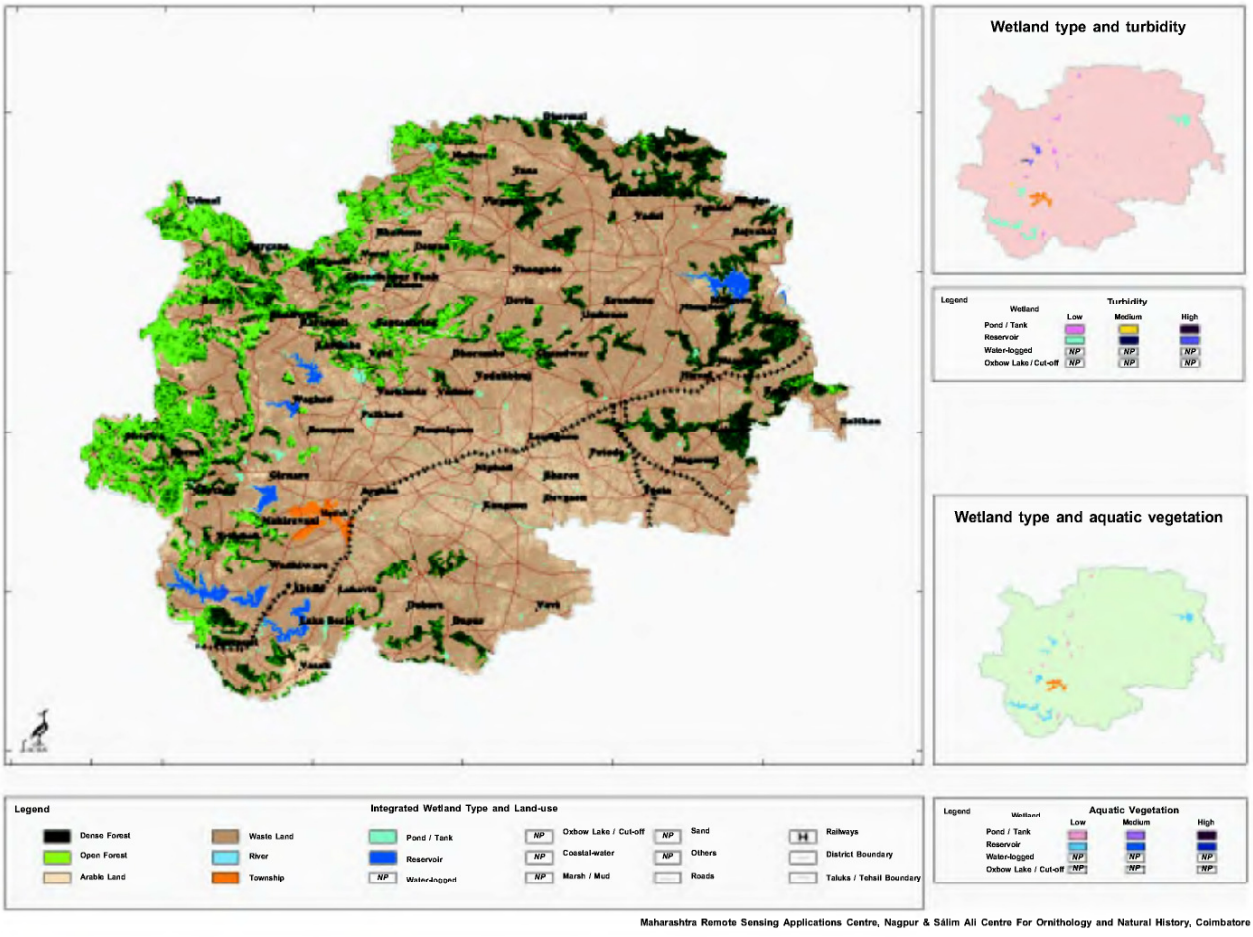


Fig. 10.11. Land use and wetland categories of the district of Nasik

Table 10.13. Area under various land use classes in the district of Nasik

Land use categories	Area (sq km)	Area(%)
Dense forest	1,977.10	12.59
Open forest	1,339.37	8.53
Arable land	2,327.49	14.83
Wasteland	9,382.71	59.78
Wetland	289.09	1.829
Others	383.22	2.40

Table 10.14. Area under different turbidity classes in the district of Nasik

Turbidity classes	Area (sq km)	Area (%)
Low	240.17	83.6
Moderate	21.38	7.44
High	25.74	8.96

Table 10.15. Seasonal pattern of wetland areas in the district of Nasik

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/tanks	73.24	10.09	63.15	86.22

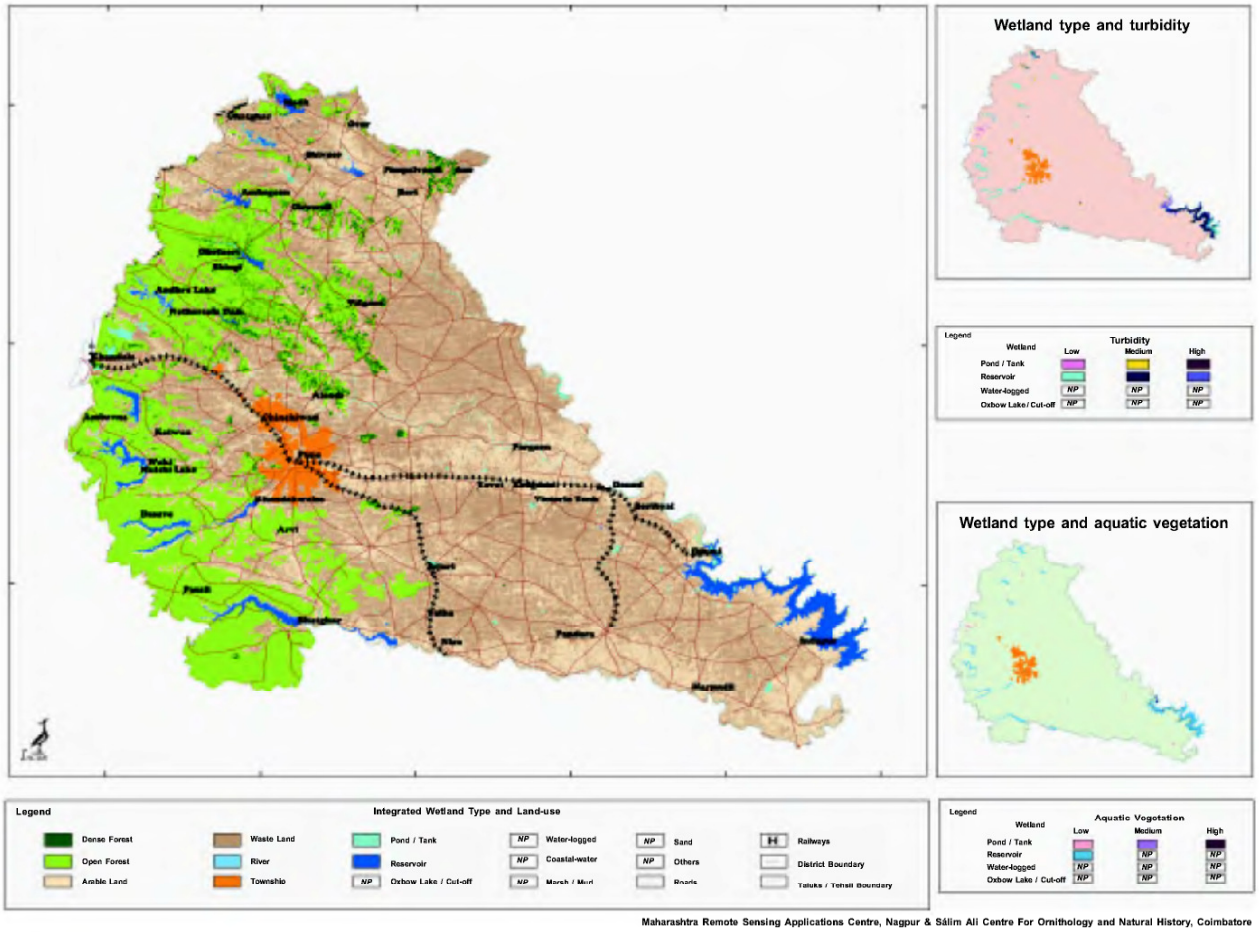


Fig. 10.12. Land use and wetland categories of the district of Pune

Table 10.16. Area under different land use classes in the district of Pune

Land use categories	Area (sq km)	Area(%)
Dense forest	375.48	2.42
Open forest	3,505.73	22.60
Arable land	5,021.24	32.36
Wasteland	6,057.00	39.04
Wetland	490.34	3.16
Others	66.71	0.43

Table 10.17. Area under different turbidity levels in the district of Pune

Turbidity classes	Area (sq km)	Area (%)
Low	252.69	51.53
Moderate	193.98	39.56
High	43.70	8.91

Table 10.18. Seasonal pattern of wetland areas in the district of Pune

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/tanks	128.87	82.73	46.14	35.80

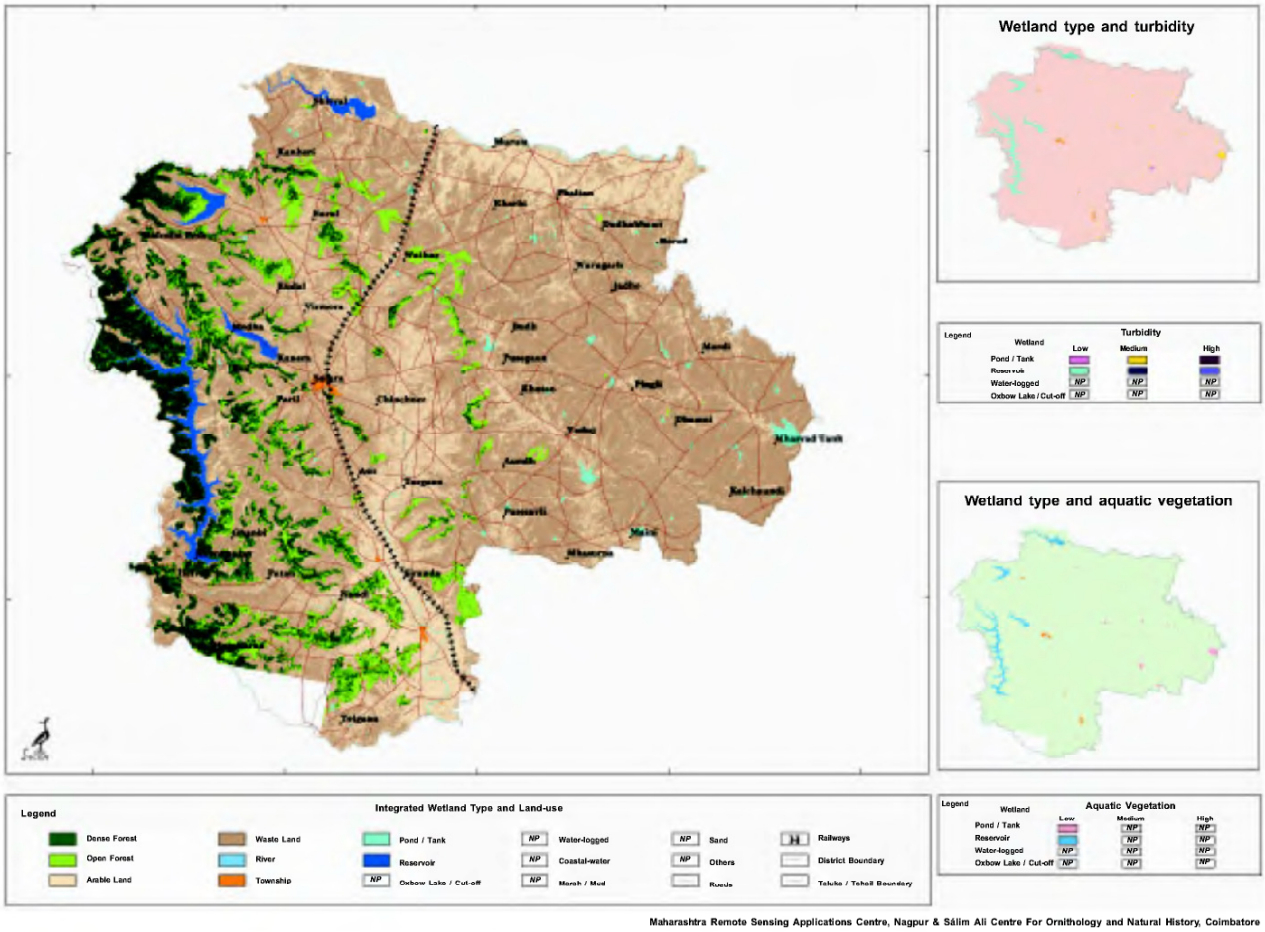


Fig. 10.13. Land use and wetland categories of the district of Satara

Table 10.19. Area under different land use in the district of Satara

Land use categories	Area (sq km)	Area(%)
Dense forest	921.33	8.75
Open forest	702.64	6.68
Arable	2,674.72	25.42
Wasteland	5,900.18	56.07
Wetland	230.19	2.19
Other	94.62	0.90

Table 10.20. Area under different turbidity classes in the district of Satara

Turbidity classes	Area (sq km)	Area (%)
Low	177.03	80.17
Moderate	43.23	19.58
High	0.55	0.25

Table 10.21. Seasonal pattern of wetland areas in the district of Satara

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/tanks	10.09	7.32	2.77	27.45

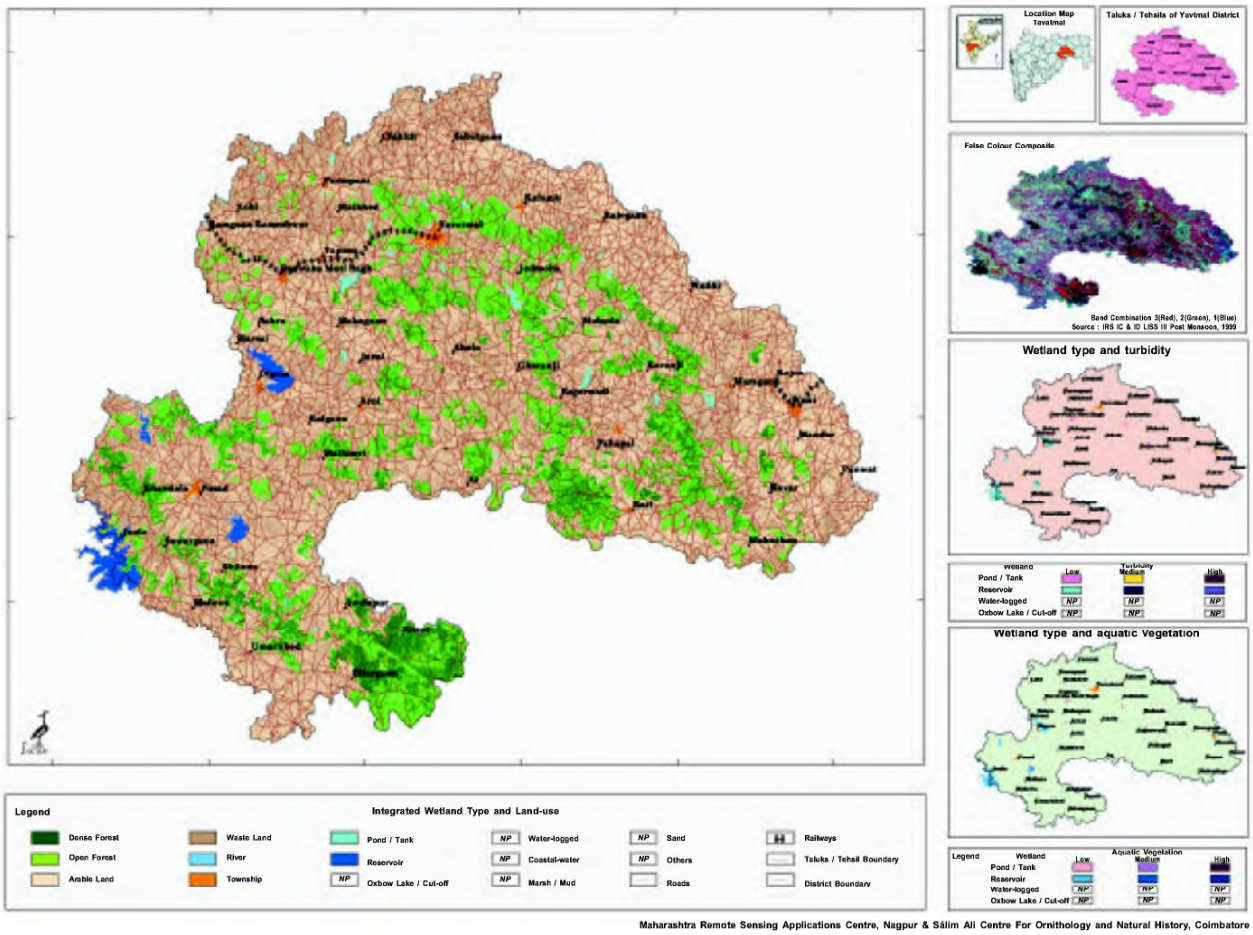


Fig. 10.14. Land use and wetland categories of the district of Yavatmal

Table 10.22. Area under different land use classes in the district of Yavatmal

Land use categories	Area (sq km)	Area(%)
Dense forest	1,029.72	7.58
Open forest	1,982.69	14.59
Arable land	5,429.65	39.96
Wasteland	4,819.55	35.47
Wetland	252.30	1.85
Others	74.73	0.55

Table 10.23. Area under different turbidity levels in the district of Yavatmal

Turbidity classes	Area (sq km)	Area (%)
Low	198.61	78.72
Moderate	39.00	15.46
High	14.68	5.82

Table 10.24. Seasonal pattern of wetland areas in the district of Yavatmal

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Reservoirs/tanks	122.09	61.75	60.34	49.42

No detailed data were collected on the plant species in different wetlands during this study. However, the information compiled from literature shows that there are 69 endemic aquatic plant species belonging to 18 families; most abundant among them being Eriocaulaceae (Table 10.27).

Fishes

Although detailed information was not collected from all the different wetlands, 38 species were recorded from 22 wetlands. Bhigwan had the maximum (31 species) followed by Jayakwadi and Veer (21 species each), Nandhur-Madhameshwar (17 species) and Mayni (10 species). *Labeo rohita* and *Cirrhinus mrigala* were recorded from 20 out of the 22 wetlands. *Oreochromis mossambicus* and *Cyprinus carpio* were recorded from 13 and 12 wetlands respectively. The former was the only major exotic species and it feeds on fingerlings of local fishes, which affects the natural fauna and the ecosystem.

Nineteen Threatened species of fishes were recorded from Maharashtra (Menon, 1999), of which six were Endangered and 13 Vulnerable (Table 10.28).

Table 10.27. Endemic aquatic plant species reported from Maharashtra

S.#	Species	Family
1	*Tonningia cucullata*	Commelinaceae
2	*Aponogeton appendiculatus*	Aponogetonaceae
3	*Aponogeton bruggenii*	Aponogetonaceae
4	*Aponogeton satarensis*	Aponogetonaceae
5	*Cladopus hookerianus*	Podostemaceae
6	*Coelachne minuta*	Poaceae
7	*Cryptocoryne cognata*	Araceae
8	*Cryptocoryne cognatoides*	Araceae
9	*Cryptocoryne spiralis*	Araceae
10	*Cyanotis papilionacea*	Commelinaceae
11	*Cyathocline lutea*	Asteraceae
12	*Eriocaulon breviscapum*	Eriocaulaceae
13	*Eriocaulon bolei*	Eriocaulaceae
14	*Eriocaulon cuspidatum*	Eriocaulaceae
15	*Eriocaulon dalzellii*	Eriocaulaceae
16	*Eriocaulon duthiei*	Eriocaulaceae
17	*Eriocaulon eurypeplon*	Eriocaulaceae
18	*Eriocaulon fysonii*	Eriocaulaceae
19	*Eriocaulon heterolepis*	Eriocaulaceae
20	*Eriocaulon lanceolatum*	Eriocaulaceae
21	*Eriocaulon parviflorum*	Eriocaulaceae
22	*Eriocaulon ratnagiricum*	Eriocaulaceae
23	*Eriocaulon richardianum*	Eriocaulaceae
24	*Eriocaulon ritchieanum*	Eriocaulaceae
25	*Eriocaulon robusto-brownianum*	Eriocaulaceae
26	*Eriocaulon rouxianum*	Eriocaulaceae
27	*Eriocaulon santapaui*	Eriocaulaceae
28	*Eriocaulon sedgwickii*	Eriocaulaceae
29	*Eriocaulon sharmae*	Eriocaulaceae
30	*Eriocaulon stellulatum*	Eriocaulaceae
31	*Eriocaulon tuberiferum*	Eriocaulaceae
32	*Fimbristylis woodrowii*	Cyperaceae
33	*Fuirena trilobites*	Cyperaceae
34	*Fuirena tuwensis*	Cyperaceae
35	*Fuirena wallichiana*	Cyperaceae
36	*Geissaspis tenella*	Fabaceae
37	*Hoppea dichotoma*	Gentianaceae
38	*Hydrobryopsis sessilis*	Podostemaceae
39	*Hygrophila serpylla*	Acanthaceae
40	*Hygrophila pinnatifida*	Acanthaceae
41	*Isachne bicolor*	Poaceae
42	*Isachne elegans*	Poaceae
43	*Isachne meeboldii*	Poaceae
44	*Ischaemum travancorense*	Poaceae
45	*Limnophila polystachya*	Scrophulariaceae
46	*Lindernia estaminodiosa*	Scrophulariaceae
47	*Lindernia quinqueloba*	Scrophulariaceae
48	*Myriophyllum oliganthum*	Haloragaceae
49	*Murdannia lanuginosa*	Commelinaceae
50	*Murdannia pauciflora*	Commelinaceae
51	*Paspalum canarae*	Poaceae
52	*Pogostemon erectus*	Lamiaceae
53	*Pogostemon salicifolius*	Lamiaceae
54	*Polypleurum dichotomum*	Podostemaceae
55	*Ramphicarpa longiflora*	Scrophulariaceae
56	*Rotala fimbriata*	Lythraceae
57	*Rotala floribunda*	Lythraceae
58	*Rotala malampuzhensis*	Lythraceae
59	*Rotala macrandra*	Lythraceae
60	*Rotala ritchei*	Lythraceae
61	*Scirpus naikianus*	Cyperaceae
62	*Sesbania procumbens*	Fabaceae
63	*Trithuria konkanensis*	Hydatellaceae
64	*Utricularia albocaerulea*	Lentibulariaceae
65	*Utricularia arcuata*	Lentibulariaceae
66	*Utricularia janarthanamii*	Lentibulariaceae
67	*Utricularia naikii*	Lentibulariaceae
68	*Utricularia praeterita*	Lentibulariaceae
69	*Wiesneria triandra*	Alismataceae

Turtles

Seven species of turtles were recorded from Maharashtra; out of which, one is Endangered, three Near Threatened, two Vulnerable and one is of Least Concern (Table 10.29).

Table 10.29. List of freshwater turtles recorded from Maharashtra

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes hurum*	VU	I	I
2	*Aspideretes leithii*	VU	-	IV
3	*Chitra indica*	EN	-	IV
4	*Kachuga tentoria*	NT	-	-
5	*Lissemys punctata*	NT	II	I
6	*Melanochelys trijuga*	LC	-	-
7	*Kachuga tecta*	NT	I	I

VU=Vulnerable; EN=Endangered;
NT=Near Threatened; LC=Least Concern

Table 10.28. Threatened freshwater fishes of Maharashtra

No.	Species	Status
1	*Anguilla bengalensis*	EN
2	*Rita pavimentatus*	EN
3	*Puntius dorsalis*	EN
4	*Pseudeutropius atherinoides*	EN
5	*Ompok bimaculatus*	EN
6	*Mystus malabaricus*	EN
7	*Anabas testudineus*	VU
8	*Bagarius bagarius*	VU
9	*Barbodes sarana*	VU
10	*Catla catla*	VU
11	*Channa orientalis*	VU
12	*Clarias batrachus*	VU
13	*Cirrhinus reba*	VU
14	*Heteropneustes fossilis*	VU
15	*Labeo dero*	VU
16	*Mystus vittatus*	VU
17	*Osteobrama cotio*	VU
18	*Puntius chola*	VU
19	*Tor khudree*	VU

EN=Endangered; VU=Vulnerable

Birds

In all, 62,891 birds of 104 species were recorded during the survey covering 33 important wetlands in Maharashtra. Bhigwan had the maximum number of species followed by Nandur-Madhmeshwar (Table 10.30). The next four wetlands with above 30 species were Gangapur dam, Mukutban, Hipperga tank and Erai dam. While 14 wetlands had 20-30 species and nine had 10-20, four wetlands had only fewer than 10 species. The highest population (12,193) of birds was noted at Jayakwadi followed by Nandur-Madhmeshwar. Three sites, namely Bhigwan, Pimpalwadi and Erai dam had more than 5,000 birds, while nine sites had between 1,000 and 5,000 birds.

While 15 species had more than 1,000 birds, only two had more than 5,000 birds. The latter were the Coot (9,770) and Tufted Duck (8,705). Pintail (3,490) and Red-crested Pochard (2,834) were the next in abundance, but the latter occurred only in a few wetlands showing preference for particular habitats. 14 species were <5 in number while 39 species were found only in one or two wetlands. Most of the water birds were migratory with ducks forming the majority; around 44%. Only a few species were resident.

Distribution of the species shows that only nine species were more widely distributed, occurring in more than 50% of the wetlands surveyed. Those were the Coot (23 wetlands), Little Cormorant, Grey Heron and Pintail (each in 21 wetlands), Pond Heron (19 wetlands), Spotbilled Duck (17 wetlands), Little Grebe, Shoveller and Common Pochard (each in 16 wetlands).

Of the 33 wetlands surveyed, only two had Threatened bird species with 20 birds; the Spoonbilled Sandpiper at Bindusar and Marbled Teal at Bhigwan. Six Near Threatened species with 456 birds were observed during

Table 10.30. Major wetlands of Maharashtra with species and number of birds

Sl.No	Site	Species	Birds
1	Ambazare	25	1,671
2	Bhigwan	65	6,307
3	Bindusara	24	670
4	Dahegaon lake	19	1,246
5	Erai dam	30	5,707
6	Gangapur tank	48	3,788
7	Hipperga tank	33	1,524
8	Isapur dam	7	174
9	Itiadoh	6	133
10	Jayakwadi	29	12,193
11	Jejuri dam	16	188
12	Kambal talav	20	380
13	Khambala tank	25	194
14	Kundalika dam	24	471
15	Majalgaon dam	11	221
16	Malharsagar	19	241
17	Mayni	17	988
18	Mukutban	43	1,207
19	Nagapur dam	13	1,627
20	Nandur-Madhmeshwar	50	10,273
21	Navegaon	18	2,753
22	Nilona	27	1,202
23	Nivali	28	756
24	Patas	16	236
25	Pimpalwadi	29	5,783
26	Salim Ali lake	22	572
27	Siddheshwar dam	8	60
28	Sukhana	24	516
29	Tarangwadi	20	167
30	Teesgaon	10	257
31	Veer	26	274
32	Yeralewadi dam	11	1,100
33	Yeldari dam	3	12
	Total	104	62,891

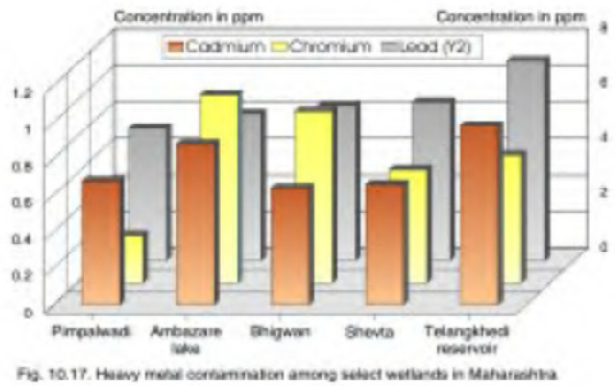


Fig. 10.17. Heavy metal contamination among select wetlands in Maharashtra

the survey; some of them only in a few wetlands (Table 10.31). Larger populations, ie. > 1% of the biogeographic population, of four species, namely Smaller Egret, Curlew Sandpiper, Spoonbill, and Redcrested Pochard were observed; the first three at Nandur-Madhameshwar and the last at Erai dam.

Table 10.31. Frequency of the sightings of Threatened and Near Threatened birds at different wetlands of Maharashtra

S.#	Species	Status	No. of wetlands	No. of birds
1	Marbled Teal	T	1	8
2	Spoonbilled Sandpiper	T	1	12
3	Blacknecked Stork	NT	1	2
4	Darter	NT	2	46
5	Painted Stork	NT	3	131
6	White-eyed Pochard	NT	3	57
7	White Ibis	NT	13	218
8	Pale Harrier	NT	1	2

T=Threatened; NT=Near Threatened

Environmental contamination

Contamination level was measured in 49 fishes comprising seven species collected from five wetlands. Although samples were received from 14 wetlands, results of those from only five wetlands are discussed, as the sample size was inadequate from the rest of the wetlands.

Heavy metals

Among the wetlands examined, Telangkhedi reservoir of Nagpur district recorded the maximum concentrations of lead (7.32±2.53 ppm) and cadmium (0.98±0.46 ppm), while Ambazare lake of the same district recorded maximum levels (1.03±0.31 ppm) of chromium (Fig. 10.17). Although copper and zinc were in quantifiable levels, they were not expected to pose any harmful effects. Variation in the contamination levels of all the metals except chromium was significant ($P<0.005$) among the wetlands.

Among the species studied, *Oreochromis mossambicus*, an omnivorous feeder recorded the maximum levels of lead (7.47±2.84 ppm) and cadmium (0.84±0.40 ppm).

Labeo rohita had the highest concentrations (1.49±1.78 ppm) of chromium (Fig. 10.18), while the levels of other metals were not high. However, copper, lead and zinc were significantly different among the species (P<0.005).

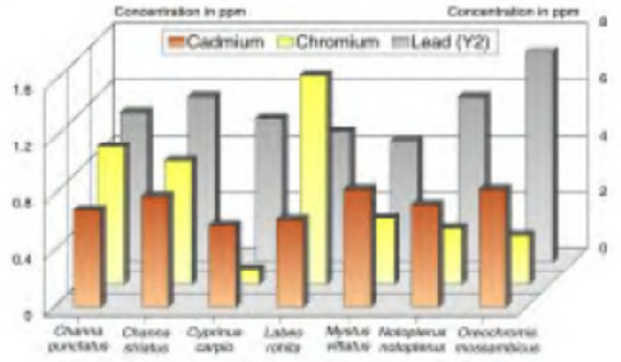


Fig. 10.18. Heavy metal contamination among select species of fishes in Maharashtra

Pesticides

Among the five wetlands studied, Ambazare lake (0.186 ppm) of Nagpur district had the maximum load of total organochlorine residues followed by Bhigwan (0.07 ppm) of Pune. The minimum concentrations were recorded in Kambal talav (0.036 ppm) of Solapur district followed by Dalaj (0.02 ppm) and Patas talav (0.012 ppm) of Pune district (Fig. 10.19).

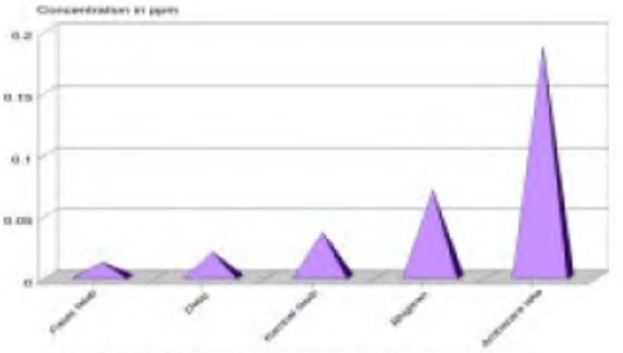


Fig. 10.19. Total organochlorine residues among various wetlands of Maharashtra

Of the seven species of fishes analyzed, *Notopterus notopterus* was the most contaminated fish in terms of organochlorine residues (0.078 ppm) followed by *Mystus vittatus* (0.071 ppm) and *Labeo rohita* (0.063 ppm). Least concentrations were detected in *Cyprinus carpio* and *Channa punctatus;* 0.024 ppm and 0.014 ppm respectively (Fig. 10.20). Among all the fishes analyzed, 93, 91, 78, 77 and 66 per cent of fishes were contaminated with HCH, heptachlor epoxide, DDT, dieldrin and endosulfan respectively.

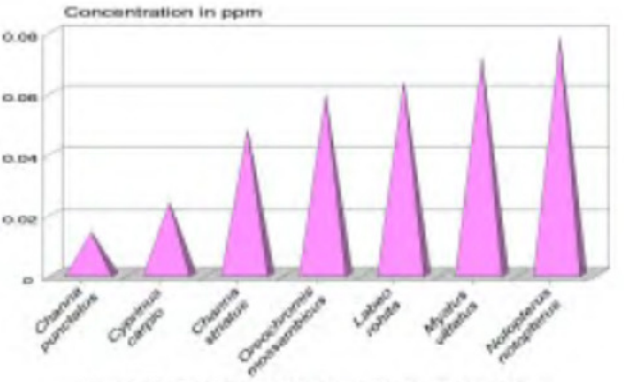


Fig. 10.20. Total organochlorine residues among various species of fishes in Maharashtra

Of the various organochlorine residues detected, HCH concentrations (0.503 ± 0.50 ppm) in *Ompok bimaculatus* of Ambazare lake of Nagpur district exceeded the Maximum Residue Levels (MRL) of 0.2 – 0.5 ppm for HCH recommended by FAO/WHO (WHO, 1993) for fish products. Other organochlorine residues detected in these fishes are less than the concentration at which it would produce ecological risk to fish and avian wildlife (USEPA, 1980).

Suitability for human consumption

An assessment of the suitability of fishes for human consumption reveals that the levels of lead (0.27 mg) in *Oreochromis mossambicus* are higher than those prescribed (0.21 mg for 60 kg adult/day). Consumption of these fishes regularly will result in hepatic and nephritic complications.

Ompok bimaculatus of Ambazare lake is not advisable for human consumption, since the calculated level of HCH (17.9 µg) is already equal to the maximum permissible limit recommended for human consumption (18 µg/60 kg person/day; Health Canada, 1996). Although considerable concentrations of pesticides have

been detected in the fishes of other wetlands, the levels do not appear to be higher than the allowable limits recommended for human consumption. However, regular intake of such fishes is not advisable.

Elevated levels of chromium in Ambazare lake of Nagpur district could be related to the discharge of industrial effluents. This has presumably resulted in 30 to 40% of reduction in fish harvest. Based on the information available, wetlands such as Ambazare lake, Telangkhedi and Bhigwan require immediate attention to safeguard them from pollution. Also, periodic monitoring of the levels of pollutants is advisable.

Socioeconomic values

Of the 33 wetlands surveyed in Maharashtra, 23 are major irrigation dams while eight are smaller percolation tanks. Both these categories are used for management of water supply not only for agriculture but also for household needs of village settlements, growing urban areas and MIDCs.

Based on the use values, grades were given for all, except for nine wetlands surveyed. Of the 33 wetlands, nine have not been evaluated for the uses while most of the sites have high (15) or medium use (7).

Prioritization of wetlands

The 33 wetlands surveyed were prioritized on a set of well-defined criteria based mainly on birds as explained under methods. The wetlands are arranged in the order of the total ratings and ranks (Table 10.32). The first 11 came under the first rank, the following nine in the second rank, 10 in the third rank and the last three in the fourth rank. The top ranking sites were Bhigwan, Nandur-Madhmeshwar, Gangapur tank, Mukutban, Bindusar, Jayakwadi, Hipperga tank, Khambala tank, Kundalika dam, Nivali and Veer. The last seven came up in the rank because of their large size. Five sites in the second rank and four in the third rank also came up in the same manner. Distribution of these wetlands is shown in Fig. 10.21. Out of the 33 wetlands, the top 20 require priority over the rest for conservation.

Most of the wetlands surveyed recorded a decrease in the fish catch over the years mainly because of over exploitation, pollution by sewage and effluents, lack of fish seeds from the Fisheries Department and the shortage of water. Domestic and industrial effluents have affected many of the wetlands. Various crops are cultivated on the edges, using chemical fertilisers and pesticides during the draw-down period, thereby compounding the threat to the wetlands.

Table 10.32. Prioritized list of the major wetlands of Maharashtra

S.No	Site	Rank	Use
1	Bhigwan	1	H
2	Nandur-Madhmeshwar	1	H
3	Gangapur tank	1	M
4	Mukutban	1	DD
5	Bindusar	1	H
6	Jayakwadi	1	H
7	Hipperga tank	1	H
8	Khambala tank	1	M
9	Kundalika dam	1	H
10	Nivali	1	H
11	Veer	1	L
12	Erai dam	2	DD
13	Nilona	2	DD
14	Pimpalwadi	2	DD
15	Mayni	2	M
16	Salim Ali lake	2	H
17	Jejuri dam	2	M
18	Majalgaon dam	2	H
19	Yeralewadi dam	2	H
20	Sukhana	2	M
21	Navegaon	3	DD
22	Ambazare	3	DD
23	Itiadoh	3	DD
24	Kambal talav	3	H
25	Dahegaon lake	3	DD
26	Tarangwadi	3	H
27	Isapur dam	3	H
28	Siddheshwar dam	3	H
29	Teesgaon	3	M
30	Yeldari dam	3	M
31	Malharsagar	4	DD
32	Nagapur dam	4	L
33	Patas	4	H

H=High; M=Medium; L=Low; DD=Data deficient

Of all the 33 wetlands, only three, namely Nandur-Madhmeshwar, Jayakwadi and Mayni have been given some level of legal protection as sanctuaries which at least protect the waterfowl from poaching. However, none of these is fully notified which should be done immediately. The five largest areas are Jayakwadi, Bhigwan, Isapur dam, Majalgaon dam, and Yeldari dam. The Irrigation Department of Maharashtra has control over a majority of these wetlands. Hence, a combined effort of stakeholders is required for the protection and sustainable use of these wetlands. Other areas may be declared as Community Reserves to be managed and protected through participatory approach and conservation awareness. Those 11 wetlands which are in the first rank are qualified to be declared as Ramsar sites.

Summary

- Maharashtra has 609 wetlands of the size 56.25 ha and above, covering 2,849.42 sq km in extent during 1992-'93.

- Recent estimates show that the number of wetlands of the size 2 ha and above in seven select districts is 1,874, covering an area of 2,145.8 sq km. This includes 1,832 lakes/ponds and 42 reservoirs, covering 634.49 sq km and 1595.47 sq km respectively.

- Turbidity of the reservoirs was mostly low except in three districts where it was low/moderate or moderate/high. Ponds/ lakes had low turbidity in four districts, while it was high in two districts.

- Maharashtra has 69 species of endemic aquatic plants; six Endangered and 13 Vulnerable species of fishes; one Endangered, three Near Threatened, two Vulnerable and one Least Concern species of freshwater turtles; and two Threatened and six Near Threatened species of aquatic birds.

- In the 33 wetlands surveyed, 62,891 birds of 104 species were recorded.

- The highest population of birds was in Jayakwadi followed by Nandur – Madhmeshwar

- More abundant species were the Coot, Tufted Duck, Pintail and Red-crested Pochard.

- Contamination levels of 49 fishes comprising seven species from five wetlands were studied.

- Telangkhedi reservoir, Ambazare lake and Bhigwan are comparatively more contaminated.

- *Oreochromis mossambicus* from Telangkhedi reservoir and *Ompok bimaculatus* from Ambazare lake are not advisable for human consumption, as the concentration of lead in the former and HCH in the latter are higher than the permissible limits.

- Thirty three wetlands were prioritized for conservation; 11 in the first rank, nine in the second rank, 10 in the third and three in the fourth rank.

- The first eleven in the prioritized list qualify to be declared as Ramsar sites.



Erach Bharucha

Nesting colony of the Large Cormorant

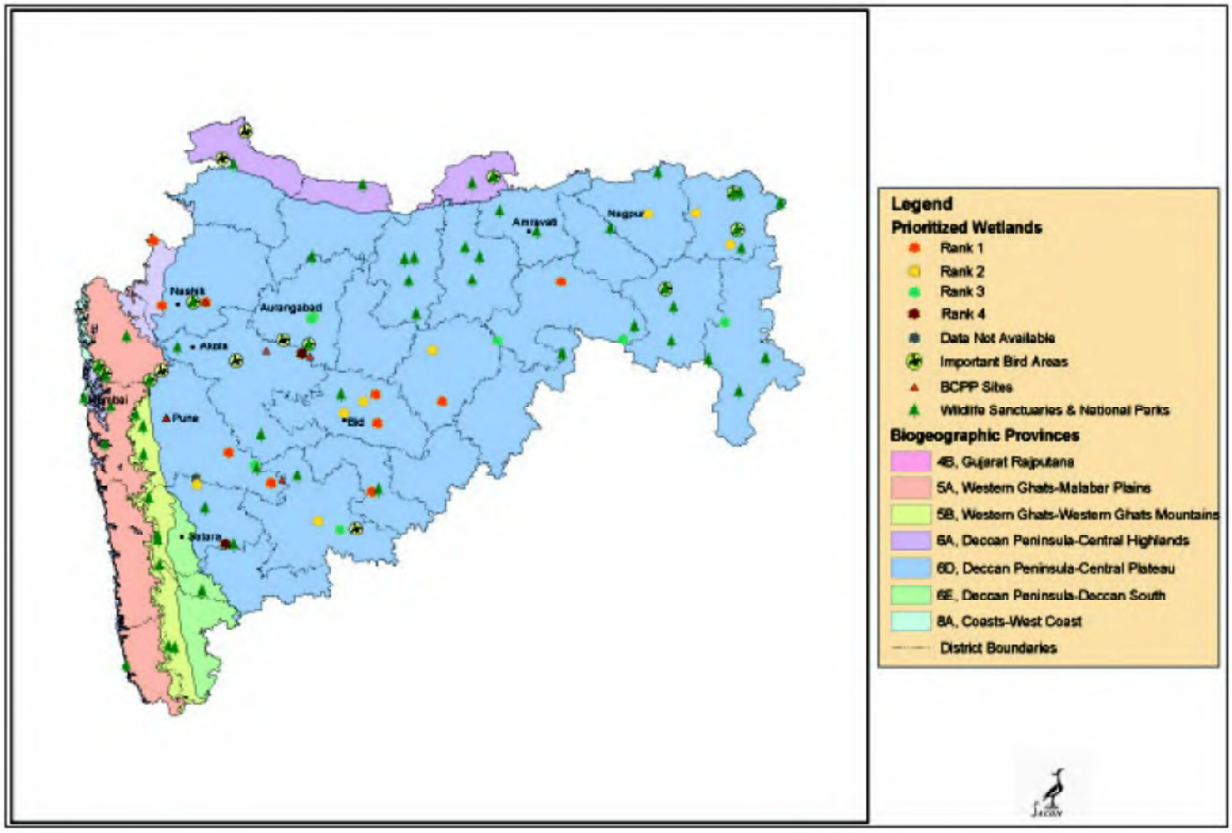


Fig. 10.21. Prioritized wetlands and other conservation areas in Maharashtra



Erach Bharucha

Painted storks at Mayni



Erach Bharucha

Migratory waterfowl at Jaikwadi, Maharashtra

GUJARAT

Gujarat, known for its 'Flamingo City' in the Great Rann of Kutch and for the multitude of migratory waterfowl and cranes, is one of the dream lands of bird-lovers. Situated on the west coast of India, Gujarat consists mostly of plain interspersed with low hills or small mountains extending from Rajasthan, Madhya Pradesh and Maharashtra. Aravalli ranges form the Pavagadh region, near Baroda and merges itself with the Vindhyas. The state has mainly three geographical regions, namely the mainland, the peninsular region of Saurashtra and the Kutch region. The last one has a large area of desert, known as Rann of Kutch where the flamingos breed in thousands. The mainland on the whole is a plain of alluvial soil. The state has a long coastline of over 1,600 km.



Gujarat has an intensely hot or cold climate. The maximum temperature varies from 36.7 to 43.3°C in summer and the minimum between 2 and 18.3°C from November to February. There is much variation in the rainfall in the state from an average of 330 mm in Kutch and parts of Saurashtra to 1,520 mm in the southern parts with Dangs recording the highest 1,900 mm.

State at a glance	
State capital	Gandhinagar
Area	1,96,024 sq km
Population (2001)	5,05,96,992
Total number of districts	25
Major rivers	Narmada, Tapi, Mahi, Sabarmati and Saraswati
Total forest area	18,590 sq km
Population density (2001)	258/sq km
Ramsar site	Nil
Proposed Ramsar sites	21
Total sites proposed for conservation	45

Status of wetlands

The land use pattern in Gujarat, according to the latest information available (Table 11.1) does not indicate the presence of wetlands. Possibly it is covered under 'wasteland' and or fallow land. However, the Space Applications Centre reported 393 wetlands of 56.25 ha and above, covering a total of 2,092.02 sq km (SAC, 1998). This forms 1.07% of the total area of the state. The number of wetlands of 2 ha and above in five select districts alone accounts for 663, covering an area of 743.76 sq km.

The variety of wetlands in Gujarat ranges from large reservoirs, lakes to small tanks and ponds.

Spatial distribution of wetlands shows that larger number of wetlands are in Surat district while there are only a few wetlands in the district of Bhavnagar. This obviously affects the distribution and status of the waterfowl and other fauna, and also the aquatic flora of the state. Of the different kinds of wetlands in the state, reservoirs form 66.62% followed by waterlogged areas (13.80%) and tanks (9.46%) (Table 11.2).

Table 11.1. Land use pattern in Gujarat

Land use category	Area (in sq km)
Total geographic area	1,96,024
Forests	18,590
Not available for cultivation	37,440
Other uncultivated land excluding fallow land	28,330
Fallow land	7,010
Net area sown	96,740
Area sown more than once	10,280
Total cropped area	1,07,020
Cultivable area	1,32,080

(Source: www.indiastat.com)

Table 11.2. Distribution of various categories of inland wetlands in Gujarat

Inland Wetlands	Area (sq km)	Percentage
Lakes	153.81	7.35
Oxbow lakes	1.81	0.09
Waterlogged (seasonal)	288.75	13.81
Marshes/swamps	49.56	2.37
Reservoirs	1,393.75	66.62
Tanks	197.94	9.46
Abandoned quarries	5.31	0.25
Cooling ponds	1.13	0.05
Total	2,092.06	100.00

Source: SAC (1998)

Habitat analyses of wetlands in select districts

Out of the 25 districts, five, namely Bhavnagar, Jamnagar, Sabarkantha, Surat and Surendranagar were chosen to map the wetlands at a finer resolution (23.5 m) to capture those above 2 ha in size and for other detailed analysis. The area covered by wetlands and other land use, turbidity and vegetation of the wetlands and a cross classification of wetlands and turbidity and, finally seasonal changes in water levels of the five districts were studied. The land use pattern and seasonal changes in water levels varied greatly among the districts (Table 11.4-11.18).

Wetlands

Among the five districts, the highest number of wetlands was in Surendranagar but the area covered was the highest in Surat. The total number of wetlands was 663, covering an area of 743.76 sq km (Table 11.3). In terms of the area covered in proportion to the total geographical area of the district, Surat had larger percentage of area under wetland (Fig. 11.1). Two main categories of wetlands, namely reservoirs and, ponds/lakes/tanks were found. Reservoirs covered 6% of the total area of the district of Surat, which was the highest per centage in comparison with other districts. Surendra Nagar had the highest number of ponds/lakes/tanks (Table 11.3). It is also to be noted that in all the districts, smaller wetlands (below 56.25 ha) were more in number than the larger wetlands (Fig. 11.3).

Table 11.3. Types, number and extent (sq km) of wetlands in five select districts of Gujarat

Districts	Ponds/lakes/tanks		Reservoirs		Total no.	Total area
	No.	Area	No.	Area	of wetlands	of wetlands
Bhavnagar	36	24.08	1	19.39	37	43.47
Jamnagar	112	35.23	2	46.72	114	81.95
Sabarkantha	185	35.71	3	35.17	188	70.88
Surendranagar	264	26.25	1	37.24	265	63.49
Surat	58	17.04	1	466.93	59	483.97
Total	655	138.31	8	605.45	663	743.76

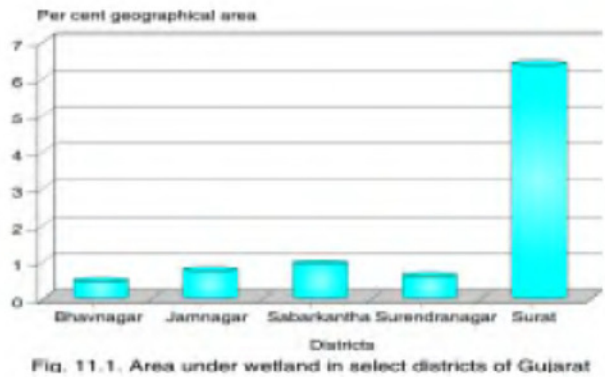


Fig. 11.1. Area under wetland in select districts of Gujarat

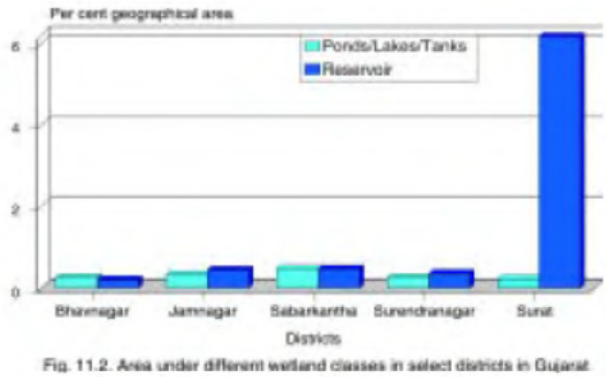


Fig. 11.2. Area under different wetland classes in select districts in Gujarat

Turbidity

Turbidity in the ponds/ lakes in Sabarkantha and Surat was high, whereas it was high/ moderate in Bhavnagar, low/ moderate in Surendranagar and low in Jamnagar (Fig. 11.4, 11.5; Table 11.20). In the case of reservoirs it is low in Bhavnagar and Surat while moderate in other districts.

Summer recession

The summer recession among the wetlands of the districts studied varied from 28% in Surat to more than 84.15% in Jamnagar. In the wetlands of Sabarkantha and Surendranagar, the recession was about 57.62 and 52.32% respectively (Fig. 11.6).

Wetlands and land use pattern in the catchment areas

The integrated land use maps of the five intensively studied districts show that almost all the wetlands are embedded in a landscape dominated by agriculture/ grassland (Fig. 11.7-11.11).

Temporal changes in wetland cover

The data generated by SAC for the wetlands of Gujarat during 1992-93 and those generated by SACON during 2000-2001 were used for comparison. Only the select five districts were considered. It is interesting to

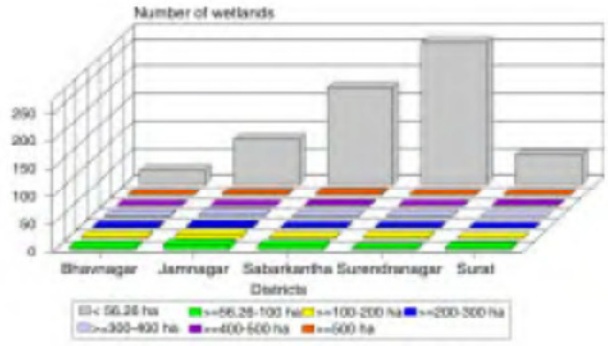


Fig. 11.3. Size class distribution of wetlands in select districts in Gujarat

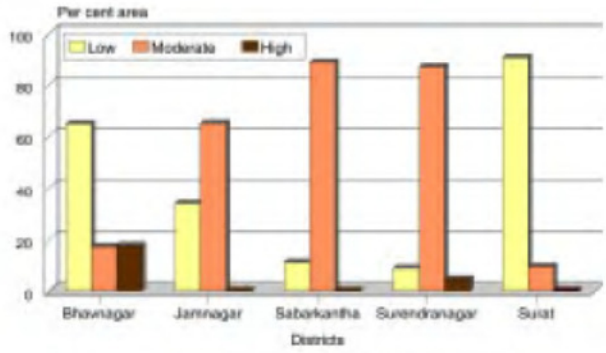


Fig.11.4. Turbidity pattern of reservoirs in Gujarat

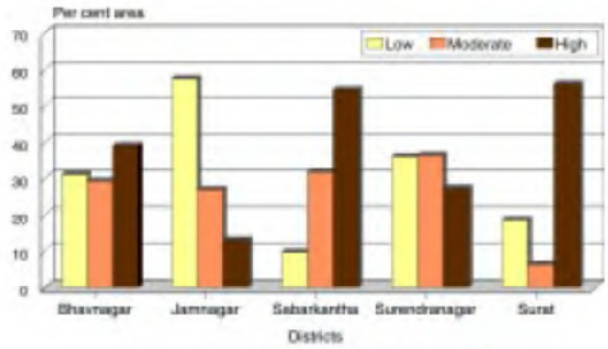


Fig. 11.5. Turbidity pattern of ponds/lakes/tanks in Gujarat

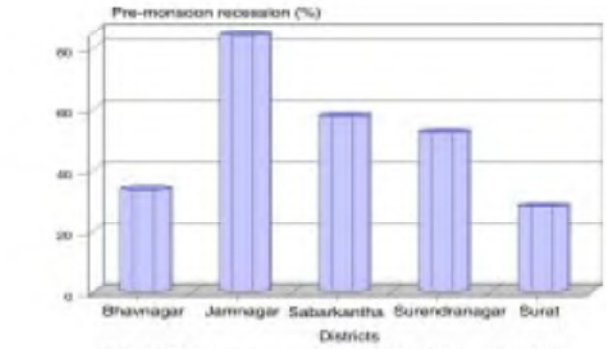


Fig. 11.6. Average summer recession in the wetlands of select districts in Gujarat

note that while the districts of Surendranagar and Sabarkantha showed a remarkable decrease of wetland cover ranging from 78% to 94% (Table 11.19), Jamnagar and Bhavnagar showed an increase; the former substantially (Fig. 11.12). These two districts have witnessed substantial alterations in land use in the form of increased industrial activity, namely expansion of chemical and petrochemical industries. One would need a more thorough study on the causes for the increase and consequent impacts on biodiversity.

Table 11.19. Changes in the wetland area (in sq km) in select districts of Gujarat

District	SAC (1991)	SACON (2001)	Variation	%Variation
Bhavnagar	121.25	152.99	31.74	26.17732
Jamnagar	99.9375	871.16	771.22	771.7048
Sabarkantha	1,171.125	70.88	-1,100.25	-93.9477
Surat	520.43	429.5025	-90.93	-17.4716
Surendranagar	273.78	60.4375	-213.34	-77.9248

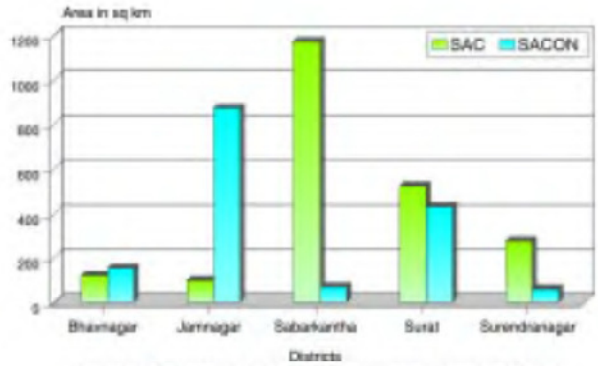


Fig. 11.12. Difference in total wetland area in select districts of Gujarat

Biodiversity

Aquatic vegetation

The satellite imageries of reservoirs and lakes/ ponds together show that the area covered by vegetation is 'low' in all the five districts. However, when considered separately, lakes and ponds in Jamnagar and Surat had high vegetation while those in Bhavnagar, Sabarkantha and Surendranagar had moderate vegetation. In the case of reservoirs, Bhavnagar and Surendranagar had moderate vegetation while in the other three districts it was low (Fig. 11.13, 14; Table 11.20).

The major aquatic flowering plants (macrophytes) recorded during the field survey were about 26 species, with 10 emergent, nine submerged and seven floating. The dominant genera of emergents were *Ipomoea, Cyperus, Sachharum, Scirpus, Typha;* while the submerged were *Ceratophyllum, Hydrilla, Najas, Potamogeton, Vallisneria* and floating *Azolla, Wolffia, Nymphoides, Nelumbo*. 11 species of endemic plants were recorded earlier (Table 11.21).

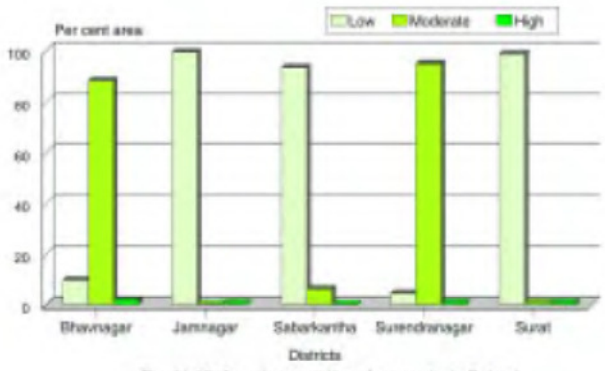


Fig. 11.13. Aquatic vegetation of reservoirs in Gujarat

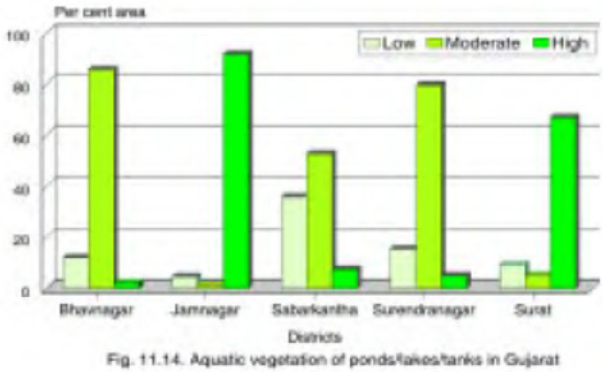


Fig. 11.14. Aquatic vegetation of ponds/lakes/tanks in Gujarat

Table 11.20. Summary of turbidity and aquatic vegetation in different types of wetlands

Wetland classes	No. of wetlands	Area (sq.km)	% area of wetland type					
			Turbidity levels			Aquatic vegetation		
			Low	Moderate	High	Low	Moderate	High
Bhavnagar								
Ponds/lakes/tanks	36	24.08	31.07	29.18	39.07	11.77	85.46	2.09
Reservoirs	1	19.39	64.93	17.34	17.72	9.73	88.18	2.08
Jamnagar								
Ponds/lakes/tanks	112	35.23	57.45	26.91	12.97	4.51	1.37	91.45
Reservoirs	2	46.72	33.77	65.17	0.07	99.23	0.07	0.49
Sabarkantha								
Ponds/lakes/tanks	185	35.71	9.68	31.76	54.51	35.73	52.76	7.46
Reservoirs	3	35.17	10.89	88.83	0.06	93.27	6.31	0.06
Surendranagar								
Ponds/lakes/tanks	264	26.25	36.09	36.46	27.24	15.24	79.64	4.9
Reservoirs	1	37.24	8.65	86.82	4.53	4.62	94.69	0.68
Surat								
Ponds/lakes/tanks	58	17.04	18.6	6.44	56.1	9.2	5.13	66.81
Reservoirs	1	466.93	90.66	9.29	0.02	98.59	0.73	0.66

Table 11.21. List of endemic aquatic plant species in Gujarat

S.No.	Species	Family
1	*Eriocaulon sedgwickii*	Eriocaulaceae
2	*Fimbristylis woodrowii*	Cyperaceae
3	*Fuirena trilobites*	Cyperaceae
4	*Fuirena tuwensis*	Cyperaceae
5	*Hygrophila serpylla*	Acanthaceae
6	*Sesbania procumbens*	Fabaceae
7	*Tonningia cucullata*	Commelinaceae
8	*Hoppea dichotoma*	Gentianaceae
9	*Najas kurziana*	Najadaceae
10	*Najas marina ssp.*	Najadaceae
11	*Ramphicarpa longiflora*	Scrophulariaceae

Fishes

There are 11 Vulnerable species of freshwater fishes in Gujarat (Table 11.22), out of the 49 reported in India (Menon, 1999). There is no report of any Critical or Endangered species from Gujarat.

Turtles

Five species of freshwater turtles were reported from Gujarat (Choudhury *et al.*, 2000, Bhupathy and Menon, 2003). Out of which one each is Vulnerable and of Least Concern and, three are Near Threatened (Table 11.23).

Table 11.22. Vulnerable freshwater fishes of Gujarat

S.No.	Species
1	*Anabas testudineus*
2	*Bagarius bagarius*
3	*Barbodes sarana*
4	*Catla catla*
5	*Cirrhinus reba*
6	*Clarias batrachus*
7	*Heteropneustes fossilis*
8	*Labeo dero*
9	*Mystus vittatus*
10	*Osteobrama cotio*
11	*Puntius vittatus*

Table 11. 23. Freshwater Turtles reported from Gujarat

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes gangeticus*	VU	-	I
2	*Kachuga tecta*	NT	I	I
3	*Kachuga tentoria*	NT	-	-
4	*Lissemys punctata*	NT	II	I
5	*Melanochelys trijuga*	LC	-	-

VU=Vulnerable; NT=Near Threatened; LC=Least concern

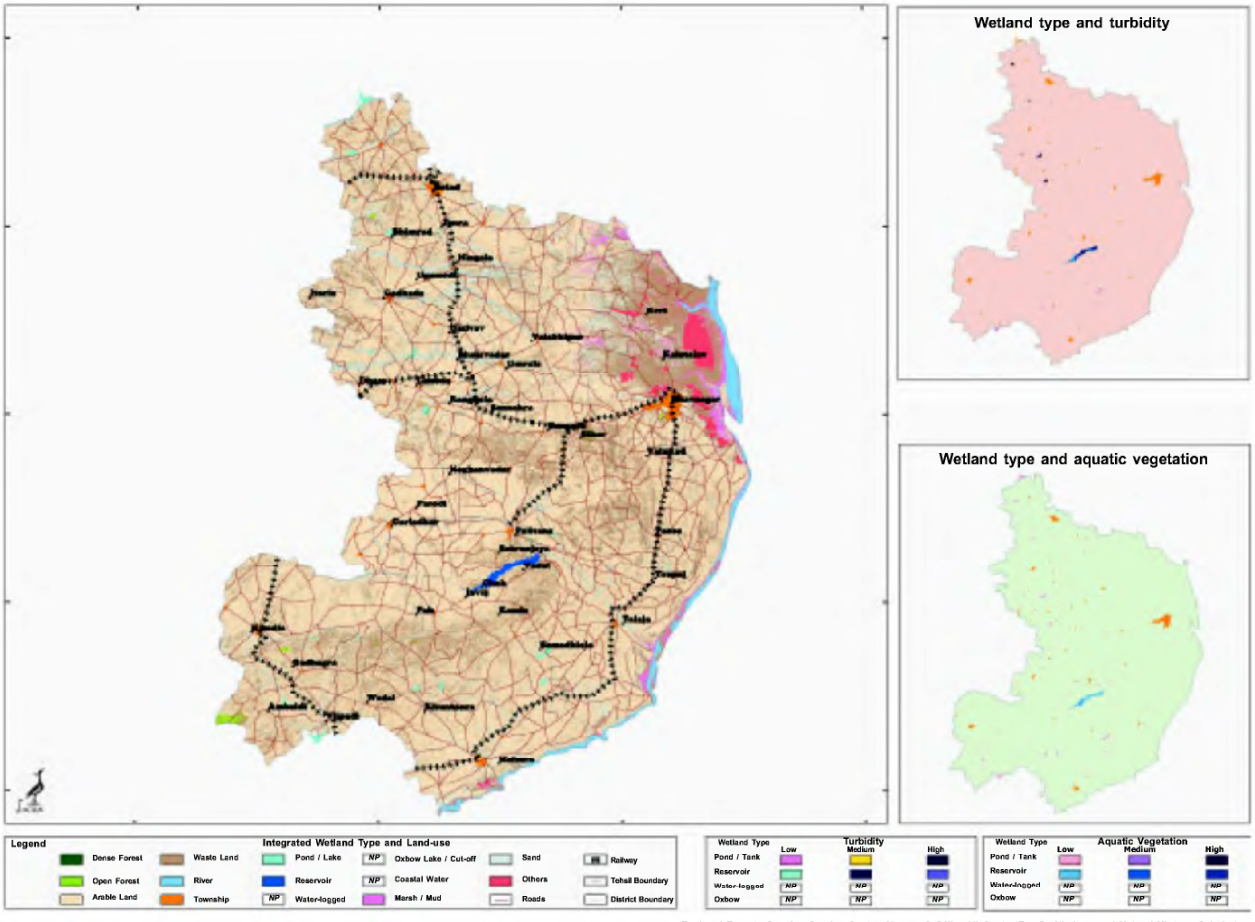


Fig. 11.7. Land use and wetland categories of the the district of Bhavnagar

Table 11.4. Area under different land use and wetland categories in the district of Bhavnagar

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	0.18	0.00
Forest-open	9.34	0.10
Arable land	5,985.11	61.67
Wasteland	2,374.89	24.47
Wetland-ponds/lakes/tanks	24.08	0.25
Wetland-reservoirs	19.39	0.20
Marshy land	109.53	1.13
Township	59.36	0.61
Sand	860.41	8.87
Other water body /river	158.02	1.63
Others (area for which satellite data not available)	105.14	1.09

Table 11.5. Area under different turbidity classes in the district of Bhavnagar

Turbidity class	Area (sq km)	% of total wetland area
Low	12.93	29.70
Moderate	19.72	45.30
High	10.88	24.99

Table 11.6. Seasonal pattern of wetland areas in the district of Bhavnagar

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	11.68	5.24	6.44	
Reservoirs	19.39	15.40	3.99	
Total	31.07	20.64	10.43	33.57

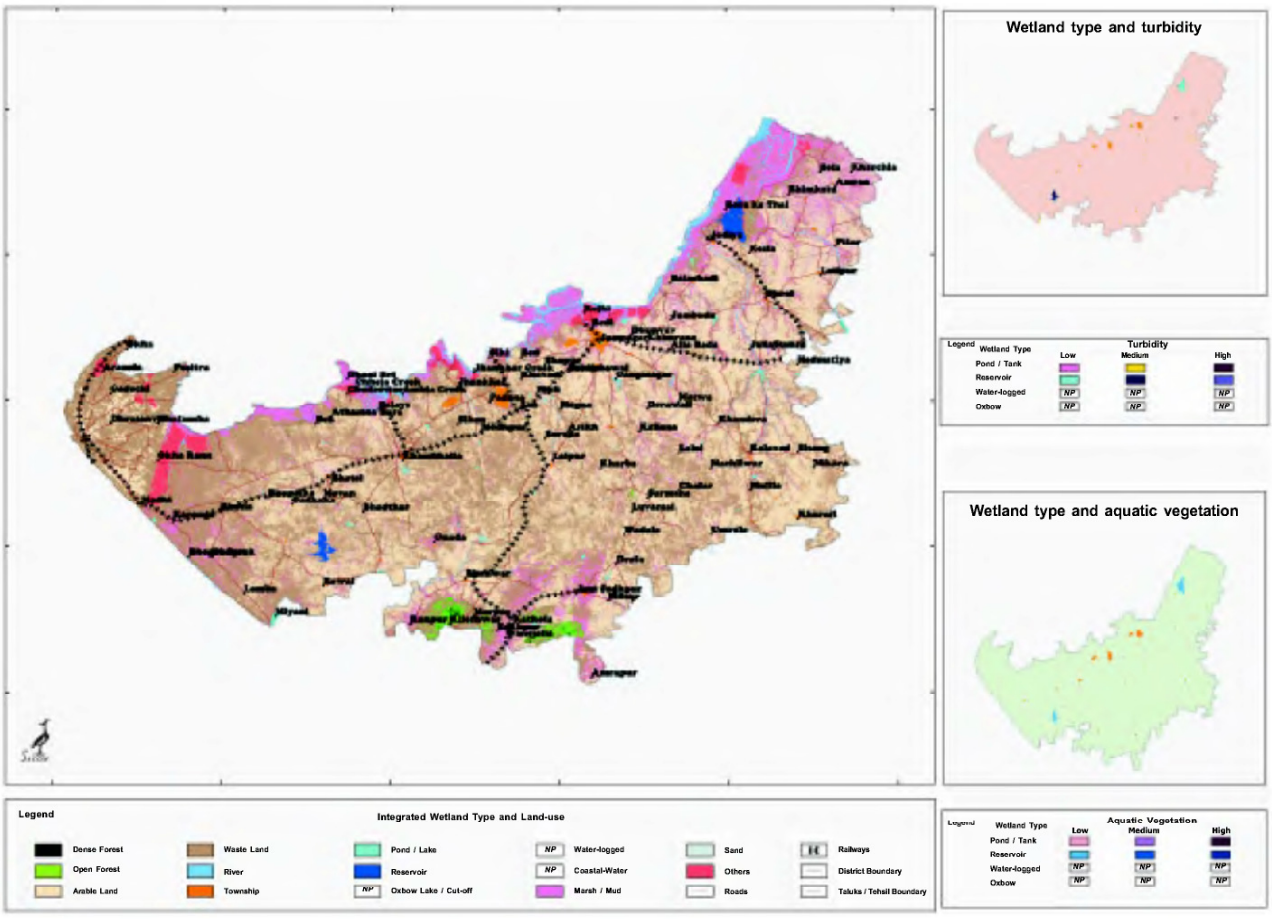


Fig. 11.8. Land use and wetland categories of the the district of Jamnagar

Table 11.7. Area under different land use and wetland categories in the district of Jamnagar

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	6.58	0.06
Forest-open	47.19	0.43
Arable land	4,670.80	42.78
Wasteland	4,599.29	42.13
Wetland-ponds/lakes/tanks	35.23	0.32
Wetland-reservoirs	46.72	0.43
Marshy land	789.22	7.23
Desert	286.13	2.62
Township	61.76	0.57
Other water body/river	175.15	1.60
Others (area for which satellite data not available)	199.00	1.82

Table 11.8. Area under different turbidity classes in the district of Jamnagar

Turbidity class	Area(sq km)	% of total wetland area
Low	39.97	49.22
Moderate	36.11	44.47
High	5.12	6.30

Table 11.9. Seasonal pattern of wetland areas in the district of Jamnagar

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	11.49	3.90	7.59	
Reservoirs	31.85	2.97	28.88	
Total	43.34	6.87	36.47	84.15

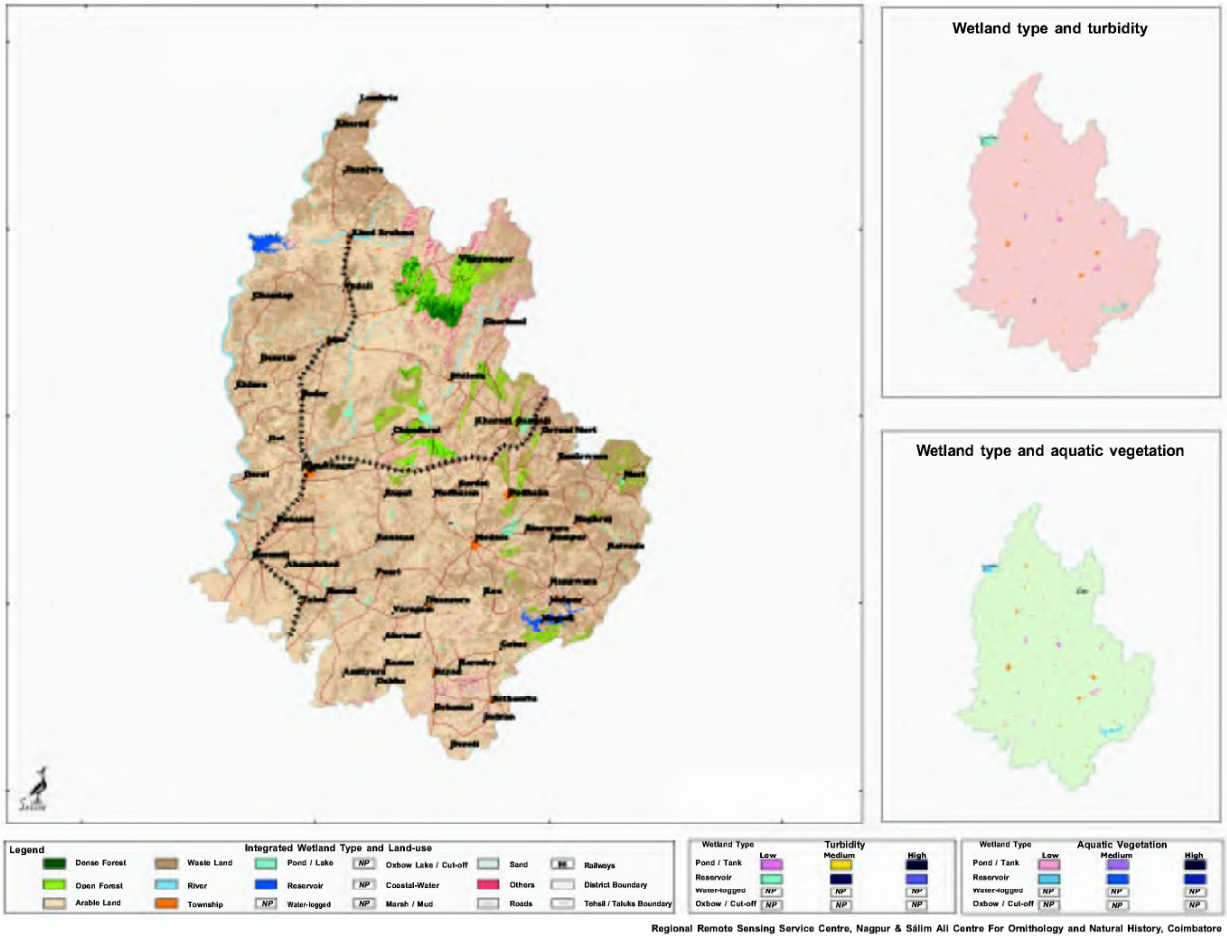


Fig. 11.9. Land use and wetland categories of the the district of Sabarkantha

Table 11.10. Area under different land use and wetland categories in the district of Sabarkantha

Land use/land cover class (level-II)	Area (sq km)	% of total study area
Forest-dense	72.63	0.94
Forest-open	154.90	2.01
Arable land	3,555.82	46.16
Wasteland	2,820.72	36.61
Wetland-ponds/lakes/tanks	35.71	0.46
Wetland-reservoirs	35.17	0.46
Township	28.87	0.37
Sand	167.28	2.17
Other water body/river	81.81	1.06
Others (area for which satellite data not available)	750.89	9.75

Table 11.11. Area under different turbidity classes in the district of Sabarkantha

Turbidity class	Area (sq km)	% of total wetland area
Low	51.85	73.11
Moderate	15.51	21.88
High	3.55	5.01

Table 11.12. Seasonal pattern of wetland areas in the district of Sabarkantha

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	24.48	13.10	11.38	
Reservoirs	19.15	5.39	13.76	
Total	43.63	18.49	25.14	57.62

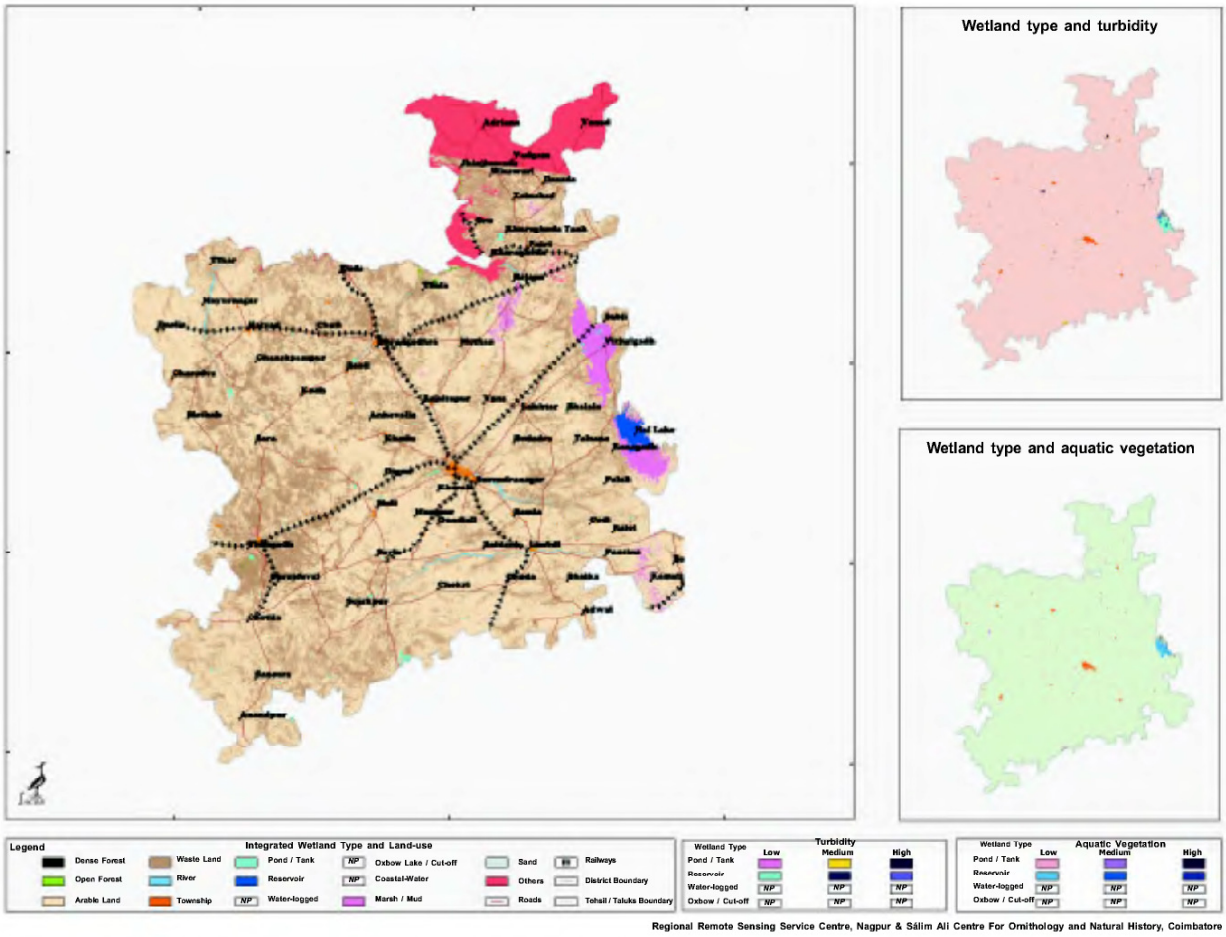


Fig. 11.10. Land use and wetland categories of the the district of Surendranagar

Table 11.13. Area under different land use and wetland categories in the district of Surendranagar

Land use/land cover class (level II)	Area (sq km)	% of total study area
Forest-dense	1.77	0.02
Forest-open	2.72	0.03
Arable land	6,565.04	62.05
Wasteland	3,055.74	28.88
Wetland-ponds/lakes/tanks	26.25	0.25
Wetland-reservoirs	37.24	0.35
Marshy	210.30	1.99
Township	39.77	0.38
Other water body /river	35.68	0.34
Others (area for which satellite data not available)	605.46	5.72

Table 11.14. Area under different turbidity classes in the district of Surendranagar

Turbidity class	Area (sq km)	% of total wetland area
Low	39.75	61.03
Moderate	13.32	20.45
High	12.06	18.52

Table 11.15. Seasonal pattern of wetland areas in the district of Surendranagar

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	15.80	5.24	10.56	
Reservoirs	37.24	20.05	17.19	
Total	53.04	25.29	27.75	52.32

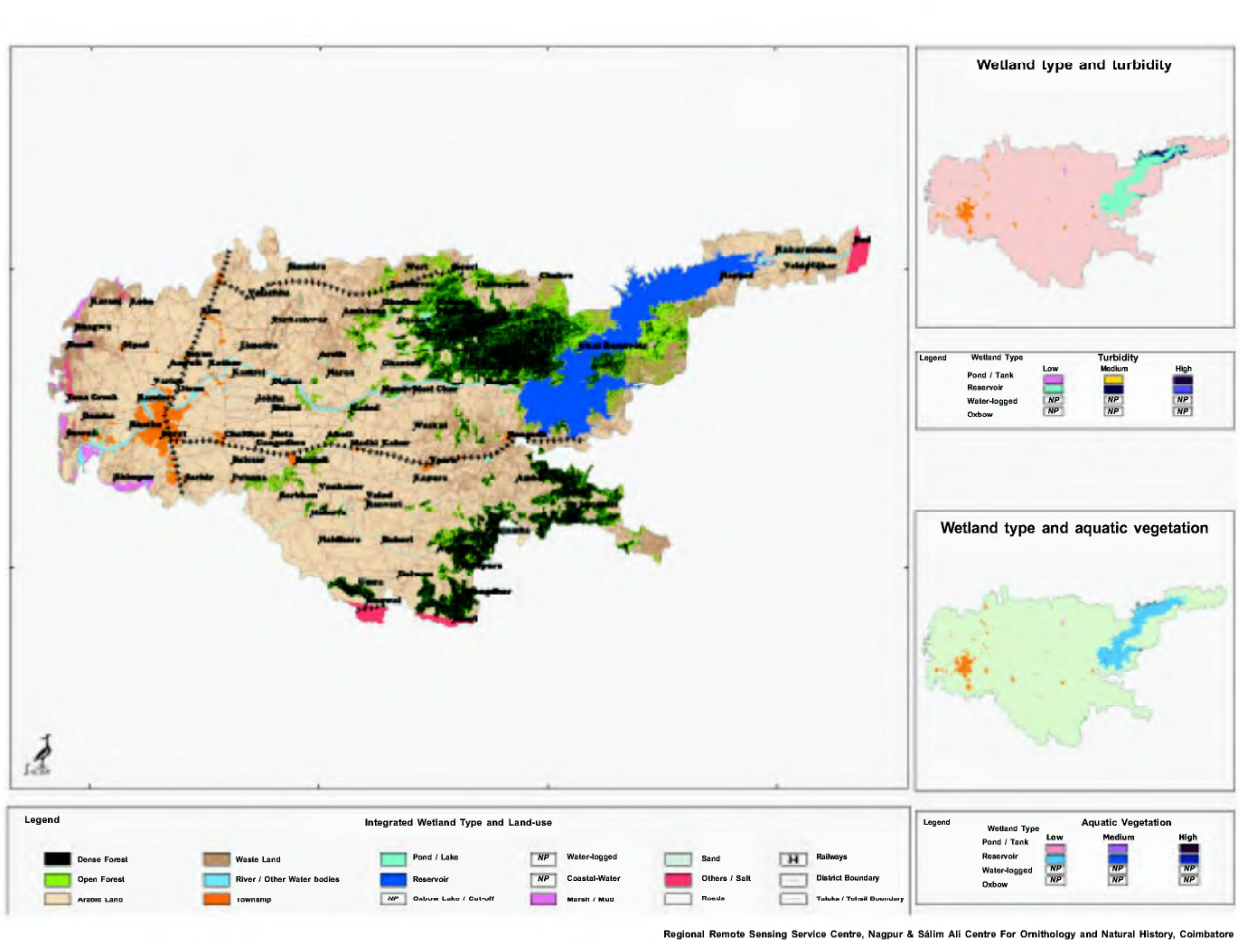


Fig. 11.11. Land use and wetland categories of the the district of Surat

Table 11.16. Area under different land use and wetland categories in the district of Surat

Land use/land cover class(level II)	Area (sq km)	% of total study area
Forest-dense	852.65	11.24
Forest-open	398.91	5.26
Arable land	3,802.00	50.11
Wasteland	1,636.39	21.57
Wetland-ponds/lakes/tanks	17.04	0.22
Wetland-reservoirs	466.93	6.15
Marshy	36.46	0.48
Township	132.19	1.74
Other water body/river	160.95	2.12
Others (area for which satellite data not available)	84.43	1.11

Table 11.17. Area under different turbidity classes in the district of Surat

Turbidity class	Area (sq km)	% of total wetland area
Low	433.00	90.04
Moderate	46.66	9.70
High	1.25	0.26

Table 11.18. Seasonal pattern of wetland areas in the district of Surat

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/tanks	1.77	0.74	1.03	
Reservoirs	466.93	336.63	130.30	
Total	468.70	337.37	131.33	28.02

Birds

Altogether 5,28,219 birds comprising 155 species, including four mostly terrestrial ones, were recorded in 45 wetlands (Table 11.24). Species richness was the highest in Gosa (112) followed by Bardasagar (111) and Kuchhadi-Jawar (105). Eight wetlands, namely Amipur, Kuchadi-Jawar, Pariej, Gosa, Vadhavana, Kaj wetland, Bardasagar and Ajwa had more than 20,000 birds. Five wetlands had 10,000 to 20,000 and only 13 wetlands had fewer than 1,000 birds. Asian Waterfowl Counts suggest that these wetlands used to support good waterfowl population during the years of normal rainfall. The present census shows that Amipur tank of Junagadh district had the highest number of waterfowl (1,08,490). This has already been identified as an internationally important site for wintering cranes (Mundkur and Taylor, 1993; Lopez and Mundkur, 1997). During the present survey also, 40,000+ cranes were recorded roosting.

Out of the 155 species of birds recorded, the most abundant species (>20,000) were the Coot, Demoiselle Crane, Shoveller, Pintail and Lesser Flamingo. Eight species, namely the Common Crane, Common Teal, Ruff, Greater Flamingo, Wigeon, Blacktailed Godwit, Common Pochard and Gadwall were between 10,000 and 20,000. Another 35 species were from 1,000 to 10,000 in number. Most abundant water birds were migratory and only a few were resident. However, the distribution shows that more widespread species were resident; 37 of them were found in more than 50% of the wetlands surveyed. Five species, namely the Little Cormorant, Grey Heron, Pond Heron, Redwattled Lapwing and Blackwinged Stilt were counted in 36 wetlands and five more species, namely the Little Egret, Shoveller, Little Grebe, Common Teal and Coot in 34 wetlands while 39 species were seen only in one or two wetlands.

Out of the 45 wetlands, 38 supported one or more Threatened or Near Threatened species. Top amongst these were Gosa (9 species), Amipur (8 species), Bardasagar and Sayant (7 species each). Totally 21 wetlands supported 1% of global population of one or more species. Top amongst these were Amipur which

Table 11.24. Major wetlands of Gujarat with species and number of birds

S.No.	Name of the wetland	Species	Total birds
1	Amipur tank	99	1,08,490
2	Kuchadi-Jawar	104	60,776
3	Pariej	89	39,234
4	Gosa	112	37,207
5	Vadhavana	69	36,691
6	Kaj wetland	57	35,944
7	Barda sagar	111	35,286
8	Ajwa	46	20,394
9	Brahmani dam	53	17,458
10	Naghrama	62	14,837
11	Veri dam	75	14,120
12	Lunivav	74	10,858
13	Machhan nala	67	9,561
14	Sayant	73	8,858
15	Narda	62	7,562
16	Chhari-Dhandh	9	6,715
17	Sudamda dam	49	6,543
18	Lakhota	54	6,431
19	Kanewal	64	6,316
20	Deo dam	53	6,276
21	Daloli	58	5,711
22	Panoli	16	4,526
23	Tapi barrage	27	3,796
24	Timbi tank	46	3,769
25	Lakhi tank	3	3,120
26	Nava talav	54	2,615
27	Aji-I	47	2,497
28	Bhimdad dam	42	1,893
29	Madhuvanti dam	42	1,835
30	Vasai irrigation	37	1,694
31	Nyari-I	38	1,432
32	Sihan dam	50	1,200
33	Ghee dam	28	914
34	Palan	38	764
35	Nadan	28	562
36	Dharoi dam babsar	28	552
37	Sukhbhadar dam	48	460
38	Heranj	14	385
39	Govindpura	31	339
40	Karajan dam	24	336
41	Bhanderaj	21	186
42	Santhalpur tank	6	76
43	Eastern Great Rann	0	0
44	Korda sandher	0	0
45	Sherva Dhandh	0	0
	Total	155	5,28,219

supported 11 species followed by Kuchadi-Jawar (9 species), Veri dam (7 species), Kaj wetland and Bardasagar (6 species each). Although Kuchadi-Jawar supported only six of these species, their number was the highest (10,073); Gosa had the second highest number (2,432). Totally, 495 birds of six Threatened species and 23,970 birds of seven Near Threatened species were recorded. Some of them were seen only in a few wetlands (Table 11.25), thereby making these wetlands eligible for priority conservation.

Table 11.25. Frequency of sightings of Threatened and Near Threatened wetland birds in Gujarat

S.#	Species	Status of species	No. of wetlands	No. of birds
1	Sarus Crane	T	17	309
2	Dalmatian Pelican	T	10	134
3	Greater Spotted Eagle	T	11	35
4	Whitebacked vulture	T	4	13
5	Spoonbilled Sandpiper	T	1	2
6	Imperial Eagle	T	1	2
7	Lesser Flamingo	NT	10	21,198
8	White Ibis	NT	29	1,212
9	Painted Stork	NT	23	915
10	White-eyed Pochard	NT	13	544
11	Darter	NT	12	49
12	Pale Harrier	NT	6	49
13	Blacknecked Stork	NT	2	3

T=Threatened; NT=Near Threatened

Environmental contamination

One hundred and fifty nine fishes belonging to 11 species from 11 wetlands from Gujarat were examined for pesticide and heavy metal contamination.

Heavy metals

Of the five metals studied, except lead, all others, namely copper, zinc, cadmium and chromium were within the permissible limits in all wetlands. Lead was the highest in Deo dam (7.79±1.1 ppm) and minimum in Meshwo dam (4.96±0.85 ppm) (Fig. 11.15). Wetlands such as Vadhwana, Dharoi dam, and Nalsarovar Bird Sanctuary showed comparatively high concentrations of all the metals analyzed and there was significant difference in the accumulation among these wetlands ($P<0.005$).

Among the various species received from Gujarat, *Oreochromis mossambicus* recorded the maximum concentrations of lead (7.31±1.82 ppm) followed by *Heteropneustes fossilis* (6.56±1.94 ppm) while *Catla catla* recorded the minimum (4.62±0.65 ppm) (Fig. 11.16). Levels of all other metals in the rest of the species appear to be safe.

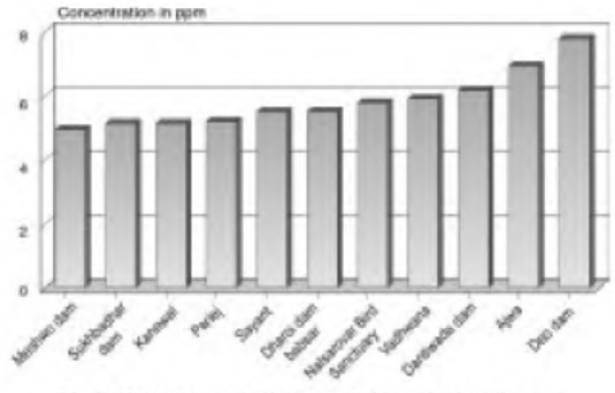


Fig. 11.15. Lead contamination among select wetlands of Gujarat

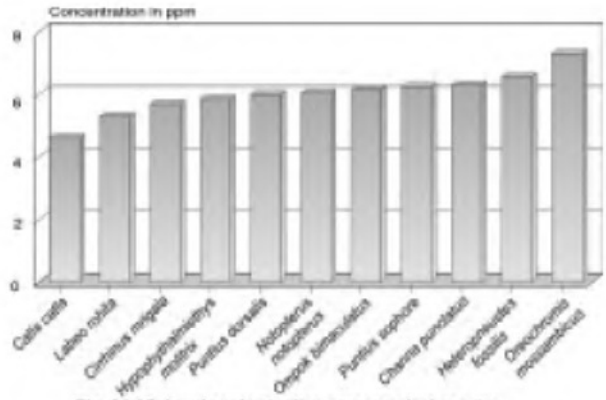


Fig. 11.16. Lead contamination among select species of fishes of Gujarat

A significant difference (P<0.005) in contamination among the species was noted which appears to be related to their feeding habits. For example, *Oreochromis mossambicus*, an omnivorous fish recorded high concentration of lead than *Catla catla* , a plankton feeder.

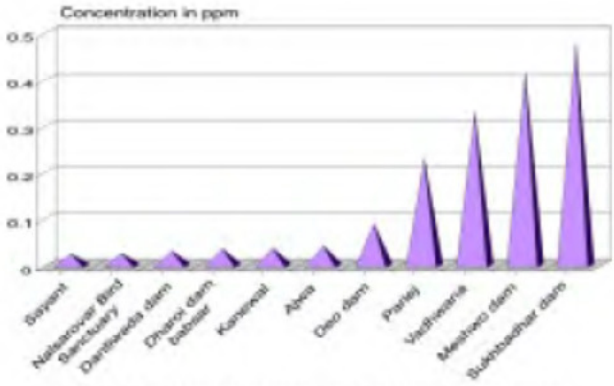


Fig. 11.17. Total organochlorine residues among select wetlands of Gujarat

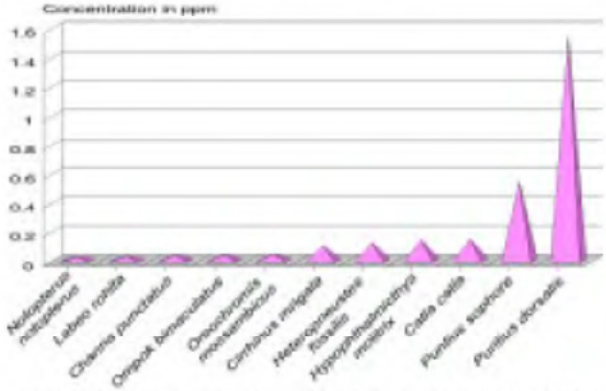


Fig. 11.18. Total organochlorine residues among select species of fishes in Gujarat

Pesticides

Quantification of organochlorine residues revealed that among the wetlands, Sukhbhadar dam (0.474 ppm) of Bhavnagar district and Meshwo dam (0.411ppm) of Sabarkanth district recorded higher load of organochlorine residues followed by Vadhwana in Baroda (0.327 ppm) and Pariej (0.227 ppm) in Anand district. The least concentration was recorded in Sayant (0.025 ppm) of Kheda district (Fig. 11.17).

Of the 11 species analyzed for organochlorine residues, *Puntius dorsalis* (1.531 ppm) and *Puntius sophore* (0.542 ppm) recorded the highest total average organochlorine residues while *Labeo rohita* (0.032 ppm) *and Notopterus notopterus* (0.026 ppm) had the least (Fig. 11.18).

It may be noted that *Puntius dorsalis* received from Gujarat had the highest pesticide load of all the fishes analyzed from the entire country. The contamination level reported in the fishes of Sukhbhadar dam, Meshwo dam, Vadhwana and Pariej is high enough to cause threat to fish and wildlife, and also to human beings.

Suitability for human consumption

Levels of cadmium, copper, and zinc do not appear to be alarming. However, the daily dietary intake of lead through fishes such as *Channa punctatus (0.22 mg), Heteropneustes fossils (0.23 mg), Notopterus notopterus (0.22 mg), Ompok bimaculatus (0.22 mg), Puntius sophore (0.22 mg)* and *Oreochromis mossambicus* (0.26 mg) will be higher than the levels prescribed (0.21 mg per 60 kg adult) by UN Committee (WHO, 1989, 1993). Increased and regular consumption of these fishes will certainly inflict serious damages to human kidney and liver.

Puntius dorsalis from Meshwo dam and Sukhbhadar dam is not suitable for human consumption, since the recorded levels of HCH (73.32µg) are four-fold higher than that recommended by Health Canada (1996) for human consumption (18µg/day/person). Among the 14 states considered for the study, Gujarat ranked second in organochlorine contamination. Incidentally, fishes from Gujarat get transported to neighbouring states and also, all the way to West Bengal in particular.

Socioeconomic values

A preliminary assessment of the use values showed that these wetlands are being utilized in different levels. Of the eight types of major uses of the wetlands, those with six and seven uses were considered as of high use, with four and five uses as of medium and less than four as of low use. Many sites had high use (Table 11.26).

Prioritization of wetlands

Of the 45 sites selected and studied, 42 sites were prioritized using birds as explained under the methodology. The remaining three which had no birds as they were dry, being affected by the severe drought during the year, were also included in the prioritized list considering the records of earlier years.

The sites are arranged in the order of total ratings and ranks (Table 11.26). 16 wetlands were rated as of high priority for conservation, as they came in the first rank, while the next 10 in the second rank. Out of these, Sihan dam, and Sukhbhadar dam came up into the second rank because of their size. The next 12 were in the third rank and the remaining seven in the fourth rank.

Many of the known wetlands were totally dry (Eastern Great Rann, Korda Sandher, Sherva Dhand) or had very little water (Santhalpur, Bhanderaj, Heranj, Nyari-I, Kanewal) because of the drought. As a result, they have been prioritized on the basis of the observations made during the previous years. This makes the total prioritized wetlands to be 45. Out of these, all the 16 in the first rank and the first five in the second rank, making a total of 21, qualify to be declared as Ramsar sites.

Spatial distribution of the prioritized wetlands in relation to BCPP and Protected Areas is given in Fig. 11.19.

Summary

- Total number of wetlands of the size 56.25 ha and above was estimated at 393, covering an area of 2,092 sq km and, those below 56.25 ha was 588 according to the satellite data of 1992-93 (SAC, 1998).

Table 11.26. Prioritized list of the major wetlands in Gujarat

S.No.	Site	Rank	Use grade
1	Kuchadi-Jawar	1	M
2	Amipur tank	1	L
3	Gosa	1	M
4	Barda sagar	1	L
5	Narda	1	L
6	Veri dam	1	H
7	Kanewal	1	L
8	Pariej	1	L
9	Kaj wetland	1	H
10	Sayant	1	L
11	Lunivav	1	H
12	Daloli	1	M
13	Machhan nala	1	M
14	Naghrama	1	L
15	Vadhavana	1	L
16	Aji-1	1	H
17	Deo dam	2	M
18	Ajwa	2	H
19	Sudamda dam	2	H
20	Chhari-Dhandh	2	H
21	Brahmani dam	2	M
22	Nava talav	2	M
23	Vasai irrigation	2	M
24	Lakhota	2	H
25	Sihan dam	2	L
26	Sukhbhadar dam	2	M
27	Bhimdad dam	3	H
28	Madhuvanti dam	3	H
29	Nyari-1	3	H
30	Palan	3	M
31	Bhanderaj	3	L
32	Govindpura	3	H
33	Timbi tank	3	M
34	Heranj	3	L
35	Ghee dam	3	L
36	Tapi barrage	3	H
37	Dharoi dam babsar	3	H
38	Karajan dam	3	H
39	Nadan	4	H
40	Panoli	4	H
41	Lakhi tank	4	H
42	Santhalpur tank	4	M
43	Eastern Great Rann	4	DD
44	Korda Sandher	4	DD
45	Sherva Dhand	4	DD

L=Low; M=Medium; H=High; DD=Data deficient

- SACON's estimate of the number and area of wetlands having 2 ha and above in five select districts is 663 and 743.76 sq km respectively.
- Smaller wetlands are numerous compared to larger ones.
- Most of the lakes/ ponds had moderate to high turbidity while the reservoirs had low to moderate.
- The district of Sabarkantha showed a drastic decline of its wetland area for the past 10 years, whereas that in Jamnagar showed many-fold increase.
- The lakes/ ponds had moderate to dense vegetation while reservoirs had low to moderate vegetation. Twenty six aquatic macrophytes including 10 emergent, nine submerged and seven floating species were recorded.
- Gujarat has 11 endemic aquatic plants; 11 Vulnerable species of fishes; and five species of turtles, of which one is Vulnerable, three are Near Threatened, and one is under the category of 'Least Concern'.
- In the 45 wetlands studied, 5,28,219 birds belonging to 159 species were recorded.
- There were six Threatened and seven Near Threatened species of birds with 495 and 23,970 birds respectively.
- One hundred and fifty nine fishes of 11 species from 11 wetlands were studied for heavy metal and pesticide contamination.
- Vadhwana, Dharoi dam babsar and Nalsarovar Bird Sanctuary had comparatively higher concentrations of metals, while Sukhbadhar dam, Meshwo dam had high concentration of pesticides.
- *Puntius dorsalis* had the highest concentration of organochlorine pesticide, among all the fishes examined throughout the country.
- Among the fishes of the 14 states studied, those from Gujarat ranked second in the organochlorine pesticide contamination.
- Forty-five wetlands have been prioritized for conservation.
- Twenty-one wetlands are qualified to be declared as Ramsar sites.



B.M. Parasharya

Demoiselle Crane at Kuchhadi - Javar

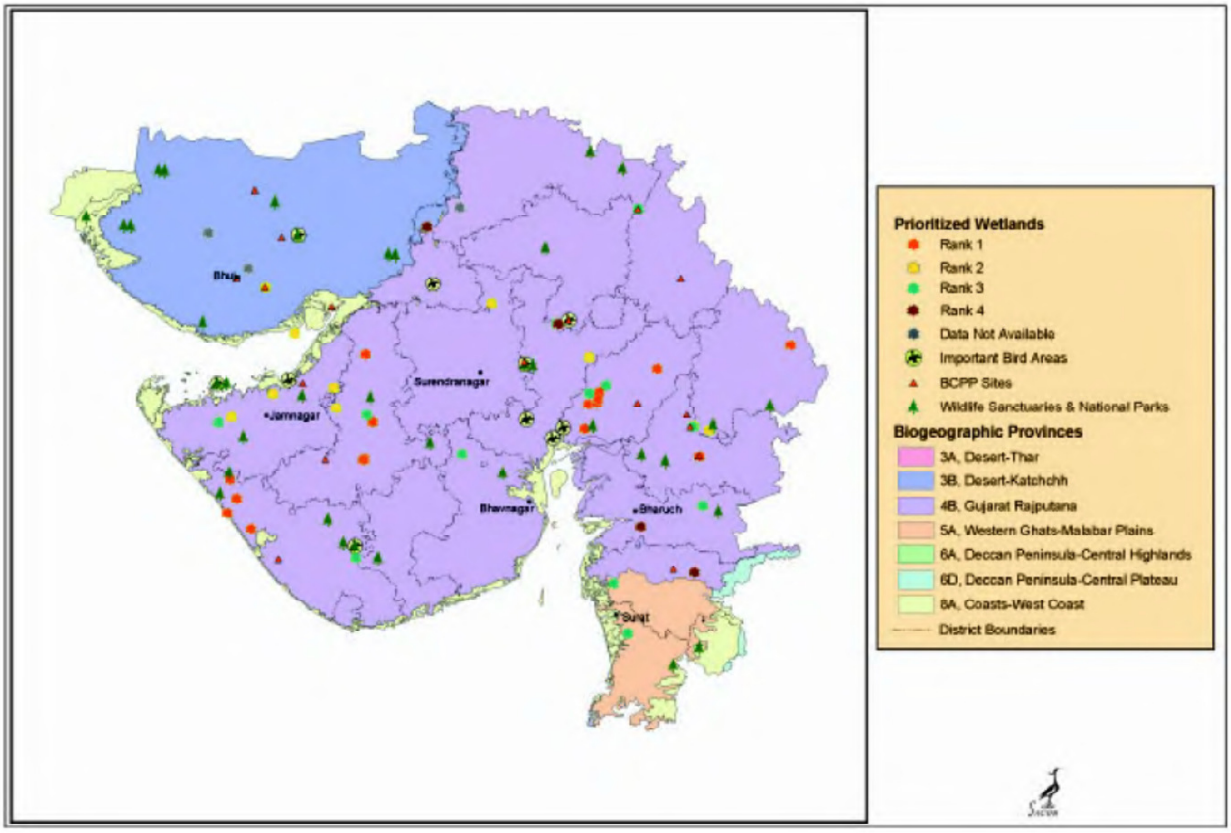


Fig. 11.19. Prioritized wetlands and other conservation areas in Gujarat



V.S. Vijayan

Common and Demoiselle cranes at Khijidia Bird Sanctuary



V.S. Vijayan

Gulls in a city tank in Jamnagar

RAJASTHAN

Rajasthan, the land of peacocks, princedoms and palaces, is the second largest state in India, after Madhya Pradesh. The Great Indian Desert, the Thar, gives the state a distinguishing character. Mount Abu in the Sirohi district is the highest mountain in Rajasthan and its tallest peak, Gurusikhar is 1,717 meters high. The Aravalli range of hills, divides the state into two major parts, south-east and north-west. The north-west consists of a series of sand dunes covering nearly two-thirds of the area. Physiographically Rajasthan can be divided into six major units, namely the Western arid region, Semi-arid region, Aravalli region, Eastern plains, South-Eastern region and Chambal ravines.



The average rainfall of the state varies from 100 mm in the arid western parts to over 1,000 mm in the Aravallis. The climate of Rajasthan is characterized by extremes of temperature and aridity. The average temperature varies from 8.6 to 40.3°C.

The main rivers of the state are Loni from Nag hills near Ajmer, Gambhiri from Karauli hills, Chambal, Banas, Banganga and Matri. The Sambhar lake is the largest natural salt lake in Rajasthan and covers an area of 230 sq km when it is full.

State at a glance	
State Capital	Jaipur
Area	3,42,239 sq km
Population (2001)	5,64,73,122
Total number of districts	32
Major Rivers	Loni, Gambhiri, Chambal, Banganga, Matri
Total forest Area	25,570 sq km
Population density (2001)	165/sq km
Ramsar sites	2
Proposed Ramsar sites	8
Total sites proposed for conservation	47

Status of wetlands

The land use statistics of Rajasthan, as in other states does not depict wetlands as a category (Table 12.1). From the estimates of SAC (1998), the state has 1.01% of its land covered by wetlands, each of the size 56.25 ha and above. The total number of wetlands in the state, on the basis of the satellite data of 1992-93, was 1,054 (SAC, 1998), covering an area of 3,449.64 sq km (Table 12.2). However, in 13 out of the 32 districts, 2,135 wetlands covering an area of 861.56 sq km were recorded when all the wetlands of the size 2 ha and above were considered (Table 12.3).

Table 12.1. Land use pattern in Rajasthan

Land use type	Area in sq km
Total geographic area	3,42,239
Forests	25,570
Not available for cultivation	43,080
Other uncultivated land excluding fallow land	68,010
Fallow land	45,250
Net area sown	1,60,730
Area sown more than once	53,280
Total cropped area	2,14,010
Cultivable area	2,73,990

(Source: www.indiastat.com)

Table 12.2. Distribution of various categories of inland wetlands in Rajasthan

Inland wetland	Area (sq km)	No. of Wetlands
Lakes/ ponds	54.21	44
Playas	1,185.19	79
Reservoirs	2,101.82	915
Waterlogged (Man-made)	108.42	16
Total	3,449.64	1054

Source: SAC (1998)

Table 12.3. Area (in sq km) under different classes of wetlands in select districts of Rajasthan

Districts	Ponds/lakes		Reservoirs		Waterlogged		Oxbow lakes		Total no.	Total area
	No.	Area	No.	Area	No.	Area	No.	Area	of wetlands	of wetlands
Barmer	24	3.33	-	-	-	-	-	-	24	3.33
Bharatpur	34	10.28	-	-	8	19.40	-	-	42	29.68
Bhilwara	312	73.95	1	0.04	27	0.78	-	-	340	74.77
Chittaurgarh	263	61.31	164	10.89	21	0.70	12	185.83	460	258.72
Jaipur	117	45.99	-	-	-	-	-	-	117	45.99
Jaisalmer	84	108.86	-	-	-	-	-	-	84	108.86
Jalore	14	1.46	3	0.08	-	-	-	-	17	1.54
Jodhpur	28	2.20	-	-	-	-	-	-	28	2.20
Nagaur	95	13.64	-	-	-	-	-	-	95	13.64
Pali	190	84.78	-	-	-	-	-	-	190	84.78
Sawai Madhopur	143	30.12	3	20.75	-	-	12	0.55	158	51.42
Tonk	330	92.71	4	41.65	-	-	-	-	334	134.36
Udaipur	206	52.26	-	-	-	-	40	-	246	52.26
Total	1,840	580.89	175	73.41	56	20.88	64	186.38	2135	861.55

The spatial distribution of wetlands (Fig. 12.1) shows that corresponding to the physiographic division of the state, the wetlands in the south-east are many and are prominently clumped in dense clusters. In contrast, in the north-west, they are few and far between.

The wetlands of Rajasthan include lakes, ponds, playas, reservoirs, and waterlogged areas (Table 12.2). In the recent times, the seepage wetlands formed because of the irrigation from the Indira Gandhi Canal, are yet another major addition to the wetland types of the state.

Habitat analyses of wetlands in select districts

Thirteen districts, namely Barmer, Bharatpur, Bhilwara, Chitturgarh, Jaipur, Jaisalmer, Jalore, Jodhpur, Nagaur, Pali, Sawai Madhopur, Tonk, and Udaipur were chosen to map wetlands at finer resolution (23.5 m) to capture wetlands above 2 ha in size. Relevant data and Information were collected on wetland numbers and extent, land use, levels of turbidity and aquatic vegetation. The results, as area under wetlands with other land uses, turbidity, a cross classification of wetlands and turbidity and seasonal difference in water levels are given in tables 12.4 to 12.41. It was found that the land use and seasonal pattern in water levels vary from district to district.

The area under wetland is the highest in Chittaurgarh; 2.41% of the geographical area of the district; followed by Tong; 1.87% of the district (Fig. 12.2). The extent of wetland was the least in Barmer, Jalore and Jodhpur; 0.01% in each district. In Jaisalmer a desert district, significant area (109 sq km) was under wetland due to lakes formed by waterlogging from the Indira Gandhi Canal (Table 12.3). Ponds and lakes contribute to most of the wetlands in the 13 districts studied (Fig. 12.3). In Chittaurgarh, almost all the wetlands were oxbow type.

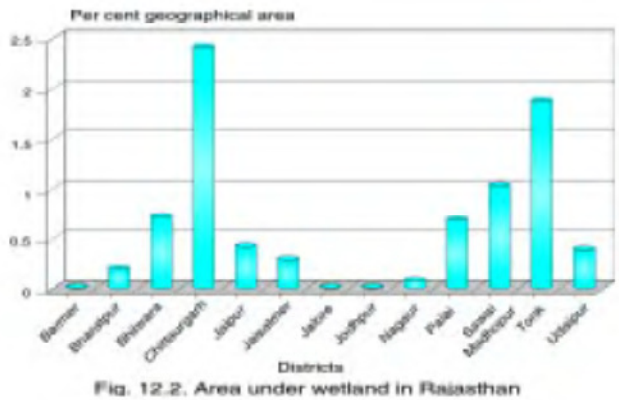


Fig. 12.2. Area under wetland in Rajasthan

It is to be noted that in all the districts, almost all the wetlands are below 56.25 ha in size with the highest number in Chittaurgarh (460) followed by Bhilwara (340) and Tonk (334) (Fig. 12.4).

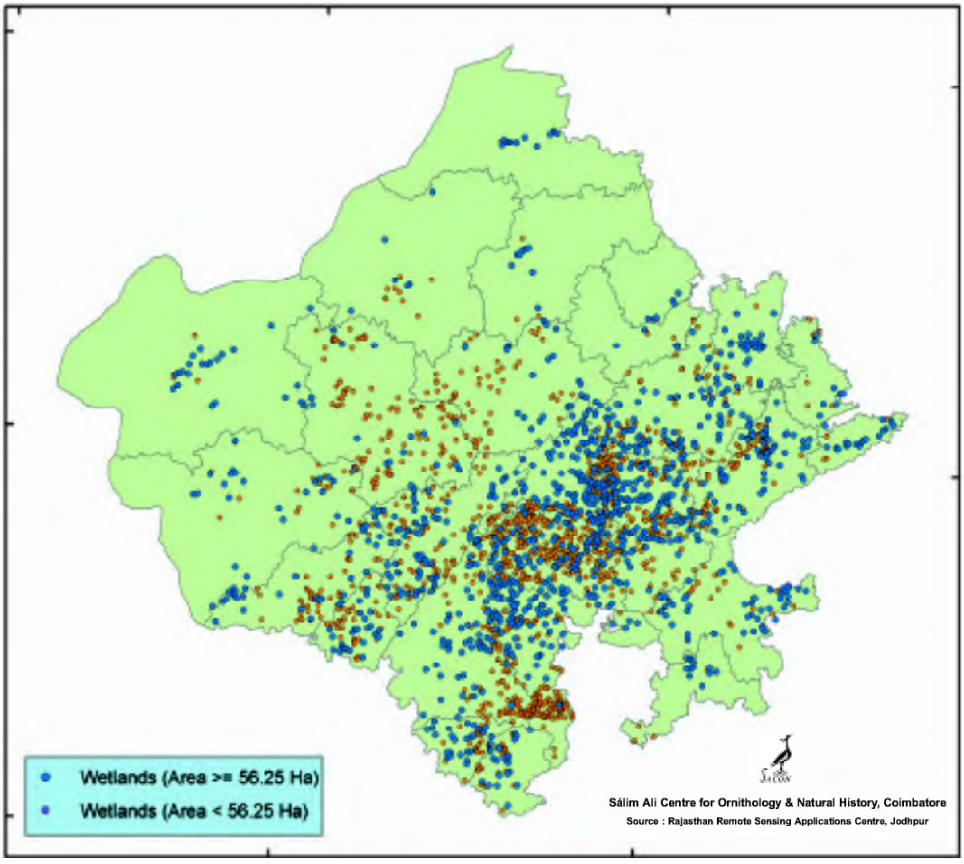


Fig. 12. 1. Distribution of wetlands in Rajasthan

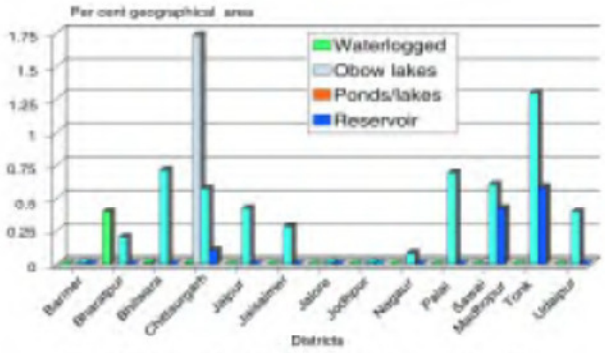


Fig. 12.3. Area under different wetland classes in Rajasthan

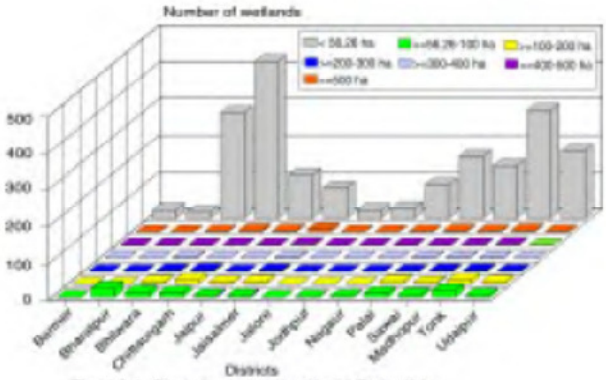


Fig. 12.4. Size class distribution in Rajasthan

Turbidity

Turbidity levels in the reservoirs and ponds/lakes were mostly moderate/high. Only in the case of the reservoirs of the district of Tonk and the ponds/lakes in the districts of Bharatpur and Udaipur did the low turbidity prevail (Fig. 12.5). In the case of the ponds/lakes of the districts of Bilwara and Chitturgarh the turbidity was low to moderate (Fig. 12.6).

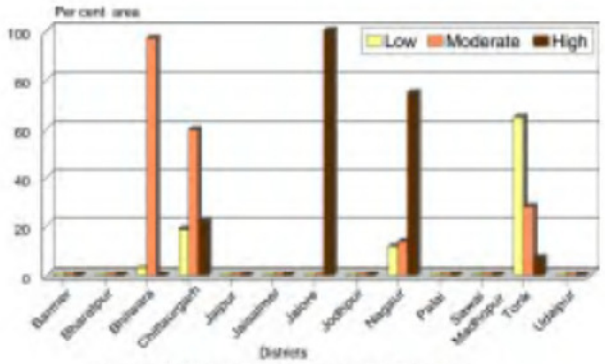


Fig. 12.5. Turbidity pattern of reservoirs in Rajasthan

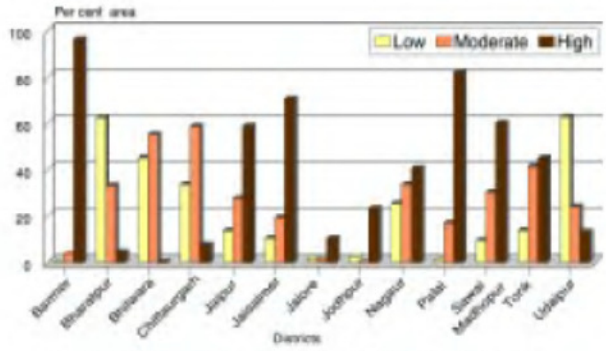


Fig. 12.6. Turbidity pattern of wetlands ponds/lakes/waterlogged areas in Rajasthan

Summer recession

The summer (pre-monsoon) recession of water was the highest in the wetlands of Tong district followed by those of Sawai Madhopur, Bilwara and Palai (Fig. 12.7). Minimum recession was found in Jaisalmer and Udaipur districts.

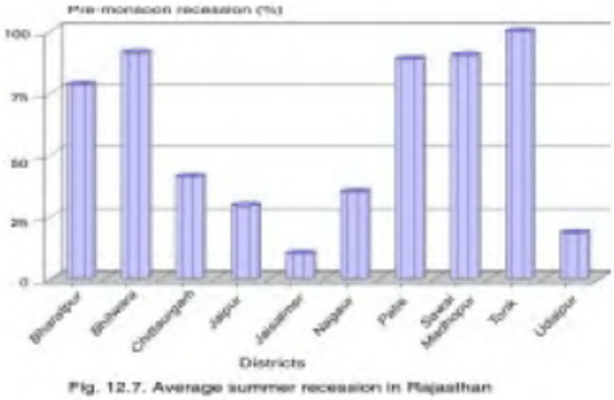


Fig. 12.7. Average summer recession in Rajasthan

Wetlands and land use pattern in the catchment areas

The integrated land use and wetland maps of all the thirteen districts show that almost all the wetlands are embedded in a landscape dominated by agricultural land (Fig. 12.8-12.20). Seasonal change analyses were not done for the districts of Barmer, Jalore and Jodhpur because of the total drying up of these wetlands. This would mean 100% loss of waterspread in the wetlands studied (Fig. 12.7).

Table 12.40. Comprehensive turbidity and aquatic vegetation pattern in the districts of Rajasthan

Wetland class	No. of wetlands	Area sq km	% of wetland type area					
			Turbidity levels			Aquatic vegetation		
			Low	Moderate	High	Low	Moderate	High
Barmer								
Ponds/ lakes/ tanks	24	3.33	0.13	3.62	96.25	75.6	23.07	1.33
Bharatpur								
Ponds/ lakes/ tanks	42	29.68	62.43	33.16	4.41	20.38	8.91	70.71
Bhilwara								
Reservoirs	1	0.04	3.11	96.89		35.88	20.34	43.78
Ponds/ lakes/ tanks	339	74.73	44.96	55.2		69.54	20.53	9.93
Chittaurgarh								
Reservoirs	164	10.89	18.6	59.59	21.81	11.97	46.55	41.48
Ponds/ lakes/ tanks	296	247.83	33.75	58.72	7.53	63.98	28.29	7.74
Jaipur								
Ponds/ lakes/ tanks	117	45.99	13.48	27.71	58.81	65.86	26.35	7.79
Jaisalmer								
Ponds/ lakes/ tanks	84	108.86	10.34	19.2	70.46	74.83	12.17	13
Jalore								
Reservoirs	3	0.08	–		100		64.39	35.61
Ponds/ lakes/ tanks	14	1.46	0.8	10.31	88.89	48.22	42.64	9.14
Jodhpur								
Ponds/ lakes/ tanks	28	2.2	0.03	23.46	76.51	69.64	19.85	10.51
Nagaur								
Ponds/ lakes/ tanks	95	13.64	0.91	16.82	82.27	94.24	3.69	2.07
Pali								
Ponds/ lakes/ tanks	190	84.78	9.47	30.41	60.12	99.39	0.59	0.02
Sawai Madhopur								
Reservoirs	3	20.75	11.81	13.82	74.37	79.96	9.18	10.86
Ponds/ lakes/ tanks	155	30.67	25.61	33.75	40.65	30.98	20.28	48.75
Tonk								
Reservoirs	4	41.65	64.68	28.12	7.2	79.56	12.63	7.81
Ponds/ lakes/ tanks	330	92.71	13.69	41.47	44.84	72.92	16.29	10.79
Udaipur								
Ponds/ lakes/ tanks	246	55.26	62.72	24.2	13.08	93.47	5.1	1.43

Temporal changes in wetland cover

The estimated wetland cover of 1992-93 (SAC, 1998) has undergone a drastic change in the 13 districts studied. The latest data of SACON show that there is a net loss of 516.55 sq km. It is a matter of serious concern. All the districts, except Jaisalmer, had loss of wetland area. The worst affected districts are Jalore and Jodhpur, the loss being 95 and 89% respectively (Table 12.41; Fig. 12.21). Jaisalmer is the only district which had a gain in the area of wetland. This might be probably because of the water from Indira Gandhi canal.

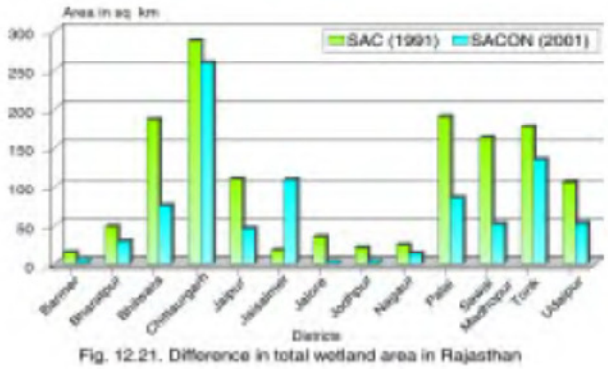


Fig. 12.21. Difference in total wetland area in Rajasthan

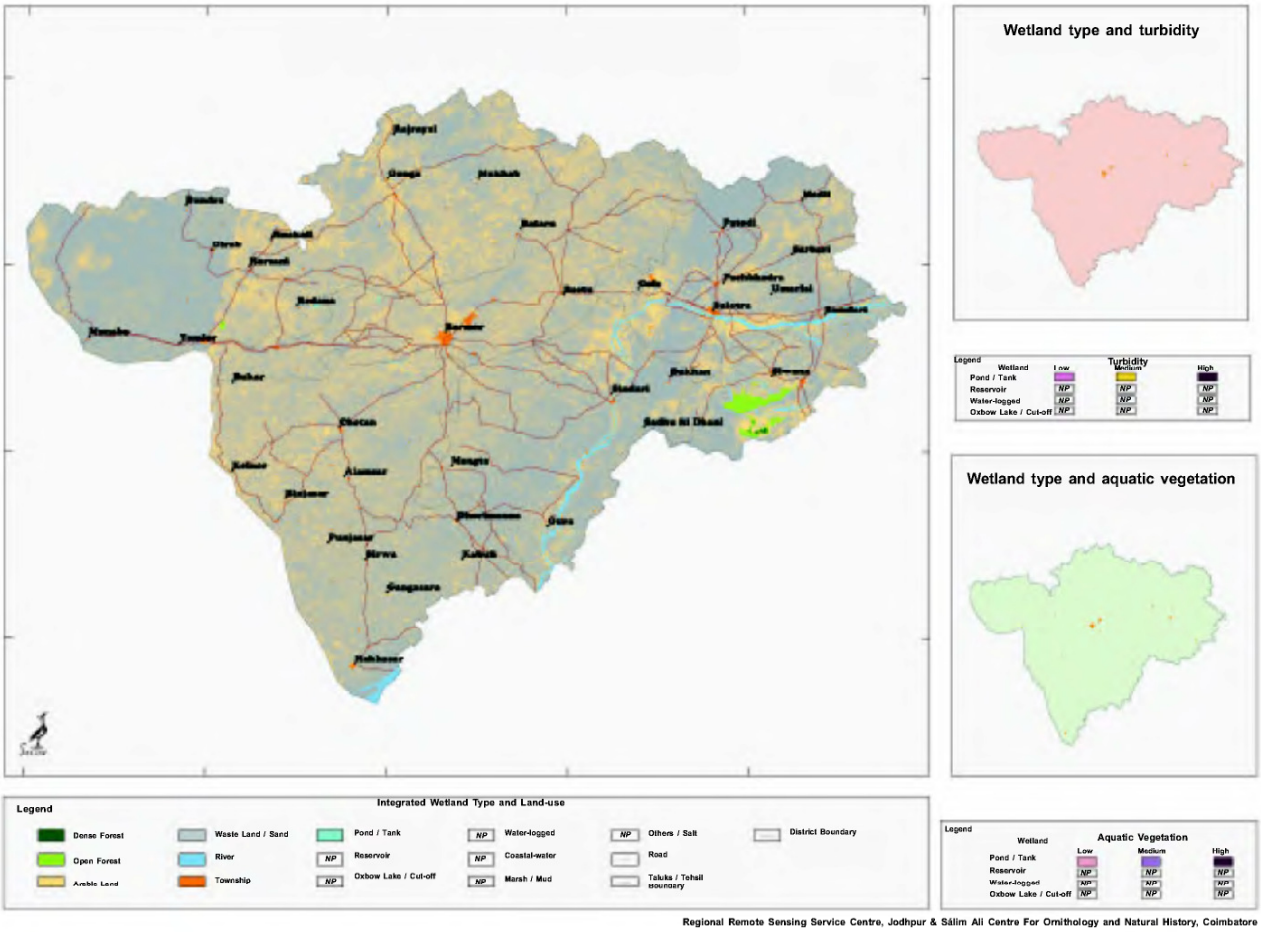


Fig. 12.8. Land use and wetland categories in the district of Barmer

Table 12.4. Area under different land use and wetlands in the district of Barmer

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	5.77	0.02
Forest- open	104.59	0.371
Arable	7,695.95	27.303
Wastelands	19,925.67	70.692
Wetland- pond/tank/lake	3.32	0.012
Wetland- reservoir	-	-
Wetland - waterlogged	-	-
Wetland- oxbow lake	-	-
River	262.36	0.930
Roads	85.09	0.302
Settlements	104.05	0.369

Table 12.5. Area under different turbidity classes in the district of Barmer

Turbidity level	Area (sq km)	% of total wetland area
Low	0.00	0.00
Moderate	0.12	4.00
High	3.20	96.00

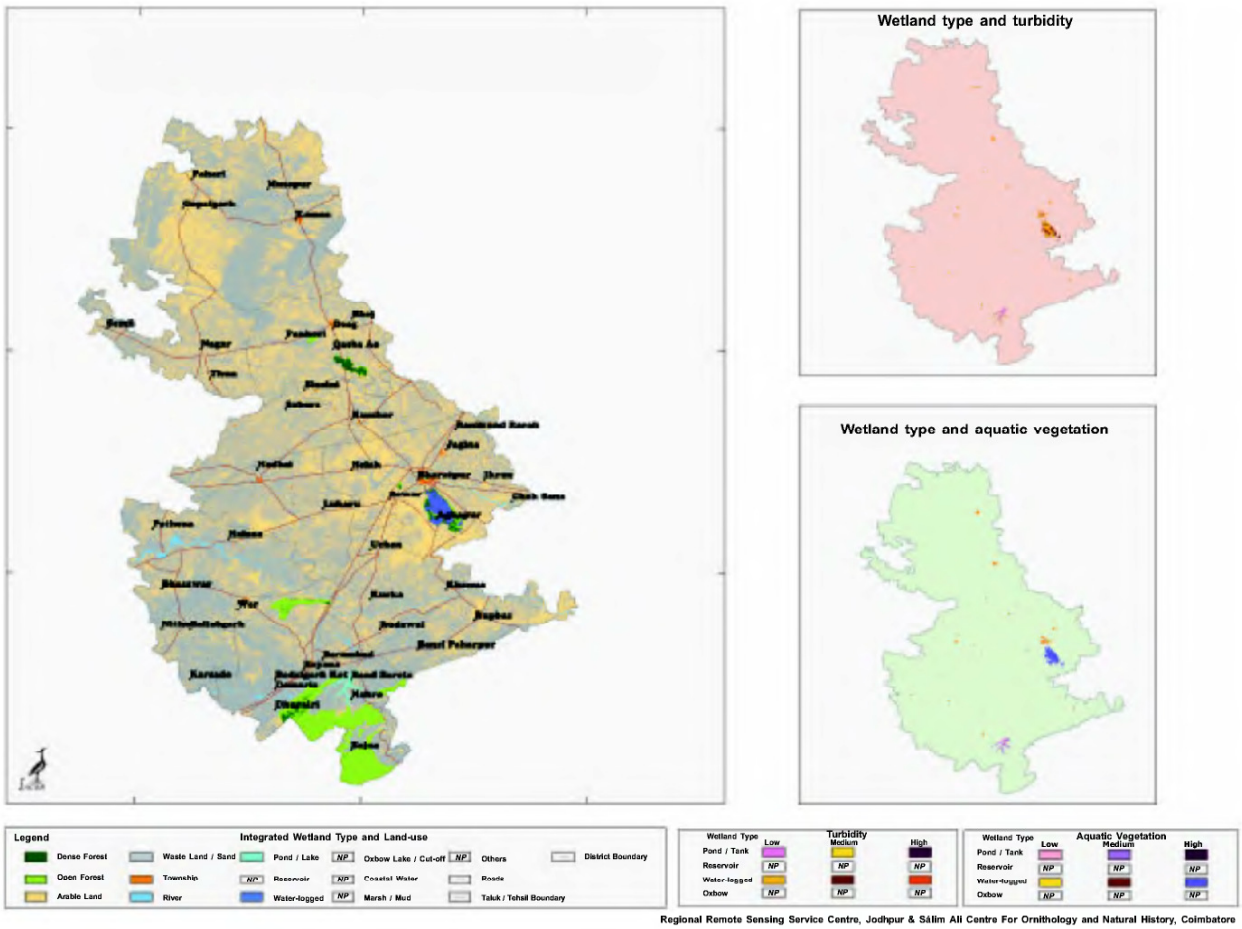


Fig. 12.9. Land use and wetland categories in the district of Bharatpur

Table 12.6. Area under different land use and wetland categories in the district of Bharatpur

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	20.59	0.408
Forest-open	147.73	2.928
Arable	1,867.02	37.014
Wastelands	2,922.38	57.937
Wetland pond/tank/lake	10.28	0.204
Wetland reservoir	-	-
Wetland waterlogged	19.40	0.385
Wetland oxbow lake/cutoff	-	-
River	25.61	0.508
Roads	17.75	0.358
Settlements	13.28	0.264

Table 12.7. Area and different turbidity classes in the district of Bharatpur

Turbidity level	Area (sq km)	% of total wetland area
Low	18.53	62.43
Moderate	9.84	33.16
High	1.31	4.41

Table 12. 8. Seasonal pattern of wetland areas in the district of Bharatpur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Baretha lake	9.00	1.99	7.01	
Keoladeo	19.43	4.19	15.23	
Total	28.43	6.18	22.24	78.25

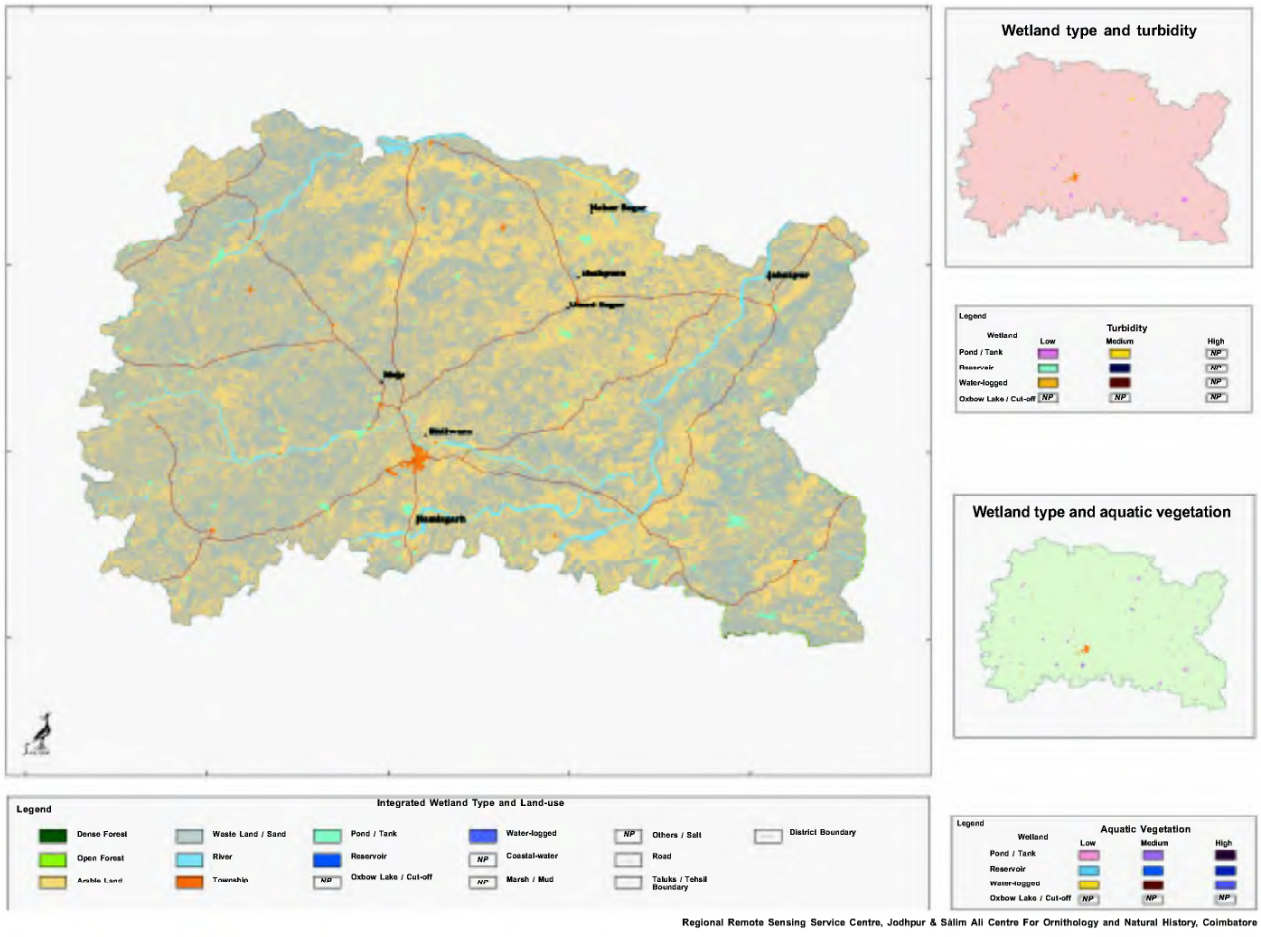


Fig. 12.10. Land use and wetland categories in the district of Bhilwara

Table 12.9. Area under different land use and wetland categories in the district of Bhilwara

Land use class (level- II)	Area (sq km)	% of total study area
Forest –dense	1.72	0.016
Forest-open	7.51	0.072
Arable	4,236.14	40.610
Wastelands	5,866.84	56.243
Wetland- pond/tank/lake	74.01	0.709
Wetland- reservoir	0.04	0.0004
Wetland-waterlogged	0.78	0.0076
Wetland-oxbow lake/cutoff	-	-
River	206.13	1.977
Roads	14.87	0.142
Settlements	23.32	0.223

Table 12. 10. Area under different turbidity classes in the district of Bhilwara

Turbidity level	Area (sq km)	% of total wetland area
Low	51.17	68.43
Moderate	23.60	31.57
High	-	-

Table 12.11. Seasonal pattern of wetland areas in the district of Bhilwara

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Near Sangni	3.21	0.39	2.82	
Near Shivpura	0.81	0.00	0.81	
Near Kukakhera	0.18	0.00	0.18	
Near Rajaji ka karera	0.28	0.02	0.27	
Total	4.48	0.41	4.08	90.89

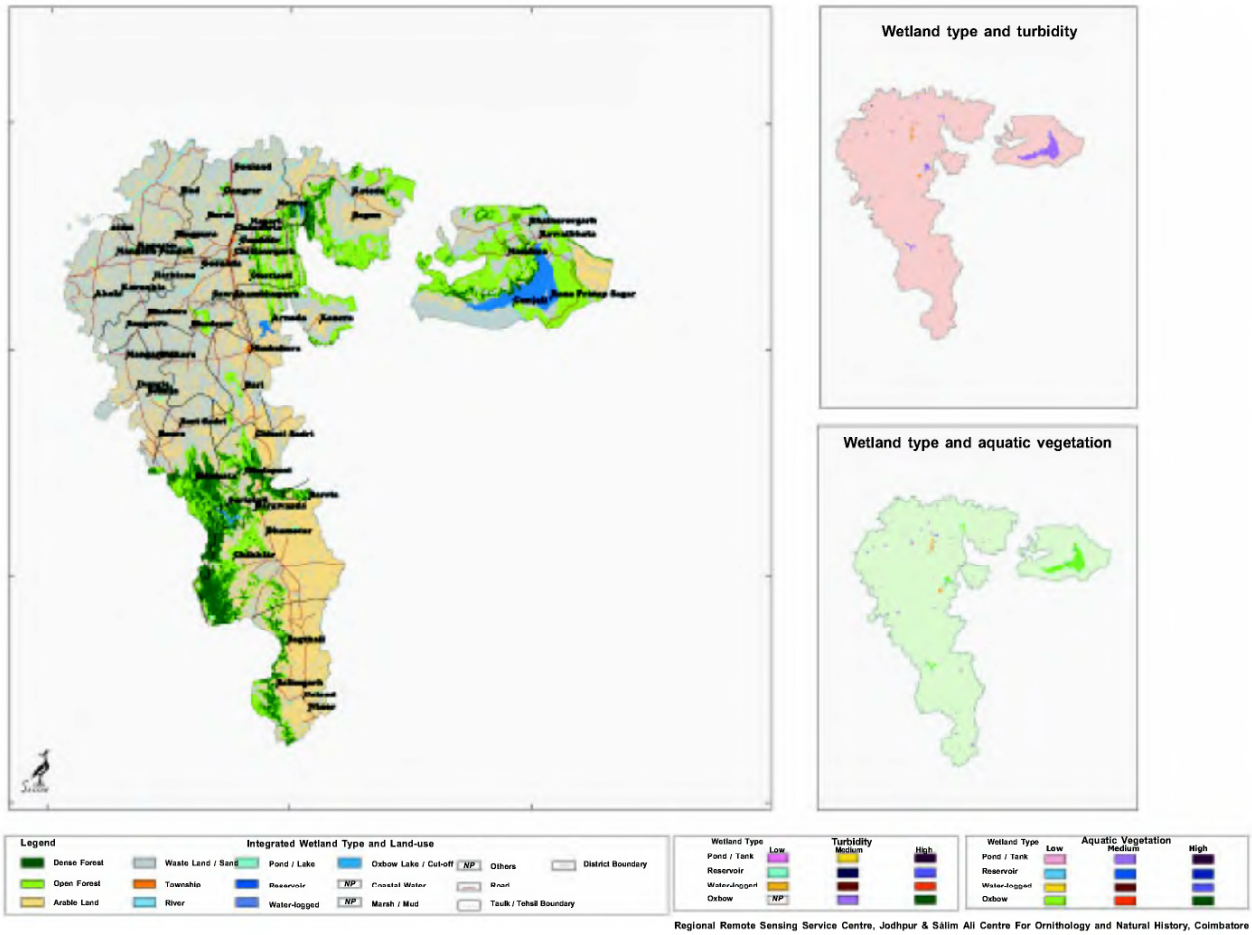


Fig. 12.11. Land use and wetland categories in the district of Chittaurgarh

Table 12.12. Area under different land use and wetland categories in the district of Chittaurgarh

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	795.25	7.407
Forest-open	1,519.92	14.157
Arable	2,840.88	26.462
Wastelands	5,147.63	47.951
Wetland- pond/tank/lake	61.31	0.571
Wetland-reservoir	10.89	0.101
Wetland-waterlogged	0.70	0.006
Wetland-oxbow lake/cutoff	185.82	1.731
River	129.60	1.207
Roads	27.54	0.256
Settlements	16.27	0.151

Table 12.13. Area under different turbidity classes in the district of Chittaurgarh

Turbidity level	Area (sq km)	% of total wetland area
Low	43.06	16.65
Moderate	204.82	79.16
High	10.85	4.19

Table 12.14. Seasonal pattern of wetland areas in the district of Chittaurgarh

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Near Gopalpura	7.96	1.35	6.61	
Near Chadaul	0.95	0.29	0.66	
Near Shabad	12.36	0.67	11.69	
Ranapratap sagar	170.60	159.71	10.89	
Gandhi sagar	420.15	200.32	219.83	
Total	612.02	362.34	249.68	40.80

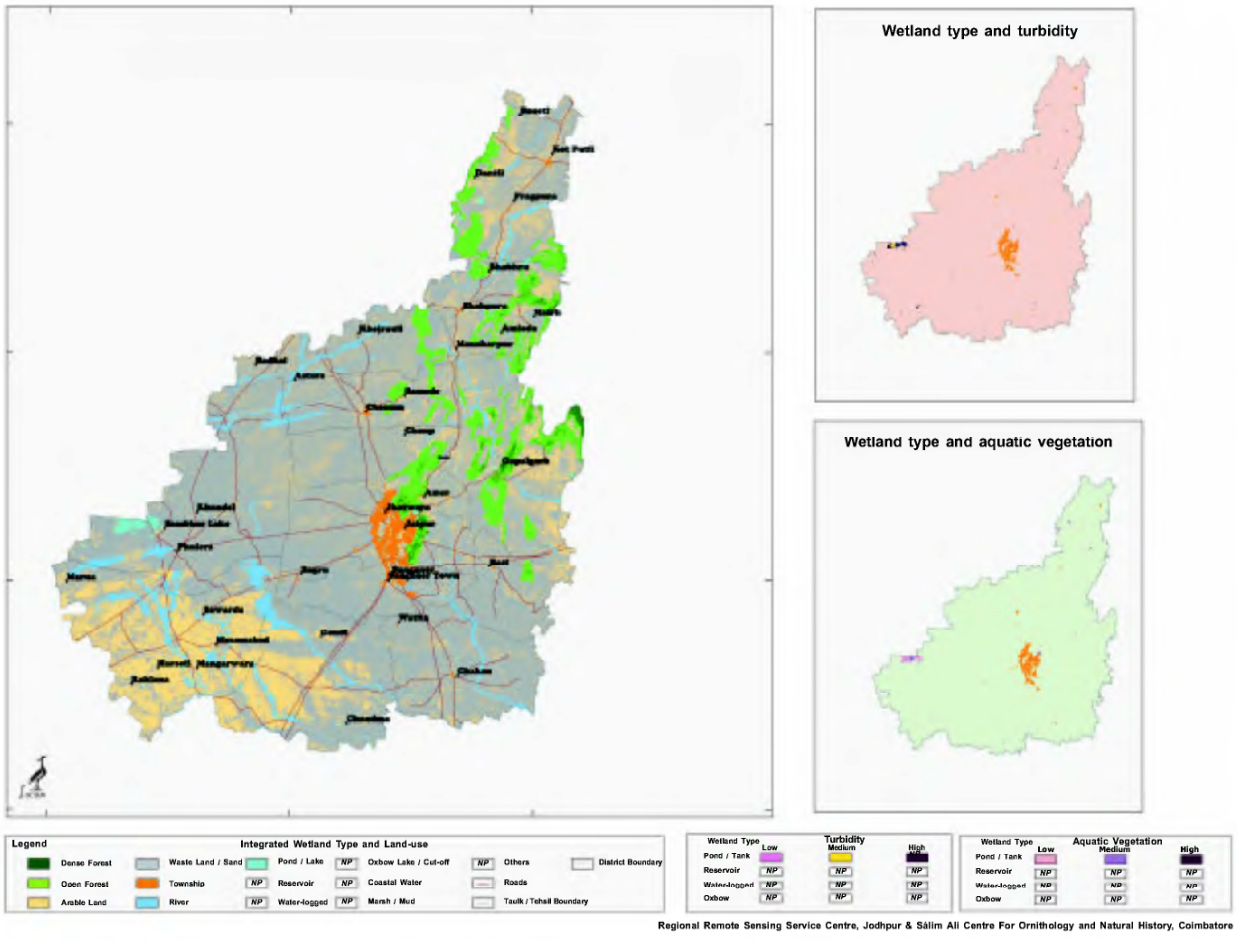


Fig. 12.12. Land use and wetland categories in the district of Jaipur

Table 12. 15. Area under different land use and wetland categories in the district of Jaipur

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	90.11	0.814
Forest-open	712.04	6.435
Arable	2,359.86	21.329
Wastelands	7,255.49	65.578
Wetland- pond/tank/lake	45.99	0.415
Wetland-reservoir	-	-
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	-	-
River	439.46	3.972
Roads	25.55	0.231
Settlements	135.68	1.226

Table 12.16. Area under different turbidity classes in the district of Jaipur

Turbidity level	Area (sq km)	% of total wetland area
Low	6.20	13.48
Moderate	12.74	27.71
High	27.04	58.81

Table 12.17. Seasonal pattern of wetland areas in the district of Jaipur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Sambhar	34.92	24.70	10.22	29.27

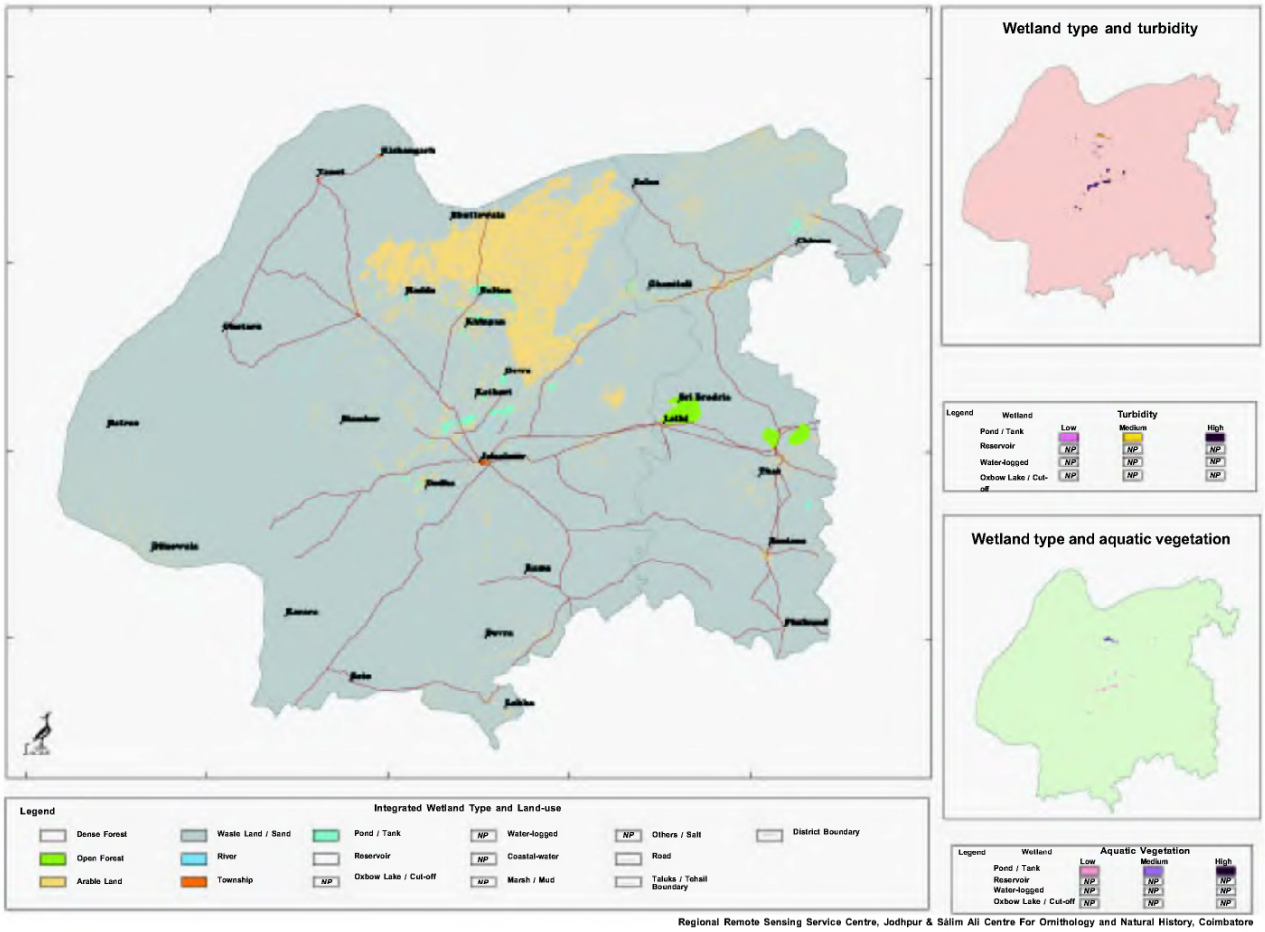


Fig. 12.13. Land use and wetland categories in the district of Jaisalmer

Table 12.18. Area under different land use and wetland categories in the district of Jaisalmer

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	-	-
Forest-open	152.41	0.40
Arable	2,622.75	6.885
Wastelands	35,087.95	92.115
Wetland- pond/tank/lake	108.86	0.286
Wetland-reservoir	-	-
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	-	-
River	61.03	0.160
Roads	53.17	0.139
Settlements	5.24	0.014

Table 12. 19. Area under different turbidity classes in the district of Jaisalmer

Turbidity level	Area (sq km)	% of total wetland area
Low	11.25	10.34
Moderate	20.90	19.20
High	76.70	70.46

Table 12.20. Seasonal pattern of wetland areas in the district of Jaisalmer

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Chachali Talav	26.30	24.09	2.21	
Khara Rann	14.99	13.12	1.87	
Total	41.29	37.21	4.08	9.89

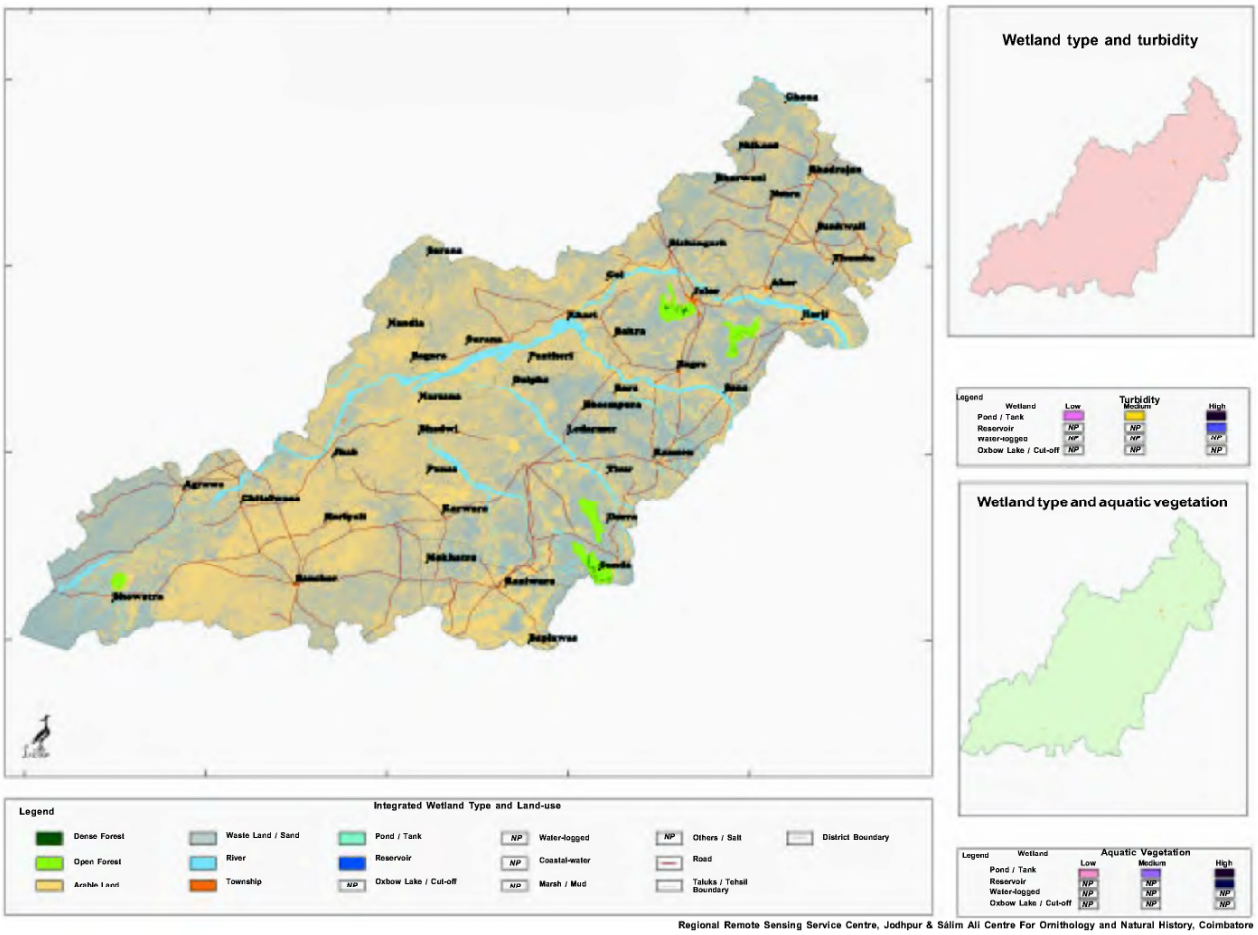


Fig. 12.14. Land use and wetland categories of the district of Jalore

Table 12. 21. Area under different land use and wetland categories in the district of Jalore

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	7.55	0.0710
Forest-open	123.92	1.1740
Arable	4,255.87	40.3310
Wastelands	5,766.86	54.6490
Wetland- pond/tank/lake	1.46	0.0130
Wetland-reservoir	0.08	0.0007
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	-	-
River	352.22	3.3370
Roads	31.60	0.2990
Settlements	0.13	0.1250

Table 12.22. Area under different turbidity classes in the district of Jalore

Turbidity level	Area (sq km)	% of total wetland area
Low	0.01	0.76
Moderate	0.15	9.76
High	1.38	89.48

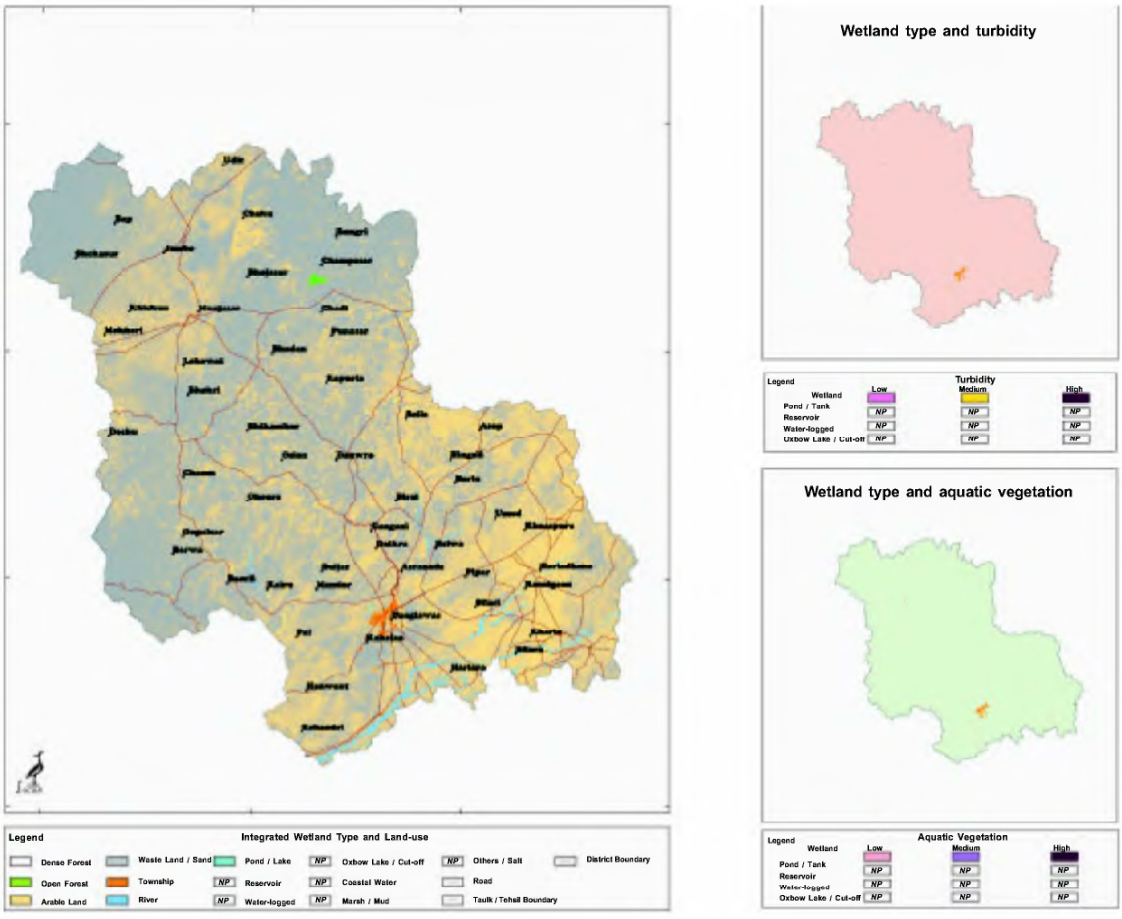


Fig. 12.15. Land use and wetland categories in the district of Jodhpur

Table 12.23. Area under different land use and wetland categories in the district of Jodhpur

Land use class (level-II)	Area (sq km)	% of total study area
Forest-dense	-	-
Forest-open	14.41	0.064
Arable	8,569.29	37.984
Wastelands	13,702.87	60.742
Wetland- pond/tank/lake	2.20	0.009
Wetland-reservoir	-	-
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	-	-
River	172.21	0.763
Roads	46.27	0.205
Settlements	52.59	0.233

Table 12.24. Area under different turbidity classes in the district of Jodhpur

Turbidity level	Area (sq km)	% of total wetland area
Low	0.00	0.03
Moderate	0.52	23.46
High	1.68	76.51

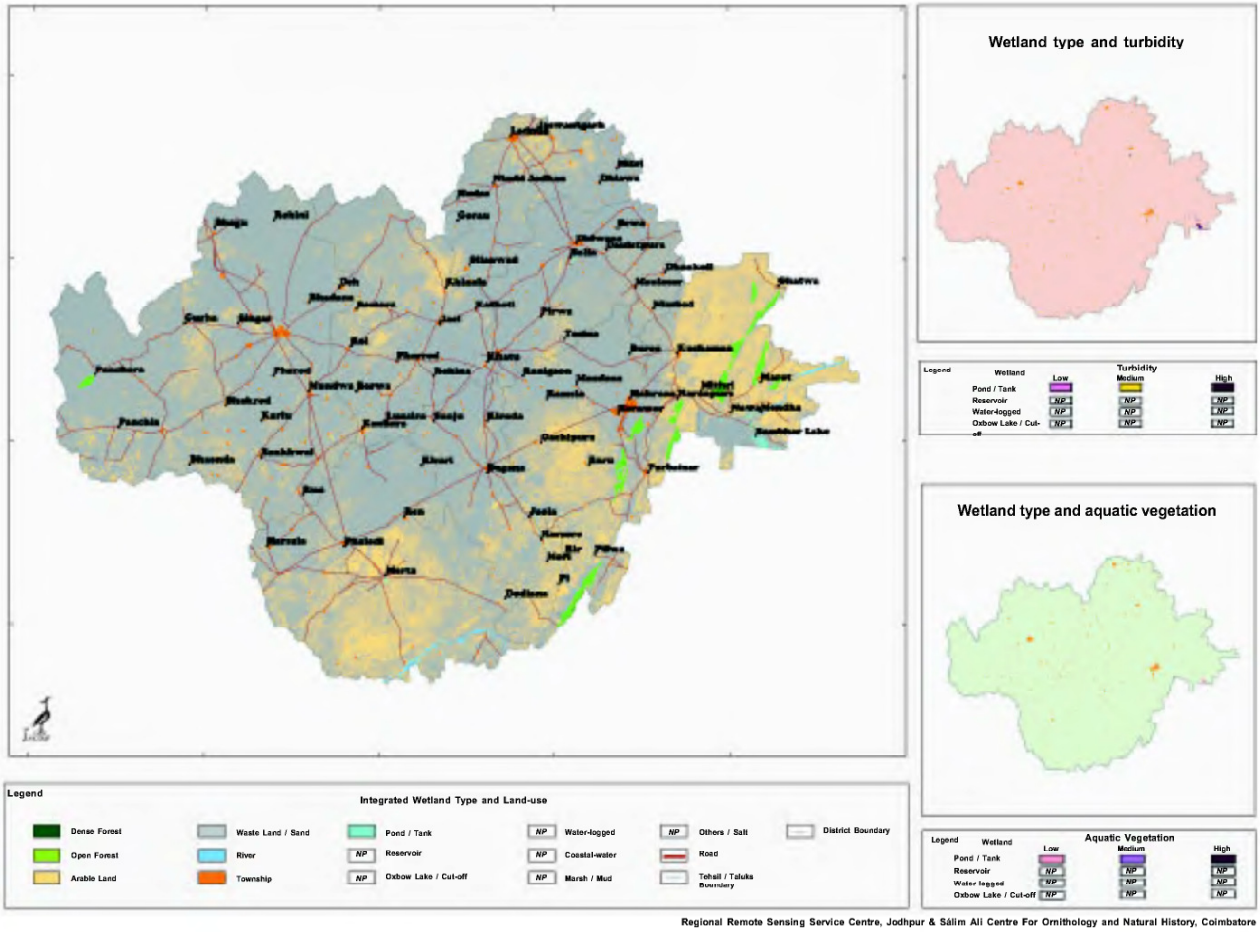


Fig. 12.16. Land use and wetland categories in the district of Nagaur

Table 12.25. Area under different land use and wetland categories in the district of Nagaur

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	1.69	0.009
Forest-open	144.37	0.816
Arable	3,549.99	20.071
Wastelands	13,710.27	77.518
Wetland- pond/tank/lake	13.64	0.077
Wetland-reservoir	-	-
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	-	-
River	42.05	0.238
Roads	69.77	0.394
Settlements	155.24	0.877

Table 12.26. Area under different turbidity classes in the district of Nagaur

Turbidity level	Area (sq km)	% of total wetland area
Low	0.12	0.91
Moderate	2.29	16.82
High	11.22	82.27

Table 12. 27. Seasonal pattern of wetland areas in the district of Nagaur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Near Didwana	0.79	0.52	0.26	
Sambhar lake	32.95	21.45	11.50	
Total	33.74	21.97	11.76	34.88

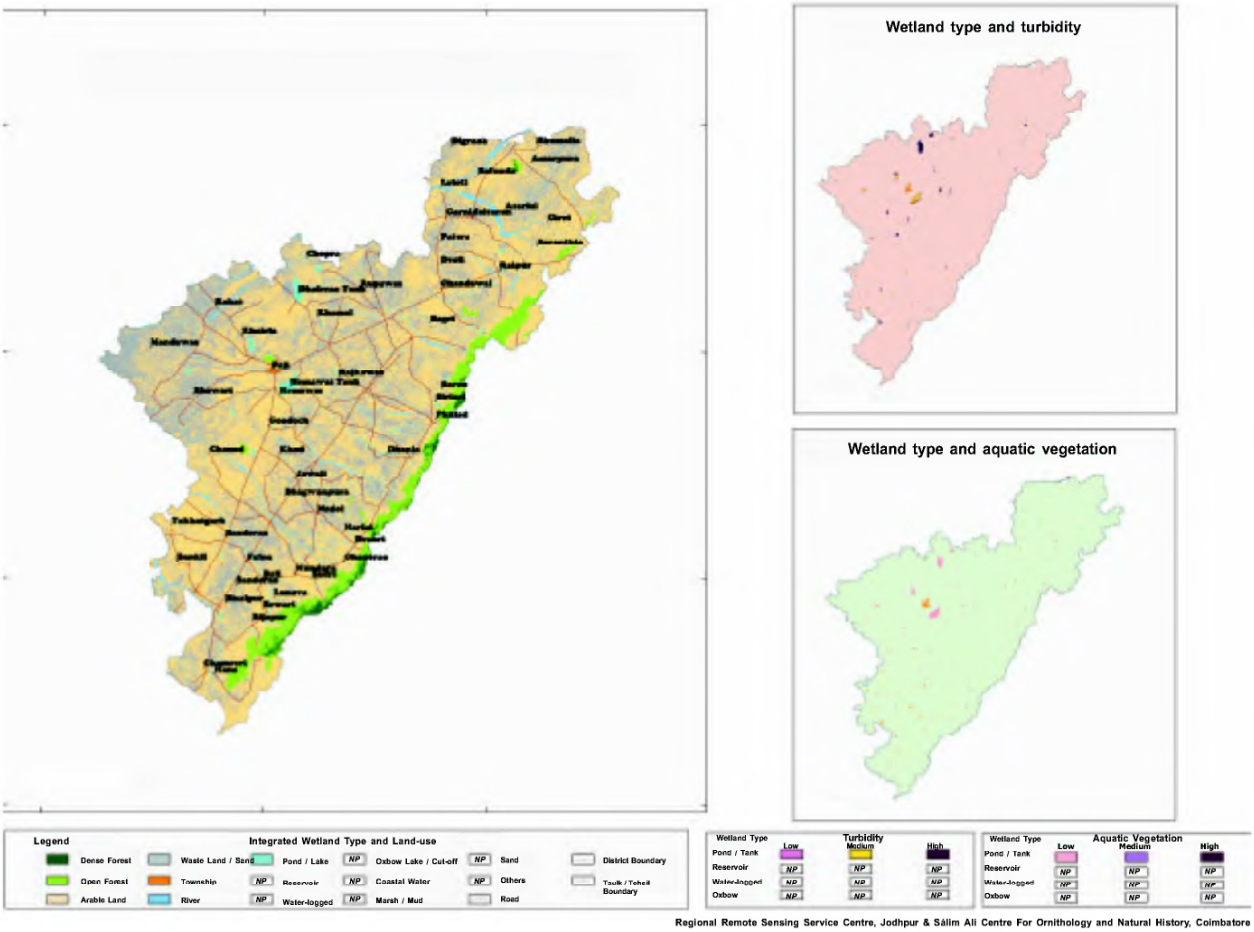


Fig. 12.17. Land use and wetland categories in the district of Pali

Table 12.28 Area under different land use and wetland categories in the district of Pali

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	87.40	0.710
Forest-open	563.27	4.578
Arable	7,294.55	59.292
Wastelands	3,867.73	31.438
Wetland- pond/tank/lake	84.79	0.689
Wetland-reservoir	-	-
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	-	-
River	334.04	2.715
Roads	34.34	0.279
Settlements	36.59	0.297

Table 12.29. Area under different turbidity classes in the district of Pali

Turbidity level	Area (sq km)	% of total wetland area
Low	8.03	9.47
Moderate	25.78	30.41
High	50.97	60.12

Table 12.30. Seasonal pattern of wetland areas in the district of Pali

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Near Mohara	1.06	0.89	0.17	
Near Nariana	0.32	0.17	0.15	
Near Raipur	2.82	0.64	2.18	
Near Kharliya	1.30	0.43	0.87	
Sardarsamand	16.22	0.59	15.62	
Near Kharda	6.36	0.58	5.79	
Total	28.08	3.30	24.78	88.25

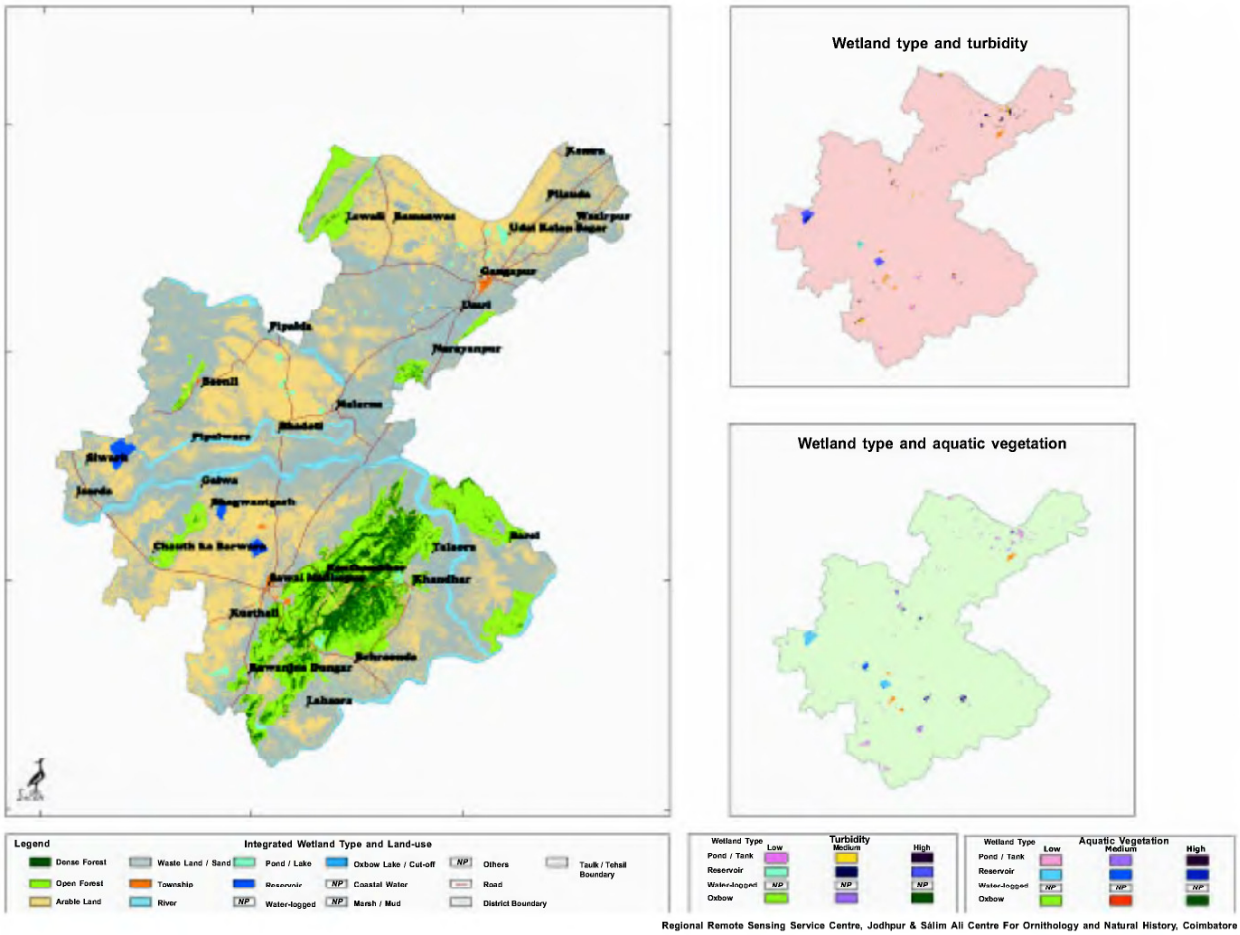


Fig. 12.18. Land use and wetland categories in the district of Sawai Madhopur

Table 12.31. Area under different land use and wetland categories in the district of Sawai Madhopur

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	214.70	4.304
Forest-open	481.40	9.651
Arable	1,565.59	31.388
Wastelands	2,481.46	49.749
Wetland- pond/tank/lake	30.12	0.604
Wetland-reservoir	20.75	0.416
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	0.55	0.011
River	176.24	3.533
Roads	9.54	0.191
Settlements	7.64	0.153

Table 12.32. Area under different turbidity classes in the district of Sawai Madhopur

Turbidity level	Area (sq km)	% of total wetland area
Low	10.09	19.62
Moderate	13.97	27.16
High	27.36	53.22

Table 12.33. Seasonal pattern of wetland areas in the district of Sawai Madhopur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Morel	8.87	0.52	8.36	
Bhagwargarh reservoir	3.07	0.71	2.36	
Rambhar talav	1.20	0.16	1.04	
Galar sagar	2.83	0.01	2.81	
Near Chaan	2.53	0.50	2.03	
Near Amli	1.50	0.13	1.37	
Total	20.00	2.03	17.97	89.87

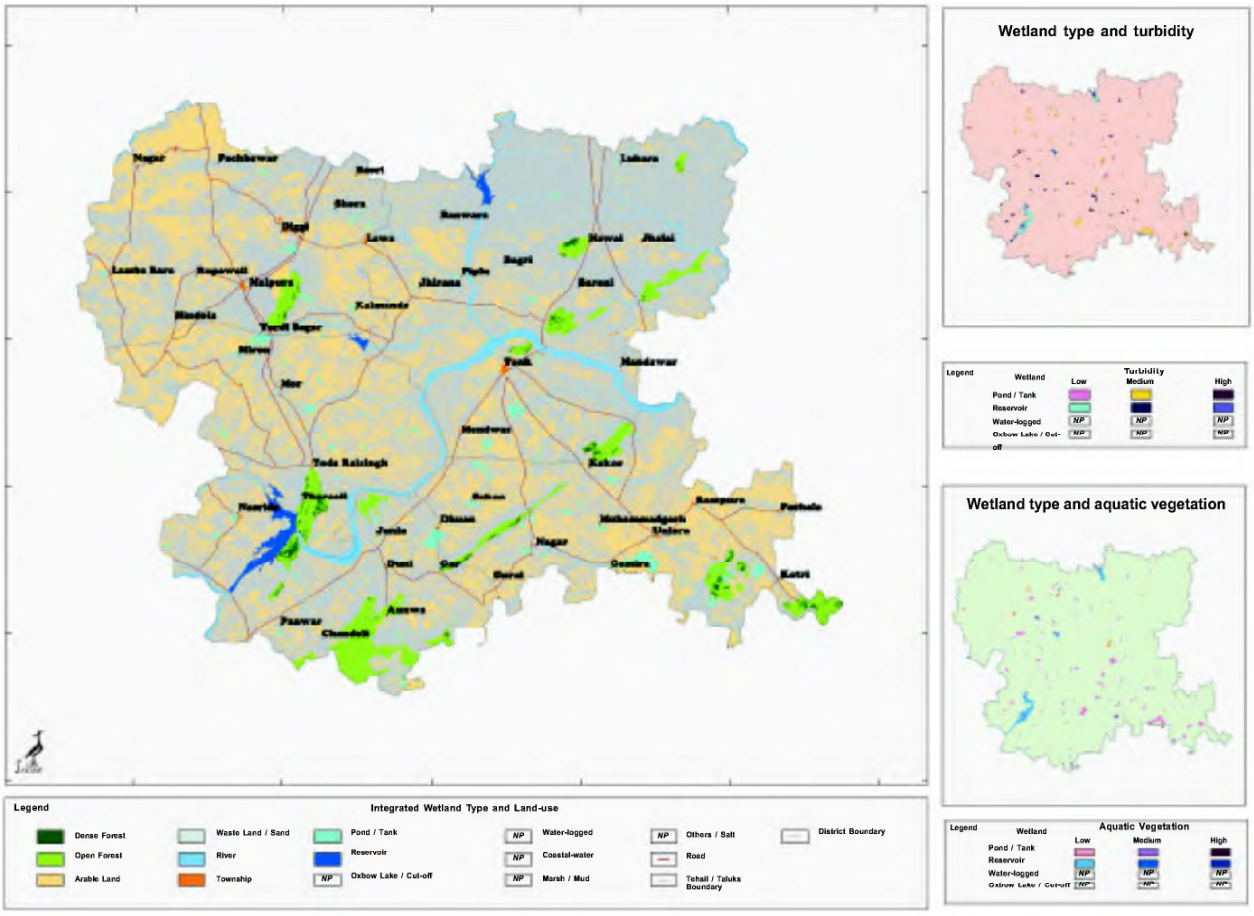


Fig. 12.19. Land use and wetland categories in the district of Tonk

Table 12. 34. Area under different land use and wetland categoriesin the district of Tonk

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	29.20	0.407
Forest-open	278.62	3.887
Arable	2,145.25	29.933
Wastelands	4,380.91	61.131
Wetland- pond/tank/lake	92.71	1.293
Wetland-reservoir	41.65	0.581
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	-	-
River	170.79	2.385
Roads	16.52	0.230
Settlements	10.97	0.153

Table 12.35. Area under different turbidity classes in the district of Tonk

Turbidity level	Area (sq km)	% of total wetland area
Low	39.64	29.50
Moderate	50.16	37.33
High	44.57	33.17

Table 12.36. Seasonal pattern of wetland areas in the district of Tonk

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Near Monoharpur	7.88	1.08	6.80	
Near Rajmahal	32.14	3.39	28.75	
Near Nagar	1.15	0.23	0.91	
Near Uniara	18.17	0.25	17.92	
Total	59.34	4.95	54.38	91.66

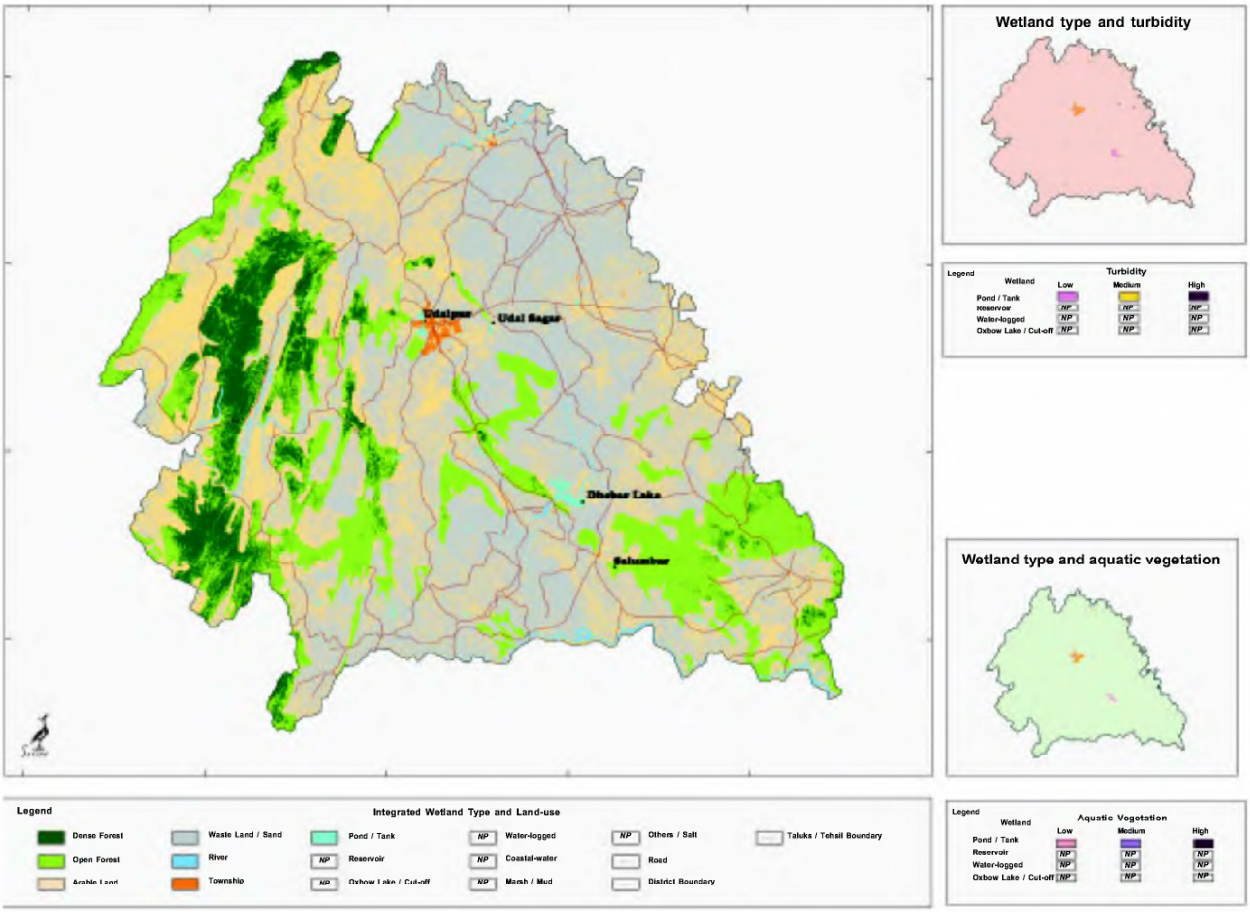


Fig. 12.20. Land use and wetland categories in the district of Udaipur

Table 12.37. Area under different land use and wetland categories in the district of Udaipur

Land use class (level- II)	Area (sq km)	% of total study area
Forest-dense	982.58	7.363
Forest-open	2,462.23	18.450
Arable	3,547.38	26.582
Wastelands	6,045.37	45.302
Wetland- pond/tank/lake	52.26	0.391
Wetland-reservoir	-	-
Wetland-waterlogged	-	-
Wetland-oxbow lake/cutoff	-	-
River	175.63	1.316
Roads	40.35	0.302
Settlements	39.26	0.294

Table 12. 38. Area under different turbidity classes in the district of Udaipur

Turbidity level	Area (sq km)	% of total wetland area
Low	32.79	62.72
Moderate	12.65	24.20
High	6.82	13.08

Table 12.39. Seasonal pattern of wetland areas in the district of Udaipur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Madri reservoir	1.33	0.95	0.39	
Near Litharcha	1.47	1.13	0.33	
Fateh sagar	2.06	1.90	0.16	
Udai sagar	1.11	0.97	0.14	
Pichola lake	2.96	2.32	0.64	
	8.93	7.27	1.66	18.53

Table 12.41. Changes in the wetland areas in select districts of Rajasthan (in sq km)

District	SAC (1992-93)	SACON (2000-2001)	Variation	%Variation
Barmer	14.82	3.33	-11.49	-77.56
Bharatpur	48.37	29.68	-18.69	-38.64
Bhilwara	186.22	74.82	-111.40	-59.82
Chittaurgarh	287.47	258.73	-28.74	-10.00
Jaipur	109.59	45.99	-63.60	-58.03
Jaisalmer	17.88	108.86	90.98	508.84
Jalore	35.10	1.54	-33.56	-95.61
Jodhpur	21.06	2.20	-18.86	-89.57
Nagaur	24.57	13.64	-10.93	-44.49
Pali	189.93	84.78	-105.15	-55.36
Sawaimadhopur	162.01	51.42	-110.59	-68.26
Tonk	175.84	134.36	-41.48	-23.59
Udaipur	105.30	52.26	-53.04	-50.37

Biodiversity

Aquatic vegetation

The vegetation was moderate to high in the reservoirs of Chittaurgarh and Jalore while it was low in those in Sawai Madhopur and Tonk. The lakes/ponds in almost all the districts had low aquatic vegetation except those in the districts of Bharatpur and Sawai Madhopur where it was dense (Fig. 12.22, 12.23).

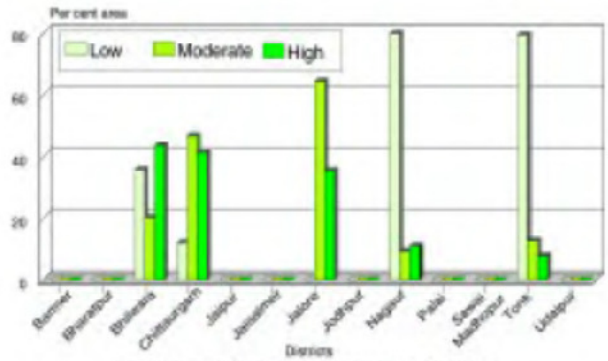


Fig. 12.22. Aquatic vegetation of reservoirs in Rajasthan

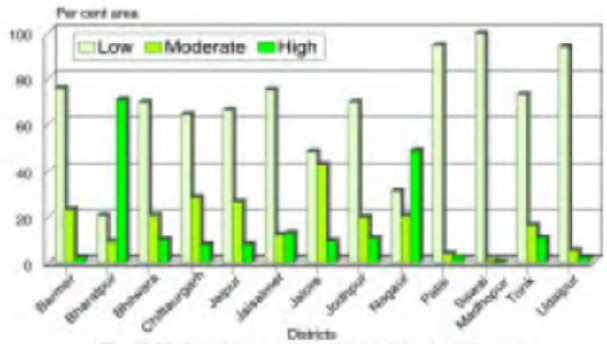


Fig. 12.23. Aquatic vegetation of ponds/lakes/waterlogged areas in Rajasthan

The common plants found in almost all water bodies are *Hydrilla verticillata, Spirodela polyrhiza, Potamogeton crispus*, and *Chara* (algae). *Aponogeton natans, Utricularia* sp. *Limnophila indica, Marsilea* sp. have specific distribution. Some weeds such as *Eichhornia* sp., *Phragmites karka* and *Typha angustata* are dominant in urban wetlands in Jaipur, Kota, and Udaipur districts. Such water bodies with thick weeds do not usually have submerged vegetation. Around 100 species of aquatic plants were recorded from Keoladeo National Park, Bharatpur alone. Nine species belonging to seven families of endemic aquatic plants were reported from Rajasthan (Table 12.42).

Fishes

In the 47 wetlands surveyed, 102 fish species were recorded, a large majority of which are widely distributed in India. There are 17 Threatened species, out of which four are Endangered and 13 Vulnerable (Menon, 1999). No Critically Endangered species of fish has been reported from Rajasthan (Table 12.43).

Table 12.42. Endemic aquatic plant species of Rajasthan

S.No.	Species	Family
1	*Tonningia cucullata*	Commelinaceae
2	*Eriocaulon richardianum*	Eriocaulaceae
3	*Eriocaulon heterolepis*	Eriocaulaceae
4	*Fimbristylis woodrowii*	Cyperaceae
5	*Fuirena wallichiana*	Cyperaceae
6	*Hoppea dichotoma*	Gentianaceae
7	*Hygrophila serpylla*	Acanthaceae
8	*Najas marina ssp.*	Najadaceae
9	*Sesbania procumbens*	Fabaceae

Turtles

Ten species of freshwater turtles have been reported from Rajasthan, out of which one is Critically Endangered, two are Endangered, four Vulnerable and, three are Near Threatened (Table 12.44).

Table 12.44. Distribution and status of turtles in Rajasthan

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes hurum*	VU	I	I
2	*Aspideretes gangeticus*	VU	-	I
3	*Chitra indica*	EN	-	IV
4	*Geoclemys hamiltonii*	VU	I	I
5	*Hardella thurjii*	VU	-	-
6	*Kachuga dhongoka*	EN	-	-
7	*Kachuga kachuga*	CR	-	I
8	*Kachuga tecta*	NT	I	I
9	*Kachuga tentoria*	NT	-	-
10	*Lissemys punctata*	NT	II	I

Table 12.43. Threatened species of freshwater fishes of Rajasthan

S.#	Species	Status
1.	*Anguilla bengalensis*	EN
2.	*Botia lohachata*	EN
3.	*Ompok bimaculatus*	EN
4.	*Pseudeutropius atherinoides*	EN
5.	*Anabas testudineus*	VU
6.	*Bagarius bagarius*	VU
7.	*Barbodes sarana*	VU
8.	*Barilius barila*	VU
9.	*Barilius vagra*	VU
10.	*Catla catla*	VU
11.	*Cirrhinus reba*	VU
12.	*Clarias batrachus*	VU
13.	*Heteropneustes fossilis*	VU
14.	*Labeo dero*	VU
15.	*Mystus vittatus*	VU
16.	*Osteobrama cotio*	VU
17.	*Puntius chola*	VU

Birds

In all 75,210 birds of 123 species, including four terrestrial species, were recorded during the survey covering 47 wetlands in Rajasthan. The highest population (20,098) of birds was noted at Sardar samand and the highest species richness (69) at Jawai dam in Pali district (Table 12.45). 18 species had more than 1,000 birds, while four species had more than 5,000 birds. The latter were the Barheaded Goose (12,355), Coot (8,984), Lesser Flamingo (6,423) and Greater Flamingo (5,537). Most of the water birds were migratory while only a few were resident.

Of the 47 wetlands studied, 24 had one or more Threatened bird species and four wetlands had three Threatened species each. 624 birds of six Threatened species and 7,713 birds of seven Near Threatened species were observed (Table 12.46).

More than 80% of the water bodies studied in Rajasthan had more than 20 bird species. Six wetlands had more than 50 species while only two wetlands had below 10 species. Distribution of the species in the wetlands shows that the Little Cormorant and River Tern were the most widely distributed birds, occurring in 40 out of the 47 wetlands surveyed. Both of them are either resident or local migrant, moving according to the availability of water. Other widely distributed species were the Coot (39 wetlands), Blackwinged Stilt and Grey Heron (each in 38 wetlands) and Shoveller (37 wetlands).

Table 12.45. Major wetlands of Rajasthan with species and number of birds

S#	Wetland	No. of species	No. of birds
1.	Sardar samand	61	20,098
2.	Jawai dam	69	11,771
3.	Bardha bandh (Talera)	56	5,603
4.	Bandh Baretha	44	4,335
5.	Ramsagar lake	20	3,454
6.	Kharda dam	44	2,590
7.	Alniya dam	49	2,362
8.	Talabeshahi	28	1,538
9.	RMC canal seepages (from Kota 7 to 16 km)	43	1,408
10.	Badopal (Suratgarh)	19	1,384
11.	Ummed sagar (Shahpura)	40	1,243
12.	Parvati sagar	17	1,187
13.	RMC canal (from Simliya 45 to 65 km)	44	1,165
14.	Pichhola lake	29	1,146
15.	Ranakpur dam	53	1,048
16.	Fateh sagar	59	1,001
17.	West Banas dam (Sarupganj)	31	920
18.	Ummedganj tank	26	863
19.	Chandlai lake	50	736
20.	Bhanda village tank	22	734
21.	Mansagar lake	48	715
22.	Kaylana & Takhat sagar	44	674
23.	Ramsagar bandh (Hirdoli)	44	615
24.	Kalakho	23	612
25.	Rajsamand lake	20	596
26.	Jaitpur village tank	43	575
27.	Surwal	34	494
28.	Mansarovar	27	479
29.	Sainthal	27	456
30.	Barli village tank	13	445
31.	Jawaja lake	24	424
32.	Patela (Talwara) lake	33	404
33.	Mansarovar (Tahala)	30	402
34.	Mangalsar	17	389
35.	Sareri bandh	25	305
36.	Gambhiri dam	28	298
37.	Balsamand	29	277
38.	Gajner (palace & village) tanks	18	274
39.	Surwania lake	16	246
40.	Ghosunda dam	13	202
41.	Sei dam	16	189
42.	Jaisamand	19	145
43.	Khajuriya lake	19	142
44.	Gadhisar lake	19	127
45.	Chadwas village tank	9	108
46.	Sabla lake	22	106
47.	Nakki lake	6	33
	Total	123	75,210

Table 12.46. Frequency of sightings of Threatened and Near Threatened birds in Rajasthan

S#	Species	Status	No. of wetlands where sighted	Total birds sighted
1	Dalmatian Pelican	T	7	200
2	Sarus Crane	T	16	149
3	Lesser Adjutant	T	2	13
4	Whitebacked Vulture	T	9	181
5	Longbilled Vulture	T	9	80
6	Greater Spotted Eagle	T	1	1
7	Painted Stork	NT	17	399
8	Lesser Flamingo	NT	3	6,423
9	Darter	NT	1	76
10	White Ibis	NT	19	722
11	White-eyed Pochard	NT	4	79
12	Blackbellied Tern	NT	3	10
13	Blacknecked Stork	NT	1	4

T=Threatened; NT=Near Threatened

Environmental contamination

Twenty nine fishes comprising five species collected from three wetlands were examined for environmental contamination.

Heavy metals

Among the three wetlands examined, Ramsagar recorded the highest concentration of lead (5.57±1.18 ppm) and zinc (34.26±8.42 ppm) while Keoladeo National Park, Bharatpur recorded the lowest of both lead (0.80±0.54 ppm) and zinc (6.70±1.52 ppm) (Fig. 12.24). Copper, cadmium and chromium were also detected but were within the safe limits.

Labeo rohita measured the maximum concentrations of all the metals, particularly lead (3.76±2.28 ppm) and zinc (22.21±15.12 ppm) (Fig. 12.25). The magnitude of contamination, particularly lead and zinc was significantly different (P<0.005) among the species and wetlands.

The concentration of metals in the fishes of Keoladeo National Park, Bharatpur shows a reduction from the level reported in 1988-'89 by Muralidharan (1995).

Pesticides

The total organochlorine residues in Talabeshahi, Ramsagar and Keoladeo National Park were 0.063 ppm, 0.052 ppm and 0.046 ppm respectively (Fig. 12.26). Among the five species of fishes analyzed, *Channa striatus* (0.067 ppm) and *Cirrhinus mrigala* (0.057 ppm) had high levels. The least concentration (0.043 ppm) was detected in *Channa punctatus* (Fig. 12.27).

Pesticide concentration among the wetlands and fishes is not significantly different (P>0.05). DDT and endosulfan residues were detected in all the fishes analyzed. About 93% of fishes were contaminated with HCH while 43% with dieldrin. It is reported that the annual consumption of pesticides in Rajasthan is about 3,101 mt. Further, studies by Indian Council of Agriculture Research (1999) revealed that about 45 to 80 % of vegetables and fruits from Rajasthan were contaminated with organochlorine residues.

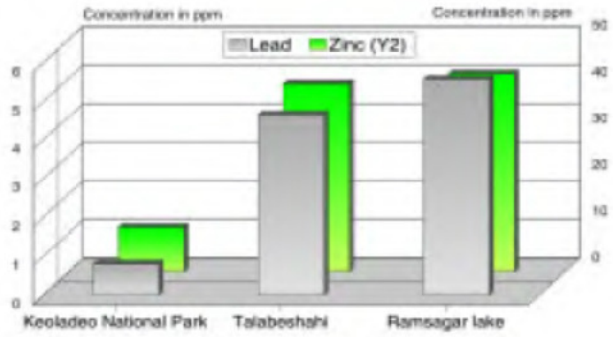


Fig. 12.24. Lead and Zinc contamination in select wetlands of Rajasthan

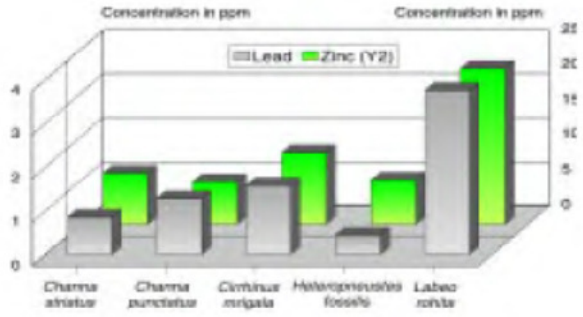


Fig. 12.25. Lead and Zinc contamination in select species of fishes in Rajasthan

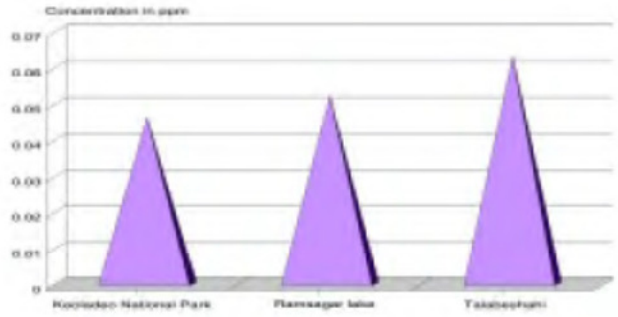


Fig. 12.26. Total organochlorine residues among various wetlands of Rajasthan

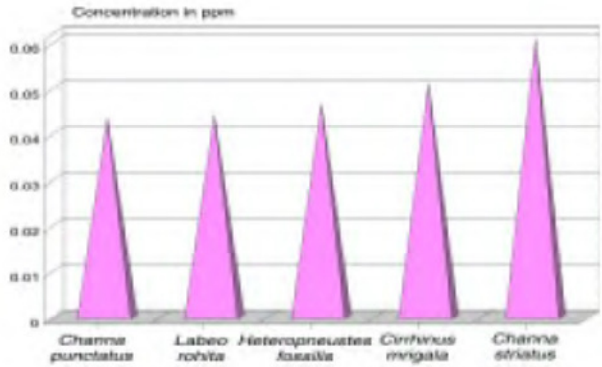


Fig. 12.27. Total organochlorine residues among various species of fishes in Rajasthan

Suitability for human consumption

The metal levels appear to be safe for human beings and piscivorous birds as well.

Although, pesticide concentrations measured in the fishes of Rajasthan appear to be safe for fishes and their consumers (human and piscivorous birds), if the same concentrations continue for long, it will exert toxic effects.

Socioeconomic values

A preliminary assessment of the use values of the wetlands showed that they are being utilized at different levels. Of the eight major uses of the wetlands, those with six and seven uses were considered as of high use, with four and five uses as of medium and with less than four as of low use. 10 out of 47 had high use, while 18 had medium and 19 had low use (Table 12.47).

Prioritization of wetlands

The 47 wetlands surveyed in Rajasthan were prioritized based on the criteria of birds observed in these wetlands. Rating was given to each wetland as described in the methods and the wetlands were ranked into four categories. The eight top ranking wetlands with priority ratings of ≥15 have come in the first rank, the next nine in the second rank (ratings of 10-14), another nine in the third rank (ratings of 5-10) and the last 21 in the fourth rank (rating <5). Sardar samand, Jawai dam, Kharda dam, Ranakpur dam, Alniya dam, Chandlai lake, Ummed sagar (Shahpura) and Bardha bandh (Talera) were the top-raking sites which should be given high priority for conservation. The second set of nine wetlands also are important. Some of the wetlands in the third and fourth ranks should also be considered on priority, as their lower rank was only because of the drought condition that prevailed in the state during the year of census. Earlier records are in favour of their promotion to higher priority (Table 12.47).

Table 12.47. Prioritised list of the wetlands of Rajasthan

Sl. No.	Name of wetland	Rank	Use
1	Sardar samand	1	M
2	Jawai dam	1	M
3	Kharda dam	1	M
4	Ranakpur dam	1	H
5	Alniya dam	1	H
6	Chandlai lake	1	M
7	Ummed sagar (Shahpura)	1	M
8	Bardha bandh (Talera)	1	H
9	Fateh sagar	2	H
10	Kaylana &Takhat sagar	2	M
11	RMC canal (from Simliya 45 to 65 km)	2	H
12	RMC canal seepages (from Kota 7 to 16 km)	2	H
13	Mansagar lake	2	L
14	Mansarovar (Tahala)	2	M
15	Bandh Baretha	2	M
16	Rajsamand lake	2	M
17	West Banas dam (Sarupganj)	2	M
18	Gajner (Palace & village) tanks	3	L
19	Jaitpur village tank	3	L
20	Ramsagar bandh (Hirdoli)	3	M
21	Sabla lake	3	L
22	Gambhiri dam	3	M
23	Patela (Talwara) lake	3	L
24	Mansarovar	3	M
25	Parvati sagar	3	H
26	Sainthal	3	L
27	Balsamand	4	L
28	Barli village tank	4	L
29	Ghosunda dam	4	L
30	Sareri Bandh	4	M
31	Sei dam	4	M
32	Ummedganj tank	4	L
33	Khajuriya lake	4	L
34	Surwal	4	M
35	Surwania lake	4	L
36	Talabeshahi	4	H
37	Badopal (Suratgarh)	4	M
38	Bhanda village tank	4	L
39	Jaisamand	4	M
40	Jawaja lake	4	L
41	Kalakho	4	L
42	Pichhola lake	4	L
43	Ramsagar lake	4	H
44	Gadhisar lake	4	H
45	Mangalsar	4	L
46	Chadwas village tank	4	L
47	Nakki lake	4	L

L=Low; M=Medium; H=High

Spatial distribution of the prioritized wetlands along with BCPP Sites, IBA and PAs is given to get a comprehensive idea about the biodiversity focal areas in the state (Fig. 12.28).

The eight wetlands in the first rank are qualified to be declared as Ramsar sites. Conservation strategies should be evolved based on the biodiversity and socioecological uses, as the wetlands are being used by the local community.

Summary

- Rajasthan, according to the satellite imageries of 1992-93, has 1,054 wetlands in the size of 56.25 ha and above, covering a total area of 3,449.64 sq km (SAC, 1998).
- In the nine select districts, mapped currently, the wetlands of the size 2 ha and above were 2,135, covering a total area of 861.56 sq km.
- There is a net loss of 561 sq km wetland area between 1992-93 and 2000-2001 in the nine select districts.
- Fifty percent of the wetlands had low turbidity while most of the wetlands had low vegetation according to satellite imageries.
- Rajasthan has nine species of endemic aquatic plants; four Endangered and 13 Vulnerable species of fishes; and one Critically Endangered, two Endangered, four Vulnerable and three Near Threatened species of freshwater turtles.
- In the 47 wetlands surveyed, 75,210 birds belonging to 123 species were recorded.
- Six hundred and twenty-four birds of six Threatened and 7,713 birds of seven Near Threatened species were recorded.
- The more abundant species were the Barheaded Goose, Coot, Lesser Flamingo and Greater Flamingo. Population of all of them were more than 5,000.
- The Little Cormorant and River Tern were the most widely distributed species.
- Twenty-nine fishes of five species from three wetlands were examined for environmental contamination.
- 93% of fishes studied had HCH while 43% had dieldrin.
- Levels of heavy metals and organochlorine pesticides in the fish tissues were within the permissible limits. However, regular consumption is risky.
- Forty-seven wetlands were prioritized for conservation.
- The eight wetlands in the first rank are qualified to be declared as Ramsar sites.



Khalid Ghani

A family of Siberian Crane at Keoladeo National Park, Bharatpur in 1986



V.S. Vijayan

A view of Keoladeo National Park in 1983 - Dr. Sálim Ali on a field visit

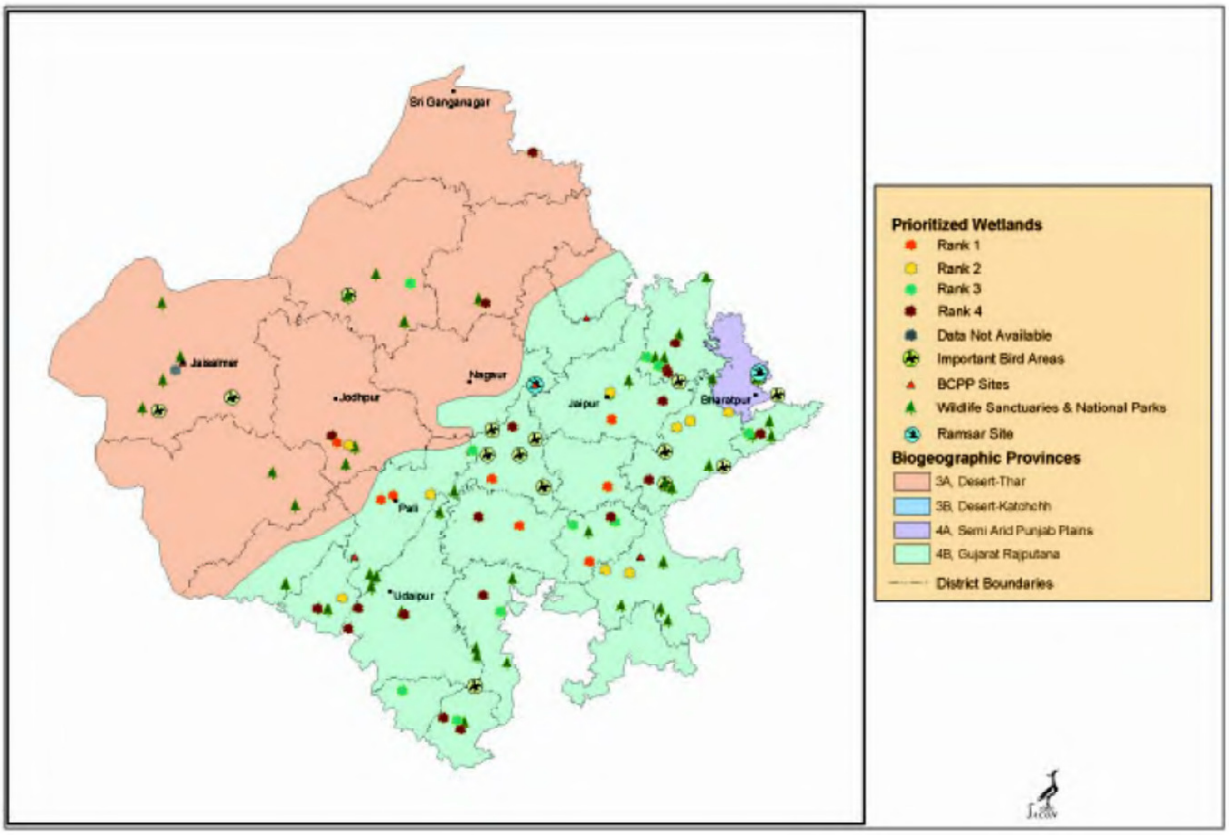


Fig. 12.28. Prioritized wetlands and other conservation areas in Rajasthan



V.S. Vijayan

Ghana canal, the 'life-line' of Keoladeo National Park



V.S. Vijayan

A view of Keoladeo National Park in a year of drought - 2001



V.S. Vijayan

Economic use of wetlands; grass is collected in massive quantity by villagers

HARYANA

Haryana presents a variety of landscapes varying from hills in the northern region to almost flat alluvial plains in the central parts, and sand dunes in the southern region. Some of the best waterfowl habitats such as Basai exist near the megapolis of New Delhi.



Haryana has clear-cut distinction in its northern, eastern, western and southern regions. All the four regions differ from one another in relief, climate, soils, sub-soil, water characteristics, economic development and population densities. The northern part is hilly, the eastern part is more fertile with higher rainfall and the south-western part is dry, sandy and barren.

The state has mainly four physiographic regions: Shivalik hills, Alluvial plains, Aravalli hills and Aeolian plains. The general slope of the state is from north to south but the slope is reversed further south and south-west due to the presence of subdued ranges of Aravalli hills. The entire state is drained by the rivers Yamuna and Ghaggar and their tributaries. Yamuna, the only perennial river in the state, forms the boundary between Haryana and Uttar Pradesh for over 320 km. Alluvial plains and wind blown sand deposits are found in the form of sandy plains and sand dunes over alluvial deposits in parts of Bhiwani, Hissar and Sirsa districts. The state has a flat topography with altitude varying from 190-480 m above mean sea level except for some hills of the Shivalik on the north.

State at a glance	
State capital	Chandigarh
Area	44,212 sq km
Population (2001)	21,082,989
Total number of districts	19
Major rivers	Ghaggar, Yamuna
Total forest area	1,150 sq km
Population density (2001)	477/sq km
Ramsar site	Nil
Proposed Ramsar sites	4
Total sites proposed for conservation	4

There are two well-marked seasons of rainfall in the state; the southwest monsoon from the middle of June till September and, the winter rains from December to February. The average annual rainfall of the state is about 650 mm, which varies from 213 mm in southwest to 1,400 mm in the northeast. Temperature varies between 6.6°C in winter and 37.9°C in summer.

Table 13.1. Land use pattern in Haryana

Land use type	Area (sq km)
Total geographic area	44,212
Forests	1,150
Not available for cultivation	4,390
Other uncultivated land excluding fallow land	660
Fallow land	1,450
Net area sown	36,280
Area sown more than once	26,920
Total cropped area	63,200
Cultivable area	38,390

(Source: www.indiastat.com)

As in the other states, land use categories of Haryana also do not include wetlands (Table 13.1).

Status of wetlands

Haryana has only inland wetlands, which are classified as natural and man-made and these in turn are sub-divided into different types (Table 13.2). Out of the total geographic area of Haryana, the wetlands of 2.25 ha and above are

estimated to cover 270.4 sq km (SAC, 1998). The total number of wetlands is 1,827; out of which 1,393 are natural covering 153.25 sq km which is 56.6% of the total wetland area in the state (Table 13.2). Man-made wetlands, 434 in number, cover an area of 117.29 sq km. In addition there are 2,060 smaller wetlands; each below 2.25 ha in size.

Table 13.2. Distribution of various categories of inland wetlands in Haryana

Type of inland wetlands	Area (sq km)	No. of wetlands
Lakes/ponds	68.39	940
Oxbow lake/Cutoff meander	1.15	5
Waterlogged (seasonal)	83.57	448
Tanks	1.24	6
Waterlogged (man-made)	113.47	423
Ash/cooling pond	2.58	5
Total	270.40	1,827

Source: SAC (1998)

Seasonal changes in water spread during post-monsoon and pre-monsoon show that there is a striking difference in the recession between the man-made and natural wetland; from 16% to 62%.

The distribution maps of wetlands of the size 2.5 ha and above of various districts (Fig. 13.2 to 13.13) show that there is a preponderance of wetlands in the districts of Hissar, Rohtak, Karnal, Sirsa, Gurgaon, Faridabad, Sonipat and Jind.

Biodiversity

Data on birds, vegetation, fishes and socioeconomic aspects of Basai wetland, Mohamedabad marshes, Western Yamuna canal and Yamuna river were collected.

Vegetation

Satellite imageries of the wetlands of Haryana by SAC (1998) show that the ponds in general do not have much vegetation, whereas the seasonal waterlogged wetlands have thick vegetation.

Field observations on the vegetation of the wetlands studied show that Basai wetland had a domination of emergent plants followed by floating vegetation and open water. Mohamedabad marshes had floating and emergent vegetation at low density in half of the area. Western Yamuna canal had all types at low density except submerged plants which were at moderate density. The spread of submerged plants was greater in the river Yamuna, compared to other categories. However, the sampled area was dominated by emergent plants. All types of vegetation showed patchy distribution in most of the wetlands.

Fishes

Three Endangered and 12 Vulnerable species (Table 13.3) of fishes were recorded from Haryana (Menon, 1999). A few more species reported from Punjab also might occur in Haryana.

Table 13.3. Endangered and Vulnerable species of freshwater fishes recorded from Haryana

S#	Species	Status
1	*Anguilla bengalensis*	EN
2	*Ompok bimaculatus*	EN
3	*Pseudeutropius atherinoides*	EN
4	*Ailia coila*	VU
5	*Anabas testudineus*	VU
6	*Bagarius bagarius*	VU
7	*Barbodes sarana*	VU
8	*Catla catla*	VU
9	*Cirrhinus reba*	VU
10	*Clarias batrachus*	VU
11	*Heteropneustes fossilis*	VU
12	*Labeo dero*	VU
13	*Mystus vittatus*	VU
14	*Osteobrama cotio*	VU
15	*Puntius chola*	VU

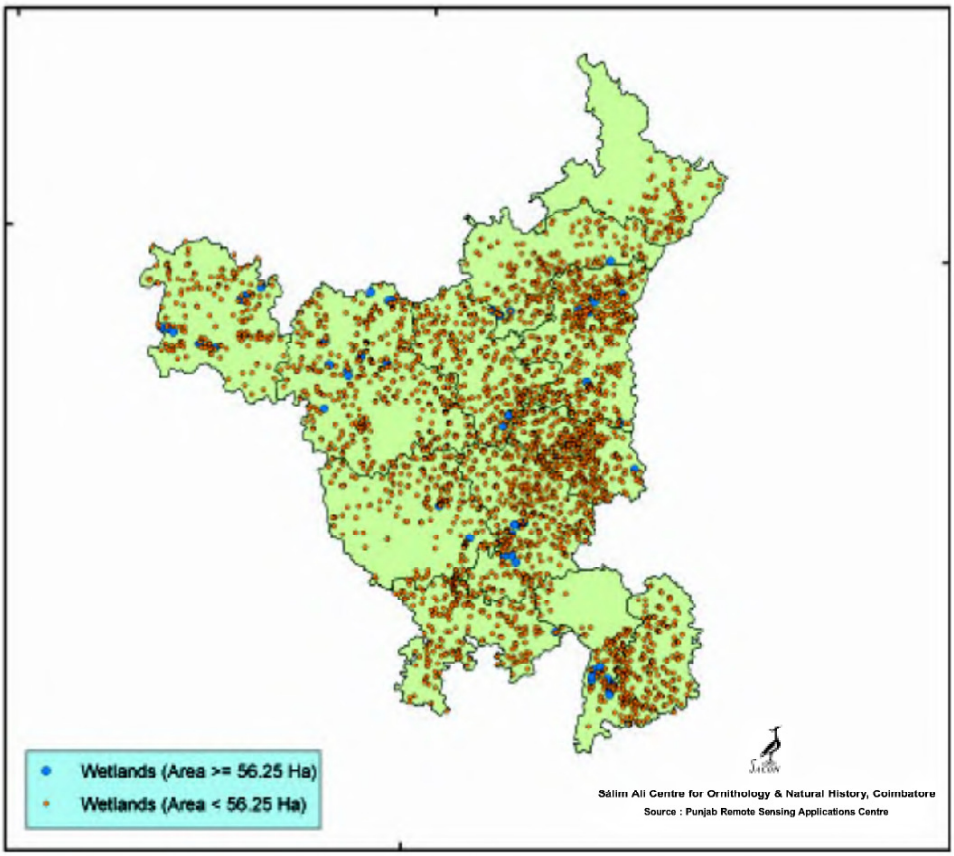


Fig. 13.1. Distribution of wetlands in Haryana

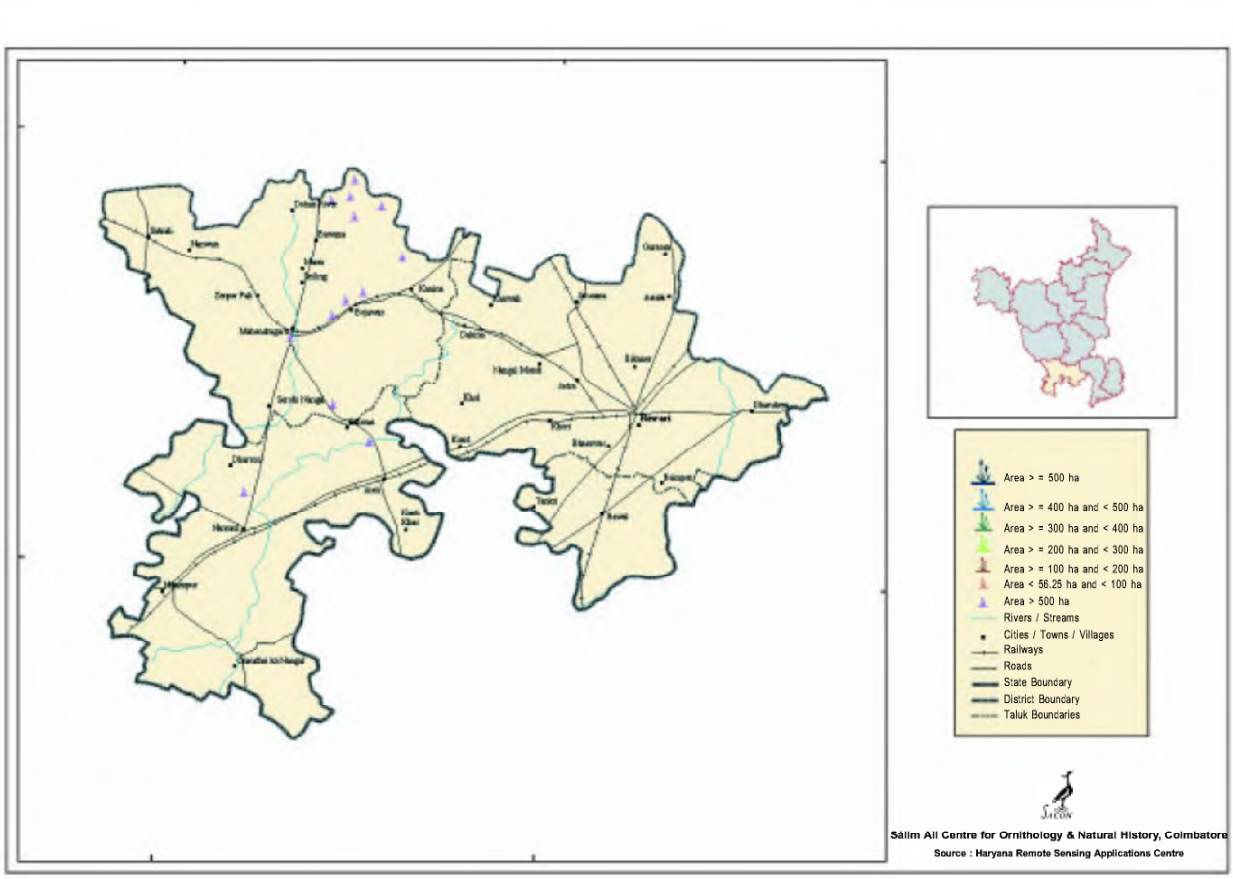


Fig. 13.2. Distribution of wetlands in the district of Mahendragarh

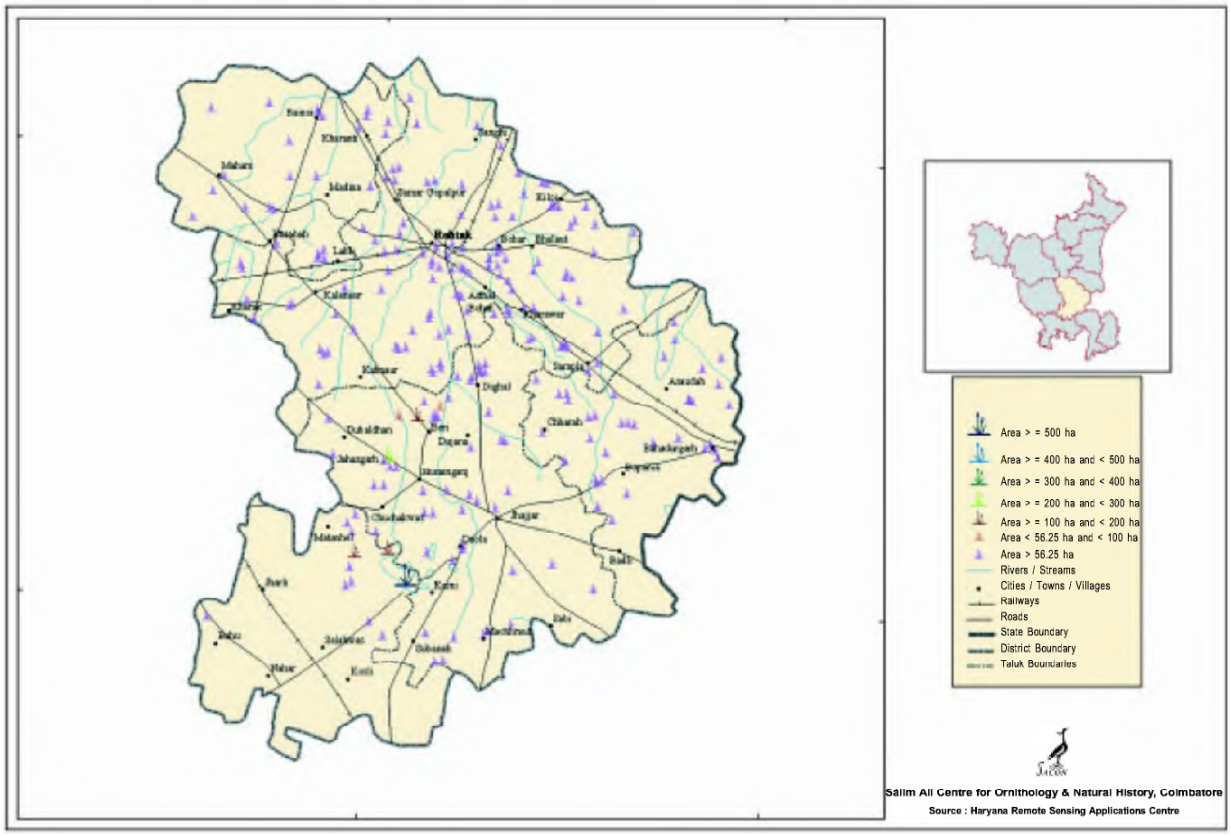


Fig. 13.3. Distribution of wetlands in the district of Rohtak

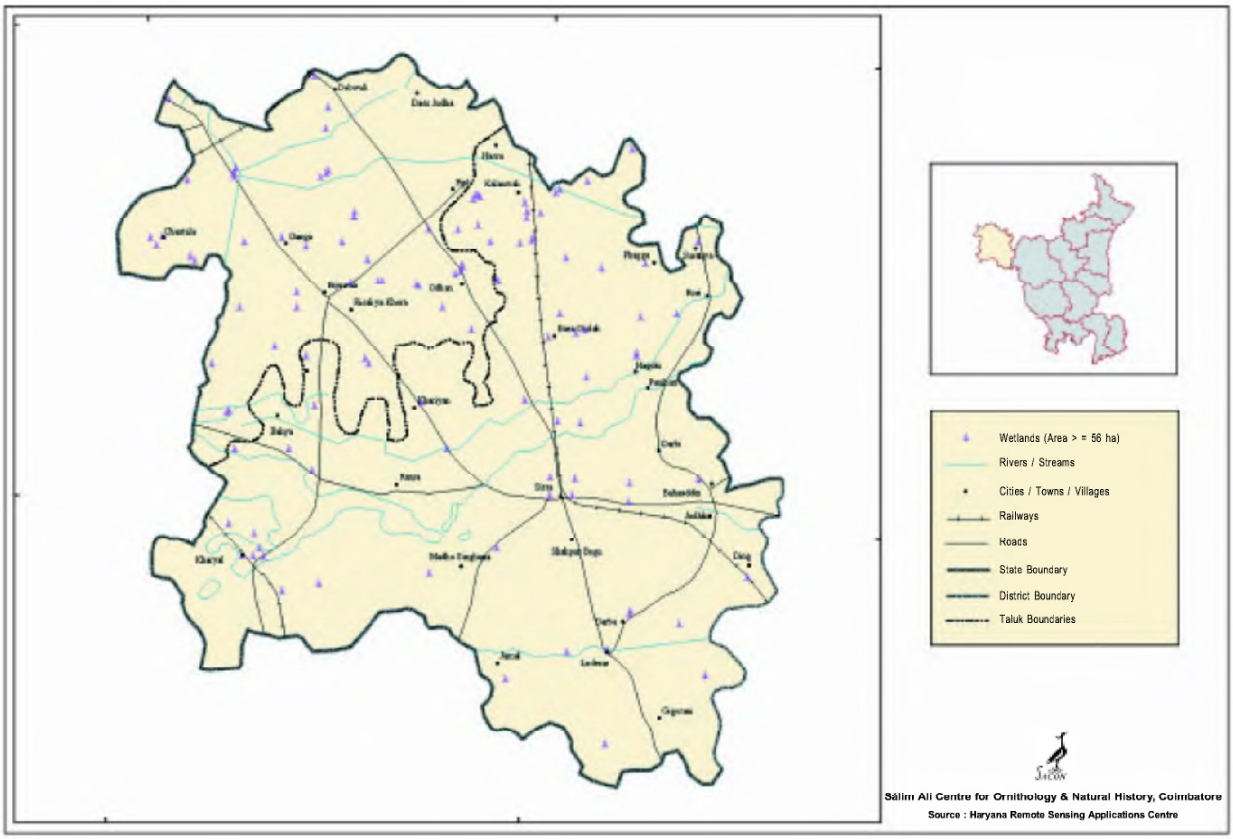


Fig. 13.4. Distribution of wetlands in the district of Sirsa

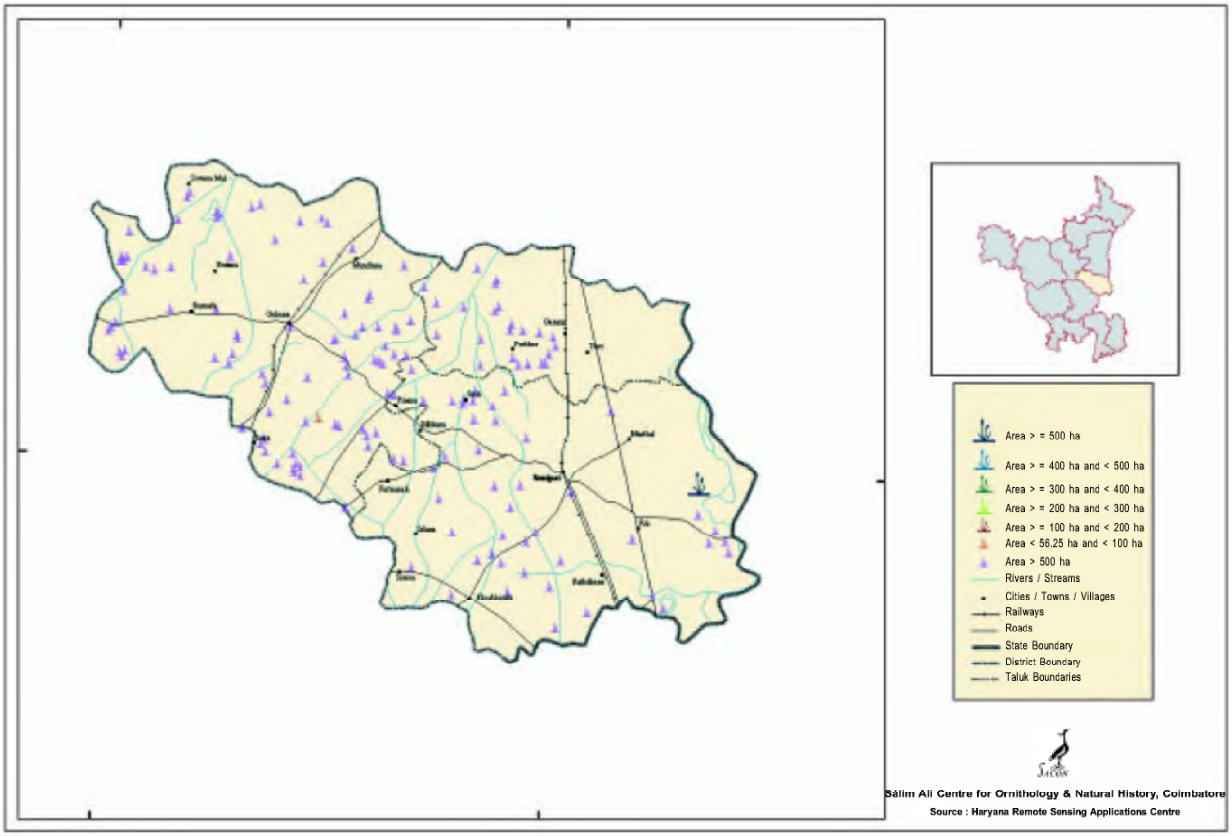


Fig. 13.5. Distribution of wetlands in the district of Sonipat

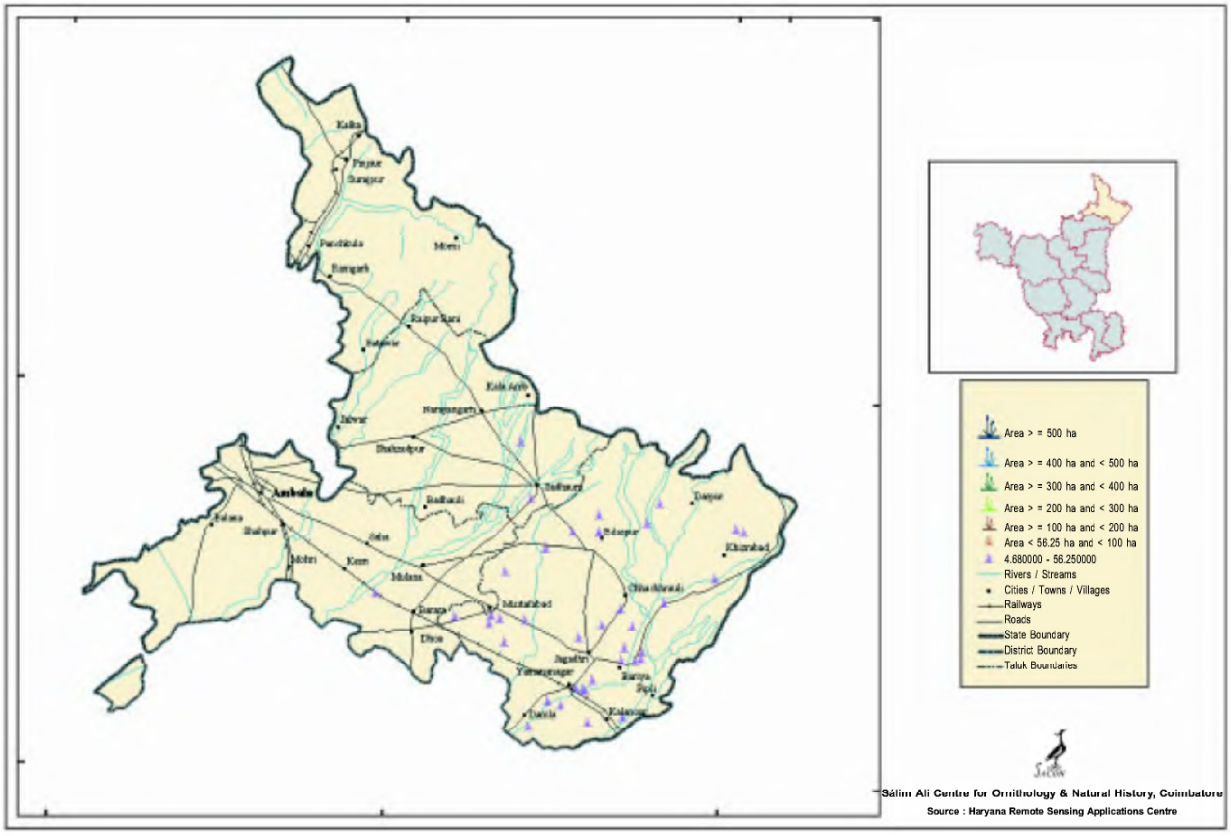


Fig. 13.6. Distribution of wetlands in the district of Ambala

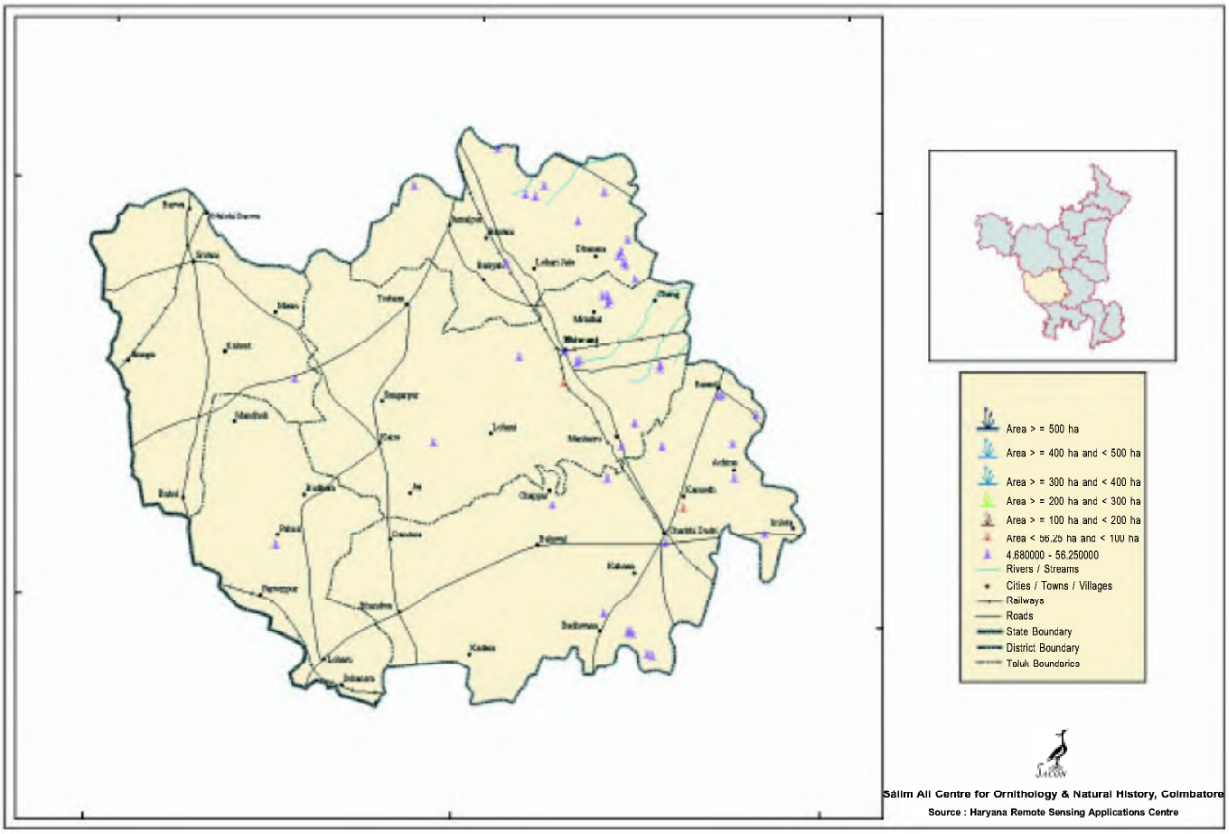


Fig. 13.7. Distribution of wetlands in the district of Bhiwani

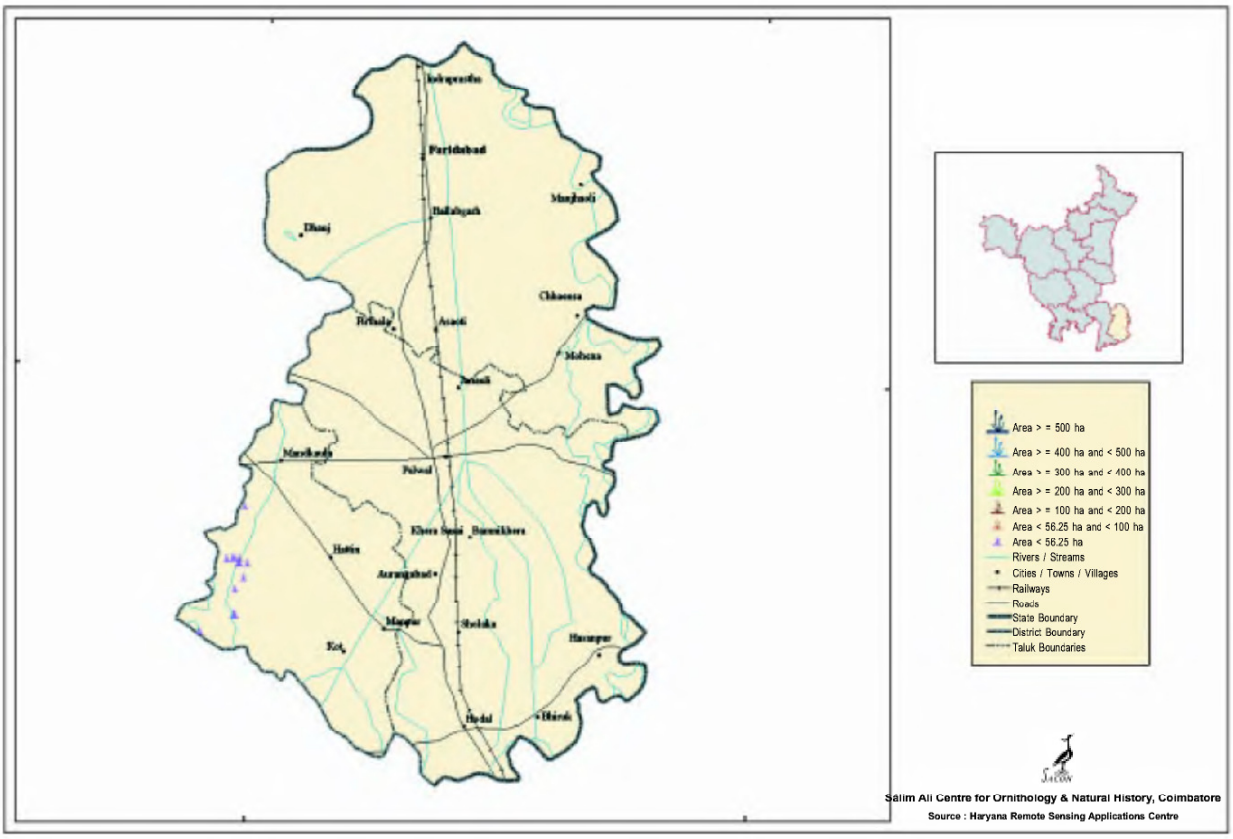


Fig. 13.8. Distribution of wetlands in the district of Faridabad

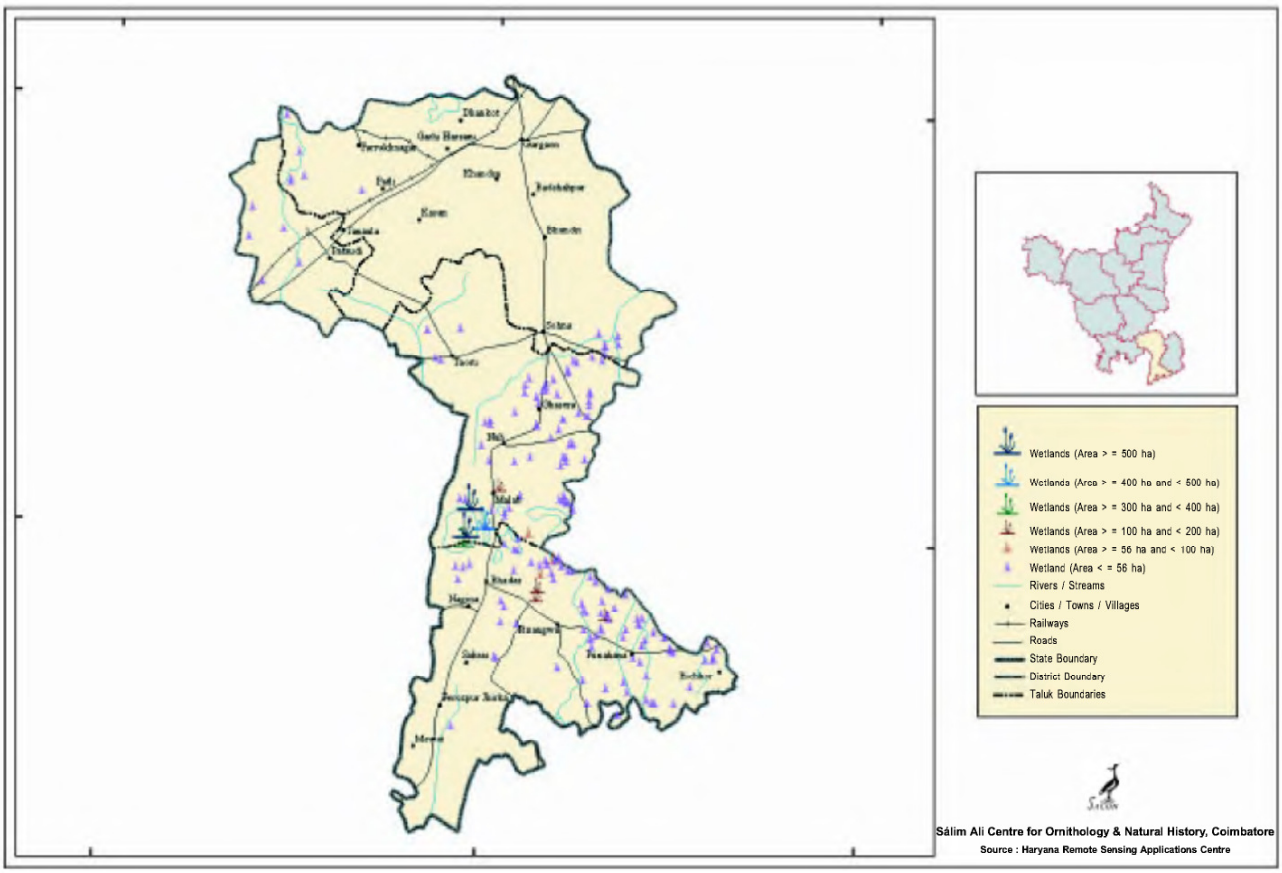


Fig. 13.9. Distribution of wetlands in the district of Gurgaon

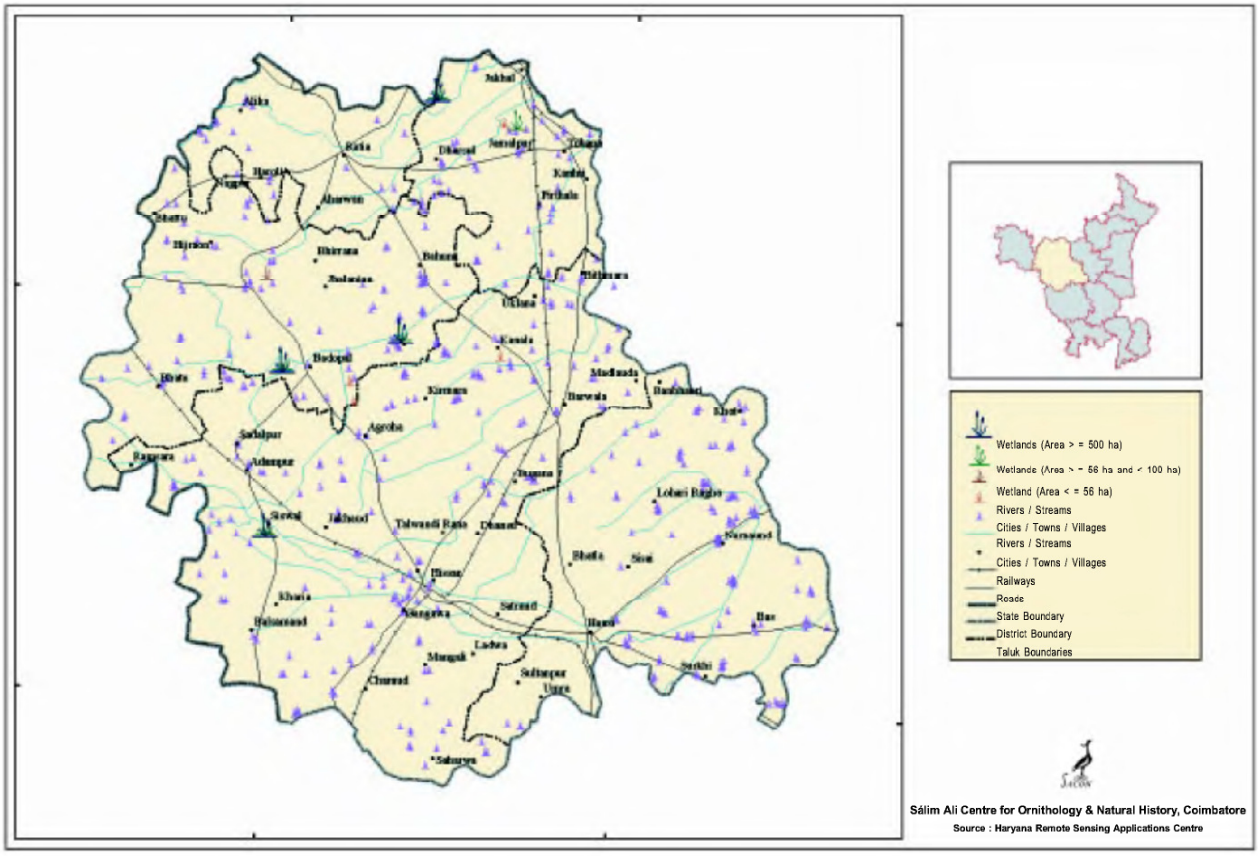


Fig. 13.10. Distribution of wetlands in the district of Hissar

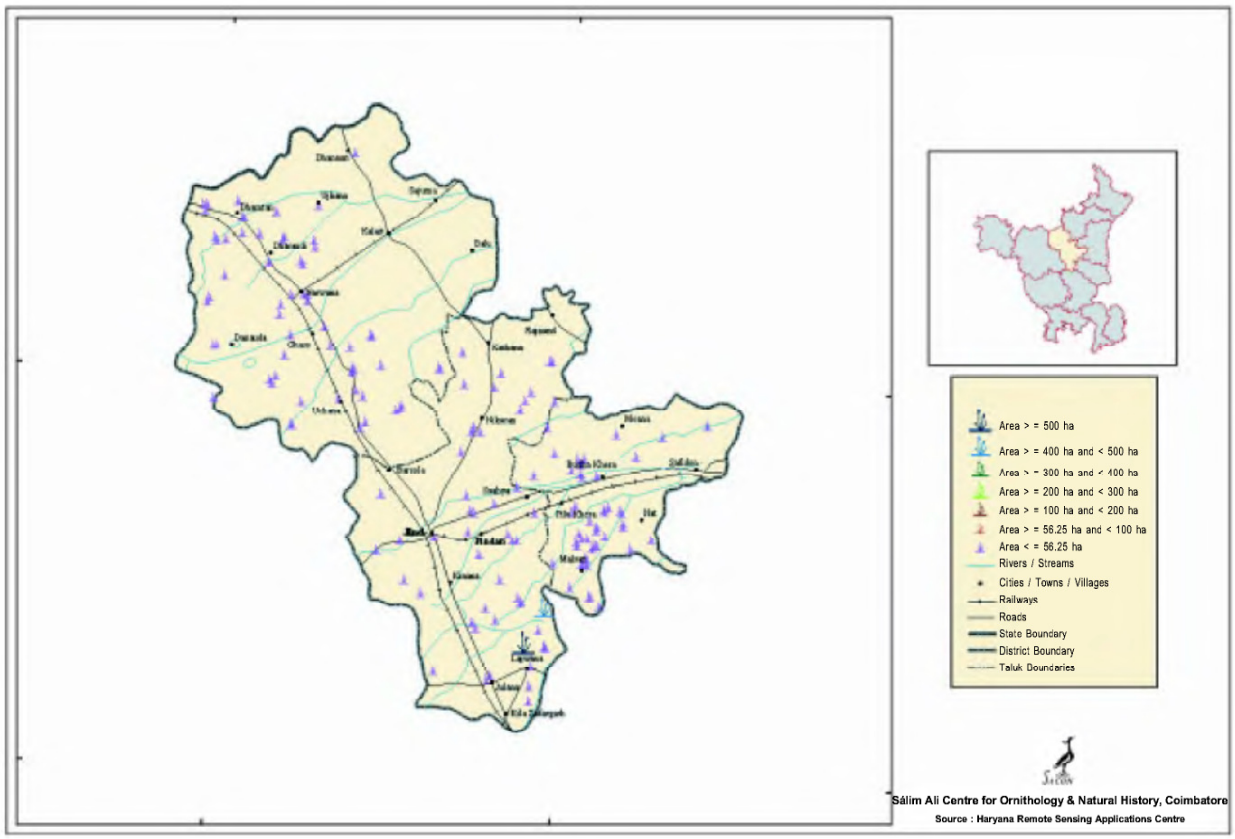


Fig. 13.11. Distribution of wetlands in the district of Jind

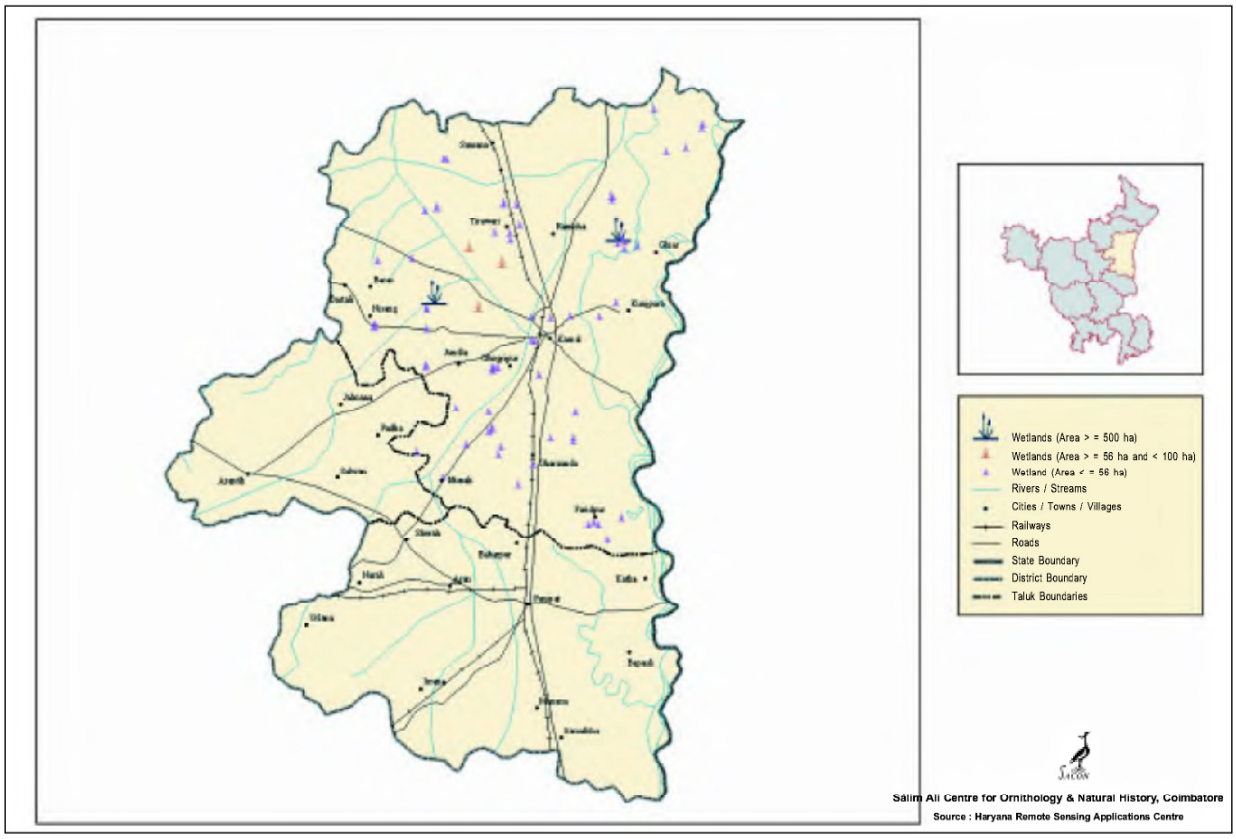


Fig. 13.12. Distribution of wetlands in the district of Karnal

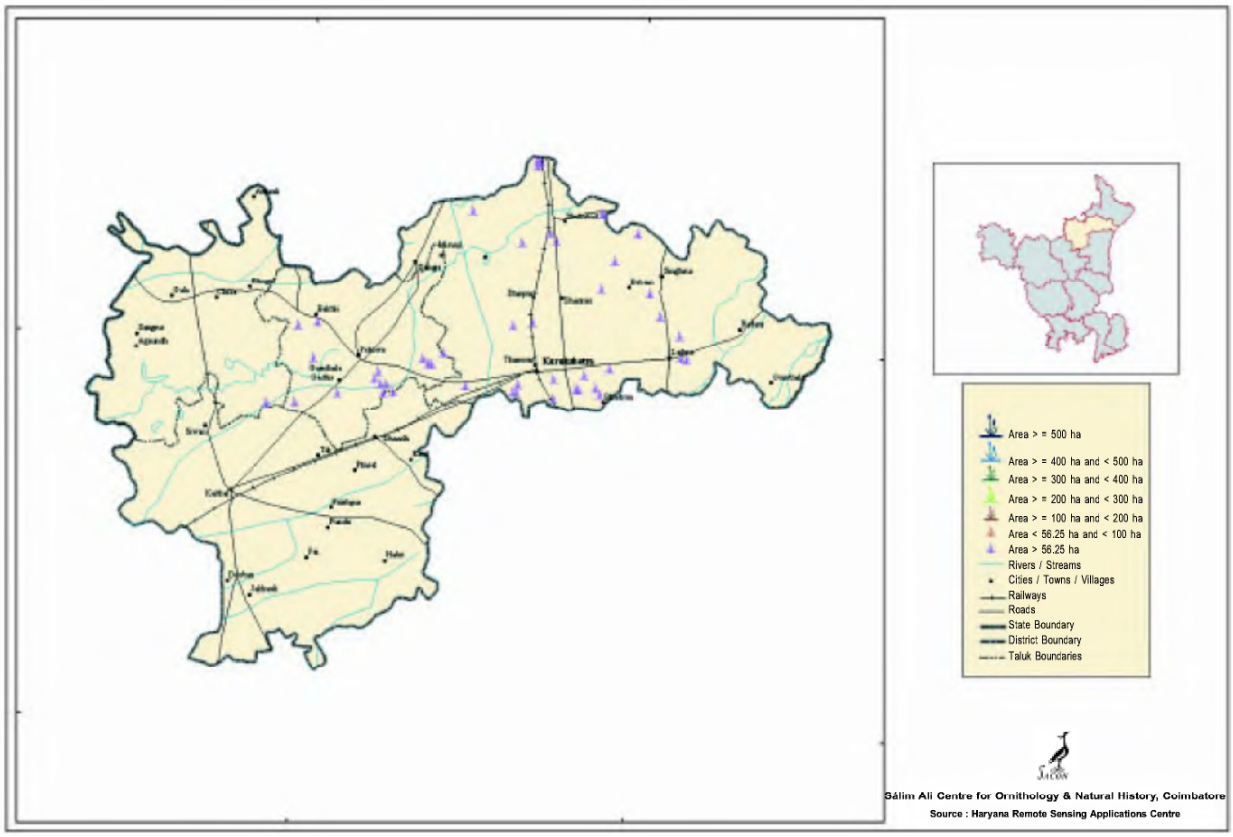


Fig. 13.13. Distribution of wetlands in the district of Kurukshetra

Turtles

Only two species of turtles were recorded from Haryana, namely *Lissemys punctata* and *Aspideretes gangeticus* belonging to Near Threatened and Vulnerable categories respectively.

Birds

Totally 23,499 birds of 132 species, with two species being mostly terrestrial, were recorded in the selected four areas. Maximum number of birds was observed at Basai wetland while maximum species (107) was at Muhamedabad marshes (Table 13.4). Of the 78 Threatened species of India, six were counted with 40 birds during the study with a maximum of four each at Basai and Western Yamuna canal and associated wetlands. Of the eight Near Threatened species observed during the survey, seven were from Muhamedabad marshes (Table 13.5).

Table 13.4. Summary of bird census in the four areas surveyed in Haryana

	Basai wetland	Mohamedabad marshes	Western Yamuna canal & associated wetlands	Yamuna river and associated wetlands
Total number of birds	9,976	1,039	4,478	8,006
Number of wetland species	80	105	85	78
Number of other species	11	2	10	7
Number of all species	91	107	95	85
Number of Threatened species	4	3	4	2
Number of Near Threatened species	4	7	5	4

The number of Near Threatened birds was 428 in the four wetlands surveyed. The Threatened Bristled Grass Warbler was observed at the Western Yamuna canal and associated wetlands. This is one of the two records of this species during the survey. The other sighting was from Punjab. Large populations i.e. more than 1% biogeographic population of two species, namely the Barheaded Goose and Ruff were found at the rivers Basai and Yamuna and associated wetlands, thereby increasing the conservation value of the sites.

Table 13.5. Frequency of sightings of Threatened and Near Threatened birds in Haryana

S.#	Species	Status	No. of wetlands	No. of birds sighted
1	Greater Spotted Eagle	T	3	10
2	Imperial Eagle	T	1	1
3	Whitebacked Vulture	T	1	1
4	Lesser Kestrel	T	2	2
4	Sarus Crane	T	2	16
4	Bristled Grass Warbler	T	1	10
5	Darter	NT	4	65
6	Painted Stork	NT	4	37
7	Blacknecked Stork	NT	3	5
8	White Ibis	NT	4	262
9	White-eyed Pochard	NT	3	41
10	Pale Harrier	NT	2	2
11	Blackbellied Tern	NT	3	16
12	Lesser Flamingo	NT	1	DD

T=Threatened; NT=Near Threatened; DD=Data deficient

Environmental contamination

Sixteen fishes collected from two stretches of the river Yamuna and associated wetlands comprising four species were analyzed for metals and pesticides.

Heavy metals

Higher concentrations of lead (6.55±2.05 ppm), copper (0.62±0.58 ppm) and chromium (0.76±0.85 ppm) were recorded in the Western Yamuna canal than in the river Yamuna and associated wetlands (Fig. 13.14). Other metals appear to be within the permissible limits.

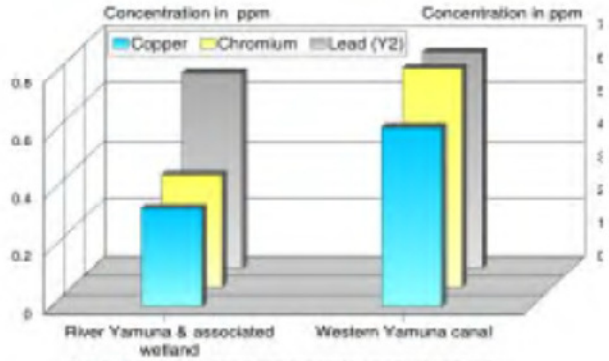


Fig. 13.14. Heavy metal contamination in select wetlands of Haryana

Concentration of metals did not vary much among the species of fishes studied, although their food habits were different. *Cirrhinus mrigala* and *Labeo rohita* were subsurface dwellers, whereas the other two, *Clarias batrachus* and *Heteropneustes fossilis*, were bottom feeders. *Labeo rohita* recorded the maximum concentrations of lead (8.96±3.93 ppm) and cadmium (1.03±0.41ppm) (Fig. 13.15).

It may be noted that the wetlands from where the fishes were collected receive industrial effluents from plywood and metal based industries.

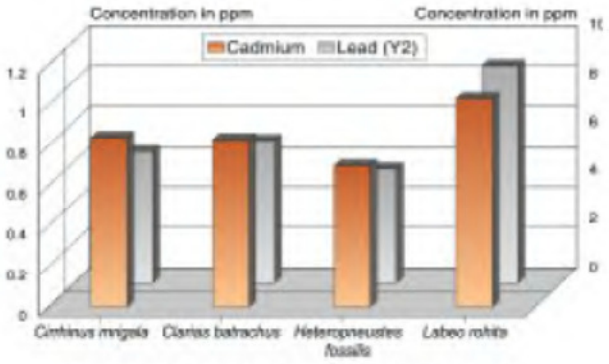


Fig. 13.15. Heavy metal contamination in select species of fishes in Haryana

Pesticides

Organochlorine residues recorded in the Western Yamuna canal and, in the river Yamuna and associated wetlands were 0.039 ppm and 0.006 ppm respectively. Among the four species analyzed, *Heteropneustes fossilis* (0.065 ppm) recorded the highest load of pesticide residues, while *Cirrhinus mrigala* the least (0.002 ppm) (Fig. 13.16).

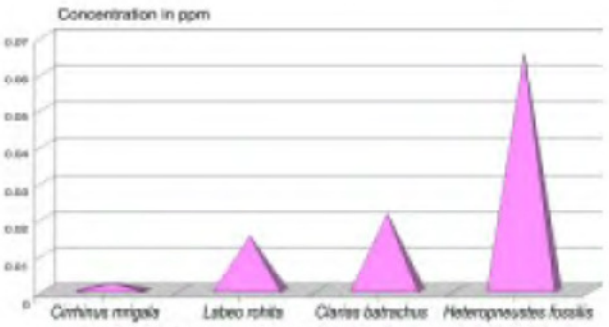


Fig. 13.16. Total organochlorine residues among various species of fishes in Haryana

Suitability for human consumption

Consumption of *Labeo rohita* with a lead level of 0.32 mg as recorded here, can inflict serious physiological disorders. The permissible maximum intake, according to the UN Committee (WHO, 1989, 1993), is 0.21 mg for 60 kg adult per day.

Although the concentrations of organochlorine residues in the fishes of Haryana appear to be safe for human consumption, about 82 % of the fishes were contaminated with both HCH and heptachlor epoxide residues and 76 % were contaminated with DDT. Moreover, studies by Indian Council of Agricultural Research (1999) revealed that about 45–80 % of the vegetables and fruits sampled from Haryana had pesticide contamination. Hence, the sample studies on both fishes and vegetables indicate an alarming situation. Annual consumption of pesticide in Haryana is estimated at 5,049 mt.

Socioeconomic values

The socioeconomic uses were graded depending on the number of uses such as fishing, agriculture, reed gathering, firewood collection, cattle grazing, drinking/ wallowing by cattle and domestic use. Only Basai had medium use value while others had high use value (Table 13.6).

Table 13.6. Prioritised list of the wetlands of Haryana

S#	Name of the wetland	Rank	Use
1	Basai	1	M
2	Mohmedabad marshes	1	H
3	Western Yamuna canal-wetlands	1	H
4	Yamuna river associated wetlands	1	H

M=Medium; H=High

Prioritization of wetlands

The wetlands surveyed were prioritized using mainly birds as the criteria as explained under methods. Size of the wetlands was also considered while giving grades. All the four wetlands had high ratings for birds (Table 13.6). Thus all these sites came in the first rank of priority. Distribution of the prioritized wetlands is given in Fig. 13.7

Three of the wetlands having high biodiversity values have high use values and hence, could be declared as Conservation Areas or Community Reserves. All the four areas are qualified to be declared as Ramsar sites.

Summary

- Haryana has 1,827 wetlands of 2.25 ha and above, covering an area of 270.4 sq km, based on the data of 1991-'92.
- Distribution of wetlands show that the districts of Hissar, Rohtak, Karnal, Sirsa, Gurgaon and Faridabad have a preponderance of wetlands.
- Haryana has three Endangered and 12 Vulnerable species of freshwater fishes and, one each of Near Threatened and Threatened species of freshwater turtles.
- In the four wetlands studied, 23,499 birds belonging to 132 species were recorded.
- Six Threatened and eight Near Threatened species with 40 and 428 birds respectively were recorded
- Western Yamuna canal was comparatively highly contaminated.
- Lead level was high in *Labeo rohita*. 82% of fishes examined had both HCH and heptachlor epoxide while 76% had DDT.
- Four wetlands have been prioritized for conservation which also qualify to be declared as Ramsar sites.

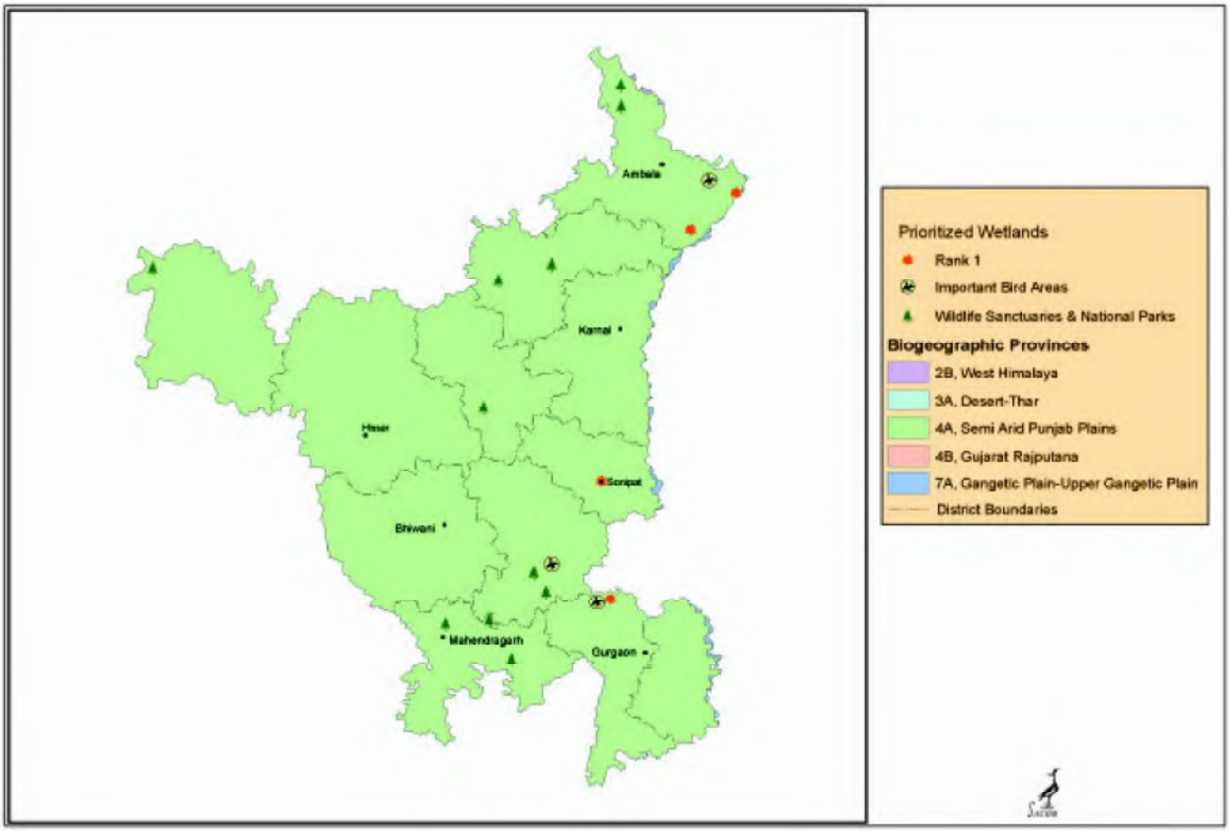


Fig. 13.17. Prioritized wetlands and other conservation areas in Haryana



Lalitha Vijayan

Basai wetland in Haryana with diversity of habitat

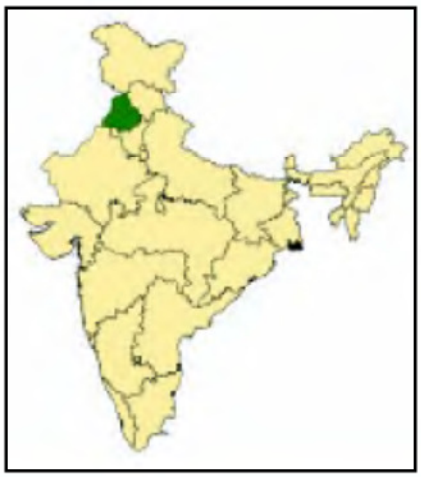


Lalitha Vijayan

A wetland overgrown with *Typha* sp.

PUNJAB

Punjab, the cradle of green revolution, is situated in the northwestern corner of the country and forms part of the Indo-gangetic plains. Physically, the state may be divided into two major parts: sub-Shivalik parts and Satluj-Ghaggar plain. The former covers the upper portion of the state, including districts such as Rupnagar, Hoshiarpur and Gurdaspur, while the latter covers the remaining districts. Punjab is bestowed with a very fertile soil.



Climate of the state is sub-tropical, semi-arid to sub-humid. The average annual rainfall is above 650 mm. Major rivers of the state are the Satluj, Ravi, Beas, Indus, Chenab and Ghaggar. The average temperature varies from 6.6 to 37.9°C.

State at a glance	
State capital	Chandigarh
Area	50,362 sq km
Population (2001)	24,289,296
Total number of districts	17
Major rivers	Ghaggar, Ravi, Beas, Satluj, Chenab,Indus
Total forest area	3050 sq km
Population density (2001)	482/sq km
Ramsar sites	3
Proposed Ramsar sites	3
Total sites proposed for conservation	13

Status of wetlands

The land use statistics of Punjab, as elsewhere in the country, does not indicate the wetland extent (Table 14.1). The total number of wetlands of the size 2.25 ha and above was estimated at 1,821 for the entire state (Table 14.2) by SAC (1998). As many as seven different types of wetlands occur ranging from oxbow lakes to lakes/ponds and reservoirs (Table 14.2). The overall distribution of wetlands in Punjab shows that the pattern of distribution largely follows the major river courses; a very high concentration is seen in the western parts all along the border of Pakistan (Fig. 14.1).

Spatial distribution of wetlands with value addition of geographical content for each district was prepared using the data obtained from Punjab Remote Sensing Centre. Wetlands with different size classes are given in Fig. 14.2-14.13.

Table 14.1. Land use pattern in Punjab

Land use type	Area in sq km
Total geographic area	50,362
Forests	3,050
Not available for cultivation	3,940
Other uncultivated land excluding fallow land	460
Fallow land	490
Net area sown	42,380
Area sown more than once	38,790
Total cropped area	81,170
Cultivable area	43,330

(Source: www.indiastat.com)

Ferozepur district ranks first in the number of wetlands (340) followed by Amritsar (327), Gurdaspur (185), Bhathinda (182), Faridkot (180), Sangrur (84) and Patiala (99). Area-wise, Amritsar district has the largest extent of wetland; 33,506.75 ha followed by Rupnagar district (12,742.75 ha). The Patiala district accounts for minimum wetland area (484.75 ha). Ferozepur district has the maximum area (2,296 ha) under seasonal waterlogging while minimum waterlogging is observed in Rupnagar district. Bhathinda district has the maximum area (628 ha) under man-made waterlogging, while minimum is observed in Hoshiarpur and Ludhiana districts.

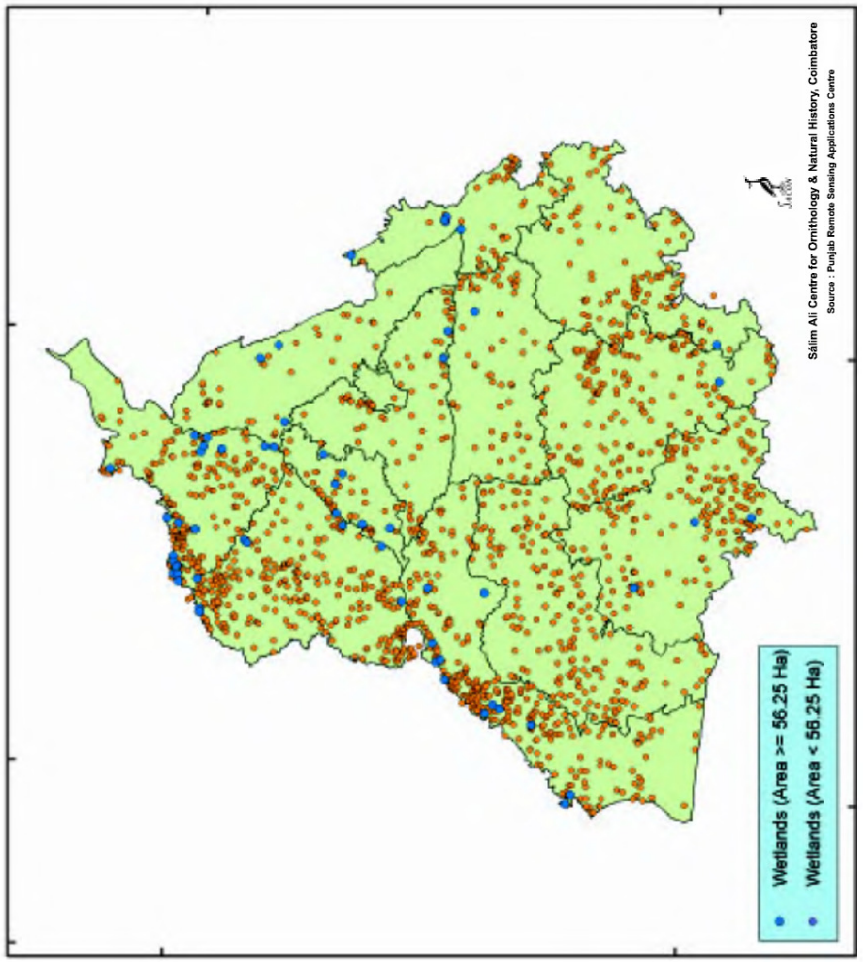


Fig. 14.1. Distribution of wetlands in Punjab

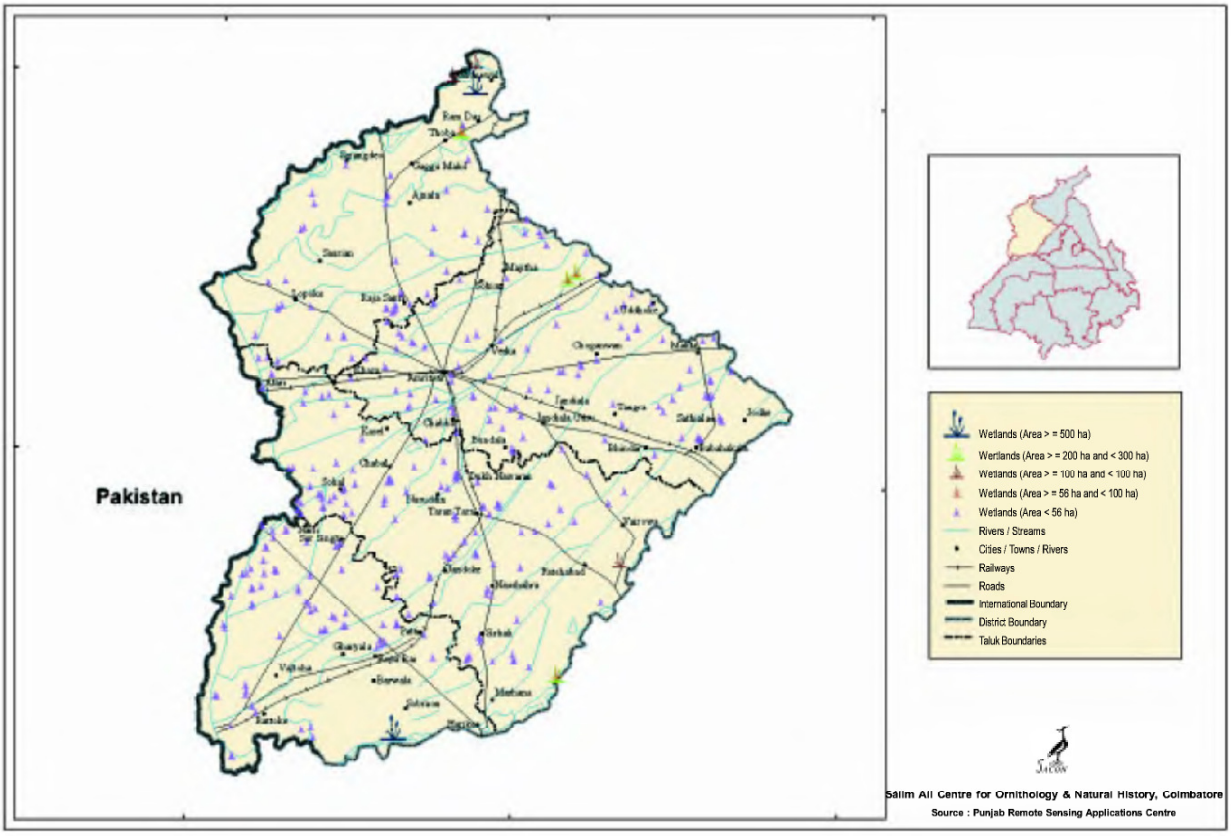


Fig. 14.2. Distribution of wetlands in the district of Amritsar

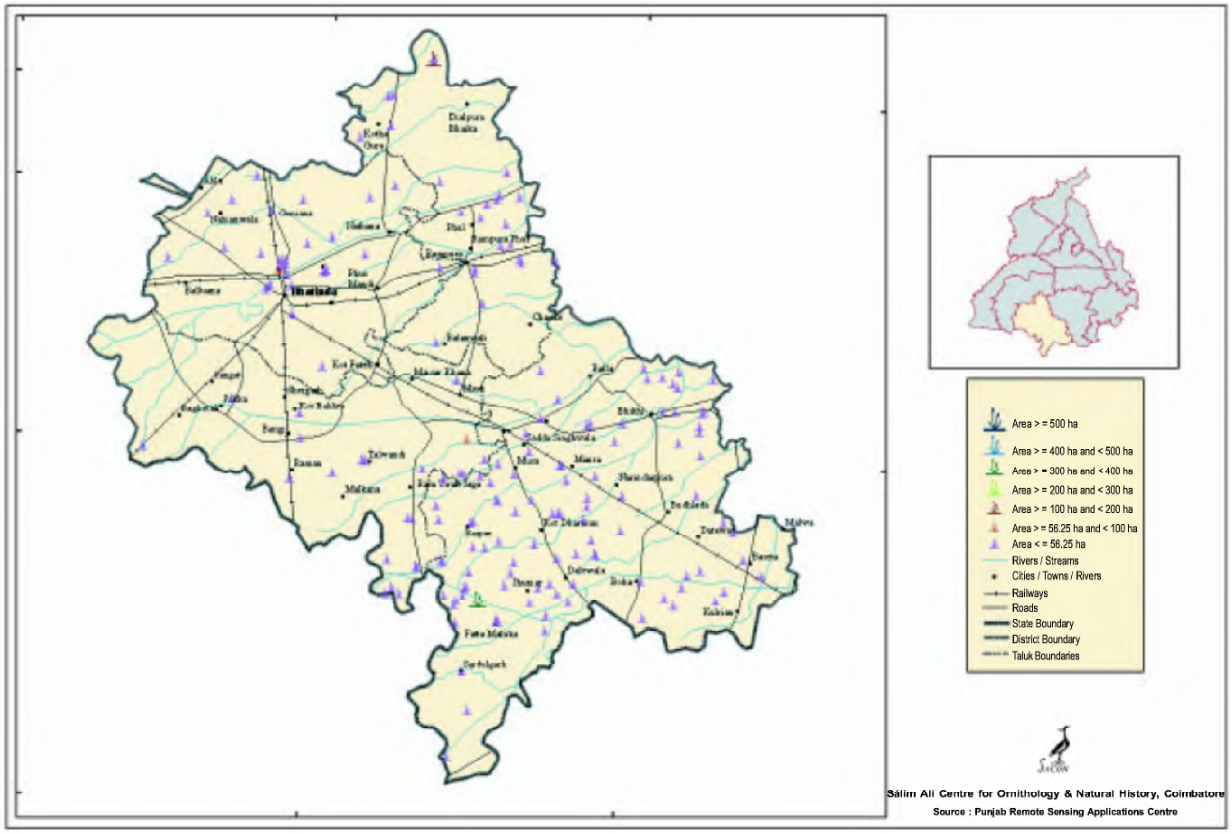


Fig. 14.3. Distribution of wetlands in the district of Bhathinda

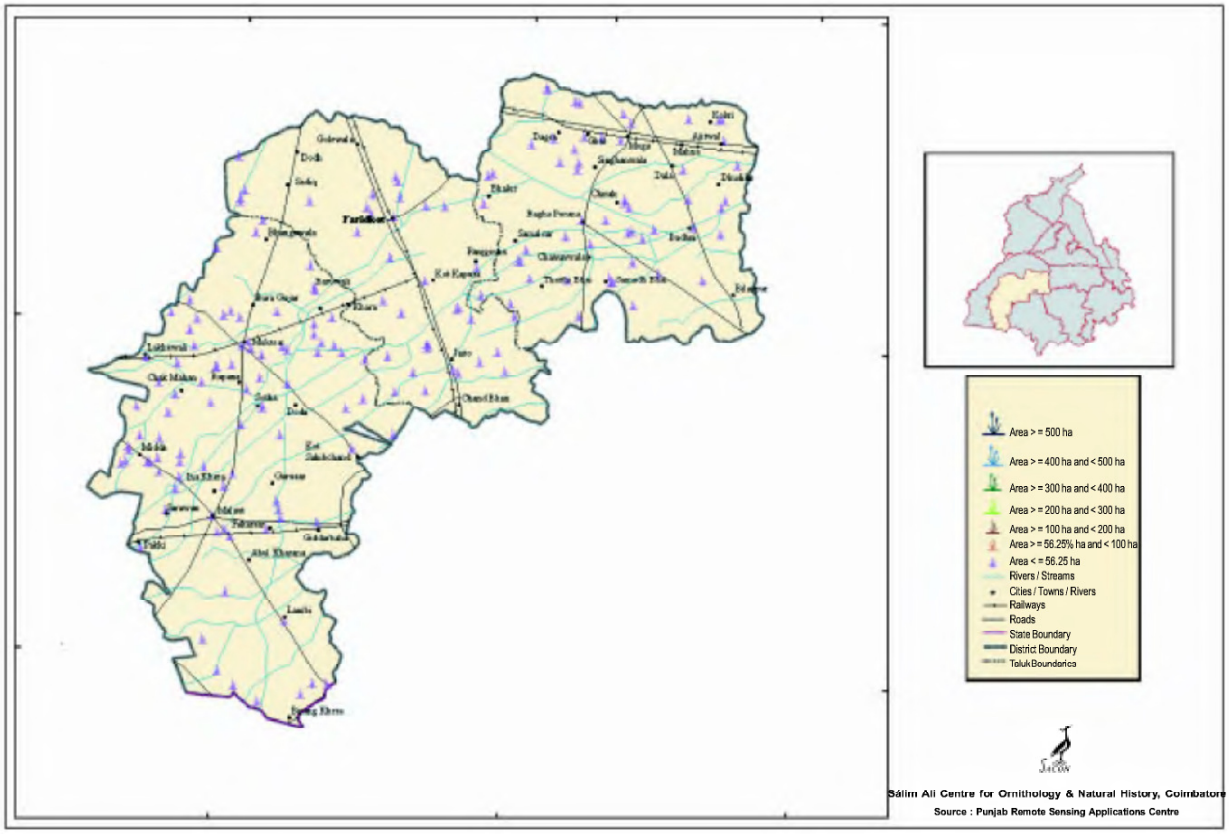


Fig. 14.4. Distribution of wetlands in the district of Faridkot

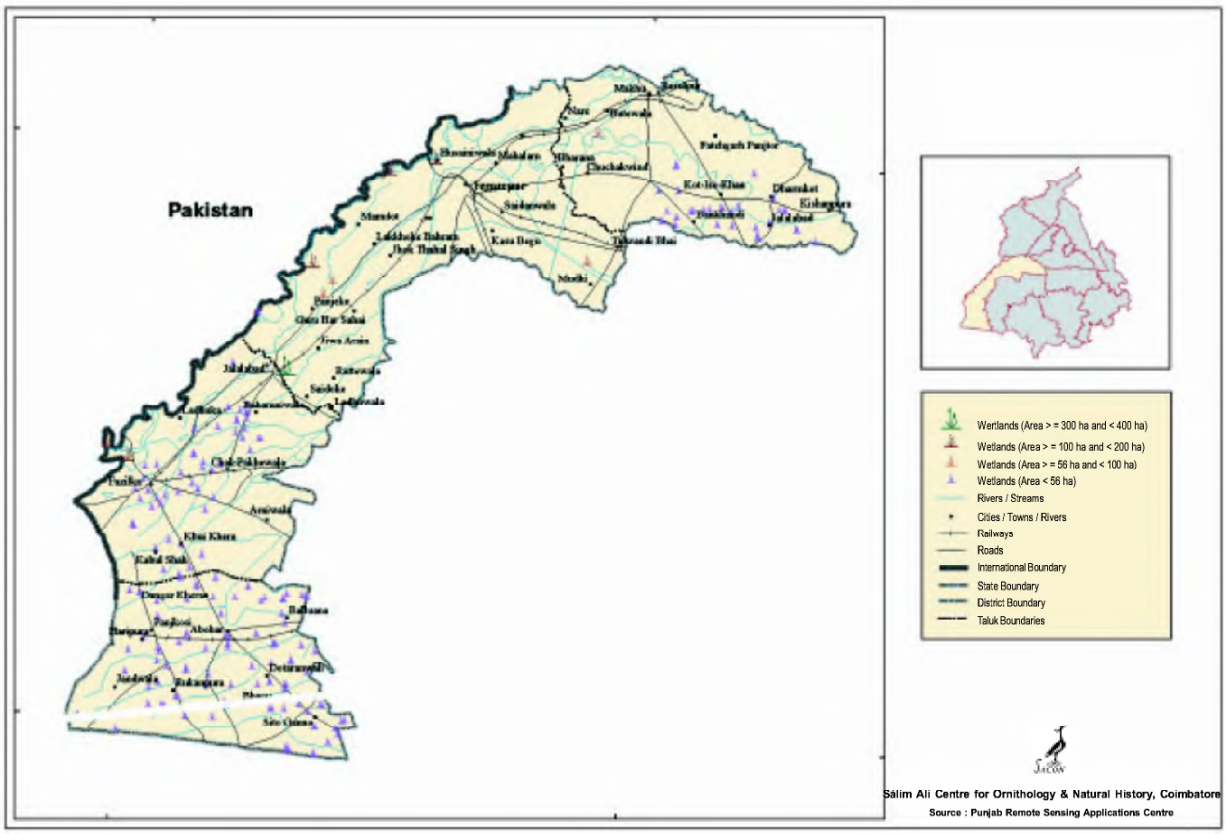


Fig. 14.5. Distribution of wetlands in the district of Ferozepur

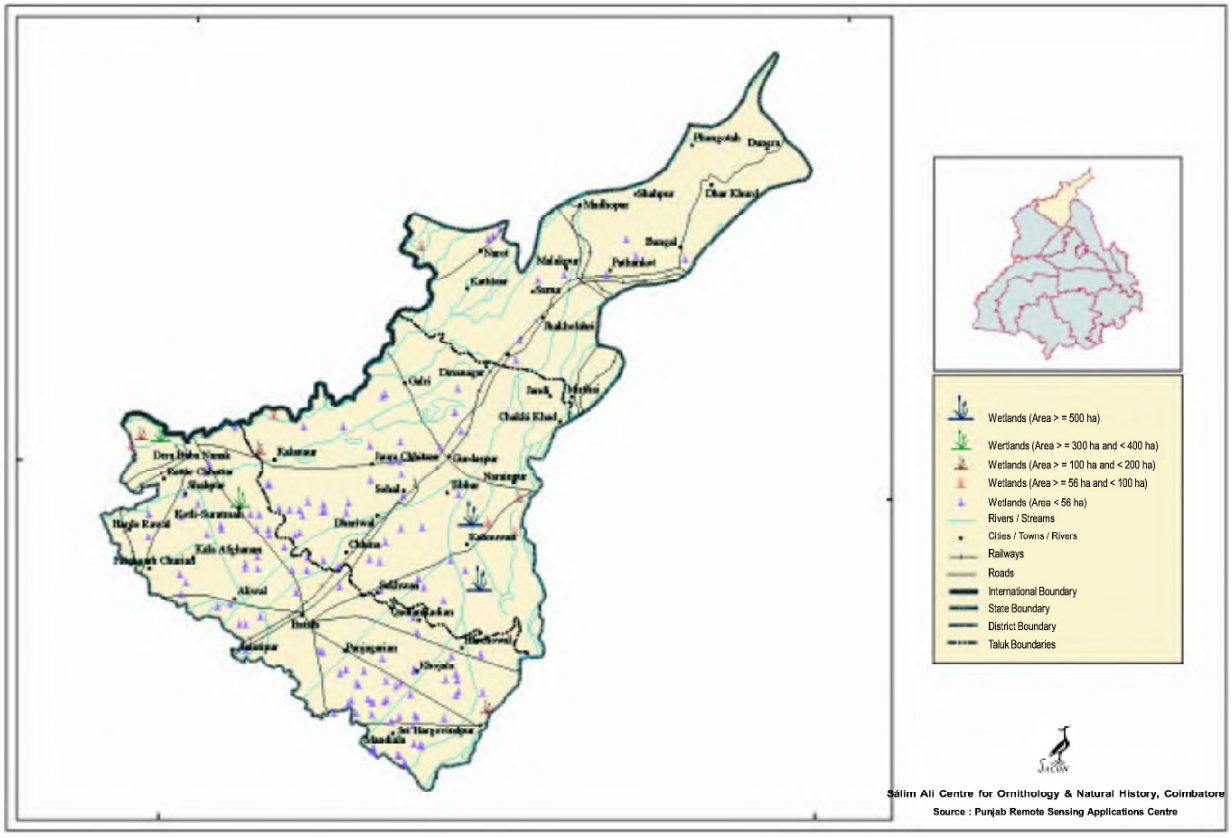


Fig. 14.6. Distribution of wetlands in the district of Gurdaspur

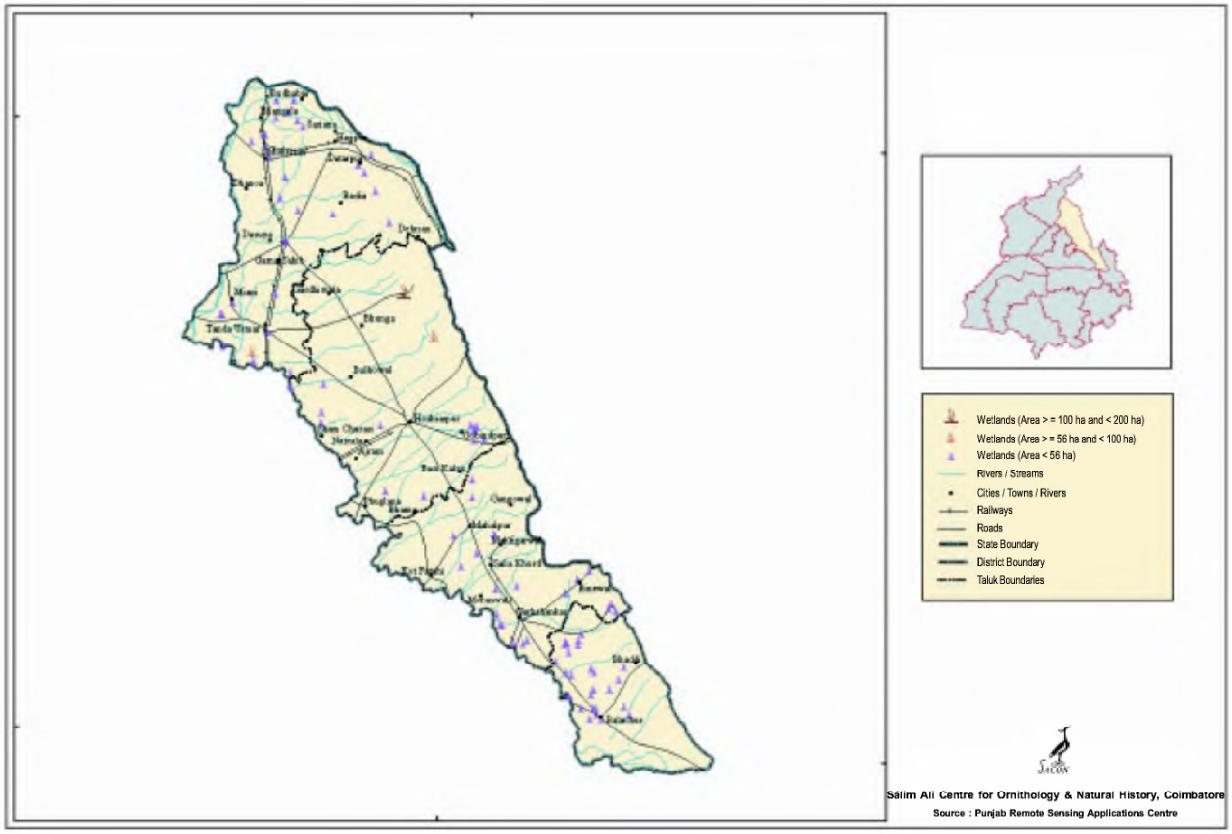


Fig. 14.7. Distribution of wetlands in the district of Hoshiarpur

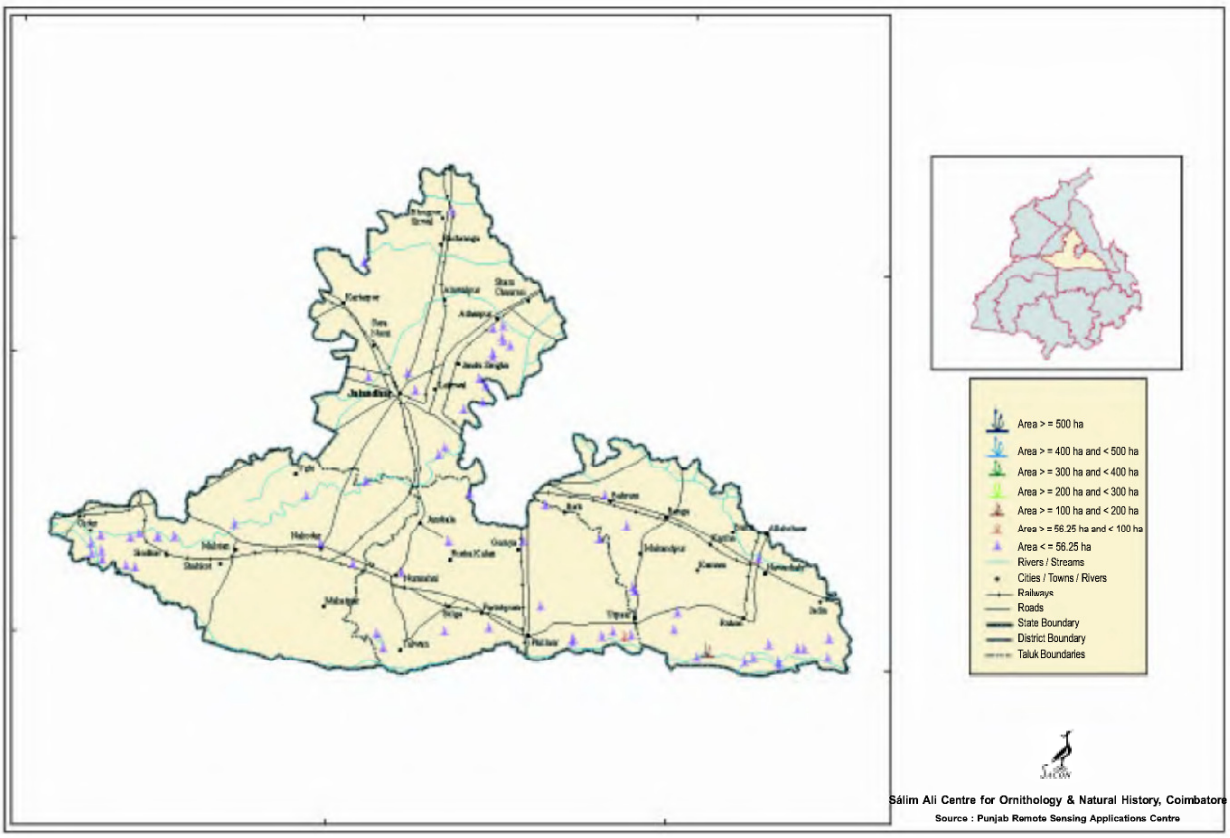


Fig. 14.8. Distribution of wetlands in the district of Jalandhar

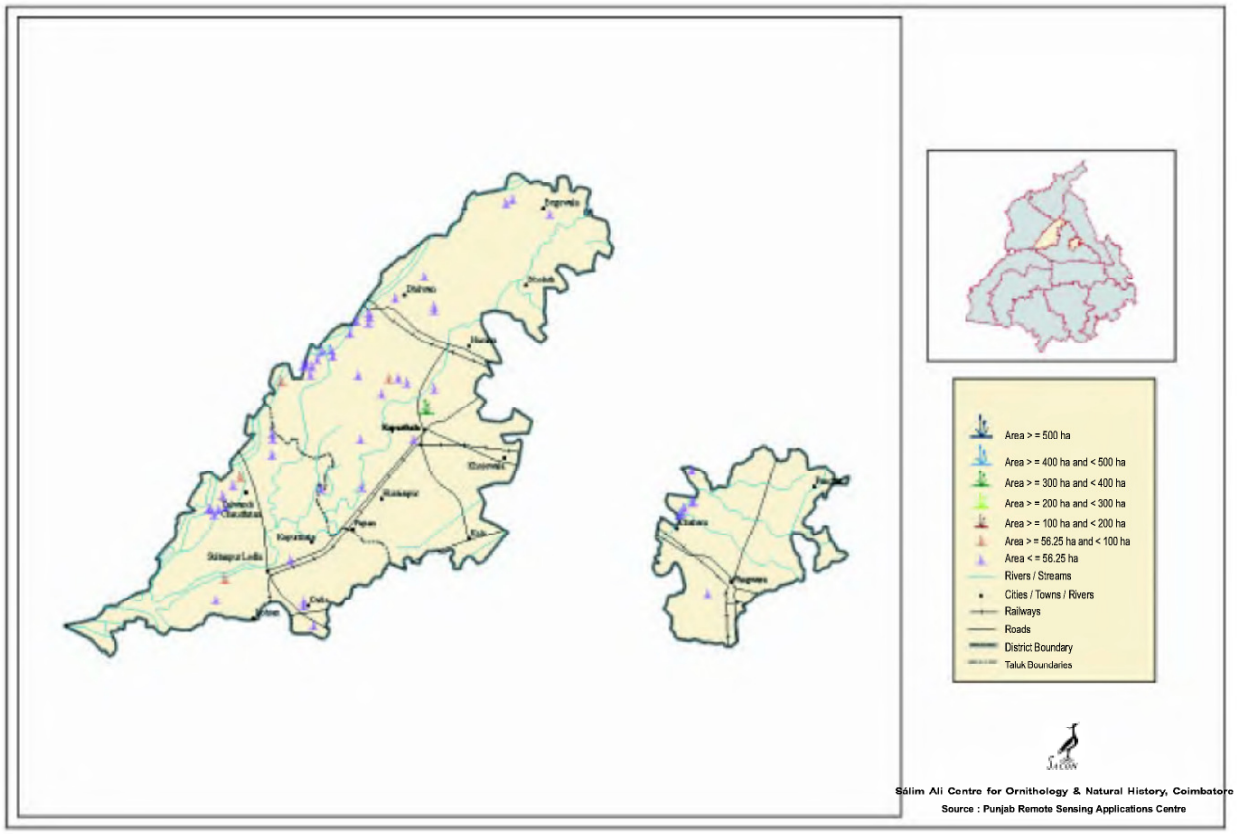


Fig. 14.9. Distribution of wetlands in the district of Kapurthala

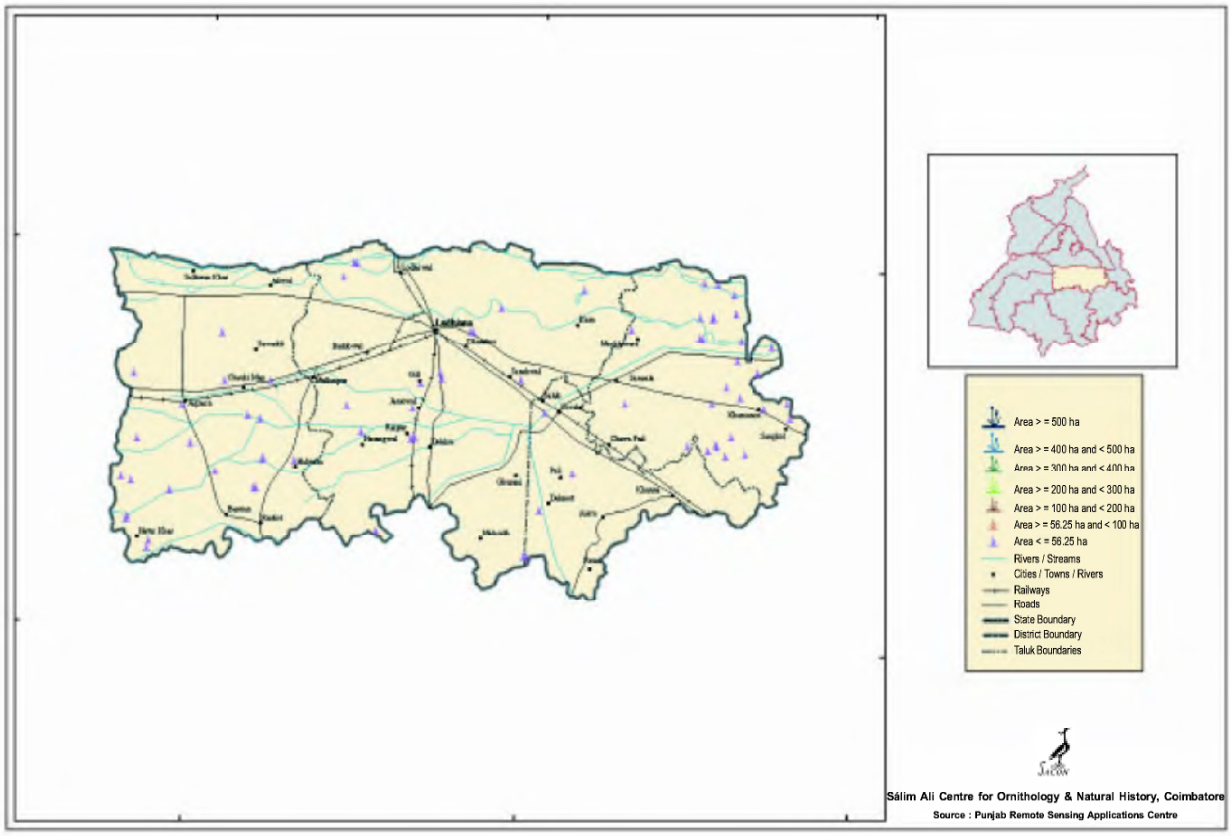


Fig. 14.10. Distribution of wetlands in the district of Ludhiana

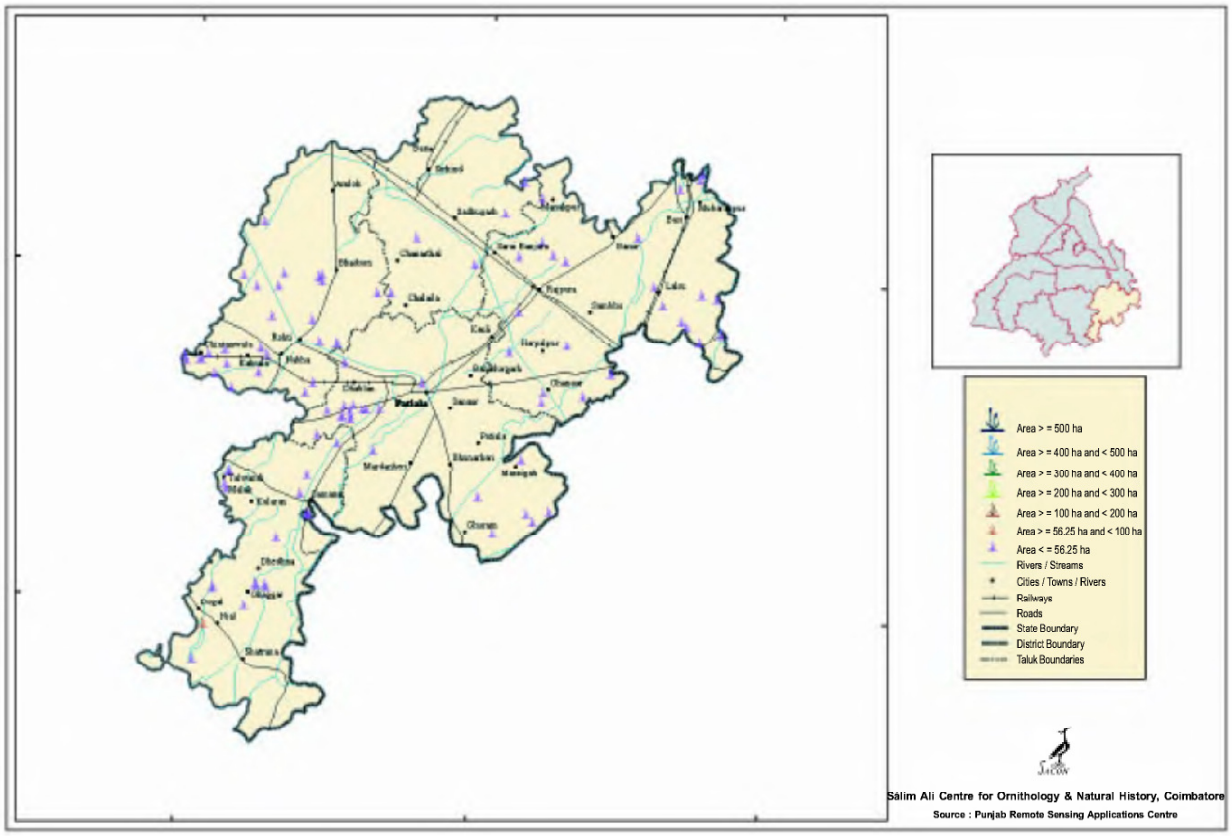


Fig. 14.11. Distribution of wetlands in the district of Patiala

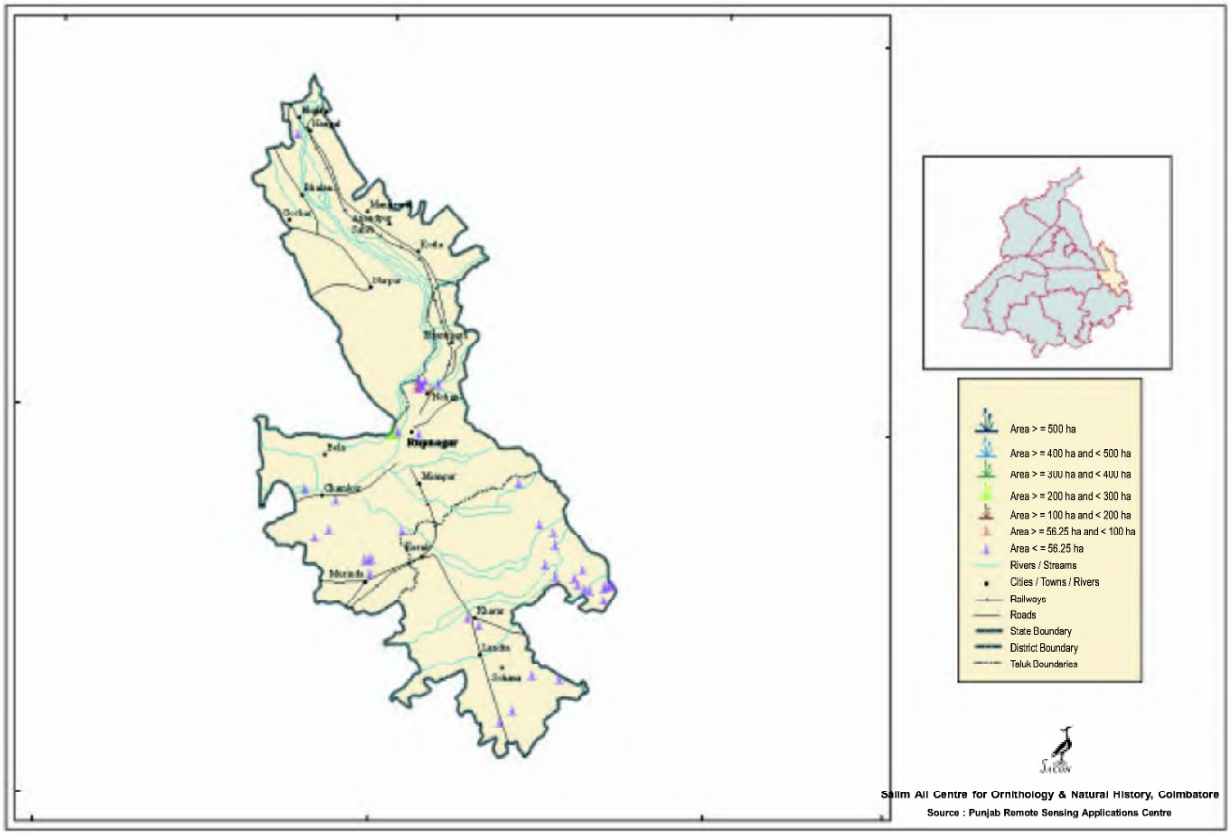


Fig. 14.12. Distribution of wetlands in the district of Rupnagar

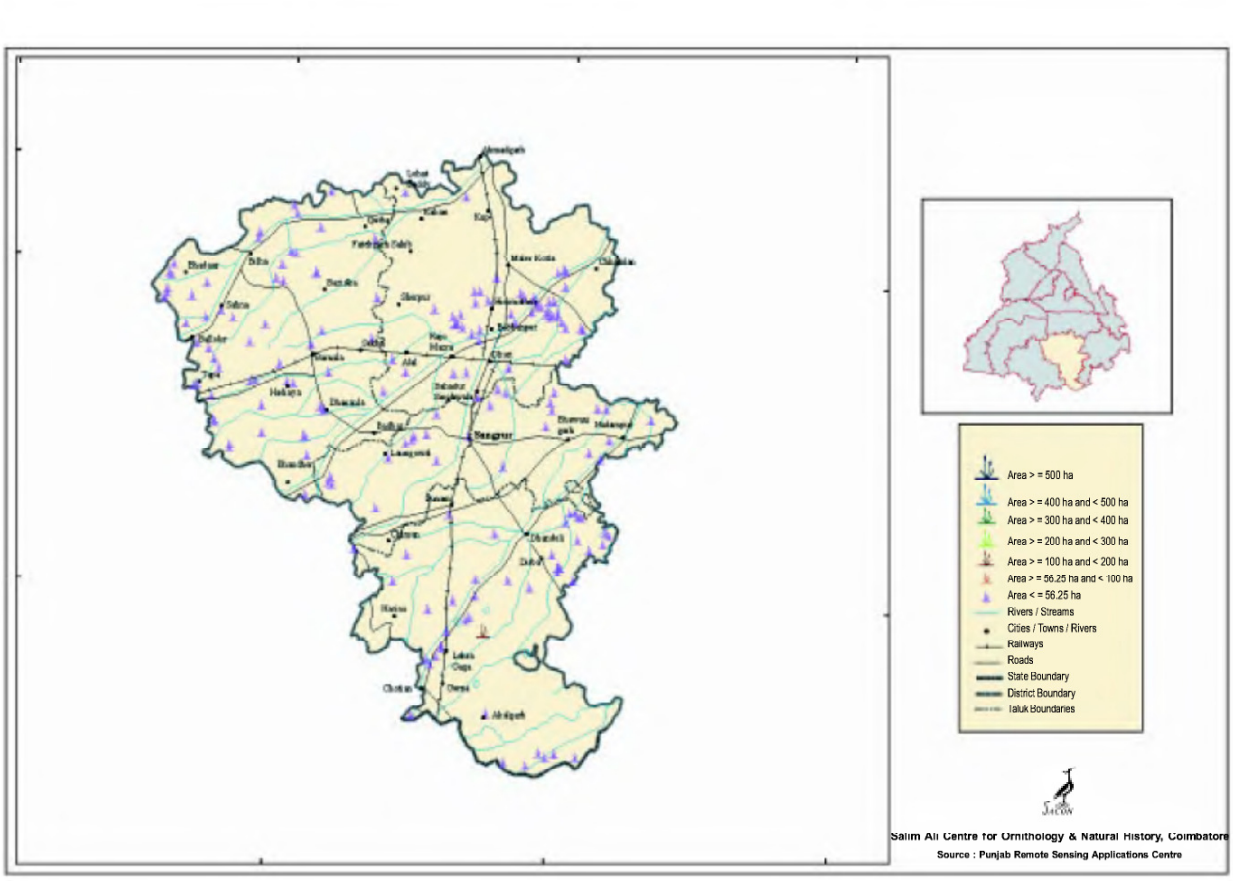


Fig. 14. 13. Distribution of wetlands in the district of Sangrur

Table 14.2. Distribution of various categories of inland wetlands in Punjab

Type of inland wetland	Area (sq km)	No. of wetlands	Pre-monsoon	Post-monsoon
Lakes/ponds	411.01	878	119.32	104.83
Oxbow lakes/cut-off meander	20.82	114	20.83	15.99
Waterlogged (seasonal)	58.17	514	57.81	25.04
Swamps/marshes	77.77	95	77.78	73.37
Reservoirs	127.24	32	8.50	6.94
Tanks	3.86	46	3.87	3.76
Waterlogged (man-made)	19.30	141	19.25	13.22
Ash/cooling ponds	0.58	1	0.58	0.58
Total	718.75	1821	307.94	243.72

Source: SAC (1998)

Biodiversity

Vegetation

Vegetation of the state was not mapped using satellite imageries as done for other states. Hence, field description for some of the major wetlands is given here.

At Tajpur Khoje vegetation was patchy with low density. Ramgarh Sandhuwan had only open water and submerged vegetation in certain areas. Thermal ash ponds of the thermal power plant in Bhathinda had large extent of submerged vegetation and open water. Rajgarh had more diverse types with low density, whereas Dholbaha had no vegetation. Maru Buchia had a small area of emergent vegetation and the rest was open water. Kanjili and Mundi Morh had more areas with submerged and floating vegetation; Zahura jheel had more floating vegetation; Shikar Machia had half the area with emergent vegetation and the rest with other types. Keshopur had sparse vegetation of emergent and floating plants; Kahnuway and Makhu had all types of aquatic vegetation, but at low density except submerged plants at medium density. No record of endemic aquatic plants is available from Punjab.

Fishes

Seven Endangered and eight Vulnerable (Table 14.3) species of fishes were recorded from Punjab (Menon, 1999).

Turtles

Eight species of turtles have been identified from Punjab; out of which one each was Endangered and Critical while three were Vulnerable and two Near Threatened and, one was of Least Concern (Table 14.4).

Birds

In all, 7,000 birds of 90 species including 14 terrestrial species were recorded during the survey covering 13 selected wetlands in Punjab. The only species that recorded more than 1,000 in number was the Spotbill Duck, while two species recorded more than 500, namely the Coot (718) and Wigeon (504). Most of the water birds were migratory, except for a few which were resident. Majority of the birds (58%) were ducks belonging to 16 species of the family Anatidae. Many species (32) were below five in number. Of the 90 species recorded, four were Threatened with 67 birds and two Near Threatened with four birds (Table 14.5).

Table 14.3. Threatened freshwater fishes of Punjab

No.	Species	Status
1	*Anguilla bengalensis*	EN
2	*Botia lohachata*	EN
3	*Eutropiichthys vacha*	EN
4	*Nemacheilus montanus*	EN
5	*Ompok bimaculatus*	EN
6	*Pseudeutropius atherinoides*	EN
7	*Puntius chilinoides*	EN
8	*Garra gotyla gotyla*	VU
9	*Heteropneustes fossilis*	VU
10	*Labeo dero*	VU
11	*Mystus vittatus*	VU
12	*Osteobrama cotio*	VU
13	*Puntius chola*	VU
14	*Puntius conchonius*	VU
15	*Raiamas bola*	VU

Table 14.4. Turtles of Punjab

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes gangeticus*	VU	-	I
2	*Chitra indica*	EN	-	IV
3	*Geoclemys hamiltonii*	VU	I	I
4	*Hardella thurjii*	VU	-	-
5	*Kachuga kachuga*	CR	-	I
6	*Kachuga smithii*	LC	-	-
7	*Kachuga tecta*	NT	I	I
8	*Lissemys punctata*	NT	II	I

VU=Vulnerable; EN=Endangered; CR=Critical; LC=Least Concern; NT=Near Threatened

Table 14.5. Frequency of sightings of Threatened and Near Threatened birds in Punjab

S#	Species	Status	No. of wetlands where sighted	No. of birds sighted
1	Spotbilled Pelican	T	3	46
2	Whitebacked Vulture	T	1	15
3	Greater Spotted Eagle	T	4	5
4	Bristled Grass Warbler	T	1	1
5	Darter	NT	3	3
6	White-eyed Pochard	NT	1	1

T=Threatened; NT=Near Threatened

Table 14.6. Major wetlands of Punjab with species and number of birds

S.#	Name of the site	# of species	# of birds
1	Maru Buchia	46	2,697
2	Mundi Morh	35	481
3	Tajpur khoje	31	451
4	Keshopur	30	554
5	Shikar Machia	29	183
6	Kahnuway	27	628
7	Makhu	24	128
8	Thermal power plant*	23	1,035
9	Rajgarh	20	171
10	Kanjili	16	223
11	Ramgarh Sandhuwan	10	213
12	Dholbaha	8	192
13	Zahura jheel	7	44
	Total	90	7,000

* in Bhathinda

Of the 13 water bodies observed during the course of the survey in Punjab, Maru Buchia had the highest population of birds (2,697) and species richness (46) (Table 14.6). Nine wetlands had more than 20 bird species, while only one wetland had more than 40 species and only two had fewer than 10 species. Distribution of the species shows that the Whitebreasted Waterhen (12 wetlands), Little Cormorant and Indian Moorhen (each in 11 wetlands) were the most widely distributed birds. All these are resident or local migrant and move locally according to the availability of water. Other widely distributed species were the Purple Moorhen and Whitebreasted Kingfisher (each in 10 wetlands). Many species were restricted to a few wetlands, to their preferred habitats. Of the 90 species, 50 were recorded only in one or two wetlands while 17 species were common occurring in >50% of the wetlands.

Environmental contamination

Only 19 fishes belonging to eight species from three wetlands were collected from Punjab for analyses. Thirteen individuals belonging to three species from three wetlands are currently discussed.

Heavy metals

Among the three wetlands, the fishes from Kanjili recorded the maximum concentrations of all metals. Moreover, levels of lead (6.61±1.05 ppm) and zinc (24.40±2.30 ppm) were comparatively high. The contamination levels among the wetlands was significantly different ($P<0.005$) for all the metals, except chromium and cadmium.

Cirrhinus mrigala had higher concentrations of lead (8.33±5.69 ppm), cadmium (0.66±0.27 ppm) and chromium (0.77±0.21 ppm) than *Labeo rohita*.

Pesticides

Among the three wetlands, Matma of Gurdaspur district recorded the maximum load of total organochlorine residues (0.053 ppm) followed by Kanjili (0.024 ppm) of Kapurthala district and Harike marshes (0.023 ppm) of Ferozepur district (Fig. 14.14). Among the three species of fishes analyzed, *Labeo rohita* recorded the maximum (0.062 ppm) concentration of pesticide residues followed by *Cirrhinus mrigala* (0.022 ppm) and *Channa punctatus* (0.02 ppm) (Fig. 14.15).

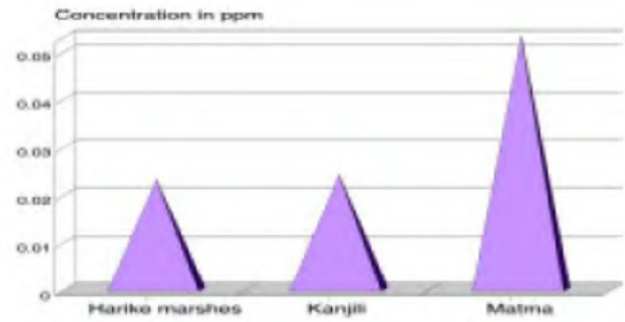


Fig. 14.14. Total organochlorine residues among various wetlands of Punjab

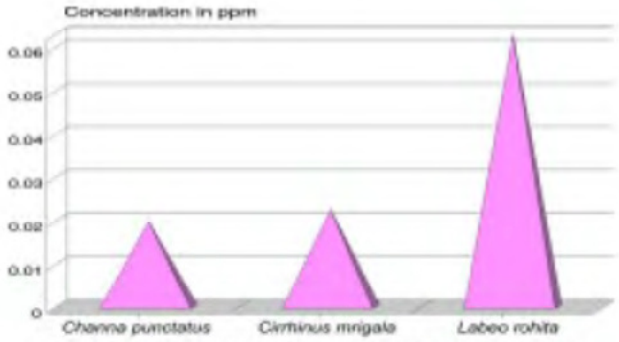


Fig. 14.15. Total organochlorine residues among various species of fishes in Punjab

While, endosulfan residues were detected in all the fishes, HCH was recorded in 94 % of the fishes analyzed. Agriculture around the wetlands, using pesticides would certainly add on the concentration. Wheat, rice and sugarcane are the commonly cultivated crops around the wetland Kanjili. Further fish harvesting was reported to have declined by 40% over the last 5-6 years. It may also be noted that the annual pesticide consumption (7,076 mt) in Punjab is comparatively higher than that in the other states.

Suitability for human consumption

While the levels of copper, zinc, cadmium and chromium were well within the safe limits, those of lead (0.20 mg), were close to the permissible levels prescribed by UN Committee (WHO, 1989, 1993); 0.21 mg for a 60 kg adult per day. If the consumption goes up, adverse effects on consumers are implicit. Pesticide concentration recorded in the fishes appears to be less than the levels reported to produce risk to fish and wildlife (USEPA, 1980 Criterion).

Socioeconomic values

A preliminary assessment of the use values shows that all the wetlands studied are being utilized in different levels. Of the seven major uses, those with 5-7 uses were considered as high use, with 3-4 uses as medium and below three as low use. Only two had high use while many had low use.

Prioritization of wetlands

The 13 wetlands surveyed in Punjab were prioritized based on the criteria of birds observed in these sites. Rating was given to each site as described in the methods and the sites were ranked into four categories. Two sites with priority ratings of ≥10 came in the first rank, the next five in the second rank (ratings of 5-10), and the last six in the third rank (<5 as rating). However, when size was also considered, the ranking has changed slightly (Table 14.7). Maru Buchia, Tajpur khoje, Shikar machia were the top-raking sites, the last one came up in the rank because of the size. Some of the wetlands got only low ranks, probably, because of the drought

Table 14.7. Prioritised list of the wetlands of Punjab

S.No.	Name of the wetland	Rank	Use
1.	Maru Buchia	1	H
2.	Tajpur khoje	1	L
3.	Shikar Machia	1	M
4.	Makhu	2	H
5.	Rajgarh	2	M
6.	Mundi Morh	2	L
7.	Thermal power plant	2	L
8.	Ramgarh Sandhuwan	2	L
9.	Dholbaha	3	M
10.	Kanjili	3	L
11.	Kahnuway	3	L
12.	Keshopur	3	L
13.	Zahura jheel	3	M

during the study period. As the wetlands were selected based mainly on the earlier records on birds and the local information, it is advisable to have a reassessment of the situation during the next season (Table 14.7). A comprehensive map of the sites prioritized, BCPP sites, IBA and Protected Areas of Punjab is provided (Fig. 14.16).

The high biodiversity areas (first and second ranks) have high, medium or even low use unlike in other states. They may have to be considered for protection as Community Reserve. Those with low use could be given protection status. Kanjili is already protected and is a Ramsar site. There are two other Ramsar sites in Punjab; Harike and Ropas.

Maru Buchia, Tajpur khoje and Shikar Machia are also qualified to be declared as Ramsar sites.

Summary

- Punjab, according to the 1992-'93 satellite data, has 1,821 wetlands of the size 56.25 ha and above, covering an area of 718.75 sq km of wetlands.
- The district of Ferozepur has the largest number of wetlands (340), while the district of Amritsar has the largest extent of area under wetland (335.07 sq km).
- Punjab has seven Endangered and eight Vulnerable species of fishes; one each of Critical and Endangered, three Vulnerable, two Near Threatened and one Least Concern species of freshwater turtles; and four Threatened and two Near Threatened species of birds.
- In the 13 wetlands surveyed, 7,000 birds belonging to 90 species were recorded.
- Maru Buchia had the highest number of species of birds (46) compared to other wetlands studied.
- The Whitebreasted Waterhen, Little Cormorant and the Indian Moorhen were the widely distributed species.
- Thirteen fishes belonging to three species from three wetlands were analysed for pesticide and metal contamination.
- Kanjili had the highest concentrations of lead, zinc and cadmium.
- The level of lead was very close to the permissible limit.
- Endosulfan was detected in all the fishes examined, while HCH in 94% of the fishes.
- Thirteen wetlands were prioritized, three in the first rank, five each in the second and third ranks.
- All the three wetlands in the top rank qualify to be declared as Ramsar sites.

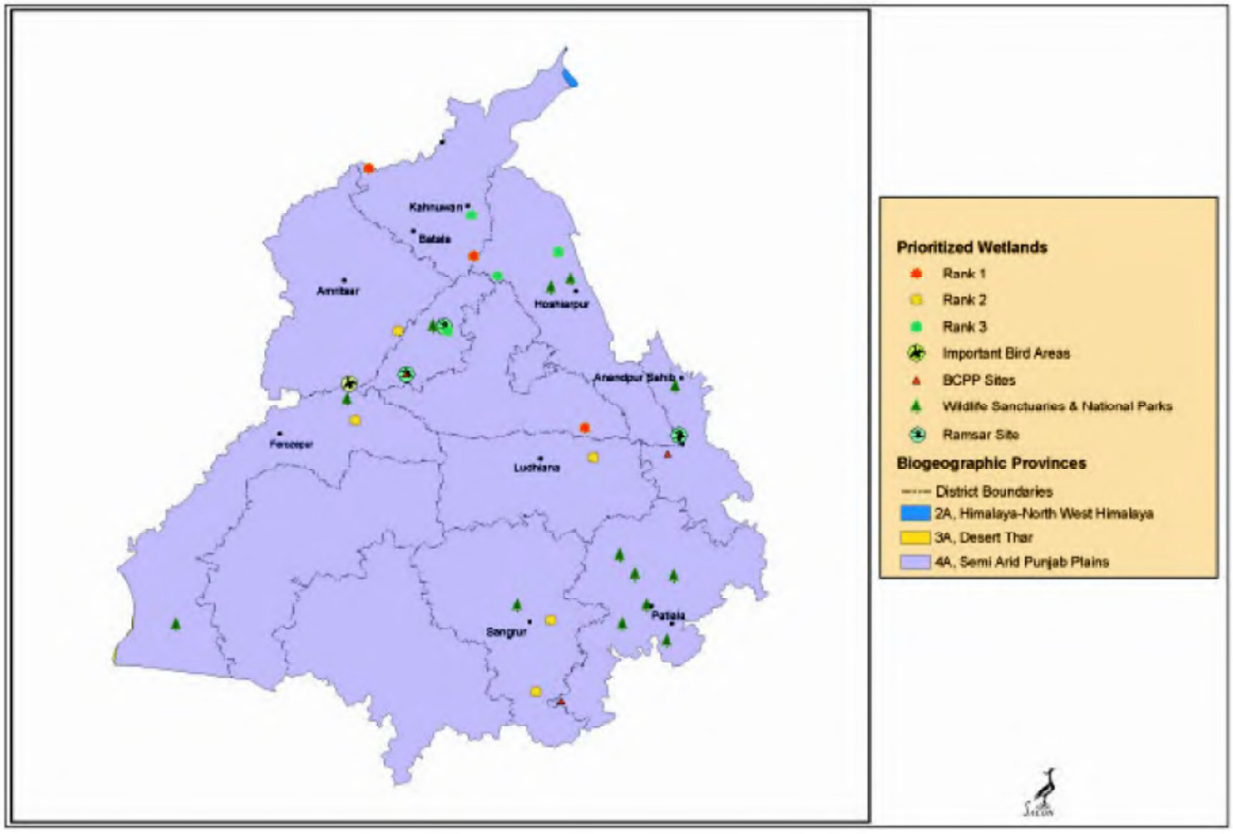
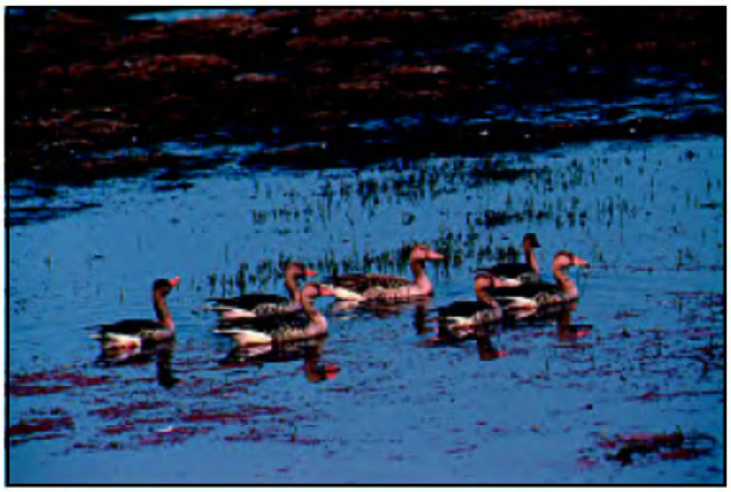


Fig. 14.16. Prioritized wetlands and other conservation areas in Punjab



Vivek R. Sinha

Greylag Geese



Mukesh Acharya

Purple Moorhen - a species preferring thick emergent vegetation



V.S. Vijayan

Coots: a species preferring open water with submerged vegetation

JAMMU & KASHMIR

Jammu and Kashmir, with its magnificent and lofty snow clad mountains, sylvan landscapes, ravishing rivers and rivulets and above all the lively picturesque lakes with vast multitudes of waterfowl, is indeed a paradise for nature lovers. More than 90 per cent of the state's territory is mountainous, and the state can be divided into seven zones that are related to the structural components of the western Himalayas. From south-west to north-east these zones consist of the plains, the foothills, the Pir Panjal range, the Vale of Kashmir, the Great Himalayan zone, the upper Indus river valley, and the Karakoram range. The highest peak of the whole of Kashmir is the Nanga Parbat, rising to 8,114 m.



State at a glance	
State capital	Srinagar
Area	2,22,236 sq km
Population (2001)	10,069,917
Total number of districts	14
Major rivers	Indus, Chenab, Sutlej
Total forest area	27,470 sq km
Population density (2001)	99/ sq km
Ramsar sites	2
Proposed Ramsar sites	7
Total sites proposed for conservation	29

Characteristic features of Kashmir lakes are the 'floating islands'. These are strips of land artificially created and towed along from place to place. These floating islands are used for growing horticultural crops. There are extreme variations in climate in the state, due to its location and topography. While, Leh is the coldest, Jammu is the hottest place. The average temperature varies from -2 to 30.1°C. The average annual rainfall of the state is 1,011 mm.

Status of wetlands

The land use statistics, as in other states, does not have a separate category to report wetlands (Table 15.1).

The wetland typology is restricted merely to three categories, namely lakes, reservoirs and waterlogged areas. The total number of wetlands of the size 56.25 ha and above was estimated at 42 (Table 15.2) covering 4,068 sq km (SAC, 1998); ie. 1.83% of the total area of the state. The present estimate of wetlands of the size 2 ha and above in the districts of Baramula, Jammu and a part of Ladakh shows that there are 454 wetlands covering an area of 750.87 sq km.

Table 15.1. Land use pattern in Jammu & Kashmir

Land use type	Area in sq km
Total geographic area	2,22,236
Forests	27,470
Not available for cultivation	5,820
Other uncultivated land excluding fallow land	3,380
Fallow land	1,050
Net area sown	7,330
Area sown more than once	3,480
Total cropped area	10,810
Cultivable area	11,760

Source: www.indiastat.com

While many districts show subsidence of water level in the pre-monsoon season, Gilgit shows increase due to the snow melt. On the average, there is a net increase in water level during the pre-monsoon season. The percipitation varies from less than 100 mm in Leh to 1,000 mm in Jammu

Habitat analyses of wetlands in select districts

Out of the fourteen districts, three were chosen to map wetlands at a finer resolution (23.5 m) to capture

Table 15.2. Distribution of various categories of inland wetlands in Jammu & Kashmir (in sq km)

Inland wetland	Area	Number
Lakes/ponds	3,867.17	24
Waterlogged	69.44	14
Reservoirs	130.25	3
Tank	0.94	1
Total	4,067.80	42

Source: SAC (1998)

wetlands of the size 2 ha and above. The outputs consist of land use, various categories of wetlands, levels of turbidity and extent of aquatic vegetation. For the district of Ladakh, only WIFS data at 188m resolution was used for a part of the area (6,788 sq km) out of the total district area of 53,000 sq km. The land use varied substantially among the three districts (Table 15.4, 15.7, 15.10).

Wetlands

The area under wetlands varied from a minimum of 0.78% in Jammu to 2.69 in Baramula (Tables 15.4,15.7,15.10; Fig. 15.1). Only two categories, namely water logged and lakes/ponds were found. Baramula district had relatively higher area under lakes/ponds than Jammu, which had a substantial waterlogged area (Table 15.3). Part of the area studied in Ladakh also had a large extent of wetland (Fig. 15.2).

Table 15.3. Types, number and extent (sq km) of wetlands in select districts

Districts	Ponds/lakes/tanks		Waterlogged		Total no. of wetlands	Total area of wetlands
	No.	Area	No.	Area		
Jammu	1	0.32	13	23.71	14	24.03
Baramula	352	221.23	8	29.56	360	250.79
Ladakh (Leh & Kargil)	80	476.05			80	476.05
Total	433	697.6	21	53.27	454	750.87

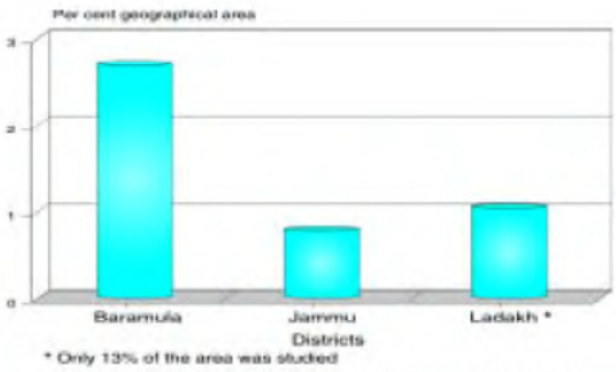


Fig. 15.1. Area under wetland in Jammu & Kashmir

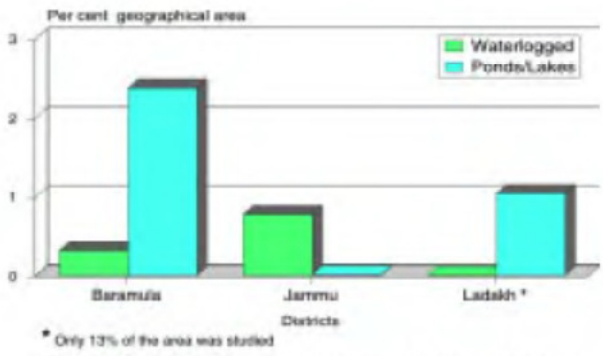


Fig. 15.2. Area under different wetland classes in Jammu & Kashmir

Turbidity

Very high levels of turbidity were found in the wetlands of Jammu region (Fig. 15.3). Since many of these are located in the agricultural areas, the sediments do contribute to the observed high levels of turbidity. In contrast, Baramula had relatively less turbidity (Tables 15.5, 15.8, 15.11).

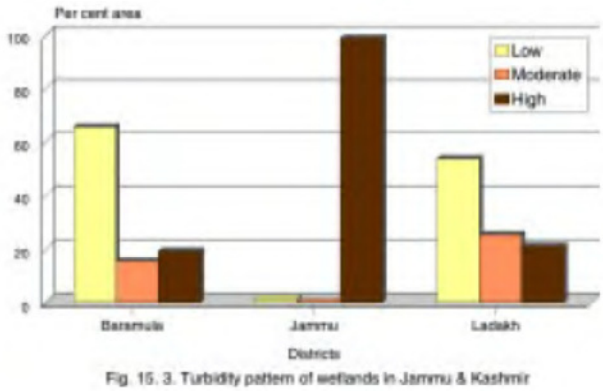


Fig. 15. 3. Turbidity pattern of wetlands in Jammu & Kashmir

Most of the ponds/ lakes had low turbidity in all the three districts, while the waterlogged areas in Jammu had high turbidity. Those in Baramula had low to moderate turbidity.

Summer recession

Pre-monsoon recession of wetlands did not show much difference between the districts of Baramula and Jammu, while it was strikingly low in the case of the wetlands of Ladakh (Table 15.6, 15.9, 15.12; Fig. 15.4).

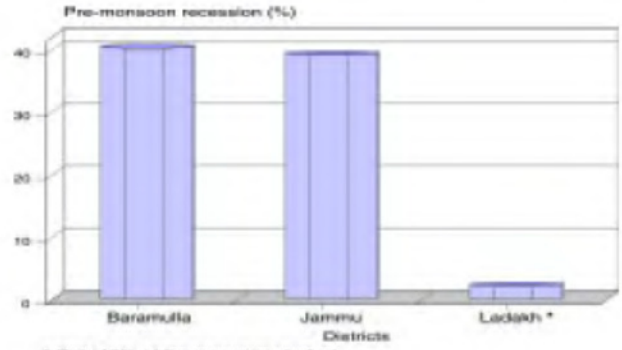


Fig. 15.4. Average summer recession in Jammu & Kashmir

Wetlands and land use pattern in the catchment areas

The integrated land use and wetland maps for the three districts (Fig. 15.5, 15.6, 15.7) show divergent situation in the land use pattern. In the case of Baramula much of the catchment of the wetlands is located in the agricultural areas. However, Wular lake has substantial amount of forest catchment. In the Jammu district, most of the wetlands are situated in the agricultural landscape. In the case of Leh (district: Ladakh), many of the wetlands seem to be in relatively undisturbed landscape containing pastures.

Temporal changes in wetland cover

Changes in the wetland cover between 1992-93 and 2000-2001 were worked out for the three districts following the methods given in Chapter 2. The Ladakh district had a substantial loss; 86.98% ie. 3,179 sq km (Table 15.13; Fig. 15.8), whereas the Baramula and Jammu districts had an increase in the wetland cover, 6 to 19% respectively.

Table 15.13. Changes in the wetland area (sq km) in select districts

District	SAC (1992-93)	SACON (2000-01)	Variation	% variation
Baramula	236.50	250.79	14.29	6.04
Jammu	20.13	24.03	3.91	19.43
Ladakh	3,655.14	476.05	-3,179.09	-86.98

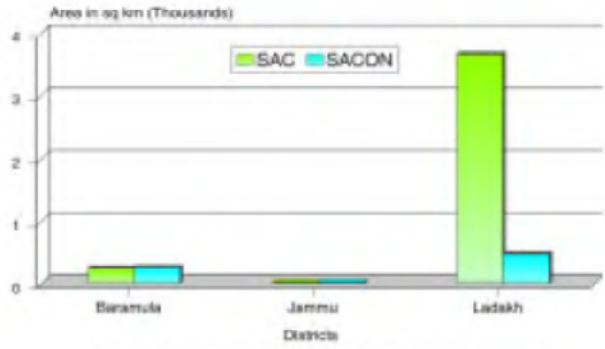


Fig. 15.8. Difference in total wetland area in select districts in Jammu & Kashmir

Biodiversity

Aquatic vegetation

SAC (1998) data, using LISS I of 76 mm resolution show that the ponds/lakes in Jammu and Ladakh had low vegetation. Those in Baramula had low vegetation in about 50% of the area while comparatively dense vegetation in the rest (Fig. 15.9). Waterlogged area had dense vegetation in Jammu and Ladakh (Table 15.14).

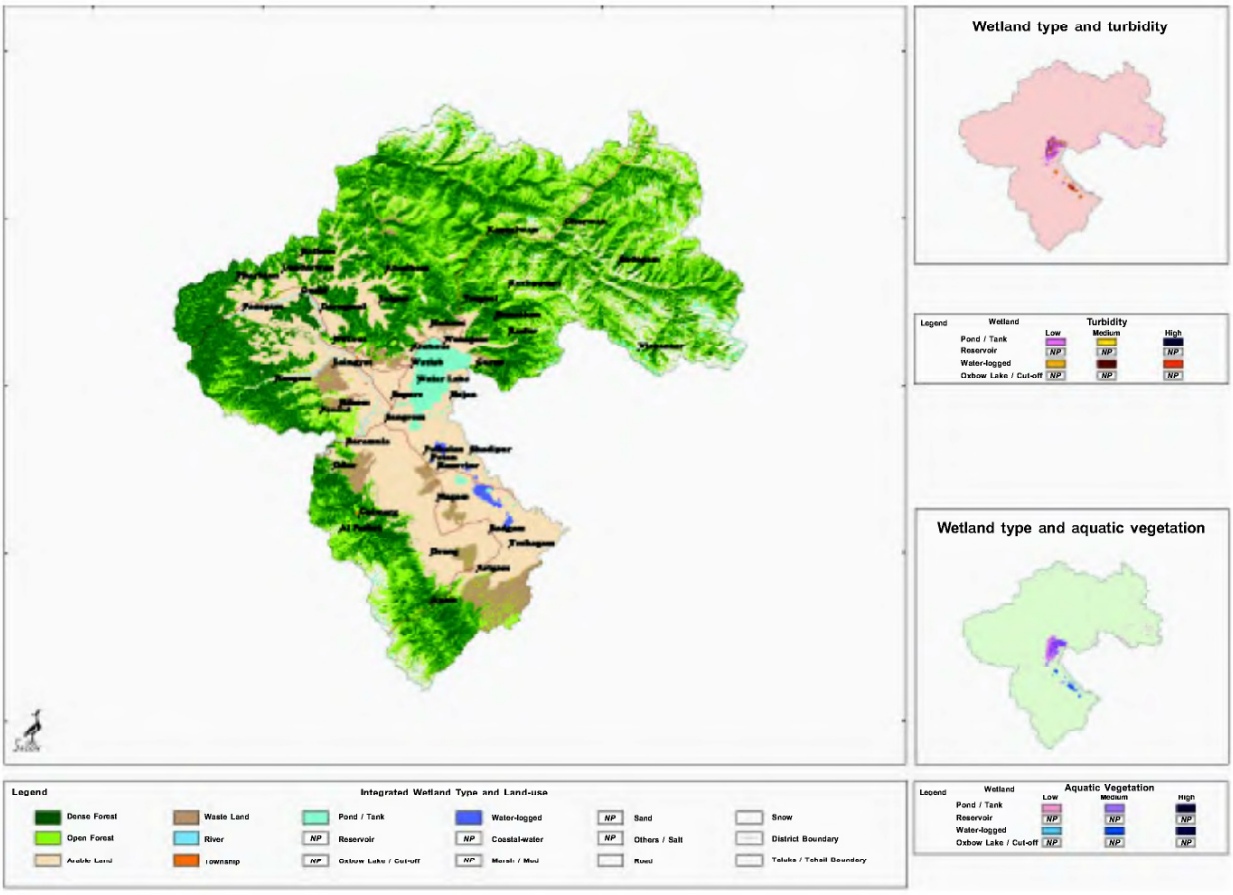


Fig. 15.5. Land use and wetland categories of the district of Baramula

Table 15.4. Area under different land use and wetland types in the district of Baramula

Land use class	Area (sq km)	Area (%)
Dense forest	2,989.60	32.08
Open forest	2,466.79	26.47
Arable land	2,639.67	28.33
Waste land	350.70	3.76
River	23.89	0.26
Snow	589.86	6.33
Settlements	7.70	0.08
Ponds/lakes	221.23	2.37
Waterlogged	29.56	0.32

Table 15.5. Area under different turbidity levels in the district of Baramula

Turbidity class	Area (sq km)	Area (%)
Low	164.55	65.61
Moderate	38.09	15.19
High	48.17	19.21

Table 15.6. Seasonal changes in water spread in the district of Baramula

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes	162.33	93.31	69.01	
Waterlogged	19.44	15.37	4.07	
Total	181.77	108.68	73.08	40.20

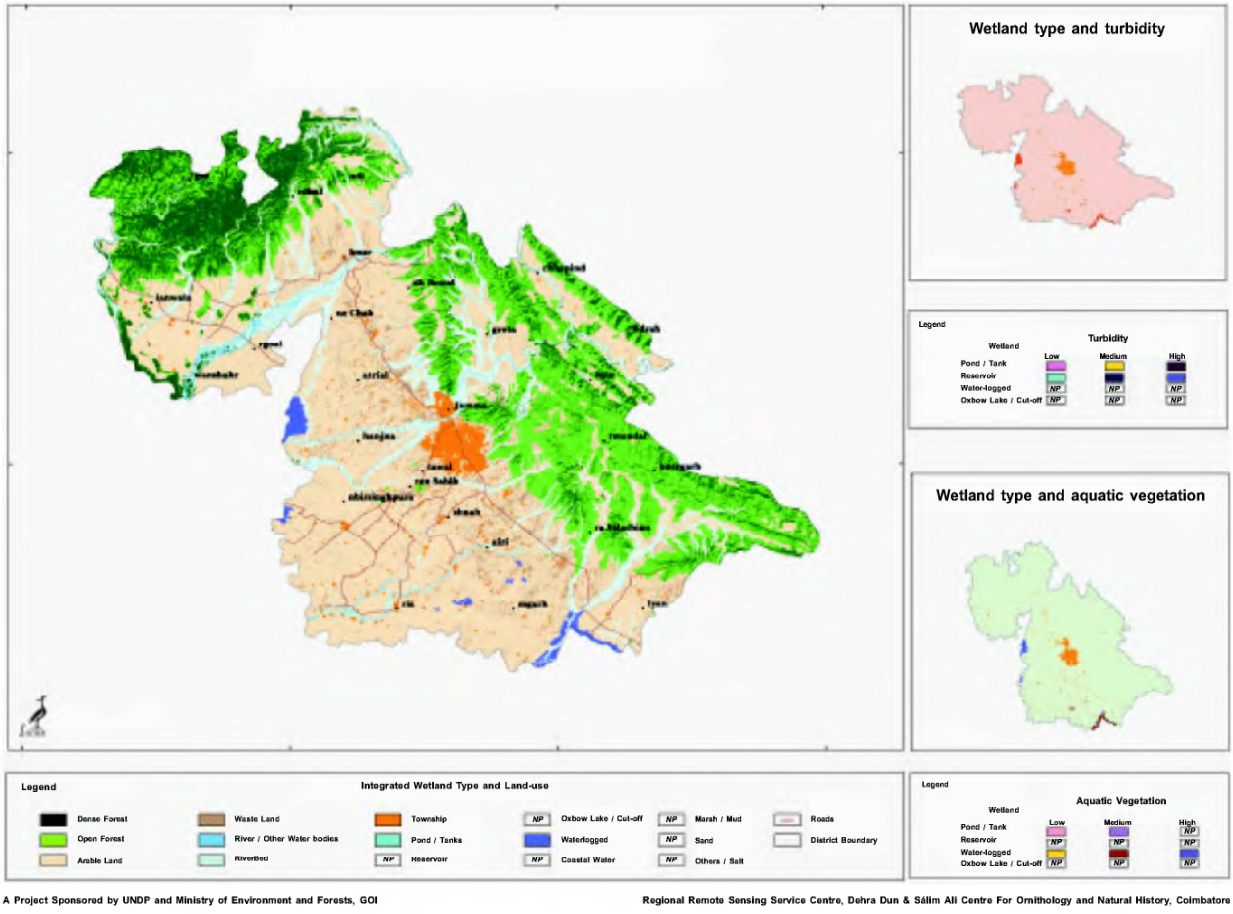


Fig. 15.6. Land use and wetland categories of the district of Jammu

Table 15.7. Area under different land use and wetland types in the district of Jammu

Land use class	Area (sq km)	Area (%)
Dense forest	396.77	12.81
Open forest	671.28	21.68
Arable land	1,467.88	47.40
Waste land	107.85	3.48
River	26.90	0.87
River bed	330.11	10.66
Settlements	65.92	2.13
Road	6.26	0.20
Ponds/lakes	0.32	0.01
Waterlogged	23.71	0.77

Table 15.8. Area under different turbidity levels in the district of Jammu

Turbidity class	Area (sq km)	Area (%)
Low	0.32	1.33
Moderate	0.00	0.00
High	23.71	98.67

Table 15.9. Seasonal changes in water spread in the district of Jammu

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes	0.31	0.31	0.00	
Waterlogged	22.81	13.75	9.05	
Total	23.12	14.06	9.05	39.14

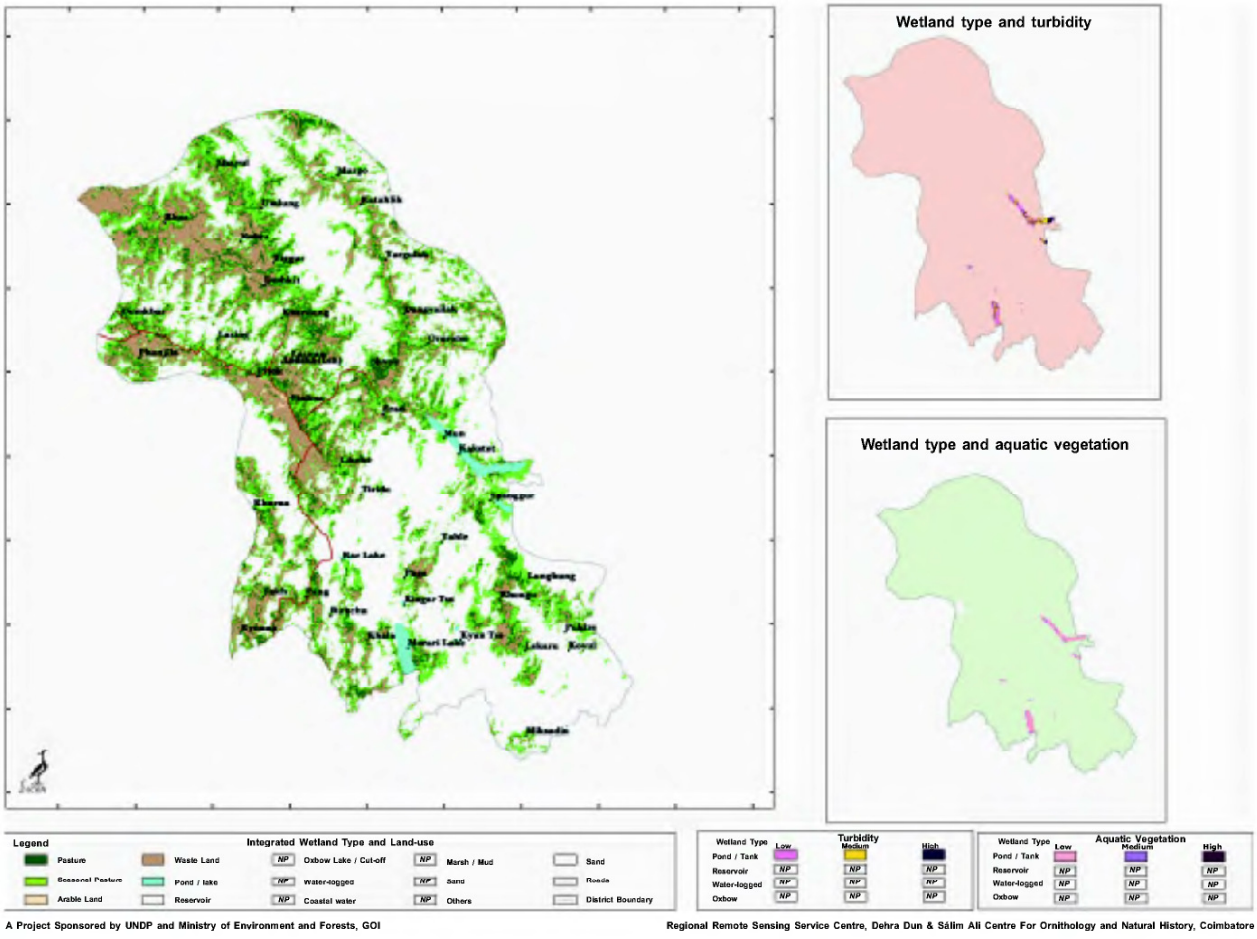


Fig. 15.7. Land use and wetland categories of the district of Ladakh

Table 15.10. Area under different land use and wetland types in the district of Ladakh

Land use class	Area (sq km)	Area (%)
Arable land	113.27	0.25
Wasteland	7,114.29	15.62
River	4,067.24	8.93
Pasture	8,117.22	17.82
Seasonal pasture	25,669.64	56.35
Wetland	476.05	1.04

Table 15.11 Area under different turbidity levels in the district of Ladakh

Turbidity class	Area (sq km)	Area (%)
Low	255.20	53.61
Moderate	120.63	25.34
High	100.26	21.06

Table 15.12. Seasonal changes in water spread in the district of Ladakh

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes	464.79	454.98	9.80	2.11

Table 15.14. Summary of turbidity and aquatic vegetation statistics for different types of wetlands

State	Wetland type	Area sq km	% area					
			Turbidity			Aquatic Vegetation		
			Low	Moderate	High	Low	Moderate	High
Jammu	Ponds/Lakes	0.32	100.00	0.00	0.00	83.86	16.65	0.00
Jammu	Waterlogged	23.71	0.00	0.00	100.00	4.04	43.61	52.35
Baramula	Ponds/lakes	221.23	69.08	13.29	17.64	54.34	33.24	12.43
Baramula	Waterlogged	29.56	39.68	23.36	30.96	15.46	50.01	34.54
Ladakh	Ponds/lakes	476.05	53.61	25.34	21.06	90.39	9.60	0.02

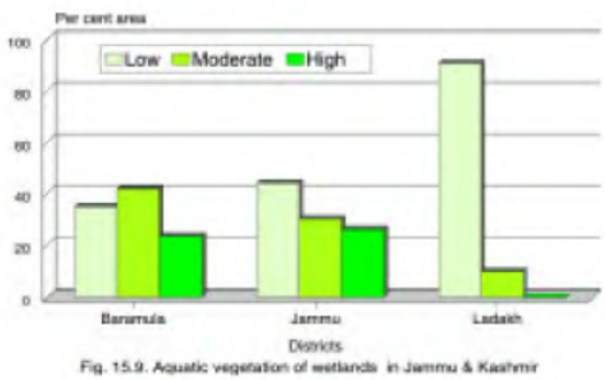


Fig. 15.9. Aquatic vegetation of wetlands in Jammu & Kashmir

Seventy five major species of aquatic plants of different types such as emergent, floating and submerged were recorded. The dominant emergents were of the genera *Saccharum, Sagittaria, Typha, Phragmites, Eleocharis* and *Scirpus*. The common submerged plants found in most water bodies are of the genera *Hydrilla, Vallisneria, Utricularia, Potamogeton, Myriophyllum, Najas* and *Ceratophyllum* and floating plants *Nelumbo, Nymphaea, Nymphoides, Trapa, Euryale* and *Lemna*. Weeds such as *Salvinia* sp. also covered some of the wetlands affecting the habitat quality. There are two endemic species of aquatic plants, namely *Najas marina ssp.* and *Hoppea dichotoma* reported from Jammu & Kashmir (Cook, 1996).

Fishes

Twenty species of Threatened fishes were recorded from the state (Menon, 1999). These include four of the 40 Endangered and, 16 of the 49 Vulnerable species occurring in India (Table 15.15). No Critically Endangered fishes were reported in Jammu & Kashmir.

Turtles

Five species of turtles were reported, out of which two each are Vulnerable and Near Threatened, while one is of Least Concern (Table 15. 16).

Table 15.16. Threatened turtles of Jammu & Kashmir

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes gangeticus*	VU	-	I
2	*Geoclemys hamiltonii*	VU	I	I
3	*Kachuga smithii*	LC	-	-
4	*Kachuga tecta*	NT	I	I
5	*Lissemys punctata*	NT	II	I

VU=Vulnerable; NT=Near Threatened; LC=Least Concern

Table 15.15. Threatened freshwater fishes of Jammu & Kashmir

S.#	Species	Status
1	*Anguilla bengalensis*	EN
2	*Ompok bimaculatus*	EN
3	*Tor pitutora*	EN
4	*Pseudeutropius atherinoides*	EN
5	*Schizothorax curvifrons*	VU
6	*Schizothorax niger*	VU
7	*Schizothorax richardsonii*	VU
8	*Puntius chola*	VU
9	*Osteobrama cotio*	VU
10	*Mystus vittatus*	VU
11	*Labeo dero*	VU
12	*Heteropneustes fossilis*	VU
13	*Cirrhinus reba*	VU
14	*Clarias batrachus*	VU
15	*Anabas testudineus*	VU
16	*Bagarius bagarius*	VU
17	*Barbodes sarana*	VU
18	*Barilius barila*	VU
19	*Barilius vagra*	VU
20	*Catla catla*	VU

En=Endangered; VU=Vulnerable

Birds

In the 29 wetlands surveyed in Jammu & Kashmir, 106 species of birds were observed, of which 25 species were land birds, occasionally visiting the wetlands, especially the drier parts. The highest number of species (43) was in Tsokar tso in the Ladakh region (Table 15.17). Two Threatened species, namely the Blacknecked Crane (at 3 sites in Ladakh) and Sarus Crane (at Gharana) and, two Near Threatened species, namely the White-eyed Pochard (at 7 wetlands in the state) and White Ibis (at 2 wetlands in Jammu) were observed during the survey. Data from the Forest Department of Jammu and Kashmir on the population of waterfowl showed very high numbers, 3,73,832 at Hokera and 3,47,047 at Hygam and above 22,580 at Wular lake.

The abundant species, the Mallard, Pintail, Gadwall, Coot, pochards and teals, were mostly migratory, while widespread species were resident such as egrets, herons and cormorants. Birds such as the Common Merganser, Ruddy Shelduck, Barheaded Goose and Endangered Blacknecked Crane, recorded in Ladakh during the survey were breeding.

Table 15.18. Prioritized list of the major wetlands of Jammu & Kashmir

No.	Sites	Rank	Use
1	Tsokar tso	1	L
2	Hokera	1	H
3	Wular lake	1	H
4	Hygam	1	H
5	Anchar	1	H
6	Narkara	1	H
7	Tsomorari	1	L
8	Mirgund	1	M
9	Pangong tso	1	M
10	Nanga	2	M
11	Paragwal	2	M
12	Shallbugh	2	H
13	Mansar lake	2	M
14	Surinsar	2	M
15	Sangral	2	L
16	Kukrian	2	M
17	Dal lake	2	H
18	Manasbal	2	H
19	Ahansar	2	M
20	Nilnagh	2	L
21	Chatlam	3	L
22	Indranagar	3	L
23	Gharana	-	M
24	Sarkootsar	-	L
25	Trigamsar	-	M
26	Naranbagh	-	M
27	Tikipora Khansar	-	M
28	Henley	-	L
29	Tsogul tso	-	L

L=Low; M=Medium; H=High

Table 15. 17. Major wetlands of Jammu & Kashmir with number of species

No.	Sites	# Species
	Jammu	
1	Mansar lake	15
2	Surinsar	15
3	Gharana	16
4	Nanga	16
5	Paragwal	18
6	Sangral	20
7	Kukrian	13
8	Sarkootsar	ND
	Kashmir	
9	Anchar	29
10	Dal lake	18
11	Hokera	33
12	Shallbugh	27
13	Manasbal	17
14	Ahansar	12
15	Wular lake	31
16	Hygam	31
17	Chatlam	6
18	Indranagar	10
19	Trigamsar	-
20	Mirgund	29
21	Naranbagh	ND
22	Nilnagh	17
23	Tikipora Khansar	ND
24	Narkara	31
	Ladakh	
25	Tsomorari	28
26	Pangong tso	17
27	Henley	ND
28	Tsokar tso	43
29	Tsogul tso	ND
	Total	106

ND=No data

Socioeconomic values

A preliminary assessment of the use values showed that these wetlands are being utilized in different levels. Of the 12 types of major uses of the wetlands surveyed, nine had low use, 12 medium and eight high use by the local community (Table 15.18).

Prioritization of wetlands

Twenty nine wetlands were surveyed in Jammu and Kashmir, eight in Jammu region, 16 in Kashmir and five in Ladakh. However, detailed data on birds were collected only from 22 sites. Again, abundance of individual species was recorded only from a

few sites. Thus, these sites were prioritized based on the criteria of bird species as given under methods and the sites were ranked into three categories, the first nine in the top rank, the next 11 in the second rank and the remaining nine in the third rank (Table 15.18).

Tsokar tso, Tsomorari, Pangong tso, Hokera, Wular lake, Hygam, Anchar, Narkara and Mirgund were the top-ranking sites. The second set of 11 wetlands and the remaining wetlands also should be considered for long-term conservation, as these were selected mainly based on earlier records of avifauna from these areas. All the wetlands selected in Ladakh are of special significance as they are breeding grounds for many locally migrating species, and also for the Endangered Blacknecked Crane in India. Most of the sites in Kashmir with higher ranks are either fully or partly protected. Distribution of the prioritized wetlands is given in Fig. 15.10

The high biodiversity areas (I & II rank) have high or medium use except for Tsokar tso, Tsomorari, Sangral and Nilnagh. Hence, they may be declared as Community Reserves, while the low use areas could be considered as sanctuaries.

Wular lake and Tsomorari from the first nine wetlands in the priority list have already been declared as Ramsar sites. The remaining seven also qualify to have the same status.

Summary

- Based on the satellite imageries of 1992-93, Jammu and Kashmir had 42 wetlands of the size 56.25 ha and above, covering an area of 4,068 sq km (SAC, 1998).

- The present estimate of wetlands of the size 2 ha and above in the districts of Baramula and Jammu and part of Ladak shows that there are 454 wetlands, covering an area of 750.87 sq km.

- The ponds/ lakes had low turbidity in all the three districts, while the waterlogged areas had high turbidity in Jammu and low to moderate in Baramula.

- Aquatic vegetation, as per satellite imageries, is low in the ponds/ lakes of Jammu and Ladakh. Those in Baramula had comparatively more aquatic vegetation.

- Jammu and Kashmir have two endemic species of aquatic plants; four Endangered and 16 Vulnerable species of fishes; two each of Vulnerable and Near Threatened, and one Least Concern species of turtles; and two each of Threatened and Near Threatened species of aquatic birds.

- In 29 wetlands, 106 species including 25 land birds were sighted.

- Twenty-nine wetlands were prioritized in Jammu & Kashmir.

- Based on the criteria of bird species, nine wetlands fall in the first rank, 11 in the second and nine in the third rank.

- All nine wetlands in the first rank qualify to be declared as Ramsar sites. Two of them, Wular lake and Tsomorari have already been declared. The remaining seven are proposed to be declared as Ramsar sites.

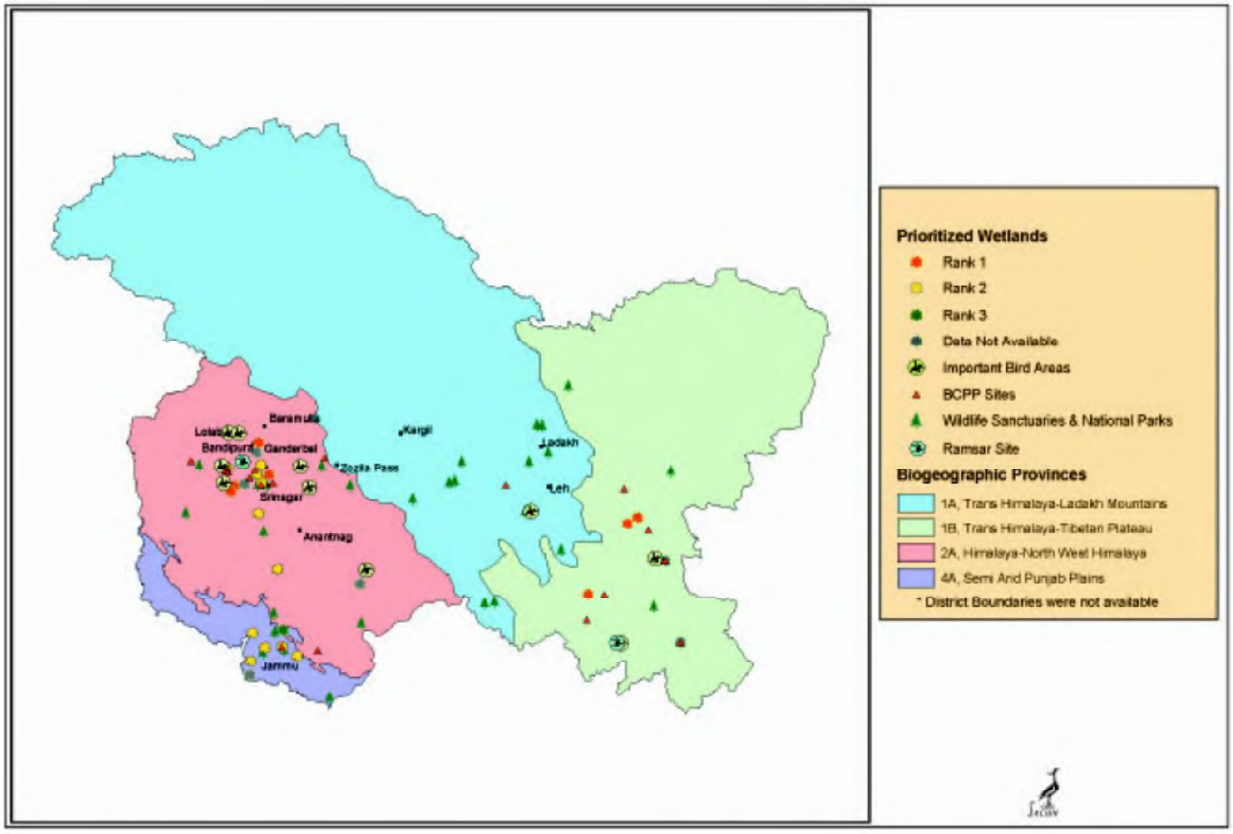


Fig. 15.10. Prioritized wetlands and other conservation areas in Jammu & Kashmir



G.S. Rawat

Tsokar Basin in Changthang Plateau, Eastern Ladakh: one of the major high altitude wetlands that supports several migratory birds and nomadic herders



G.S. Rawat

Sedge meadow in Changthang (lake banks of Tsokar lake) that forms breeding site for the Endangered Blacknecked Crane during summer and important grazing ground for livestock during autumn and early winter



Bivash Pandav

Tsogul tso, Chushul, Ladakh; a major high altitude lake

HIMACHAL PRADESH

Himachal Pradesh, a mountainous state, magnificent for its forests, rivers, hills, and dales, is located at a height between 450 metres and 6,500 metres above sea level. Physiographically, the state can be divided into (1) the outer Himalayas or the Shivaliks, (2) the lesser Himalayas or the Central Zone and, (3) the Great Himalayas and Zaskar or the Northern Zone. Himachal provides water to both the Indus and Ganges basins. Major river systems are the Chenab, Ravi, Beas, Sutlej and Yamuna. These perennial rivers are fed by snow and rainfall and are protected fairly well by forests.

The climate varies from hot and sub-humid tropical in lower elevation to cold alpine and glacial on high mountain ranges. Rainfall, mostly from southwest monsoon varies from 50 mm to 3,400 mm. The annual average temperature vareis from 1.7 to 25.1°C

The land use pattern of the state, as in other states does not indicate wetland as a separate category (Table 16.1). However, SAC (1998) has identified 92 wetlands of the size 2.5 ha and above, covering a total area of 547.66 sq km.

Types of wetlands

There are only two types of wetlands in Himachal Pradesh, namely lakes/ ponds and reservoirs (Table 16.2).



State at a glance	
State capital	Shimla
Area	55,673 sq km
Population (2001)	60,77,248
Total number of districts	12
Major rivers	Chenab, Ravi, Beas, Sutlej, Yamuna
Total forest area	10,770 sq km
Population density (2001)	109/ sq km
Ramsar site	1
Proposed Ramsar sites	Nil
Total sites proposed for conservation	4

Table 16.1. Land use pattern in Himachal Pradesh

Land use type	Area (sq km)
Total geographic area	55,673
Forests	10,770
Not available for cultivation	11,480
Other uncultivated land excluding fallow land	16,710
Fallow land	850
Net area sown	5,490
Area sown more than once	4,210
Total cropped area	9,700
Cultivable area	23,050

Source: www.indiastat.com

Table 16.2. Distribution of various categories of inland wetlands in Himachal Pradesh

Class	Number of wetlands	Wetland area sq km
Lakes/ Ponds	85	15.56
Reservoirs	7	532.10
Total	92	547.66

Source: SAC (1998)

Biodiversity

Aquatic vegetation

Reservoirs which form the major part of wetlands in the state, do not support much aquatic vegetation. Most of them are used for commercial fisheries. The adjoining areas have mixed deciduous and pine forests. The marshes support some of the reeds such as *Cyperus* sp. However, no detailed studies were conducted on the vegetation during the survey. No endemic plants are reported from Himachal Pradesh according to the list compiled from literature. However, considering the physiographic set up and rainfall regime of the area, one would expect a rich floral diversity. The absence of the same, probably, suggest only the lack of inventories and publications.

Fishes

There are five Endangered and 14 Vulnerable species of fishes in Himachal Pradesh (Table 16.3).

Table 16.3. Threatened species of fishes from Himachal Pradesh

S.#	Species	Status
1	*Anguilla bengalensis*	EN
2	*Nemacheilus montanus*	EN
3	*Ompok bimaculatus*	EN
4	*Pseudeutropius atherinoides*	EN
5	*Puntius chilinoides*	EN
6	*Ailia coila*	VU
7	*Anabas testudineus*	VU
8	*Bagarius bagarius*	VU
9	*Barbodes sarana*	VU
10	*Catla catla*	VU
11	*Channa orientalis*	VU
12	*Cirrhinus reba*	VU
13	*Clarias batrachus*	VU
14	*Clupisoma garua*	VU
15	*Glyptothorax brevipinnis*	VU
16	*Heteropneustes fossilis*	VU
17	*Labeo dero*	VU
18	*Mystus vittatus*	VU
19	*Puntius chola*	VU

En=Endangered; VU=Vulnerable

Turtles

The only fresh water turtle recorded from the Himachal Pradesh is *Melanochelys trijuga,* which is in the category of Least Concern.

Birds

Altogether four sites were covered, but the bird data are reported only from three sites. 28,971 birds of 45 species including five terrestrial ones, were recorded in the three wetlands (Table 16.4). Species richness was the highest at Pong dam (28) followed by Sheetal Sagar (23). Only one site, Pong dam had more than 20,000 birds.

Out of the 45 species recorded, the most abundant species (>5,000) were the Coot (6,500), Pintail (5,500) and Common Pochard (5,000). The three other dominant species were the Barheaded Goose (4,000), Little Cormorant (2,500) and Ruddy Shelduck (2,500). All these had more than 1% of the biogeographic population

Table 16.4. Mmajor wetlands of Himachal Pradesh with species and number of birds

S#	Wetland sites	# Species	# Birds
1	Pong dam	28	27,754
2	Sheetal Sagar& adjoining jheels	23	1,117
3	River Beas pools at Raison - Katrain	2	100
	Total	45	28,971

Table 16.5. Threatened and Near Threatened species of birds observed

S#	Species	Status	No. of sites	No. of birds
1	Sarus Crane	T	2	6
2	Pallas's Fishing Eagle	T	1	2
3	Painted Stork	NT	1	10

T=Threatened; NT=Near Threatened

as per AWB records. All others were fewer than 500 birds except the Mallard and Shoveller. Pong dam had two Threatened species while Sheetal dam had one. Two Threatened species and one Near Threatened species were found during the survey (Table 16.5).

Socioeconomic values

Wetlands in Himachal Pradesh are also used for the usual purposes, except, Govind Sagar which is used more for water sports. Unlike the other states, these wetlands are not affected by dumping solid waste, sewage or effluents. A preliminary assessment of the use values of Pong dam and Govind Sagar, showed that these sites are being utilized at different levels. Of the eight major uses of the wetlands, these had seven and six uses respectively which means that they are highly used in spite of them being fully or partially protected.

Prioritization of wetlands

Of the four sites selected and studied, one had no bird data and the remaining three sites were prioritized using birds as explained under the methodology. The sites are arranged in the order of the total ratings and the ranks (Table 16.6). Pong dam with the maximum rating came in the first rank. Distribution of the prioritized wetlands along with other conservation areas is given in Fig. 16.1.

Table 16.6. Prioritized list of the major wetlands in Himachal Pradesh

S#	Wetland sites	Rank	Use
1	Pong dam	1	H
2	Sheetal Sagar& adjoining jheels	2	-
3	River Beas pools at Raison - Katrain	3	-
4	Govind Sagar	-	H

The top ranking site (Pong dam) with high biodiversity value had high socioeconomic use value also. Eventhough it is being fully protected as a sanctuary, commercial fishery operations are going on under supervision. This has already been declared as a Ramsar site, but requires proper management and monitoring. The other wetlands are also regionally significant in terms of the site for the Sarus Crane and the Painted Stork and hence should be declared as Community Reserves.

Summary

- Himachal Pradesh has 92 wetlands of the size 2.25 ha and above, covering a total area of 547.66 sq km, according to SAC (1998).
- The three major wetlands studied had 28,971 birds of 45 species.
- Two Threatened species, namely the Sarus Crane and Pallas's Fishing Eagle were reported.
- Literature surveyed shows that there has been no record of endemic plant species from Himachal Pradesh. There are five Endangered and 14 Vulnerable species of freshwater fishes and, one freshwater turtle, *Melanochelys trijuga* which comes in the category of Least Concern.
- Four wetlands have been identified for long-term conservation, of which one (Pong dam) is a Ramsar site.

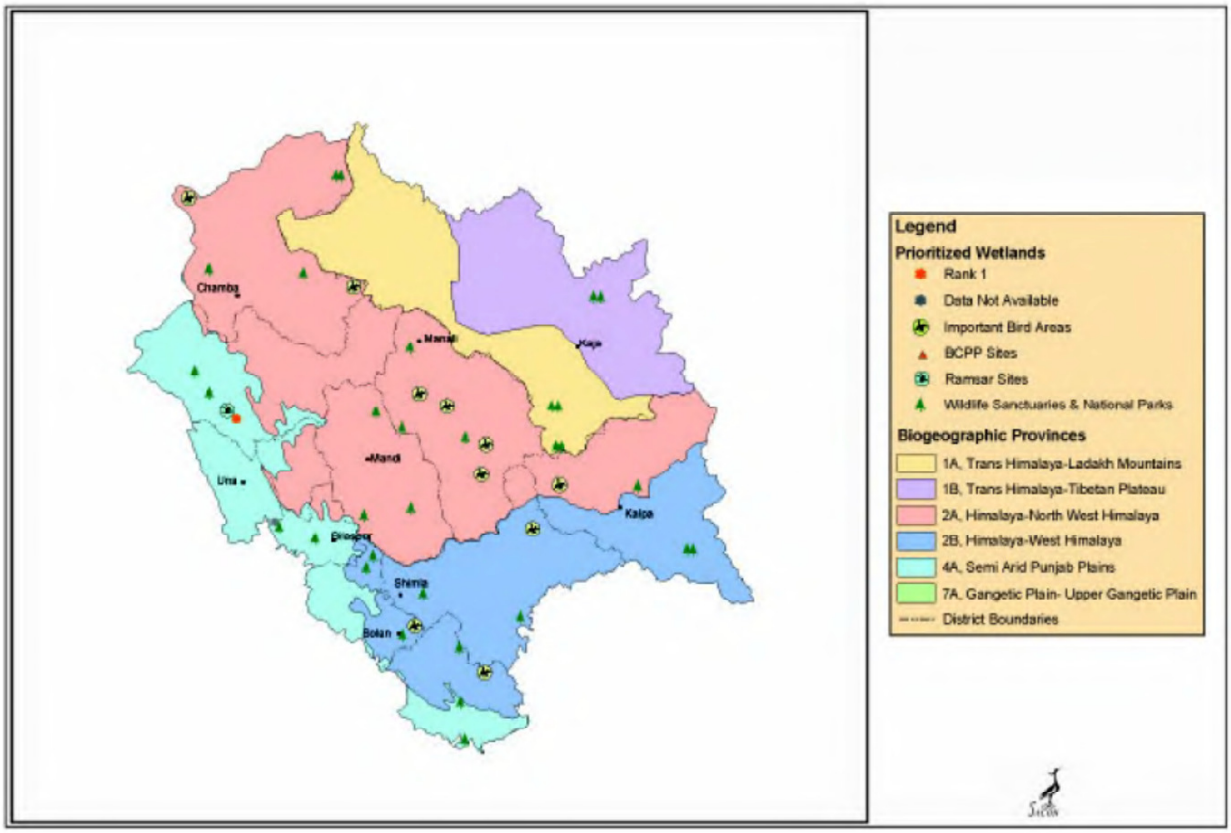


Fig. 16.1. Prioritized wetlands and other conservation areas in Himachal Pradesh

UTTAR PRADESH and UTTARANCHAL

The undivided Uttar Pradesh popularly known as the rainbow land, is gifted with two of the mightiest rivers, the Yamuna and the Ganga which flood the lives and lores of men from time immemorial. The state can be divided into three distinct regions: a) the Himalayan region in the north, b) the Gangetic plains in the centre and, c) Vindhya hills and plateau in the south. Out of its total length of 2,525 km, the river Ganga has as much as 1,450 km of its long run in UP. The other major river Yamuna meets the river Ganga at Prayag. The other rivers are the Ramganga, Gomati, Ghagra, Gandak, and the tributaries of Yamuna such as Chambal, Betwa, Sind, and Ken. Most of the rivers join the Ganga. The rivers are perennial, snow fed and emerge from the Himalayas except the river Gomati. They flow from west to east.



State at a glance	
State capital	Lucknow
Area	240,928 sq km
Population (2001)	16,60,52,859
Total number of districts	70
Major rivers	Ganga, Yamuna, Ramganga, Gomati, Ghagra, Chambal, Betwa, Sind, Ken
Total forest area	52,130 sq km
Population density (2001)	689/sq km
Ramsar site	Nil
Proposed Ramsar sites	25
Total sites proposed for conservation	50

The average annual rainfall is above 1,200 mm. The state has a tropical climate except for the Himalayan region, which has a temperate climate. The temperature varies from 7.9 to 39.3°C.

Status of wetlands

There is, at present, no category as wetlands in the current land use statistics (Table 17.1), although the per cent wetland area for the entire state is 1.12 (SAC, 1998). The total number of wetlands of the size 56.25 ha and above was estimated at 1,193 covering a land area of 3,286.82 sq km (Table 17.2). SACON's estimate of the number of wetlands of the size 2 ha and above for seven select districts in Uttar Pradesh comes to 768 covering a total area of 1,851.58 sq km.

Table 17.1. Land use pattern in Uttar Pradesh

Land use category	Area in sq km
Total geographic area	2,94,411
Forests	52,130
Not available for cultivation	34,860
Other uncultivated land excluding fallow land	17,390
Fallow land	17,710
Net area sown	1,75,850
Area sown more than once	90,240
Total cropped area	2,66,090
Cultivable area	2,10,950

(Source: www.indiastat.com)

Table 17.2. Distribution of various categories of inland wetlands in Uttar Pradesh

Inland wetlands	Area (sq km)	No. of wetlands
Lakes/ponds	204.43	104
Oxbow lakes	727.90	411
Waterlogged (seasonal)	199.93	32
Marshes/swamps	707.05	313
Reservoirs	979.24	71
Tanks	41.09	39
Waterlogged	426.37	222
Ash ponds	0.84	1
Total	3,286.85	1,193

Source: SAC (1998)

The spatial distribution of the wetlands is given in Fig. 17.1. The pattern shows that the wetlands are distributed mainly along the flood plains of the rivers and it correlates well with the drainage system. This will have a substantial bearing in the distribution and abundance of wetland birds and other aquatic species. Further, the impact of proposed interlinking of rivers can be qualitatively gauged from the distribution of wetlands.

Uttar Pradesh has as many as eight different types of wetlands (Table 17.2). The majority are oxbow lakes followed by marshes/ swamps.

Habitat analyses of wetlands in select districts

Out of the 70 districts, seven were chosen to analyse various attributes of habitats (Table 17.3). The satellite data of finer resolution (23.5 m) was used to characterize wetlands above 2 ha. In addition, land use, wetland classes, turbidity and aquatic vegetation were analyzed (Table 17.4-17.17). Study on the seasonal changes in water spread of the select districts was also carried out. The land use pattern varies greatly among the seven districts selected for the study.

Table 17.3. Area (in sq km) under different classes of wetlands in select districts of Uttar Pradesh

Districts	Ponds/lakes		Reservoirs		Waterlogged		Oxbow lakes		Total no.	Total area
	No.	Area	No.	Area	No.	Area	No.	Area	of wetlands	of wetlands
Bahraich	-	-	2	41.52	41	190.99	67	354.31	110	586.82
Sitapur	-	-	-	-	72	82.25	38	38.25	110	120.5
Lalitpur	101	29.85	7	240.11	-	-	-	-	108	269.96
Hardoi	-	-	-	-	53	83.32	57	121.1	110	204.42
Unnao	-	-	-	-	38	52.18	72	112.86	110	165.04
Mirzapur	93	11.42	12	79.21	5	6.16	-	-	110	96.79
Sonebhadra	105	25.06	5	376.96	-	-	-	-	110	402.02
Total	299	66.33	26	737.8	209	414.9	234	626.52	768	1,845.55

Wetlands

The area under wetlands (Fig. 17.2) in the seven districts varied from a minimum of 2.1% in Sitapur to a maximum of 8.62% in Bahraich. Four major categories of wetlands occur in these districts (Fig. 17.3). While reservoirs constitute a major part of the wetlands in the districts of Sonebhadra and Lalitpur, oxbow lakes and waterlogged areas do so in the districts of Bahraich and Hardoi.

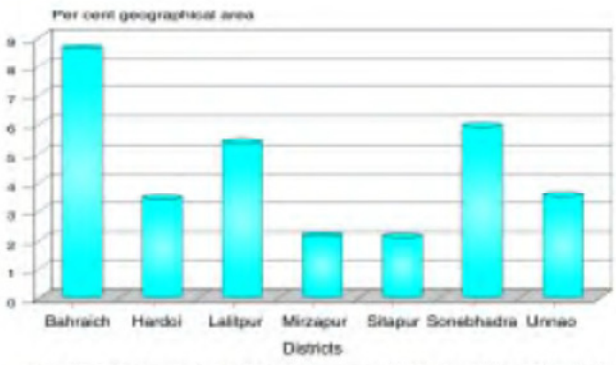


Fig. 17.2. Area under wetland in select districts of Uttar Pradesh

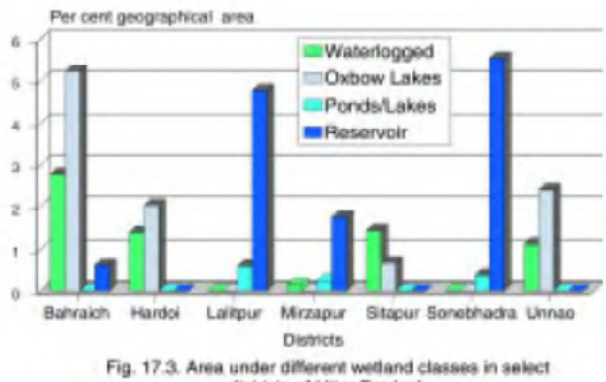


Fig. 17.3. Area under different wetland classes in select districts of Uttar Pradesh

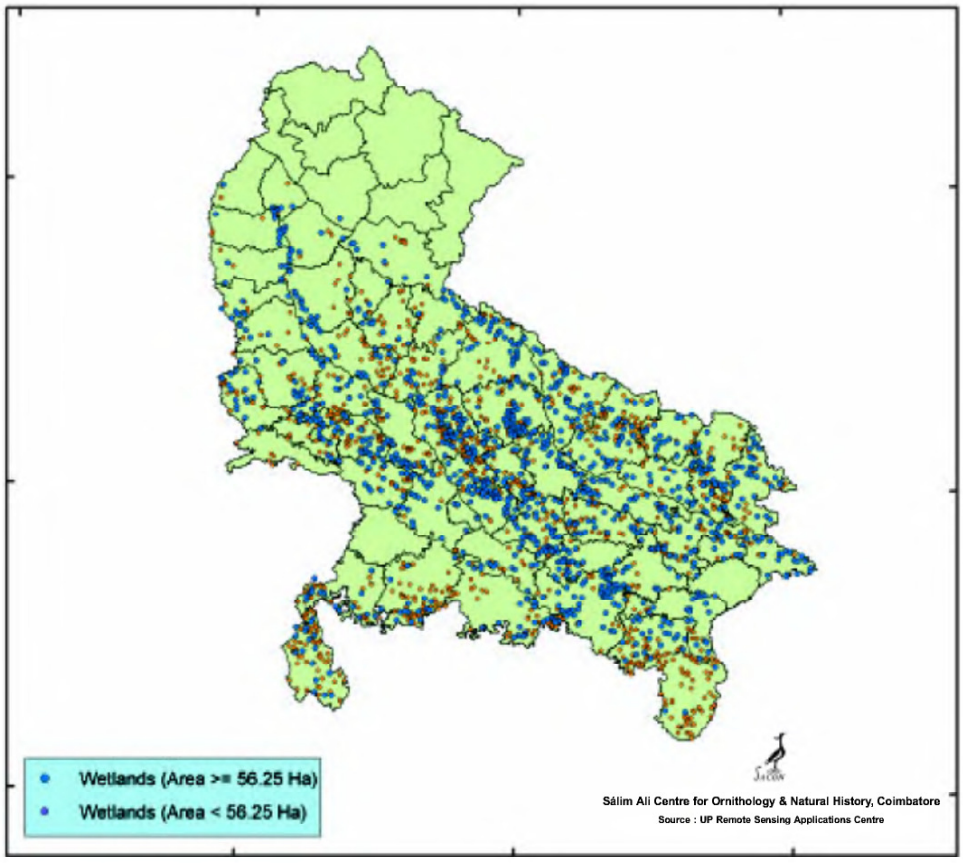


Fig. 17.1. Distribution of wetlands in Uttar Pradesh (undivided)

Smaller wetlands below 56.25 ha are more abundant in the districts of Lalitpur, Unnao, Sitapur and Mirzapur, whereas the larger wetlands occur in equal abundance in the district of Bahraich (Fig. 17.4; Table 17.3).

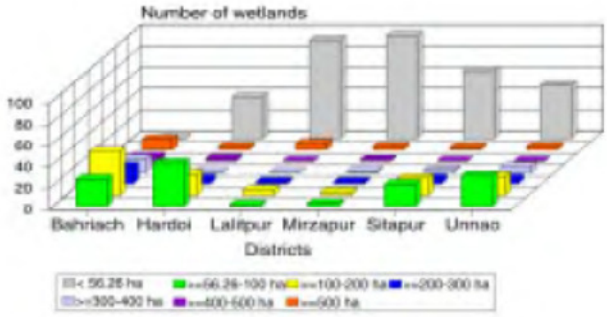


Fig. 17.4. Size class distribution in the wetlands of select districts in Uttar Pradesh

Turbidity

Wetlands of Bahraich, Hardoi , Lalitpur, Unnao and Sitapur have low levels of turbidity. In most cases it was noticed that the reservoirs have low turbidity. Higher turbidity was found in Sonebhadra district followed by Mirzapur (Fig. 17.5). In the case of Sonebhadra, although there are five reservoirs, covering 377 sq km; 94% of the total wetland area of the district; it shows very high turbidity indicating the higher sedimentation rate and increased anthropogenic activities in the catchment areas (Fig. 17.5, 17.6; Table 17.5, 17.7, 17.9, 17.11, 17.13, 17.15, 17.17).

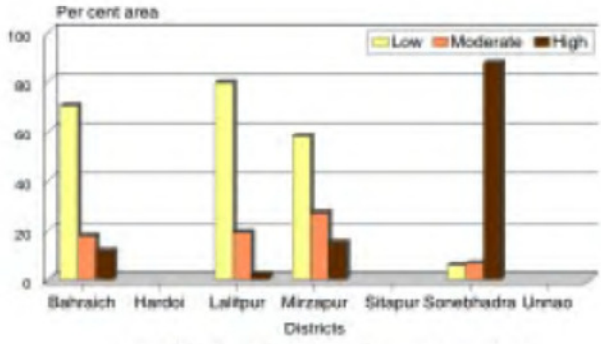


Fig. 17.5. Turbidity pattern of reservoirs in select districts of Uttar Pradesh

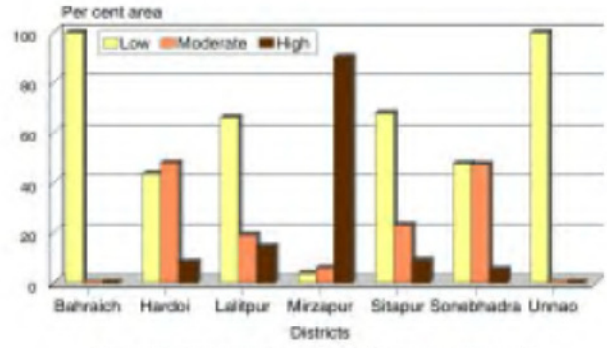


Fig. 17.6. Turbidity pattern of ponds/lakes/waterlogged areas in Uttar Pradesh

Summer recession

The summer recession was found to be the highest in the wetlands of the districts of Sitapur, Bahraich and Sonebhadra and the lowest in the district of Hardoi (Fig. 17.7).

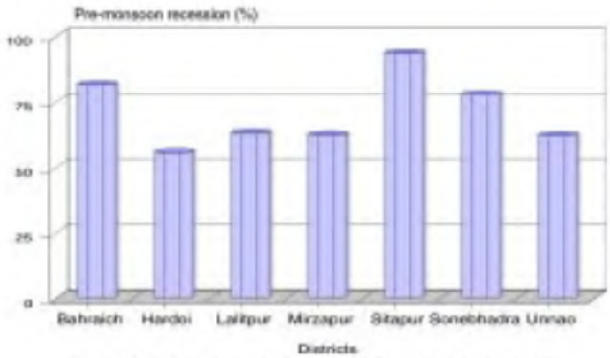


Fig.17.7. Average summer recession in the wetlands of select districts in Uttar Pradesh

Wetlands and land use pattern in the catchment areas

Integrated land use maps of the seven select districts show that catchment areas of the wetlands are mostly arable land (Fig. 17.8 to 17.14).

Table 17.18. Summary of wetlands statistics for the select districts of Uttar Pradesh

Wetlands class	No. of Wetlands	Area (sq km)	% area					
			Turbidity			Aquatic vegetation		
			Low	Moderate	High	Low	Moderate	High
Bahraich								
Oxbow lakes	67	354.32	100.00	0.00	0.00	15.24	81.36	3.40
Reservoirs	2	41.53	70.38	17.82	11.82	61.58	38.02	0.41
Waterlogged	41	191.00	100.00	0.00	0.00	17.08	79.49	3.43
Hardoi								
Oxbow lakes	57	121.11	37.24	53.36	9.40	37.24	53.36	9.40
Water logged	53	83.33	49.97	42.27	7.77	49.97	42.27	7.77
Lalitpur								
Ponds/lakes	101	29.85	66.17	19.10	14.73	66.17	19.10	14.73
Reservoirs	7	240.11	79.40	19.18	1.42	79.40	19.18	1.42
Mirzapur								
Ponds/lakes	93	11.42	7.58	11.54	80.87	71.46	13.69	14.85
Reservoirs	12	79.21	57.96	26.89	15.15	96.06	2.12	1.82
Water logged	5	6.16	0.00	0.19	99.82	22.19	42.22	35.60
Sitapur								
Oxbow lakes	38	38.26	53.15	39.74	7.12	53.15	39.74	7.12
Waterlogged	72	82.26	82.41	6.14	11.44	82.41	6.14	11.44
Sonebhadra								
Ponds/lakes	105	25.07	47.51	47.18	5.31	89.86	6.80	3.35
Reservoirs	5	376.97	5.68	6.59	87.73	98.61	0.72	0.67
Unnao								
Oxbow lakes	72	112.86	100.00	0.00	0.00	19.99	67.68	12.33
Water logged	38	52.18	100.00	0.00	0.00	19.89	67.23	12.88

Temporal changes in the wetland cover

The wetland cover of 1991-'92 and 2000-2001 in the seven select districts shows considerable variation. In the case of five districts there was a gain varying from 16.35 sq km to 452.27 sq km (Table 17.19; Fig. 17.15). Districts of Sitapur and Mirzapur had loss of wetlands. It may be noted that one of the caveats, as explained under methodology (Chapter 2), is that for this comparison all the wetlands of the size 2 ha and above have been considered for 2000-2001, whereas only those wetlands which are 56.25 ha and above in size are considered for 1991-'92. Therefore, the gain could be because of the smaller wetlands. However, the loss has to be taken more seriously, as the loss has occurred, in spite of considering all the smaller wetlands.

Table 17.19. Changes in the wetland area (in sq km)

District	SAC (1991-'92)	SACON (2000-'01)	Variation	% Variation
Bahraich	134.55	586.82	452.27	336.14
Sitapur	121.87	120.51	-1.36	-1.12
Lalitpur	196.77	269.96	73.19	37.20
Hardoi	146.42	204.44	58.02	39.63
Unnao	148.70	165.05	16.35	10.99
Mirzapur	129.82	96.80	-33.02	-25.43
Sonebhadra	360.41	402.03	41.63	11.55

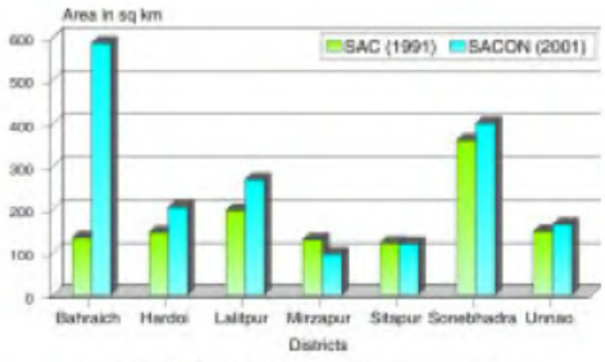


Fig. 17.15. Difference in total wetland area in Uttar Pradesh

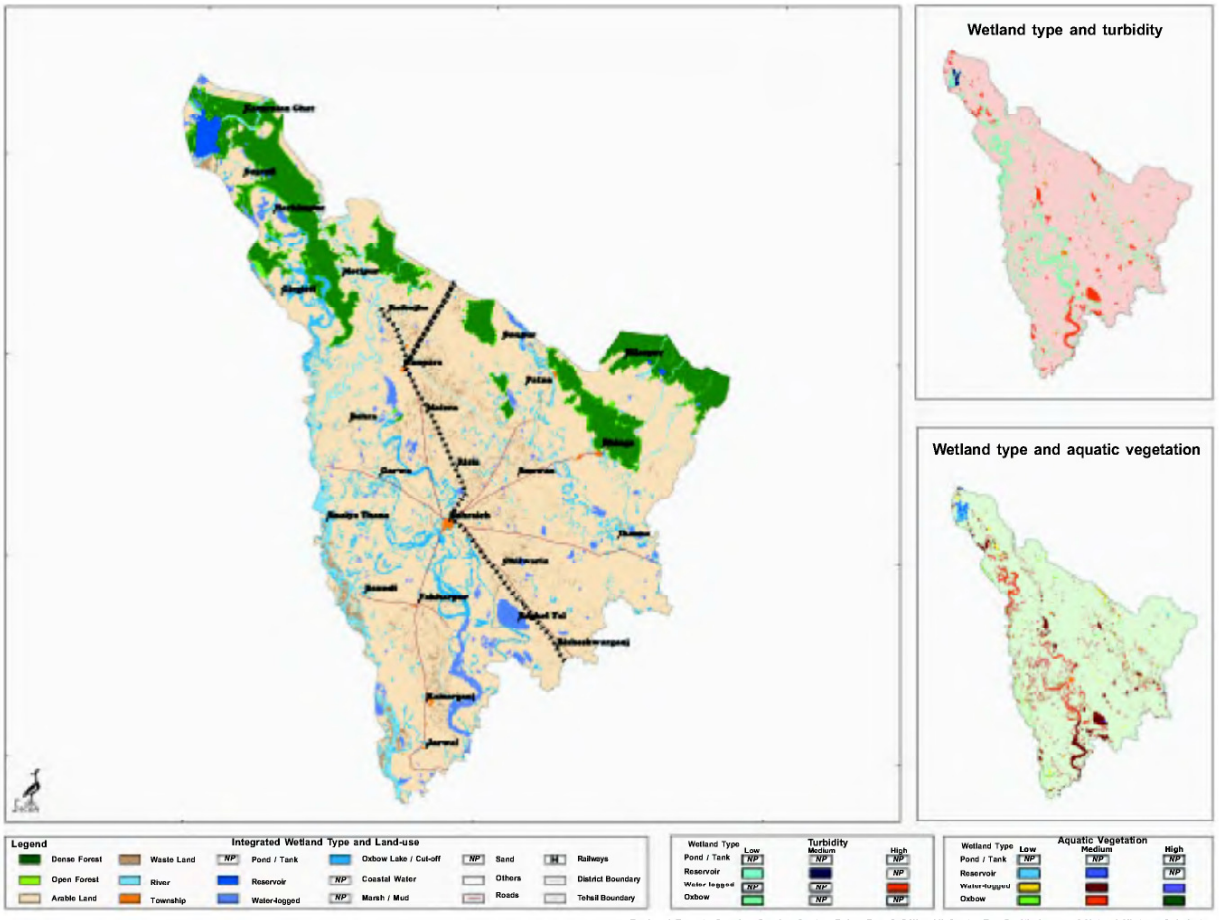


Fig. 17.8. Land use and wetland types in the district of Bahraich

Table 17.4. Area under different land use and wetlands in the district of Bahraich

Land use classes	Area (sq km)	Area (%)
Dense forest	815.75	11.86
Open forest	75.07	1.09
Arable land	5,012.10	72.88
Wasteland	203.43	2.96
Rivers	155.28	2.26
Settlement	12.77	0.19
Roads	7.51	0.11
Rail	2.30	0.03
Reservoirs	41.95	0.61
Waterlogged	191.22	2.78
Oxbow lakes	354.31	5.23

Table 17.5. Area under different turbidity levels in the district of Bahraich

Turbidity classes	Area (sq km)	Area (%)
Low	580.07	97.85
Moderate	7.39	1.25
High	5.33	0.90

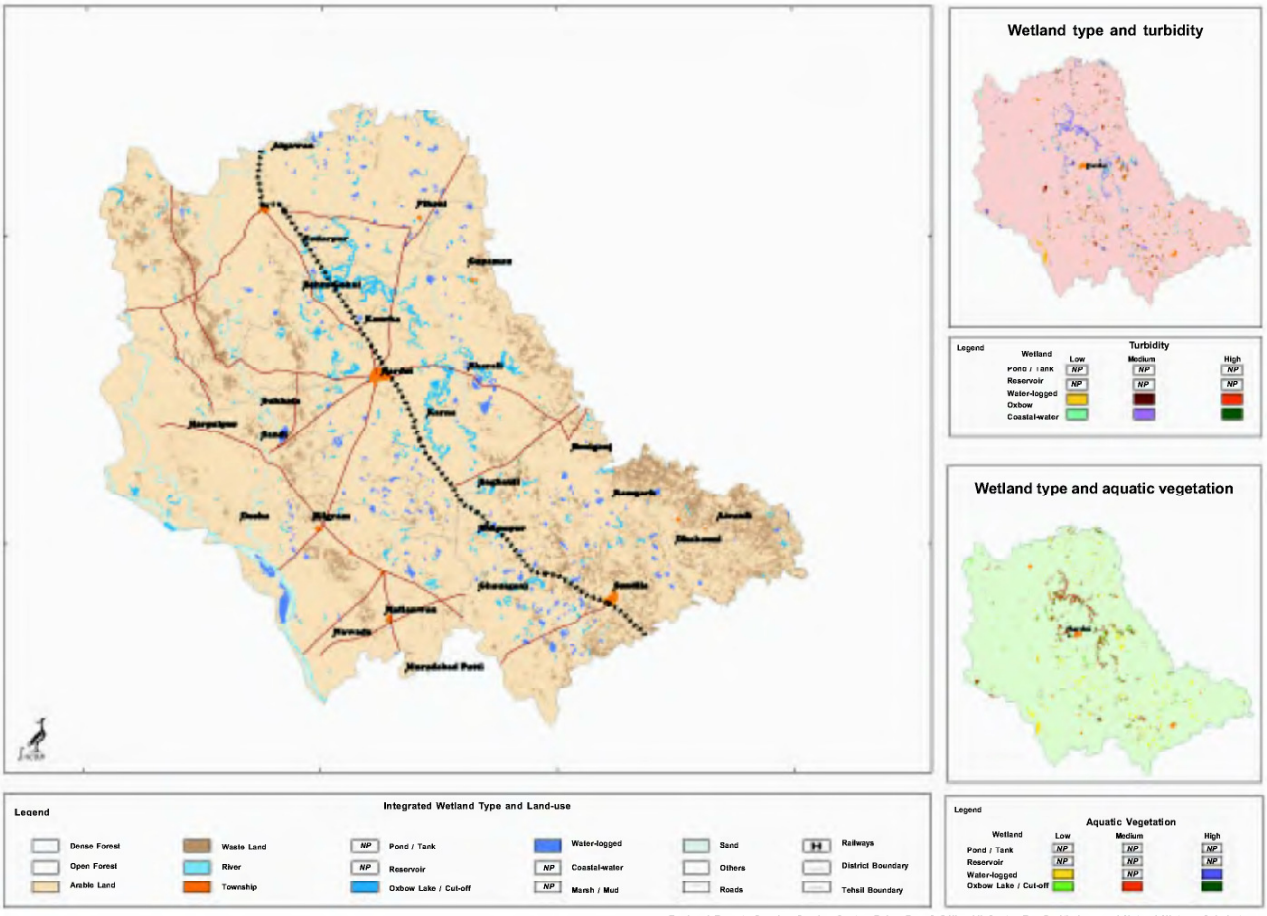


Fig. 17.9. Land use and wetland types in the district of Hardoi

Table 17.6. Area under different land use and wetland types in the district of Hardoi

Land use classes	Area (sq km)	Area (%)
Arable land	5,185.19	86.62
Wasteland	480.12	8.02
Rivers	35.97	0.60
Sand	51.99	0.87
Waterlogged	83.33	1.39
Oxbow lakes	121.11	2.02
Total wetlands	204.44	3.42
Othets	28.29	0.47

Table 17.7. Area under different turbidity levels in the district of Hardoi

Turbidity classes	Area (sq km)	Area (%)
Low	204.44	100.00
Moderate	0.00	0.00
High	0.00	0.00

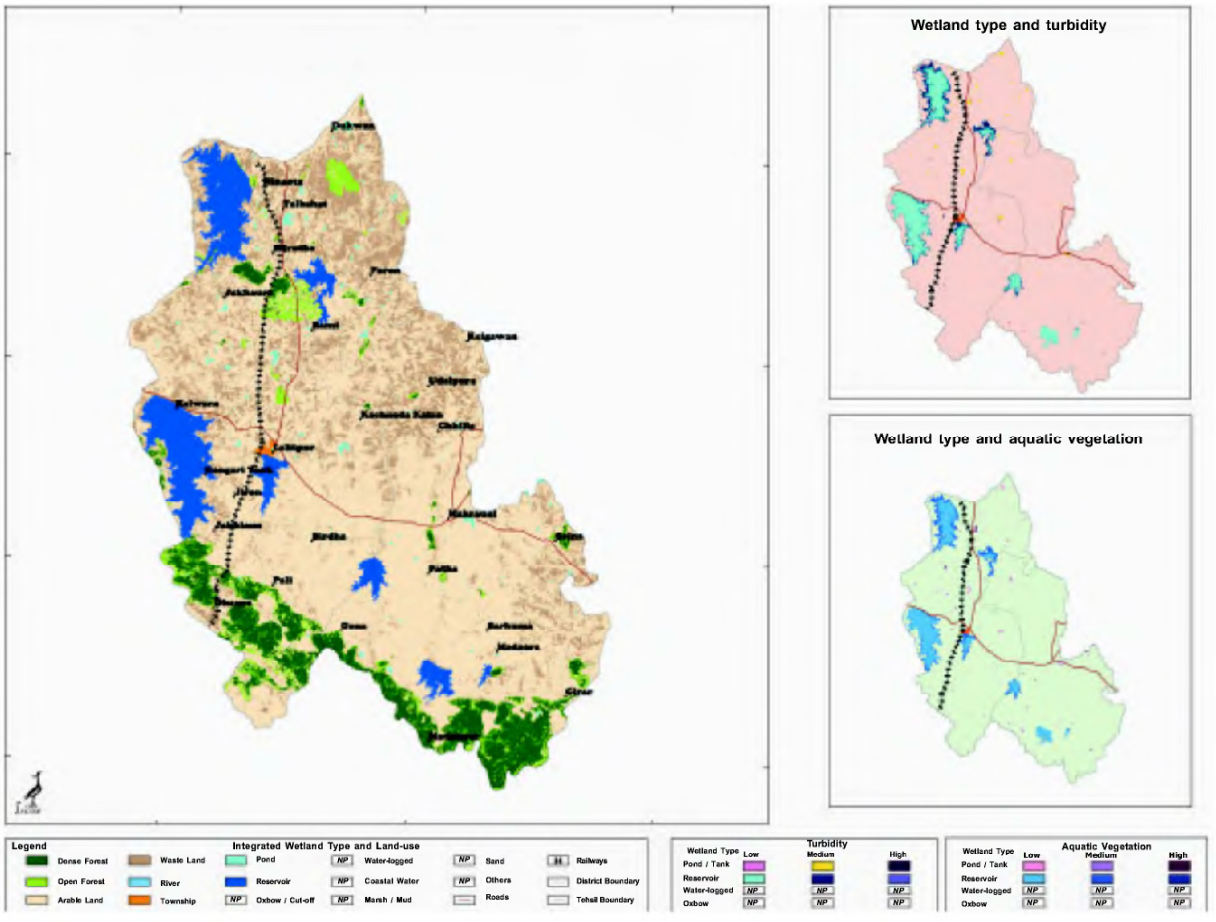


Fig. 17.10. Land use and wetland classes in the district of Lalitpur

Table 17.8. Area under different land use and wetland types in the district of Lalitpur

Land use classes	Area (sq km)	Area (%)
Dense forest	368.29	7.31
Open forest	158.44	3.14
Arable land	3,328.17	66.05
Wasteland	874.28	17.35
Rivers	27.23	0.54
Ponds/lakes	29.85	0.59
Reservoirs	240.11	4.77
Wetlands	269.96	5.36
Others	12.62	0.25

Table 17.9. Area under different turbidity classes in the district of Lalitpur

Turbidity classes	Area (sq km)	Area (%)
Low	198.65	73.59
Moderate	63.84	23.65
High	7.48	2.77

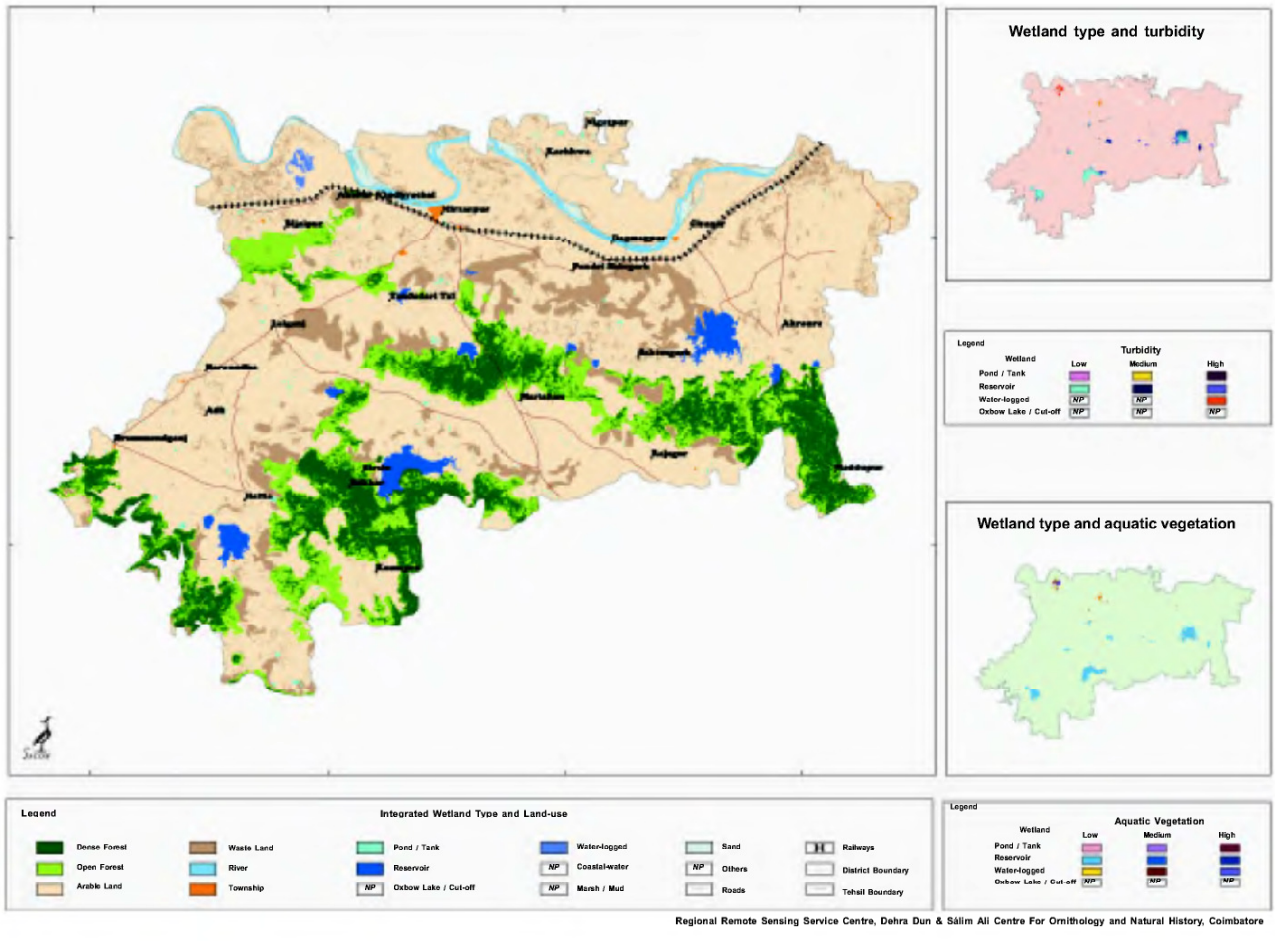


Fig. 17.11. Land use and wetland types in the district of Mirzapur

Table 17.10. Area under different land use and wetland types in the district of Mirzapur

Land use classes	Area (sq km)	Area (%)
Dense forest	509.39	11.26
Open forest	498.70	11.03
Arable land	2,810.38	62.15
Wasteland	498.68	11.03
Rivers	55.24	1.22
Sand	37.73	0.83
Settlement	5.32	0.12
Roads	7.91	0.17
Rail	1.87	0.04
Ponds/lakes	11.42	0.25
Reservoirs	79.21	1.75
Waterlogged	6.16	0.14
Total wetlands	96.80	2.14

Table 17.11. Area under different turbidity levels in the district of Mirzapur

Turbidity classes	Area (sq km)	Area (%)
Low	46.78	48.33
Moderate	22.63	23.38
High	27.39	28.29

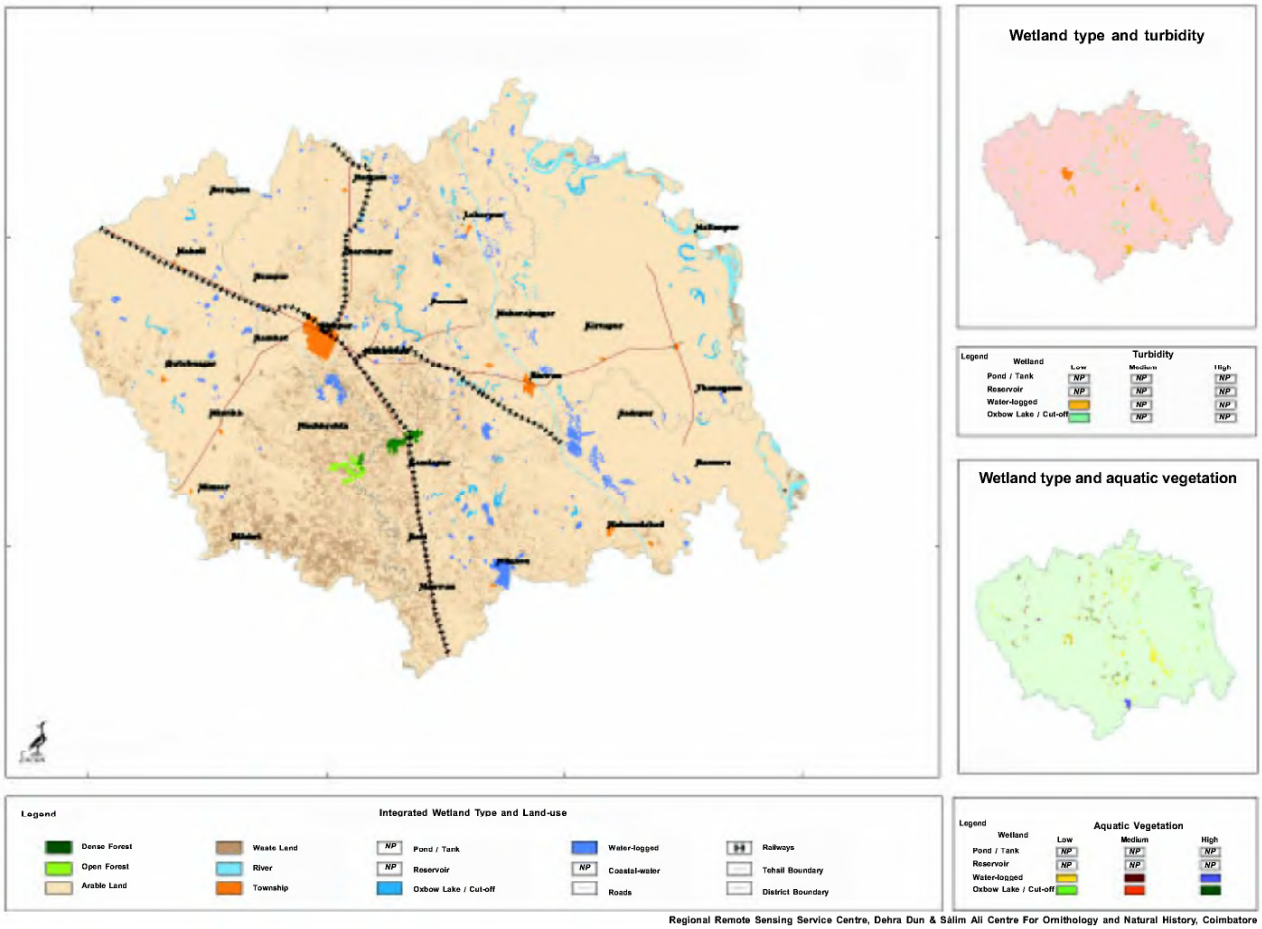


Fig. 17.12. Land use and wetland types in the district of Sitapur

Table 17.12. Area under different land use and wetland types in the district of Sitapur

Land use classes	Area (sq km)	Area (%)
Dense forest	7.89	0.14
Open forest	7.35	0.13
Arable land	5,091.96	88.66
Wasteland	422.38	7.35
Rivers	57.52	1.00
Settlement	29.66	0.52
Roads	5.73	0.10
Oxbow lakes	38.26	0.67
Waterlogged	82.26	1.43
Total wetlands	120.51	2.10

Table 17.13. Area under different turbidity levels in the district of Sitapur

Turbidity classes	Area (sq km)	Area (%)
Low	120.51	100.00
Moderate	0.00	0.00
High	0.00	0.00

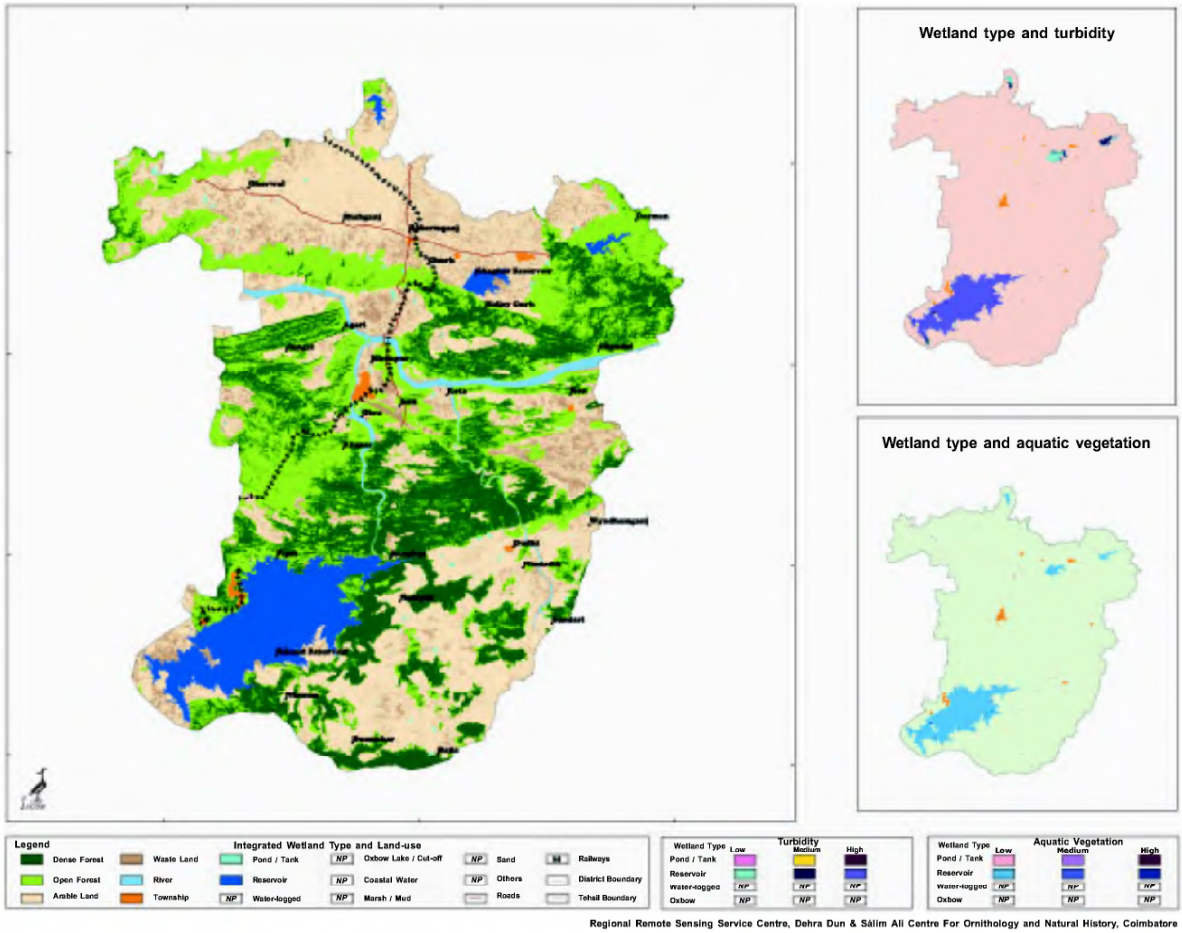


Fig. 17.13. Land use and wetland types in the district of Sonebhadra

Table 17.14. Area under different land use and wetland types in the district of Sonebhadra

Land use classes	Area (sq km)	Area (%)
Dense forest	1,523.92	22.45
Open forest	1,864.63	27.47
Arable land	2,368.83	34.90
Wasteland	479.68	7.07
Rivers	114.88	1.69
Ponds/lakes	25.07	0.37
Reservoirs	376.97	5.55
Total wetlands	402.03	5.92
Others	34.03	0.50

Table 17.15. Area under different turbidity levels in the district of Sonebhadra

Turbidity classes	Area (sq km)	Area (%)
Low	33.31	8.29
Moderate	36.66	9.12
High	332.07	82.60

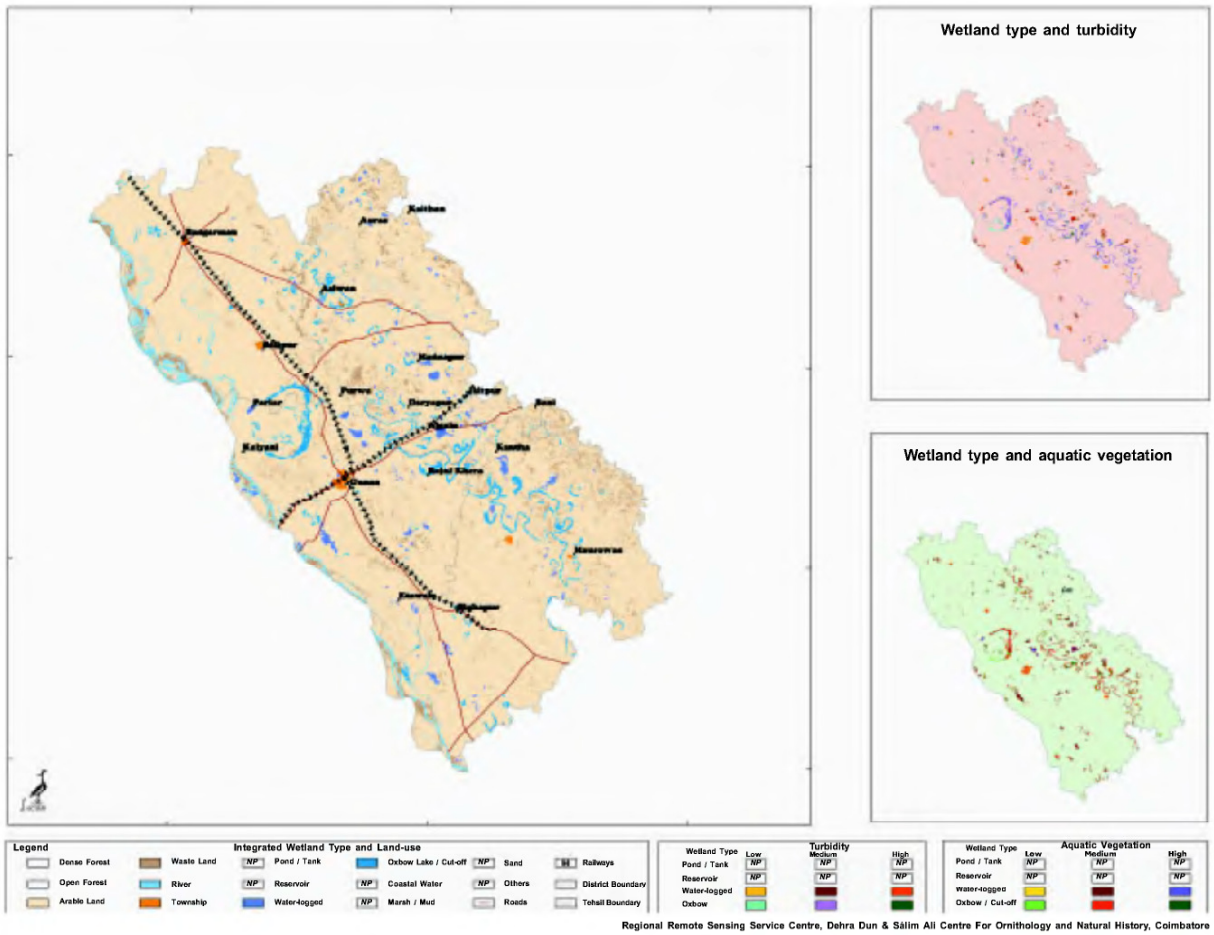


Fig. 17.14. Land use and wetland classes in the district of Unnao

Table 17.16. Area under different land use and wetland types in the district of Unnao

Land use classes	Area (sq km)	Area (%)
Arable land	4,150.38	88.46
Wasteland	270.55	5.77
Rivers	83.61	1.78
Waterlogged	52.18	1.11
Oxbow lakes	112.86	2.41
Others	22.41	0.48
Wetlands	165.05	3.52

Table 17.17. Area under different turbidity levels in the district of Unnao

Turbidity classes	Area (sq km)	Area (%)
Low	165.04	100.00
Moderate	0.00	0.00
High	0.00	0.00

Biodiversity

Aquatic vegetation

Out of the seven districts studied for vegetative cover in the wetlands of Uttar Pradesh, using satellite imageries, the wetlands of four districts, namely Lalitpur, Sonebhadra, Sitapur and Mirzapur had low growth of aquatic vegetation. Wetlands with high and moderate vegetation were comparatively less in extent. All other districts had higher proportion of wetland area under moderate vegetation (Fig. 17.16, 17.17).

Three species of endemic plants belonging to three families were recorded from the undivided Uttar Pradesh: (1) *Fuirena wallichiana* (Cyperaceae), (2) *Hygrophila pinnatifida* (Acanthaceae) and, (3) *Hoppea dichotoma* (Gentianaceae). The last two species were recorded from the districts Jaunpur, Ballia and Azamgarh of eastern Uttar Pradesh (Singh and Srivastava, 2000).

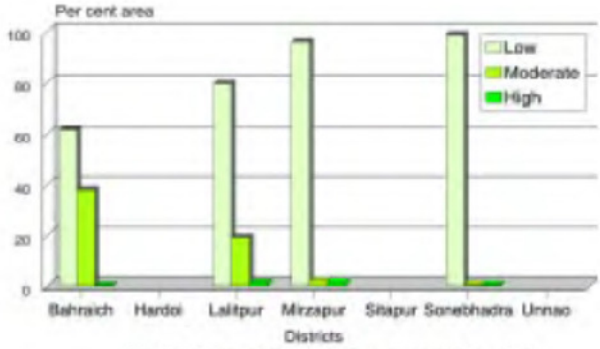


Fig. 17.16. Aquatic vegetation in reservoirs in select districts of Uttar Pradesh

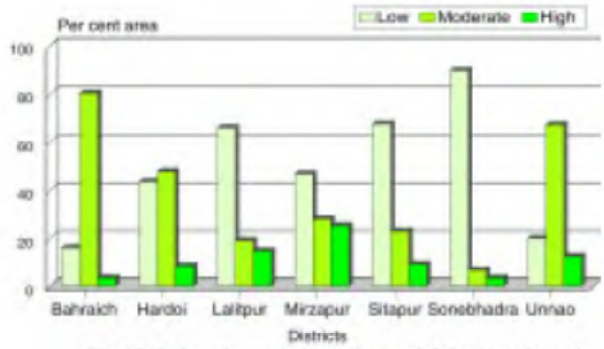


Fig. 17.17. Aquatic vegetation in the ponds/lakes/waterlogged areas of select districts in Uttar Pradesh

Fishes

Thirty four species of fishes (Table 17.20) comprising three Critically Endangered (CR), eight Endangered (EN) and, 23 Vulnerable (VU) were recorded from the undivided Uttar Pradesh. Since site-wise information could not be obtained for these species, they could not be used for prioritizing the sites.

Turtles

Uttar Pradesh and Uttaranchal together have 15 freshwater turtles, out of which one is Critical, two are Endangered, seven Vulnerable, three Near Threatened, and two are of Least Concern (Table 17.21).

Table 17.21. Distribution and status of freshwater turtles in Uttar Pradesh and Uttaranchal

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes gangeticus*	VU	-	I
2	*Aspideretes hurum*	VU	I	I
3	*Aspideretes leithii*	VU	-	IV
4	*Chitra indica*	EN	-	IV
5	*Geoclemys hamiltonii*	VU	I	I
6	*Hardella thurjii*	VU	-	-
7	*Kachuga dhongoka*	EN	-	-
8	*Kachuga kachuga*	CR	-	I
9	*Kachuga smithii*	LC	-	-
10	*Kachuga tecta*	NT	I	I
11	*Kachuga tentoria*	NT	-	-
12	*Lissemys punctata*	NT	II	I
13	*Melanochelys tricarinata*	VU	I	IV
14	*Melanochelys trijuga*	LC		
15	*Morenia petersi*	VU	-	-

VU=Vulnerable; EN=Endangered; CR=Critical; LC=Least Concern; NT=Near Threatened

Table 17.20. Threatened freshwater fishes of undivided Uttar Pradesh

No.	Species	Status
1	*Barilius dimorphicus*	CR
2	*Pangasius pangasius*	CR
3	*Pinniwallago kanpurensis sp.nov*	CR
4	*Botia lohachata*	EN
5	*Chitala chitala*	EN
6	*Eutropiichthys vacha*	EN
7	*Ompok bimaculatus*	EN
8	*Pseudeutropius atherinoides*	EN
9	*Psilorhynchus sucatio*	EN
10	*Puntius chilinoides*	EN
11	*Tor pitutora*	EN
12	*Ailia coila*	VU
13	*Anabas testudineus*	VU
14	*Bagarius bagarius*	VU
15	*Barbodes sarana*	VU
16	*Barilius barila*	VU
17	*Barilius vagra*	VU
18	*Catla catla*	VU
19	*Channa orientalis*	VU
20	*Cirrhinus reba*	VU
21	*Clarias batrachus*	VU
22	*Clupisoma garua*	VU
23	*Garra gotyla gotyla*	VU
24	*Glyptothorax brevipinnis*	VU
25	*Heteropneustes fossilis*	VU
26	*Labeo dero*	VU
27	*Mystus vittatus*	VU
28	*Osteobrama cotio*	VU
29	*Puntius chola*	VU
30	*Puntius conchonius*	VU
31	*Raiamas bola*	VU
32	*Rhinomugil corsula*	VU
33	*Schizothorax richardsonii*	VU
34	*Sicamugil cascasia*	VU

CR=Critically Endangered; EN=Endangered; VU=Vulnerable

Birds

Although 60 wetlands were surveyed in Uttar Pradesh (51 sites) and Uttaranchal (9 sites), birds were recorded only from 50 sites. Out of the 60 wetlands, 35 were natural, while 25 were reservoirs. In all, 102 species of wetland birds and 47 species depending partly on wetlands were recorded. The highest number of species richness was in Haripura and Bor dam (88), which was followed by Katra (71 spp.) and the lowest in Golatappar-Laltappar (3 spp.), while there was no wetland birds in Bandarkhera, Durban lake, Nirmal Paray, Pahu and Sultanpur, as these sites were dry. Ten sites had more than 50 species while only seven sites had below 10 spp. Haripura (Khatima) and Bor dam together had the highest population (32,171 individuals) of waterfowl, followed by Katra (16,769). Bakharpur had the lowest (25). Four wetlands had more than 10,000 birds while three had 5,000 to 10,000 birds (Table 17.22).

Total number of birds counted during the survey was 1,49,171, out of which 53% were ducks. Total of each species from all the wetlands showed that the Coot (17,729) was the most abundant species, followed by the Pintail (13,841), Red-crested Pochard (8,988), and Gadwall (6,814); all these are migratory. The Temminck's Stint and Yellow Bittern were fewer in number with three birds each, followed by the Spotted Redshank (4), Yellow-wattled Lapwing, Common Snipe and Green Sandpiper with six birds each. The maximum number of a species in a wetland was again of the Coot (7,500 birds), followed by Pintail (5,000). Abundance and distribution are not similar; a few species are abundant in a few areas while others are distributed widely but thinly. The Large Cormorant was the most widely distributed species, occurring in 45 wetlands, followed by the Large Egret (44) and Indian Pond Heron (40).

Thirteen globally Threatened and nine Near Threatened species with 2,047 and 1,779 birds respectively were recorded during the survey. Almost all (92%) the globally Threatened species are restricted to fewer than 10 wetlands, while 45% of the Near Threatened ones were recorded from more than 10 wetlands (Table 17.23).

Environmental contamination

One hundred and twenty two fishes comprising 15 species from 17 wetlands were sampled. However, to have uniformity and ease of comparison with other states, information on 103 fishes comprising nine species of fishes collected from nine wetlands are discussed here.

Table 17.22. Major wetlands of Uttar Pradesh and Uttaranchal with species and number of birds

S.No	Name of the wetland	No.of Spp	No.of Birds
1	Asan reservoir	36	3,995
2	Aspan	50	14,937
3	Bakharpur	7	25
4	Bhanwant	28	441
5	Bheerpur	27	1,478
6	Bheemgoda barrage	62	2,177
7	Chapharia -Daurehara	28	417
8	Chaturbhuja	15	1,312
9	Dahraon	15	835
10	Fattepur	66	1,155
11	Ganga - Yamuna	20	3,830
12	Ganga barrage	30	186
13	Golatappar-Laltappar	3	32
14	Goomchini (Jamitha taal)	31	326
15	Gundera	18	74
16	Handia	17	1,912
17	Haripura dam and Bor dam	88	32,171
18	Ibrahimpur	53	2,662
19	Kalagarh	15	153
20	Katra	71	16,768
21	Lakh-Bahusi lake	39	9,009
22	Lalauli	5	231
23	Matatila	25	568
24	Nanakmata	65	5,808
25	Narayanpur Kalan	39	4,876
26	Patna Bird Sanctuary	14	216
27	Pilee dam	12	1,656
28	Purwa	7	52
29	Pyarepur	9	294
30	Ramiabehad (Bhagehar Taal)	27	208
31	Ramnagar	7	345
32	Razawan	11	283
33	Sahaswan	39	898
34	Saman	31	495
35	Sandi lake	40	669
36	Saranag Nagla	9	554
37	Sareli taal	22	182
38	Sarsai Nawal	16	595
39	Sauj	26	703
40	Semarai	33	248
41	Shaikha	57	15,477
42	Sherpur	69	1,077
43	Sherwaskalan	17	3,394
44	Sirsi (Marihan)	11	800
45	Sirsi Lalganj	13	728
46	Sukwa-Dukwa dam	19	2,609
47	Taalgaon (Sherpur)	25	253
48	Tumaria dam	54	4,133
49	Vijay Sagar	30	7,094
50	Viswanathpur	11	830
	Total	149	1,49,171

Heavy metals

On an average, among the wetlands, Durban of Ambdekar Nagar recorded the highest concentrations of lead (10.16±1.08 ppm), cadmium (0.89±0.30 ppm) and chromium (1.87±1.97 ppm) (Fig. 17.18). Zinc and copper were within the permissible limits. Variation in the levels of copper, lead, zinc and cadmium ($P<0.005$) was significant among the wetlands.

Among the fishes, surface dwellers recorded the maximum concentrations of all metals. *Cyprinus carpio* had lead concentration as high as 8.03±2.88 ppm, followed by *Anabas testudineus* (6.60±2.31 ppm), *Clarias batrachus* (6.26±2.29 ppm) and *Cirrhinus mrigala* (6.22±2.70 ppm) (Fig. 17.19). About 90% of the fishes recorded chromium below detection limits. Levels of copper, zinc and cadmium were within the permissible limits. The concentrations of lead, zinc and copper varied significantly among the species ($P<0.005$).

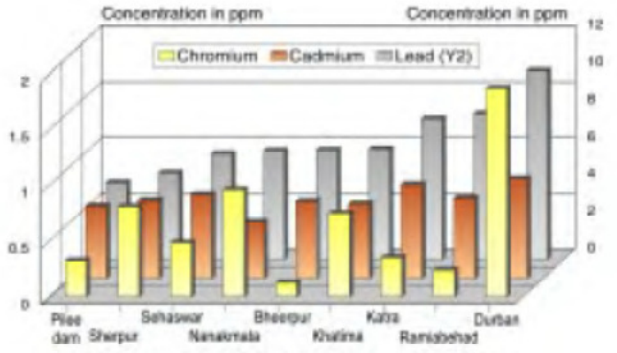


Fig. 17.18. Heavy metal contamination in select wetlands of Uttar Pradesh

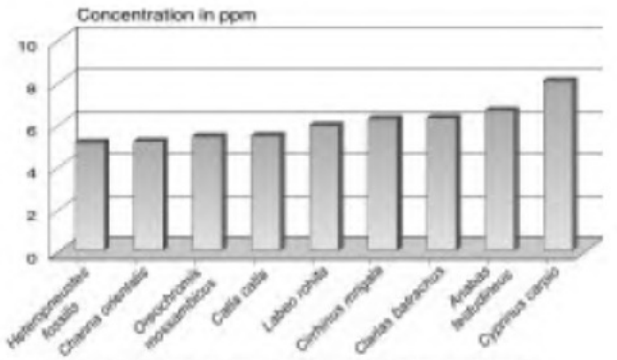


Fig. 17.19. Lead contamination in select species of fishes of Uttar Pradesh

Table 17.23. Frequency of sightings of Threatened and Near Threatened wetland birds in Uttar Pradesh and Uttaranchal

S.#	Species	Status	No. of wetlands	Total birds sighted
1	Spotbilled Pelican	T	4	127
2	Dalmatian Pelican	T	2	60
3	Adjutant Stork	T	2	45
4	Lesser Adjutant	T	4	39
5	Sarus Crane	T	26	1,266
6	Baer's Pochard	T	1	240
7	Marbled Teal	T	3	61
8	Baikal Teal	T	1	35
9	Greater Spotted Eagle	T	4	102
10	Whitebacked Vulture	T	8	17
11	Pallas's Fishing Eagle	T	7	49
12	Spotted Greenshank	T	1	1
13	Sociable Lapwing	T	3	5
14	Darter	NT	26	664
15	Blackheaded Ibis	NT	14	142
16	Painted Stork	NT	14	396
17	Blacknecked Stork	NT	17	235
18	Lesser Flamingo	NT	2	50
19	White-eyed Pochard	NT	3	25
20	Pale Harrier	NT	6	16
21	Greyheaded Fishing Eagle	NT	1	1
22	Blackbellied Tern	NT	73	250

Pesticides

Quantification of organochlorine residues in the wetlands of Uttar Pradesh revealed that Khatima of Udhamsingh Nagar recorded the highest load (1.052 ppm), while Pilee dam of Udhamsingh Nagar the least (0.036 ppm) (Fig. 17.20).

Among the various fishes, *Anabas testudineus* recorded the maximum concentrations of organochlorine residues (0.515 ppm), followed by *Catla catla* (0.124 ppm) and *Channa orientalis* (0.106 ppm), while *Oreochromis mossambicus* (0.028 ppm) had the least (Fig. 17.21). Moreover, fishes from Khatima in Udhamsingh Nagar district recorded the maximum mean concentrations of HCH (0.352 ± 0.768 ppm) and endosulfan (0.40 ± 1.10 ppm), which are higher than the Maximum Residue Limits (MRL) suggested for fish and fish products in India by Food and Drug Administration (FAD, 1998). The limits prescribed are 0.2-0.5 ppm and 0.2 ppm for HCH and endosulfan respectively.

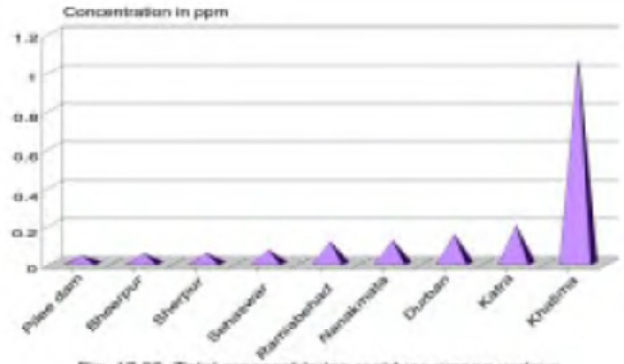


Fig. 17.20. Total organochlorine residues among various wetlands of Uttar Pradesh

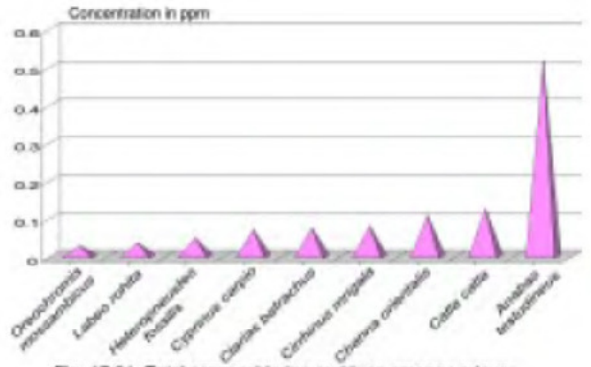


Fig. 17.21. Total organochlorine residues among various species of fishes in Uttar Pradesh

Suitability for human consumption

Of all the fishes, lead levels recorded in *Cyprinus carpio* (0.29mg), *Anabas testudineus* (0.24mg), *Cirrhinus mrigala* (0.22 mg) and *Clarias batrachus* (0.22 mg) are higher than the permissible levels (0.21 mg for 60 kg adult daily) stipulated by UN Committee (WHO, 1993). Regular consumption, may lead to serious neurological and nephrological complications. It may be noted that the guideline values are framed presuming that a person consumes 250 g per week.

In Uttar Pradesh, 85% of fishes were contaminated with HCH residues and 71% with heptachlor epoxide. Fishes from Khatima wetland reveal a serious situation, the HCH being 12.6 ppm; which is three quarters of the concentration recommended (18 ug/60 kg/person/day) by Health Canada (1996) for human consumption.

Although no specific information over the effluent discharge into the wetlands are available, the only factor that could be responsible for high concentrations of pesticides is agricultural run off. It is to be noted that those fishes recorded higher concentrations of contaminants are commercially propagated. Regular consumption of these fishes may lead to serious physiological consequences. Wetlands such as Durban, Ramiyabehad and Sehaswan require continuous monitoring.

Socioeconomic values

Eleven, out of the 17 possible uses of the wetlands were recorded from Uttar Pradesh. Most common and abundant use of the wetlands was fishing and agriculture, as reported in 42 welands. 14 wetlands were used for fuel wood collection and, 12 for reed gathering and collection of edible aquatic plants. At the same time, almost all (32) wetlands are used for irrigation purpose and livestock grazing (28). Wetlands with the ratings of 1-3 were categorized as low use, 4-6 as medium and >6 as high use areas. Many of the sites were of low (23), or medium (24) use, while 10 had high use and three had no socioeconomic use by the local community. 26 out of the 60 wetlands surveyed had problems from solid waste dumping, sewage disposal and, or effluents from industries.

Prioritization of wetlands

Conservation priorities of the wetlands surveyed were assessed based on the biodiversity values, mainly of the birds and size of the wetland, as explained under methods. The 50 wetlands where birds were observed were given ratings and ranks of priority. Accordingly fourteen came in the first rank, 17 in the second, 12 in the third and seven in the fourth rank. The last three in the first rank, six in the second rank and seven in the third rank came up because of the size of the respective wetlands (Table 17.24).

Table 17.24. Prioritized list of the wetlands of Uttar Pradesh and Uttaranchal

No	Name of the wetland	Rank	Use Grade
1	Haripura dam & Bor dam	1	M
2	Katra	1	M
3	Nanakmata	1	L
4	Lakh-Bahusi lake	1	L
5	Shaikha	1	H
6	Bhanwant	1	M
7	Saman	1	M
8	Sauj	1	M
9	Sareli taal	1	L
10	Aspan	1	L
11	Ibrahimpur	1	M
12	Fattepur	1	L
13	Narayanpur kalan	1	H
14	Sahaswan	1	M
15	Chapharia - Daurehara	2	L
16	Sandi lake	2	L
17	Bheemgoda barrage	2	M
18	Tumaria dam	2	H
19	Bheerpur	2	L
20	Sarsai Nawar	2	L
21	Semarai	2	H
22	Sherpur	2	M
23	Kalagarh	2	L
24	Ramiabehad (Bhagehar taal)	2	H
25	Goomchini (Jamitha taal)	2	-
26	Matatila	2	H
27	Viswanathpur	2	L
28	Chaturbhuja	2	M
29	Asan reservoir	2	L
30	Sirsi (Marihan)	2	H
31	Taalgaon	2	H
32	Sarang Nagla	3	L
33	Gundera	3	H
34	Vijay Sagar	3	L
35	Ganga barrage	3	L
36	Lalauli	3	L
37	Razawan	3	H
38	Dahraon	3	H
39	Handia	3	M
40	Sherwaskalan	3	H
41	Sirsi Lalganj	3	H
42	Sukwa-Dukwa dam	3	H
43	Ganga-Yamuna	3	H
44	Ramnagar	4	H
45	Patna Bird Sanctuary	4	M
46	Pilee dam	4	H
47	Purwa	4	M
48	Bakharpur	4	L
49	Golatappar-Laltappar	4	-
50	Pyarepur	4	L

Among the top ranking sites, Lakh-Bahusi and Saman have already been declared as sanctuaries, but partial use of the area is being made which should be regulated and monitored. Most of the wetlands are of low to medium use and, hence could be protected. Of the top ranking sites, five were of low use, eight of medium use and, only one was of high use, namely Narayanpur Kalan, which is also affected by sewage, solid waste and effluent disposal. Aspan, Sareli taal and Fattepur are among the top ranking sites, but of low use by the local community and hence could be declared as protected areas. Although, Aspan is partly protected, it is affected by solid waste disposal.

Many of the sites are in the Indo-Gangetic Plains. Haripura and Bor dams are in the sub-Himalayan Terai. Similarly Tumaria dam, although in the second rank, is also in the same region and hence should be given more importance. Kalagarh in the second rank is inside the National Park and it has already been proposed as an IBA. Most of the IBAs are in Protected Areas, while Asan reservoir, Tumaria dam and Pilee dam are outside Protected Areas. Distribution of the prioritized wetlands along with other conservation areas is given in Fig. 17.22.

The first 25 wetlands in the priority list are qualified to be declared as Ramsar sites.

Summary

- The undivided Uttar Pradesh during 1991-'92 had 1,193 wetlands of the size 56.25 ha and above, covering an area of 3,286.82 sq km (SAC, 1998).
- In the seven select districts studied in 2000-'01, the number of wetlands of the size 2 ha and above was 768, and they covered a total of 1,851.58 sq km.
- District of Mirzapur had a loss of 25% of its wetlands during the period between 1991-'92 and 2000-'01.
- Turbidity as revealed by satellite imageries was low in most wetlands.
- In general, aquatic vegetation was low in large parts of the wetland area, although some of the wetlands had dense vegetation in the seven districts studied.
- The undivided Uttar Pradesh had three species of endemic plants; three Critically Endangered, eight Endangered, and 23 Vulnerable species of fishes; one Critically Endangered, two Endangered, three Near Threatened and seven Vulnerable, and two Least Concern species of freshwater turtles.
- In the 50 wetlands surveyed, 1,49,171 birds belonging to 149 species were recorded.
- Thirteen globally Threatened and nine Near Threatened species with 2,047 and 1,779 birds respectively were recorded.
- The most abundant bird species were the Coot, Pintail, Redcrested Pochard and Gadwall.
- The rare sightings were of the Temminck's Stint, Yellow Bittern and Spotted Redshank.
- One hundred and twenty-two fishes of 15 species from 17 wetlands were studied for environmental contamination.

- Fishes from Durban, Ramiabehad, Seheswar and Khatima had comparatively high concentrations of contaminants.

- The levels of HCH, and endosulfan in the fishes of Khatima were higher than the maximum limits prescribed by Food and Drug Administration.

- In Uttar Pradesh, 85% of the fishes sampled had HCH residues and 71% had heptachlor epoxide.

- Concentration of lead was higher than the permissible limits for human consumption in *Cyprinus carpio, Cirrhinus mrigala* and *Clarias batrachus.*

- Fifty wetlands have been prioritized for conservation, 14 of them fall in the first rank, 17 in the second, 12 in the third and seven in the fourth rank.

- The first 25 wetlands in the priority list qualify to to be declared as Ramsar sites.



Ajeeth Singh

A view of Bhanwant (Bhawat) wetland in Manipuri district

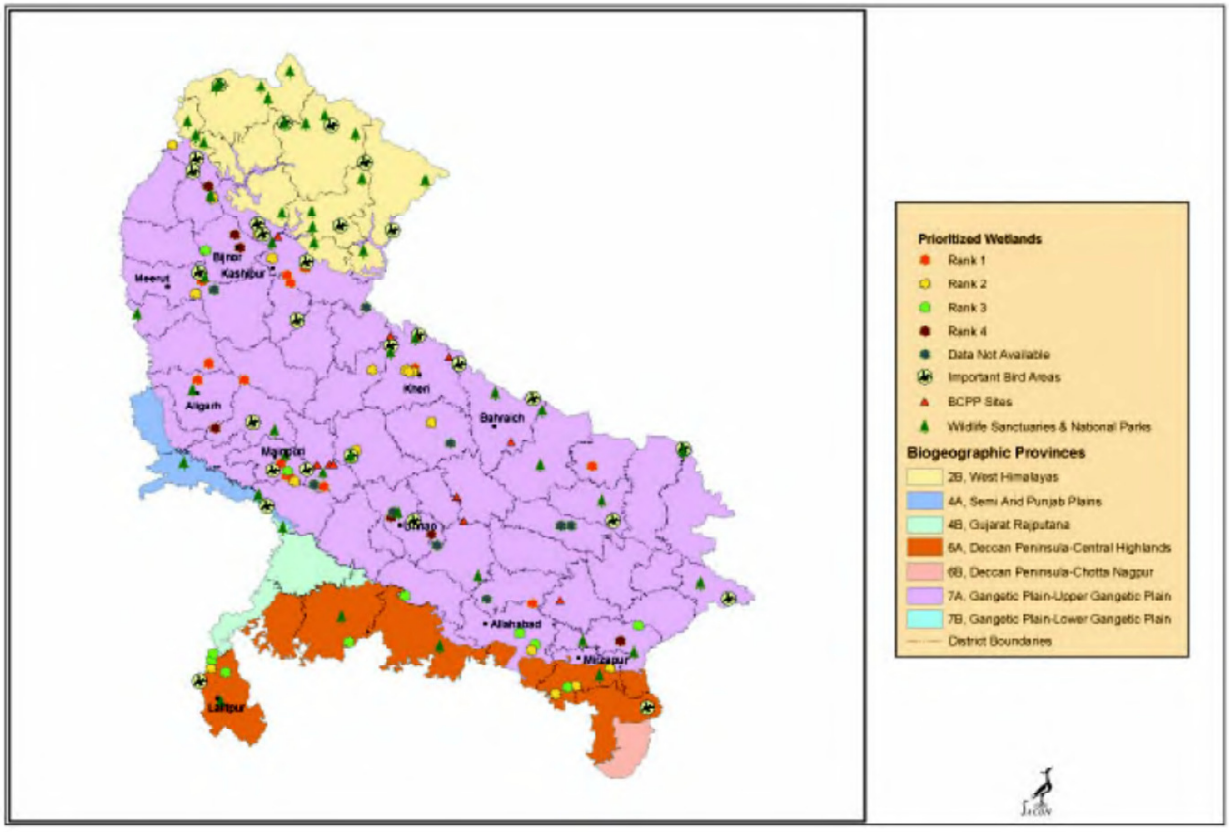


Fig. 17.22. Prioritized wetlands and other conservation areas in Uttar Pradesh (undivided)



Mukesh Acharya

Sarus crane with a chick on the nest



Ajeeth Singh

Sarus Crane : a species under serious threat from pesticides

BIHAR and JHARKHAND

Bihar, a storehouse of vast mineral wealth of India and a land of wetlands and waterfowl, is flanked by West Bengal, Orissa, Madhya Pradesh and Uttar Pradesh and reaches up to the foothills of Himalaya in the north and is completely landlocked. The river Ganga cuts the state into two unequal halves, flowing from west to east. The southern half is almost double in size of the northern part. Physiographically, north Bihar is almost entirely a level tract while south Bihar is hilly and undulating. South Bihar is again divided into two parts consisting of the alluvial land along the bank of Ganga and the Chotanagpur plateau. Chotanagpur plateau largely comprises highlands, hills and valleys. This region is also noted for waterfalls on some rivers like Suvarnarekha (Hundru falls). The major rivers in north Bihar are the Ganga, Kosi, Gandak, and, in south Bihar they are the Punpun, Phalgu, Sone, Sakri, Kiul, Damodar, Baraker and Suvarnarekha. Most of the rivers flow into the Ganga.



State at a glance	
State capital	Patna
Area	94,163 sq km
Population (2001)	82,878,796
Total number of districts	37
Major rivers	Ganga, Ghagra, Gandak, Baghmati, Kosi, Baraker, Damodar, Sone, Suvarnarekha
Total forest area (including Jharkhand)	29,490 sq km
Population density (2001)	880/sq km
Ramsar site declared	Nil
Proposed Ramsar sites	3
Total sites proposed for conservation	42

The state generally has three seasons, hot season from March to May, the rainy season from June to September and the cold season from November to February. The average rainfall varies from about 1,000 mm to 1,500 mm. The temperature varies from 9.2 to 36.3°C.

Status of wetlands

In the land use classification in Bihar, as in the other states, wetlands have not been demarcated; they might have been classified under wasteland (Table 18.1). However, the Space Applications Centre has estimated that the wetlands of 56.25 ha and above cover a total of 1,776.8 sq km in Bihar; 1.02% of the total geographical area (SAC, 1998).

The total number of wetlands, in the size 56.25 ha and above in Bihar was estimated at 759 (Table 18.2). However, when all the wetlands of 2 ha and above were included, in five of the districts, the total number comes to 3,666 covering an area of 996.01 sq km. Spatial distribution of the wetlands of the size 56.25 ha and above shows that they are confined mostly to the north western region, and scattered in the rest of the state (Fig. 18.1).

Table 18.1. Land use pattern in Bihar and Jharkhand

Land use type	Area in sq km
Total geographic area	1,73,877
Forests	29,490
Not available for cultivation	34,380
Other uncultivated land excluding fallow land	7,720
Fallow land	27,400
Net area sown	74,310
Area sown more than once	26,220
Total cropped area	1,00,530
Cultivable area	1,09,430

(Source: www.indiastat.com)

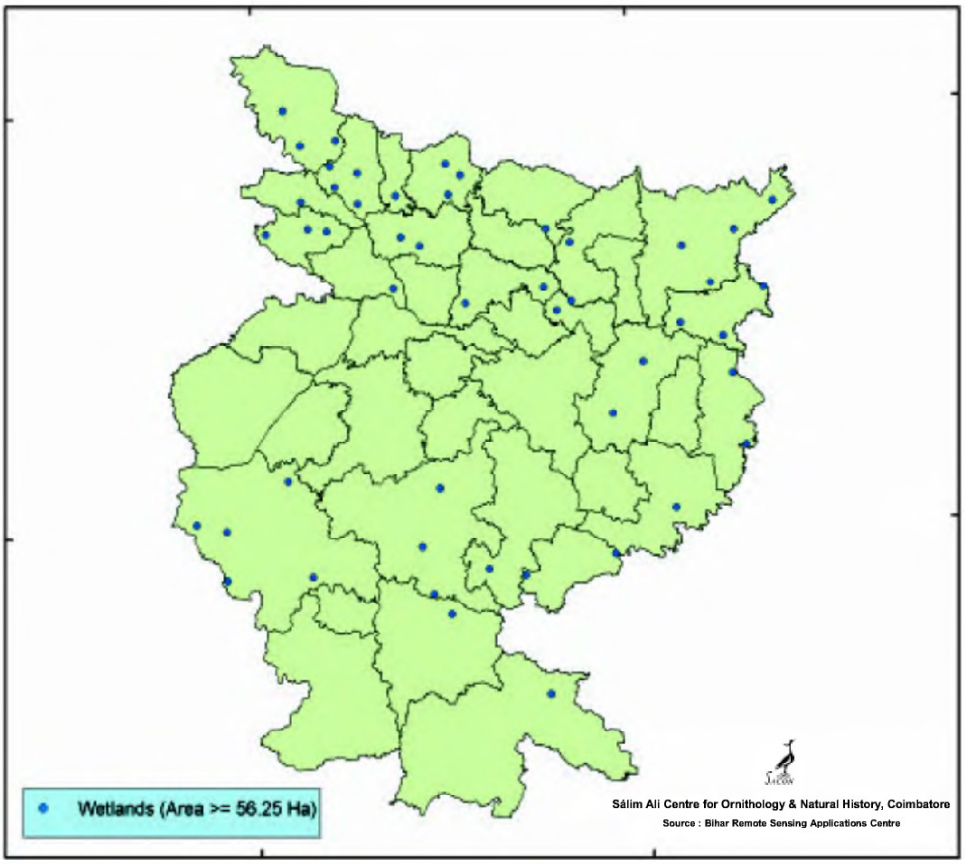


Fig. 18.1. Distribution of wetlands in Bihar

Bihar has a variety of wetlands ranging from large oxbow lakes and reservoirs to small ponds (Table 18.2). Waterlogged areas are more in number and extent, compared to other types of wetlands.

Table 18.2. Distribution of various categories of inland wetlands in Bihar

Wetland Category	Area (sq km)	No. of Wetlands
Natural		
Lakes/Ponds	73.22	26
Oxbow lakes	302.30	191
Waterlogged (Seasonal)	632.68	327
Swamp/marsh	395.59	142
Man-made		
Reservoirs	34.28	48
Tanks	23.07	21
Abandoned quarries	1.87	2
Ash/Cooling Pond	5.62	2
Total	1,776.83	759

Source: SAC (1998)

Habitat analyses of wetlands in select districts

Five districts, namely Vaishali, Saran, Muzaffarpur, East Champaran and Bhagalpur were chosen to map wetlands at a finer resolution (23.5 m) to capture wetlands above 2 ha in size in order to make detailed studies on the wetland habitats, turbidity, aquatic vegetation, catchment areas and seasonal recession in wetland area. Land use pattern and the extent of wetlands vary from district to district. Relevant statistics of the districts studied along with the turbidity levels and seasonal changes in the wetland area is given in Tables 18.4-18.18.

Wetlands

In the five districts studied, the number of wetlands varied from 570 to 1,041 and the area from 107 to 283.05 sq km (Table 18.3). The per cent area under wetlands in the five districts varies from 2.71 to 11.43 in East Champaran and Vaishali respectively (Fig.18.2). The major type of wetlands in all the districts, except in Saran, is waterlogged. In Saran, ponds and lakes dominate while in Vaishali also these types of wetlands occupy a substantial area (Fig. 18.3). It is very striking that in all the five districts studied wetlands of the size less than 56.25 ha are more abundant (Fig. 18.4).

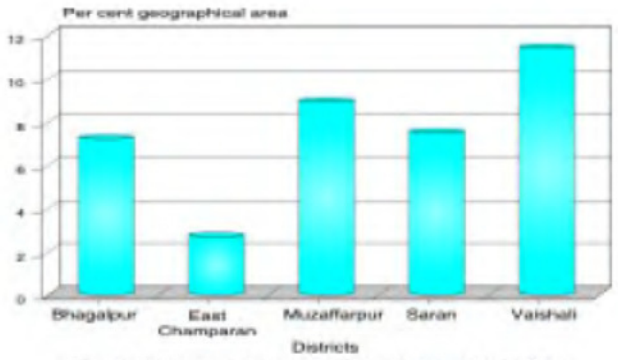


Fig. 18.2. Area under wetland in select districts in Bihar

Table 18.3. Types, number and extent (sq km) of wetlands in five select districts of Bihar

Districts	Ponds/lakes/tanks		Waterlogged		Oxbow lakes		Total no.	Total area
	No.	Area	No.	Area	No.	Area	of wetlands	of wetlands
Bhagalpur	133	17.26	334	141.36	103	16.18	570	174.8
East Champaran	86	3.05	518	72.58	96	31.72	700	107.35
Muzaffarpur	90	5.47	360	261.56	144	16.02	594	283.05
Saran	701	117.5	60	81.29	-	-	761	198.79
Vaishali	113	99.91	928	132.11	-	-	1,041	232.02
Total	1,123	243.19	2,200	688.9	343	63.92	3,666	996.01

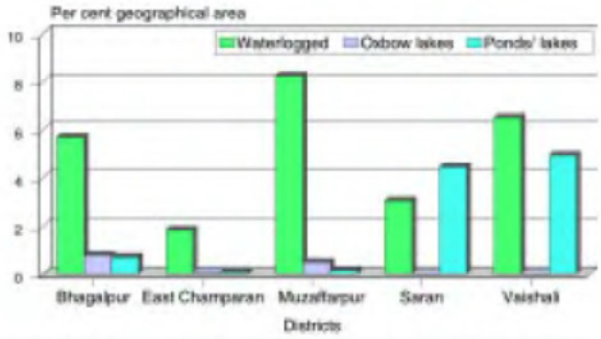


Fig. 18.3. Area under different wetland classes in select districts in Bihar

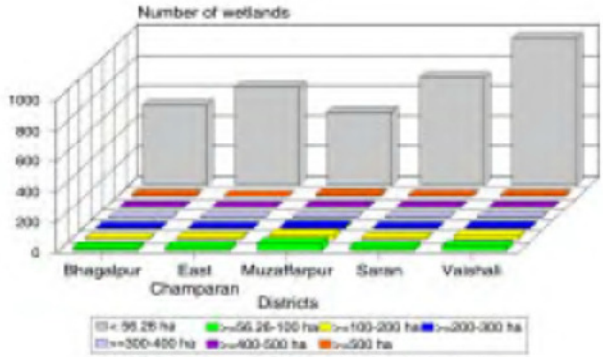


Fig. 18.4. Size class distribution of wetlands in select districts in Bihar

Turbidity

Wetlands in all the districts, except those in Saran had moderate turbidity. They were of low turbidity in Saran while those in Muzaffarpur had almost equal proportion of moderate and high turbidity (Fig. 18.5). The moderate and high values of turbidity indicate higher sedimentation.

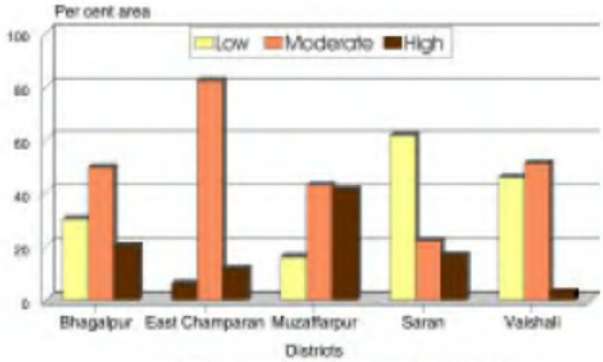


Fig. 18.5. Turbidity pattern of wetlands in Bihar

Summer recession

The summer recession was the highest in Bhagalpur (88%), while it was the lowest in Muzaffarpur, around 18.43% (Fig. 18.6).

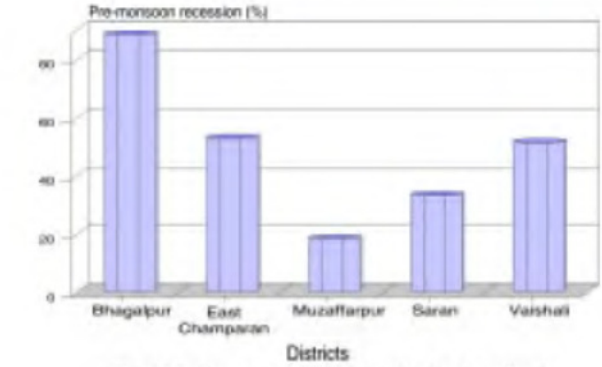


Fig. 18.6. Average summer recession in the wetlands of select districts in Bihar

Wetlands and land use pattern in the catchment areas

The integrated land use maps of all the five districts show that almost all the wetlands are embedded in a landscape predominantly covered by agriculture (Fig. 18.7-18.11).

Temporal changes in wetland cover

A comparison of the data on the wetland cover of the five districts collected during 1992-93 and 2000-'01, as explained in the methodology, shows that there was an overall increase of 534.09 sq km. In East Champaran, there was a loss of 50.20 sq km (Table 18.19, Fig. 18.12).

Table 18.19. Changes in the wetland areas (sq km) in Bihar

	Wetland Area (sq km)			
District	SAC (1992-'93)	SACON (2000-'01)	Variation	%Variation
Bhagalpur	103.10	174.80	71.70	69.54
East Champaran	157.55	107.35	-50.20	-31.86
Muzaffarpur	109.73	283.06	173.33	157.96
Saran	69.27	198.79	129.52	186.98
Vaishali	22.28	232.02	209.74	941.38
Total	461.93	996.02	534.09	

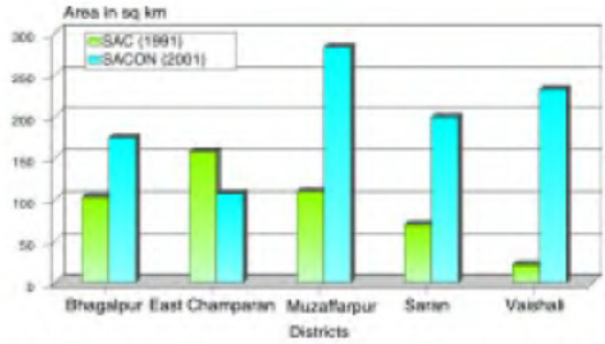


Fig. 18.12. Difference in total wetland area in select districts of in Bihar

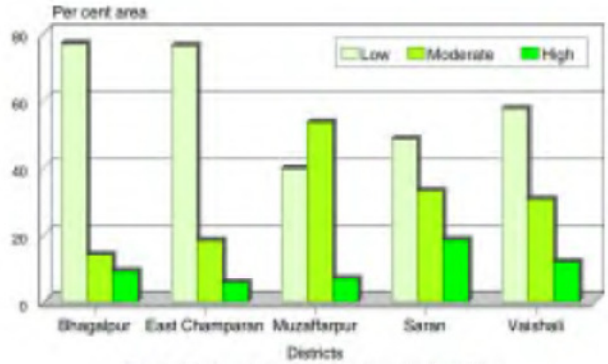


Fig. 18.13. Aquatic vegetation of wetlands in Bihar

Table 18.20. Endemic aquatic plants recorded from undivided Bihar

S.No.	Species	Family
1	*Hoppea dichotoma*	Gentianaceae
2	*Cryptocoryne spiralis*	Araceae
3	*Ischaemum nilagiricum*	Poaceae
4	*Lindernia estaminodiosa*	Scrophulariaceae
5	*Rotala illecebroides*	Lythraceae

Biodiversity

Aquatic vegetation

The satellite imageries of the wetlands in the five districts of Bihar show that all the wetlands, except those in Saran district, had moderately dense vegetation (Fig. 18.13, Table 18.21). The wetlands of Saran had poor vegetation while those in Muzaffarpur had very dense vegetation. *Cyperus* spp. were the dominant emergents, besides *Eleocharis* spp. A few sites had only submerged and floating plants with open water. The common submerged plants found in almost all water bodies are *Hydrilla verticillata, Vallisneria spiralis* and floating plants *Eichhornia crassipes* and *Azolla pinnata*. Five endemic aquatic plants, each belonging to a separate family, occur in the undivided Bihar (Table 18.20). *Lindernia estaminodiosa* and *Rotala illecebroides* were recorded only from Jharkhand.

Fishes

Nineteen species of Threatened fishes including five Endangered and 14 Vulnerable species were recorded from Bihar (Table 18.22). There is no record of any Critically Endangered species in Bihar (Menon, 1999).

Turtles

Fourteen species of turtles have been recorded from Bihar, out of which one is Critically Endangered, two are Endangered, six Vulnerable, three Near Threatened, and two Least Concern (Table 18.23).

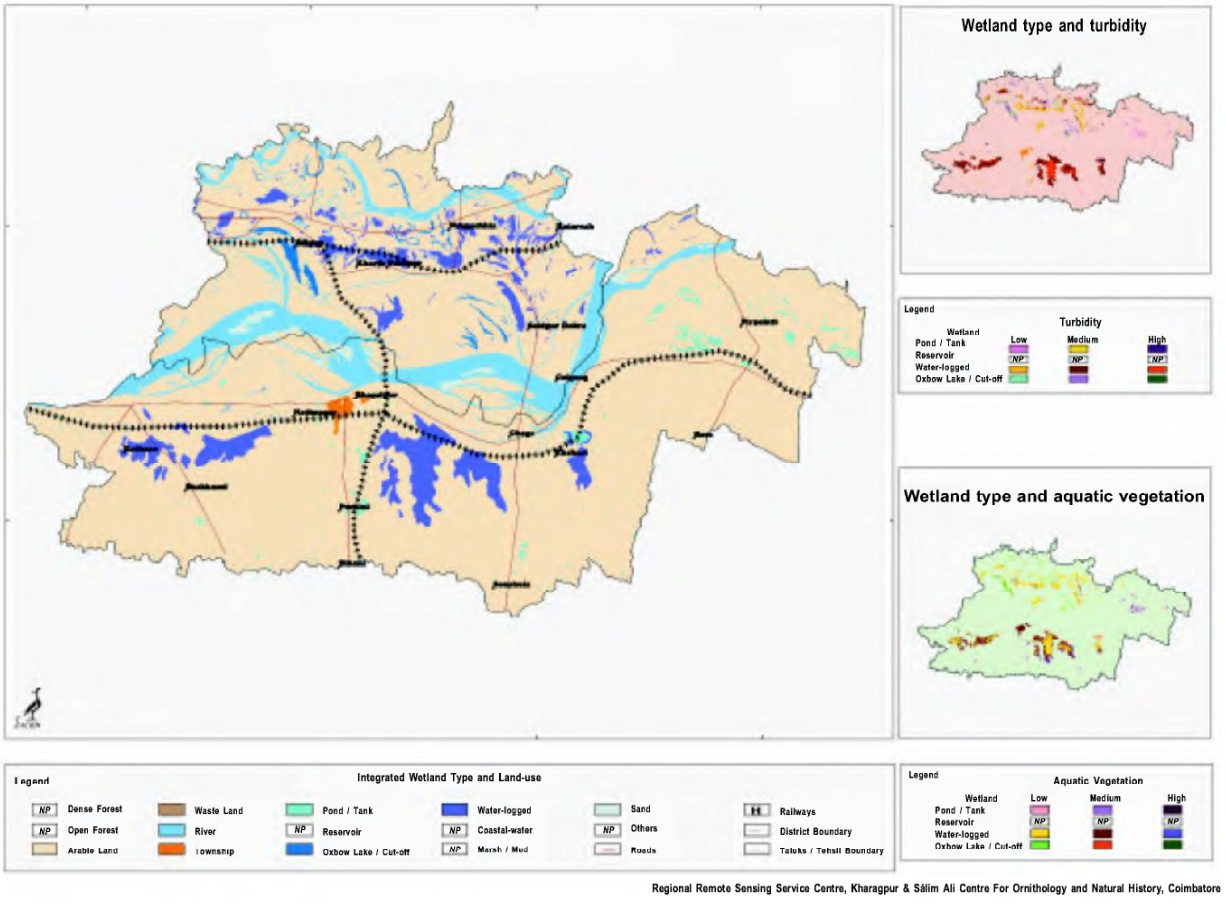


Fig. 18.7. Land use and wetland types in the district of Bhagalpur

Table 18.4. Integrated land use/ land cover and wetland statistics of the district of Bhagalpur

Class names	Area (sq km)	Area (%)
Arable land	2,142.50	82.94
River/waterbodies	222.01	8.64
Township	5.33	0.21
Sand	24.87	0.97
Ponds/lakes	17.26	0.73
Waterlogged	141.36	5.70
Oxbow lakes	16.18	0.81
Total	2,569.51	

Table 18.5. Area under different turbidity classes in the district of Bhagalpur

Turbidity level	Area (sq km)	Area (% of wetland)
Low	52.66	30.12
Moderate	86.67	49.58
High	35.48	20.30
Total area	174.8	100.00

Table 18.6. Seasonal pattern of wetland area of the district of Bhagalpur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/oxbow lakes	9.90	7.90	2.00	
Waterlogged	97.88	4.67	93.21	
Total	107.78	12.57	95.21	88.34

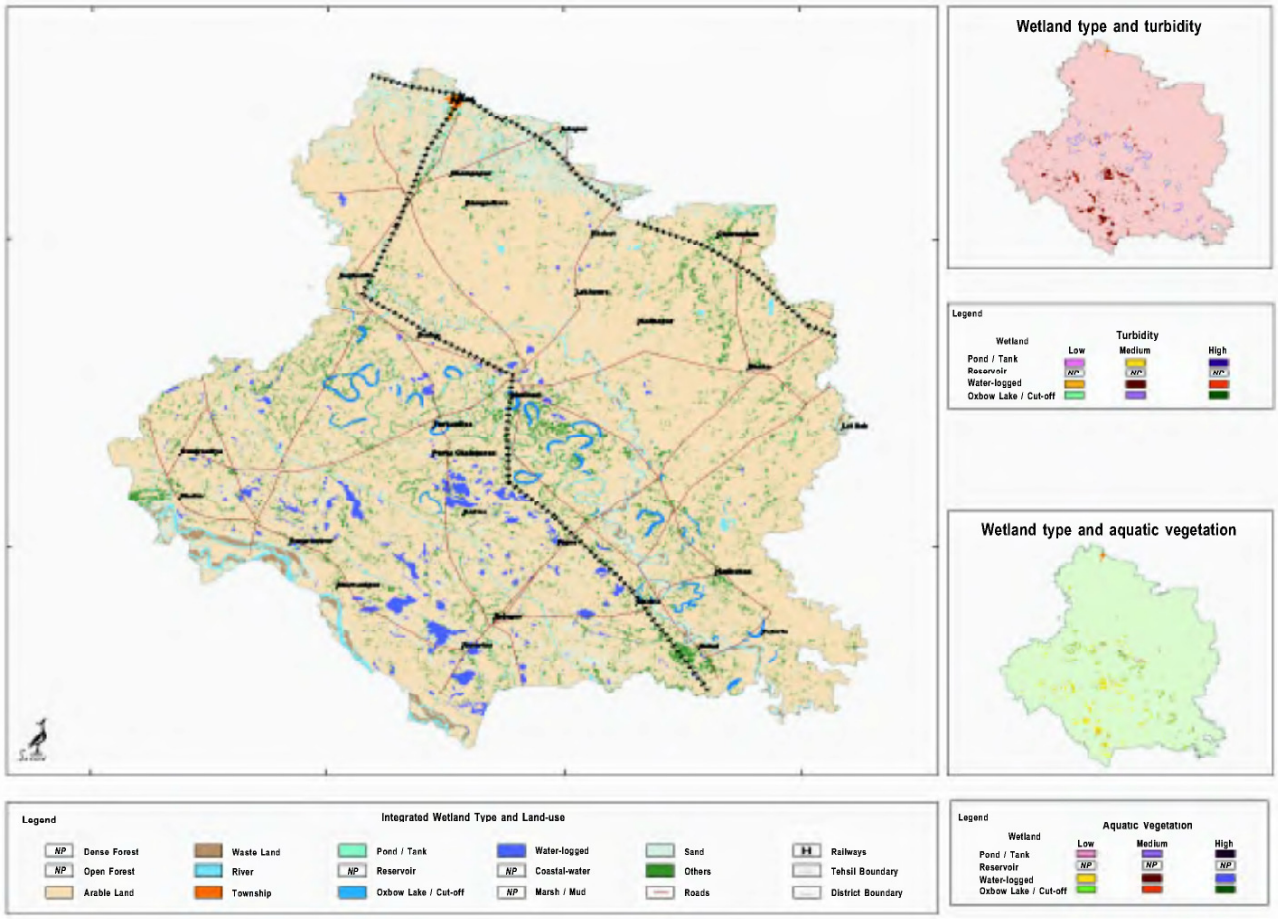


Fig. 18.8. Land use and wetland types in the district of East Champaran

Table 18.7. Integrated land use/ land cover and wetland statistics of the district of East Champaran

Class names	Area (sq km)	Area (%)
Arable land	3,252.93	81.96
Wasteland	195.07	4.92
Orchard	259.92	6.54
River/waterbodies	106.12	2.68
Township	2.40	0.66
Sand	45.21	1.13
Ponds/lakes	3.05	0.08
Waterlogged	72.58	1.83
Oxbow lakes	31.72	0.80
Total	3,969.00	100.00

Table 18.8. Area under different turbidity classes in the district of East Champaran

Turbidity level	Area (sq km)	Area (% of wetland)
Low	6.67	6.21
Moderate	88.17	82.13
High	12.51	11.66
Total area	107.35	100.00

Table 18.9. Seasonal pattern of wetland area of the district of East Champaran

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/oxbow lakes	26.76	18.30	8.46	
Waterlogged	35.51	10.91	24.60	
Total	62.27	29.21	33.06	53.09

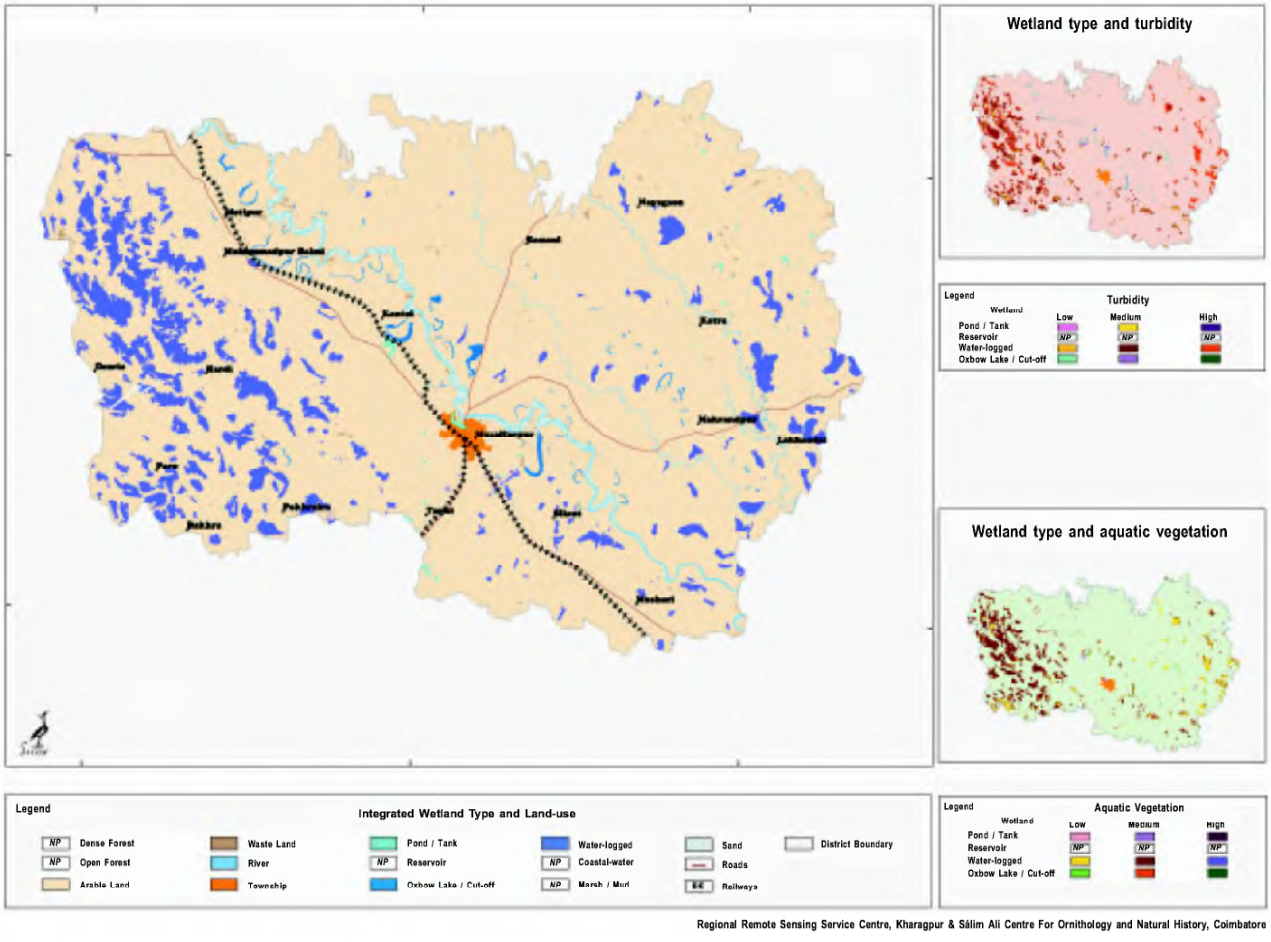


Fig. 18.9. Land use and wetland types in the district of Muzaffarpur

Table 18.10. Integrated land use/ land cover and wetland statistics of the district of Muzaffarpur

Class names	Area (sq km)	Area (%)
Arable land	2,799.92	88.28
Wasteland	18.10	0.57
River/waterbodies	32.24	1.00
Township	12.55	0.40
Sand	26.23	0.82
Ponds/lakes	5.47	0.17
Waterlogged	261.57	8.25
Oxbow lakes	16.02	0.51
Total	3,172.00	100.00

Table 18.11. Area under different turbidity classes in the district of Muzaffarpur

Turbidity level	Area (sq km)	Area (% of wetland)
Low	44.86	15.85
Moderate	121.38	42.88
High	116.82	41.27
Total area	283.06	100.00

Table 18.12. Seasonal pattern of wetland area of the district of Muzaffarpur

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/oxbow lakes	21.49	15.60	5.89	
Waterlogged	261.57	215.30	46.27	
Total	283.06	230.90	52.16	18.43

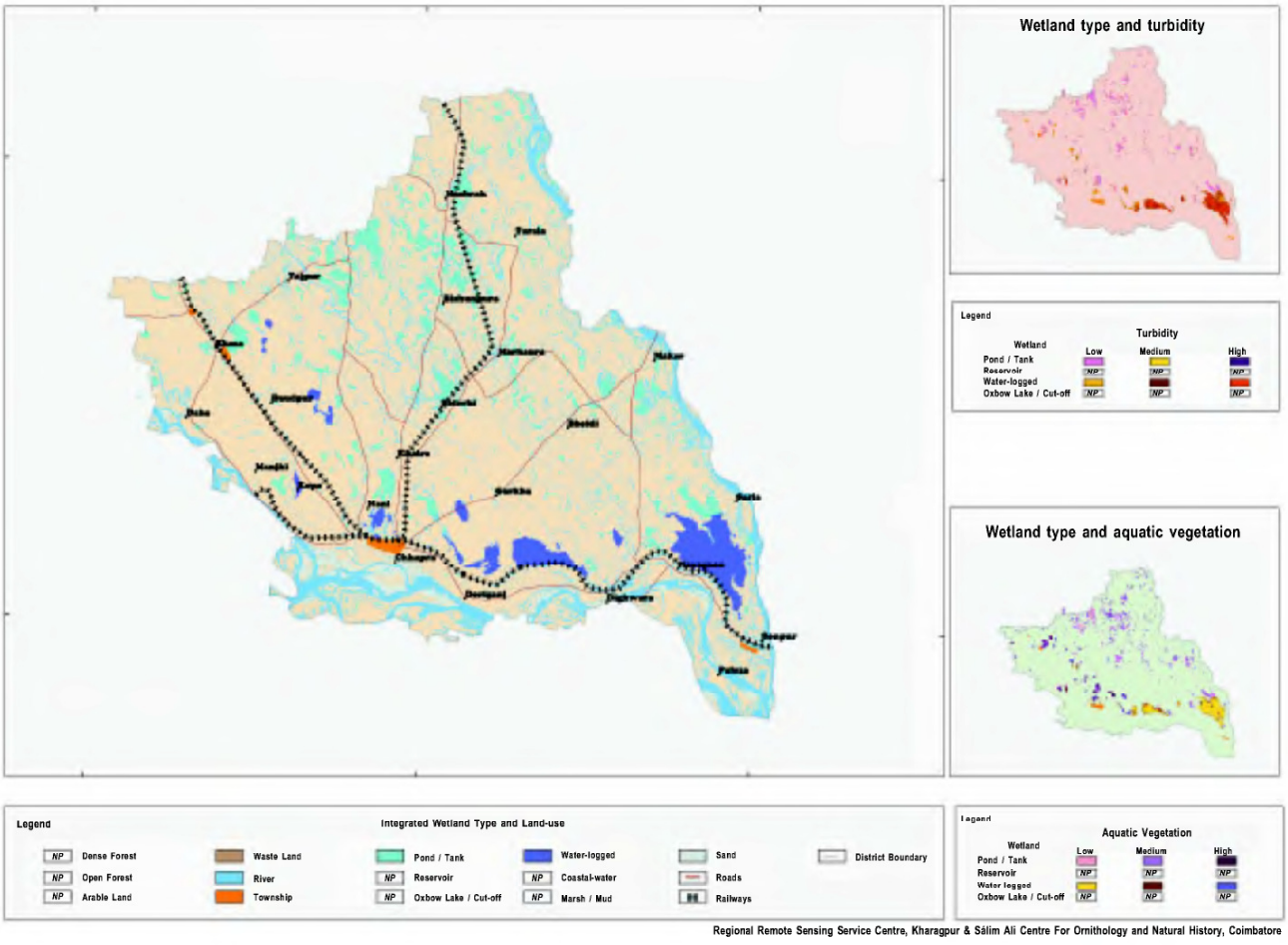


Fig. 18.10. Land use and wetland types in the district of Saran

Table 18.13. Integrated land use/ land cover and wetland statistics of the district of Saran

Class name	Area (sq km)	Area (%)
Arable land	1,996.10	75.58
Township	8.22	0.31
River/waterbodies	399.38	15.12
Sand	38.51	1.46
Ponds/lakes	117.50	4.45
Waterlogged	81.29	3.08
Total	2,641.00	100.00

Table 18.14. Area under different turbidity classes in the district of Saran

Turbidity level	Area (sq km)	Area (% of wetland)
Low	122.32	61.54
Moderate	43.91	22.09
High	32.56	16.37
Total area	198.79	100.00

Table 18.15. Seasonal pattern of wetland area of the district of Saran

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/oxbow lakes	30.30	20.13	10.17	33.56

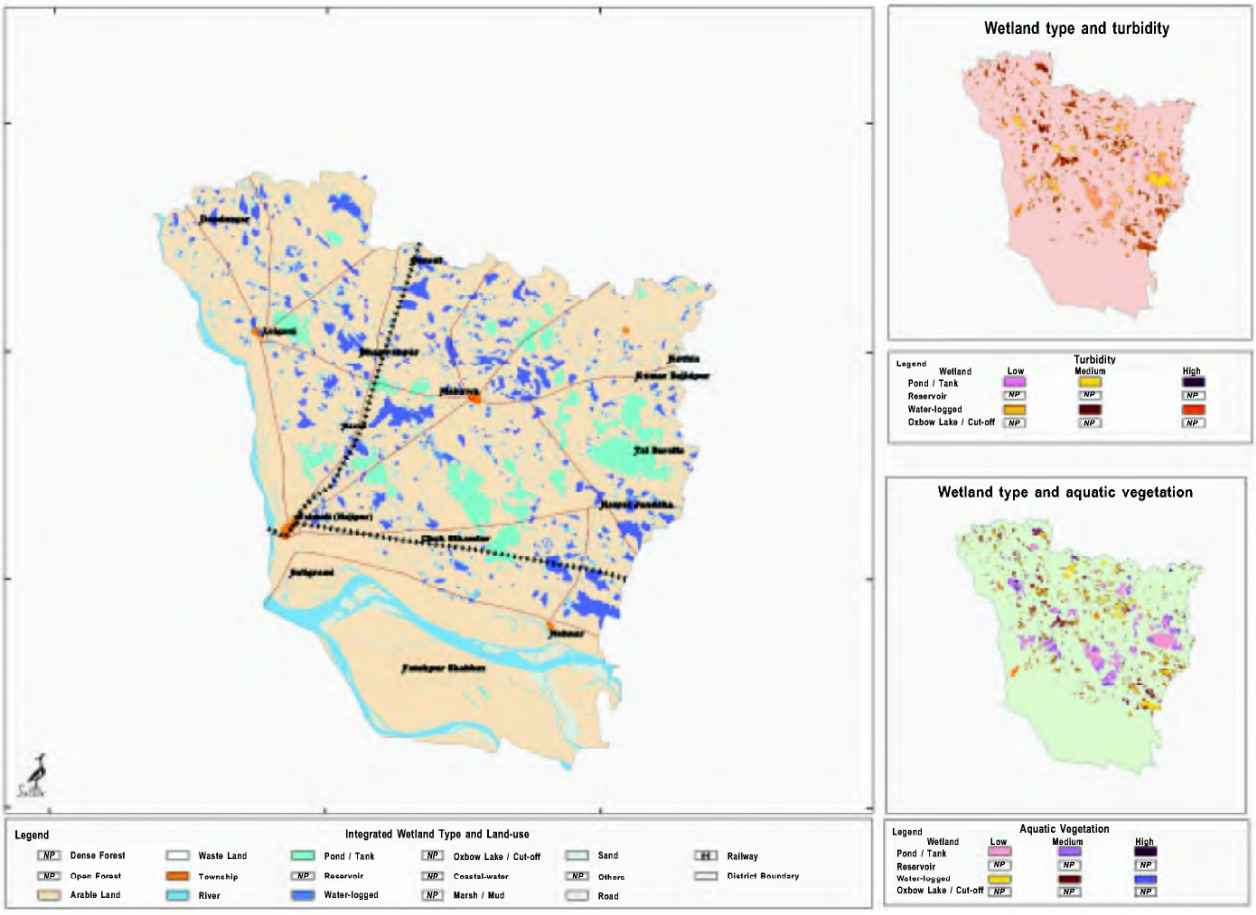


Fig. 18.11. Land use and wetland types in the district of Vaisali

Table 18.16. Integrated land use/ land cover and wetland statistics of the district of Vaishali

Class name	Area (sq km)	Area (%)
Arable land	1597.52	78.28
River/waterbodies	177.49	8.85
Township	5.54	0.27
Sand	23.43	1.17
Ponds/lakes	99.91	4.92
Waterlogged	132.11	6.51
Total	2036	100.00

Table 18.17. Area under different turbidity classes in the district of Vaishali

Turbidity level	Area (sq km)	Area (% of wetland)
Low	106.45	45.88
Moderate	118.70	51.16
High	6.87	2.96
Total area	232.02	

Table 18.18. Seasonal pattern of wetland area of the district of Vaishali

	Area in sq km			
Wetland class	Post-monsoon	Pre-monsoon	Variation	% Variation
Ponds/lakes/oxbow lakes	65.11	35.62	29.49	
Waterlogged	34.29	12.51	21.78	
Total	99.40	48.13	51.27	51.58

Table 18.21. Summary of wetland statistics of the select districts in Bihar

Wetland category	Total number	Area sq km	% of wetland					
			Turbidity			Aquatic vegetation		
			Low	Moderate	High	Low	Moderate	High
Bhagalpur								
Ponds/lakes	133	17.26	59.1	26.16	14.75	68.55	15.04	16.41
Waterlogged	334	141.36	26.95	50.45	22.61	67.5	24.00	8.51
Oxbow lakes	103	16.18	26.95	67.0	6.05	94.46	2.96	2.58
East Champaran								
Ponds/lakes	86	3.05	0.99	87.59	11.42	76.42	19.76	3.83
Waterlogged	518	72.58	0.47	85.70	13.83	89.13	9.03	1.84
Oxbow lakes	96	31.72	19.86	73.44	6.7	63.2	25.85	10.96
Muzaffarpur								
Ponds/lakes	90	5.47	53.84	30.44	15.72	47.28	40.5	12.22
Waterlogged	360	261.56	13.2	41.37	45.43	29.41	68.65	1.95
Oxbow lakes	144	16.02	46.0	40.59	13.41	42.19	51.36	6.44
Saran								
Ponds/lakes	701	117.50	79.28	16.97	3.75	26.82	48.21	24.97
Waterlogged	60	81.29	35.88	29.48	34.64	70.2	18.00	11.80
Vaishali								
Ponds/lakes	113	99.91	42.19	55.44	2.37	66.24	24.36	9.40
Waterlogged	928	132.11	48.67	47.78	3.55	48.69	36.97	14.34

Table 18.22. Threatened freshwater fishes of Bihar

S. No.	Species	Status
1	*Eutropiichthys vacha*	EN
2	*Chitala chitala*	EN
3	*Anguilla bengalensis*	EN
4	*Ompok bimaculatus*	EN
5	*Pseudeutropius atherinoides*	EN
6	*Rhinomugil corsula*	VU
7	*Puntius chola*	VU
8	*Puntius conchonius*	VU
9	*Osteobrama cotio*	VU
10	*Mystus vittatus*	VU
11	*Labeo dero*	VU
12	*Heteropneustes fossilis*	VU
13	*Cirrhinus reba*	VU
14	*Clarias batrachus*	VU
15	*Anabas testudineus*	VU
16	*Bagarius bagarius*	VU
17	*Barbodes sarana*	VU
18	*Barilius barila*	VU
19	*Catla catla*	VU

EN=Endangered; VU=Vulnerable

Birds

Ninety five species of birds were recorded during the survey, covering six wetlands in Bihar and Jharkhand with the maximum species at Jagatpur lake (Table 18.24). Of the 95 species, 68 were aquatic or semi-aquatic and 27 were land birds that visit wetlands occasionally. Most of the wetland birds were migratory. The widely distributed species were residents such as egrets and herons. Three Threatened species, namely the Pallas's Fishing Eagle (at Goga beel), Lesser Kestrel (at Jagatpur lake) and Lesser Adjutant (in four wetlands) and, three Near Threatened species, namely the White Ibis (in four wetlands), Blacknecked Stork (at Baghar beel) and White-eyed Pochard (at Jagatpur lake), have been reported.

Environmental contamination

One hundred and thirty six fishes comprising 23 species from 17 wetlands in Bihar were collected to assess the contamination status. However, to have uniformity and comparability of data from other states, information on only 12 species of fishes from 13 wetlands are discussed here.

Table 18.23. List of freshwater turtles recorded from Bihar

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes gangeticus*	VU	-	I
2	*Aspideretes hurum*	VU	I	I
3	*Chitra indica*	EN	-	IV
4	*Geoclemys hamiltonii*	VU	I	I
5	*Hardella thurjii*	VU	-	-
6	*Kachuga dhongoka*	EN	-	-
7	*Kachuga kachuga*	CR	-	I
8	*Kachuga smithii*	LC	-	-
9	*Kachuga tecta*	NT	I	I
10	*Kachuga tentoria*	NT	-	-
11	*Lissemys punctata*	NT	II	I
12	*Morenia petersi*	VU	-	-
13	*Melanochelys tricarinata*	VU	I	IV
14	*Melanochelys trijuga*	LC	-	-

NT=Near Threatened; VU=Vulnerable; CR=Critical; EN=Endangered; LC=Least concern

Table 18.24. Major wetlands of Bihar & Jharkhand with number of species

S.#	Site	Total species	Threatened	Near Threatened
	Bihar			
1	Goga beel	49	2	1
2	Jagatpur lake	54	2	2
3	Kharagpur jheel	25	0	0
4	Baghar beel	46	1	2
	Jharkhand			
5	Chand Shahar lake	33	1	1
6	Udhuwa nala	39	0	0
	Total	95	3	3

Heavy metals

On an average, among the wetlands, Sukhaldari dam and Baghar beel recorded the maximum concentrations of copper (9.24±9.59 ppm) and lead (7.96±1.69 ppm) respectively. Levels of metals in all other wetlands were not harmful (Fig. 18.14).

Among the species, *Puntius dorsalis* recorded the maximum concentrations of zinc (39.06±8.60 ppm) and cadmium (0.85±0.35 ppm) while *Channa punctatus* recorded maximum concentrations (8.47±1.53 ppm) of lead (Fig. 18.15). Although detectable levels of copper and chromium have been recorded, they are below the permissible levels. Variations in contamination among wetlands and species are significant (P<0.005).

Pesticides

Among the various fishes analyzed for organochlorine residues, fishes from Sukhaldari dam of Garhwa district and Cheriya Bariyarpur of Begusarai district recorded the maximum load of total

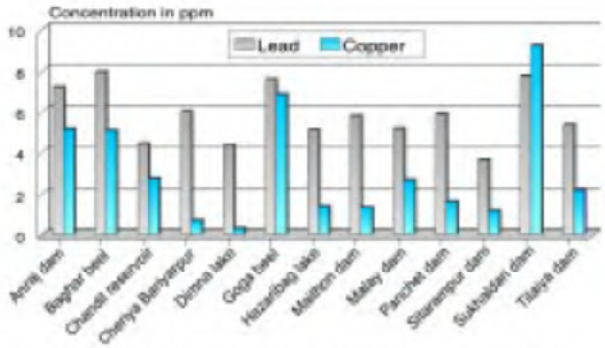


Fig. 18.14. Lead and copper concentration in select wetlands in Bihar

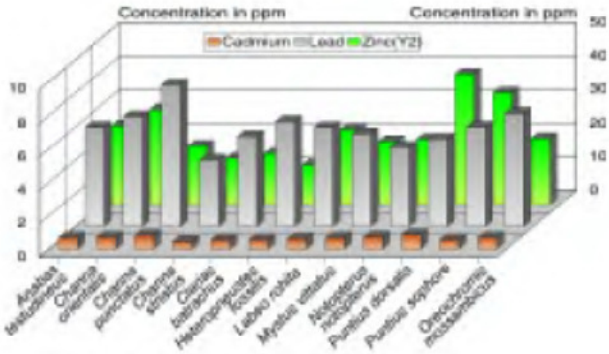


Fig. 18.15. Heavy metal contamination in select species of fishes in Bihar

average concentration (0.502 ppm and 0.434 ppm respectively) of organochlorine pesticides followed by Chandil reservoir (0.177 ppm) and Tilaiya dam (0.175 ppm). The minimum concentrations were recorded in Bhaghar beel (0.026 ppm) of Katihar district and Dimna lake (0.023 ppm) of Singbhum district (Fig. 18.16).

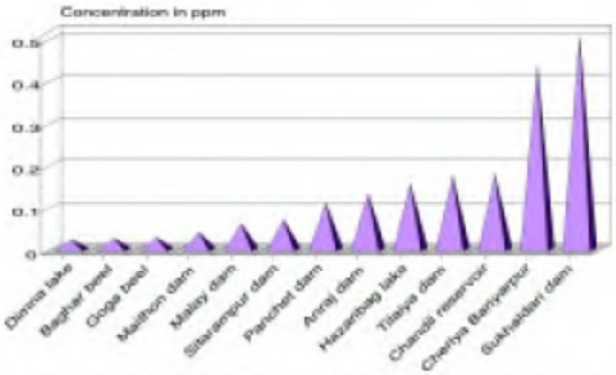


Fig. 18.16. Total organochlorine residues in various wetlands of Bihar

Of the 12 species analyzed, *Heteropneustes fossilis* (0.383 ppm) and *Puntius sophore* (0.344 ppm) recorded the maximum load of total organochlorine residues followed by *Puntius dorsalis* (0.253 ppm). The lowest level (0.032 ppm) was recorded by *Labeo rohita* and *Channa punctatus* (Fig. 18.17).

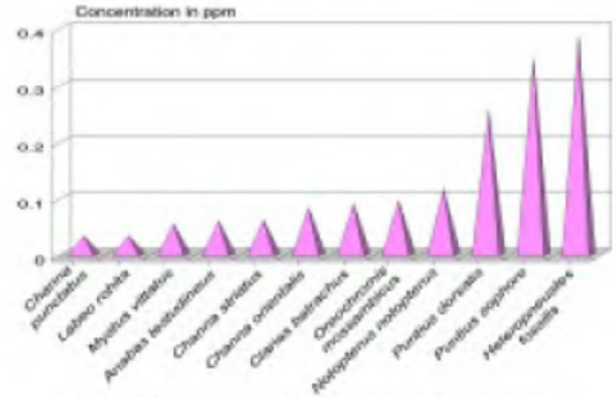


Fig. 18.17. Total organochlorine residues among various species of fishes in Bihar

Among different organochlorine residues analyzed, HCH, *p,p'*-DDT and endosulfan were higher in concentrations. Variation in endosulfan and HCH concentrations among the species was statistically significant ($P < 0.05$). Pesticide application in agricultural crops in the catchment area is the main source of input to the aquatic environment. Paddy, wheat and maize are the commonly cultivated crops. As referred to elsewhere in the report, a large quantum of DDT is being used in Bihar to control Kala-azar disease. It is also reported that the pesticide consumption in Bihar is about 1,322 mt per year. It is frightening to note that about 19.2% of the bovine's milk tested in Bihar was contaminated with DDT.

Suitability for human consumption

HCH concentration recorded in *Heteropneustes fossilis* from Sukhaldari dam of Garhwa district and *Puntius sophore* from Cheriya Bariyarpur of Begusarai district is high enough to pose threat, not only to fishes and wildlife, but also to human beings.

Lead levels recorded in *Channa orientalis (0.24 mg)*, *Channa punctatus (0.30 mg)*, *Heteropneustes fossilis (0.23 mg)* and *Oreochromis mossambicus (0.24 mg)* are higher than the permissible levels (0.21 mg for 60 kg adult daily) stipulated by UN Committee (WHO, 1989, 1993). On regular consumption, it may lead to serious health problems.

It can be concluded that the fishes of Sukhaldari dam, Baghar beel, Chandil reservoir, and Goga beel are not safe for public consumption with reference to lead contamination. It is recommended that regular monitoring of the contamination should be done so that corrective measures and conservation strategies could be worked out.

Socioeconomic values

A preliminary assessment of the use values showed that these wetlands are being utilized in different levels. Of the eight major uses of the wetlands, those with six and seven uses were considered as high use, with four

and five uses as medium and less than four as low use. Of the 18 wetlands surveyed, low, medium and high uses were found in nine, five and four wetlands respectively.

Prioritization of wetlands

Eighteen wetlands were surveyed in Bihar and Jharkhand together, six in Bihar and 12 in Jharkhand. Data on birds were collected only from six wetlands while socioeconomic data from all the 18 wetlands. These sites were prioritized based on the criteria of bird species and size of the wetlands as given under methods and, the sites were ranked into two categories. Three from Bihar came in the first rank and one from Bihar (Baghar beel) and two from Jharkhand (Chand Shahar lake and Udhuwa nala) came in the second rank. Goga beel, Jagatpur lake and Kharagpur jheel were the top-ranking sites. Apart from the above 18 wetlands, 22 wetlands from Bihar and two from Jharkhand, may also be considered for conservation (Table 18.25). There is no quantitative data on these wetlands; however, knowledge of local bird-watchers do show that these wetlands are important for aquatic birds, especially waterfowl. Efforts should be made to encourage monitoring the population of aquatic birds in these wetlands which are recommended for inclusion in the national priority list of wetlands for conservation, based on the knowledge of local resource personnel.

Spatial distribution of these potential wetlands for conservation along with BCPP sites and Protected Areas is given in Fig. 18.18.

The top three in the prioritized list qualify to be declared as Ramsar sites.

Summary

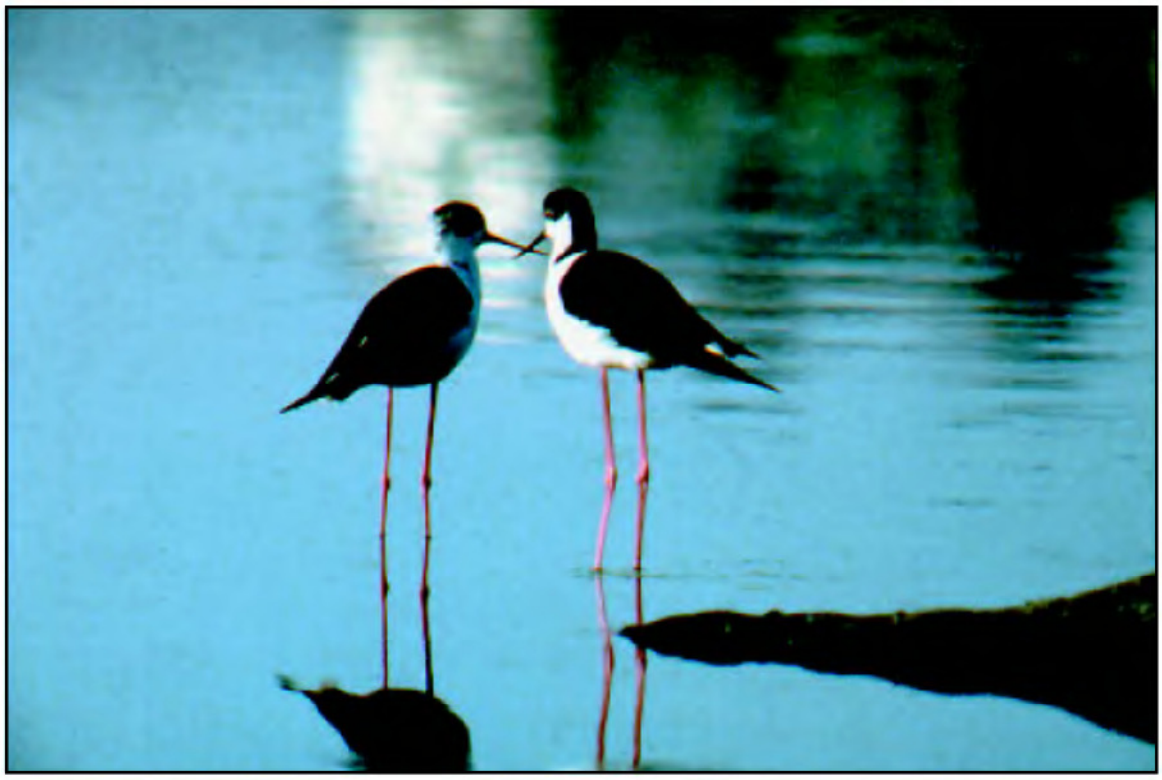
- Bihar, according to the data of 1992-93, has 759 wetlands of the size 56.25 ha and above, covering an area of 1,776.83 sq km (SAC, 1998).
- Land use classification map with wetlands for five select districts was prepared.

Table 18.25. Prioritised list of wetlands for conservation in Bihar and Jharkhand

S.#	Site	Rank	Use grade
	Bihar		
1	Goga beel	1	M
2	Jagatpur lake	1	L
3	Kharagpur jheel	1	H
4	Baghar beel	2	M
5	Cheriya Bariyarpur	DD	H
6	Barauni	DD	H
	Jharkhand		
7	Chand Shahar lake	2	L
8	Udhuwa nala	2	H
9	Dimna lake	DD	M
10	Sitarampur dam	DD	L
11	Chandil reservoir	DD	M
12	Hatiya dam	DD	L
13	Kanke dam	DD	L
14	Rukka dam	DD	L
15	Anraj dam	DD	M
16	Sukhaldari dam	DD	L
17	Batane dam	DD	H
18	Malay dam	DD	L
	Bihar		
19	Fatua	DD	DD
20	Chandan	DD	DD
21	Hanumana	DD	DD
22	Indrapuri	DD	DD
23	Mora tal	DD	DD
24	Moti jheel	DD	DD
25	Mawda dam	DD	DD
26	Birpur-Sipaul-Kosi barrage	DD	DD
27	Kosi east & west	DD	DD
28	Kajra Ararja	DD	DD
29	Disha-Patha	DD	DD
30	Rajauli	DD	DD
31	Darong tal	DD	DD
32	Surya pokhar	DD	DD
33	Mehdar	DD	DD
34	Khemaith	DD	DD
35	Kesaria	DD	DD
36	Brahmaputra	DD	DD
37	Hardia	DD	DD
38	Bhimbandh	DD	DD
39	Kursela	DD	DD
40	Amarpur	DD	DD
	Jharkhand		
41	Maithon dam	DD	DD
42	Tilaiya dam	DD	DD

L=Low; M=Medium; H=High; DD=Data deficient

- In the five districts studied, there are 3,662 wetlands of 2 ha and above covering 996.01 sq km area.
- Of the wetlands studied in five districts, those in three districts had low turbidity, while those in one district each had low, and moderate/ high levels of turbidity.
- Bihar and Jharkhand together have five species of endemic plants; five species of Endangered and, 14 species of Vulnerable fishes; and one Critically Endangered, two Endangered, three Near Threatened, six Vulnerable, and two Least Concern species of turtles.
- Eighteen wetlands were surveyed for birds, six in Bihar and 12 in Jharkhand.
- Ninety five bird species were recorded, out of which three each were Threatened and Near Threatened.
- 136 fishes belonging to 23 species from 17 wetlands were studied for environmental contamination.
- Fishes of Sukhaldari dam, Bhaghar beel, Chandil reservoir and Goga beel are not safe for consumption, as the level of lead is above permissible limit. Again, *Heteropneustes fossilis* from Sukhaldari dam and *Puntius sophore* from Cheriya Bariyarpur area also are inadvisable for human consumption, on account of higher levels of HCH.
- Forty two wetlands have been prioritized, 28 from Bihar and 14 from Jharkhand, out of which 24 are data deficient but are reported to be important for waterfowl.
- Three wetlands, namely Goga beel, Jagatpur lake and Kharagpur jheel qualify to be declared as Ramsar sites.



Erach Bharucha

Blackwinged Stilt

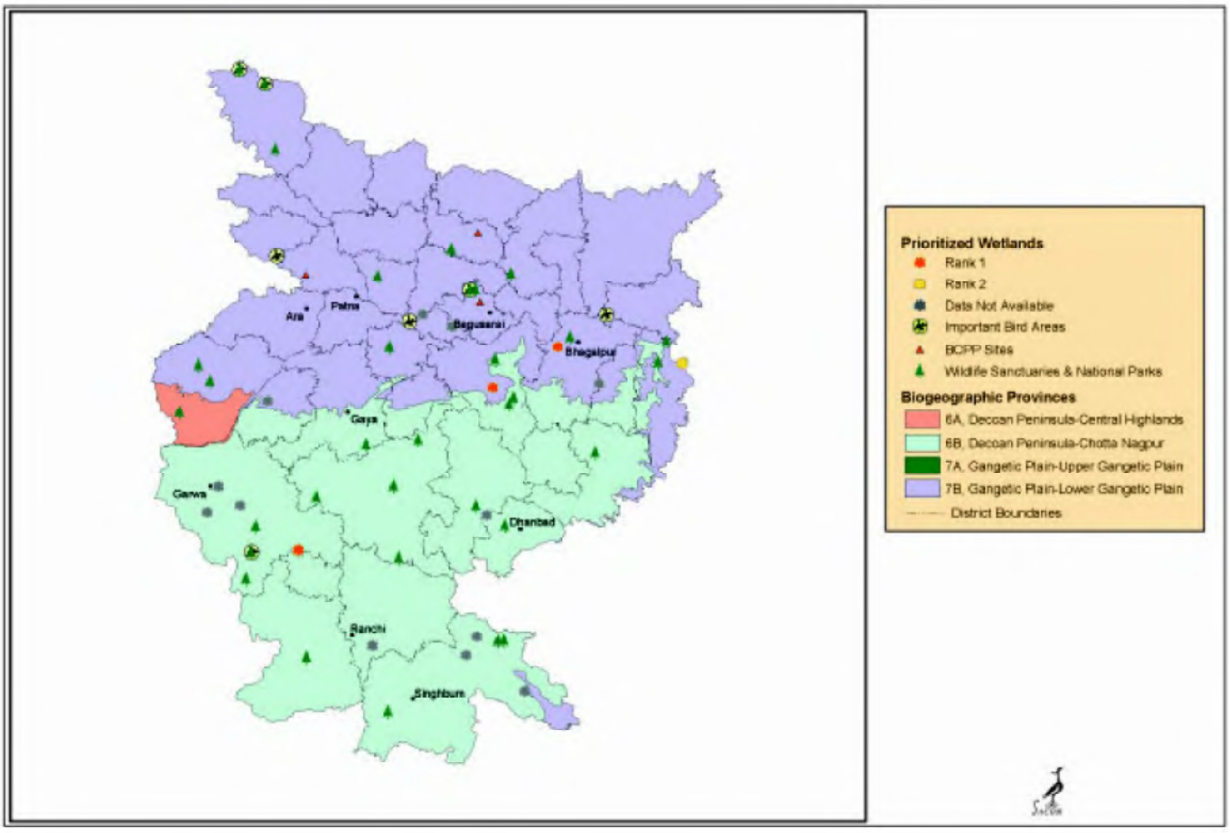
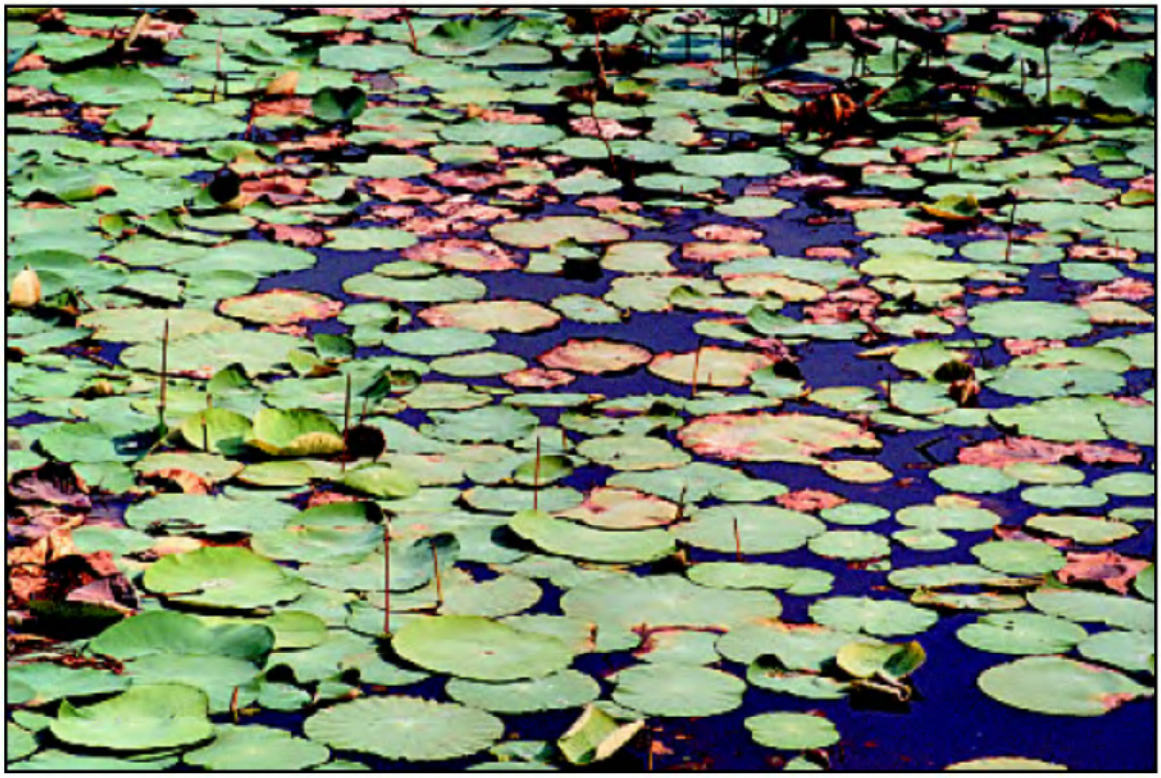


Fig. 18.18. Prioritised wetlands and other conservation areas in Bihar (undivided)



V.S. Vijayan

Nelumbo nucifera - a common wetland plant



Vivek R. Sinha

Openbilled Stork at the nest

WEST BENGAL

West Bengal is unique as the only state in India to stretch from the sea shore to the loftiest peaks of Himalayas. The hilly terrains with temperate and tropical forests, the enormous deltaic plains, vast stretches of sea coast, tidal creeks, swamps and the mangroves, including the extensive Sundarbans make the state rich in biodiversity. The state has four major geographical regions; the Chotanagpur plateau in its north-western parts, the Himalaya mountain, the lower Gangetic plain, and the coastal belt.

An intricate network of rivers, streams and rivulets cris-cross the entire state. Rivers in the southern West Bengal contribute in the formation of the immense network of the deltaic region of the Sunderbans. Physiographically, the state of West Bengal can be differentiated into five broad divisions, namely the northern mountain, the western plateau, the great plain, the Sunderban deltas and, the sand dunes of Kanthi coast. The climate of the state is tropical, hot and humid. Average temperature varies from 15 to 45°C. Rainfall varies from 1,000 mm in the south-western region to 3,000 mm in the northern region. Most of the rainfall is from the southwest monsoon.

Status of wetlands

The land use data of the state do not have wetlands as a separate entity (Table 19.1). The only data available on wetlands are those generated during 1992-'93 by SAC (1998).

Nine types of wetlands have been recognized (Table 19.2). Tanks are more numerous, but the waterlogged area is more in extent. Although there are 358 reservoirs, the total area covered by them is only 227 sq km. The total number of wetlands of the size 2.25 ha and above are 6,049; and it covers 1,438.56 sq km.



State at a glance	
State capital	Kolkota
Area	88,752 sq km
Population (2001)	8,02,21,171
Population density (2001)	904/sq km
Total number of districts	18
Major rivers	Teesta, Torsha, Mahanadi, Ganga, Bhagirathi, Hoogly, Damodar, Mayurakshi, Kangsabati, Indumati, Matla, Bidlyadhuri
Total forest area	11,920 sq km
Ramsar sites	1
Proposed Ramsar sites	13
Total sites proposed for conservation	25

Table 19.1. Land use pattern in West Bengal

Land use type	Area in sq km
Total geographic area	88,752
Forests	11,920
Not available for cultivation	16,670
Other uncultivated land excluding fallow land	1,250
Fallow land	2,630
Net area sown	54,400
Area sown more than once	38,490
Total cropped area	92,900
Cultivable area	58,280

(Source: www.indiastat.com)

Table 19.2. Distribution of various categories of inland wetlands in West Bengal

Type of Inland wetland	Area (sq km)	No. of wetlands
Lakes/ponds	216.53	326
Oxbow lakes/cut-off meanders	275.99	1,489
Waterlogged	3.96	36
Waterlogged (seasonal)	435.98	1,351
Swamps/marshes	150.73	313
Reservoirs	227.02	358
Tanks	116.55	2,098
Abandoned quarries	4.15	63
Ash/cooling ponds	7.65	15
Total	1,438.56	6,049

Source: SAC (1998)

Biodiversity

Vegetation

Five species of endemic wetland plants belonging to five families have been reported from West Bengal (Table 19.3). Infestation of water hyacinth was reported from several wetlands. However, it may be noted that the SAC's (1998) data show that a vast majority of tanks and oxbow lakes had no appreciable vegetation. Reservoirs, tanks and, to an extent oxbow lakes have partial/ moderate aquatic vegetation.

Table 19.3. List of endemic plants of West Bengal

S.#	Species	Family
1	*Eriocaulon martianum*	Eriocaulaceae
2	*Hoppea dichotoma*	Gentianaceae
3	*Aponogeton appendiculatus*	Aponogetonaceae
4	*Najas marina ssp.*	Najadaceae
5	*Sesbania procumbens*	Fabaceae

Fishes

Thirty two species of Threatened fishes were recorded from West Bengal (Menon, 1999); out of which one is Critically Endangered, eight are Endangered, and 23 Vulnerable (Table 19.4).

Table 19.4. Threatened species of fishes recorded in West Bengal

No.	Species	Status
1	*Pangasius pangasius*	CR
2	*Anguilla bengalensis*	EN
3	*Botia lohachata*	EN
4	*Chitala chitala*	EN
5	*Eutropiichthys vacha*	EN
6	*Glyptothorax cavia*	EN
7	*Ompok bimaculatus*	EN
8	*Pseudeutropius atherinoides*	EN
9	*Tor putitora*	EN
10	*Anabas testudineus*	VU
11	*Bagarius bagarius*	VU
12	*Barbodes sarana*	VU
13	*Catla catla*	VU
14	*Channa orientalis*	VU
15	*Cirrhinus cirrhosus*	VU
16	*Cirrhinus reba*	VU
17	*Clarias batrachus*	VU
18	*Heteropneustes fossilis*	VU
19	*Labeo dero*	VU
20	*Mystus bleekeri*	VU
21	*Mystus vittatus*	VU
22	*Nemacheilus multifasciatus*	VU
23	*Nemacheilus scaturigina*	VU
24	*Neolissochilus hexagonolepis*	VU
25	*Osteobrama cotio*	VU
26	*Pangio pangio*	VU
27	*Pseudecheneis sulcatus*	VU
28	*Puntius chola*	VU
29	*Puntius conchonius*	VU
30	*Raiamas bola*	VU
31	*Rhinomugil corsula*	VU
32	*Semiplotus semiplotus*	VU

CR=Critically Endangered; EN=Endangered; VU=Vulnerable

Table 19.5. List of turtles recorded from West Bengal

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes hurum*	VU	I	I
2	*Batagur baska*	CR	I	I
3	*Cyclemys oldhamii*	NT	-	-
4	*Chitra indica*	EN	-	IV
5	*Geoclemys hamiltonii*	VU	I	I
6	*Hardella thurjii*	VU	-	-
7	*Kachuga dhongoka*	EN	-	-
8	*Kachuga kachuga*	CR	-	I
9	*Kachuga sylhetensis*	EN	-	I
10	*Kachuga tecta*	NT	I	I
11	*Kachuga tentoria*	NT	-	-
12	*Lissemys punctata*	NT	II	I
13	*Morenia petersi*	VU	-	-
14	*Melanochelys tricarinata*	VU	I	IV
15	*Melanochelys trijuga*	LC	-	-
16	*Pelochelys cantorii*	EN	-	I

VU=Vulnerable; CR=Critically Endangered; NT=Near Threatened; EN=Endangered; LC=Least Concern

Turtles

Sixteen species of turtles comprising two Critically Endangered, four Endangered, five Vulnerable, four Near Threatened, and one Least Concern were recorded from West Bengal (Table 19.5).

Birds

Twenty five wetlands distributed in the Northern hill ranges, Western plateau and the Great plains were surveyed. Altogether, 1,38,156 birds of 131 species were recorded (Table 19.6). These include migratory, resident and also those species which are dependent on wetlands partly or fully as well as five terrestrial species. 63% of the birds counted were Anatids (ducks & teals). The most abundant species was the Lesser Whistling Teal (41,635), which was followed by the Pintail (13,422). While 18 species had a total population of more than 1,000 birds in all the wetlands counted, 19 species occurred in more than 50% of the total wetlands. The most widely distributed species were the Little Cormorant (21 wetlands), Gadwall and Openbill Stork (each in 20 wetlands).

Six species each of the Threatened and Near Threatened, with 87 and 771 birds respectively were observed during the study in various wetlands. It is to be noted that as in the other states, the threatened species are confined to limited number of wetlands (Table 19.7).

More than one per cent population of only one species (Openbill Stork) was found at a site. However, sighting of species such as the Greater Adjutant, Baer's Pochard and Spotted Greenshank in particular wetlands should be checked in the coming years in order to augment conservation measures of the concerned wetlands.

Table 19.6. Major wetlands of West Bengal with species and number of birds

S.#	Name of the wetland	Total birds	Species
1	Adina Deer Park	7,126	31
2	Ahiran, Farraka	1,688	20
3	Ash dykes of Farraka	10,331	35
4	Baghar beel	4,100	50
5	Bara sagardighi	3,882	50
6	Domohini	1,846	32
7	Durgapur barrage	777	20
8	Farakka barrage	30,781	61
9	Fulbari-Mahananda barrage	1,175	36
10	Gajoldoba	2,821	35
11	Kansabati river	703	35
12	Karnail Singh Park	7,770	48
13	Kumari dam, Purulia	233	8
14	Maithon reservoir	727	7
15	Maitybandh	562	36
16	Mechi river	1,664	23
17	Nayabandh	10,528	55
18	Palta waterworks	395	16
19	Panchet dam, Purulia	2,476	9
20	Purbasthali	18,162	72
21	Rasik beel	5,618	57
22	Saheb bandh - Purulia	4,548	34
23	Saheb bandh - Adra	2,383	13
24	Santragachhi thermal power plant	15,841	13
25	Tilpara barrage	2,019	34
	Total	1,38,156	131

Table 19.7. Frequency of sightings of Threatened and Near Threatened Birds in West Bengal

S.#	Species	Status	No. of wetlands	No. of birds sighted
1	Lesser Adjutant	T	6	25
2	Baer's Pochard	T	1	10
3	Spotted Greenshank	T	1	28
4	Whitebacked Vulture	T	4	10
5	Pallas' Fishing Eagle	T	7	12
6	Greater Spotted Eagle	T	2	2
7	Darter	NT	10	49
8	Blacknecked Stork	NT	1	15
9	White-eyed Pochard	NT	12	636
10	Greyheaded Fishing Eagle	NT	3	6
11	Pale Harrier	NT	1	3
12	White Ibis	NT	2	62

T=Threatened; NT=Near Threatened

Most of the wetlands had more than 10 species, except in three, namely Panchet dam, Kumari dam and Maithon reservoir. The Purbasthali island complex had the maximum species richness of waterfowl with 72 species followed by the Farakka barrage complex with 61 species. Four more wetlands, namely Rasik beel, Nayabandh, Baghar beel and Bara sagardighi, had more than 50 different species of waterfowl in each. Abundance of waterfowl was the highest in the Farakka barrage complex followed by the Purbasthali island complex with 30,781 and 18,162 birds respectively (Table 19.6).

The only site with more than 20,000 birds was Farakka barrage. Four more sites, namely Purbasthali, Santragachhi, Nayabandh and Ash dykes of Farraka thermal power plant supported more than 10,000 birds.

Altogether 18 wetlands hold one or more of the globally Threatened or Near Threatened birds. Nayabandh had the highest number of Threatened species of birds (7) and naturally has the highest priority.

Out of the 25 wetlands for which detailed data are available, most of the lakes such as Rasik beel in northern West Bengal, Nayabandh in central West Bengal and Purbasthali and Santragachhi in southern West Bengal represent unique freshwater lentic ecosystems attracting a large number of migratory as well as resident waterfowl.

Environmental contamination

One hundred and eighty two fishes comprising 17 species from 14 wetlands were collected. Data on 150 fishes comprising eight species from 13 wetlands are discussed here.

Heavy metals

Mechi river of Darjeeling recorded the maximum concentrations of cadmium (0.98±0.30 ppm) and Nayabandh of Malda recorded the highest concentrations of lead (6.97±2.31 ppm) (Fig. 19.1). The concentrations of zinc, copper and chromium were within the permissible limits. The variation in contamination of copper, lead, zinc and cadmium ($P<0.005$) was significant among the wetlands.

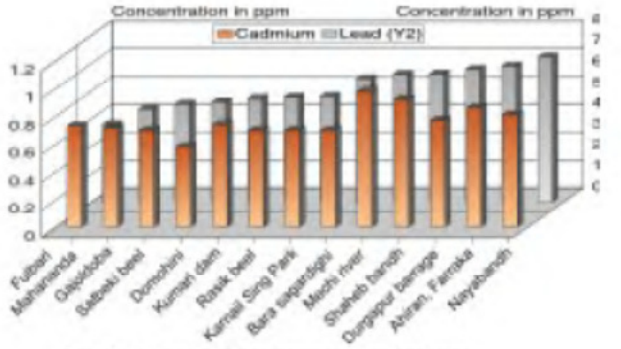


Fig. 19.1. Lead and cadmium contamination in select wetlands of West Bengal

Lead and cadmium levels, among the species, invariably ranged between 5 and 6 ppm and, 0.6 and 0.8 ppm respectively (Fig. 19.2). Copper, zinc and chromium were within the permissible limits. While the contamination levels particularly of lead, zinc and copper among the species are significantly different; the surface dwellers appear to be accumulating more than the other species.

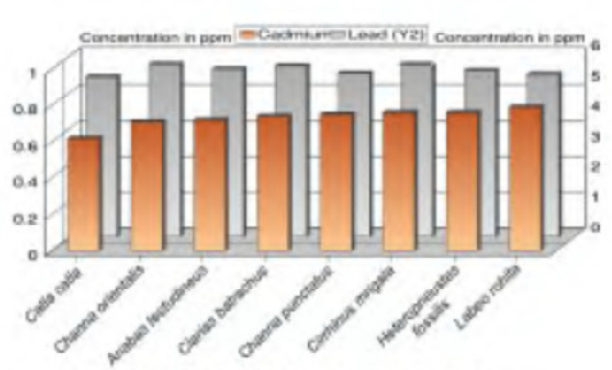


Fig. 19.2. Lead and cadmium contamination in select species of fishes of West Bengal

Mechi river and Nayabandh are reported to have heavy decline in fish yield and the probable reason cited is unscientific method of fishing, using toxic agents, namely pesticides. Further, agricultural run off is also one of the factors for the decline.

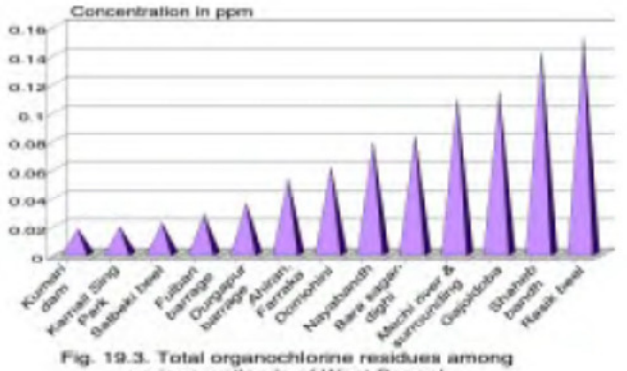


Fig. 19.3. Total organochlorine residues among various wetlands of West Bengal

Pesticides

Among the various wetlands studied, Rasik beel of Cooch Behar district recorded the highest concentrations of total organochlorine residues (0.150 ppm). Shaheb bandh (0.141 ppm) of Purulia district and Gajoldoba (0.090 ppm) of Darjeeling also had comparable levels. Lower concentrations were recorded in Fulbari barrage (0.027 ppm) of Darjeeling district followed by Satbeki beel (0.021 ppm) of Jalpaiguri district, Karnail Sing Park (0.019 ppm) of Bardhaman district and Kumari dam (0.017 ppm) of Purulia district (Fig. 19.3). It is also observed that the variation in organochlorine residues among the wetlands is significant ($P < 0.05$).

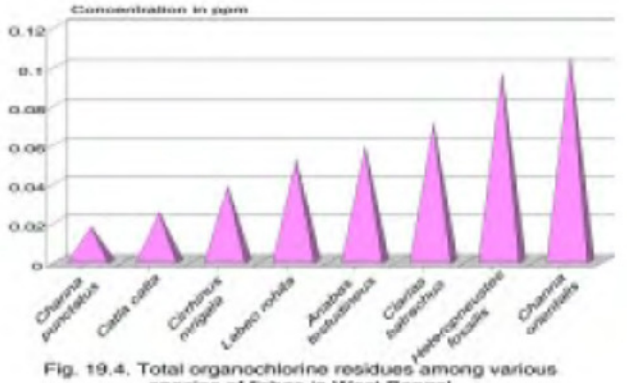


Fig. 19.4. Total organochlorine residues among various species of fishes in West Bengal

Among the different species of fishes analyzed, *Channa orientalis* recorded the highest load (0.104) of total organochlorine residues followed by *Heteropneustes fossilis* (0.095 ppm), while *Channa punctatus* recorded the lowest (0.017 ppm) (Fig. 19.4). Among the various pesticides tested, heptachlor epoxide was the most frequently (85%) detected chemical followed by dieldrin (79%), HCH (73%), DDT (67%) and endosulfan (43%).

Reports from Gajoldoba indicate that there has been 75 % decline in fish catch during the last 5-6 years. Application of endosulfan in the surrounding areas and intrusion of polluted water into the wetland also have been noticed. These factors might explain mass mortality of fish being observed in this wetland over the last few years. Similarly, in some of the wetlands, like Satbeki beel of Jalpaiguri district, water hyacinth seems to be the reason for reduction in fish catch up to 30%.

Suitability for human consumption

As the predominant position of fish in the diet of the people of West Bengal is indisputable, a presumption that a person consumes 100 g per day becomes logical to calculate the average daily dietary intake.

According to the UN Committee (WHO, 1989, 1993), the allowable limit of lead and cadmium through fishes is 0.21 mg and 0.12 mg respectively for a 60 kg adult. The lead and cadmium levels of all the fishes studied presently were twice the prescribed levels and hence, are quiet alarming. These fishes are totally unsafe for human consumption and consuming them regularly will certainly lead to metal poisoning. As the per capita consumption of fish in West Bengal is high, it is imperative to emphasize the need for (1) protecting these wetlands from pollutants and (2) keeping a vigil on the level of pollution, so that the people can be kept informed of it.

Although the levels of pesticide contamination in the wetlands of West Bengal appear to be less than the Maximum Residue Limits for fish products prescribed by Food and Drug Administration (1998), *Mystus vittatus* from Gajoldoba of Darjeeling district measured 5.2 µg of dieldrin, which is almost equal to the maximum concentration (6-µg/60 kg person/day) recommended by International Agency for Research on Cancer (IARC, 1987) for human consumption. It is important to note that this permissibility is worked out on the assumption that one takes only 250 g of fish in a week. Since, the per capita consumption of fish in the state is very high, reported to be one million tonnes annually, the danger from pesticide is obvious. It is also significant to note that the annual pesticide use in the state is as high as 3,886 mt.

Socioeconomic values

Among all the wetlands covered, the Purbasthali island complex has by and large the greatest anthropogenic pressure in terms of habitat reclamation for agricultural purpose. The wetlands in Karnail Singh Park at Chittaranjan are affected by domestic sewage and industrial effluents. Panchet dam and Kumari dam have only small-scale fishing and domestic usage. Large-scale fishing was noticed in Tilpara and Durgapur barrages, although fishing is prohibited in these two areas.

Prioritization of wetlands

Twenty five wetlands have been prioritized assigning grades for different criteria, especially based on birds. Size of the wetlands and earlier bird counts were also considered for giving ranks of priority. The first seven came in the first rank followed by eight in the second rank, and six in the third rank and the rest in the fourth rank (Table

Table 19.8. Prioritized list of the wetlands in West Bengal

No.	Name of the site	Rank	Use
1	Nayabandh	1	H
2	Farakka barrage	1	H
3	Purbasthali	1	H
4	Bara sagardighi	1	M
5	Rasik beel	1	L
6	Baghar beel	1	H
7	Karnail Singh Park	1	L
8	Ashdykes of Farraka	2	L
9	Domohini	2	L
10	Kansabati river	2	L
11	Gajoldoba	2	H
12	Adina Deer Park	2	H
13	Maitybandh	2	L
14	Fulbari-Mahananda barrage	2	H
15	Ahiran, Farraka	2	M
16	Mechi river	3	H
17	Santragachhi	3	L
18	Tilpara barrage	3	L
19	Maithon reservoir	3	L
20	Kumari dam, Purulia	3	M
21	Panchet dam, Purulia	3	L
22	Saheb bandh - Adra	4	L
23	Saheb bandh - Purulia	4	M
24	Durgapur barrage	4	L
25	Palta waterworks	4	L

19.8). The top ranking sites, namely Nayabandh, Farakka barrage, Purbasthali, Bara sagardighi, Rasik beel, Baghar beel and Karnail Singh Park are qualified to be declared as Ramsar sites. Spatial distribution of the prioritized wetlands is given in Fig. 19.5.

Out of the 25 wetlands, except the wetland of Palta waterworks, all have socioeconomic use values. Nayabandh and Baghar beel have high use values; reed gathering, fishing and fish culture, domestic usage and fuel wood collection. Since all these wetlands are used by the local people, a conservation programme involving the local stakeholders may have to be worked out.

Summary

- According to the 1992-'93 data of SAC (1998), West Bengal has 6,049 wetlands of the size 2.25 ha and above, covering a total area of 1,438.56 sq km.
- Nine types of wetlands occur in West Bengal, of which tanks are the highest in numbers followed by oxbow lakes and waterlogged areas.
- West Bengal has five species of endemic plants; one Critically Endangered, eight Endangered and 23 Vulnerable species of fishes; two Critically Endangered, four Endangered, five Vulnerable, four Near Threatened and, one Least Concern species of freshwater turtles.
- In the 25 wetlands studied, 1,38,156 birds belonging to 131 species were recorded.
- Six species each of Threatened and Near Threatened with 87 and 971 birds respectively were observed.
- The most abundant species of waterfowl were the Lesser Whistling Teal and the Pintail.
- The most widely distributed wetland birds in West Bengal were the Little Cormorant, Gadwall and Asian Openbill.
- Purbasthali island complex had the highest species richness; 72 species of wetland birds.
- One hundred and fifty fishes comprising eight species from 13 wetlands were analyzed for environmental contamination.
- Fishes of Mechi river, in the Darjeeling district, and Nayabandh, in the Malda district had high concentrations of cadmium and lead respectively; twice the limit prescribed for human consumption. Hence, regular consumption of these fishes would be risky.
- *Mystus vittatus* from Gajoldoba, Darjeeling had high concentration of dieldrin, as much as the maximum limit prescribed for human consumption. Therefore, regular intake of it would lead to health hazards.
- Twenty-five wetlands have been prioritized; seven in the first rank, eight in the second, six in the third and the rest in fourth rank.
- The first 13 wetlands in the prioritized list are qualified to be declared as Ramsar sites.

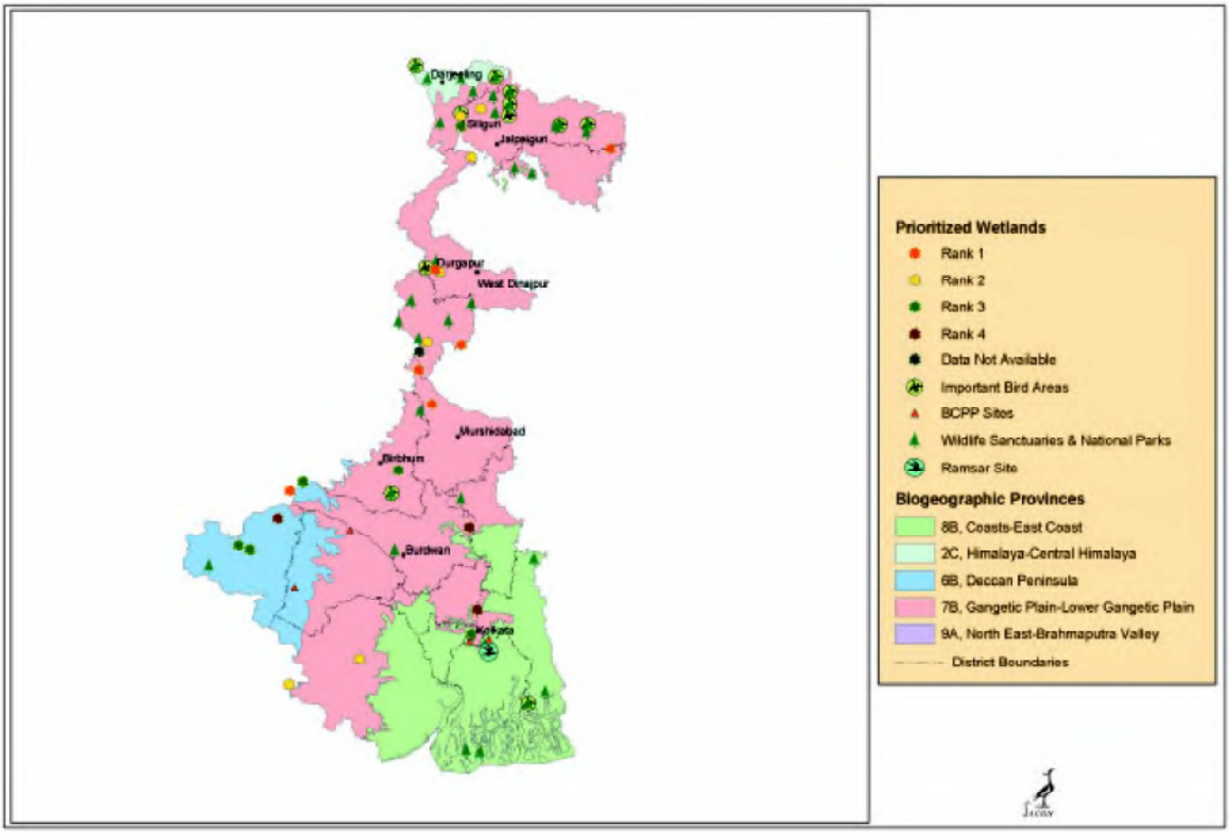


Fig. 19.5. Prioritized wetlands and other conservation areas in West Bengal

SIKKIM

Sikkim with its magnificent mountains, dense forests, fertile valleys, swift flowing rivers and placid lakes, is an abode of a multitude of species. It is unique again that it has India's highest mountain peak and world's third highest peak (Kanchanjunga; 8,759 m). The state extends to about 115 km from north to south and 65 km from west to east. Nearly two third of Sikkim is snow covered for most of the year. The climate varies; the upper region is extremely cold, but tropical climate prevails in the valleys. The state receives annual rainfall between 2,000 and 4,000 mm. The average temperature varies from 8 to 31°C.



Forest covers 36% of the geographic area of the state. In the land use statistics no mention of wetlands has been made (Table 20. 1).

State at a glance	
State capital	Gangtok
Area	7,096 sq km
Population (2001)	5,40,493
Total number of districts	4
Major river	Teesta
Total forest area	2,570 sq km
Population density (2001)	76/sq km
Ramsar site	Nil
Proposed Ramsar sites	2
Total sites proposed for conservation	4

Status of wetlands

Sikkim has 160 wetlands, each 2.5 ha and above, covering an area of 19.85 sq km. The state has only one type of wetland; lakes/ponds (SAC, 1998). Among the lakes, there are three categories, namely valley lakes, tectonic/landslide lakes and glacial lakes.

Biodiversity

Fishes

Of the nineteen Threatened species of fishes from Sikkim (Menon, 1999), four are Endangered and 15 Vulnerable (Table 20.2).

Turtles

Three species of fresh water turtles have been recorded from Sikkim; one each Vulnerable, Near Threatened and Least Concern (Table 20.3).

Birds

Thirty species of wetland birds are reported from Sikkim. This includes two Threatened species; an old record of Pallas's Fishing Eagle and the recent record of Blacknecked Crane breeding at Thepley tso (Ganguli-Lachungpa, 1998), a high altitude lake.

Table 20.1. Land use pattern in Sikkim

Land use type	Area (sq km)
Total geographic area	7,096
Forests	2,570
Not available for cultivation	2,700
Other uncultivated land excluding fallow land	750
Fallow land	130
Net area sown	950
Area sown more than once	320
Total cropped area	1,270
Cultivable area	1,830

(Source: www.indiastat.com)

Table 20.2. Threatened freshwater fishes of Sikkim

No	Species	Status
1	*Anguilla bengalensis*	EN
2	*Ompok bimaculatus*	EN
3	*Pseudeutropius atherinoides*	EN
4	*Puntius clavatus clavatus*	EN
5	*Anabas testudineus*	VU
6	*Bagarius bagarius*	VU
7	*Barbodes sarana*	VU
8	*Catla catla*	VU
9	*Cirrhinus reba*	VU
10	*Clarias batrachus*	VU
11	*Clupisoma garua*	VU
12	*Heteropneustes fossilis*	VU
13	*Labeo dero*	VU
14	*Mystus vittatus*	VU
15	*Nemacheilus multifasciatus*	VU
16	*Nemacheilus scaturigina*	VU
17	*Osteobrama cotio*	VU
18	*Puntius chola*	VU
19	*Schizothorax richardsonii*	VU

EN=Endangered; VU=Vulnerable

Table 20.3. List of freshwater turtles reported from Sikkim

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Lissemys punctata*	NT	II	I
2	*Melanochelys tricarinata*	VU	I	IV
3	*Melanochelys trijuga*	LC	-	-

NT=Near Threatened; VU=Vulnerable; LC=Least Concern

Socioeconomic values

The major stakeholders from the Government are army, tourism, fisheries and forest departments while those from private are yak graziers, pilgrims, fishermen and fringe villagers. Major threats to the wetlands stem from the large scale, uncontrolled tourism.

Prioritization of wetlands

Four wetlands were surveyed during the study and prioritized for conservation. Two each came in the first and second ranks (Table 20.4). Thepley tso, a marsh in the extreme north has the highest priority. Breeding of the rare, and Endangered, Blacknecked Crane has made this wetland an extremely important one. Sikkim is the only other state where this Endangered crane is reported to be breeding, besides Ladakh in Jammu and Kashmir. Khechiperi, a natural lake comes next, followed by Batangcho/Bitangcho and Tsomgo. Both in the top rank qualify to be declared as Ramsar sites. Location of the prioritized areas is given in Fig. 20.1.

Table 20.4. Prioritized list of the main wetlands of Sikkim

No.	Name of the wetland	Rank	Use
1	Thepley tso	1	-
2	Khechiperi	1	-
3	Batangcho or Bitangcho	2	-
4	Tsomgo lake	2	-

Summary

- Sikkim, according to the satellite imageries of 1992-93, had 160 wetlands of the size 2.25 ha and above, covering 19.85 sq km.
- The state has only one type of wetland – ponds/ lakes.
- Sikkim has four Endangered and fifteen Vulnerable species of fishes; three species of freshwater turtles, one each Vulnerable, Near Threatened and Least Concern; and two Threatened species of birds.
- Four wetlands were prioritized; two came in the first rank and two in the second rank.
- Both in the top rank, namely Thepley tso and Khechiperi qualify to be declared as Ramsar sites.

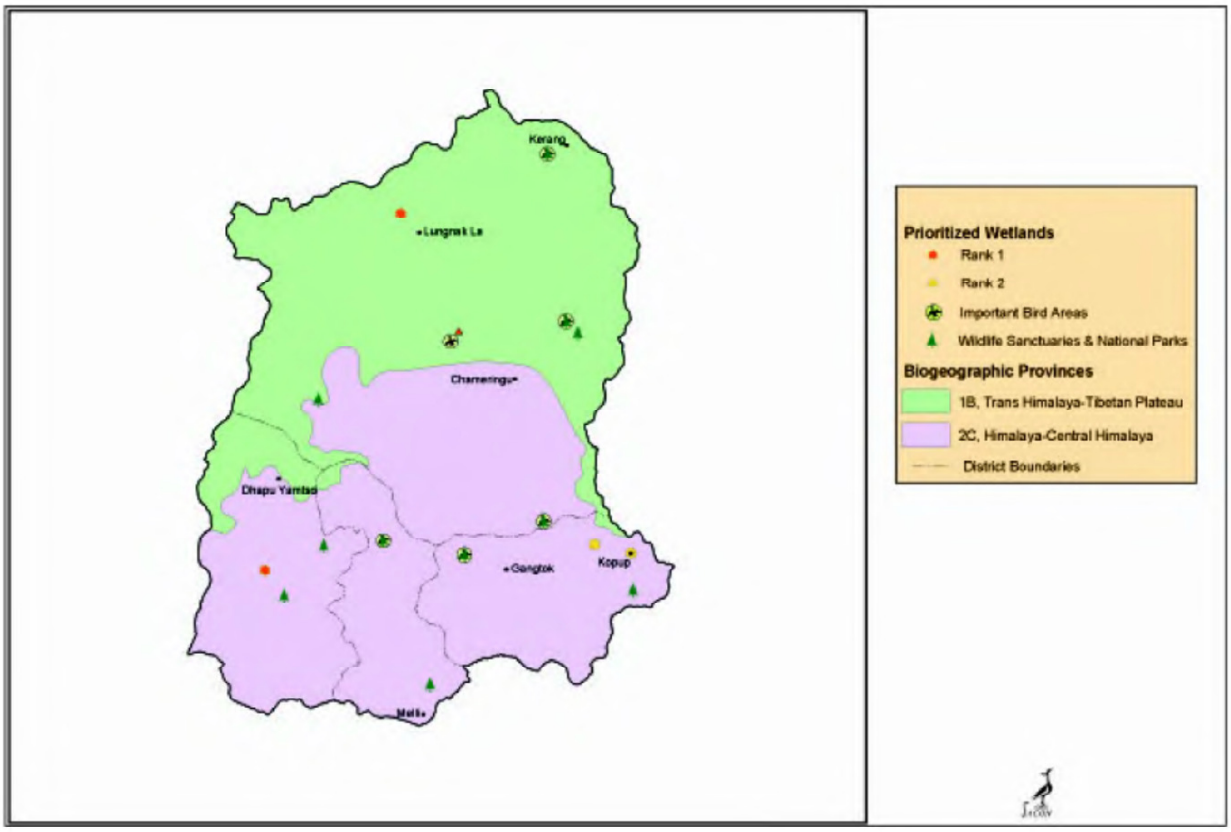


Fig. 20.1. Prioritized wetlands and other conservation areas in Sikkim



Lalitha Vijayan

Khechiperi lake



Lalitha Vijayan

Tsomgo lake

MEGHALAYA

Meghalaya, "the abode of clouds", is a magnificent land with its undulating hills, rolling grasslands, cascading waterfalls and winding rivers. The state has also the distinction of having the world's highest rainfall area; the Mawsynram village with an average rainfall of about 12,670 mm. The average rainfall of the state is about 3,360 mm. The average maximum temperature is 37°C and minimum 10°C. Meghalaya has three natural regions of Khasi, Jaintia and Garo Hills.



Nearly half of the geographical area of the state is covered by forests while no wetland is shown in the land use classification (Table 21.1).

State at a glance	
State capital	Shillong
Area	22,429 sq km
Population (2001)	23,06,069
Total number of districts	7
Major rivers	Ildek, Dudnai, Krishnai, Jinari, Didak, Jinjiram, Mahadeo, Maheshkola, Someshwari, Jadukata, Umtru, Kopili, Lubha
Total forest area	9320 sq km
Population density (2001)	103/sq km
Ramsar site	Nil
Proposed Ramsar sites	3
Total sites proposed for conservation	7

Status of wetlands

Meghalaya has 98 wetlands of 2.5 ha and above in size. However, the total area covered by the wetlands is only 22.21 sq km, about 0.1% of the total area of the state.

There are four categories of lakes, namely valley lakes, oxbow lakes or cut - off meanders, tectonic / landslide lakes, and artificial reservoirs. Waterlogged wetlands are more common than any other type. However, reservoirs cover 44% of the total wetland area (Table 21.2). All the reservoirs were created for hydro-electric projects. The largest and well known is Umiam or Barapani lake located on the busy Shillong- Guwahati national highway. There are small natural lakes in the depressions, while small valley lakes are also found. Birbah lake in Ri-Bhoi district is one

Table 21.1. Land use pattern in Meghalaya

Land use type	Area (sq km)
Total geographic area	22,429
Forests	9,320
Not available for cultivation	2,250
Other uncultivated land excluding fallow land	6,280
Fallow land	2,350
Net area sown	2,210
Area sown more than once	440
Total cropped area	2,660
Cultivable area	10,840

(Source: www.indiastat.com)

Table 21.2. Distribution of various categories of inland wetlands in Meghalaya

Type of wetland	Area (sq km)	No. of wetlands
Oxbow lakes/ cut-off meanders	0.42	5
Waterlogged (seasonal)	7.9	58
Swamp/marsh	2.25	9
Reservoirs	9.82	12
Tanks	1.82	14
Total	22.21	98

Source: SAC (1998)

such example. The oxbow lakes, locally called beels, are rare and found in West Garo Hills district. The value added maps of the spatial distribution of wetland sites, along with wetland distribution in some districts show that the wetlands are few and far between unlike in many other states in the country.

Biodiversity

Fishes

Eighteen species of Threatened fishes are reported from Meghalaya (Menon, 1999), of which four are Endangered and 14 Vulnerable (Table 21.3).

Turtles

Meghalaya has eight species of freshwater turtles, out of which two each are Endangered and Vulnerable, three Near Threatened and one is of Least Concern (Table 21.4).

Table 21.4. List of turtles reported from Meghalaya

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Cyclemys oldhami*	NT	-	-
2	*Geoclemys hamiltonii*	VU	I	I
3	*Hardella thurjii*	VU	-	-
4	*Kachuga sylhetensis*	EN	I	I
5	*Kachuga tecta*	NT	II	I
6	*Lissemys punctata*	NT	-	I
7	*Melanochelys trijuga*	LC	II	-
8	*Pyxidea mouhotii*	EN		-

NT=Near Threatened; VU=Vulnerable; EN=Endangered; LC=Least Concern

Table 21.3. Threatened freshwater fishes reported from Meghalaya

No.	Species	Status
1	*Anguilla bengalensis*	EN
2	*Ompok bimaculatus*	EN
3	*Pseudeutropius atherinoides*	EN
4	*Psilorhynchus sucatio*	EN
5	*Anabas testudineus*	VU
6	*Bagarius bagarius*	VU
7	*Barbodes sarana*	VU
8	*Catla catla*	VU
9	*Cirrhinus reba*	VU
10	*Clarias batrachus*	VU
11	*Clupisoma garua*	VU
12	*Garra lissorhyncus*	VU
13	*Puntius chola*	VU
14	*Labeo dero*	VU
15	*Heteropneustes fossilis*	VU
16	*Semiplotus semiplotus*	VU
17	*Osteobrama cotio*	VU
18	*Mystus vittatus*	VU

EN=Endangered; VU=Vulnerable

Birds

Forty-seven species of birds were recorded in and around the seven wetlands surveyed in Meghalaya. There were two Near Threatened species of birds; the Darter at three sites and the Blyth's Kingfisher at one site.

Prioritization of wetlands

Seven wetlands of Meghalaya were surveyed. On an evaluation of the biodiversity values based on the methods already explained elsewhere in the report, three fall in the first rank, two each in the second and third ranks (Table 21.5). Of the seven wetlands surveyed, four are artificial lakes. Birbah, a natural lake inside a Protected Area (Nongkhyllem Sanctuary) has topped the list with highest rating, followed by Umiam lake and Tasek lake complex. Umiam (also known as Barapani) is a large artificial lake and has great tourism potential being located on the main Shillong-Guwahati national highway. Tasek lake is inside Songsak Reserve Forest. Hence, these two could be declared as Protected Areas. The next two are in the second rank. Of these Kopili reservoir has the potential of becoming an important wetland considering its size and location. It extends to the North Cachar hills in Assam. Chidampong and Bolgisim, a natural lake in east Garo Hills, is also important. However, since the socioeconomic pressures are higher in this wetland than in any other wetlands surveyed in Meghalaya, it

Table 21.5. Prioritized list of the main wetlands of Meghalaya

No	Name of the wetland	Rank	Use
1	Birbah lake	1	L
2	Umiam lake	1	M
3	Tasek lake complex	1	M
4	Chidampong and Bolgisim	2	H
5	Kopili reservoir	2	L
6	Umtru lake near Nongkhyllem RF	3	L
7	Kyrdemkullai (north of the road)	3	L

may be considered for Community Reserve. Distribution of the wetlands in four districts is given in Fig. 21.1 - 21.4, and, the location of the prioritized wetlands along with IBAs is given in Fig. 21.5.

Birbah lake, Umiam lake and Tasek lake complex, the top three in the priority list, are qualified to be declared as Ramsar sites.

Summary

- Meghalaya has 98 wetlands of the size 2.25 ha and above, covering a total area of 22.21 sq km, based on the data of 1986-87 and 1993-94 (SAC, 1998).
- Seasonal waterlogged areas are more in number, although reservoirs cover comparatively larger area.
- Meghalaya has got four Endangered and 14 Vulnerable species of fishes; two each of Endangered and Vulnerable, three Near Threatened and one Least Concern species of freshwater turtles; and two Near Threatened species of birds.
- Forty-seven species of wetland birds were recorded.
- Seven wetlands were surveyed and prioritized.
- Birbah lake, Umiam lake and Tasek lake complex qualify to be declared as Ramsar sites.



Anwaruddin Choudhury

Umiam lake in Meghalaya; one of the IBAs and proposed Ramsar site

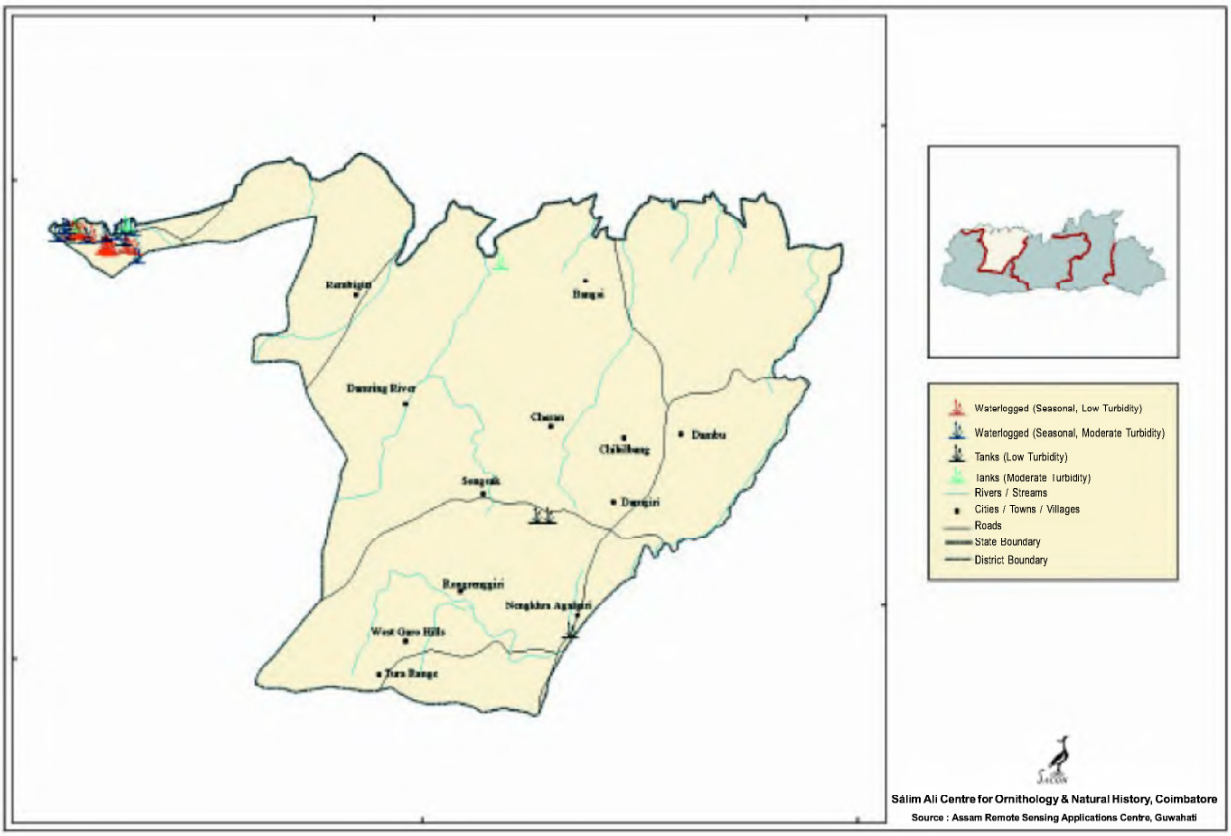


Fig. 21.1. Distribution of wetlands in the district of East Garo Hills

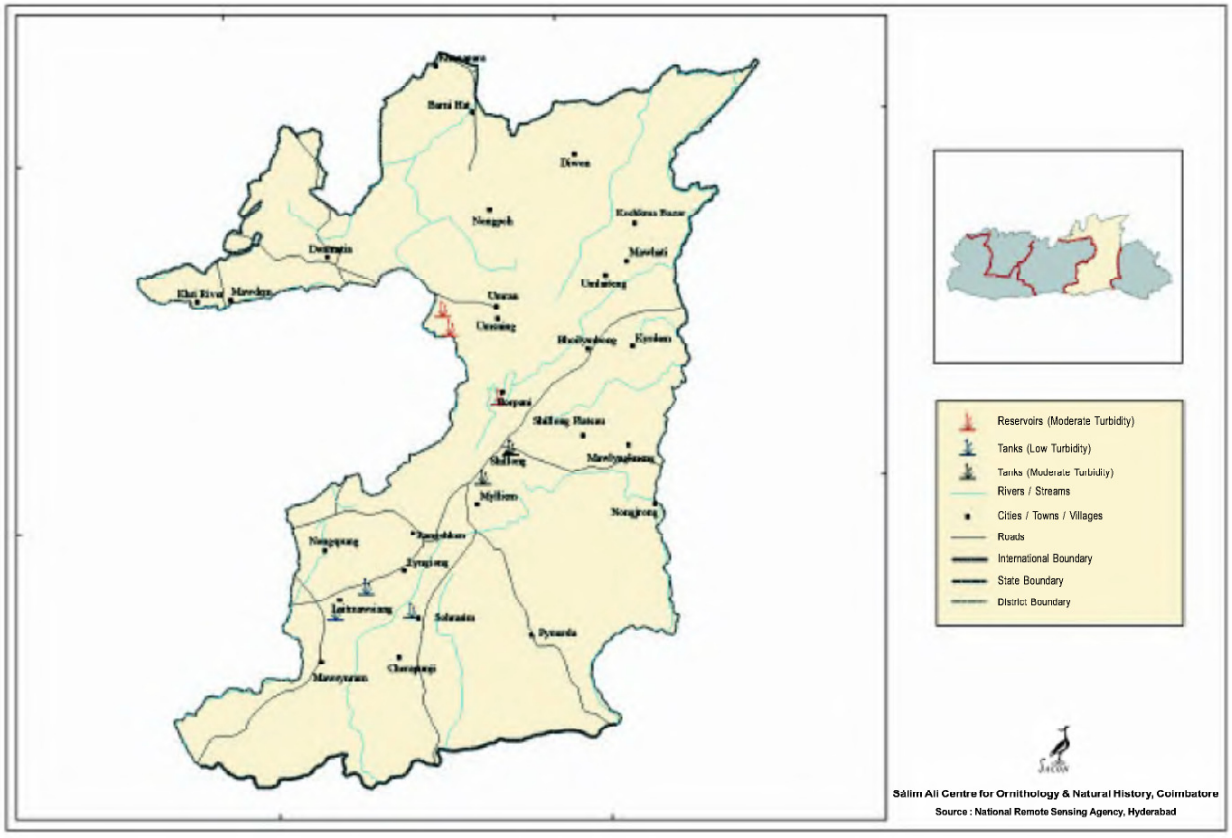


Fig. 21.2 Distribution of wetlands in the district of East Khasi Hills

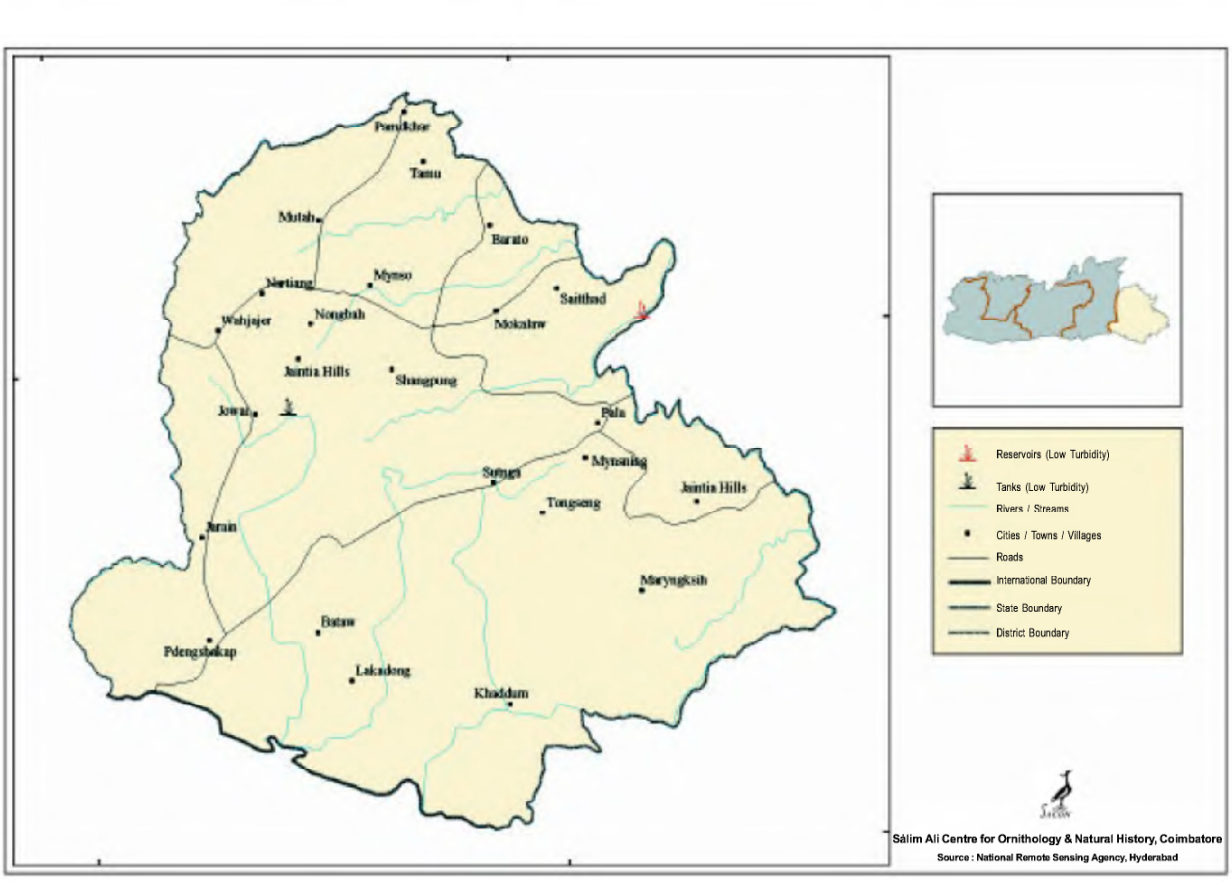


Fig. 21.3 Distribution of wetlands in the district of Jaintia Hills

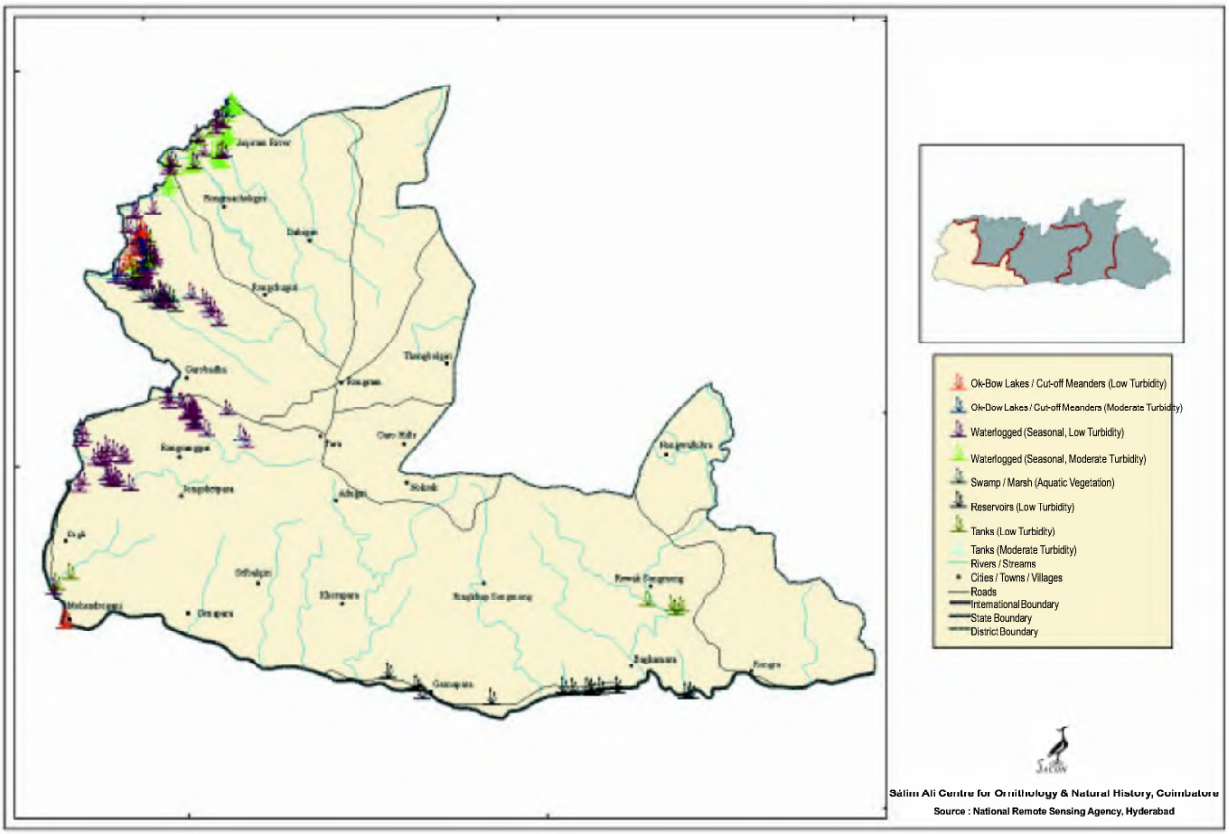


Fig. 21.4. Distribution of wetlands in the district of West Garo Hills

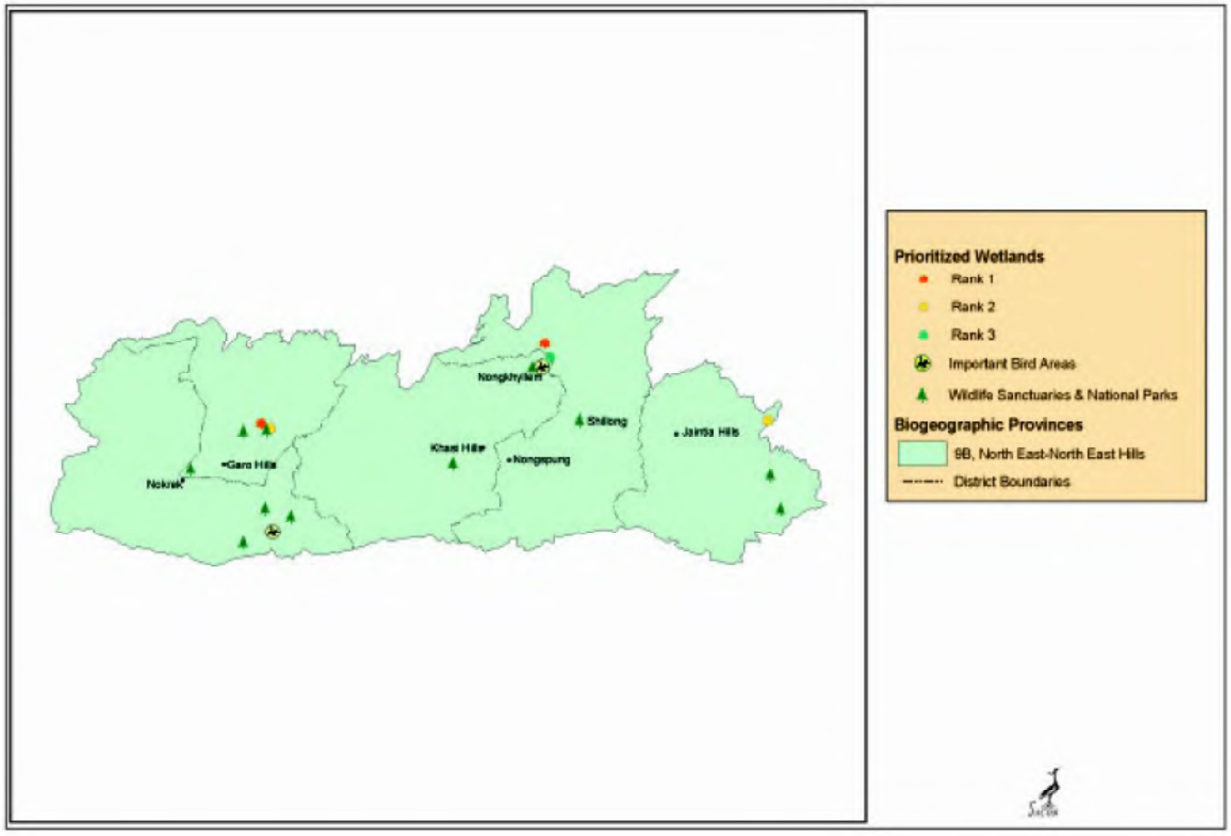


Fig. 21.5. Prioritized wetlands and other conservation areas in Meghalaya

ASSAM

Assam, the sentinel of the east is a very fascinating and diverse state. It is surrounded on all sides by predominantly hilly or mountain tracts. The entire area of Assam is divided into three major parts - the Brahmaputra valley (or the Assam valley), Barak valley (Cachar plains) and the hills and plateau (Karbi Anglong and Barail range). The Assam valley, built mostly by the aggradations of Brahmaputra and its tributaries, is a flat terrain having very little slope from its northeast corner at Sadiya to Dhubri in the west. The valley is fairly wide in upper Assam, with an average width of 80-100 km; but is narrow with an average width of 55 km in the middle.



State at a glance	
State capital	Dispur
Area	78,438 sq km
Population (2001)	26,638,407
Total number of districts	23
Major rivers	Brahmaputra, Barak, Subansiri, Manas, Burhi-Dihing
Total forest area	19,300 sq km
Population density	340/sq km
Ramsar site	1
Proposed Ramsar sites	24
Total sites proposed for conservation	75

Assam has humid tropical climate. Average temperature ranges from 7°C in winter to 36°C in summer. It gets a rainfall between 1,780 mm and 3,050 mm from June to September.

Status of wetlands

The land use statistics at the state level does not include wetlands as a separate entity (Table 22.1), although the state has as many as 3,513 freshwater wetlands (Table 22.2). The spatial distribution of the wetlands of 2 ha and above is given in Fig. 22.1. As may be noted, most of the wetlands are in the flood plains of the rivers Brahmaputra and, Barak and their tributaries. There are a large number of *beels*, swamps and marshes, locally known as *jalah, doloni, hola and pitoni*. All these water bodies comprise a vast sheet of water with varying shape, size and depth with rich flora and fauna.

Table 22.1. Land use pattern in Assam

Land use type	Area in sq km
Total geographic area	78,438
Forests	19,300
Not available for cultivation	25,100
Other uncultivated land excluding fallow land	4,830
Fallow land	2,260
Net area sown	27,010
Area sown more than once	12,400
Total cropped area	39,410
Cultivable area	34,100

(Source: www.indiastat.com)

According to the Directorate of Fisheries of Assam (1997-98) there are 1,196 beels in Assam, of which 430 are registered while the remaining 766 are unregistered. The areas covered by registered and unregistered beels are 60,250.24 and 40,603.37 hectares respectively. The total number of wetlands according to the typology at the state level (Table 22.2) shows that the most abundant type is waterlogged wetlands followed by oxbow lakes. The detailed spatial distribution of wetlands is given for three select districts in Figs. 22.2 - 22.4.

Besides *beels*, Assam contains numerous ponds and tanks. As per estimates, there are about 1,85,623 ponds and

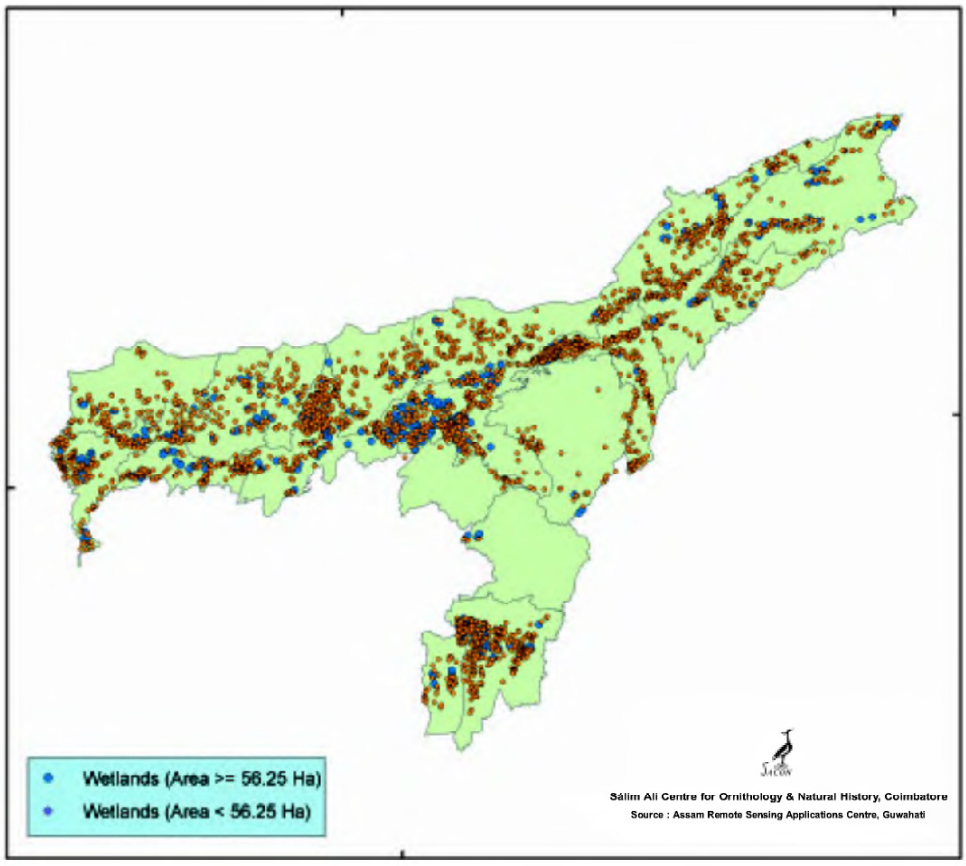


Fig. 22.1. Distribution of wetlands in Assam

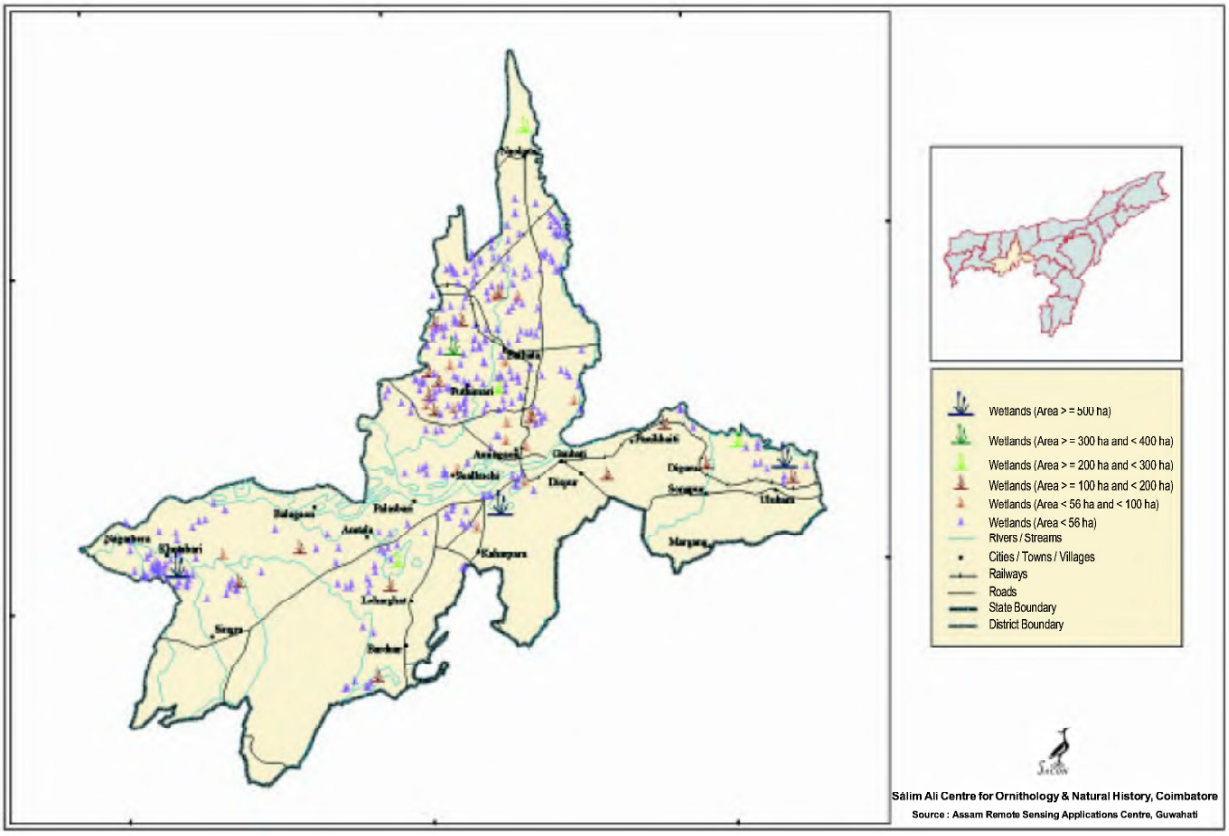


Fig. 22.2. Wetland distribution in the district of Kamrup

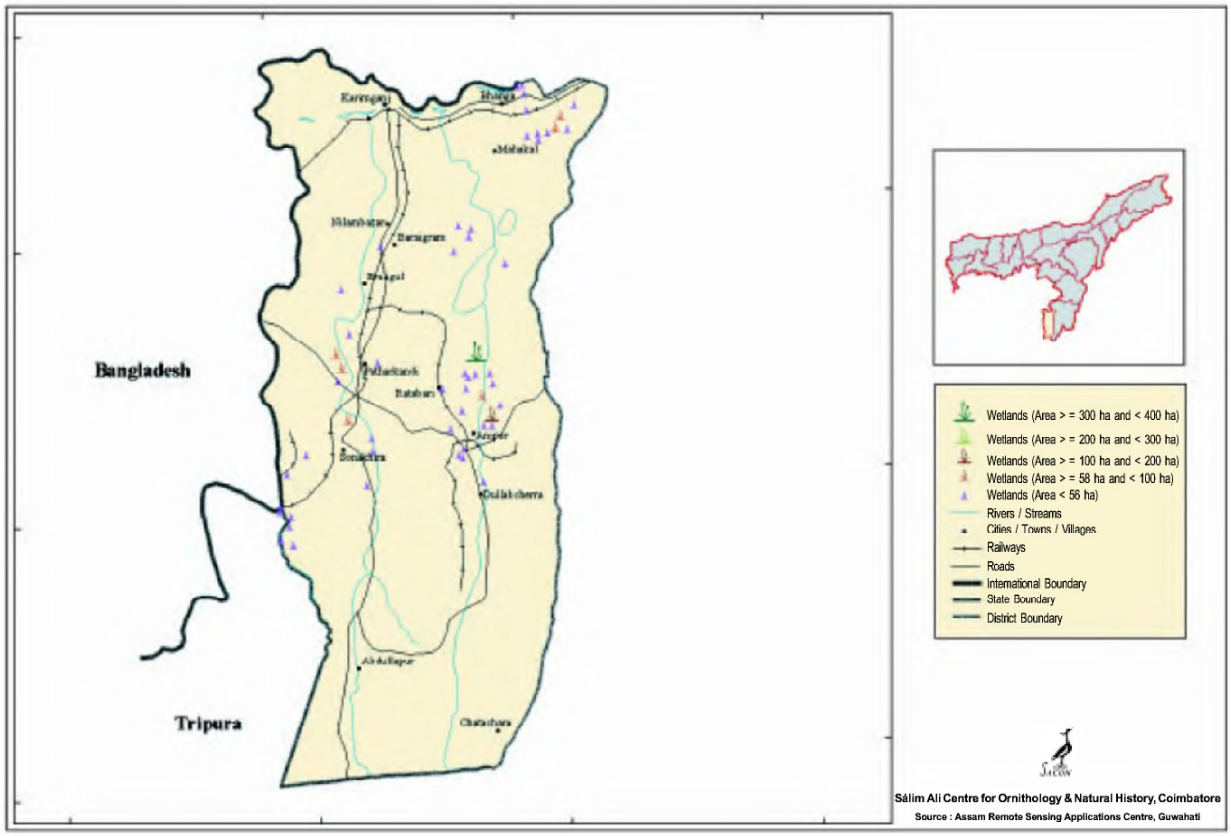


Fig. 22.3. Wetland distribution in the district of Karimganj

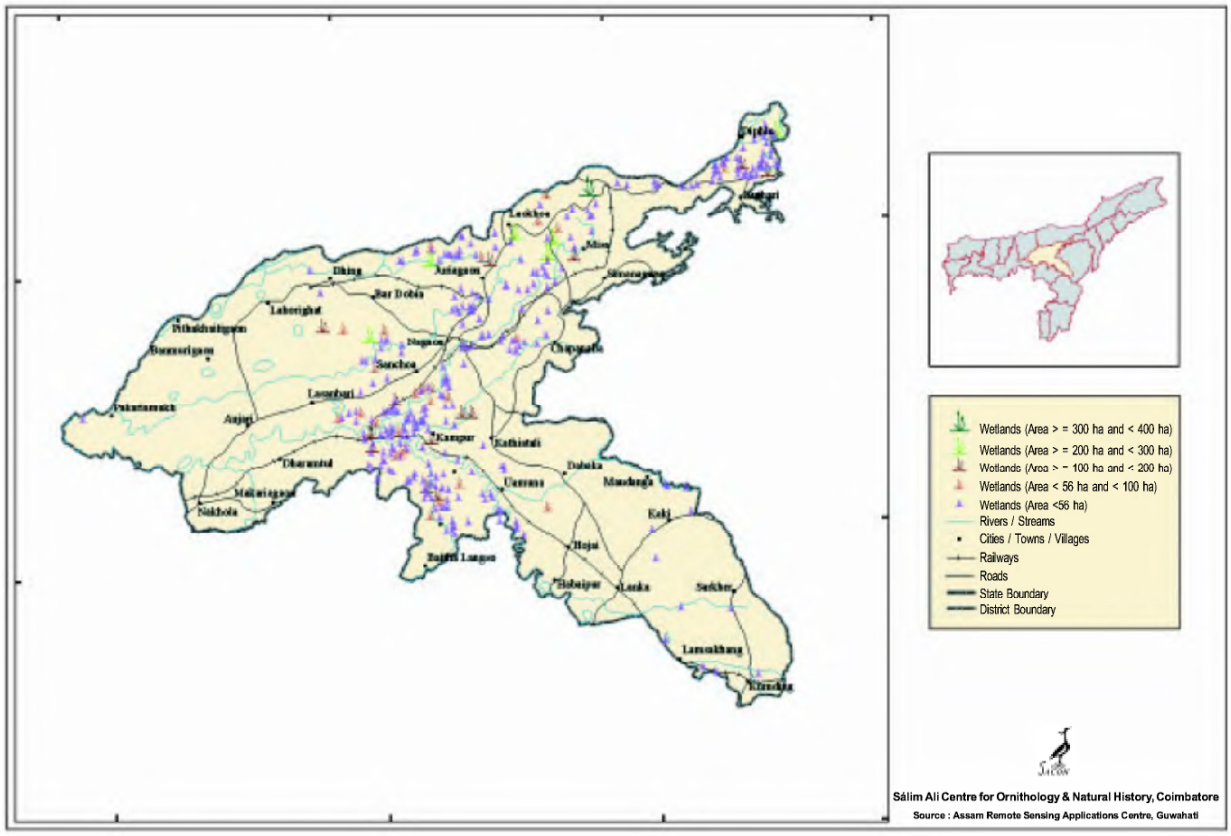


Fig. 22.4. Wetland distribution in the district of Nagaon

tanks in Assam covering 25,423.81 ha and 1,192 swamps and marshes of significance covering 10,729.35 ha. Also the National Parks including Kaziranga, Manas, Dibru-Sowkhowa, and Wildlife Sanctuaries such as Laokhowa and Burhachapori have sizeable areas of wetlands.

Table 22.2. Distribution of various categories of inland wetlands in Assam

Type of inland wetland	Area (sq km)	No. of wetlands
Lakes/ponds	154.94	690
Oxbow lakes	154.60	861
Waterlogged(seasonal)	234.31	1,125
Swamps/marshes	434.33	712
Reservoirs	26.62	10
Tanks	7.49	115
Total	1,012.29	3,513

Biodiversity

Aquatic vegetation

The aquatic plant species of Assam identified so far come to around 100. *Eichhornia crassipes, Nymphaea* spp, *Ottelia* sp, *Ludwigia* spp, *Pistia stratiotes, Azolla pinnata, Monochoria hastata, Cyperus* spp, *Scirpus* spp, *Ipomoea aquatica, Nelumbo nucifera, Trapa natans* and *Euryale ferox* are common in many wetlands. Recently *Ipomoea fistulosa* (commonly known as Panibhotera) has become the most dominant weed of marshy lands and also of ecotone regions between aquatic and terrestrial zones in almost all parts of the state.

The following two species of endemic aquatic plants were reported from Assam:

1. *Eriocaulon robusto-brownianum* (Family: Eriocaulaceae)
2. *Hoppea dichotoma* (Family: Gentianaceae)

Fishes

Thirty five Threatened species of fishes have been reported from Assam (Menon, 1999), the highest number from any state. Out of these, two are Critically Endangered, seven Endangered and 26 Vulnerable (Table 22.3).

Table 22.3. Threatened freshwater fishes of Assam

No.	Species	Status
1	*Erethistoides montana*	CR
2	*Pangasius pangasius*	CR
3	*Chitala chitala*	EN
4	*Eutropiichthys vacha*	EN
5	*Glyptothorax cavia*	EN
6	*Anguilla bengalensis*	EN
7	*Psilorhynchus sucatio*	EN
8	*Puntius chilinoides*	EN
9	*Tor pitutora*	EN
10	*Anabas testudineus*	VU
11	*Bagarius bagarius*	VU
12	*Barbodes sarana*	VU
13	*Barilius barila*	VU
14	*Barilius vagra*	VU
15	*Catla catla*	VU
16	*Channa orientalis*	VU
17	*Cirrhinus reba*	VU
18	*Clarias batrachus*	VU
19	*Clupisoma garua*	VU
20	*Garra gotyla gotyla*	VU
21	*Heteropneustes fossilis*	VU
22	*Labeo dero*	VU
23	*Mystus bleekeri*	VU
24	*Mystus vittatus*	VU
25	*Nemacheilus multifasciatus*	VU
26	*Nemacheilus scaturigina*	VU
27	*Neolissochilus hexagonolepis*	VU
28	*Osteobrama cotio*	VU
29	*Pangio pangio*	VU
30	*Pseudecheneis sulcatus*	VU
31	*Puntius chola*	VU
32	*Puntius conchonius*	VU
33	*Raiamas bola*	VU
34	*Schizothorax richardsonii*	VU
35	*Semiplotus semiplotus*	VU

CR=Critially Endangered; EN=Endangered; VU=Vulnerable

Turtles

Eighteen species of turtles were recorded from Assam. Out of which four are Endangered, six Vulnerable, five Near Threatened and two Least Concern (Table 22.4).

Birds

Seventy five wetlands were surveyed, of which bird numbers were estimated only for 35 wetlands; for the rest only the list of species could be obtained. In the 35 wetlands, 79,430 birds of 131 species including six terrestrial species were counted.

Table 22.4. List of freshwater turtles reported from Assam

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes gangeticus*	VU	-	I
2	*Aspideretes hurum*	VU	I	I
3	*Aspideretes nigricans*	CR	I	?
4	*Cuora amboinensis*	NT	II	-
5	*Cyclemys oldhami*	NT	-	-
6	*Chitra indica*	EN	-	IV
7	*Geoclemys hamiltonii*	VU	I	I
8	*Hardella thurjii*	VU	-	-
9	*Kachuga dhongoka*	EN	-	-
10	*Kachuga smithii*	LC	-	-
11	*Kachuga sylhetensis*	EN	-	I
12	*Kachuga tecta*	NT	I	I
13	*Kachuga tentoria*	NT	-	-
14	*Lissemys punctata*	NT	II	I
15	*Melanochelys tricarinata*	VU	I	IV
16	*Melanochelys trijuga*	LC	-	-
17	*Pyxidea mouhotii*	EN	-	-
18	*Morenia petersi*	VU	-	-

VU=Vulnerable; CR=Critically Endangered;
NT=Near Threatened; EN=Endangered; LC=Least Concern;

Five wetlands had more than 50 species and four had more than 5,000 birds. Diplai and Dheer beels had more than 10,000 birds (Table 22.5). In many cases total count could not be made because of low visibility or inaccessibility.

Fifteen species were abundant with more than 1,000 birds, namely the Lesser Whistling Teal, Pintail, Little Cormorant, Pond Heron, Purple Moorhen, White-eyed Pochard , Cattle Egret, Gadwall, Openbill Stork, Coot, Common Teal, Little Egret, Cotton Teal, Greylag Goose and Little Grebe. The Lesser Whistling Teal was the most abundant species with 23,710 birds. Distribution of the species did not depend on their total numbers; the abundant species were not always widely distributed. 20 species were seen in more than 50% of the wetlands surveyed. The Pond Heron and Cattle Egret were the most common species found in most of the wetlands followed by the Whitebreasted and Small Blue Kingfisher and Little Cormorant.

Table 22.5. Major wetlands of Assam with species and number of birds

S.#	Name of the wetland	# species	No. of birds
1	Bhakatgaon beel	11	177
2	Botha beel	38	2,587
3	Boralimora beel	41	2,234
4	Bordoibam Beelmukh Bird Sanctuary	62	1,530
5	Danduwa beel	25	1,122
6	Deobali	22	439
7	Dheer beel	53	12,463
8	Dighali beel	48	3,553
9	Dinjan Gereki beel	43	270
10	Diplai beel	45	10,368
11	Doloni beel	17	3,025
12	Haribhanga beel	35	2,891
13	Jamjing-Sengajan beel	39	922
14	Khamti Guwali beel	43	344
15	Kurua beel	37	1,322
16	Kuzi beel complex	20	706
17	Lali River beel	12	77
18	Mach Bhandar beel	11	236
19	Maguri beel	57	792
20	Misamari beel	53	6,678
21	Monoha beel	17	238
22	Morikolong beel	20	790
23	Nandini-Karmari beel	13	367
24	Pakaria Brahmaputra river	16	1,086
25	Potakalang beel	42	2,291
26	Salmari beel	26	3,135
27	Samoguri beel	19	2,535
28	Sareshwar beel	15	2,957
29	Sariyani beel	40	942
30	Sataryajan beel	34	879
31	Solmari beel	26	2,802
32	Tamranga-Konora-Paropota	23	2,429
33	Udari beel	9	65
34	Urpad beel	33	2,126
35	Bhereki beel	62	5,052
	Total	131	79,430

Ten Threatened species with 509 birds and eight Near Threatened species with 3,741 birds were recorded during the survey in Assam (Table 22.6). Lesser Adjutant was noted at 26 wetlands. The only sightings of Finn's Baya and Swamp Francolin during the entire study were from Solmari beel and Deobali respectively.

Table 22.6. Frequency of sightings of Threatened and Near Threatened birds in Assam

S.#	Species	Status	No. of wetlands where sighted	No. of birds
1	Lesser Adjutant	T	26	218
2	Spotbilled Pelican	T	11	93
3	Adjutant Stork	T	10	50
4	Baer's Pochard	T	4	50
5	Longbilled Vulture	T	7	26
6	Whitebacked Vulture	T	5	25
7	Pallas's Fishing Eagle	T	5	7
8	Swamp Francolin	T	1	25
9	Spotted Greenshank	T	3	14
10	Finn's Weaver	T	1	1
11	Darter	NT	15	102
12	Painted Stork	NT	2	32
13	Blacknecked Stork	NT	5	6
14	White Ibis	NT	1	70
15	White-eyed Pochard	NT	14	3,512
16	Greyheaded Fishing Eagle	NT	6	10
17	Pale Harrier	NT	5	6
18	Blackbellied Tern	NT	1	3

T=Threatened; NT=Near Threatened

Environmental contamination

Seventy six fishes belonging to five species from six wetlands were analyzed for heavy metals and pesticides.

Heavy metals

Of all the wetlands, Son beel had the maximum concentrations of zinc (27.83±15.41 ppm) and cadmium (0.87±0.25 ppm) (Fig. 22.5). Lead was the highest in Misamari beel (8.33±1.35 ppm) while chromium (0.74±1.47 ppm) and copper (2.40±1.76 ppm) were the highest in Monoha beel and Diplai beel respectively. Variation in the level of contamination was significant ($P<0.005$).

Among the five species of fishes, interestingly, each species recorded the highest concentration of one of the metals with significant variation ($P<0.005$). *Channa orientalis, Heteropneustes fossilis, Cyprinus carpio, Clarias batrachus, and Anabas testudineus* recorded the highest concentrations of lead (7.78±1.64 ppm), chromium (0.65±1.29 ppm), zinc (38.63±16.55 ppm), copper (2.12±1.29 ppm) and cadmium (0.78±0.21 ppm) respectively (Fig. 22.6).

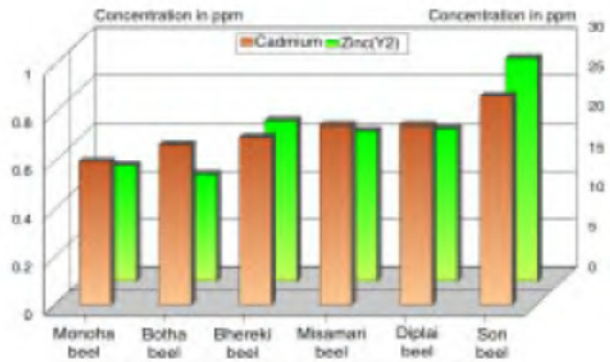


Fig. 22.5. Zinc and Cadmium contamination in select wetlands of Assam

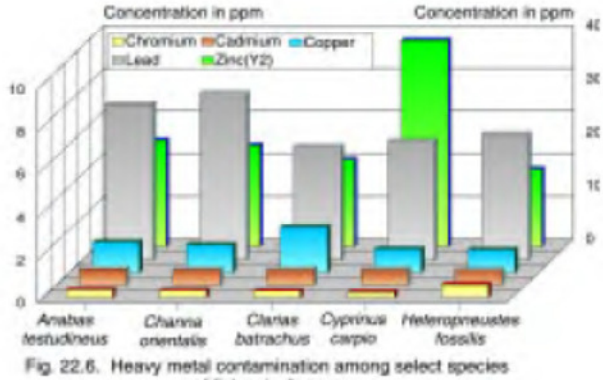


Fig. 22.6. Heavy metal contamination among select species of fishes in Assam

Pesticides

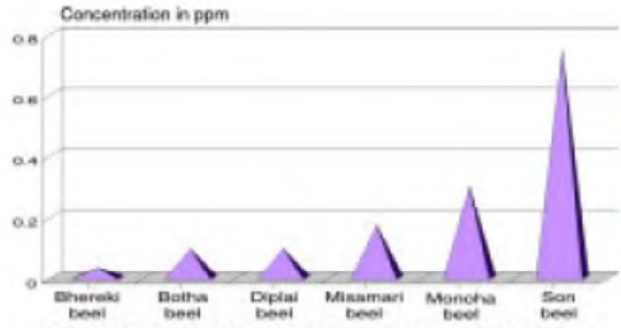


Fig. 22.7. Total organochlorine residues among various wetlands of Assam

On an average, among the wetlands, Son beel of Karimganj recorded the highest (0.743ppm) load of total organochlorine residues followed by Monoha beel (0.30 ppm) of Morigaon district and Misamari beel (0.172 ppm) of Jorhat district (Fig. 22.7), whereas the lowest concentrations were recorded in Bhereki beel (0.034 ppm) of Jorhat district. One of the major reasons for the decline in fish catch, particularly in Son beel by 30%, could be pesticide.

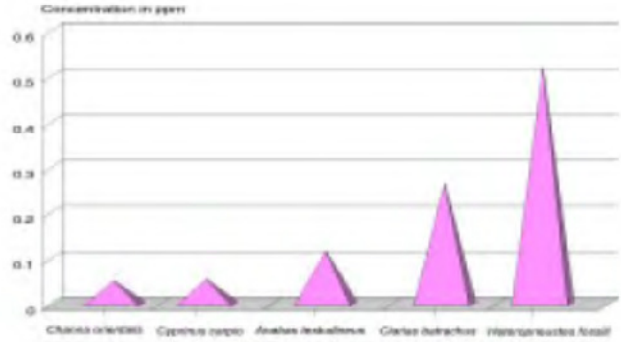


Fig. 22.8. Total organochlorine residues among various species of fishes in Assam

Among the different species of fishes analyzed in Assam, *Heteropneustes fossilis* is the most contaminated species with 0.519 ppm of organochlorine residues. *Channa orientalis* recorded the least, 0.05 ppm (Fig. 22.8). Of the various organochlorine residues in Assam, HCH was the most frequently (87%) detected chemical. This indicates the current use pattern and persistence. According to a report published by ICAR (1999), 45-85% of the vegetables and fruits in Assam were contaminated with organochlorines. Although, annual pesticide consumption in Assam (260 mt) is less than the other states, crop-wise or unit area-wise consumption pattern is discernibly high.

Suitability for human consumption

The calculated daily dietary lead intakes through *Anabas testudineus* (0.26 mg), *Channa orientalis* (0.28 mg) and *Oreochromis mossambicus* (0.27 mg) are quite alarming compared to the levels prescribed by UN Committee (WHO, 1989, 1993) which admits only up to 0.21 mg/day for a 60 kg adult. As referred to elsewhere in this report, increased and regular consumption may pose more serious problems. The levels of other metals appear to be safe for human consumption.

Oreochromis mossambicus, which recorded 19 µg of HCH, from Son beel, exceeded the tolerance levels (18-µg) recommended for human consumption (Health Canada, 1996). It may constitute a threat to fishes and piscivorous birds. Other pesticides appear to be not harmful, if the consumption does not exceed 250g per week.

Son beel of Karimganj, Misamari beel of Jorhat and Diplai beel of Dhubri districts require urgent action to protect them from contamination.

Socioeconomic values

A preliminary assessment of the use values showed that all the wetlands surveyed are being utilized in different levels. In Assam, the wetlands have seven major uses. Those with five to seven, three to four and less than three uses have been considered as of high use, medium use and low use respectively. The high biodiversity areas (I & II rank) were having high or medium use except for a few with low use (Table 27.7).

Table 22.7. Prioritized list of wetlands in Assam

S.#	Site	Rank	Use Grade
1	Beedorou	1	H
2	Bordoibam Beelmukh BS	1	M
3	Danduwa beel	1	M
4	Deobali	1	M
5	Dheer beel	1	H
6	Dighali beel	1	H
7	Diplai beel	1	L
8	Haribhanga beel	1	M
9	Khamti Guwali beel	1	L
10	Kurua beel	1	M
11	Maguri beel	1	L
12	Misamari beel	1	H
13	Potakalang beel	1	M
14	Salmari beel	1	M
15	Sariyani beel	1	M
16	Sataryajan beel	1	M
17	Solmari beel	1	M
18	Bhereki beel	1	M
19	Deepor beel	1	H
20	Dibru-Sowkhoa	1	M
21	Kapla beel	1	H
22	Kaziranga NP- Wetland	1	H
23	Panidihing Phokoloi	1	M
24	Urpod beel	1	M
25	Botha beel	1	H
26	Son beel	2	H
27	Auniati beel	2	H
28	Bardoloni	2	H
29	Bauwwa	2	H
30	Bheriki	2	H
31	Burhachapori WLS	2	H
32	Chandubi beel	2	L
33	Chariani beel	2	H
34	Chenimari marshes	2	L
35	Boralimora beel	2	H
36	Dinjan Gereki beel	2	L
37	Doloni beel	2	M
38	Morikolong beel	2	H
39	Daimari R.F.	2	L
40	Dhakinpat wetland (Majuli)	2	H
41	Upper Dihing-East block-pools and marshes including DLB	2	L
42	Kotabali	2	M
43	Nandini-Karmari beel 2m	2	M
44	Laokhowa WLS	2	H
45	Maher beel	2	M
46	Orang NP	2	L
47	Pabitora WLS	2	H
48	Rata beel	2	H
49	Samarajan	2	M
50	Sonowa	2	H
51	Soulmari	2	H
52	Doom Duma RF	2	L
53	Jengdia beel	2	H
54	Angang beel	3	H
55	Bhakatgaon beel	3	L
56	Chatla haor	3	H
57	Jamjing Sengajan wetlands	3	H
58	Kuzi beel complex	3	M
59	Monoha beel	3	M
60	Samoguri beel	3	M
61	Urpad beel	3	M
62	Gaurisagar tank	3	M
63	Joysagar tank	3	H
64	Lukka haor	3	H
65	Nameri NP	3	L
66	Sanai-Rupai WLS	3	L
67	Sapkali	3	H
68	Sibsagar tank	3	H
69	Umrangsu reservoir	3	M
70	Sareshwar beel	3	M
71	Lali River beel	4	H
72	Mach Bhandar beel	4	L
73	Pakaria-Brahmaputra river	4	H
74	Tamranga-Konora-Paropota	4	H
75	Udari beel	4	L

Prioritization of wetlands

Seventy five wetlands have been prioritized in Assam for conservation initiatives (Table 22.7); 35 based on the criteria explained under methodology and 41 on the basis of number of species of birds and size of the wetland. Location of all the prioritized wetlands is given in Fig. 22.9.

Twenty sites came in the first rank; Botha beel which was in the second rank was added to the first considering its size. The next 28 came in the second rank, followed by 18 in the third rank and five in the fourth rank. Conservation actions need to be taken up based on these priorities. The top ranking 25 wetlands qualify the criteria for Ramsar sites. One of them, Deepor beel has already been declared as a Ramsar site. The rest 24 are proposed for declaration as Ramsar sites. Sites with high use values may be considered as Community Reserves, while those with low use values may be considered to be declared as sanctuaries.

Conservation issues

The ever increasing commercial fisheries is an immediate issue of concern for conservation of wetland biodiversity in most cases in Assam. Construction of embankment as a flood control measure threatens a large number of wetlands, so also the jhum cultivation and deforestation in the catchment areas resulting in siltation. Aquatic weeds such as *Ipomoea fistulosa*, water hyacinth and *Mimosa* species invading the wetlands also form a major issue. Enactment of proper laws are urgently needed to prevent the loss of wetlands.

Summary

- Assam has 3,513 wetlands of the size 2.25 ha and above, covering 1,012.29 sq km, according to the satellite data of 1990-91 (SAC, 1998).
- Assam has two species of endemic aquatic plants; two Critically Endangered, seven Endangered and 26 Vulnerable species of fishes; and four Endangered, five Near Threatened, six Vulnerable and two Least Concern species of freshwater turtles.
- 133 species of birds with a total population of 79,445 were recorded from 35 wetlands.
- The Lesser Whistling Teal was the most abundant species, while the Pond Heron and Cattle Egret were more common, found in most of the wetlands.
- Five hundred and nine birds of 10 Threatened and 3,741 birds of eight Near Threatened species of birds were recorded.
- Seventy-Six fishes belonging to five species from six wetlands were studied for environmental contamination.
- Son beel, Misamari beel and Diplai beel were more contaminated than other wetlands studied.
- The fishes had high concentrations of heavy metals, at least one of the five metals in each species studied. Organochlorine was the highest in *Heteropneustes fossilis*.
- 75 wetlands were prioritized; 25 in the first rank, 28, 17, and five in the second, third and fourth ranks respectively.
- 24 wetlands qualify to be declared as Ramsar sites; one is already declared and the rest are proposed.
- Action needs to be taken to reduce pollution levels in the identified wetlands.



Anwaruddin Choudhury

Dibru-Saikhowa, Assam; one of the IBAs and a proposed Ramsar site



V.S. Vijayan

Euryale ferox , an economically important plant

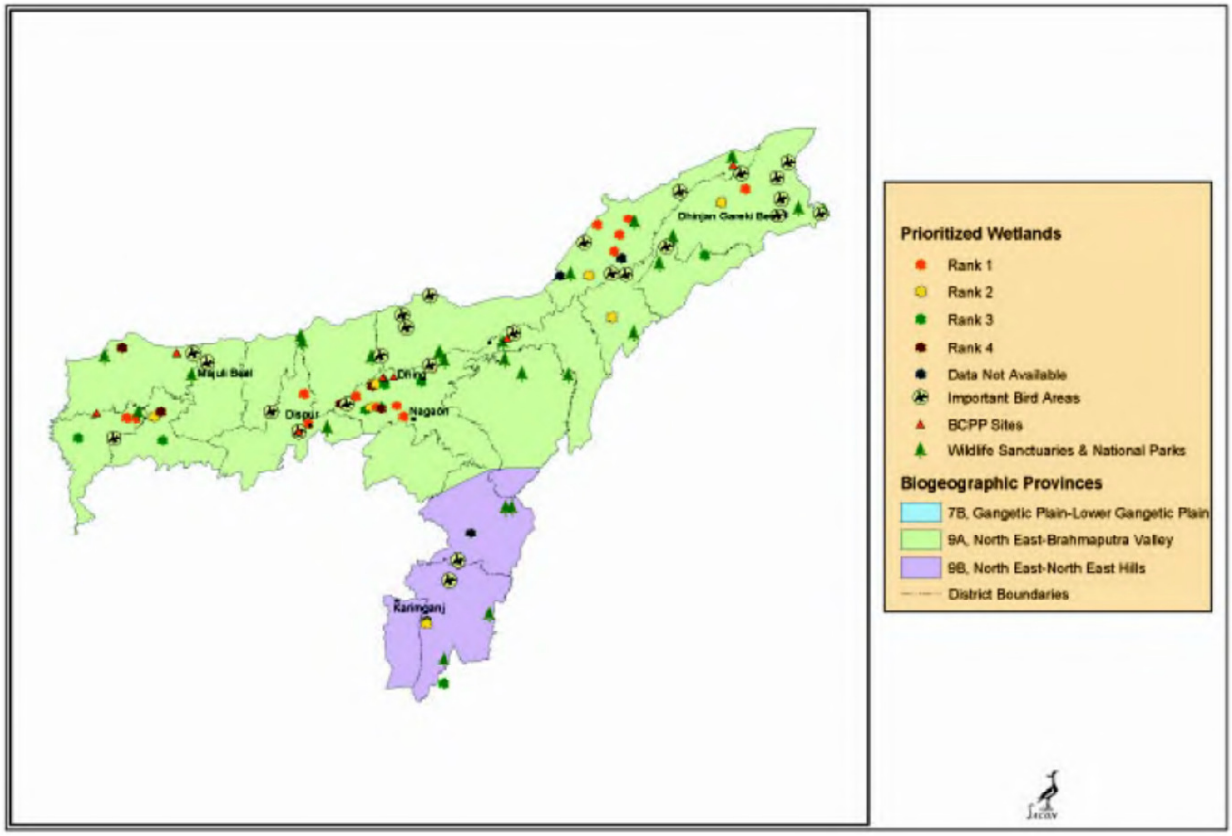


Fig. 22.9. Prioritized wetlands and other conservation areas in Assam



Anwaruddin Choudhury

Son beel, Assam; one of the IBAs and proposed Ramsar sites

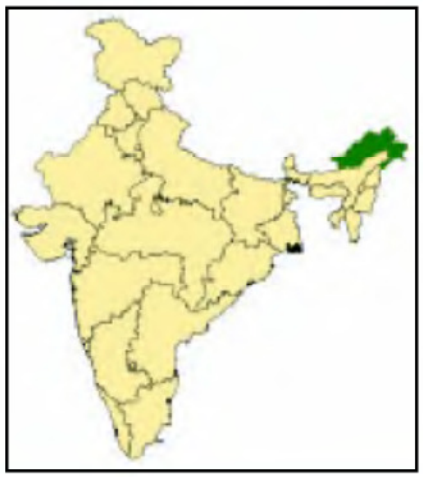


Parag Muley

Wetlands and Wild Buffaloes in Kaziranga National Park

ARUNACHAL PRADESH

Arunachal Pradesh, literally, the land of rising sun, is a fascinating frontier of the country. With its unmatched diversity of land, mountains, rivers, forests, wildlife and a kaleidoscope of culture, Arunachal is a hotspot of biodiversity . It is the largest north-eastern state and has 13 districts.



The terrain, consists of submontane and mountainous ranges, sloping down to the plains of Assam, divided into valleys by the river Kameng, Subansiri, Siang, Lohit and Tirap.

The state gets an average of 5,000 mm rainfall in a year. The average temperature varies from 12 to 36°C, the minimum reaching below freezing point in the higher regions.

The land use pattern of Arunachal Pradesh shows that almost 62% of the area is under forests (Table 23.1). But there is no mention about the wetlands, which probably would have been clubbed with some other types.

State at a glance	
State capital	Itanagar
Area	83,743 sq km
Population (2001)	10,91,117
Total number of districts	13
Major rivers	Dibang, Kameng, Subansiri, Siang, Lohit and Tirap
Total forest area	51,540 sq km
Population density (2001)	120/sq km
Ramsar site	Nil
Proposed Ramsar sites	8
Total sites proposed for conservation	18

Status of wetlands

Arunachal Pradesh, according to SAC (1998), has 806 wetlands of the size 2.5 ha and above, covering an area of about 563 sq km (Table 23.2). It amounts to 0.67% of the total geographic area of the state.

Four types of wetlands were described. Although the number of lakes/ponds and waterlogged wetlands did not vary much, the area they cover did vary significantly (Table 23.2). The lakes are further classified into four, namely oxbow lakes or cut-off meanders, tectonic /landslide lakes, glacial lakes and artificial reservoirs. The oxbow lakes, locally called

Table 23.1. Land use pattern in Arunachal Pradesh

Land use type	Area (sq km)
Total geographic area	83,743
Forests	51,540
Not available for cultivation	480
Other uncultivated land excluding fallow land	440
Fallow land	640
Net area sown	1,850
Area sown more than once	650
Total cropped area	2,500
Cultivable area	2,930

Source: www.indiastat.com

Table 23.2. Distribution of various categories of inland wetlands in Arunachal Pradesh

Type of inland wetland	No. of wetlands	Area of wetland (sq km)
Lakes/ponds	380	30.99
Oxbow lakes	6	2.45
Waterlogged (seasonal)	396	451.87
Swamps/marshes	24	77.93
Total	806	563.24

Source: SAC (1998)

beels, are scarce in most part of Arunachal Pradesh but found mostly in Namsai- Bordumsa areas of Lohit district, in parts of Changlang district and in the southern areas of East Siang district along the rivers Noa-Dihing, Lohit and Siang. Most of them are small and are being silted up because of the deforestation in the hills and reclamation for farming. There is one significant lake of tectonic/ landslide origin, namely Mehao, which was created during the Great Assam Earthquake of 1950. However, there are innumerable glacial lakes in the Great Himalaya and a few in the Mishmi hills. Many of these are still unexplored and located in difficult terrain. There is one artificial reservoir near Yazali in Paum Pare district, which came up after construction of a dam across the Ranga river. There are also a few lakes in the depressions in the hills.

Biodiversity

Aquatic vegetation

Aquatic weeds, especially the water hyacinth, have invaded the wetlands, especially those in the low-lying areas, posing a threat to their survival.

List of endemic aquatic plants has been given together for the entire North-Eastern states, except for Assam which has been given separately. Five species are reported as per our compilation (Table 23.3), mainly from the literature including Flora volumes and the herbaria of BSI. The herbarium collections at BSI, Shillong could not be checked and thus would have missed many species.

Table 23.3. Endemic aquatic Angiosperms recorded from the North-Eastern states

No.	Species	Family
1	*Eriocaulon echinulatum*	Eriocaulaceae
2	*Wiesneria triandra*	Alismataceae
3	*Hoppea dichotoma*	Gentianaceae
4	*Najas marina ssp.*	Najadaceae
5	*Tonningia cucullata*	Commelinaceae

Fishes

Altogether 34 species of freshwater fishes are reported from the North-East (Menon, 1999). Arunachal Pradesh has 17 species, of which three are Endangered and 14 Vulnerable (Table 23.4).

Table 23.4. Threatened freshwater fishes of Arunachal Pradesh

No.	Species	Status
1	*Anguilla bengalensis*	EN
2	*Ompok bimaculatus*	EN
3	*Pseudeutropius atherinoides*	EN
4	*Anabas testudineus*	VU
5	*Bagarius bagarius*	VU
6	*Barbodes sarana*	VU
7	*Catla catla*	VU
8	*Cirrhinus reba*	VU
9	*Clarias batrachus*	VU
10	*Clupisoma garua*	VU
11	*Semiplotus semiplotus*	VU
12	*Puntius chola*	VU
13	*Labeo dero*	VU
14	*Heteropneustes fossilis*	VU
15	*Osteobrama cotio*	VU
16	*Mystus vittatus*	VU
17	*Neolissochilus hexagonolepis*	VU

EN=Endangered; VU=Vulnarable

Turtles

Nine species of turtles are reported from Arunachal Pradesh, out of which two each are Endangered and Vulnerable while five are Near Threatened (Table 23.5).

Birds

Eighteen wetlands were surveyed in Arunachal Pradesh. Six Threatened and one Near Threatened species of birds were recorded (Table 23.6). The number of birds was not enumerated separately.

Table 23.5. List of turtles reported from Arunachal Pradesh

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes hurum*	VU	I	I
2	*Cuora amboinensis*	NT	II	-
3	*Cyclemys oldhami*	NT	-	-
4	*Kachuga sylhetensis*	EN	-	I
5	*Kachuga tecta*	NT	I	I
6	*Kachuga tentoria*	NT	-	-
7	*Lissemys punctata*	NT	II	I
8	*Melanochelys tricarinata*	VU	I	IV
9	*Pyxidea mouhotii*	EN	-	-

VU=Vulnerable, NT=Near Threatened; EN=Endangered

Table 23.6. Distribution of Threatened & Near-Threatened species of birds in Arunachal Pradesh

S#	Species	Status	# of sites
1	Whitewinged Wood Duck	T	4
2	Great Whitebellied Heron	T	1
3	Lesser Adjutant	T	1
4	Spotbilled Pelican	T	1
5	Pallas's Fishing Eagle	T	1
6	Blacknecked Crane	T	1
7	Himalayan Greyheaded Fishing Eagle	NT	1

T=Threatened; NT=Near Threatened

Prioritization of wetlands

Eighteen wetlands were surveyed in Arunachal Pradesh. Based on the ratings, eight of them came in the first rank, three in the second and the remaining seven in the third rank (Table 23.7). Mehao lake topped the list followed by Glao. The former is inside the Mehao Wildlife Sanctuary while the latter is in Kamlang Wildlife Sanctuary. Both are surrounded by subtropical forest at moderate elevation. The high elevation glacial lakes, Dungpin tso and Lamchuer tso come next. Both these are accessible only for a few months in summer and are important breeding grounds for waterfowl. The next three wetlands are Donchang tso (a glacial lake), Japang beel (inside D'Ering memorial Sanctuary, on the floodplains of the Siang river) and Mandela Phudung wetlands (a complex of lakes and marshes above 3,300m elevation). Sangti marshes although got a low rating, was elevated to the first rank, as it is an important wintering site of the rare and Threatened Blacknecked Crane. All the eight top ranking wetlands qualify to be declared as Ramsar sites.

The major stakeholders of the wetlands are army, tourism, fisheries and forest departments, yak graziers, pilgrims, fishermen and fringe villagers. The wetlands in the high altitude areas have very low key regime by the local people. Hence, they can be given full protection status.

Table 23.7. Priority ratings of the main wetlands of Arunachal Pradesh

No.	Name of the wetland	Rank	Use
1	Mehao lake	1	M
2	Glao lake	1	M
3	Dungpin tso	1	M
4	Lamchuer tso	1	M
5	Dhonchang tso	1	M
6	Japang beel	1	L
7	Mandela Phudung wetlands	1	M
8	Sangti marshes	1	M
9	Gorjo tso	2	M
10	Sela Lake	2	M
11	Moti Jheel-Rani Jheel-Raja Jheel	2	M
12	Ganga lake	3	M
13	PT Sho & lakes S of Nagula Pass	3	M
14	Sally lake	3	M
15	Sangetsar / Sagheswar lake	3	M
16	Unnamed 1 on way to T Gompha	3	M
17	Complex in Geshela and Y-Jn. Areas	3	M
18	Near Y-Jn.	3	M

L=Low; M=Medium

Summary

- Arunachal Pradesh has 806 wetlands, each of the size 2.25 ha and above, covering a total of 563 sq km (SAC, 1998).
- In number and extent, waterlogged type is more than other types of wetlands.
- The lakes and ponds are too small in size.
- Arunachal has three Endangered and 14 Vulnerable species of fishes; two each of Endangered and Vulnerable and five Near Threatened Species of freshwater turtles; and seven Threatened and one Near Threatened species of birds.
- Eighteen wetlands were surveyed and prioritized; eight received the top rank while three were in the second and seven in the third rank.
- The eight wetlands in the first rank qualify to be declared as Ramsar Sites.



Anwaruddin Choudhury

Sela lake, Arunachal Pradesh

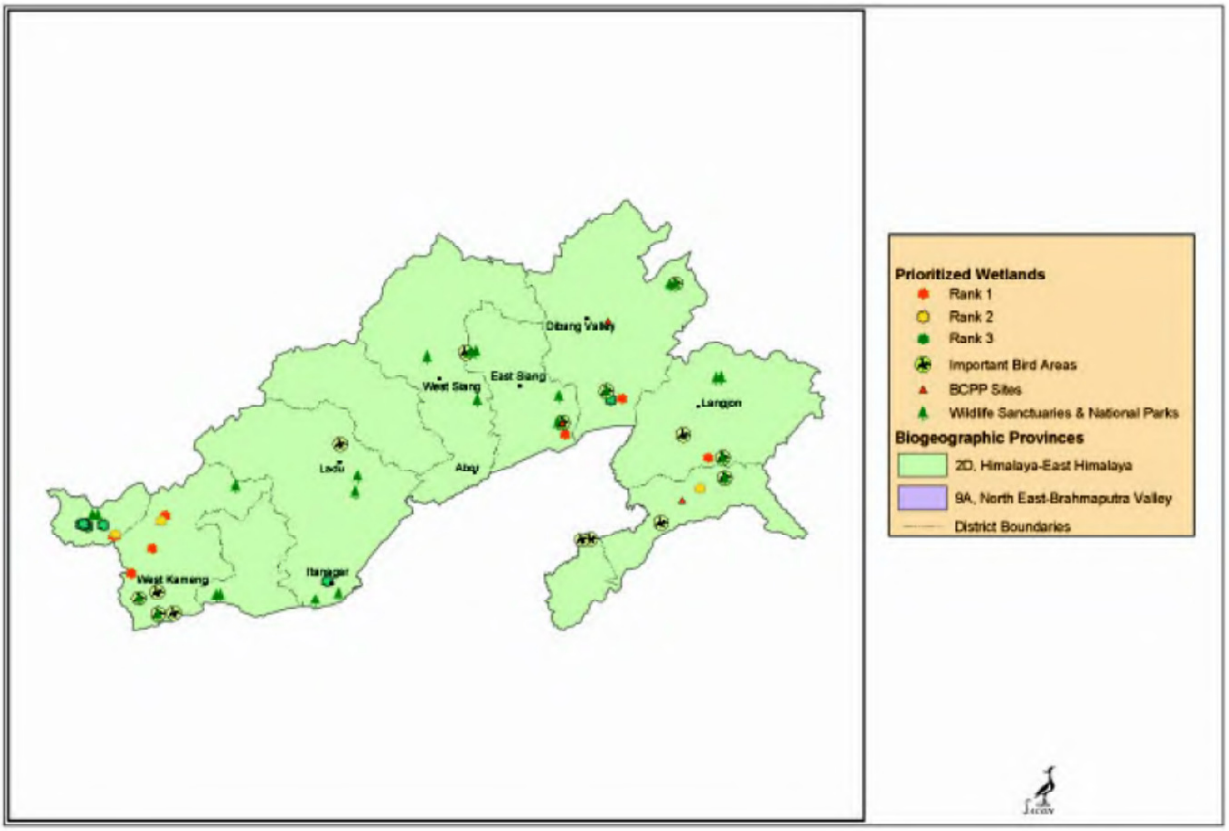
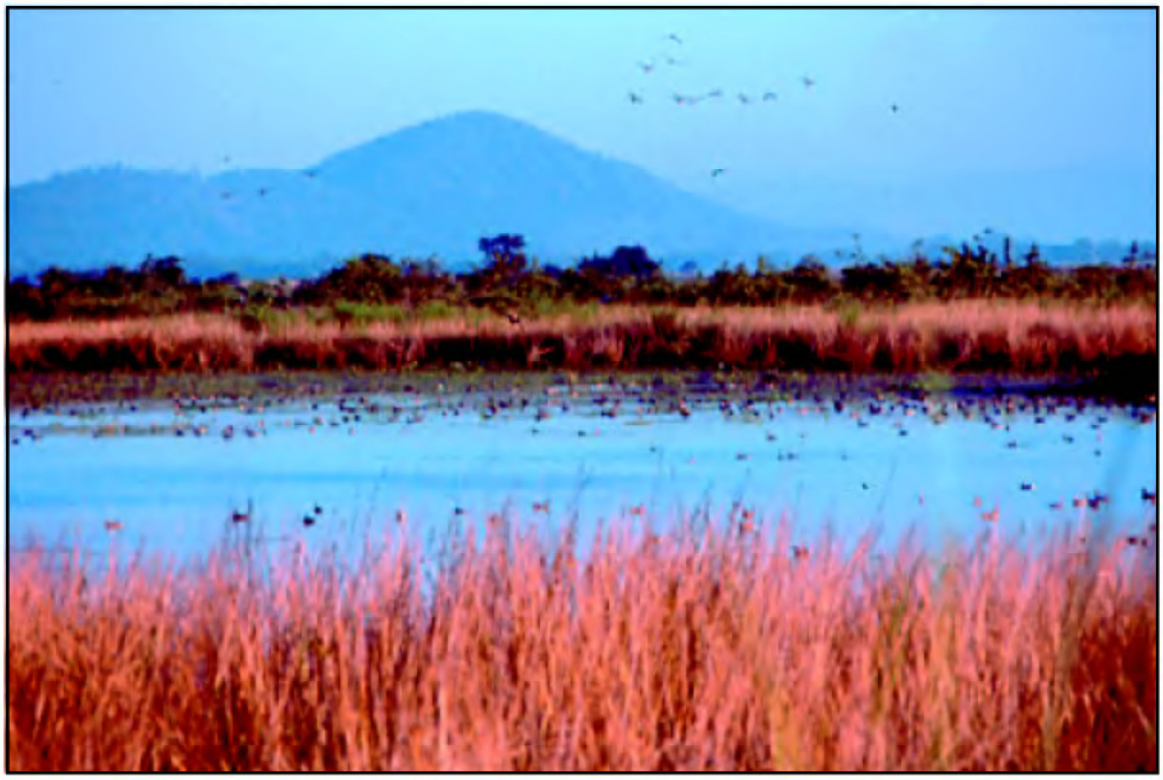


Fig. 23.1. Prioritized wetlands and other conservation areas in Arunachal Pradesh



Anwaruddin Choudhury

Wetland in Pabitora WS, Assam: one of the IBAs

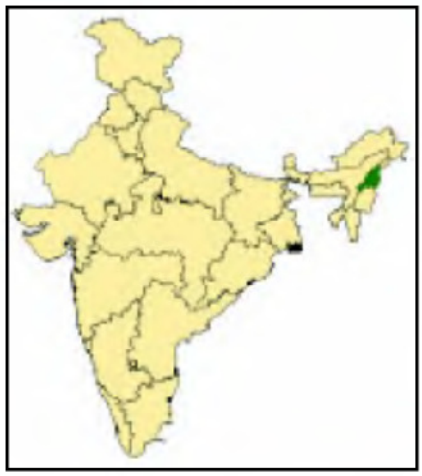


Anwaruddin Choudhury

Birbal lake, Meghalaya

NAGALAND

Nagaland, a narrow strip of hilly, rugged, mountainous territory with luxurious vegetation, lies between Assam and Myanmar on the west and east respectively, in the extreme north-east of India. The average height of the peaks is 900-1,200 metres; the highest being 3,849 meters (Sararamati). The rapid changes in topography result in climatic changes within short distances. The foot-hill plains sheltered by valleys and the ranges are marked with climatic contrasts. In summer the maximum and minimum temperatures are 31 and 16°C respectively while they are 24 and 4°C respectively in winter, the minimum going even below zero. The average rainfall of the state is about 1,750 mm.



The forest covers almost 53% of the total land area of the state. The area covered by the wetlands is not indicated (Table 24.1).

Table 24.1. Land use pattern in Nagaland

Land use type	Area (sq km)
Total geographic area	16,579
Forests	8,750
Not available for cultivation	650
Other uncultivated land excluding fallow land	1,890
Fallow land	1,690
Net area sown	2,610
Area sown more than once	250
Total cropped area	2,860
Cultivable area	6,190

Source: www.indiastat.com

State at a glance	
State capital	Kohima
Area	16,579 sq km
Population (2001)	19,88,636
Total number of districts	8
Major rivers	Dhansiri, Doyang, Dikhu, Milak, Zungki and Tizu
Total forest area	8,750 sq km
Population density (2001)	120 / sq km
Ramsar site	Nil
Proposed Ramsar sites	3
Proposed sites for conservation	3

Status of wetlands

A small portion of the geographical area of the state is covered by wetland; those in the size of 2.5 ha and above cover about 9.16 sq km; 0.01 % of the total area of the state (Table 24.2).

Apart from waterlogged wetlands, swamps and tanks, Nagaland has three categories of lakes, oxbow lakes or cut-off meanders, tectonic/ landslide lakes, and artificial reservoirs (Table 24.2). A large reservoir has been formed due to construction of a dam across the river Doyang, a tributary of the river Dhansiri in the district of Wokha for generating hydro-electric power. This is not included in Table 24.2. The largest natural lake in Nagaland is Shilloi

Table 24.2. Distribution of various categories of inland wetlands in Nagaland

Inland wetland type	Area (in sq km)
Lakes/ponds	0.07
Oxbow lakes/cut off meanders	0.53
Waterlogged(seasonal)	4.36
Swamps/marshes	3.82
Tanks	0.36
Waterlogged (man-made)	0.02
Total	9.16

Source: SAC (1998)

in the Phek district. This could be a tectonic lake. There is also a landslide lake in the same district (Dzudu lake). The oxbow lakes, (locally called 'beels') are found mostly along the river Dhansiri in the Dimpapur district. Value added maps of the spatial distribution of wetlands in some of the districts show the rarity of wetlands in the state (Fig. 24.1 - 24.3).

Biodiversity

Fishes

Twenty two species of Threatened fishes are reported from Nagaland (Menon, 1999), of which four are Endangered and 18 Vulnerable (Table 24.3).

Turtle

There are only two freshwater turtles recorded from Nagaland; one is Endangered and the other is Near Threatened (Table 24.4).

Birds

Only five species of birds were recorded during the survey. Out of which, one (Wood Snipe) was Threatened.

Table 24.3. Threatened freshwater fishes reported from Nagaland

No.	Species	Status
1	*Anguilla bengalensis*	EN
2	*Ompok bimaculatus*	EN
3	*Pseudeutropius atherinoides*	EN
4	*Puntius clavatus clavatus*	EN
5	*Anabas testudineus*	VU
6	*Bagarius bagarius*	VU
7	*Barbodes sarana*	VU
8	*Barilius barila*	VU
9	*Catla catla*	VU
10	*Cirrhinus reba*	VU
11	*Clarias batrachus*	VU
12	*Clupisoma garua*	VU
13	*Garra lissorhyncus*	VU
14	*Heteropneustes fossilis*	VU
15	*Labeo dero*	VU
16	*Mystus bleekeri*	VU
17	*Mystus vittatus*	VU
18	*Nemacheilus manipurensis*	VU
19	*Neolissochilus hexagonolepis*	VU
20	*Osteobrama cotio*	VU
21	*Psilorhynchus homaloptera*	VU
22	*Puntius chola*	VU

EN=Endangered; VU=Vulnerable

Socioeconomic values

All the three wetlands surveyed had medium use values (Table 24.5).

Prioritization of wetlands

Table 24.4. List of freshwater turtles reported from Nagaland

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Cuora amboinensis*	NT	II	-
2	*Kachuga sylhetensis*	EN	-	I

Two of the three wetlands surveyed in Nagaland, namely Shilloi and Doyang are equally important (Table 24.5). Shilloi, a natural lake near India-Myanmar border, has the highest ratings, followed by Doyang, a fairly large reservoir which came up recently. Dzudu, second in the rank, is also important as it is located inside dense temperate forest and harbours an endangered wetland bird species. Location of the prioritized wetlands is given in Fig. 24.4.

The major threat to Shilloi is the siltation caused by felling in the catchment areas. The socioeconomic uses of all the three wetlands are moderate. All of them could be declared as Community Reserves.

All the three wetlands qualify to be declared as Ramsar sites.

Table 24.5. Prioritized list of the main wetlands of Nagaland

No.	Name of the wetland	Rank	Use
1	Shilloi lake	1	M
2	Doyang reservoir	1	M
3	Dzudu (Zanibu) lake	2	M

Summary

- Nagaland has a total area of 9.16 sq km under wetlands of the size 2.25 ha and above, according to the data of 1992-93 (SAC, 1998).
- The state has four Endangered and 18 Vulnerable species of fishes; one each of an Endangered and Near Threatened species of freshwater turtles; and one Threatened species of bird.
- Three wetlands were surveyed and prioritized.
- All the three wetlands qualify to be declared as Ramsar sites.



Anwaruddin Choudhury

Laokhowa, Assam : one of the IBAs

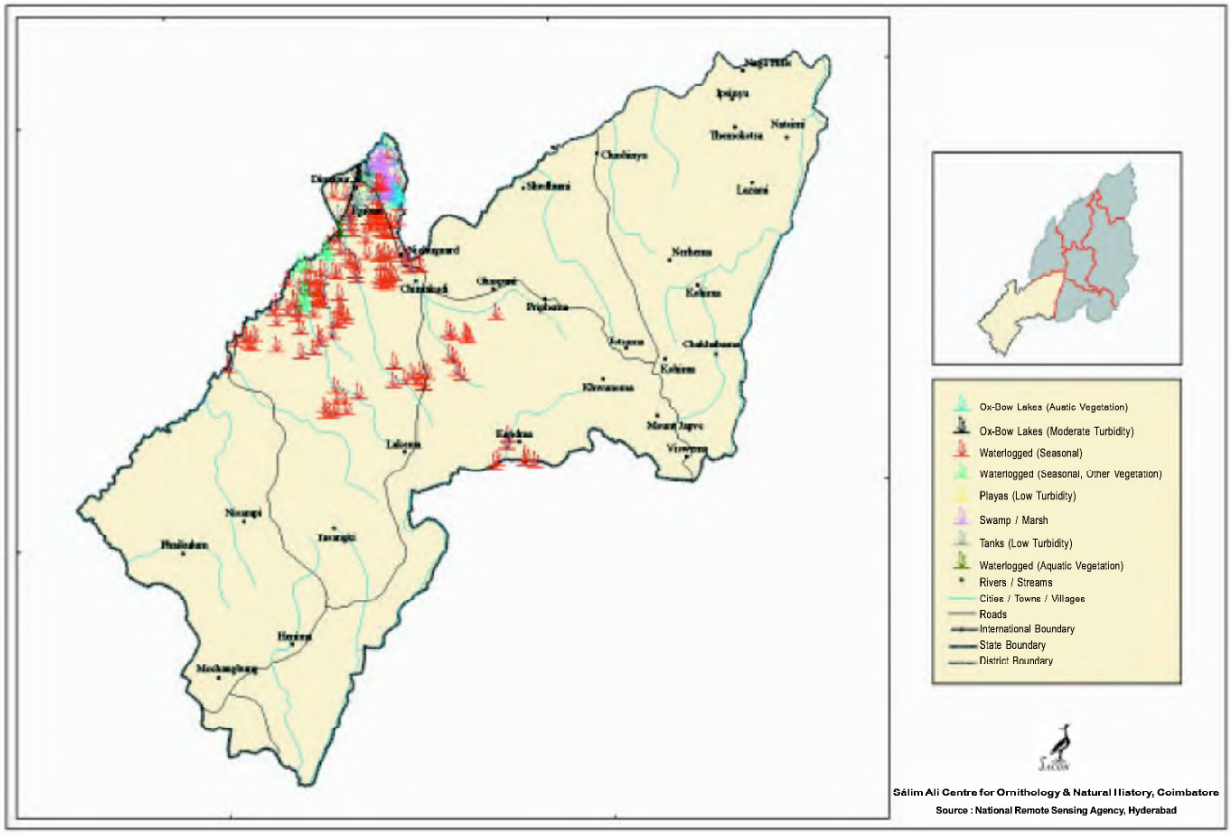


Fig. 24.1. Distribution of wetlands in the district of Kohima

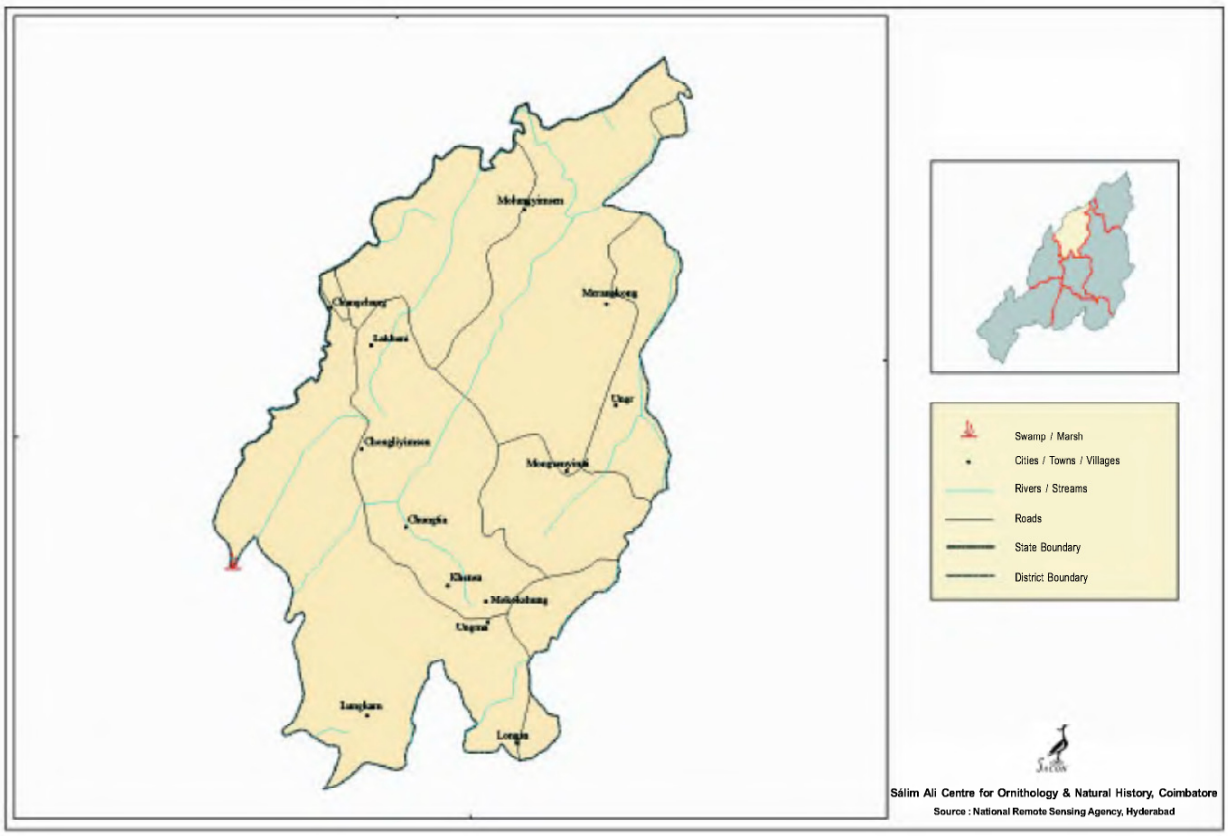


Fig. 24.2. Distribution of wetlands in the district of Mokokchung

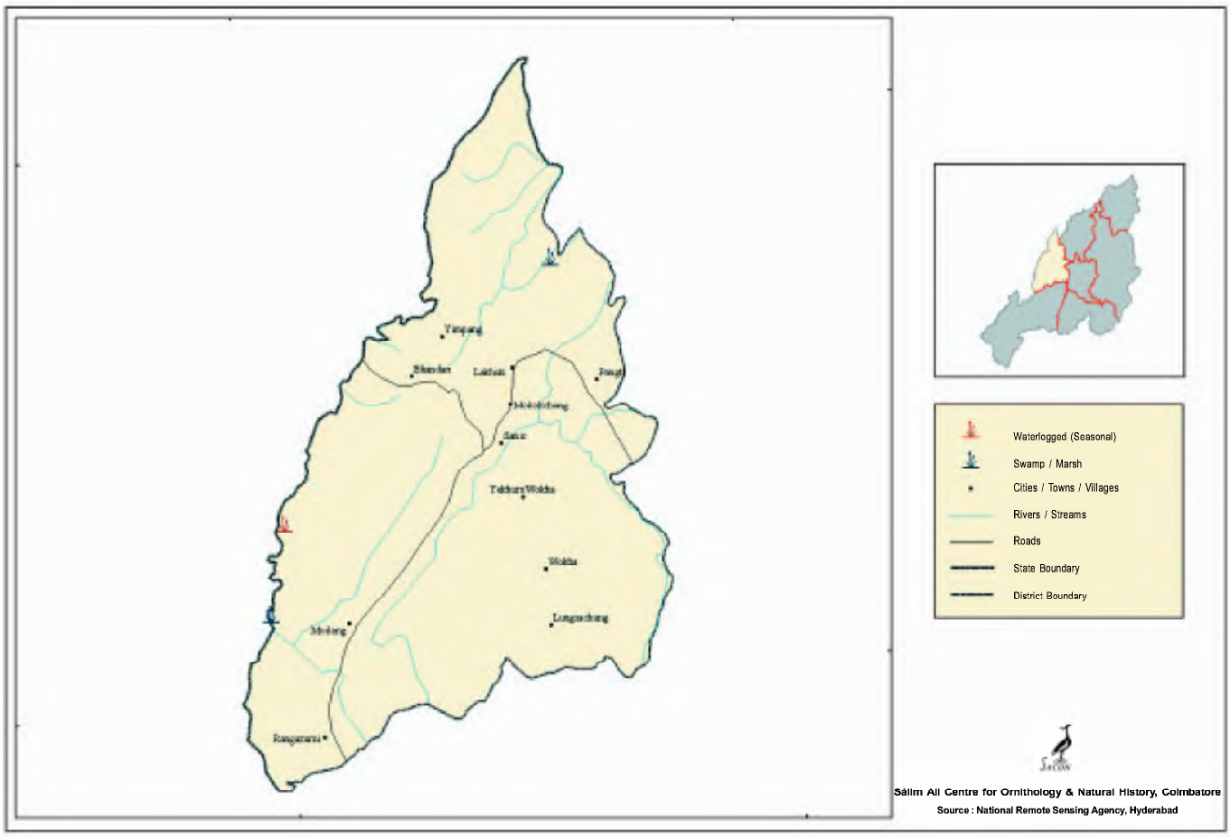


Fig. 24.3. Distribution of wetlands in the district of Wokha

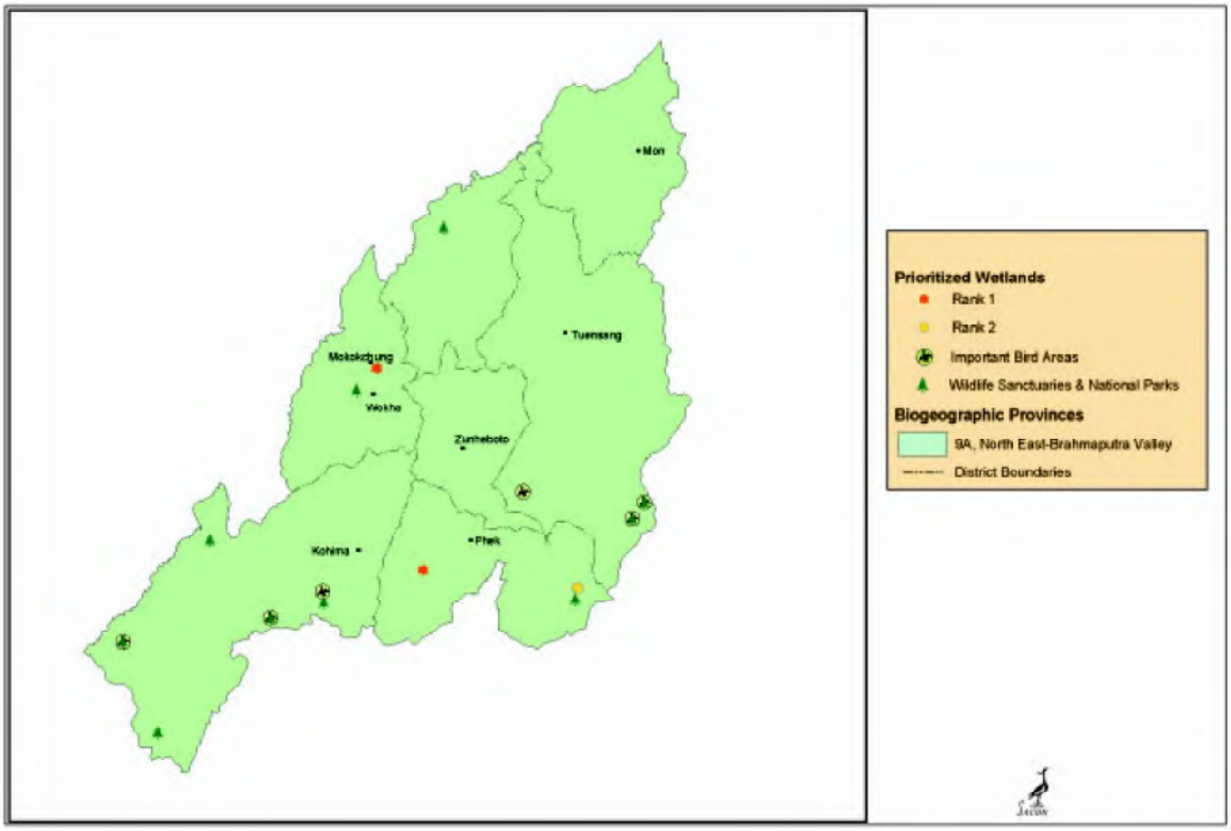


Fig. 24.4. Prioritized wetlands and other conservation areas in Nagaland

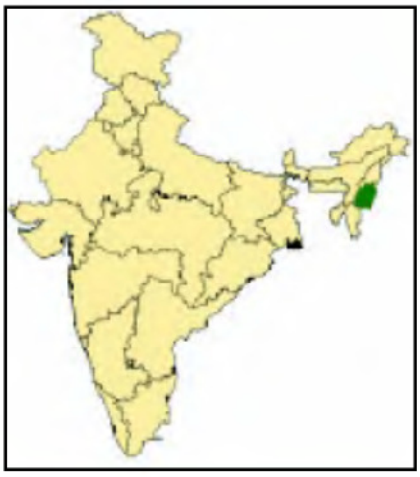


Bivash Pandav

Ya Ya Tso Chang Thang, Ladakh

MANIPUR

Manipur literally, the bejeweled land, is the abode of Shiroy Lily (*Lilium macklinae*), the paradise flower, which is not found elsewhere in the world. Likewise, Manipur has the only habitat of Sangai, the Dancing Deer, in the famous wetland of Keibul Lamjao National Park. The state is divided into two tracts, the hills and the plains. The river Manipur (Imphal) and its tributaries constitute the plains of the state; the state's capital Imphal is situated on the bank of this river.



The climate of Manipur is moderate. January is the coldest and July-August, the hottest. The state receives plenty of rainfall varying from 1,016 to 1,778 mm a year, often reaching 2500 mm in the extreme west. The average temperature varies from 13 to 35°C.

Considerable portion of the geographic area (60%) of the state is covered by forests. However, there is no separate category of wetlands in the land use classification (Table 25.1).

State at a glance	
State capital	Imphal
Area	22,327 sq km
Population (2001)	23,886,34
Total number of districts	9
Major rivers	Barak, Iril, Jiri, Makru, Irang, Khuga, Chapki, Manipur
Total forest area	6020 sq km
Population density (2001)	107/sq km
Ramsar site declared	1
Proposed Ramsar sites	4
Total sites proposed for conservation	6

Status of wetlands

The state has 155 wetlands of 2.5 ha in size, covering a total area of 529 sq km (Table 25.2).

Manipur has four categories of lakes, namely valley lakes, oxbow lakes or cut-off meanders, tectonic/landslide lakes, and artificial reservoirs. All these lakes together constitute

Table 25.1. Land use pattern in Manipur

Land use type	Area (sq km)
Total geographic area	22,327
Forests	6,020
Not available for cultivation	14,450
Other uncultivated land excluding fallow land	240
Fallow land	-
Net area sown	1,400
Area sown more than once	760
Total cropped area	2,160
Cultivable area	1,640

(Source: www.indiastat.com)

Table 25.2. Distribution of various categories of inland wetlands in Manipur

Type of wetland	Area (sq km)	No. of wetlands
Lakes/ponds	433.58	21
Oxbow lakes	0.35	2
Waterlogged	94.66	130
Reservoirs	1.00	2
Total	529.59	155

Source: SAC (1998)

about 82% of the wetlands of the state (Table 25.2). The 'valley lake', locally known as 'pat' are very prominent in Manipur. The physiography of the state is dominated by the basin of Loktak, the largest freshwater lake in India. Pumlen is another major lake in the valley. The oxbow lakes, locally called beels, are scarce and are found mostly in Jiribam area of Imphal East district. There is a complex of lakes in Tamenglong district (Zeilad lake complex), which does not fall in any of these categories or a combination of some of these. The value added maps of the spatial distribution of wetlands of the districts show that the wetlands in Manipur are few and far between unlike in many other states (Fig. 25.1 to 25.4).

Biodiversity

Fishes

Twenty three species of Threatened fishes are reported from Manipur (Menon, 1999), of which seven are Endangered and 16 Vulnerable (Table 25.3).

Turtles

Six species of freshwater turtles have been reported from Manipur, of which one is Endangered, two are Vulnerable, and three Near Threatened (Table 25.4).

Table 25.3. Threatened freshwater fishes reported from Manipur

No.	Species	Status
1	*Anguilla bengalensis*	EN
2	*Barilius dogarsinghi*	EN
3	*Botia berdmorei*	EN
4	*Chitala chitala*	EN
5	*Ompok bimaculatus*	EN
6	*Pseudeutropius atherinoides*	EN
7	*Raiamas guttatus*	EN
8	*Bagarius bagarius*	VU
9	*Barbodes sarana*	VU
10	*Barilius barila*	VU
11	*Catla catla*	VU
12	*Cirrhinus reba*	VU
13	*Clarias batrachus*	VU
14	*Clupisoma garua*	VU
15	*Puntius chola*	VU
16	*Labeo dero*	VU
17	*Heteropneustes fossilis*	VU
18	*Osteobrama cotio*	VU
19	*Mystus vittatus*	VU
20	*Pangio pangio*	VU
21	*Nemacheilus manipurensis*	VU
22	*Nemacheilus kangjupkhulensis*	VU
23.	*Nemacheilus prashadi*	VU

EN=Endangered; VU=Vulnerable

Table 25.4. List of freshwater turtles reported from Manipur

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Aspideretes gangeticus*	VU	-	I
2	*Aspideretes hurum*	VU	I	I
3	*Cuora amboinensis*	NT	II	-
4	*Cyclemys oldhami*	NT	-	-
5	*Kachuga tentoria*	NT	-	-
6	*Pyxidea mouhotii*	EN	-	-

Birds

Six wetlands were selected and surveyed in Manipur. 2,815 birds of 46 species were recorded, out of which three species are Threatened and two Near Threatened (Table 25.5).

Prioritization of wetlands

Six wetlands were selected and surveyed in detail in Manipur. Five of them received high ratings and hence placed in the first rank (Table 25.6) and one which received slightly less rating is placed in the second rank. Loktak lake topped the priority list with very high ratings, followed by Pumlen, Ikop, Kharung and Zeilad. The very high rating of Loktak was apparent as it is the largest freshwater lake in India and is also important from ornithological and other biodiversity points of view. It is already declared as a Ramsar site. Zeilad is inside the Wildlife Sanctuary and thus partly protected. However, human pressures need to be monitored. Waithou lake came in the second rank, because of the fewer species richness and the size of the wetland. Location of the prioritized wetlands along with other conservation areas is given in Fig. 25.5.

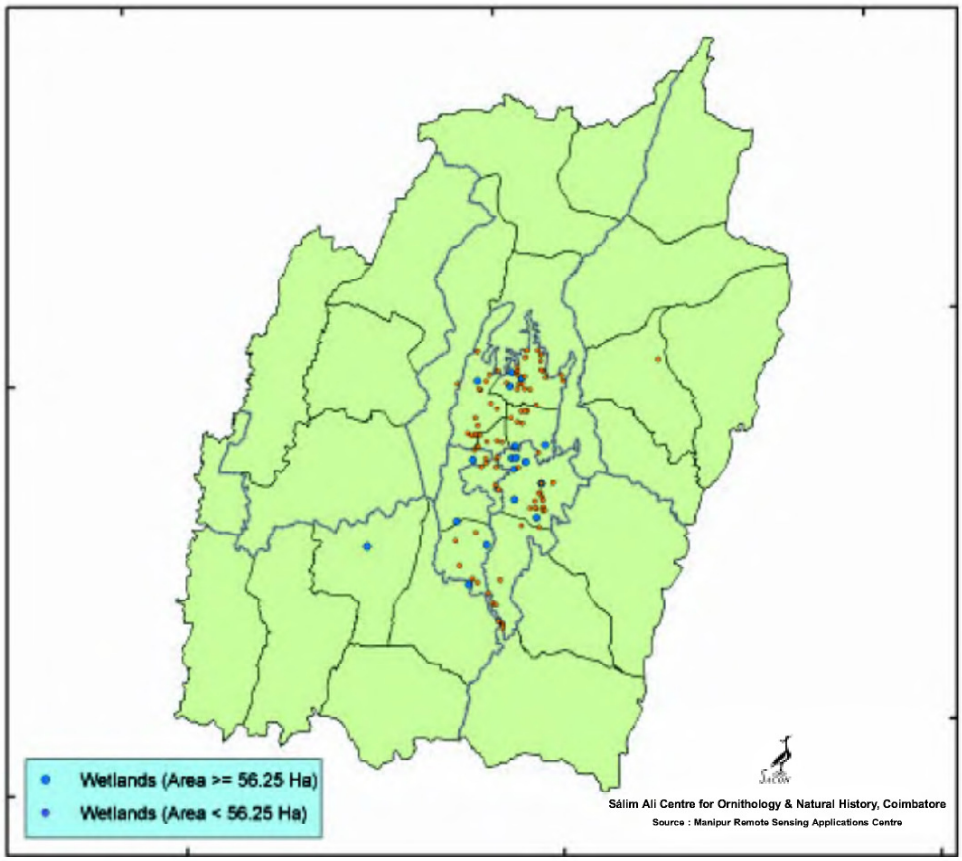


Fig. 25.1. Distribution of wetlands in Manipur

Table 25.5. Threatened and Near Threatened species of birds reported from Manipur

S.#	Species	Status	No.of sites
1	Whitewinged Wood Duck	T	1
2	Lesser Adjutant	T	1
3	Pallas's Fishing Eagle	T	1
4	White-eyed Pochard	NT	6
5	Darter	NT	6

T=Threatened; NT=Near Threatened

Table 25.6. Prioritized list of the main wetlands of Manipur

No.	Name of the wetland	Rank	Use grade
1	Loktak lake	1	H
2	Pumlen pat	1	H
3	Ikop pat	1	H
4	Kharung pat	1	H
5	Zeilad lake complex	1	H
6	Waithou lake	2	H

The major stakeholders are tourism, power, fisheries and forest departments, Loktak Development Authority, fishermen, fringe villagers and bird/animal trappers or hunters. All the top ranking wetlands have high use value to the local population, and hence need to be considered on priority for conservation and sustainable use. Loktak has already been declared as a Ramsar site. The next four in the prioritized list are also eligible for declaration as Ramsar sites.

Summary

- Manipur, according to the survey using the satellite imageries of 1994-95, has 155 wetlands of 2.25 ha and above in size, covering an area of 529 sq km (SAC, 1998).
- Oxbow lakes cover a larger area, although their number is low. Waterlogged type is higher in number and smaller in size.
- Manipur has seven Endangered and 15 Vulnerable species of fishes; one Endangered, two Vulnerable and three Near Threatened species of freshwater turtles; and three Threatened and two Near Threatened species of birds.
- Six wetlands were surveyed and prioritized. Five fall in the first rank and one in the second rank.
- Loktak lake which is the first one in the prioritized list is already a Ramsar site. The remaining four in the top rank may be considered for declaration as Ramsar sites.



Anwaruddin Choudhury

Phumdis in Keibul Lamjao National Park, Manipur

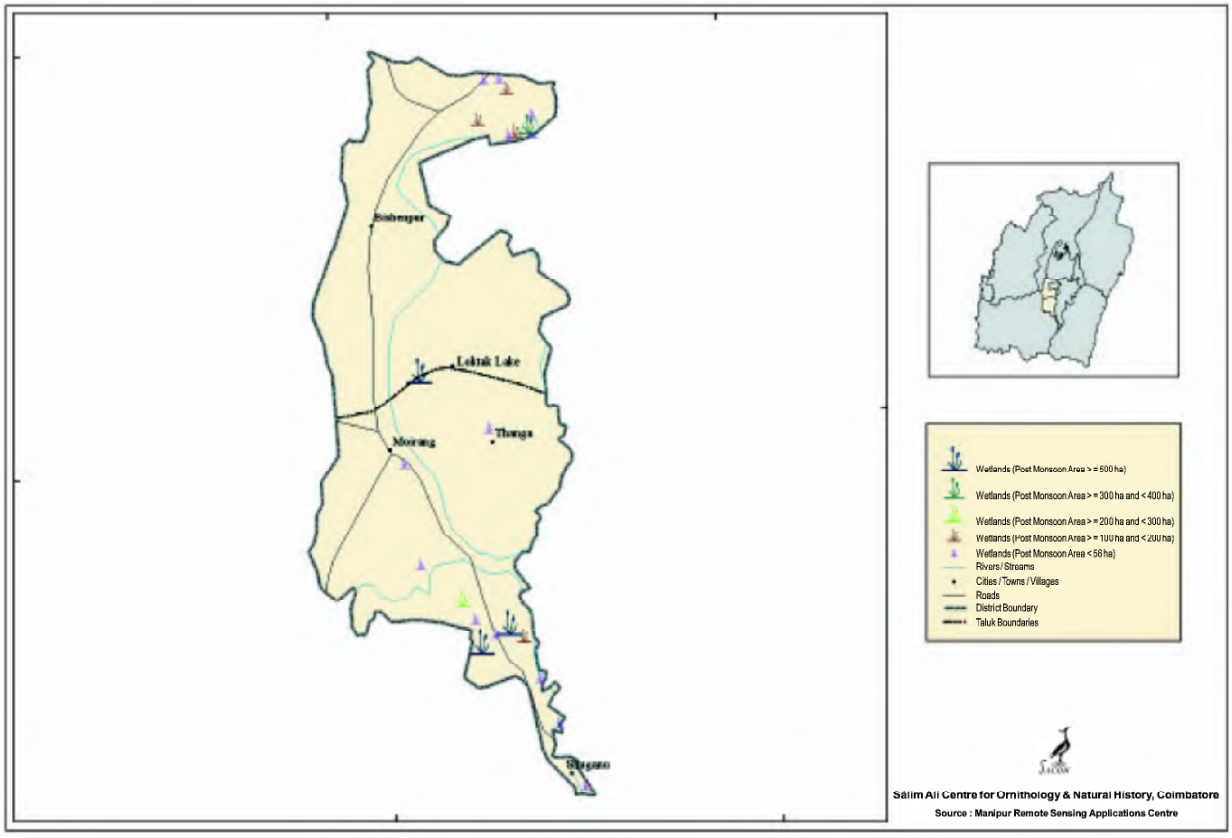


Fig. 25.2. Wetland distribution in the district of Bishnupur

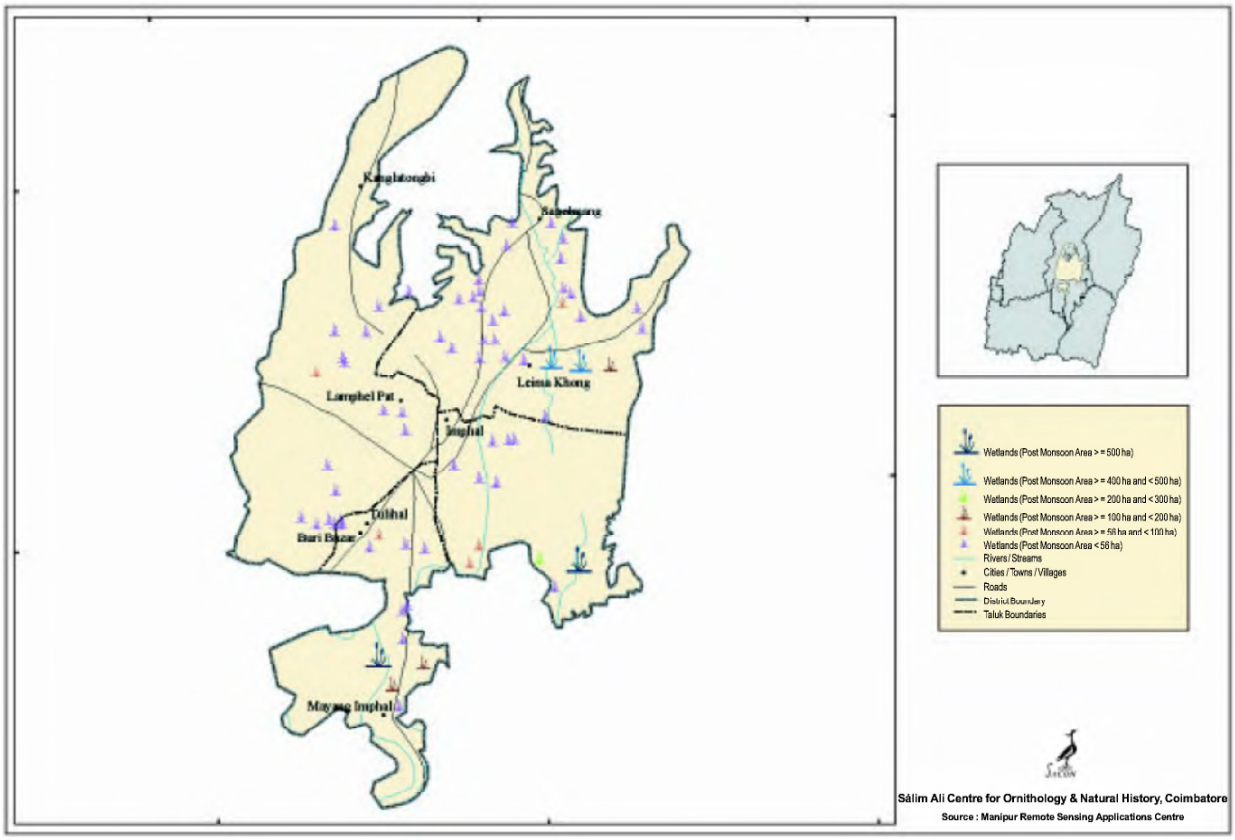


Fig. 25.3. Wetland distribution in the district of Imphal

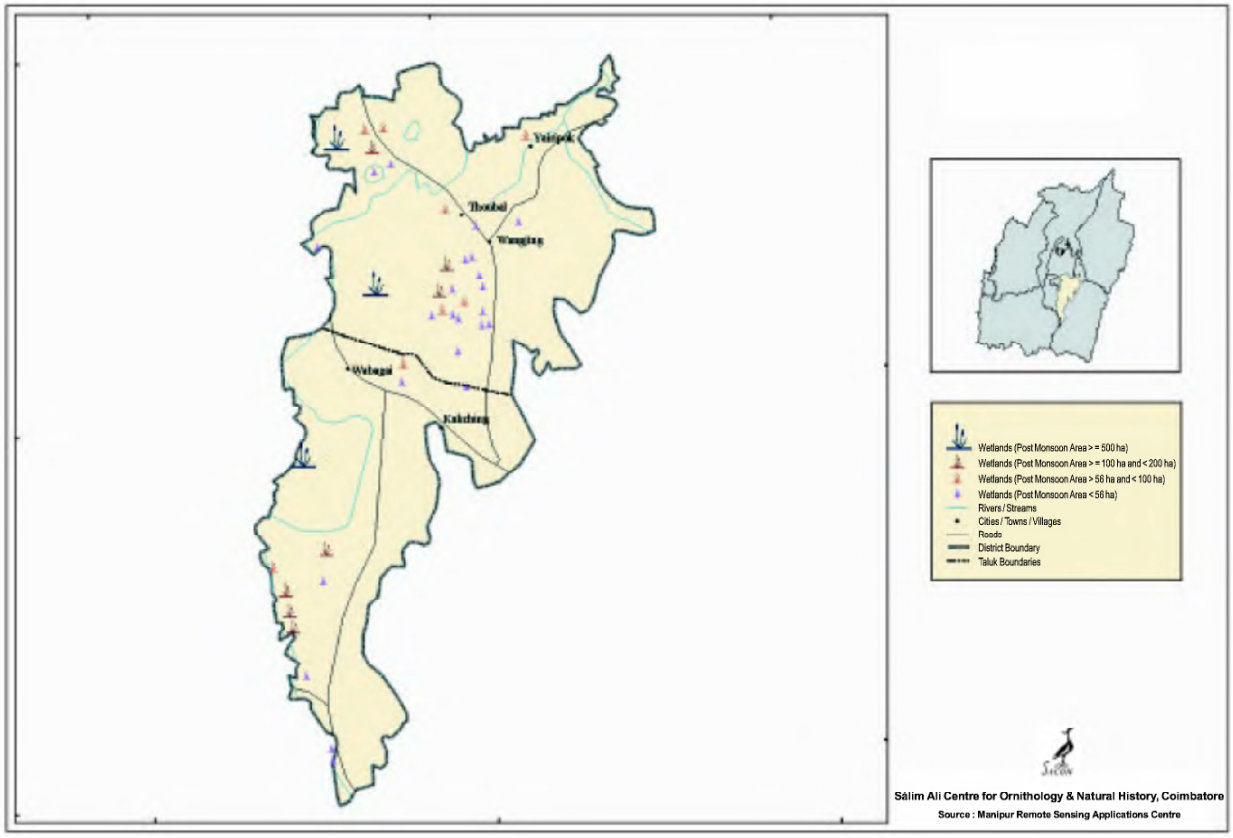


Fig. 25.4. Wetland distribution in the district of Thoubal

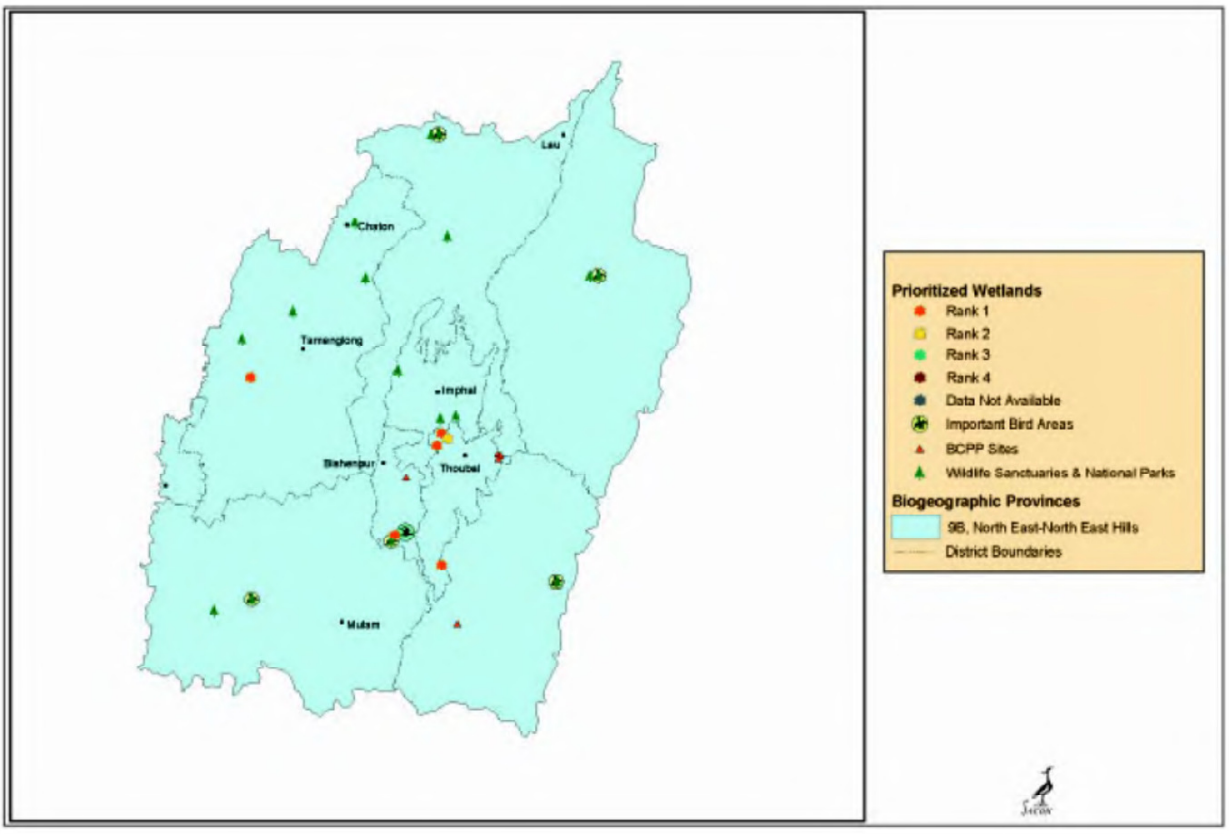


Fig. 25.5. Prioritised wetlands and other conservation areas in Manipur

MIZORAM

Mizoram, famous for its blue mountains and deep valleys with fast flowing rivers, is shaped almost like a narrow and inverted triangle, situated in the northeast corner of India.

Hills in Mizoram run from north to south and have an average height of about 900 meters; the highest peak being the Blue Mountain (2,157 meters). Average annual rainfall is about 3,000 mm. Even during summer, the higher hills are quite cool and pleasant. The mean temperature varies from 12°C in winter to about 30°C in summer.

Almost 76% of the geographic area of the state is covered with forests. However, presence of wetlands is not indicated in the land use pattern of the state (Table 26.1).



State at a glance	
State capital	Aizawl
Area	21,087 sq km
Population (2001)	8,91,058
Total number of districts	8
Major rivers	Tlawng (Dhaleswari), Sonai, Tuivai, Tuirial, Barak, Longai, Manipur (Imphal)
Total forest area	15,980 sq km
Population density (2001)	42/sq km
Ramsar site	Nil
Proposed Ramar site	1
Total sites proposed for conservation	3

Status of wetlands

The state does not have large wetlands; the total area of wetlands of the size 2.5 ha and above is only 1.5 sq km (SAC, 1998).

Mizoram has three categories of lakes, namely valley lakes, tectonic/landslide lakes, and artificial reservoirs but except for one lake, all are insignificant. There is a reservoir under construction on the Tuirial or Sonai river. The only lake of significance is Palak dil, which is a natural lake in a depression in the hills. Palak could be a combination of 'valley and tectonic lake'. The lakes are known locally as 'dils'. There are many such 'dils' scattered all over the state but all are either tiny pools or marshy depressions such as Reng dil, Tam dil and Mampui dil. Value added maps of the spatial distribution of wetlands

Table 26.1. Land use pattern in Mizoram

Land use type	Area (sq km)
Total geographic area	21,087
Forests	15,980
Not available for cultivation	650
Other uncultivated land excluding fallow land	1,740
Fallow land	1,630
Net area sown	1,090
Area sown more than once	70
Total cropped area	1,160
Cultivable area	4,460

Source: www.indiastat.com

Table 26.2. Distribution of various categories of inland wetlands in Mizoram

Inland wetland type	Area (in sq km)
Lakes/ponds	0.29
Waterlogged (seasonal)	1.16
Tanks	0.05
Total	1.50

Source: SAC (1998)

in some districts show that the wetlands <2.5 ha are few and far between.

Biodiversity

Fishes

Altogether 15 species of Threatened fishes are reported from Mizoram (Menon, 1999), of which four are Endangered and 11 Vulnerable (Table 26.3).

Turtles

Mizoram has seven species of turtles. Out of which two are Endangered, three are Near Threatened and one each is Vulnerable and of Least Concern (Table 26.4).

Table 26.4. List of freshwater turtles reported from Mizoram

S.#	Species	Status category		
		IUCN listing	CITES	Indian Wildlife Protection Act
1	*Amyda cartilaginea*	VU	-	-
2	*Cyclemys oldhami*	NT	-	-
3	*Kachuga sylhetensis*	EN	-	I
4	*Kachuga tecta*	NT	I	I
5	*Kachuga tentoria*	NT	-	-
6	*Melanochelys trijuga*	LC	-	-
7	*Pyxidea mouhotii*	EN	-	-

VU=Vulnerable; NT=Near Threatened; EN=Endangered; LC=Least Concern

Table 26.3. Threatened freshwater fishes reported from Mizoram

No.	Species	Status
1	*Anguilla bengalensis*	EN
2	*Ompok bimaculatus*	EN
3	*Pseudeutropius atherinoides*	EN
4	*Semiplotus modestus*	EN
5	*Anabas testudineus*	VU
6	*Bagarius bagarius*	VU
7	*Barbodes sarana*	VU
8	*Catla catla*	VU
9	*Cirrhinus reba*	VU
10	*Clarias batrachus*	VU
11	*Puntius chola*	VU
12	*Labeo dero*	VU
13	*Heteropneustes fossilis*	VU
14	*Osteobrama cotio*	VU
15	*Mystus vittatus*	VU

EN=Endangered; VU=Vulnerable

Birds

Thirty-two species of birds have been reported from Mizoram. Out of which one each was Threatened and Near Threatened; the Whitewinged Wood Duck and the Darter respectively. The former was recorded from Mampui dil and Palak dil, whereas the latter only from Palak dil.

Socioeconomic values

All the three wetlands surveyed had medium use (Table 26.5).

Prioritization of wetlands

Three wetlands of Mizoram were surveyed. Palak dil, declared recently as a Protected Area, got the highest rank (Table 26.5). It is a natural lake in a depression in the hills. It is surrounded by some fine primary rain forests and is the largest natural lake in the entire Mizoram. The other two wetlands, in the second rank are also important and should be considered for conservation. Since these wetlands are used to a medium level, these could be protected as Community Reserves. Prioritized wetlands along with other conservation areas are given in Fig. 26.1.

Palak dil qualifies to be declared as a Ramsar site.

Table 26.5. Priority ratings of the main wetlands of Mizoram

No.	Name of the wetland	Rank	Use
1	Palak dil	1	M
2	Mampui dil	2	M
3	Tam dil	2	M

Summary

- The total area of wetlands in Mizoram is only 1.5 sq km as per the satellite imageries of 1992-'93 (SAC, 1998).
- Mizoram has four Endangered and 11 Vulnerable species of fishes; two Endangered, three Near Threatened and one each of Vulnerable and Least Concern species of turtles; and one each of Threatened and Near Threatened species of birds.
- Thirty-two species of birds were recorded.
- Three wetlands have been surveyed and prioritized; one in the first rank and two in the second rank.
- Palak dil which tops the list, qualifies to be declared as a Ramsar site.



Anwaruddin Choudhury

Palak dil, Mizoram: one of the IBAs and proposed Ramsar sites

Anwaruddin Choudhury



Another view of Palak dil

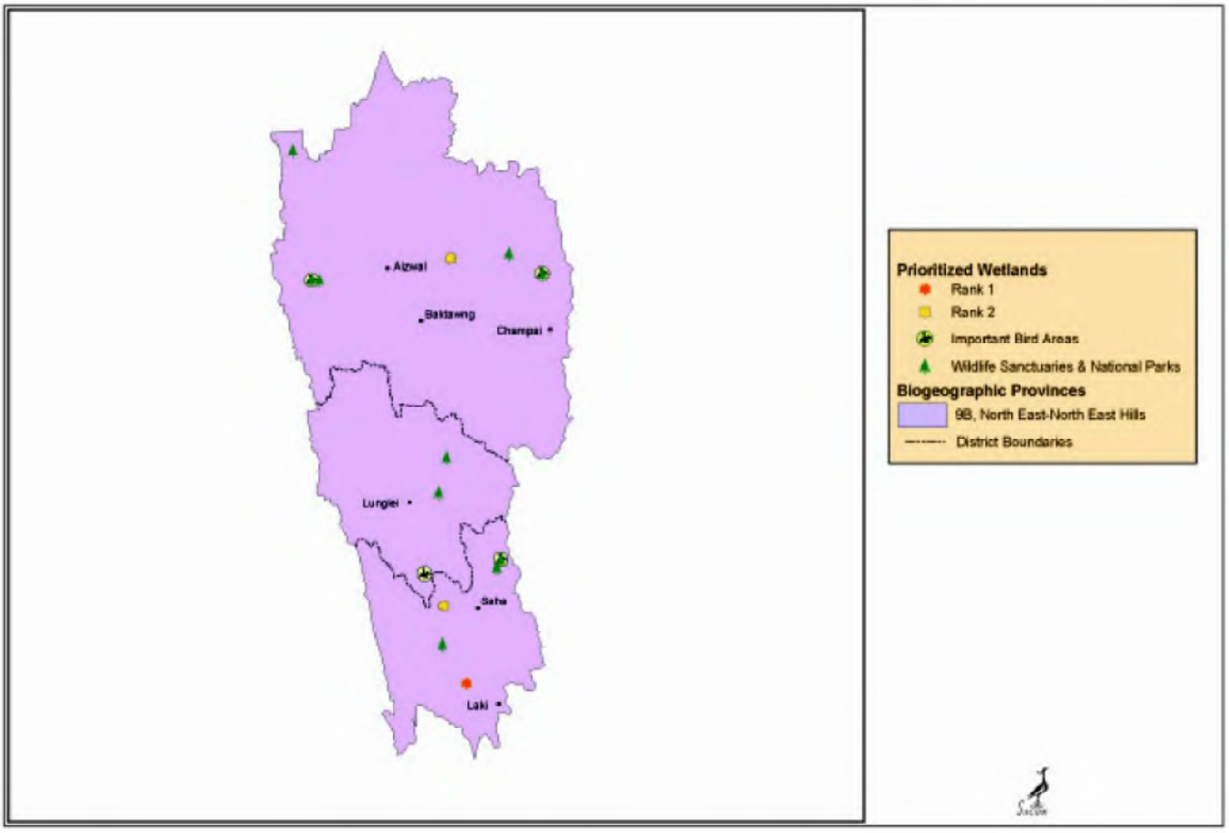


Fig. 26.1. Prioritized wetlands and other conservation areas in Mizoram

TRIPURA

Tripura, picturesque with its hills and valleys, is the second smallest state of India. The hills and sub-mountains occur in the central and eastern region. The Gumti is the largest river in the state, which is revered in Tripura in the same way as the Ganges in North India. The state's climate is tropical moist or warm and humid with the maximum temperature of 35°C in summer and minimum of 10.5°C in winter. The average rainfall of the state is around 2,300 mm.



Nearly 58% of the total land area is under forest. However, no wetlands have been indicated (Table 27.1).

Table 27.1. Land use pattern in Tripura

Land use type	Area (sq km)
Total geographic area	10,491
Forests	6,060
Not available for cultivation	1,330
Other uncultivated land excluding fallow land	280
Fallow land	50
Net area sown	2,770
Area sown more than once	1,670
Total cropped area	4,440
Cultivable area	3,100

Source: www.indiastat.com

State at a glance	
State capital	Agartala
Area	10,491 sq km
Population (2001)	31,91,168
Total number of districts	4
Major rivers	The Gumti, Manu, Haorah, Doloi, Khowai
Total forest area	6,060 sq km
Population density (2001)	304/sq km
Ramsar site	Nil
Proposed Ramsar sites	2
Total sites proposed for conservation	7

Status of wetlands

The SAC (1998) has reported, according to the satellite data of 1992-'93, 408 wetlands, each 2.25 ha and above, covering a total area of 98.95 ha (Table 27.2).

There are six types of wetlands, of which reservoirs cover the largest area, but waterlogged wetlands are more numerous (Table 27.2).

The oxbow lakes, mostly tiny, are scattered in the plains. The largest artificial lake in the region is the Dumbur lake or Gumti reservoir, formed by the construction of a dam across the river Gumti, near the confluence of the rivers Raima and Sarma in 1974 for generating hydro-electric power in the South Tripura district. At least 6 sq km

Table 27.2. Distribution of various categories of inland wetlands in Tripura

Type of wetland	Area (sq km)	No. of wetlands
Lakes/ponds	25.04	74
Oxbow lakes	3.60	84
Waterlogged (seasonal)	15.43	222
Reservoirs	53.22	5
Tanks	1.36	19
Waterlogged	0.30	4
Total	98.95	408

Source: SAC (1998)

in Gandachara subdivision of this 42 sq km lake had been silted up over the years due to jhum and felling in the catchment areas. There are 48 islands in the lake.

Biodiversity

Aquatic vegetation

No information could be gathered on the aquatic vegetation. The literature surveyed did not yield any.

Fishes

Fourteen species of Threatened fishes are reported from Tripura (Menon, 1999), of which two are Endangered and 12 Vulnerable (Table 27.3).

Table 27.3. Threatened freshwater fishes of Tripura

No.	Species	Status
1	*Anguilla bengalensis*	EN
2	*Pseudeutropius atherinoides*	EN
3	*Anabas testudineus*	VU
4	*Bagarius bagarius*	VU
5	*Barbodes sarana*	VU
6	*Catla catla*	VU
7	*Cirrhinus reba*	VU
8	*Clarias batrachus*	VU
9	*Clupisoma garua*	VU
10	*Puntius chola*	VU
11	*Labeo dero*	VU
12	*Heteropneustes fossilis*	VU
13	*Osteobrama cotio*	VU
14	*Mystus vittatus*	VU

EN=Endangered; VU=Vulnerable

Turtles

No freshwater turtles have been reported from Tripura (Bhupathy and Menon, 2003).

Birds

There were no Endangered birds in the seven wetlands studied; only one Near Threatened species was recorded, the Darter in one of the sites; Gumti reservoir.

Socioeconomic values

All the seven wetlands surveyed have been used by people at medium level (Table 27.4).

Prioritization of wetlands

Seven major wetlands of Tripura were surveyed and prioritized for conservation; two came in the first rank, three in the second rank and two in the third rank (Table 27.4). An artificial lake, Gumti or Dumbur ranks high in the list because of its large size and presence of a large number of species. Rudrasagar also deserves high conservation attention because of the high species richness. With proper planning, this large lake could become an important wildlife habitat as well as a centre of eco-tourism. Distribution of the prioritized wetlands is given in Fig. 27.1.

Gumti reservoir and Rudrasagar are qualified to be declared as Ramsar sites. Since all the seven wetlands are having medium use by the people living around, it is advisable to declare them as Community Reserves, while the first two should have the status of Ramsar sites.

Table 27.4. Prioritized list of the main wetlands of Tripura

No.	Name of the wetland	Rank	Use
1	Gumti reservoir (Dumbur lake)	1	M
2	Rudrasagar (Nirmahal)	1	M
3	Sipahijala reservoir	2	M
4	Trishna wetlands	2	M
5	Sattar Mia's Haor	2	M
6	Batapura lake	3	M
7	College Tilla lake	3	M

Summary

- Tripura, according to the satellite data of 1992-93, has 408 wetlands of the size 2.25 ha and above, covering an area of 98.95 ha (SAC, 1998).
- Six types of wetlands are present in the state; waterlogged is more numerous, but the reservoirs cover larger areas.
- Tripura has two Endangered and 12 Vulnerable species of fishes; and one Near Threatened species of bird.
- Seven wetlands were surveyed and prioritized.
- The two wetlands, namely Gumti reservoir (Dumbur lake) and Rudrasagar (Nirmahal), which come under the first rank, qualify to be declared as Ramsar sites.



Anwaruddin Choudhury

Dibru-Saikhowa National Park, Assam: one of the IBAs

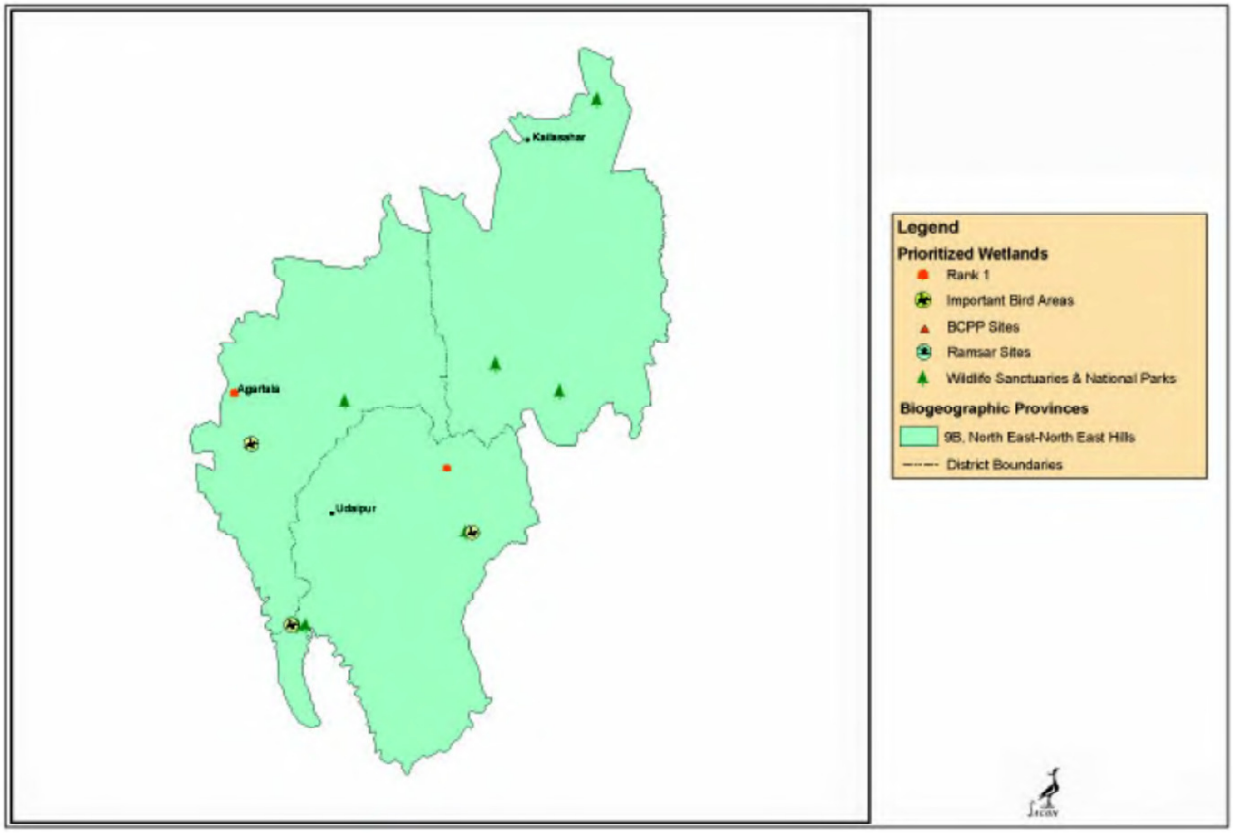


Fig. 27.1. Prioritized wetlands along with other conservation areas in Tripura

Environmental contamination in the North-Eastern states (excluding Assam)

Samples of fishes could be collected only from Manipur, Nagaland and Meghalaya. Information on twenty fishes from three wetlands comprising seven species are discussed here which would give an indication of the pollution levels.

Heavy metals

Among the three wetlands examined, Loktak lake of Manipur recorded the highest concentration of all metals (lead 7.44±1.44 ppm; zinc 26.12±15.18 ppm; copper 1.06±0.98 ppm and cadmium 1.13±0.15 ppm), except chromium (Fig. 27.2). Umiam lake of Meghalaya recorded the highest level of chromium (0.84±0.43 ppm).

Among the seven species studied, *Anabas testudineus*, a species reported in all the states, recorded the maximum concentrations of lead (8.36±2.84 ppm), zinc (34.72±14.92 ppm) and cadmium (1.22±0.19 ppm). The levels of copper appear to fall within the tolerable limits (Fig. 27.3).

Significant variation in the levels of lead and zinc among the wetlands was observed ($P<0.005$). However, variation in the concentration among species was discernible only in *Hypothalmicthys molitrix* and *Channa punctatus*.

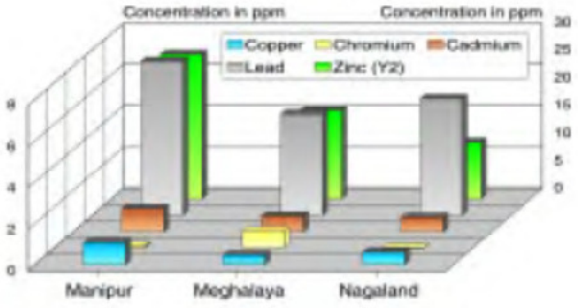


Fig. 27.2. Heavy metal contamination among the wetlands of the North-Eastern states

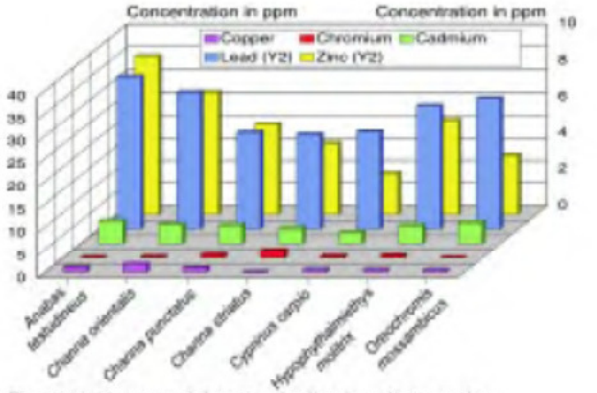


Fig. 27.3. Heavy metal contamination in select species of fishes in the North Eastern states

Pesticides

Fishes from the wetlands of the three North-Eastern states had lower load of organochlorine residues than those from other states, particularly Assam, Gujarat and Bihar. Among the pesticides tested, HCH is quite prevalent followed by heptachlor epoxide and DDT. Among the three states, fishes from Nagaland (0.16 ppm) detected the maximum load of organochlorine residues. Levels in Loktak lake in Manipur and Umiam lake in Meghalaya were 0.058 ppm and 0.038 ppm respectively (Fig. 27.4).

Of the seven species of fishes analyzed, *Cyprinus carpio* (0.153 ppm) had the highest level of total organochlorine residues followed by *Oreochromis mossambicus* (0.113 ppm). Less contaminated fishes are *Hypophthalmicthys molitrix (0.074 ppm)* and *Channa punctatus* (0.002 ppm). Although only one sample of *Oreochromis mossambicus* was received from Nagaland, it had a higher concentration of organochlorine residues (Table 27.5).

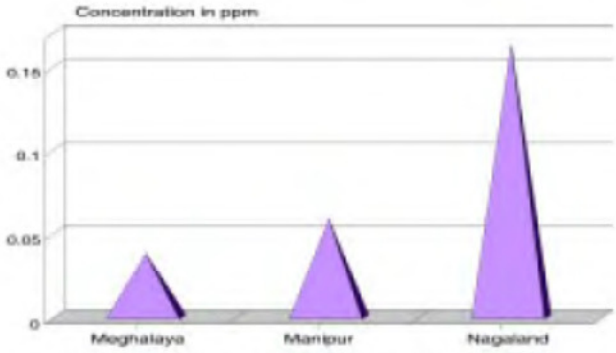


Fig. 27.4. Total organochlorine residues among various wetlands of the North-Eastern states

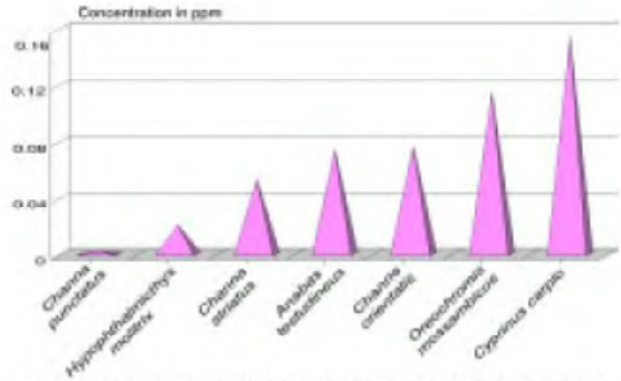


Fig. 27.5. Total organochlorine residues among various species of fishes in the North-Eastern states

Suitability for human consumption

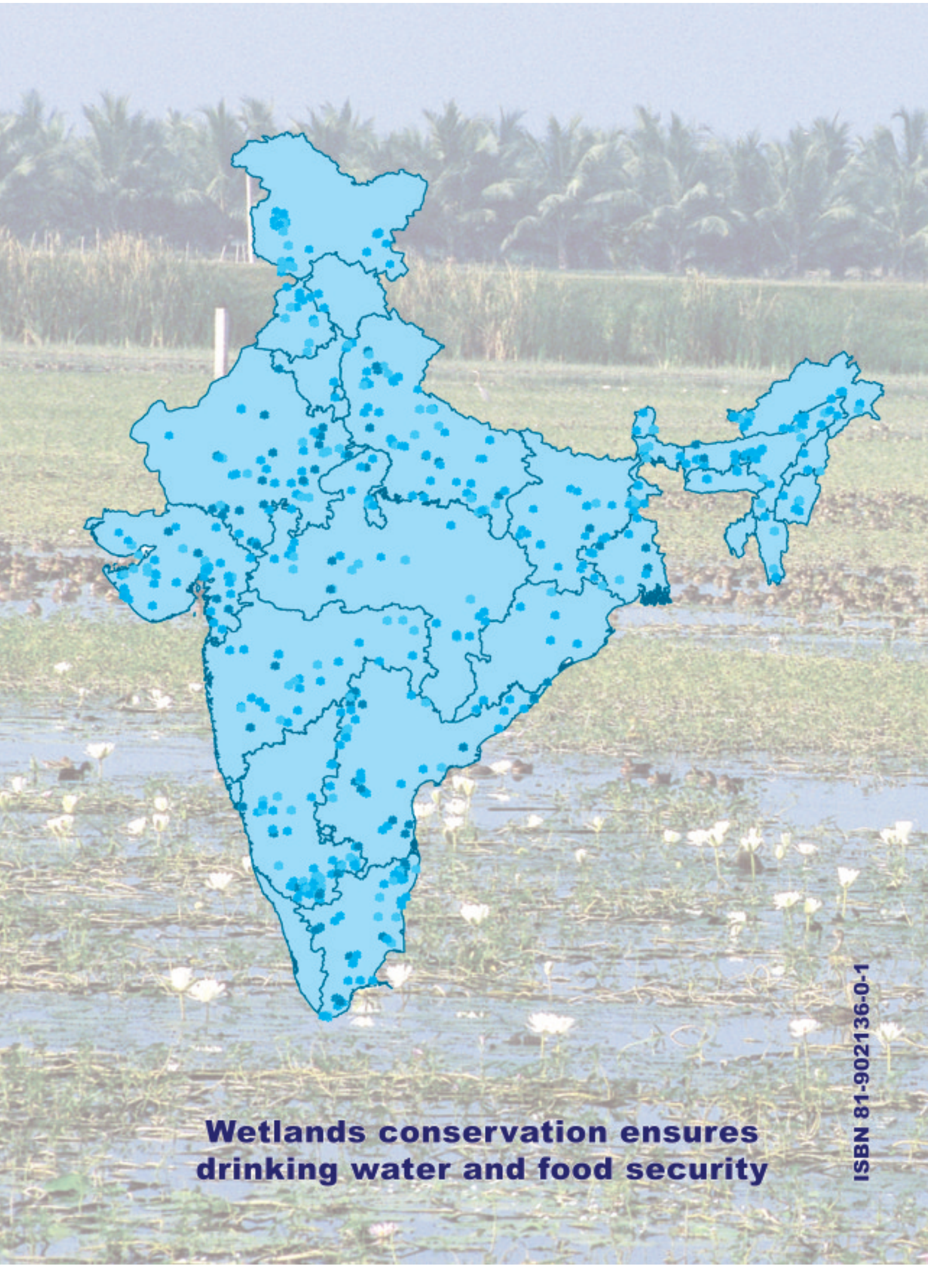
Among the fishes evaluated for public consumption, lead input through *Hypothalmicthys molitrix* is calculated as 0.24 mg which is higher than the limit stipulated by UN Committee (WHO, 1989, 1993) which stipulates only 0.21mg per 60 kg adult/day. Excess consumption may lead to lead toxicosis.

Although varying levels of pesticide residues have been detected in fishes from the three states of North-East, the levels were lower than the maximum residue limits permitted for fish and wildlife (FAO, 1983). Moreover, it also appears to be safe for human consumption according to the guidelines prescribed by UNEP/FAO/WHO (1989) and Health Canada (1996). Excessive fishing and drought were reported to be responsible for the decline in fish catch (*Clarias batrachus* and *Anabas testudineus)* by 50% in Loktak lake and Umiam lake. However, pesticide and metal concentrations cannot be ruled out, since discharge of effluents from some small scale industries and intrusion of city sewage into the wetland have been noticed. It is also to be noted that pesticide consumption in Manipur, Meghalaya and Nagaland is about 29,11 and 9 mt/year, respectively.



S. Mualidharan

Tell-tale traces of chemicals in fishes provide clues to the potential problem in the ecosystem



Wetlands conservation ensures drinking water and food security

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