REMOTE SENSING AND GEOGRAPHIC INFORMATION SYTEM FOR CONSERVATION AND MANAGEMENT OF BIOLOGICAL DIVERSITY

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ABSTRACT:

The Biological diversity is characterised by exploring three different levels of biological perception such as ecological diverstiy, species diversity and genetic diversity. In coastal zone the diversity is mainly concerned with specialised ecosystems such as mangroves, coral reefs and sea grass beds. This paper highlights the application of remote sensing and geographic Information System in finding the coastal wetland changes in Pichavaram mangrove forest of Tamil Nadu, India which has been carried out in Centre for Research and Sustainable Agricultural and Rural Development of M.S.Swaminathan Research Foundation. Which reveals that there occured considerable change in the coast line bordering the mangroves as well as topography of the wetland itself and reduction in mangrove forest area. This study provided vital information for developing and implementing restoration strategies. And similar study is being carried out for Bhitarkanika National Park, Orissa, Inida. Different parameters such as physical setting,ecological resources, social environmentand human impact are to be studied and data are to be collected and stored in spatial and non-spatial format in Geographic Information System to develop an approach for conservation, restoration, evoluation, classification and utilisation of the natural resources of this coastal ecosystem.

1. INTRODUCTION

Biodiversity is more at risk now than at any time in human history. The continuing rapid rate of habitat loss and degradation, have led to unprecedented threats to the biodiversity on which the current and future livelihoods of local communities and national economies ultimately depend.

The value of biodiversity lies in its contribution to the ecological systems which maintain life and human economic activity; in the utilisation of components of this diversity by humankind for food, medicines and raw materials and in its cultural, spiritual and aesthetic significance for human societies. The destruction of habitats rich in biodiversity also disrupts hydrological cycles and leads to such human hardship.

India has a variety of geological and biogeographical zones viz., Trans-Himalayan, Himalayan, Indian desert, Semi arid, Western Ghats, Deccan peninsula, Gangetic plains, Northern India, Islands and coasts.

Throughout the Indian coasts, mangrove wetlands, a major natural resource for the ecological and livelihood security of the coastal communities, have seen severely degraded. Similarly in the inland areas including hilly terrain, soil is being degraded by cultivating high yielding crop varieties which require high inorganic fertilisers. In the biologically rich areas such as tropical rain and moist forests, genetic resources are being depleted at a fast rate due to human induced stresses such as deforestation and their developmental activities.

And the Geographic Information System is also used for the analysis for identifying and suggesting management practices in block level for a district as a pilot work.

To tackle these problems and provide necessary input to the Government agencies for better management M.S. Swaminathan Research Foundation has conducting a variety of research and demonstration projects. In most of these projects remotely sensed data are being used for planning, implementation and monitoring activities.
A case study related to the conservation and management of mangrove wetlands of Pichavaram in which remotely sensed data were effectively utilised is given below.

2. ROLE OF REMOTELY SENSED DATA IN THE CONSERVATION AND MANAGEMENT OF PICHAVARAM MANGROVES - A CASE STUDY

Pichavaram mangrove wetland (Latitude 11 27'N and Longitude 79 47' E) is located at the northern end of the Cauvery delta, in the state of Tamil Nadu, in the south east coast of India. Compared to to other mangroves of India, Pichavaram mangroves are rich in species and diversity, especially of true mangrove plant species. A total number of 14 exclusive mangrove species are recorded in the mangrove wetlands, out of which conservation of 3 species namely, Rhizopora apiculata, Rhizopora mucronata and Rhizopora lamarckii require urgent attention. These species, though once present in other mangroves of India, now have become locally extinct in the localities like Muthupet mangroves or have become endangered in other mangroves of India such as Sunderban, Godavari, and Krishna mangroves. Realising these facts, Government agencies have been taking a

number of steps in the last 10 years to conserve and manage these mangrove on a sustainable basis. However, many of their attempts proved futile and two factors, along with others, responsible for this are

- lack of information as the degree to which this mangrove wetland is degraded and
- lack of information on the true causes for degradation.

Remotely sensed data played a crucial role in solving the above two problems.

2.1 Assessment of degree of degradation of Pichavaram mangrove using remotely sensed data

The Pichavaram mangrove forest is declared as a reserve Forest in 1897 and during that time the total area of the mangrove forest was about 700 ha. However, due to various reasons, the extent of this mangrove forest has degraded drastically. Though, the Government management agencies were aware of the degradation, they were unable to quantify the area of the degraded mangrove since conventional method of surveying was not possible in the mangrove wetlands. This lack of information, along with other reasons, impaired the Government agencies to prepare a reliable conservation and management plan. However, using Indian Remote Sensing Satellite (IRS) data, it was found that nearly 62.8% of the Pichavaram mangrove forest was degraded between the years 1897 and 1994 (Figure.1a & 1b) and the rate of degradation was about 5 ha per year. The above information was passed on to the Government agencies which made them to realise the urgency for the restoration and conservation of this important mangroves. Now, the Government agency is also using remotely sensed data to analyse the extent of degradation in other mangrove of Tamil Nadu.

2.2 Analysis of the causes for the degradation of Pichavaram mangroves using remote sensing

It was considered both by the Government agencies and research Institutions working in the Pichavaram are that cattle grazing and illegal felling were the main causes for the degradation. However, remote sensing analysis by creating False Colour Composites (FCC), ratioed output, and vegetation indices showed that the degradation was severe in the middle portion. This indicated that apart from grazing and felling there could be some other reasons for degradation since if there two factors were alone responsible for degradation then the peripheral areas should have affected more rather than the central portion. This assumption led the M.S. Swaminathan Research Foundation to conduct intensive ecological studies which revealed that changes in topgraphy into "trough" shaped and stagnation of tidal water in the trough were tha main cause for the degradation. Thus, for the first time one of the main causes for degradation was indentified and on the basis of which restoration techniques were developed and successfully demonstrated.

2.3 Analysis of shoreline changes and its impact on Mangroves

The Pichavaram mangrove is being protected from wave action by a long stretch of sandy beach. However, comparison of Survey of India toposheet and remote sensing imageries of IRS 1B LISS II revealed that breadth of this beach reduced by 550m between 1930 and 1970 (Figure 2) and about 150m betwween 1970 and 1992 (Figure 3). The rate of erosion is about 13m/year. This indicated that there is danger of the Pichavaram mangroves exposed directly to the open sea where the wave action is very high which will not allow the establishment and regeneration of mangrove plant genesis. Apart from these, comparison of topsheets and recent remote sensing imageries also indicate that which the Pichavaram mangroves erosion and sedimentation occurs simultaneously. This indicated by the enlargement of some islands and sedimentation of some of the tidal creeks and canals. All there will have severe impact on mangrove plant communities and hydrodynamics.

Considering all the aspects explained, a long term management plan is being prepared for the Pichavaram mangroves in which both remotely sensed data and Geographic Information System are used extensively. On the basis of this experience similar kind of work is also being undertaken at Bhitarkanika mangrove of Orissa. (Figure.4)

3. APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM IN SOCIO- ECONOMIC STUDIES

The application of Geographic In-formation System is spreading very widely in all disciplines. In MSSRF GIS is applied in evaluating various socio economic factors of Dharmapuri district of Tamil Nadu. The different factors in block level like Infant mortality ratio, birth rate, death rate, population below poverty line, Scheduled Caste & Scheduled Tribe population below poverty line, sex ratio, female literacy etc. were overlaid and the status of the blocks were identified based on the given factors by giving weightages to each layer based in the importance of them in well-being of human life.

In addition to these, it has been proposed to carry out the following work in the collaboration with other remote sensing apllication agencies.

1. Evolving a coastal zone management system and its monitoring in Tamil Nadu - Using remotely sensed data and Geographic Information System - Submitted in collaboration with Space Application Centre, Ahmedabad to the Department of Ocean Development, Govt. of India, New Delhi

   To map the landuse and wetland maps at three years interval as well as turbidity, sea surface temperature and primary productivity using satellite data for the Tamil Nadu coast. The remote sensing based data and environmental data will be integrated to prepare coastal zone management plans. These

plans will suggest preservation, conservation and developmental strategies.

2. Developing an anticipatory approach to the mitigation of the impacts of potential sea level rise on coastal ecosystems: The case of the Mangroves - Submitted to The Department of Ocean Development, Govt. of India, New Delhi

   The study aims at development of changes in the mangrove ecosystem, particularly species composition, as an indicator of changes occurring in the sea level. A secondary objective is the development of a method for the use of data products in the analysis of changes in the coastal biodiversity.

3. A project proposal on Integrated Coastal Environment stidies have been proposed to be undertaken subject to funds being available.

   The goal of the project is to enhance national capacity and national action in the conservation and sustainable management of coastal mangrove wetlands. Remote sensing and Geographic Information System is applied here for creating geographic data base, mapping wetland and landuse maps for management. This work will be done for the states Tamil Nadu, Andra Pradesh and Orissa.

The recently launched IRS 1C (28th Dec 1995) has three different sensors and offers unique applications opportunities. The Panchromatic (PAN) camera provides data with a spatial resolution of 5.8meters and a ground swath of 70 Km. It will operate in the 0.50 - 0.75 microns spectral band. This camera can be steered up to ± 26 degrees (upto ±398 Kms across the track from nadir) which in turn increases the revisit capability to 5 days.

Linear Imaging and Self scanning sensor (LISS III) provides multispectral data collected in four bands of the visible and near short wave infrared (SWIR) regions. While the spectral resolution and swath in the case of visible (two bands) and Near infrared (one band) regions is about 24 meters and 141 km respectively, they will be 70.5 m and 148 Km for the data collected in SWIR region.

The wide Field Sensor (WiFS) collects data in two spectral bands and have a ground swath of 810 Kms, with a spatial resolution of 188.3m. The satellite has an on - board tape recorder also, capable of recording limited amount of specific sensor data.

Many applications like crop acreage and yield estimation, draught monitoring and assessment, flood mapping, wasteland identification and mapping, ocean/marine resources survey, mineral prospecting, forest resources survey etc. have become and excellent tool for effective management of India's Natural Resources. Besides this, a better understanding of our bio-resources and biodiversity studies have become possible to visualise possible sources of degradation and enable taking possible remedial measures well on time and monitor changes. It may be mentioned here that the EOSAT of USA has entered into agreement with space department of the Government of India, to receive IRS 1C data for world-wide distribution of this data.

4. CONCLUSION

M.S. Swaminathan Research Founda-tion, is a unique research Institution, concerned with study of biodiversity and also rural development to enrich rural population and generating employment opportunities, particul-arly of enhancing purchasing power of landless rural labour in India. Being a non-governmental organisation founded by Prof.M.S. Swaminathan, an internationally renowned agri-cultural scientist and past Director General of International Rice Research Institute and Chairman of Governing body of FAO sometime ago, was the first world food price winner, (equivalent to Nobel prize) world environmental award winner, 1994, and has several achievement and awards to his credit. He was the author and implementation of green revolution in India, which has led India from a country of severe food shortage to one capable of even exporting food to other countries. The Foundation is active in the area of research on sustainable agricultural and rural development, organising anticipatory research, women's welfare, coastal systems research, research in Biotechnology tissue culture and in developing methods to protect the endangered plant species and biodiversity in general in accordance with Agenda 21 of Rio-conference held in 1992. In all these activities, use of advanced technologies like Remote Sensing, Geographical Information Systems, introduction of useful management concepts are encouraged with great promise. It is in this context this paper has been presented here as Remote Sensing and G.I.S. as a tool have high promise of integrating various information, both in respect of natural resources base as well as socio economic dimensions.

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Figure 1 a. Map showing Pichavaram Mangrove forest (1986)
& its ecosystem

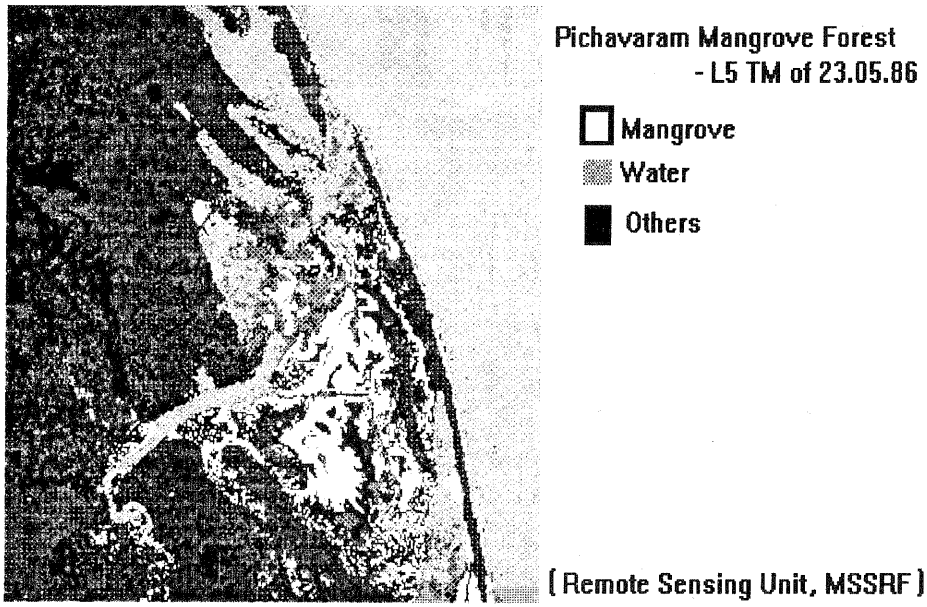
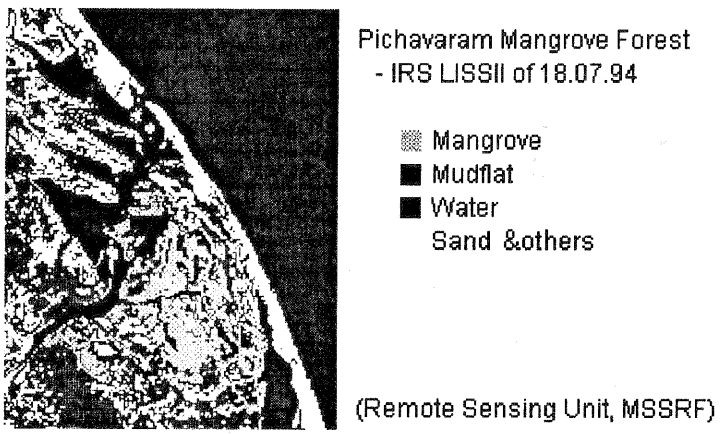


Figure 1b. Map showing Pichavaram Mangrove forest (1994)
& its ecosystem



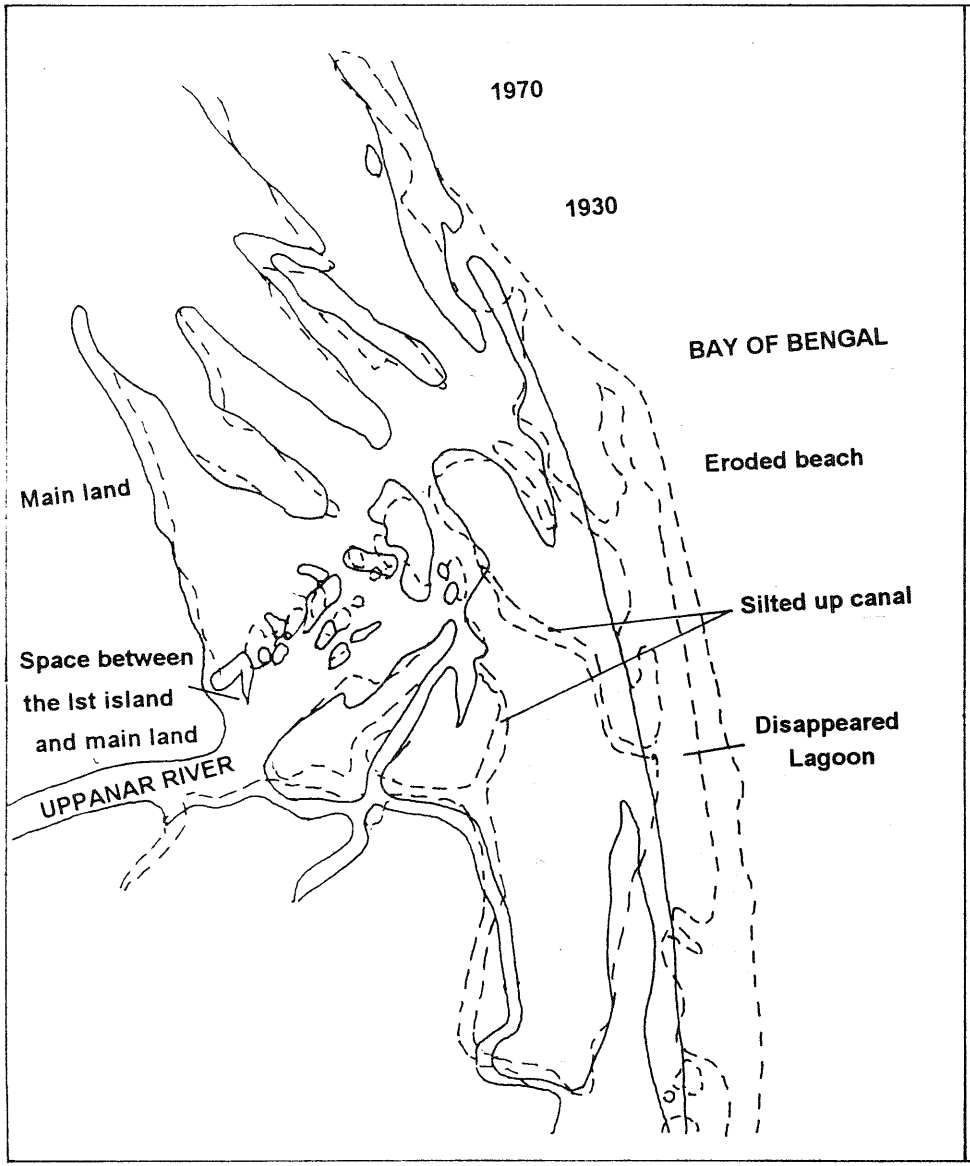


Figure 2. Changes in Coastline configuration between 1930 and 1970

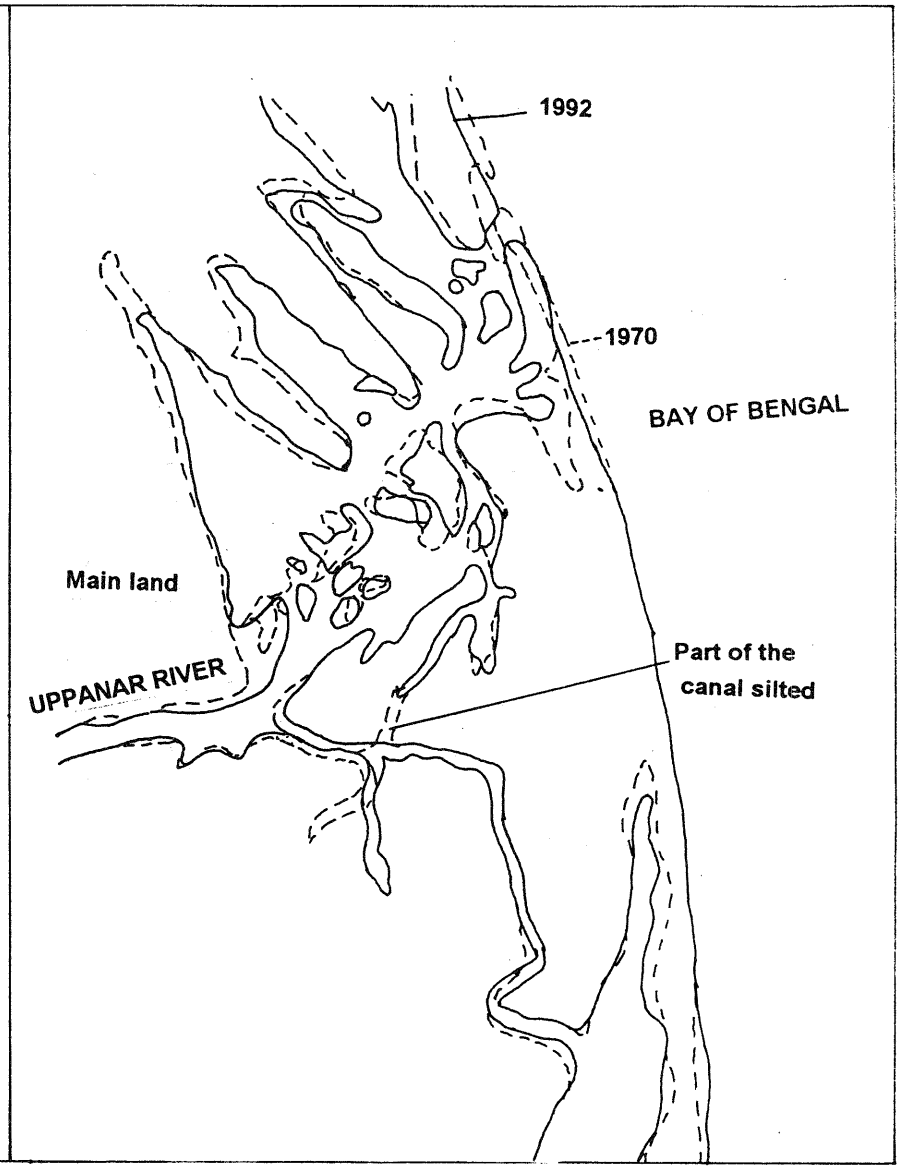


Figure 3. Changes in Coastline configuration between 1970 and 1992

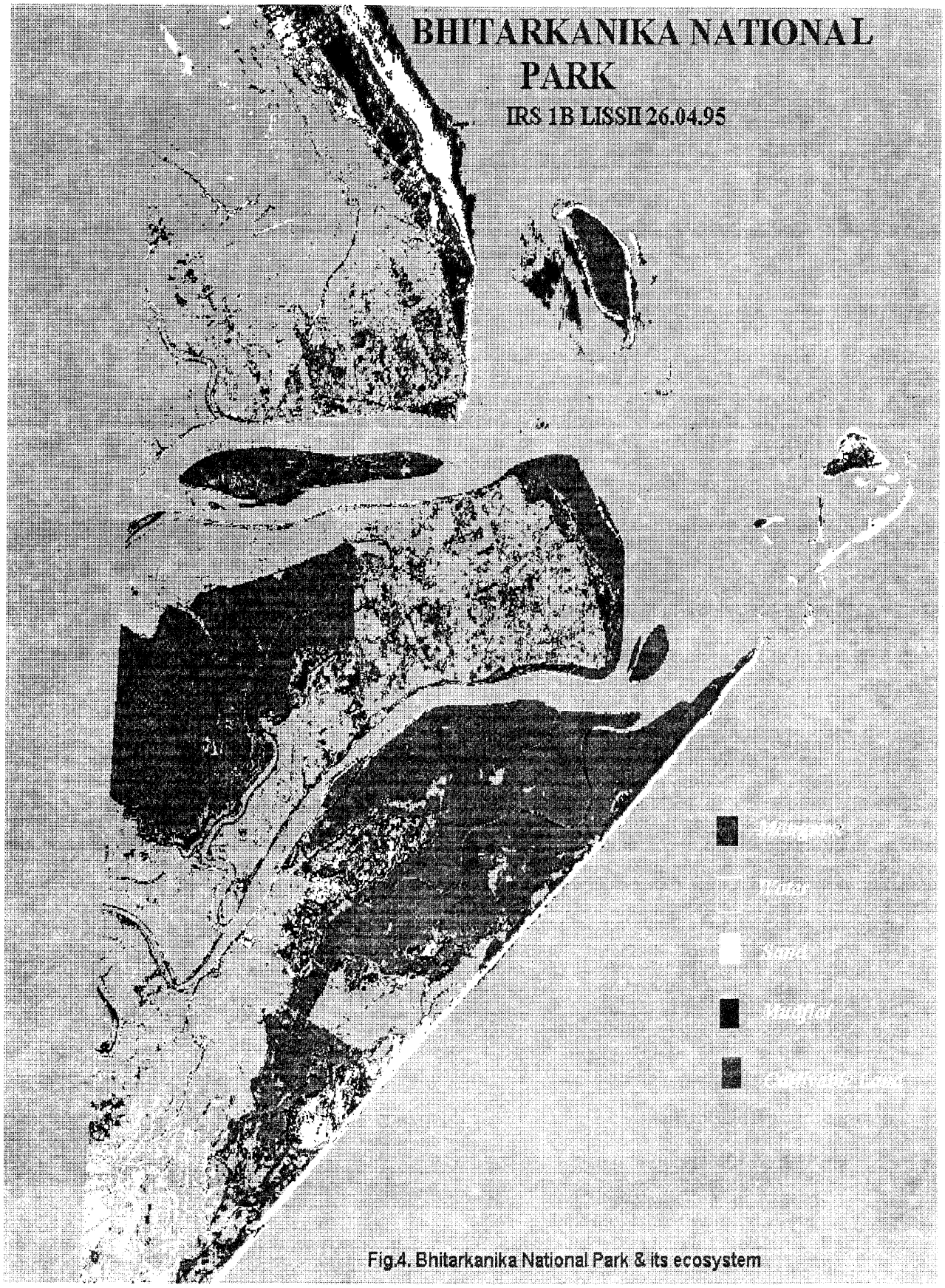


Fig.4. Bhitarkanika National Park & its ecosystem