

# Annual Report 2009-2010



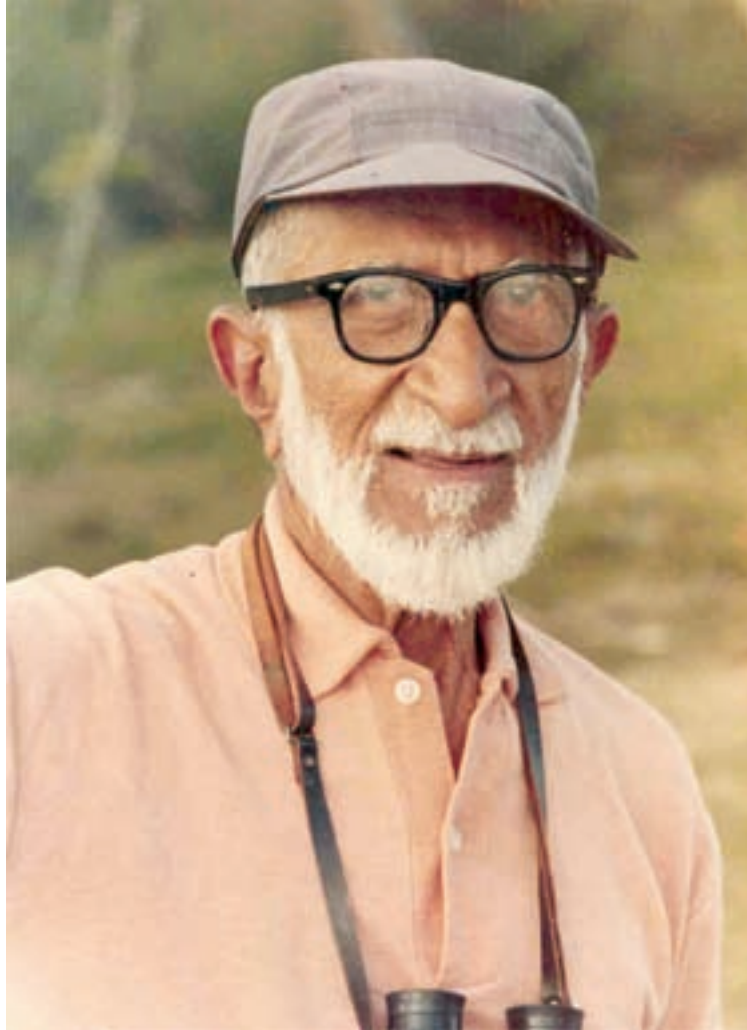
**Salim Ali Centre for Ornithology and Natural History**

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**Dr Sálim Ali**  
(1896-1987)

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## **BACKGROUND**

**Sálim Ali Centre for Ornithology and Natural History (SACON)** funded by the Ministry of Environment and Forests (MoEF), Government of India, was established in 1990. The management of SACON is vested in a Governing Council. The President of the SACON society is the Honourable Minister for Environment and Forests, Government of India and Chairman of the Governing Council is the Secretary to the Government of India, Ministry of Environment and Forests. Realising the significance of a holistic approach in avian studies and conservation, the major objectives of SACON have been designed to cover the entire field of natural history with ornithology at the centre stage.

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### **SACON'S MISSION**

“To help conserve India's biodiversity and its sustainable use through research, education and people's participation, with birds at the centre stage.”

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### **OBJECTIVES**

The objectives of SACON :

- Design and conduct research in ornithology, covering all aspects of biodiversity and natural history
- Develop and conduct regular courses in ornithology and natural history at the level of M Sc., M Phil., and Ph.D. and also short-term orientation courses in related subjects
- Create a data bank on Indian ornithology and natural history, and disseminate knowledge relating to ornithology and natural history for the benefit of the community.

## EXECUTIVE SUMMARY

In the year 2009-10, we have undertaken 26 programs that include studies, consultancy works, environmental impact assessments and nature education related activities.

During the year we continued with our work on single species and ecosystems. The study on Spot-billed Pelican, a near-threatened species as per BirdLife International, was continued at Uppalapadu in Andhra Pradesh, a breeding colony with more than 500 nests. We have suggested expanding the area by acquiring adjacent land, providing additional nest platforms, and conservation of the area through community participation. The program to conserve the Edible-nest Swiftlet in the A & N Islands, undertaken in collaboration with the A & N forest department since 1999, has made significant progress; population of the species has increased at the focal sites. Experiments with *ex-situ* breeding of the species, transferring eggs of the Edible-nest Swiftlet into the nests of the White-bellied Swiftlet in the *ex-situ* Swiftlet houses, are also progressing well with 97% hatching success. SACON has continued pursuing ecological investigations of the island ecosystems. Our study to monitor post-tsunami coastal ecosystem in the Nicobar Islands reports notable plant regeneration in affected areas. Species such as Robber crabs have become less abundant. However, recovery of other species is apparently in progress.

With respect to community participation in our conservation program in Nagaland, one community conservation area (CCA) has been declared. At least six more CCAs, managed by the local communities are expected to be declared shortly. Our work highlights the need for a long-term program with appropriate funding to strengthen the community efforts in conservation.

Lion-tailed macaque is an endemic and endangered species. One of the largest known populations of the species is in the forests of Sirsi-Honnava, a reserve forest with high human density and a mosaic of various

plantations and agriculture, in Karnataka. A study of the species was undertaken to understand habitat utilization, ranging pattern, inter and intra specific competition and precise threats to their persistence and management requirements. Biligiri Rangaswamy Temple Wildlife Sanctuary (BRTWLS), considered as a live bridge between the Western and Eastern Ghats, is important for the conservation of Asian elephant and tiger. A study on the mammalian species of BRTWLS reveals that it is one of the high mammalian biomass areas in the country. Our faculty members are helping forest departments to prepare a biodiversity conservation plan for the Mysore forest division (Karnataka State). The forests in the area, even highly fragmented and exposed to anthropogenic activities, support many species.

For several years SACON has been working on various aspects of the ecology of the world heritage site, Keoladeo National Park, Bharatpur. Since 2007, we have been conducting a study, first time in the country, to understand the ecology of Indian python, an endangered species. The study has obtained valuable information on the species useful to propose conservation measures.

SACON has continued the MoEF-ENVIS center on the theme 'Wetlands of India'. A new program of mapping and monitoring of Ramsar sites of India using geospatial technology was launched. Wetlands of India website was also revamped in accordance with MoEF guidelines. A program to develop a Directory of wetlands of north Kerala was undertaken during the year. A web enabled wetland information system at the district, block and Panchayat level ([www.keralawetlands.in](http://www.keralawetlands.in)) to help all the stakeholders in using, updating and monitoring, was developed as a part of the program. As part of a project Land Use, Land Use Change and Forestry (LULUCF) assessment using satellite data Orissa, Jharkhand, West Bengal and Bihar states were mapped; considerable changes in wetland cover and forest areas from 1995 to 2005 could be observed.

Industries can claim carbon credits under the Clean Development Mechanism. SACON has been involved in providing information for the same. A project was undertaken to map Eucalyptus plantation plots spread across seven districts of Orissa, Chhattisgarh, and Andhra Pradesh and to compare it with that of 1990. The maps are required for delineating the increase in vegetation cover, used for carbon credits by the organization undertaking plantation. A Survey of Neyveli Lignite Corporation (NLC) environment was undertaken to quantify tree plantation during the period, the outcome of which would help NLC claim carbon credits. The project to assess environmental and ecological impacts of the Andhra Pradesh Community Forest Management project, while assessing growing stocks for natural vegetation, plantation, and social forestry found an increase in vegetation and mangrove cover from 2002 to 2008.

River basins are undergoing rapid changes due to anthropogenic pressures. SACON, in collaboration with NRSC (Hyderabad), has undertaken a study of the Land use Land cover change in the Yamuna river basin. The change detection will help compare the past and present status and to predict the future scenario in the basin.

We have continued the study on insect and bird pollinators, and avian seed dispersers of woody plants in various forest types in Tamil Nadu. Honeybees, butterflies and sunbirds are the major pollinators in most of the forest types, while bulbuls, barbets, crows and Nilgiri Laughing Thrush form principal avian seed dispersers. Native tree species that attract insect, bird pollinators and avian seed dispersers are recommended to the Tamil Nadu forest department for planting under their afforestation program.

As part of our ongoing ecotoxicological investigations and residue analysis we have undertaken three projects. The first looked at impact of agricultural pesticides on the population status and breeding success of select species of fish-eating birds in Tamil Nadu. It was found that residue levels of pesticides are less than levels considered lethal. Nevertheless, this has to be viewed with concern, as these

pesticides are capable of causing several abnormalities. The second study, to monitor and compare pesticide residues in agro ecosystem of a village practicing organic and chemical farming shows higher organochlorine pesticides residues in the samples collected from chemical farming than the organic farming. The Nalabana Bird sanctuary in Chilika has been experiencing large scale bird mortality. This was the theme of one study. The study is in progress and we expect to shortly arrive at conclusions regarding reasons for the large scale mortality of birds in the sanctuary.

During the year 2009-10 we have undertaken a rapid environmental impact assessment of the proposed India Based Neutrino Observatory (INO) at Bodi Hills (Theni district, Tamil Nadu). Most of the construction work of the proposed project will be carried out deep underneath the earth's surface. The study on the impact of urbanization and other anthropogenic factors on the House sparrow population was continued, identifying factors responsible for the decline of the species. Another study that was continued from previous years was on the environmental changes in the Bharathapuzha river basin. The study showed an increase in the temperature in the basin, decreasing rainfall and considerable land use change that influence the discharge in the river Bharathapuzha, the lifeline water resource for a large population. As a continuation of our previous years study on the ecological impact of bauxite mines in Arakku area we undertook a study of the bioavailability of heavy metals in soils and select plant species in opencast mines analyzing different plant species and soil types with respect to their heavy metal contents and their ecotoxicological implications. Contaminated plants are likely to be a source of heavy metal intake in consumer organisms.

SACON has undertaken nature education activities more intensively. We could reach out to several schools and the public with the message of conservation. We were given the responsibility of the Department of Biotechnology's Natural Resources Awareness Clubs for School Children (The DNA Clubs) in the A & N Islands. Several programs including one residential program with students as a target





group were organized in the islands to spread awareness on natural resource conservation.

During the year, SACON has recruited one principal scientist, and three scientists. We are in the process of recruiting more core scientific staff. We expect to intensify our research activities in terms of undertaking more research projects in the coming years and improve our outputs.

SACON is pursuing, in earnest, the development of human resources in conservation and biodiversity studies. As of now 20 PhD projects are in progress in the Centre. During the year, three researchers of SACON were awarded PhDs and 3 were awarded MPhils. Two PhD theses are submitted and are awaiting results. We have also supported several short term projects and summer training programs for PG students of various institutions.

The honorable Minister of Environment and Forests Mr Jairam Ramesh visited SACON during the year. The honorable Minister's interaction with the researchers here was very encouraging and rewarding. Recognizing the need for further infrastructure development in SACON the honorable Minister offered

additional funds. Steps towards conversion of SACON as an autonomous centre under the MoEF, GoI as per the decision of the SACON Society, are in progress. Becoming an autonomous centre of the MoEF will be a great step in SACON's development.

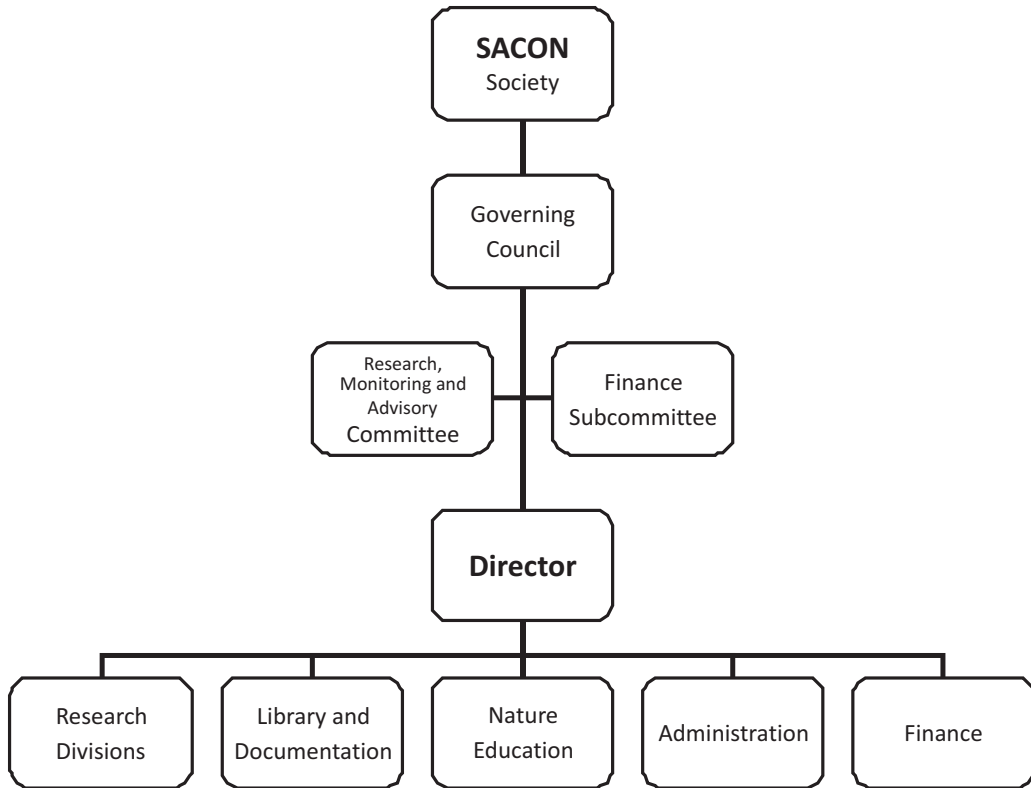
The Annual Research Seminar at SACON was held on 11 November 2009 followed by the 19th meeting of the Research, Monitoring and Advisory Committee of SACON on 12 November 2009. The 59<sup>th</sup> and 60<sup>th</sup> Governing Council Meetings were held on 29<sup>th</sup> May 2009 and 23<sup>rd</sup> November 2009, respectively at the MoEF, New Delhi.

SACON has remained very active during this year in terms of publications, participation in seminars / symposia and workshops. Our researchers have published 24 articles in national reviewed journals, 28 in international peer reviewed journals, 2 chapters in books, 6 technical reports and 19 papers in conferences/ seminar/ proceedings/ edited volumes. We remain committed to improve our research outputs and contributions to conservation of our environment and biodiversity.

**Director**



**ORGANIZATION STRUCTURE OF SACON**



<b>FIELD STATIONS</b>	
1.	Mayabunder (Andaman & Nicobar Islands) Campbell Bay-Great Nicobar
2.	Bharatpur (Rajasthan)
3.	Hyderabad (Andhra Pradesh)
4.	Upper Bhavani, The Nilgiris (Tamil Nadu)
5.	Silent Valley National Park (Kerala)
6.	Tuensang (Nagaland)
7.	Vaigai (Tamil Nadu)
8.	Attapadi (Kerala)
9.	Sathyamangalam (Tamil Nadu)
10.	Uppalapadu, Guntur (Andhra Pradesh)

## ORGANIZATION

### SACON Society

The SACON Society comprises the President, the members of the Governing Council and experts in the field of ornithology, wildlife sciences and management. The Honourable Minister for Environment and Forests (MEF) or his nominee, Minister of State for Environment and Forests (MoS) is the President of the SACON Society and the Director/Director In-charge of SACON is the Member Secretary. The total members in the SACON Society are 29 of which one place is currently vacant (Appendix).

### Governing Council (GC)

The Chairperson of the GC is the Secretary to the Government of India, Ministry of Environment and Forests. The GC has 16 members; Financial Advisor, MoEF, Jt. Secretary (CS) or nominee, MoEF, four ex-officio members, eight nominees of the Governing Council and the Director, SACON (Member Secretary). The GC is advised by Finance Sub-Committee (FSC), and Research, Monitoring and Advisory Committee (RMAC). The GC has also constituted a Building Sub-Committee (BSC) to oversee and advice on the construction activities of SACON.

### Present Members of the Governing Council

1. Mr Vijai Sharma, IAS, Secretary to the Govt. of India, Ministry of Environment and Forests, New Delhi (Chairman)
2. Mr E. K. Bharat Bhushan, IAS, Jt. Secretary and Financial Advisor, Govt. of India, Ministry of Environment and Forests
3. Mr A. K. Goyal, IFS, Jt. Secretary, Govt. of India, Ministry of Environment and Forests
4. Dr A. R. Rahmani, Director, Bombay Natural History Society, Mumbai
5. Dr R. Sukumar, Chairman, Center for Ecological Sciences, Indian Institute of Science, Bangalore
6. Dr C. Swaminathan, Vice Chancellor, Bharathiar University, Coimbatore
7. Mr P. R. Sinha, IFS, Director, Wildlife Institute of India, Dehra Dun

8. Prof. H. S. A. Yahya, Dept. of Wildlife Sciences, Aligarh Muslim University, Aligarh
9. Prof. P. C. Bhattacharjee, Dept. of Zoology, Guwahati University, Assam
10. Mr R. G. Soni, IFS (Retd), Principal Chief Conservator of Forests, Rajasthan
11. Dr P. Pushpangadan, Honorary Director General, Amity Institute for Herbal and Biotech products Developments, Thiruvananthapuram
12. Dr C. K. Varshney, Professor (Retd), Jawaharlal Nehru University, New Delhi
13. Dr S. K. Dutta, Professor, PG Department of Zoology, North Orissa University
14. Dr Krishnakumar, Director, Indian Institute of Management, Lucknow
15. Public Sector/ Enterprise/Banks (as of now vacant)
16. Dr P. A. Azeez, Director, SACON (Member Secretary)

### Research, Monitoring and Advisory Committee (RMAC)

The mandate of the RMAC is to i) act as an advisory body to the scientific and educational faculty of the SACON, ii) review scientific research proposals developed by the Centre , iii) review and assess scientific research projects implemented by the Centre, and monitor publication of dissertations, reports, papers in scientific journals and other publications, iv)



Welcoming Dr P. A. Azeez on his new appointment as Director of SACON on 01/12/2009

conduct an annual review of all research and extension activities of the Centre and advise the Centre about changes required for improvement, and v) examine any new programs or suspend / abandon any of the ongoing ones, depending upon the utility and/or the level of participation

The Governing Council at its 59<sup>th</sup> meeting held on 29<sup>th</sup> May 2009, reconstituted the Research, Monitoring and Advisory Committee of SACON. The members of the newly constituted RMAC are given below:

1. Dr Sukhdev Thakur, IFS (Retd), Principal Chief Conservator of Forests, Tamil Nadu (Chairman)
2. Dr A. R. Rahmani, Director, Bombay Natural History Society, Mumbai
3. Dr V. C. Soni, Professor, Dept. of Biosciences, Saurashtra University, Rajkot
4. Dr B. M. Parasharya, AINP on Agricultural Ornithology Biological Control Research Lab, Anand Agricultural University, Anand
5. Prof. B. C. Choudhary, Wildlife Institute of India, Dehra dun
6. Dr Mewa Singh, Professor, Dept. of Psychology, Mysore University
7. Senior most Scientist of SACON

8. Director/ Director In-charge, SACON (Member Secretary)

The reconstituted committee met on 12<sup>th</sup> November 2009 in SACON under the Chairmanship of Dr Sukhdev Thakur, IFS (Retd), and reviewed the ongoing research projects and evaluated the new projects proposed to be undertaken by SACON.

#### **Staff of SACON**

The core scientific staff strength of the year (until November 2009) was eight, three Senior Principal Scientists, three Principal Scientists One Nature Education Officer and one Scientist. In December 2009, the faculty members were promoted to the next grade on recommendation of the Assessment Committee and approval of the Chairperson, Governing Council. By the end of March 2010, three more (One Principal Scientist and two scientists) were inducted into the team as faculty and core staff scientific strength, presently, is eleven.

Dr P. A. Azeez, who was Director In-charge of SACON since February 2009, was appointed as Director of SACON. He took charge as Director of SACON on 1<sup>st</sup> December 2009.





## SCIENTIFIC

Director	:	Dr P. A. Azeez (since 1 <sup>st</sup> December 2009)
Conservation Ecology	:	Dr Lalitha Vijayan, Sr Principal Scientist (Gr.I) Dr S. Bhupathy, Principal Scientist Dr Manchi Shirish, S, Scientist
Conservation Biology	:	Dr Shomita Mukherjee, Principal Scientist Dr H. N. Kumara, Scientist
Landscape Ecology	:	Dr S. N. Prasad, Sr Principal Scientist Dr P. Balasubramanian, Principal Scientist
Ecotoxicology	:	Dr S. Muralidharan, Principal Scientist
Environmental Impact Assessment	:	Dr P. A. Azeez, Sr. Principal Scientist (Gr.I) (till 30 <sup>th</sup> Nov 2009) Dr B. Anjan Kumar Prusty, Scientist
Nature Education	:	Dr P. Pramod, Senior Scientist

## TECHNICAL

Library and Documentation	:	Mr M. Manoharan, Library Assistant
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## ADMINISTRATION

Senior Finance Officer	:	Mrs. Jayashree Muralidharan (From 1/1/2010)
Finance Officer	:	Mr P. Karuppiah (Till 31/12/2009, on contract)
Jr. Administrative Manager	:	Mr R. Jayakumar
PA to Director	:	Mr V. Vaidyanathan
Accountant	:	Mr M. Muthupandi
Administrative Assistant	:	Mr S. Patturajan
Office Assistant	:	Mrs. R. Rajalakshmi
Stenographer	:	Mr M. Eanamuthu
Receptionist/ LDC	:	Mrs. M. Jayageetha
Site Engineer	:	Lt Col. (Retd) N Sundararaj (on contract)
Computer Assistant	:	Mr A. Srinivasan (on contract)
Drivers	:	Mr R. Ravi and Mr P. Subramanian
Office Attendants	:	Mr A. Devaraj Mrs. V. Santhalakshmi

## NEW APPOINTMENTS



**Dr Manchi Shirish S.** joined SACON as Scientist in Ornithology on 30<sup>th</sup> September 2009. He has specialized in Ornithology. He has a special interest on Island ecosystems and is also interested in grassland conservation. Dr. Shirish worked for his PhD on the Edible-nest Swiftlet in Andamans. He also worked on the Lesser Florican in Gujarat grasslands.



**Dr Honnavalli Nagaraj Kumara** joined SACON as Scientist in Conservation Biology on 1<sup>st</sup> March 2010. Dr. Kumara has done his doctoral work at the University of Mysore. Since 2005, Dr. Kumara worked with the National Institute of Advanced Studies, Bangalore. Dr Kumara's research interest lies in biodiversity conservation.



**Dr Shomita Mukherjee** joined SACON as Principal Scientist in Conservation Biology on 1<sup>st</sup> March 2010. An alumna of the Wildlife Institute of India, Dehra Dun Dr Mukherjee has worked on carnivores. She has also worked with M/s Wildlife Trust of India, New Delhi; Tiger Watch, Ranthambore; Nature Conservation Foundation, Mysore and National Centre for Biological Sciences, Bangalore. She focuses on molecular ecology and conservation genetics.



**Dr B. Anjan Kumar Prusty** joined SACON as Scientist in Environmental Impact Assessment on 22<sup>nd</sup> March 2010. He is an alumnus of SACON and worked on detrital and limnological dynamics in Keoladeo National Park (KNP) wetland ecosystem, Bharatpur, Rajasthan for his doctoral research work. Earlier, Dr Prusty worked as a Junior Scientist (Environment) at the Gujarat Institute of Desert Ecology (GUIDE), Bhuj, Gujarat (July 2007-March 2010). His major interests are environmental assessment, mining and environment, biogeochemistry and ecological management.

## RESEARCH HIGHLIGHTS

### 1. Ecology and Conservation of the Spot-billed Pelican *Pelecanus philippensis* in Andhra Pradesh

Research Student	: N. Sheeba
Research Supervisors	: Lalitha Vijayan and S.N. Prasad
Duration	: Five years
Date of commencement	: October 2006
Date of completion	: September 2011
Budget	: ₹ 10.20 lakhs
Funding Source	: University Grants Commission (UGC), New Delhi

#### Background

The Spot-billed Pelican *Pelecanus philippensis*, is considered as a near-threatened species by BirdLife International. The population of this species has been fluctuating in different locations in Andhra Pradesh. A new breeding population has been identified at Uppalapadu, an Important Bird Area, where a detailed study is being conducted.

#### Objectives

- Assess the current status and regional population of this species and the ecological value of Uppalapadu wetland, a potential home of the Spot-billed Pelican,
- Study its habitat selection, social organization and association with other species,
- Understand its foraging and breeding ecology, and
- Examine potential threats to the population of this species, and suggest conservation measures.

#### Methods

Breeding populations of Spot-billed Pelican were assessed by surveying five locations (breeding sites), namely Uppalapadu, Telineelapuram, Nelapattu, Kolleru and Ramachandra Palayam in Andhra Pradesh.

#### Results and Discussion

During the study period, the highest number (890 nests) was observed in Uppalapadu. A steady

increase in the number of breeding birds was seen in Uppalapadu and Nelapattu compared to earlier years. On the other hand, in Kolleru no nesting was found during 2008 and 2009, where in 2007 about 250 nests were recorded. Other heronry species such as Little Cormorant, Little Egret, Darter, Painted Stork, Openbill, Black-headed Ibis and Black-crowned Night Heron were also nesting in Uppalapadu. Four pelicans were marked in February 2009. However, they could not be traced.



N. Sheeba

#### Uppalapadu heronry

Congregation of Spot-billed Pelican, Painted Stork and Ibis was observed at Ramachandra Palayam, a private fish tank about 2 km from Uppalapadu, but their breeding was not observed as the area dried up during summer.

#### Recommendations:

We recommend expanding the area by acquiring the adjacent land, providing additional nest platforms, and conservation of the area through community participation. Reducing human disturbance in the nesting area is essential at all sites.

#### Summary

Status and ecology of Spot-billed Pelican was studied at Uppalapadu, Guntur, where about 890 nests were located. Large population of the Asian Openbill Storks (about 7000) and smaller populations of Painted Stork, Darter and Black-headed Ibis also use this wetland.

## 2. Monitoring post-tsunami coastal ecosystem recovery in the Nicobar Islands and developing site specific restoration measures

Principal Investigator	: P. Balasubramanian Lalitha Vijayan
Co-investigators	: S.N. Prasad P. Pramod DCF, Nicobar Division.
Collaborative Agencies	: Dept of Environment and Forests, Andaman and Nicobar Islands
Research Fellows	: A.P. Zaibin and P. Nehru
Duration	: Three years
Date of Commencement	: December 2008
Date of Completion	: December 2011
Budget	: ₹ 30.10 lakhs
Funding Source	: Dept. of Environment and Forest, Andaman and Nicobar Islands
Status	: Ongoing

### Background

The earthquake and tsunami of December 26, 2004 destroyed large areas of coastal and mangrove forests in the Andaman and Nicobar Islands. It also resulted in a tilt in the land with the southern-most Nicobar Islands having sunk by about 1.6 m while the Northern most Andaman Islands have been elevated by about 1.2 m. The impacts to coastal ecosystems have been i) the physical uprooting of coastal forests and mangroves by the tsunami, ii) the scorching of littoral vegetation due to salt stress from sea water inundation, iii) the dying out of mangroves due to perennial submergence of the pneumatophores, iv) sea water inundation of inland freshwater bodies, v) the destruction of marshes and creeks, and v) the physical destruction of coral reefs by the tsunami waters. Hence, a project was planned by SACON and

the Andaman forest department, to assess avifaunal diversity, study plant regeneration and colonization in tsunami affected areas, and to devise and implement site-specific restoration measures.

### Objectives

The major objectives of the study are:

- Assess and monitor vegetation regeneration in tsunami affected areas,
- Monitor species that inhabit coastal ecosystems, especially the Nicobar Megapode and Robber Crab,
- Develop and implement appropriate site specific strategies to restore the damaged habitats, and
- Aid regeneration through targeted restoration activities, wherever necessary.

### Methods

Vegetation monitoring was conducted using 0.1 ha (50x20m) plots in the tsunami affected littoral forests at 31 predetermined points in different islands, for long-term monitoring. Number of plots at each location was decided depending upon the extent of tsunami damage as well as logistics. Plots were also established in the unaffected forests for comparison. Regenerating mangrove habitats were also surveyed in three locations, namely Safed Balu, Dering and East Bay Katchall. All the woody species ( 10cm Girth at Breast Height) were enumerated. Saplings and herbs were enumerated through 3x3m plots within the larger plots. Variables such as substrate, strata structure, vegetation height, disturbances, tsunami induced deposition and



Nicobar Bulbul, an endemic species

A.P. Zaibin



distance from the nearest human habitation was collected for each plot.

Birds were monitored using the point count method. Sampling was done in 10 locations in the Great Nicobar group and 21 in the Nancowrie group of islands. Tsunami-affected areas were categorized into two types: open (with sparse vegetation growing largely on sandy substrate and closed (with secondary vegetation dominated by *Macaranga sp.* and other secondary growth). Sampling was also done in the adjoining unaffected forest.

Searches were done in predetermined areas to locate Nicobar Megapode mounds, which were classified into three types: Type A (built independent of any tree), Type B (built around the buttress of a growing tree) and Type C (built around base of tree stump or a fallen log). Distance of mounds from the coast was measured. Status of the mound was considered abandoned if the mound was compact, hard and impenetrable with a stick. A mound is considered unused if it is easily penetrable with a stick. The inactive nests are usable during breeding season. Canopy cover and height were estimated within 5-10m radius the above mounds.

Opportunistic surveys of turtle nests were done along beaches adjacent to study sites. Identities of the nests were determined by tread impressions of turtles on beaches and with the help of knowledgeable Nicobarese.

## Results

In the littoral forests, 150 woody species were recorded. In most of the tsunami affected littoral habitats signs of regeneration could be seen. This is apparently influenced by the soil substrate. Wherever the substrate is of sand-loamy the stem density and the number of colonizing species was higher when compared to locations where substrate is constituted of sand. *Macaranga peltata*, *Tremma tomentosa*, *Boehmeria nivea*, *Ficus hispida* and *Terminalia bialata* were dominant in places where substrate is largely sand-loamy. *Casuarina equisetifolia*, *Terminalia catappa*, *Hibiscus tiliaceus*,

*Barringtonia asiatica* and *Pongamia pinnata* are dominant where the substrate was affected by sand and coral rubble deposition during the tsunami.

Mangrove habitats in the Nicobar Islands were badly damaged. However, it is remarkable to note the regeneration of mangrove species in the affected areas. Surveys done in three mangrove sites indicated successful regeneration of the following species, *Bruguiera gymnorhiza*, *Rhizophora mucronata*, *Sonneratia caseolaris*, *Nypa fruticans*, *Dolichandrone spathacea*, *Lumnitzera racemosa*, *Lumnitzera littorea*, *Acrostichum aureum* and *Excoecaria agallocha*.

82 bird species were recorded during this study. Nicobar Megapodes were detected (21 sightings and 9 call detections) from 30 different locations on the islands. Each detection yielded an average of 1.7 individuals (ranging from 1-4 individuals/ detection). 50% of the detections were made from mixed hill forest/forest edge, 40% from regenerating secondary vegetation in tsunami affected areas and 10% from coconut grooves. Regular point count bird sampling in tsunami affected areas and adjacent coastal hill forests yielded a few detections of Nicobar Megapode. Encounter rate was exceptionally high in Bompoka Island and low in Katchal, where they were sighted only in two sites.

Among the 36 mounds located, type C mounds were common (44.5%), followed by type A (30.5%). Type B mounds were found to be less common (25%). Out of the total mounds recorded, 14 mounds were inactive, 13 active with toe marks of Megapodes on them and 8 were abandoned. Signs of recent digging by Monitor lizards were evident on some of the mounds. Type B mounds were largely built around huge buttressed trees of *Terminalia sp.* (in Great Nicobar group) and generally around coconut saplings/*Pandanus* growths (in Nancowrie group). Average distance of the mounds from the coast was 76.97m (SD±106.1). Average maximum mound diameter and height was 3.74m (SD±1.4), 0.67m (SD±0.3), respectively.

Occurrence of the Coconut Crab or Robber Crab *Birgus latro* in its potential habitat was found to be extremely rare. Of the 31 predetermined points surveyed, the crabs were found at only one point, Atluch (Bompoka Island), where a pair was sighted in regenerating coastal forest. In total, 22 nests of three species of turtles were recorded. Nests of Leather-backed turtle, *Dermochelys coriacea*, were found in Raanauyy (Little Nicobar), Pilo Bed (Great Nicobar) and Jansin (Katchal). Green Sea-turtle *Chelonia mydas* was sighted in the coastal waters between Kasingdon and Kopenheat (Great Nicobar).

Data entry, detailed analyses and preparation of the technical report is underway.

### Summary

The project was taken up to study plant regeneration and colonization in tsunami affected areas, monitor fauna inhabiting coastal ecosystems particularly avifauna and to devise and implement site-specific restoration measures. 150 woody species were recorded in the littoral forests. In most of the tsunami affected littoral habitats signs of plant regeneration were noticed. The regeneration is apparently influenced by the soil substrate.

82 bird species were recorded in the Nicobar group of islands. Nicobar Megapodes were seen at 30 locations. Encounter rate was high in Bompoka Island and low in Katchal. Average distance of the mounds from the coast was 76.97m (SD  $\pm$ 106.06). Average maximum mound diameter and height were 3.74m, 0.67m respectively. Robber Crab was found to be extremely rare.



### Study plot locations, birds and plants recorded in Nicobar Group of Islands during the study

No.	Island	Location	Woody Plant Species	Herbaceous species	Bird Species
1	Little Nicobar	Lanaeyi	25	9	28
2		Thavaithav	25	11	31
3		Komath	7	12	23
4		Rein Rein	21	4	17
5	Great Nicobar	Chingampasthy	37	12	28
6		Pilobakka	35	8	30
7		Khopenheat	48	10	29
8		Ayoam bay	21	6	29
9		Pethai	40	9	20
10	Menchal	Menchal	2	7	15
11	Kamorta	Masla tapu	--	12	27
12		Remyok	27	11	18
13		Mohreak	29	20	35
14		Oi-hin-pun	23	16	31
15		Kakana	26	10	21
16		Nyikalang	26	27	38
17		11 km camp	14	6	18
18	Trinket	Trinket settlement	38	15	34
19		Safed balu	6	11	17
20	Nancowry	Mus	17	9	33
21		Olthyak	17	7	29
22	Katchall	West bay 1	23	10	39
23		West bay 2	27	8	---
24		Hoi-hi-poh	33	7	35
25		Jansin	50	11	29
26	Teressa	Safed balu	52	3	25
27		Kolaeru	45	7	27
28		Reksal	8	8	20
29	Bomboka	Hinam	12	6	---
30		Atluch	41	12	25
31		Chukmisuyi	33	2	17

### 3. Strengthening community conservation efforts in Nagaland: A program to impart technical support on biodiversity conservation and livelihood options to communities; Phase 1: Phek, Tuensang, Longleng, Kiphire and Mon districts.

Program Coordinator	: Venkota Nakro,
Associate Coordinators	: S. Bhupathy and P.A. Azeez
Collaborative Agency	: Nagaland Empowerment of People through Economic Development, Kohima
Duration	: Three years
Date of Commencement	: April 2007
Date of Completion	: October 2010 (with six month no cost extension)
Budget	: ₹ 287.13 lakhs
Funding Source	: Sir Dorabji Tata Trust, Mumbai
Status	: Ongoing

#### Background

About 2% of global fauna and flora are endemic to the Indo-Burma biodiversity hotspot. Northeastern India is also one of the richest areas in the country in terms of indigenous people and cultures. Three major factors directly affect biodiversity in the region: *jhum* cultivation, hunting and timber extraction. In Nagaland, over 95% of the forests are owned by local communities and it is pertinent to involve them in environment protection and conservation. In this background, the present program was initiated with the following objectives.

#### Objectives

- i) To assist villages, which have or propose to have community conservation areas, in developing biodiversity registers, resource maps and management plans and develop

- the process by which biodiversity registers are legally protected,
- ii) Advocate and assist in establishing community conservation areas, where such efforts are currently lacking
- iii) Document indigenous ecological knowledge
- iv) Identify technical, developmental and financial requirements of community conservation areas
- v) Provide necessary technical support and linkages on information, processes, markets and developmental and financial programs, to villages who are developing community conservation areas, and
- vi) Use the Blyth's Tragopan, which is the state bird of Nagaland as a flagship species in enhancing conservation reach.

#### Results and Discussion

The districts covered under the present program were Phek, Mon, Tuensang, Kiphire and Longleng. In all, 375 villages with nine indigenous people/tribes were studied during this project. During this and the previous years about 35 experts in 11 subject areas were involved as resource persons for inputs on various aspects. Facilitators of Community Conservation (FCC), the key people interacting with the indigenous communities and link between the researchers and the communities, were given training in recording Indigenous Ecological Knowledge with respect to animals and plants, generating GPS locations and GIS ground truthing and



Declaration meet of Saramati community conservation area at Pinkim village, Kiphira district, Nagaland

S. Ramesh Kumar

Herbarium techniques. Free listing of plants for 145 villages, IEK-plants for 232 villages and IEK-animals for 234 villages were completed. A draft report on land cover, land use, rivers, road net work and primary forest patches was prepared. Stakeholders of the Community Conservation Area (CCA) at multi village level meetings were organized at Tuensang, Pungro, Meluri and Shamatur. At all locations, people were interested in developing joint CCAs. The primary forests in Pungro have already been declared as a CCA jointly by 18 villages on 31st October 2009. The formal declaration of this CCA (Saramati Range Community Conservation Area) was made by Shri R. Tohanba (Honorable Parliamentary Secretary for Information, Public Relation, Economics and Statistics, Government of Nagaland) in the presence of the Saramati Awung Conservation and Management Society (SACMS) members. Several members from the Village Council officials of NEPED and scientists from SACON attended the meeting.

It is also planned to provide exposure to the FCC and other active Village Council members in nature conservation at a location outside Nagaland, where community conservation is practiced. If funds are available, it is planned to support Saramati CCA initially, at least for one year. Analysis and entry of the data collected so far is in progress. The final report is scheduled to be completed by October 2010.

#### Recommendations

To strengthen the community conservation efforts initiated by locals, a long term program with appropriate funding is required. Funds for protection of CCA from intruders, creation of corridors between/among CCAs to make the conservation sustainable, and further awareness program to take locals in to confidence are needed.

#### Summary

This project was initiated during 2007 to get local communities involved in conservation of environment. The fieldwork of the project has been completed during by March 2010. An important outcome of this work was the declaration of Saramati Community Conservation Area (CCA) by people belonging to 18 villages. At least six more CCAs are to be declared in the near future and they would be managed by the local communities. Funds for protection of CCA from intruders, creation of corridors between/among CCAs to make the conservation sustainable, and further awareness program to take locals in to confidence are needed. A long-term program with appropriate funding is required to strengthen the community conservation efforts initiated by locals.

#### 4. Ecology of the endangered Indian rock python, *Python molurus molurus* in Keoladeo National Park, Bharatpur, Rajasthan, India

Principal Investigator	: S. Bhupathy
Research Personnel	: C. Ramesh
Duration	: Three years
Date of Commencement	: 2 <sup>nd</sup> August 2007
Date of Completion	: 21 <sup>st</sup> August 2010 (with 6 months no cost extension)
Budget	: ₹ 11.06 lakhs
Funding Source	: MoEF (Wildlife Division)
Status	: Ongoing

#### Background

The Indian rock python, *Python molurus molurus*, one of the largest non-venomous snakes of the world is a threatened species listed in Schedule I of the Indian Wildlife Protection Act 1972. Despite its wide spread distribution in the Indian subcontinent, information on its ecology is meagre. The paucity of data makes species conservation and management decision difficult

and therefore, the present study was initiated with the following objectives.

### Objectives

- i) Study the population trend in python in KNP comparing results from earlier studies,
- ii) Gather data on aspects of ecology of Indian python such as population, basking, burrow fidelity and ranging, cohabiting species in the burrow and food habits,
- iii) Assess the impact of tourists on the basking and movement patterns of pythons, and
- iv) Propose a conservation plan for Indian pythons found in the drier zones, particularly in Keoladeo National Park, Bharatpur, and Rajasthan.

### Methods

Mapping of the distribution of python burrows in KNP was done subsequent to a survey on foot, covering the entire park recording GPS locations. Ground burrows with python signs (tracks, sloughs, snakes) were considered python burrows. As in the previous years, fortnightly surveys were conducted. The maximum number of sightings of pythons at a given burrow during various surveys would be considered as the number of snakes dwelling there, and the sum of these figures from all burrows accounts for the population. Size of individual snakes was estimated visually from a full view of the snake. The length data of snakes have been categorized in to various size classes for analyses. GPS records of sightings and re-



Scat of *Python molurus molurus*

sighting of individually identified pythons (using natural markings) are being gathered to understand their ranging, movement and activity patterns. Scat samples were collected to determine the diet of the python using tricotaxonomy techniques. Changes in the vegetation of python habitats are being monitored seasonally using quadrats (10X10m).

### Results and Discussion

Pythons were observed in 26 ground burrows and in total 45 snakes were observed during November 2009-March 2010. The number is much lower than the previous year (105 pythons in 33 burrows). This may be due to the exceptionally colder winter and the snakes would have gone for hibernation. As in the previous years, majority of snakes observed were of 8-10 feet length. Most of the snakes showed fidelity to the burrows used within and between years. A few individuals were re-sighted 2-3 km from previous sightings. Based on 39 scat and 8 direct observations, it was found that the spotted deer formed about 42.5% of the food of pythons followed by birds (19.2%) and rhesus macaques (8.5%). Data on basking behavior, cohabiting species and vegetation in python habitats are being analyzed.

### Recommendations

Fieldwork is completed and data analysis is in progress. Upon completion of the analysis, a conservation plan for the species will be submitted to the Rajasthan Forest Department.

### Summary

The study was initiated in August 2007 to understand the ecology of Indian python, an endangered species. Aspects such as population, basking, ranging, diet, associated species and breeding biology are being studied in Keoladeo National Park, Bharatpur. Pythons were observed in 26 ground burrows and a minimum of 45 adult snakes were estimated to be present in the park during the winter of 2009-10. Attack by jackal and hyena were major reasons for python mortality in this park. Chital formed the major food of this species in the area. Fieldwork is nearing completion.

S. Jayakumar

## 5. Conservation of endangered species and habitats - The Edible-nest Swiftlet in the Andaman and Nicobar islands

Principal Investigator	: Lalitha Vijayan
Co-Principal Investigator	: Manchi Shirish S. (September 2009 onwards)
Co-Investigator	: P. Pramod
Collaborative Agencies:	Department of Environment and Forests, A&N Islands
Research Associate	: Manchi Shirish S. (August to September 2009)
Duration	: Five years
Date of Commencement	: 1 <sup>st</sup> April 2009
Date of Completion	: On going
Budget	: ₹ 8.96 lakhs (For the Financial year 2009-10)
Funding Source	: Ministry of Environment and Forests (through Department of Environment and Forests, A&N Islands)
Status	: Ongoing



Cave Opening at Wrafter's Creek, Baratang Island

Manchi Shirish S

### Background

A program to conserve the Edible-nest Swiftlet in the Andaman and Nicobar islands is in progress since 1999. The program is being carried out by the Department of Environment and Forests, Andaman and Nicobar Islands and SACON. During Phase 1 (1999-2002) and Phase 2 (2002-2008), the conservation strategy that has been undertaken included: (a) organising and motivating nest-collectors to protect caves round the clock for the duration of the breeding season, and (b) developing alternate populations of the Edible-nest Swiftlet in houses, both to increase populations as well as to augment livelihoods. Since 1999, significant progress has been made; up to 49% increase in population is recorded at our focal sites. We are in the process of establishing a population of Edible-nest Swiftlet in a customized house; nest building and egg laying have taken place. We have demonstrated that this approach will lead to far wider recoveries in population of the swiftlets, thus positively benefiting these islands. In the Phase



Egg and the hatchling in the nest of an edible nest swiftlet at Chalis-ek

Manchi Shirish S

3 (2009-2014), we intend to continue the program, expand it and bring it to completion.

### Objectives

The three major components along with the objectives of phase 3 are:

- i) Research and development
  - 1 To develop the technology and the methodology to attract and induce Edible-nest Swiftlet to breed in customized human habitations,
  - 2 To continue ongoing studies on the breeding and foraging ecology of the species, and
  - 3 To study longevity and dispersal patterns of the Edible-nest Swiftlet.
- ii) In-situ conservation
  - 1 Consolidation and expansion of cave sites where conservation action is being implemented from the existing two to eight (5 in the Andaman and 3 in the Nicobar) caves, where nest-collectors will be organised and supervised in scientifically managing Swiftlet colonies, and
  - 2 To establish scientific harvesting systems.
- iii) Ex-situ conservation
  - 1 The development, and expansion of the number of houses in which the Edible-nest Swiftlet breed, thus establishing alternate populations and enabling widespread ranching of swiftlets from houses, and
  - 2 To establish scientific harvesting systems in Edible-nest Swiftlet colonies in houses.
- iv) Swiftlet Conservation Co-operative
  - 1 The establishment of a co-operative that will develop market linkages for nests harvested under supervised scientifically managed systems, which is fundamental to the conservation of the Edible-nest Swiftlet.

### Methods

1. Entry-exit counts, egg laying, hatching and fledging success, and dispersal patterns by studying marked birds, is continued and the whole program is continued under rigorous scientific monitoring.
2. Two sites, one at Interview Island and the

other at Chalis Ek are being protected and studied under the conservation program. The third site, Wraffter's Creek, Baratang Island (a complex of 170 caves), is incorporated in the conservation network.

3. Each nest is identified, numbered and its history traced from commencement of construction until the fledging of chicks, thus ensuring successful breeding within the colony and growth in population.
4. The colony of the Edible-nest Swiftlet at the house in Tugapur will be further augmented through the cross-fostering method. New houses were designed following designs in South-east Asia and with further modifications according to information available and requirement of the local sub-species. House ranching of Edible-nest Swiftlet will contribute to the economy of the islands as well as in building up populations of the species.

### Results and Discussion

Protection of the Edible-nest Swiftlet at 2 sites, 28 caves at Chalis-ek, Pattilevel and one cave on Interview Island was continued. Both sites were protected during the breeding season of the Edible-nest Swiftlet between January and July 2009. During 2010 with two existing protection sites third new site at Wraffters Creek, Baratang Island with 170 existing breeding caves was added for protection of the Edible-nest Swiftlet. In all three protection sites in North and Middle Andaman Islands 28 motivated nest collectors were engaged on daily wages for protection during the breeding season.

At Chalis-ek the population in 28 caves reached to 784 nests from 708 nests from the last season (2008). This was the maximum annual growth recorded after the Tsunami, in December 2004. Approximately 942 chicks fledged successfully from 784 nests. With further growth (over 16%) in 2010, the population reached up to 914 nests/breeding pairs and approximately 1107 chicks fledged successfully.

By the end of the season in July 2009 the population of the Edible-nest Swiftlet in the caves on Interview Island increased to 154



nests/breeding pairs from 137 nests and the roost count reached up to 473 individuals, an addition of 97 individuals from the previous count. Approximately 279 chicks fledged successfully from 154 nests. With further growth in 2010, the population reached up to 163 nests/breeding pairs.

After a population decline greater than 70% between 1997 and 2008, new protection camps between Wraffter's Creek and Naya Dera on Baratang Island was set up. Protection of almost all the known caves (170 caves) was started by enlisting 12 motivated nest protectors. As a result, the nest count in the caves reached 427 nests in 152 caves and approximately 598 chicks fledged. In total, approximately 1966 chicks were fledged successfully through the protection of 1504 nests in 2009.

Under ex-situ conservation, 101 eggs of the Edible-nest Swiftlet were transferred into the nests of the White-bellied Swiftlet in the ex-situ swiftlet house at Tugapur in 2009. More than 97% hatching success was recorded in the house later. As periodic disturbance may cause chick mortality, fledging success could not be calculated. However, no dead chicks of the Edible-nest Swiftlet were found in the house.

The existing ex-situ swiftlet house at Tugapur was renovated. After renovation the average temperature in the house dropped from 28°C to the required 23°C.

Three new sites at Ramnagar, Khara Nalha and Baratang Island were identified and the ex-situ swiftlet houses were constructed. Immediately after completion of the house construction at Khara Nalha near Mayabunder, White-bellied Swiftlets were seen visiting the house.

### Recommendations

With respect to the results achieved

1. *In-situ* protection program should be expanded to other potential sites according to the objectives
2. After constituting the Steering Committee, nest marketing system has to be set up so

that the motivation in nest protectors does not reduce.

3. Alternate incentive should be arranged for nest protectors till the nest marketing system is set up.
4. Further detailed studies on population structure and colonial and post-natal dispersal should be undertaken using genetics.
5. The commercial swiftlet, colonization of the species in the ex-situ sites should be studied in detail at every step.

### Summary

The program to conserve the Edible-nest Swiftlet in the Andaman & Nicobar Islands has been underway since 1999, implemented by the Department of Environment and Forests, Andaman & Nicobar Islands and SACON. Since 1999, significant progress has been made; population has already increased at the focal sites. We are in the process of establishing a population of Edible-nest Swiftlet in a house; nest building and egg laying have taken place; and have demonstrated that this approach will lead to far wider recoveries in population of the swiftlets and positively benefit these fragile islands. In addition to the existing focal sites new site was identified and protection system has been implemented from current season. These additional 152 caves shelter 427 breeding pairs of the species. This makes the number of protected breeding pairs to reach 1504. From these 1504 protected nests, 1966 chicks fledged successfully. In Addition to the ex-situ Swiftlet house at Tugapur, 3 new houses for ex-situ breeding of the species were designed and constructed on the basis of the techniques and knowledge available from South-east Asian countries and the Andaman and Nicobar Islands. In one of the houses, non-commercial Glossy Swiftlet has already started nest-site searching activities.

## 6. Influence of resource availability on ranging pattern in conspecific groups of free ranging lion-tailed macaques (*Macaca silenus*)

Principal Investigator	: H. N. Kumara
Collaborative agencies	: National Institute of Advanced Studies, Bengaluru
Duration	: Three years
Date of Commencement	: January 2008
Date of Completion	: December 2010
Budget	: ₹ 15.04 lakhs
Funding source	: Department of Science and Technology, Govt. of India
Status	: Ongoing

### Background

Studies of habitat use and ranging pattern have facilitated understanding the complexities of animal behaviour and ecology, including feeding strategies. Primates are interesting, since they exhibit wide inter-specific variation in activity and ranging pattern. Like most animals, primates show strong attachment to a particular area "the home range". Investigators have used different methods to estimate or measure primate home ranges, the area occupied by an individual or a group during a specified period. Measuring home ranges can be achieved through understanding how a group travels or ranges everyday and uses the habitat. The aim of the present project is to study the influence of resource availability on ranging pattern in con-specific groups of free ranging lion-tailed macaques.

### Objectives

- i) The diet of lion-tailed macaques
- ii) The impact of resource distribution and availability on ranging pattern
- iii) Inter-group interaction in relation to resource availability and its impact on ranging pattern



H. N. Kumara

Lion-tailed macaque in the forests of Sirsi-Honnava Karnataka

### Methods

Two groups of lion-tailed macaques were selected for the study. Instantaneous sampling or scan sampling is used to gather information on the group/individual activity. 50m x 50m random plots were used and food tree species of the study groups were marked. The tree species were chosen based on feeding observation. The fruiting and flowering phenology of trees of GBH >10cm, are monitored monthly. Ranging was plotted using hand held GPS units, at every 30 minutes. For any significant movement by the group outside the time frame, movements were recorded using way points in the GPS.

### Results and Discussion

Of the two groups of lion-tailed macaques for long-term monitoring data has come from one group i.e. Halballikodlu group. The group had two adult males, nine adult females and ten immature individuals. A ratio of 1: 4.5 (adult male to female) and a number of immature individuals were observed in the group. To understand the resource availability and stand structure, I cut five transects in the range of the study group. A total of 627 trees were measured for the basal area with species identity, and marked the species for long-term phenology monitoring.

3510 scans were made during the post monsoon season. Time was spent mainly on foraging (>60%) and eating (24%), and less on movement (5%) and social activity (7%). Tree height used was lower than 25 m. However, feeding and foraging were observed at ground

level to 15 m. Though the area has a higher canopy, it appears that they preferred the lower canopy and ground levels. The probable reason could be that availability of food resources are low during this period, hence they were searching and feeding more at the lower strata. Lion-tailed macaques were observed about 24% of the time feeding. Further, feeding data was analyzed to determine time spent on various food items of which more than 80% was on plant food items, 14% was on faunals and 5% on mushrooms. Using geo-coordinate data of daily movement, the total area used by the monkeys was estimated as 4.0 km<sup>2</sup>. However, this is a preliminary result.

### Summary

Like most animals, primates show strong attachment to a particular area “the home range”. Lion-tailed macaque, endemic to rain forests of the Western Ghats, lives in small populations. One of the largest known populations of the species is in the forests of Sirsi-Honnava, a reserve forest with high human density with mosaic of various plantations and agriculture.

The study aims at understanding their habitat utilization and ranging pattern in such a landscape. Two groups of lion-tailed macaque are followed for monitoring their ecology and ranging patterns. Scan sampling is used to assess the feeding ecology of the species. Latitudinal and longitudinal coordinates are recorded using a handheld GPS unit, while following the group to evaluate the ranging pattern. Fieldwork and data compilation are in progress. Preliminary analysis reveals high seasonal variation in habitat use and ranging pattern, and the estimated home range size of each group is ~4 sq. km.

## 7. Development of conservation strategy for a newly discovered lion-tailed macaque *Macaca silenus* population in Sirsi-Honnava, Western Ghats: II. Understanding of the impact of NTFP collection on the lion-tailed macaques

Principal Investigator	: H.N. Kumara
Research Personnel	: K. Santhosh
Duration	: 18 months
Date of Commencement	: August 2009
Date of Completion	: January 2011
Budget	: ₹ 6.06 lakhs
Funding source	: Critical Ecosystem Partnership Fund (CEPF) small grants
Status	: Ongoing

### Background

Most populations of the endemic and endangered Lion-Tailed Macaque (LTM) *Macaca silenus*, are declining or severely fragmented, and the species has gone locally extinct in some areas. The newly discovered population of the primate in Sirsi-Honnava is possibly the largest population with more than 650 individuals. However, this population is confined to unprotected reserve forests with extensive human habitation, agricultural land and livestock. The forests of Sirsi-Honnava lie in the central Western Ghats, in the district of Uttara Kannada, Karnataka.

### Objectives

The major objectives of the project are as follows

- i) Study the impact of NTFP collection on feeding ecology of LTM
- ii) Assess the status of LTM' s food plant species, and
- iii) To develop a strategy for sustainable harvesting of NTFPs

### Methods

Data on food-plant use was collected using scan sampling. At the end of each fourth month, local

people were interviewed using a custom-made questionnaire for NTFP collection.

### Results and Discussion

Twelve households of 73 sampled, extracted honey from the forest. Most households generally collect and sell honey every year but the harvest was very poor due to the scarcity of the resource and therefore high competition was seen. As a result, only three households extracted honey, *Mangifera indica* as well as *Garcenia indica*. The harvests of *Garcenia indica* were only from those that were planted in the backyard and none from the forest. The fruits are used as a flavouring agent in food and also for medicinal purposes. The unripe fruits of *Mangifera* were used in pickles and none of the households sold the fruits.

The seeds of *Garcenia morella* were collected by 11 households only. The seeds are used to extract oil to be used mostly for lighting purposes and rarely for consumption. The seeds were mostly collected from middens from fruits eaten by bats. Only 10 households were seen to extract unripe fruits of *Artocarpus lakoocha*, which people use as a flavoring agent along with common salt after slicing and drying it. This was also a resource with a high demand and commercial value. None of the households sold it since it was in shortage. Although the leaves and buds of *Cinnamomum* spp., pepper and seeds of *Callophyllum* spp. were extracted as NTFP previously, it was observed that none of them were extracted in this year.

The possible reasons for people not to extract NTFP, varied for different species. For *Callophyllum* spp. it was probably due to intensive labour involved in extraction of oil from its seeds and no notable commercial value is attached to the resource. With reference to *Cinnamomum* spp., it was evident and clear that due to over extraction by people in the forest the resource is severely depleted. It is almost impossible to observe a fully grown *Cinnamomum* spp. tree in the forest. The extraction of wild pepper was also negligible.

The compilation of data on feeding ecology of lion-tailed macaque is in progress.



### Summary

The recently discovered lion-tailed macaque population in the forests of Sirsi-Honnavara in southern Karnataka possibly represents the largest, contiguous population of the macaque in its natural habitat. However, baseline information on various aspects of the forest is lacking. The forests also harbour a high density of people and a large extent of agricultural land. It is necessary to understand the interaction of people and the forest to properly manage the region. NTFP collection has been an integral part of the life system of the local people.

To understand the impact of NTFP collection on the ecology of lion-tailed macaques, studies on availability of forest produce and its use by both monkeys and people have to be studied together. In the present study along with a study on lion-tailed macaques for their ecology, 73 households in the home range of the study group have been monitored for NTFP extraction. The study has found an overlap in resource use by monkeys and people. Further, detailed analysis of data would provide particulars on resource use and competition between them.

## 8. Distribution and Abundance of large mammals in Biligiri Rangaswamy Temple Wildlife Sanctuary (Phase I)

Principal Investigator :	H.N. Kumara
Research Personnel :	S. Rathnakumar
Duration :	Seven months
Commencement :	October 2009
Date of Completion :	April 2010
Budget :	₹ 2.00 lakhs
Funding source :	Karnataka Forest Department
Status :	Ongoing

### Background

The Biligiri Rangaswamy Temple Wildlife Sanctuary (BRTWLS) lies between 11° 40'-12° 09' N and 77° 05'-77° 15' E, with an area of 540 sq. km. The sanctuary is rich in flora and fauna due to high variation of altitude and wide array of vegetation types available. Examining the avifauna recording their sightings in the sanctuary were also attempted. Recently the Zoological Survey of India, Kolkata came up with a document on fauna of all major taxa in the sanctuary. However, it was restricted to a checklist for most taxa. From available literature, it appears that scientific knowledge on amphibians, reptiles, birds and mammals are inadequately documented in the sanctuary and therefore the present study was proposed.

### Objectives

- To assess the distribution of mammals (large herbivores, arboreal, small and large carnivores) in association with the forest types available in the BRTWLS.
- To evaluate the abundance of large mammals (large herbivores and arboreal mammals) in the BRTWLS

### Methods

Line transect method was adopted to estimate densities of large herbivores. Night surveys were conducted to assess the status of nocturnal mammals. Track plots were also used to record signs of different species. All sightings of



H. P. Ashwin

Elephants in BRTWLS

important species were recorded as incidental data. During the study period, abundance estimates of large herbivores were obtained and secondary data (scrapes and scratch marks) on large carnivore species were collected. We have used sighting records from all techniques to establish a distribution pattern for each species on a vegetation map. Since the data from line transects was not enough to estimate densities at the level of forest range, encounter rates were computed to compare between forest ranges and vegetation types.

### Results and Discussion

During October 2009 and April 2010, in the sanctuary 795.5 km was covered by walk by a single observer, 258 km of transect were walked by multiple observers during day hours and 462 km surveys were conducted during night hours.

Among the 34 expected species of large mammals in the sanctuary, 30 were sighted and



H. P. Ashwin

BRTWLS: One of the potential sites for conservation of tiger in India

information on the presence of one species was found in the records of the Forest Department. Elusive species such as leopard cat, rusty spotted cat, slender loris, flying squirrel and chevrotain were recorded during the survey. Eleven sightings of rusty spotted cat in the sanctuary is the highest sightings for the species for a sanctuary anywhere in India. The majority of these sightings were in the drier forests at the foothills of the sanctuary.

The estimated densities (animals/ km<sup>2</sup>) for large herbivore species was gaur = 5.08, sambar = 6.01, chital = 13.96, muntjac = 3.70, wild pig = 5.33, four-horned antelope = 2.44, Hanuman langur = 6.34 and bonnet macaque = 6.56. Estimates of large herbivore density in the present study, compared to those from other parks in the country, revealed that BRTWLS holds a higher density of muntjac, medium density of sambar and gaur and very low densities of chital and Hanuman langur. Nevertheless, the density of sambar was on par or higher than that of other parks of similar landscape. Though gaur density in BRT was lower than that of Bandipur and Nagarahole, it seems to have good potential over the landscape.

The density of large herbivore species multiplied with the average body mass of the respective species provides an estimate of biomass for that species. By summing up the biomass of all the species, a total biomass of 4127.82 kg km<sup>-2</sup> was obtained for the BRT Wildlife Sanctuary. Biomass varied from as low as 1277.25 kg km<sup>-2</sup> in Bhadra to 7638 kg km<sup>-2</sup> in Nagarahole. Six parks in the country viz. Nagarahole, Ranthambore, Pench, Bandipur, Kaziranga and Kanha have prey biomass in excess of 4000 kg/km<sup>2</sup> and the present study reveals that BRT Wildlife Sanctuary stands as one of the biomass rich areas in the country.

The overall herbivore density in BRT Wildlife Sanctuary was lower than many other protected areas. However, the density of large bodied species like gaur and sambar, being very high, contributes to the high biomass. Since the biomass of large prey species is high in the

sanctuary, the possibility of higher density of tiger, compared to other carnivore species, may be expected.

### Summary

BRT Wildlife Sanctuary has been considered as a live bridge between the Western and Eastern Ghats. The sanctuary is part of the larger forest complex of the region considered for the conservation of Asian elephant and tiger. Among the 34 expected species of large mammals, 30 species were sighted during the present study. Elusive animals like the leopard cat, rusty spotted cat, slender loris, flying squirrel and chevrotain were sighted. The present study reveals that BRT Wildlife Sanctuary stands as one of the high mammalian biomass rich areas in the country.

### 9. Preparation of biodiversity conservation plan for Mysore Forest Division

Principal Investigator	: H.N. Kumara
Co-Investigators	: M.K. Saptha Girish, K.B. Sadananda and A. Shivaprakash
Duration	: Six months
Commencement	: October 2009
Date of Completion	: March 2010
Budget	: ₹ 1.00 lakh
Funding source	: Karnataka Forest Department
Status	: Completed

### Background

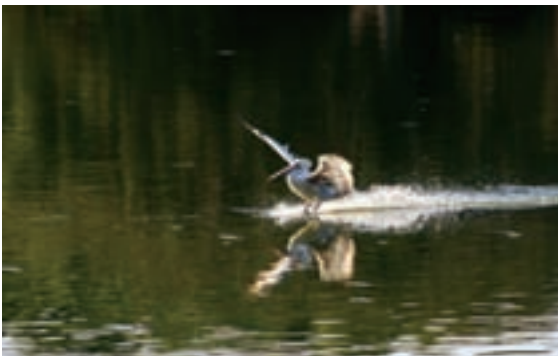
In wildlife research, highest attention is given to large mammals in the Protected Areas. Many critical species such as Indian fox, hyena, gray wolf, ratel, four-horned antelope, pangolin and several small mammals have not been given as much attention and the ecological status of such species is little known. Many of these species inhabit areas outside the Protected Area Network, and need to be studied. Forests outside protected areas play very important role



M. K. Saphtha Girish

### Crested Serpent Eagle in remnant patches of a reserve forest in Mysore forest division

for dispersal of animals, as temporary shelters and refuge for animals having larger ranges, permanent shelter for many small animals and a place for re-establishment for population growth. Thus, it is necessary to document the role of such forest patches adjacent to protected areas. The present study was an attempt to assess occurrence and abundance of large mammals, plant diversity and stand structure in the reserve forests of Mysore Forest Division. The significance of this study is further enhanced because the forests of Mysore forest division are the fringe forests of Nagarhole National Park and Bandipura National Park and act as buffer zones to these forests.



M. K. Saphtha Girish

### Kukkarahalli tank in Mysore city is one of the breeding sites for Spot-billed Pelican

## Objectives

The major objectives of the program are:

- i) Prepare an inventory for mammals and plants for the selected reserve forests
- ii) Evaluate the conservation status of three water tanks in Mysore city

## Methods

We have used existing trails to monitor mammals and used secondary information for the presence of each species. We have laid plots for vegetation assessment.

## Results and Discussion

All the study sites are fragmented and highly exposed to anthropogenic activities. In spite of such pressures, wildlife persists in these fragmented forests. Among the study sites, Chammundi hills is better conserved and protected. The metal fencing has worked well to a great extent and acted as a shield. Protection has led to increasing vegetation growth and bird species over the years. Similar method of protection cannot be applied everywhere. Nevertheless, these can be attempted in places such as Mallesawara gudda, Vadagal Ranganatha Swamy betta and Mallikarjunaswamy betta. Our findings suggest that, the Sollepura reserve forest adjoining the Nagarhole NP harbors many large mammals and is contiguous with the National Park. This area should become part of Nagarhole, so that management and protection can be properly enforced.

## Summary

The study sites are highly fragmented and exposed to anthropogenic activities. In spite of such pressures, these fragmented forests support wildlife. It is time now for proper and strict conservation actions to be taken to preserve these forest patches as they prove to be refuge zones for several mammals and birds.

Among all the study sites, Chammundi hill is better conserved and protected due to the metal fencing. Although the same method cannot be applied everywhere, it can be tried in places such as Mallesawara gudda, Vadagal Ranganatha Swamy betta and Mallikarjunaswamy betta.

### 10. Establishment of ENVIS center at SACON on theme 'Wetlands of India'

Principal Investigators	: S.N. Prasad (ENVIS Coordinator) Lalitha Vijayan
Collaborating Agency	: MoEF, Govt. of India
Research Personnel	: Chiranjibi Pattanaik Santosh Gaikwad Madhu Routhu
Duration	: Long term project
Date of Commencement	: April 2009 (for the present year)
Date of completion	: March 2010 (ongoing)
Budget	: ₹ 4.80 lakhs
Funding source	: Ministry of Environment and Forests
Status	: Ongoing

#### Background

Wetlands, undoubtedly, are one of the most valuable resources for India. Wise use and conservation of wetlands ensure water, food and ecological security. SACON is involved in wetland conservation since its inception. Ministry of Environment and Forests (MoEF) established one ENVIS nodal center on Wetland Ecosystem to disseminate knowledge on wetlands of India. This center is working since 2004 and a good number of spatial databases have been created and uploaded in the ENVIS website for the users.

#### Overall Objectives:

The major objectives of the project are the following.

- i) Creation of a website on Wetland Ecosystem with a regional language interface
- ii) Monthly compilation of news items on the Wetland ecosystem
- iii) Identification of information/data gaps in the specified subject area and action taken to fill these gaps

- iv) Contribution of news items to the ENVIS newsletter on a quarterly basis
- v) Establish and operate a distributed clearing house to answer and channel queries related to wetlands
- vi) Establish linkages with information users, carriers and providers from among government, academia, business and non-governmental organizations including that with ENVIS

A new initiative on mapping and monitoring Ramsar sites of India was started by SACON under the ENVIS project. We are now making the LULC maps of certain Ramsar sites of India as per satellite data available from different projects. The specific objectives, methodology, results and discussion for each site are provided below.

Study area: Bhitarkanika National Park (Orissa)

#### Objectives:

- i) Temporal monitoring of Bhitarkanika mangroves using multi-temporal satellite data.
- ii) Change in Biodiversity of Bhitarkanika mangroves

#### Methods

The analysis is based on a multi-temporal satellite imagery study of the mangroves of Bhitarkanika and adjacent areas, the extent that was analyzed over time. As a result of the analysis, classified thematic maps were prepared to obtain a land-cover map. The satellite data and materials used for the study were the following; Landsat multi-spectral scanner (MSS), Indian Remote Sensing satellite 1A (IRS-1A) Linear Imaging Self Scanner (LISS-II), IRS P6 (Resourcesat) LISS III (January) and Survey of India (SOI) of a scale of 1:50,000. In addition, Landsat Thematic Mapper (TM) and IRS P6 LISS III (April) data were used as reference data (Table 1). All the images were recorded in approximately the same season between December and January corresponding to the wet season in this region. All datasets were geometrically corrected. For geo-referencing, the IRS-P6 LISS III data was co-registered to





SOI topographic maps at 1: 50,000 scale using ground control points. The datasets were brought into WGS 84 datum and UTM projection. These satellite data were visually interpreted on-screen on a Silicon Graphics Workstation using ERDAS IMAGINE (version 8.7) image processing software. Ancillary data (SOI toposheets and forest management maps) were used to complement the results of the classification.

### Results and Discussion

To determine the accuracy of the thematic map obtained using visual interpretation from the latest 2004 image, an accuracy assessment was carried out. Doubtful areas were identified and the geographic co-ordinates of these points were noted from the visually interpreted classified map. All these points were checked in the field with a handheld GPS unit. The overall accuracy assessment stands at 94% in 2004. The spatial changes in the mangrove cover have been assessed and the details are given in the table. Change analysis map shows that the major changes are in the proximity of agricultural lands due to high anthropogenic pressure. River creeks are also affected perhaps due to tidal inundation and sedimentation. Agriculture land with habitation is the major category (51.8%) followed by dense mangroves (21.8%), open

### Summary

A new program of mapping and monitoring of Ramsar sites of India using geospatial technology was launched. Under this program, Bhitarkanika Wildlife Sanctuary, one of the two Ramsar sites of Orissa was examined. From the change detection study (1973-2004), a loss of 1534 ha mangrove area and an increase of 2436 ha of agriculture area was observed.

CEPA activity was extended to different institutions, NGOs and other relevant bodies to raise awareness on wetlands. Expert databases and news clippings were added to the ENVIS website for dissemination. Wetlands of India website was also revamped as per MoEF guidelines.

mangroves (2.7%) and water bodies (20.2%) in 2004. The overall change area statistics of different land cover categories from 1973-1988 and 1988-2004 are presented. The study area represents a rich repository of plant wealth.

(2004): The land cover system undergoes a significant change according to the change in socio-economic of the people. Agriculture is gradually increasing from 32346 ha (1973) to 33501 ha (1988) reaching 34782 ha in 2004. A

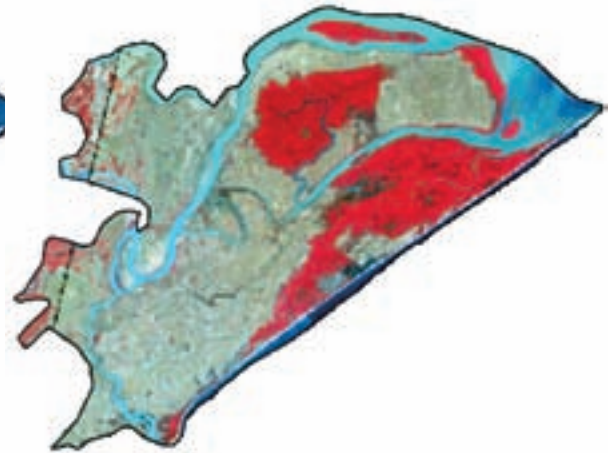
### Distribution of areas in mangroves and other land use categories (Ha) in Bhitarkanika Wildlife Sanctuary from 1973-2004

Category	Area in 1973 (Ha)	Area in 1988 (Ha)	Area in 2004 (ha)	Percentage of total area	Change (Ha) (1973-2004)
Dense mangrove	14646	14532	14630	21.77	-16
Open mangrove	3350	3333	1832	2.73	-1518
Fresh water swamp	103	103	103	0.15	0
Littoral scrub	0	0	48	0.07	48
Grassland	28	28	28	0.04	0
Plantation	0	237	270	0.40	270
Mudflat	2298	1661	1219	1.81	-1079
Sand	664	464	723	1.08	59
Water body	13767	13344	13568	20.19	-199
Agriculture	32346	33501	34782	51.76	2436
<b>Total</b>	<b>67202</b>	<b>67202</b>	<b>67202</b>	<b>100.00</b>	

### Multi-temporal FCC image of Bhitarkanika Wildlife Sanctuary, Orissa



Landsat MSS; 17 January, 1973



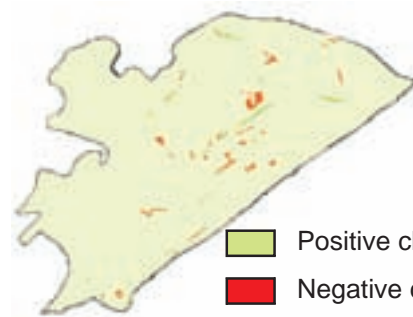
IRS 1A LISS II; 17 December, 1988



IRS P6 LISS III; 13 January, 2004



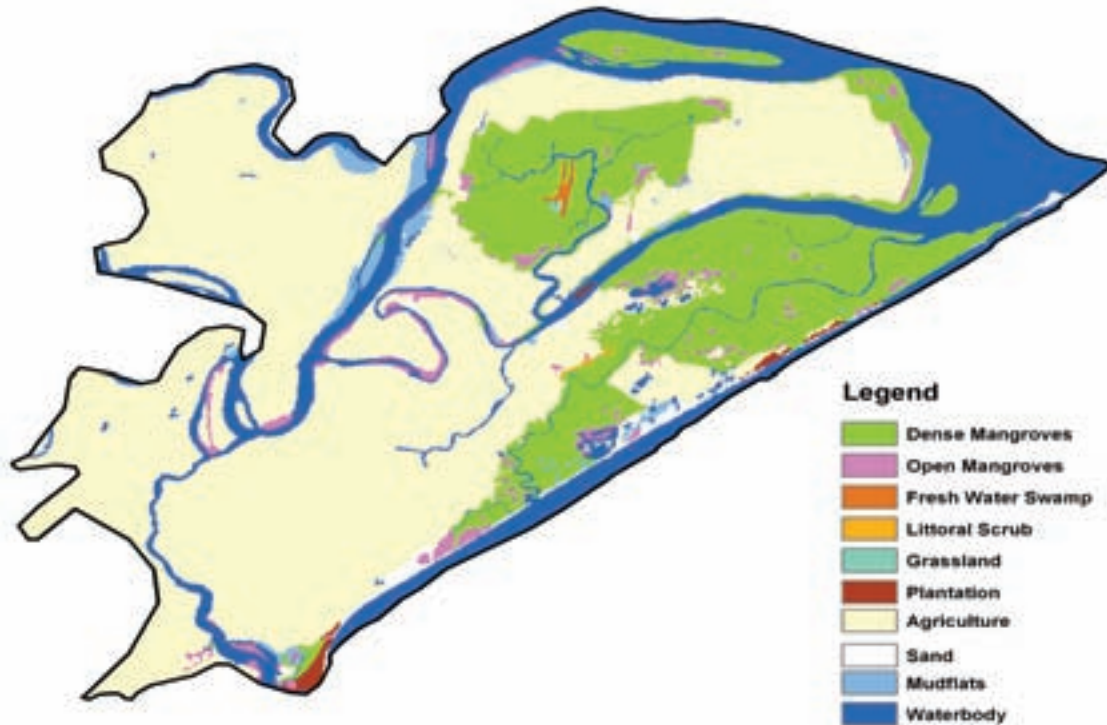
a. Change between 1973-1988



b. Change between 1988-2004

Positive change  
Negative change

Mangrove and other land cover change in sanctuary area during  
(a) 1973-198 and (b) 1988-2004



### Classified Land use/Land cover map of Bhitarkanika Wildlife Sanctuary

net change of 2436 ha area observed due to conversion of dense and open mangrove forests to agriculture. Littoral scrub vegetation was formed due to mangrove deforestation. Several exotic species spread over the area affecting the native vegetation. The present study has shown that there is a significant decrease of 1534 ha of mangrove forest from 1973 to 2004. The information generated for the Bhitarkanika Sanctuary area will aid in understanding the spatial distribution of the mangrove forest and periodical change over more than 30 years, which will help the forest department, Government of Orissa in further planning and taking timely decision for sustaining the mangrove cover.

Communication Education Public Awareness (CEPA) Activity: World Wetlands Day was Celebrated in collaboration with Andhra Pradesh Pollution Control Board (APPCB), India on 2nd February 2010.

SACON as a part of its Environmental Information System (ENVIS) activities

celebrated World Wetlands Day on 2nd February 2009 at Andhra Pradesh Pollution Control Board (APPCB), Hyderabad. More than 100 participants including several academicians, scientists, policy makers from a number of organizations took part in the event.

#### Recommendations:

The following recommendations will be added to the Wetlands of India website in the future.

- i) Mapping of wetlands of size 2 ha and above for the 1990 base year in the remaining states of India
- ii) Mapping of Ramsar sites of India and comparing with the present status
- iii) Habitat change assessment and creation of spatial databases by using Landsat TM and ETM datasets of 1990 and 2000
- iv) Development will be done using FOSS or free tools and other FOSS tools as per the requirement.
- v) Interactive web mapping using FOSS software with Google maps

- vi) Developments of data acquisition tools and make the available to other organizations to digitize data related to the wetland.
- vii) Interoperability feature using web services to promote data exchange or sharing.
- viii) Greater regional language interfaces for Wetlands of India.
- ix) Intensive education activities for creating awareness among the local people on wetlands.

### 11. Directory of wetlands of North Kerala

Principal Investigator	: S.N. Prasad
Co-Investigator	: Lalitha Vijayan
Research Fellow	: Chiranjibi Pattanaik, Santosh Gaikwad
Project Period	: April 2008 to December 2009
Date of Commencement	: April 2008
Date of completion	: December 2009
Budget	: ₹ 3.89 lakhs
Funding source	: Kerala State Biodiversity Board (KSBB)
Status	: Completed

#### Background

Kerala, blessed with copious rainfall, is a haven for inland and coastal wetlands. Millions eke out their livelihood from the backwaters. There were many attempts to inventory and prioritize wetlands of Kerala. However, none of these studies has used high-resolution mapping and linkage with various hierarchical levels of administration. Recently, a comprehensive summary of the work on wetlands in Kerala has been brought out by the Kerala Environment Congress, 2007 focusing on wetland Resources of the state. It was obvious that the wetlands in the state as elsewhere in the country are facing severe pressure from competing land uses. Consequently, there is a growing need to understand and stem this loss along with mounting effective conservation and wise use policies. It is with this aim the Kerala State Biodiversity Board commissioned the project

"Directory of wetlands of Kerala". The wetlands in southern half of the state are being studied by KFRI. SACON has been given the work of the Directory of wetlands of North Kerala, which aims to provide an extensive baseline information and data on spatial distribution of wetlands in six districts of Kasargod, Kannur, Kozhikode, Malappuram, Palghat and Wayanad.

As the scale of mapping is very crucial issue for wetland conservation, an attempt has been made to use existing land use land cover information including wetlands at 1:12500 scale at different hierarchical levels, namely district, block and panchayat level. Since the database has been organized and is compatible with a Geographic Information System, many relevant themes such as plant and bird diversity, socioeconomic, demographic and economic dimensions can be easily captured and added as thematic layers. Further with the aim of taking the data to the actual stakeholders, a web based Geographic information system has been developed. A novel feature added onto the web GIS, is to enhance usability and ready access. Hence the web GIS has been dovetailed with Google earth map application. We believe this effort is one of the first of its kind in conservation and management of fast depleting wetland ecosystems in the country.

#### Objectives

The major objectives of the project are the following.

- i) Map all wetlands in North Kerala districts using high-resolution satellite data
- ii) Create a web enabled GIS information system for the user

#### Methodology

The details of the data used while developing the spatial database for Kerala Wetlands are the following.

Data Source	: Kerala Planning Board
Data Type	: Vector data in shape files
Scale	: 1:12500

Thematic layers: a) Land use and land cover, b), Roads, c) Place Names, d) Drainage, e) Kerala State Boundary, f) Kerala Panchayats,

and g) Other administrative units like blocks or districts. (These were obtained through union function available in PostGIS on the fly)

**Database Structure:** Database structure was designed accordingly to support the needs of Kerala wetlands. The following tables were created from the provided shape files.

- i. k\_bnd (Kerala Boundary)
- ii. k\_drainage (Kerala Drainage)
- iii. k\_fallow (Fallow lands in Kerala)
- iv. k\_paddy (Paddy Lands in Kerala)
- v. k\_panchayat (Panchayat boundaries for Kerala)
- vi. k\_roads (Kerala Roads)
- vii. k\_stat (Statistical table)
- viii. k\_wetland (Kerala Wetlands) and
- ix. k\_biodiversity (Kerala PAN FISH data table)

### Results and Discussion

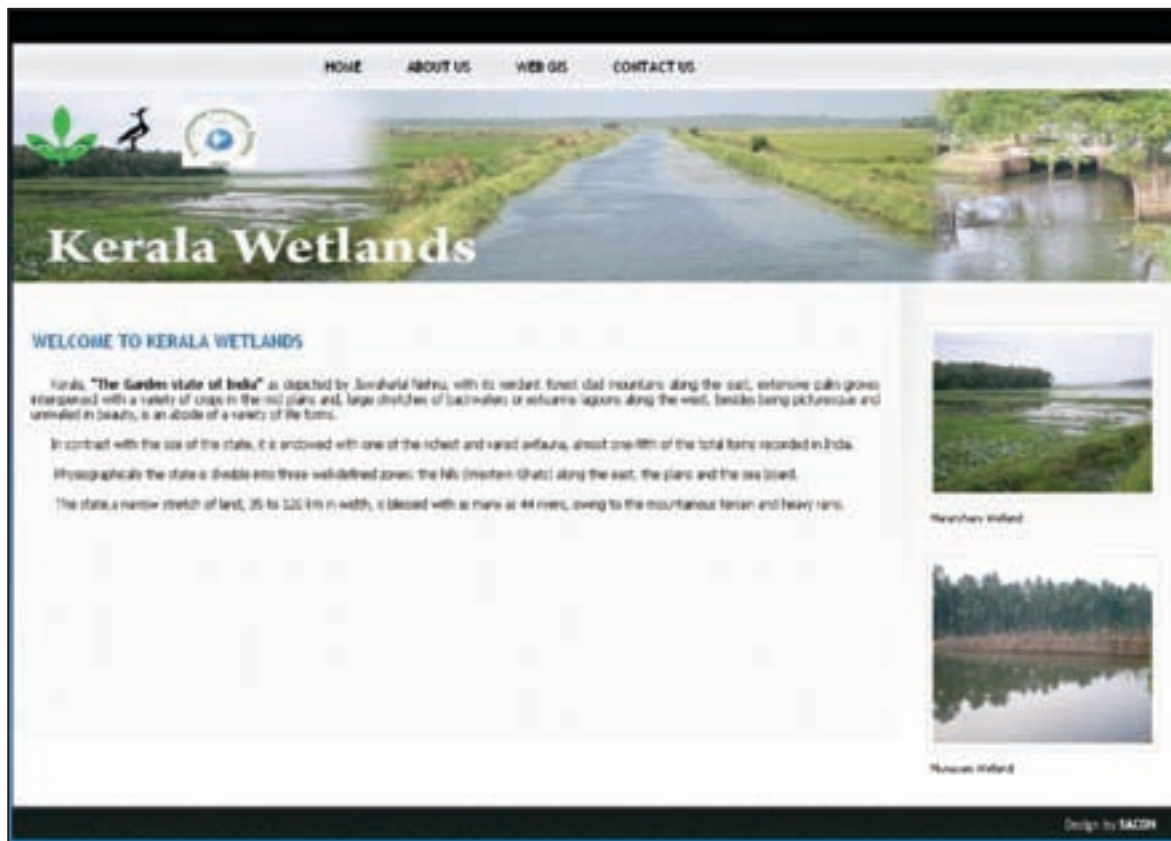
The land use database has been developed at a scale of 1:12500 for the Kerala State Planning

Board. This was developed based on LISS III satellite data, by a collaborative effort of ISRO and State Remote sensing centre. However, this data has several lacunae which were resolved both at thematic and at basic data preparation level using open-source geospatial tools. The reconstructed data thus formed the basis for developing a web enabled wetland information system.

### Monitoring at different administrative units

In the following pages, the use of open source geospatial tools for furthering the goals of a participatory wetland monitoring at four hierarchical levels of Panchayat, block, district and state is described.

Google Maps provide a highly responsive, intuitive mapping interface with embedded, detailed street and aerial imagery data. Google Maps provides the map, satellite image or a hybrid of both and a range of operations on the



Website of Kerala Wetlands ([www.keralawetlands.in](http://www.keralawetlands.in))

**Summary**

The vector database received from the state Biodiversity Board on 1:12,500 scales was extensively used in developing a web enabled wetland information system at district, Block and Panchayat level ([www.keralawetlands.in](http://www.keralawetlands.in)). This is a first of its kind for any state using open source geospatial technology tools. All the shape files are uploaded to the website for visualization purpose. It is hoped that this will help all the stakeholders in using, updating and monitoring at the three hierarchical levels.

map including zooming, panning, information pop-ups and overlays. Google Maps API provides an interface into these operations through JavaScript objects. The GIS application for Kerala Wetlands has been developed using Google Maps API. A spatial database was developed for it in PostgreSQL / PostGIS, two key open source geospatial tools. The major advantage of creating spatial database for the entire state is that the data reside in a central database with well-defined user privileges. This makes it possible to extend the standard SQL queries with spatial queries.

## **12. Land Use, Land Use Change and Forestry (LULUCF) assessment using satellite data.**

Principal Investigator	: S.N. Prasad
Collaborating Agency	: National Remote Sensing Centre (NRSC), Hyderabad
Research Fellow	: K.S. Ramachandra Murthy
Project Period	: July 2009 to December 2010
Date of Commencement	: July 2009
Date of completion	: March 2011 (On going)
Budget	: ₹ 3.27 lakhs
Funding source	: National Remote Sensing Centre, Hyderabad
Status	: Ongoing

**Background**

India is party to the United Nations Frame Work Convention on Climate Change (UNFCCC), a multilateral treaty, the objective of which is to stabilize the concentration of green house gasses of anthropogenic origin at a level, where its influence on the earth's climate is at a minimum. Being party to the UNFCCC India is required to furnish information on implementation of the convention in the form of a National Communication report in accordance with the article 12 of UNFCCC. Further, the National Communication is to be prepared in accordance with the guidelines adopted by the Conference of Parties (COP). Towards fulfillment of India's obligation, India furnished the Initial (first) National Communication (INC) to the UNFCCC. Communication of Information by the parties is a continuing requirement and the submission of the communication is done in accordance with the decision of COP. The Second National Communication (SNC) is required to be furnished by the Government of India. Ministry of Environment and Forests (MoEF) has recently initiated the work relating to one of the core components of SNC, i.e., preparation of inventory of green house gases of anthropogenic origin (emission by source and removal by sinks) in the sectors of energy, industry, agriculture, forestry and waste. To estimate the carbon stocks and emissions and removal of greenhouse gasses associated with land use, land use change and forestry (LULUCF) activities, development of a matrix of Land Use and Land Cover (LULC) and LULC change areas under crop, forests, wasteland, settlements and others through remote sensing and simultaneous ground based assessments is considered as one of the primary task. In this context, MoEF has requested NRSA to provide input for the entire country. In this context, the present project aims to develop a matrix of land use and land use change of areas under crops, forests, wasteland, settlements and others through remote sensing for the period 1994 and 2004 and simultaneous onsite assessment.

**Objectives**

The specific objective of the project is to determine areas under different land cover

classes (forests, grassland, wetland, settlement and cropland) and map changes between years.

### Study area

Under this program, four states (Orissa, Jharkhand, Bihar and West Bengal) are studied for LULC.

### Methodology

The methodology followed for the study is:

- i) Regrouping of AWiFS based 19 classes of LULC classified map, 2005 to 8 classes as mentioned above.
  - a. Regroup plantation, evergreen forest, deciduous forest, degraded forest and littoral swamp to Forest;
  - b. Regroup *kharif*, *rabi*, *zaid*, double crop and current fallow to agriculture;
  - c. Grassland to grassland
  - d. Scrub to scrub;
  - e. Built up to settlements; and
  - f. Regroup other wasteland, gullied, snow covered, shifting cultivation and rann to others
- ii) Re-sampling, smoothing and vectorization of the LULC classified map
- iii) Re-sample classified to the pixel size of the LISS-1 image i.e., 72.5 m and the majority filter of window size 3X3 has to be used twice to filter the classified image.
- iv) Geo-rectification of the 2 season 1994 LISS-1 satellite data with reference to 2006 IRS P6 LISS-1 data.
- v) Overlay of 2005 'eight' class vector layer on 1994 and update the changes in all the classes.
- vi) Calculate accuracy assessment viz., over all classification accuracy and Kappa statistics from the classified map.
- vii) Prepare a change map and generate state wise statistics and prepare the mosaic for all the given states.

- viii) Calculate area statistics of different LU/LC classes, pie charts and bar graphs for the two time periods.

### Results and Discussion

**Orissa:** The state has a tropical climate with average temperatures ranging between 10 °C in the winter to 45 °C in summer. The southeast monsoon appears in mid-June. The average annual rainfall is 154 cm, most of which is recorded between June and October. The LULC analysis has been done for 1995 and 2005. The area statistics of both years has given below. Significant change is observed in agriculture and scrub area. Agriculture area has decreased from 1995 to 2005, while scrub area increased in that time. Increase in settlement area clearly depicts high anthropogenic pressure. The LULC map of Orissa for the period of 1995 and 2005 are given below.

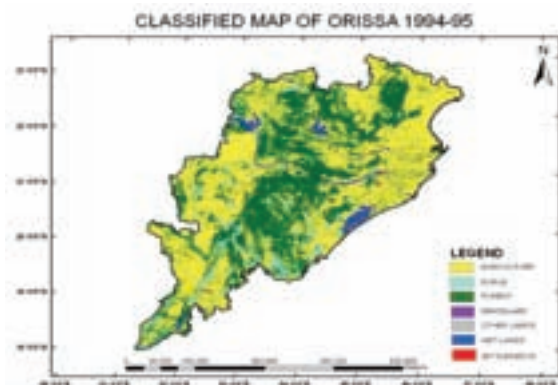
**Jharkhand:** The state lies on the Chota Nagpur Plateau which is the source of the Koel, Damodar, Brahmani, Kharkai, and Subarnarekha rivers. The upper watersheds of these rivers lie within the state, much of which is still covered by forest. Forest preserves support populations of tigers and Asian elephants. The land use land cover analysis has been done for 1995 and 2005. The area statistics of both years is given below.

**Bihar:** The land use land cover analysis of Bihar has been done for 1995 and 2005. The area statistics of both years is below.

**West Bengal:** The land use land cover analysis of West Bengal has been done for 1995 and 2005. The area statistics of both years has given below.

Considerable reduction in wetland cover and increase in forest area are observed from 1995 to 2005.





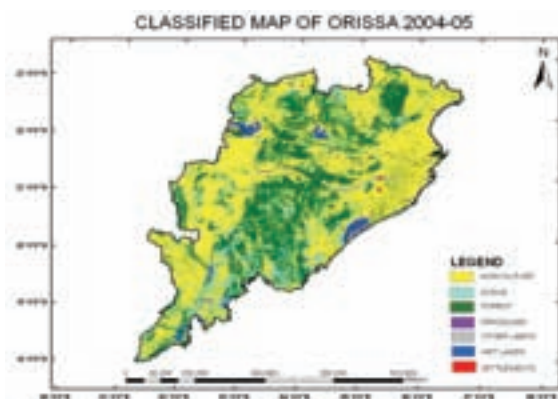
LULC map of Orissa using IRS 1A LISS-I satellite data (1994-95)

### Area (ha) statistics of Orissa state in 1995 and 2005

Land cover	1995	2005
Agriculture	8234725.9	8214523
Scrub	1374015.1	2069686.5
Forest	5447556.1	4252423.7
Grassland	4651.1	77810
Other land	2735.1	553182.1
Wetland	527514.5	416878.9
Settlements	13088	15366.4

### Area (ha) statistics of Jharkhand state in 1995 and 2005

Land cover	1995	2005
Agriculture	6135379.2	6075879.9
Scrub	276980.6	357540
Forest	2430416.3	2427136.2
Grassland	3.1	3.5
Other land	103559.5	121839.1
Wetland	133153.3	94475.4
Settlements	45898.2	48444.6



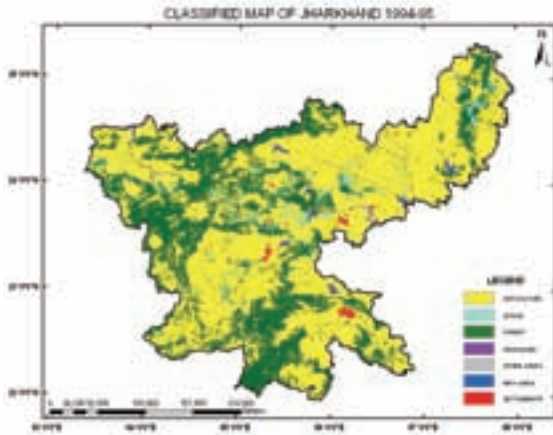
LULC map of Orissa using IRS P6 AWiFS satellite data (2004-05)

### Area (ha) statistics of Bihar state in 1995 and 2005

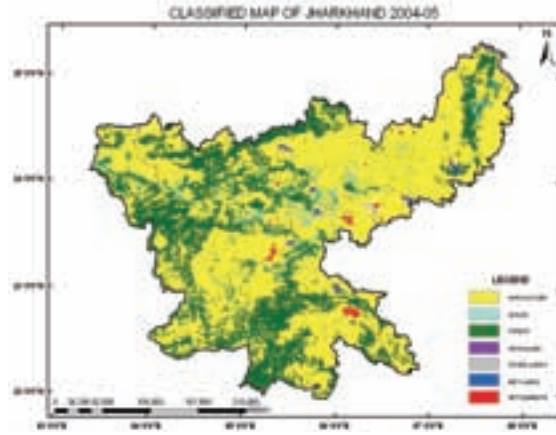
Land cover	1995	2005
Agriculture	8917126.3	9129955.7
Scrub	180404.4	200358.1
Forest	649955.8	604337.3
Grassland	8325.5	12128.2
Other land	187401.4	194955.4
Wetland	704599.3	496816.1
Settlements	59273.8	68441.6



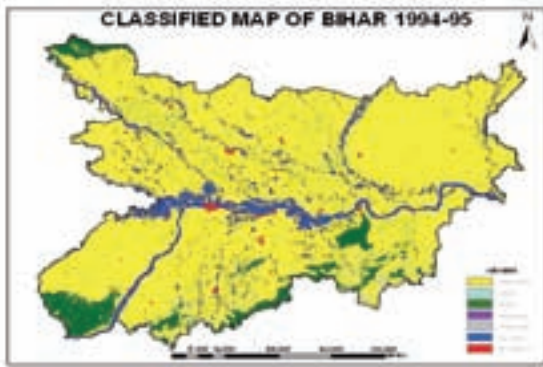




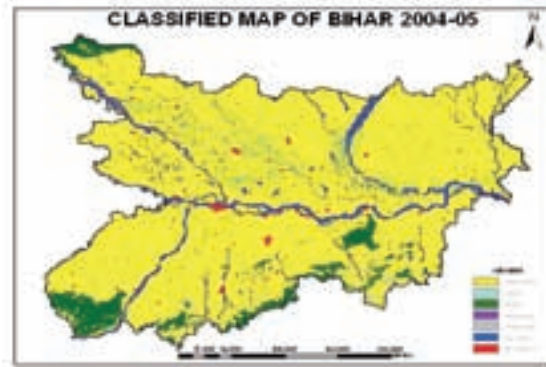
LULC map of Jharkhand state using IRS 1A LISS-I data (1994-95)



LULC map of Jharkhand state using IRS P6 AWiFS data (2004-05)

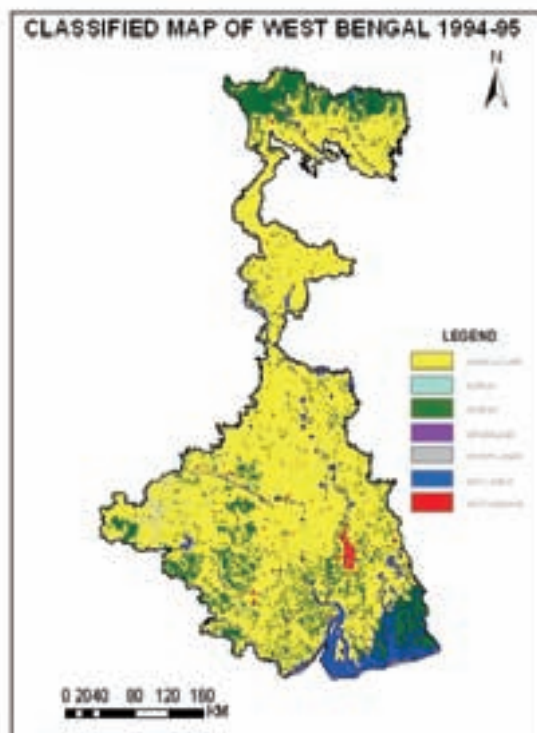


LULC map of Bihar state using IRS 1A LISS-I data (1994-95)

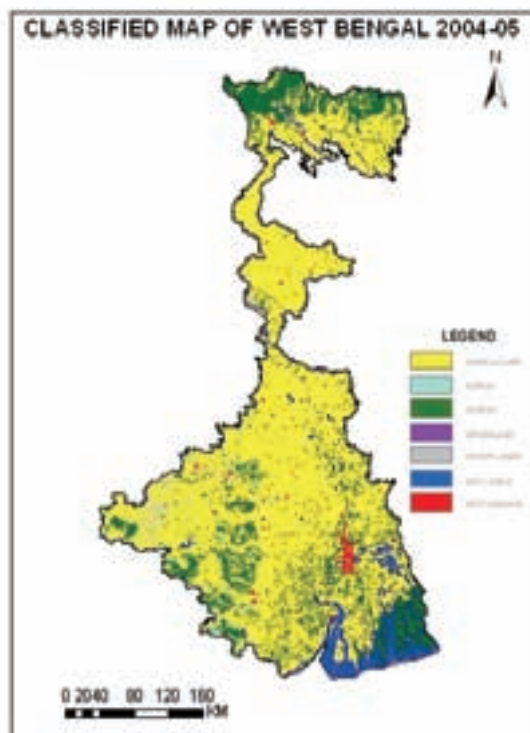


LULC map of Bihar state using IRS P6 AWiFS data (2004-05)





LULC map of West Bengal state using IRS 1A LISS-I data (1994-95)



LULC map of West Bengal state using IRS P6 AWiFS data (2004-05)

#### Area (ha) statistics of West Bengal state in 1995 and 2005

Land cover	1995	2005
Agriculture	7664519.8	7463352
Scrub	15532.6	93784.6
Forest	1625981.8	1723872.4
Grassland	9745.1	16135
Other land	272563.2	385808.6
Wetland	764285.8	657866.9
Settlements	86493.1	97603

#### Summary

According to the Second National Communication to UNFCCC, Land use, Land use change and Forestry assessment is required for estimating carbon stocks, emissions and removal of greenhouse gasses. The development of a matrix of Land Use and Land Cover (LULC) and LULC change areas under crop, forests, wasteland, settlements and others through remote sensing and simultaneous ground based assessments is considered as one of the primary task for this project. The data of two times (1994-95-IRS 1A LISS I and 2004-05-IRS P6 AWiFS) were considered for the present study. Orissa, Jharkhand, West Bengal and Bihar states were mapped using above satellite data. The change in land use was also estimated using two satellite datasets.

### 13. Mapping and monitoring of *Eucalyptus* plantation in three states of India using satellite remote sensing and GIS techniques

Principal Investigator	: S.N. Prasad
Research Personnel	: Chiranjibi Pattanaik
Collaborating Agency	: M/s Mangalam Timer Products Ltd (MTPL), Kolkata
Project Period	: Eight months (after two extensions)
Date of Commencement	: December 2008
Date of completion	: August 2009
Budget	: ₹ 7.10 lakhs
Funding source	: Mangalam Timber Products Limited (MTPL)
Status	: Completed

#### Background

Clean Development Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialized countries with a green house gas reduction commitment to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries. A crucial feature of an approved CDM carbon project is that it has established that the planned reductions would not occur without additional incentive provided by emission reduction credits. To help countries meet their emission targets, and to encourage the private sector and developing countries to contribute to emission reduction efforts, negotiators of the Protocol included three market-based mechanisms – Emissions Trading, the Clean Development Mechanism and Joint Implementation.

The CDM project activity involves augmentation of carbon sequestration of degraded land through afforestation activities. Along this line, M/s Mangalam Timber Products Ltd (MTPL) has initiated a plantation program in collaboration with farmers in three states, Orissa, Andhra Pradesh and Chhattisgarh. The entire project

areas include many discrete pieces of land that are managed by The Farm Forestry Scheme/Public Private Plantation Scheme taken up by MTPL. The species selected for the sequestration is a *Eucalyptus* hybrid, which will be harvested at 5-year intervals. The project is undertaken to protect land that was severely degraded, to increase vegetation cover and to promote natural regeneration. The lands identified for plantation were wastelands without much plant cover due to severe soil erosion. The project also aims at enhancing sources of livelihood and income in rural areas by generating large employment opportunities.

#### Objectives

The major objective of the study was the following:

- i) Generate site specific spatial database on plantation using satellite remote sensing
- ii) To make change detection studies with previous satellite datasets (Landsat Thematic Mapper) of 1990 period

#### Methodology

Study area: The study covers entire plantation sites under the project, distributed in seven districts across three states. The seven districts are i) Nabarangpur, Koraput and Malkangiri in Orissa, ii) Vishakapatnam, Vizianagaram and

#### Summary

As per the Clean Development Mechanism activity, carbon sequestration of degraded land through afforestation activities must be evaluated. Identification of plantation sites using GIS and GPS are one of the primary criteria. The current project was undertaken to map all *Eucalyptus* plantation plots spread across seven districts of Orissa, Chhattisgarh, and Andhra Pradesh. The status of the land was also compared to the 1990. 132 maps were generated using IRS P6 LISS III satellite images of 2008 year. In a similar way, 69 maps of the period between 1989 and 1990 were generated using Landsat TM images. These maps are helpful for delineating the increase in vegetation cover, which is used for carbon credits.

### Distribution of plantation area in Orissa, Andhra Pradesh and Chhattisgarh

S.No.	State	District	Plantation Area (Ha)	Total Area (Ha)
1	Orissa	Nabarangpur	4999.4	13200.05
2	Orissa	Koraput	7445.73	
3	Orissa	Malkangiri	754.92	
4	Andhra Pradesh	Vishakapatnam	3294.19	3664.12
5	Andhra Pradesh	Vizianagaram	86.35	
6	Andhra Pradesh	Srikakulam	283.58	
7	Chhattisgarh	Bastar	571.16	571.16
	Total		17435.33	17435.33

Srikakulam in Andhra Pradesh and iii) Bastar in Chhattisgarh. The plantation activities were started in 2001 and so far 17,435.33 hectares of plantation is done by MTPL in collaboration with the farmers. The planted areas in the three states are given in the table below .

GPS location collection and satellite data processing: Ten teams of two members each were formed to collect GPS locations in the three states. Six teams covered Orissa, three teams Andhra Pradesh and One team Chhattisgarh. Satellite data were procured from NRSC, Hyderabad and georectified. GPS points were overlaid on the image and the boundary of each plantation plot was drawn. The status of the land cover was also studied using Land sat TM data of 1990.

#### Results and Discussion

In total 132 maps were generated using IRS P6 LISS III satellite images of the year 2008. 69 maps for the 1989-90 period were generated using Landsat TM images. The study has been completed in all the seven districts listed above. A total of 17,435.33 ha plantation area were mapped using IRS P6 LISS III satellite data. The areas were again crosschecked with 1990 period using Landsat TM data. Although the study will help for estimation of carbon for CDM project, it was found that High-resolution datasets should be used for better extraction of the plantation area since LISS III images have some limitations.

#### 14. Survey and Ecological conservation of NLC environment through bioremediation with tree species

Principal Investigator	: S.N. Prasad
Collaborating Agency	: Tamil Nadu Agricultural University (TNAU), Coimbatore Neyveli Lignite Corporation, Neyveli
Research Personnel	: Chiranjibi Pattanaik
Duration	: August 2009 to December 2009
Date of Commencement	: August 2009
Date of completion	: February 2010
Budget	: ₹ 2.41 lakhs
Funding source	: Tamil Nadu Agricultural University, Coimbatore
Status	: Completed

#### Background

The establishment of a super thermal station brings in changes in land cover pattern due to various factors. The land clearance, power transmission lines, coal transport system, reclamation of wastelands as a part of compensatory plantation activities, development of ash ponds and lignite mining are some of the

processes that cause changes in land cover. These changes in land cover might affect cropping conditions; surface water areas, productivity patterns, and species distribution in the surroundings of power plants. In view of these, assessment of environment related sensitive factors associated with the operation of thermal power stations and periodic ecological monitoring has become desirable as well as mandatory. It is evident that all the above-mentioned factors have both spatial and temporal characters and hence satellite remote sensing with its multi temporal and multi spectral capabilities along with GIS technique would be useful for monitoring these changes. Besides satellite data analysis, surrounding vegetation also need to be studied to generate impact of mines. The results and recommendations are necessary in formulating Environmental / Ecological Management plans. Considering the above, at the instance of Neyveli Lignite Corporation (NLC) Limited, Neyveli, we undertook land use land cover assessment from 2000 to 2008. Satellite data of Landsat ETM+ of 2000 and IRS P6 LISS-III of year 2006/2008 were used for the analysis.

### Objectives

The objectives of the study were:

- i) Mapping of LULC with one season satellite data
- ii) Mapping of vegetation covering an area of 8 km radius of NLC

### Methodology

Study area: NLC, a large lignite-based thermal power plant situated near the semi-urban area of Neyveli in the South Arcot District of Tamil Nadu, India, situated between 11° 33' - 11° 35' N and 79° 28' - 79° 32' E at a distance of ~ 200 km South of Chennai, India. The NLC mines and utilizes lignite, a low-grade fossil fuel for power generation. Indian Remote Sensing satellite (IRS) P6 LISS IV multi-spectral high-resolution datasets were used as to determine the present scenario of the study area and Landsat ETM+ data of 28 October 2000 with path/row 142/52 was selected to study the change scenario of the vegetation and land cover.

### Results and Discussion

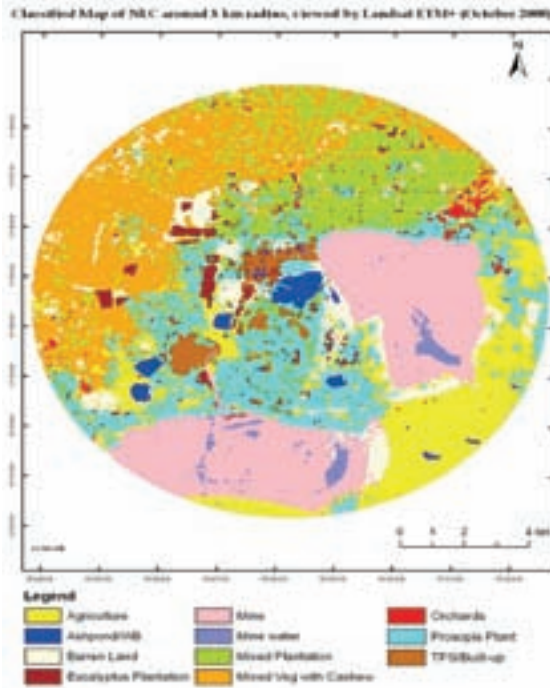
Vegetation and Land cover status (2000): The classified Landsat ETM+ data of October 2000 representing different LULC shows the following: Standing croplands 15.3%, mixed plantations 12.3%, mixed vegetation with cashew plantation 21.7%, orchards 1.1% and barren land 6.7%. Lignite Mines covered 17.1% (3447.2 ha), of which (3.7% (737.2 ha) in the mines is covered by water.

Vegetation and Land cover status (2006/08): IRS P6 LISS-IV multi-spectral satellite data of April 2006 and October 2008 are used for analysis of vegetation and land cover of NLC. It is found that in LISS IV analysis, standing crop land accounted for 12.8% of area, followed by orchards and mixed plantations 6.7% (1341.9 ha) and 13.1% (2632.9 ha), respectively. NLC plant area, ash pond and lignite mine areas constitutes 3.2 % (652 ha), 2.1% (427.6 ha), 24.3% (4890.3 ha) of the 8 km radius, respectively.

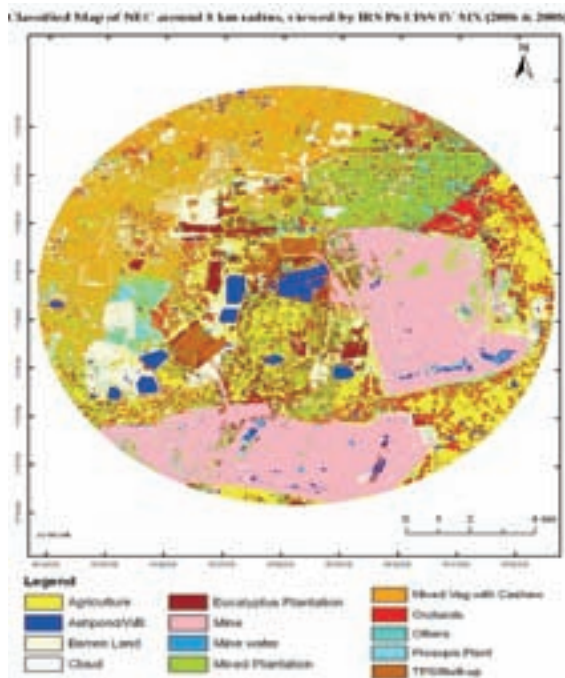
### Recommendations

The study reveals that the vegetation growth and development is normal in the study area except near the edges (100-250 m) of ash pond that has lower plant productivity due to relatively higher deposition of fly ash on leaf surface during the summer/dry season. The ash pond behind TPS-I has been utilized for floriculture and growing vegetables. No negative impact was observed in the 8 km radius of NLC. An increase in mixed plantation and other green cover may work as a potential sink based on the available leaf area as absorptive surface and its resistance level. The establishment of an automated weather station with continuous data recording facility may be considered to be installed at different locations in different directions within a 10 km radius, which will strengthen predictability of air quality and modeling as well.

The remote sensing and GIS based impact monitoring studies should be undertaken around NLC, every year to update the environmental databases. The area should be mapped with very high-resolution multi-season satellite data such as IKONOS/QUICKBIRD/CARTOSAT-2 to



Classified map of NLC using Landsat ETM+ satellite data (October 2000)



Classified map of NLC using IRS P6 LISS IV MX satellite data (2008)

### Summary

The present study used high-resolution satellite data highlighted for mapping and monitoring of mining areas of Neyveli Lignite Corporation (NLC) Limited. An area of 8 km radius was mapped using IRS P6 LISS III datasets of 2008. These data were compared with Landsat ETM+ satellite data of 2000 year. Increase in mixed vegetation area in NLC shows some plantation activities going on in NLC township area and abandoned mine areas. The ash pond area is reclaimed for floriculture, and is prominently visible in the image. The outcome of the study will be helpful NLC for claiming carbon credits .

know the impacts of NLC expansion on environment quality. The vector database should be archived and put to use. Afforestation program taken up by NLC should be regularly monitored because it links to carbon credits in the future.

### 15. Land use and land cover dynamics and impact of human dimension in Indian river basins

Principal Investigator : S.N. Prasad

Collaborating Agency : National Remote Sensing Centre (NRSC), Hyderabad

Research Personnel : N. Ravi Kumar

Duration : June 2009 to March 2011

Date of

Commencement : June 2009

Date of completion : March 2011

Budget : ₹ 6.00 lakhs

Funding source : National Remote Sensing Centre, Hyderabad

Status : On going

### Background

Land cover is likely to be the single most important factor of change in all river basins. It is well established that LULC change has significant effects on many processes in basins

that include soil erosion, global warming, and impact on biodiversity. It is also expected to cause a greater impact on human habitability than climate change. In the last few decades, the impacts of land use change have increasingly assumed significant to threatening proportions. Land use/land cover change plays a key role in regional and global environmental change by its impact on terrestrial ecosystems-atmosphere interactions, and earth-atmospheric interactions. As regards the former, International Geosphere-Biosphere Program (IGBP) and the International Human Dimensions Program (IHDP) are the main scientific activities undertaken at international level. In India, these programs have been undertaken by the Indian Space Research Organization (ISRO) addressing the concern on land use change, human vulnerability and environmental change. Linking observations at a range of spatial and temporal scales to empirical models provide a comprehensive approach to understand land cover change and at the same time provides important inputs to policy development. Based on the above, this project aims to examine the LULC dynamics in entire river basins of India in the last 30 years.

### Objectives

- i. Analysis of indicators and drivers and impact of human dimension on LULC dynamics and

### Summary

The present project is part of an exercise undertaken by ISRO to address the concern on land use change, human vulnerability and environmental change at the river basin level across the country. SACON as a collaborating agency has undertaken the work on the Yamuna river basin. The LULC change maps were done for all the states (IRS 1A LISS I data of 1994-95). The river flows through, using 2005 vector layer provided by NRSC. The mapping of all states using Landsat MSS (1984-85) are in progress. This change detection will help to compare the past and present status and to predict the future scenario using modeling.

- ii. Projecting future LULC scenarios using appropriate models.
- iii. To generate LULC database with uniform classification scheme for 1984-85, 1994-95 and 2004-05 using satellite data at 1:250,000 scale.

### Methodology

The geo-corrected satellite data of LANDSAT-MSS and IRS-LISS-1 for pre and post monsoon seasons for the period 1994-95 and 2004-05 were utilized in order to understand the dynamics of land use/land cover change. The LULC maps generated for the period 2004-05 at a scale of 1:50,000 were harmonized at a scale of 1:250,000 and the same were used as reference data. During the process of harmonization, the polygons in the vector layer of master map (LULC map for the period 2004-05 at 1:50,000 scale) were re-sampled to view the minimum mapable area at a scale of 1:250,000 which is equivalent to 56.24 ha. Polygons smaller than 56.25 ha were dissolved with the adjoining polygons to generate the map at a scale of 1:250,000. For the other period, LULC maps were generated using the succeeding time map as the master map. The same will be compared with each other to understand the dynamism of LULC change.

**Study Area (Yamuna River Basin):** The River Yamuna originates from the Yamnatri Glacier located in the Himalayas at a height of 6,387 msl. This river's geography is linked to the topography and the geographical formation of the northern parts of India. Approximately 1,380 km long, it initially flows south and then southeast, parallel and west of the Ganges. The Yamuna river basin covers seven states (partially), namely Himachal Pradesh, Uttarakhand, Uttar Pradesh, Haryana, Delhi (UT), Rajasthan and Madhya Pradesh. Presently we have presented land use land cover statistics of only two states (Delhi and Uttaranchal).

### Results and Discussion

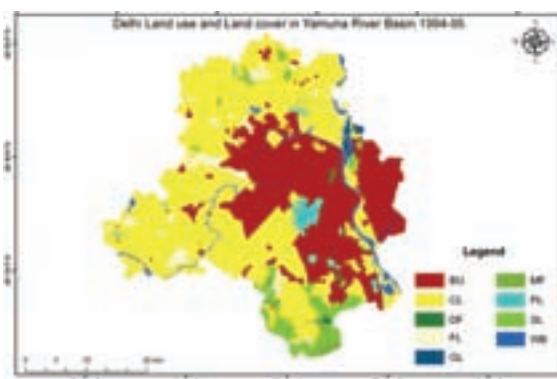
**Delhi:** From the table given below, there is an increase in built up land from 30.86% to 52.01% in area during the period while the population



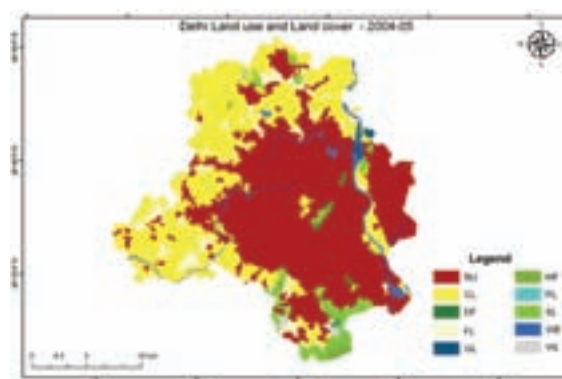
Location map of the Yamuna river basin

increase was from 9.4 million to 13.78 million. Significant decrease in cropland area was found from 54.34% to 34.06%. Decrease in water bodies from 2.55% to 2.27% and decrease in shrub land from 4.81% to 4.19% were seen in Delhi. The images given below show the LULC changes for the years 1994-95 and 2004-05:

**Uttarakhand:** From the table given below it is evident that i) built up land has increased from 0.81% to 1.14%, ii) water bodies decreased from 3.01% to 2.48%, iii) Significant decrease in snow and ice from 7.82% to 6.28% and iv) Barren land has increased from 2.16% to 3.18% in the state. The image given below shows the Land use and Land cover changes for the years 1994-95 and 2004-05.



LULC cover map of Delhi region (1994-95)

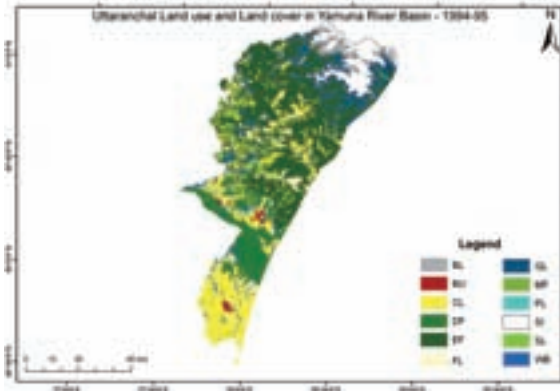


LULC map of Delhi region (2004-05)

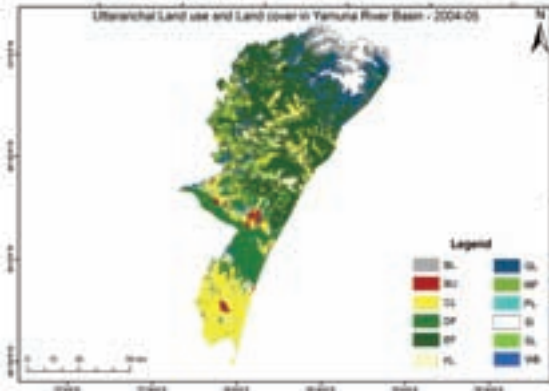
### Statistics of Land use and Land cover in Delhi for the year 1994-95 and 2004-05

Land Cover type	Code	1994-95 Area (ha)	2004-05 Area (ha)	Change (%)	% of land cover in 1994	% of land cover in 2005
Built up	BU	46817.94	78913.26	68.55	30.85	52.00
Agriculture	CL	82451.69	51678.95	-37.32	54.34	34.05
	FL	5350.66	7729.93	44.47	3.52	5.09
	PL	2919.13	76.68	-97.37	1.92	0.05
Forest	DF	392.05	518.73	32.31	0.25	0.34
	MF	1949.77	1590.81	-18.41	1.28	1.04
	SL	7298.64	6352.55	-12.96	4.81	4.18
	GL	681.28	700.59	2.83	0.44	0.46
Barren/ waste land	WL	0.00	718.63		0.00	0.47
Water bodies	WB	3870.29	3451.28	-10.83	2.55	2.27
<b>Total</b>		<b>151731.46</b>	<b>151731.42</b>			





LULC map of Uttarakhand (partially) – (1994-95)



LULC map of Uttarakhand (partially) – (2004-05)

### Statistics of Land use and Land cover in Uttaranchal for the years 1994-95 and 2004-05

Land Cover type	Code	1994-95 Area (ha)	2004-05 Area (ha)	Change (%)	% of land cover in 1994	% of land cover in 2005
Built up	BU	7588.71	10674.14	40.66	0.81	1.14
Agriculture	CL	174105.91	175868.90	1.01	18.68	18.87
	FL	28924.57	33276.86	15.05	3.10	3.57
	PL	6418.58	6515.21	1.51	0.68	0.69
Forest	EF	360574.67	354575.38	-1.66	38.70	38.06
	DF	95847.55	95564.34	-0.30	10.28	10.25
	MF	63424.52	63682.31	0.41	6.80	6.83
	SL	3074.68	3143.38	2.23	0.33	0.33
	GL	70538.05	76997.73	9.16	7.57	8.26
Barren/waste land	BL	20136.72	29647.20	47.23	2.16	3.18
Water bodies	WB	28063.92	23127.13	-17.59	3.01	2.48
Snow and Ice	SI	72878.10	58503.3	-19.72	7.82	6.28
<b>Total</b>		<b>931575.98</b>	<b>931575.88</b>			

The study of the LULC changes for seven states (1984-85) using Landsat MSS data is in progress.



## 16. Assessment of environmental and ecological impacts of Andhra Pradesh community forest management project

Principal Investigator :	S. N. Prasad
Collaborating Agency :	Development and Research Services and Andhra Pradesh Forest Department
Duration :	November 2009 to January 2010
Date of Commencement :	November 2009
Date of completion :	March 2010
Budget :	₹ 1.50 lakhs
Funding source :	Development and Research Services Pvt. Limited
Status :	Completed

### Background

The Government of Andhra Pradesh has been implementing the APCFM project since 2002. The project objective is to reduce rural poverty through improved forest management with community participation. The activities were initially organized into three inter-linked components namely i) creating enabling environment for CFM, ii) Forest management dealing with activities for rejuvenation of degraded forests, and iii) community development with a focus to enhance quality of life

Implementation of APCFM Project will be completed by March 2010. As the implementation is ending, it is now time to assess the impacts and efficacy of the project implementation with reference to achieving the development objective of the project. It is in this backdrop the present study was commissioned.

### Objectives

The major objectives of the project were:

- i) Quantify and assess the impact of project treatment practices and investments on enhancement of productivity of the VSS forest and

assess the rate of improvement with reference to baseline information through scientific economic analyses.

- ii) To quantify environmental and ecological benefits from the proposed project interventions

### Methodology

The study incorporates quantitative and qualitative approaches to collect primary data and other relevant information. While structured questionnaires were used to collect primary data from the VSS groups, project affected households and other important primary stakeholders, qualitative research tools were used to collect information from the concerned government departments, specific groups of respondents and individual informants. The qualitative research tools include in-depth interviews and FGDs using issue specific checklists. 150 project VSS and 40 control VSS were selected as indicated in the Terms of Reference. Clusters of VSS belonging to different treatment plans were marked on the GIS maps. From among these clusters, proportionate numbers of VSS were selected randomly representing all the treatment plans totaling to 151. Using GIS maps, 39 VSS, (20 from non-APCFM areas and another 19 from those areas where there is no intervention at all) were selected to serve as control groups.

### Results and Discussion

In total 172 ha *Eucalyptus* plantations were raised in 19 VSS areas, in different years. The total volume of *Eucalyptus* plantations raised in these years was estimated to be 474.93 m<sup>3</sup>. The average volume per hectare *Eucalyptus* plantation is 2.76 m<sup>3</sup>/ha.

**Remote sensing study:** It is evident that the dense forest cover has increased by 2866.57 ha during 1996-2008, whereas open forest cover has decreased by 1858.93 ha from 1996-2008. Most of the open forest has been converted to dense forest presumably due to protection by VSS community. There is, however, not much change in the extent of scrub. Scrub was found to be 9989.98 ha in 1996, while it was 9721.16 ha in 2008 showing a decline of 268.82 ha in 12 years.



There is a loss of 294.45 ha of barren land from 1996 to 2008.

The forest change cover analysis is done for three time periods in 151 VSS sampled areas, i.e. 1996, 2002, and 2008. In control VSS, 11.7% of dense forest area decreased from 1996 to 2008. This is indicative of non-protection of dense forest in control VSS. At the same time, 29% of open forest has increased in 12 years in control VSS areas. There is a decrease in dense forest cover in sampled VSS areas (2651.5 ha) from 1996 to 2002. There may be some omission and commission in the interpretation of the extent of forest cover. As it is very unlikely, the forest cover would have decreased by 2651.5 ha in a span of 6 years and again increased by 5518 ha. Therefore, on a conservative basis 35% increase seem to be closer to the reality. The scrub forest area has drastically reduced from 2374.79 ha to 1720.1 ha (27.6%). A significant increase of 13.2% of barren land were also observed in control VSS areas. While comparing with sampled 151 VSS which are under APCFM project, a significant increase of 39.5% dense forest cover were observed. The open forest area has decreased 1858.93 ha (18.19%) in 12 years. The area under scrub and barren land also decreased by 2.69% and 34.56%, respectively. Dense forest cover has increased, presumably because of protection by the VSS. The highest survival of plantations was seen in avenue plantation followed by Tank Foreshore areas and other village common lands. The block plantation showed average 98.5% survival rate, while other community land showed 22% in Srikakulam district.

**Shelterbelts and Bio-shields:** Shelterbelts and bio-shields form one significant component APCFM. It may be mentioned that some of the mangroves areas in the estuaries of Godavari, Krishna and Pannar have very high survival and high growth rates indicating the success of the program. This has also resulted in better livelihood options for local fishermen and villagers.

### Summary

This study was conducted to assess environmental and ecological impacts of the APCFM project. Growing stock assessment for natural vegetation, plantation, and social forestry were estimated for the VSS areas. Increase in vegetation and mangrove cover was observed from 2002 to 2008. Soil and moisture conservation activities, fire occurrence, collection of fuel wood and impact on livelihood were also studied in the project. Quantitative and qualitative assessment of each component was evaluated using remote sensing technology, ground based measurements and selection of sample plots in the study sites.

### 17. Study on pollinators and seed dispersers in scrub, dry evergreen and shola forest ecosystems of Tamil Nadu

Principal Investigator :	P. Balasubramanian
Collaborative agency :	Tamil Nadu Forest Department
Research Personnel :	C. Anbarasu R. Aruna S. Silambarasan
Duration :	Two years
Date of Commencement :	May 2008
Date of completion :	April 2010
Budget :	₹ 10.00 lakhs
Funding Source :	Tamil Nadu Forest Department
Status :	Ongoing

### Background

Pollination and seed dispersal are important events in the life of plants. The process of pollination and seed dispersal are fundamental to long-term sustainability of plants. The mechanism of pollination and seed dispersal among the higher plant groups has been under investigation from very early times and it is highly significant in biological studies. Most of the flowering plants depend on animal vectors for pollen transfer and seed dispersal. Under the

Tamil Nadu Afforestation Program (TAP), the state forest department desired to plant trees that attract pollinators and seed dispersers. Hence, a project to find out pollinator and seed disperser attracting trees was entrusted to SACON by the Research Wing of Tamil Nadu Forest Department, as a collaborative initiative.

### Objectives

- i) Study the reproductive phenology and determine the flowering, fruiting periods of arborescent flora in the scrub, dry evergreen, and shola forests of Tamil Nadu
- ii) Study animal visitation to flowers and fruits and identify pollinators and seed dispersers in the above vegetation types.
- iii) Identify native tree species that attract key pollinators and seed dispersers and recommend species for restoration of degraded forests in Tamil Nadu

The collaborative research committee of the Tamil Nadu forest department suggested conducting the study in i) Nilgiris - Shola forest, ii) Pachamalais - Dry deciduous forest, iii) Kanchipuram/Chengalpet-Scrub forest, iv) Point Calimere - Tropical Dry Evergreen forest and v) Muthupet - Mangrove forest.

### Methods

To identify insect pollinators of various tree species, direct observations were made on the inflorescences of select trees, mostly 3 m away from the plant, using a pair of binoculars. Closer observations were made using a handheld lens. Extended observations were made from 6.00 am to 6.00 pm at the focal flowering trees. We made observations of 24 hrs for each tree to record the flower visitors noting the following details: i) time of the observation, ii) name of the flower visitors, iii) number of flower visitors, iv) time spent by the visitor in each flower, and v) whether they collect pollen or feed nectar. The flower visitors were captured by a sweeping net and preserved in an insect box. Avian frugivores and pollinators were documented by recording the activities of birds foraging on fruit or nectar bearing plants. Extended watches were conducted on focal fruit and nectar producing flower bearing trees to record the frugivorous and pollinator bird



E. Santhosh Kumar

*Ficus benghalensis*: Important bird-attracting species in scrub, dry deciduous and dry evergreen forests

visitation, respectively. Foraging observations were made following focal animal sampling. The birds were observed between 6.0 am and 6.0 pm by using a pair of binoculars.

### Results

In the shola forests of the Nilgiris, the Nilgiri Laughing Thrush (18%) followed by Red-whiskered Bulbul (13.3%) and Jungle Crow (12%) were the major seed dispersers. Most avian frugivores were attracted by *Ilex wightiana* (n=17) followed by *Daphniphyllum neilgherrense* (n=9) and *Syzygium montanum* (n=9). Among the nectarivores, Purple sunbird (26.3%) followed by Oriental White-eye (21.7%) and Tickell's Flowerpecker (13%) made frequent visits. Most nectarivorous bird species were attracted by *Isonandra candolleana* (n=8) followed by *Euodia lunu-ankenda* (n=7) and *Phoebe lanceolata* (n=6). The insect visitors to flowers include honey bee (35.5 %) followed by butterflies (25.2%). Other flies constituted 24.1% of the visitors). Among the insects, honeybees made maximum number visits and maximum number of plant species. *Ligustrum perrottetii* followed by *Syzygium montanum* and *Daphniphyllum neilgherrense* attracted large number of butterflies.

In the dry deciduous forests of Pachamalai hills, Common Myna (27.1%) followed by Asian Koel (15.2%) and House Crow (12.0%) were found to be the major avian seed dispersers. Most of the avian seed dispersers were attracted by *Ficus*



*benghalensis* (n=13) followed by *Canthium dicoccum* (n=9) and *Syzygium cumini* (n=8). Purple Sunbird (38%) followed by Purple-rumped Sunbird (38%) and Loten's Sunbird (14.3%) formed principal avian nectarivores. Most nectarivorous birds visited *Feronia elephantum* (n=5), followed by *Chloroxylon swietenia* (n=5) and *Azadirachta indica* (n=4). Most insect pollinators were attracted by *Feronia elephantum* (44%) followed by *Erythroxyllum monogynum* (8.9%) and *Terminalia arjuna* (8.4%). Honey bees (55.7%) and butterflies (18.4%) were the principal insect pollinators.

In the tropical dry evergreen forest of Point Calimere, Common Myna (21%) followed by Jungle Crow (16%) and Asian Koel (13%) were the major frugivores. Purple Sunbird (50.2%) followed by Purple-rumped Sunbird (39.5%) and Tickell's Flowerpecker (10.3%) formed major avian pollinators. Most frequently visited insect pollinators include butterflies (28.3%) followed by honey bees (26%) and beetles (20%). Highest number of insects were attracted by *Atlantia monophylla* (18%) followed by *Walsura trifolia* (15%) and *Randia malabarica* (13%).

In the scrub forests of Kanchipuram / Chengalpet, Common Myna (33%) followed by House Crow (21%) and Red-vented Bulbul

### Summary

Insect and bird pollinators, and avian seed dispersers of woody plants in shola forests in Nilgiris, Western Ghats, tropical dry deciduous forest in Pachamalai hills, scrub forests in Kanchipuram / Chengalpet in Eastern Ghats and tropical dry evergreen forests, Point Calimere and mangrove forests of Muthupet in Coromandel Coast were studied. Honeybees, butterflies and sunbirds form the major pollinators in most of the forest types. Bulbuls, barbets, crows, Nilgiri Laughing thrush form principal avian seed dispersers. Native tree species that attract insect, bird pollinators and avian seed dispersers are suggested for planting in the respective forest types under the afforestation program of Tamil Nadu Forest Department.

(12%) form major seed dispersers. *Ficus religiosa* (33.2%) followed by *Ficus benghalensis* (15.5%) attracted maximum number of birds. In the mangrove forests of Muthupet, *Acanthus ilicifolius*, *Avicennia marina*, *Rhizophora mucronata* and *Aegiceras corniculatum* form major pollinator attracting plants. Majority of the flower visitors were attracted by *Avicennia marina*. Carpenter bees among insects and sunbirds among birds formed major pollinators. Suitable native pollinator attracting and avian seed disperser attracting tree species for each of the forest types were identified and suggested for planting.

### 18. Impact of agricultural pesticides on the population status and breeding success of select species of fish-eating birds in Tamil Nadu

Project Investigator	: S. Muralidharan
Co-investigator	: C. Sivasubramanian
Research Fellow	: S. Jayakumar
Technical Assistant	: P. Navamani
Duration	: Three years
Date of Commencement	: January 2007
Date of Completion	: March 2010
Budget	: ₹ 14.62 lakhs
Funding Agency	: Ministry of Environment and Forests (MoEF), Govt. of India, New Delhi
Status	: Completed

### Background

Agrochemicals used to protect crops and enhance productivity also exert deleterious effects on different biological and non-biological ecosystem components. Birds, more specifically fish-eating birds suffer the most due their position in the food chain. The present study was undertaken to assess the impact on fish-eating birds in select traditional breeding sites in Tamil Nadu.

### Objectives

The major objectives of the study were:

- i) Conduct surveys and locate heronries in Tamil Nadu,



Breeding pair of Painted Stork in Koonthankulam Bird Sanctuary

- ii) Monitor breeding ecology, nesting success in select species of fish-eating birds,
- iii) Identify factors responsible for population decline and or breeding failure, and
- iv) Generate database on the eggshell thickness and residue levels of persistent chemicals.

### Methods

Direct count method was followed to estimate the number of bird species and individuals in the study locations. Focal nest method was followed for studying breeding ecology. Multi residue extraction method was followed with suitable solvents for extraction, and the residues were estimated with Gas Chromatography fitted with Electron Capture Detector.

### Results and Discussion

**Population and abundance:** At the Vedanthangal Bird Sanctuary, during April 2009 - March 2010, 23 species of fish-eating birds were observed. Population was the highest (31,316) during March 2010 and lowest (116) during September 2009. Of these, Cattle Egret, Glossy Ibis, Painted Stork, Spot-billed Pelican and Little Cormorant were the predominant species. White-breasted Kingfisher and Pied Kingfisher

S. Jayakumar

were only a few in numbers. Out of 23 species found in the sanctuary, 14 species were observed breeding. However, we monitored only eight species (Spot-billed Pelican, Asian Openbill, White Ibis, Painted Stork, Grey Heron, Little Cormorant, Darter, Eurasian Spoonbill and Little Egret). Altogether 3000 nests belonging to the eight species were studied. Among the eight species the highest number of nests was of Spot-billed Pelican (881) followed by Asian Openbill (540) and Painted Stork (495). Nests of Darter and Little Egret were only a few. About 322 nests were studied using focal nest method to assess the breeding outcome.

At the Koonthankulam Bird Sanctuary, 21 species of fish-eating birds were observed, with the highest (29,538) in March 2010 and lowest (67) in October 2009. Of these, Cattle Egret, Glossy Ibis, Painted Stork, Grey Pelican, Spot-billed Pelican and Indian Cormorant were the predominant species. Only very few White-breasted Kingfisher and Pied Kingfisher were observed. Out of 21 species found in the sanctuary, 15 species were observed breeding. However, we monitored only five species, namely Spot-billed Pelican, Painted Stork, Indian Cormorant, Intermediate Egret and Little Egret. Altogether 2806 nests belonging to eight species of birds were located. The highest number of nests was of Painted Stork (1861) followed by Spot-billed Pelican (877) and Indian Cormorant (191). Nests of Darter and Eurasian Spoonbill were only a few. About 250 nests were studied using focal nest method to assess the breeding outcome.



Congregation of Cattle Egret; Do they get safe food?

S. Muralidharan

At Vettangudipatti Bird Sanctuary, the population and number of species were relatively few compared to Vedanthangal and Koonthankulam. Total population was the highest (510) during April 2009 and lowest (67) during February 2009. Initially seven species of birds began nesting in December 2009, but due to inadequate water and disturbance by Black Eagle they deserted the Sanctuary soon.

**Breeding success:** Information on breeding success of select species of fish-eating birds in Vedanthangal and Koonthankulam Bird Sanctuary is being compiled. About 555 nests belonging to five families, namely *Ardeidae*, *Pelecanidae*, *Ciconiidae*, *Phalacrocoracidae* and *Therkisornithidae* were followed regularly. The breeding season is expected to be over by June - July 2010.

**Nest-site selection of fish-eating birds:** In Vedanthangal bird Sanctuary, most nests were found on *Acacia nilotica* and *Barringtonia acutangula*. Among the birds, Asian Open bill, Painted Stork, White Ibis, Grey Heron, Eurasian Spoonbill and Little Egret predominantly used *Barringtonia acutangula*. Indian Cormorant, Spot-billed Pelican and Darter mostly preferred *Acacia nilotica*. In Koonthankulam Bird Sanctuary, while many of the birds used *prosopis juliflora*, Indian Cormorant, Spot-billed Pelican and Darter used *Acacia nilotica*.

**Pesticide contamination:** Samples of water, fishes, (both breeding and non-breeding seasons), unhatched eggs and tissues of dead birds (opportunistic), from the study sites were analyzed for levels of organochlorine residues, particularly HCH and DDT residues, which varied among the study sites and components.

**Organochlorine pesticide residues in water:** Residues of  $\Sigma$  HCH ranged between 0.03 and 2.231 ppb in different locations. Among the isomers,  $\beta$ -HCH was found to be higher (2.21 ppb) than  $\alpha$ ,  $\gamma$ ,  $\delta$  isomers. Koondankulam detected the highest levels of  $\Sigma$  HCH followed by Vettangudipatti and Vedanthangal. The total HCH is comparable with the concentration reported by Muralidharan (2000) in Keoladeo

National Park, Bharatpur, Rajasthan and less than the level reported by Amaraneni (2006) in Kolleru wetland. While total DDT ranged from BDL to 0.048 ppb, heptachlor epoxide ranged between BDL and 0.34 ppb.

**Organochlorine pesticide residues in fishes:** Till date 248 individuals comprising 12 species of fishes covering two seasons (breeding and non breeding) were collected from the intensive study sites. Among the organochlorines analyzed, HCH was most frequently detected followed by Heptachlor epoxide, endosulfan and DDT. Significant variations ( $p < 0.05$ ) in organochlorine levels could be observed among species. Concentrations reported in this study are lower than the levels reported by Vijayan et al. (2004) in inland wetland fishes in India and higher than the levels reported in the fishes of Ganges Estuary, Bangladesh (1-2 ppb, Jebber et al. 2001) and fresh water fishes of Punjab, India (Kaur et al. 2008).

**Organochlorine pesticide residues in tissue of birds:** Five species of birds, (Grey Heron, Little Cormorant, Little Egret, Painted Stork and White Ibis), found dead were analyzed for pesticide residues in various tissues. Among various organochlorine pesticide residues analyzed, isomers of HCH were the maximum. Total HCH ranged between 6.7ppb in liver of White Ibis and 572 ppb in brain of Little Egret. Heptachlor epoxide, total endosulfan and total DDT ranged from 1.0 to 23 ppb, 1.7 to 23 ppb and 2.1 to 382ng/g respectively. Comparatively low levels of dieldrin, ranging between below detectable levels (BDL) and 15 ppb, was recorded among the tissues of birds. Overall, levels of organochlorine residues detected were highest in the tissues of Little Egret followed by Grey Heron, Little Cormorant and Indian Cormorant while tissues of Painted Stork had low levels. Organochlorine pesticide levels detected in these species are almost comparable with the levels reported in select species of fish-eating birds collected from the Nilgiris (Vijayan and Muralidharan, 1996).

**Organochlorine pesticide residues in eggs of birds:** Totally 45 unhatched eggs of Grey Heron, Painted Stork, Spot-billed Pelican, Asian

**Summary**

Of the 41 traditional breeding sites in Tamil Nadu, three (Vedanthalgal Bird Sanctuary, Vettangudipatti Bird Sanctuary and Koonthankulam Bird Sanctuary) were selected for intensive study. Of these three sites, number of species of fish-eating birds was higher in Vedanthalgal (23) followed by Koonthankulam (21) and Vettankuddipatti Bird Sanctuary (10). Among the birds, Cattle Egret, Glossy Ibis, White Ibis, Asian Open bill and Painted Stork were high.

Among the breeding birds, Painted Stork, Spot-billed Pelican, Darter and White Ibis are near threatened. Nesting activity such as, nesting tree selection, nesting season and breeding success varied among the sites and species.

To assess the magnitude of pesticide contamination samples of water and fishes were seasonally collected and analyzed. Un-hatched eggs and tissues of dead birds (opportunistic samples), from the intensive sites were also analyzed. Among the organochlorines analyzed, HCH and DDT residues varied among the study sites and components. Although the residue levels are less than the levels considered lethal, they have to be viewed with concern, as these pesticides are capable of causing several abnormalities.

Openbill, Indian Pond Heron, Intermediate Egret, Spoonbill and Little Cormorant were analyzed. Isomers of HCH were the maximum followed by Heptachlor epoxide, total endosulfan and total DDT. These levels are comparable with those reported for select colonial water birds breeding at Keoladeo National Park, Bharatpur, India (Muralidharan et al., 1992). additionally, 47 eggs belonging to six species of birds were collected and analyzed for residues and the data are being compiled.

### 19. Monitoring of pesticide residues in select components of an agro ecosystem adopting organic and chemical farming in Padayetti village, Palakkad District, Kerala

Project Investigator	: S. Muralidharan
Research Fellow	: K. Ganesan
Project Period	: Three years
Date of Commencement	: May 2009
Expect date of Completion	: May 2012
Budget	: ₹ 15.45 lakhs
Funding Source	: Kerala State Biodiversity Board, Govt. of Kerala.
Status	: Ongoing

**Background**

Indiscriminate use of chemical fertilizers and pesticides to enhance food production has contaminated every possible ecosystem component and agricultural produces. This project will develop a monitoring system to document the residue levels of persistent chemical contaminants in sediment, fish / crab / mollusk, agricultural produces (rice, straw and cow-milk) and select species of resident birds in chemical and organic farms in Kerala.

**Objective**

The major objective of the study is to monitor residues of select pesticides in a few components of agro ecosystem adopting organic and chemical farming.

**Methods**

Number of species and individual birds were estimated using the direct count method. To quantify pesticides residues, samples of sediments, fishes, crabs, mollusc, frogs, paddy, fodder and cow milk are being collected seasonally from both organic and chemical farms. Samples of milk marketed by Kerala cooperative society milk (Milma) were also collected for comparison. The first season (Kharif - *Virippu* - April-May to August-September) samples were processed and





K. Ganesan

**Bio-pesticides: Eco friendly agricultural input**

analyzed for organochlorine pesticide residues. Samples collected during the second and third seasons are in various stages of processing. Multi residue extraction method was followed with suitable solvents for extraction and residues were estimated with Gas Chromatography fitted with Electron Capture Detector. Focal nest method will be followed for studying the breeding ecology.

**Results and Discussion**

**Field survey:** Out of 59 farmers living in the Padayetti, 21 randomly chosen were interviewed, of which, 11 farmers practice organic farming while the rest use chemical fertilizers and pesticides. A few farmers were observed adopting convenient farming. Educational status of the farmers was also gathered. About 69% of farmers have studied up to 10th standard, with experience in farming ranging between 20 and 40 years. Paddy is the predominant crop, followed by rubber, vegetables and banana.

**Bird Count:** During December 2009- March 2010, 53 and 38 species of birds were recorded in organic and chemical farms, respectively. In organic farming, population was the highest (463) in December 2009 and lowest (316) in March 2010. In conventional farms, bird population (334) was the highest in January 2010 and lowest (293) in February 2010. Cattle Egret, Indian Pond Heron, Swiftlet and House Crow were found to be frequently visiting the farms. Only a few Golden Oriole, Red-wattled Lapwing, Grey Hornbill and Spotted Owlet were seen. Organic farming areas attracted more

birds than the chemical farming areas. Abundance of insects could be one of the reasons for the congregation of birds in organic farming.

**OC's residues in different components of an agroecosystem:**

**Sediments:** In the sediment samples residues of total HCH ranged between 1.11 and 3.14 ppb, and 4.29 and 132.67 ppb in organic and chemical farming, respectively. Among the isomers of HCH,  $\alpha$ -HCH was high (70.7 ppb) in chemical farms. Total DDT ranged from 0.87 to 4.09 ppb and 1.11 to 59.3 ppb in organic and chemical farms, respectively. The heptachlor epoxide and total endosulfan were found to be higher in chemical farms. Further, the levels of all pesticides and metabolites are higher than the levels recorded in the sediments collected from Mahala water reservoir, Jaipur (Misra 1989). The  $\alpha$ -HCH and  $\alpha$ -DDT levels are higher than the levels recorded in the coastal sediments, Chennai and lower than the level reported by Senthil Kumar *et al.* (2001) from Cochin and Vishakapatnam, South India. The  $\alpha$ -HCH,  $\alpha$ -DDT, HE and  $\alpha$ -Endosulfan levels recorded in the present study are higher than the level reported (Malik *et al.* 2009) in Lucknow, India.

**Fishes:** *Channa punctatus* (2), *Anbas testudinus* (2), *Puntis sophore* (2), *Puntis dorsalis* (3), and *Cirrhinus mrigala* (1) were collected from organic and chemical farms based on availability. Residues of  $\alpha$ -HCH ranged between 2.87 and 152.13 ppb and 1.24 and 11.33 ppb in organic and chemical farming, respectively.  $\beta$ -HCH was



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An organic farm at Paelayetti village, Kerala

found to be the highest in chemical farms, whereas levels of  $\alpha$ ,  $\beta$ ,  $\gamma$  isomers were low. DDT ranged from 0.72 to 1.38 ppb and 0.66 to 2.2 ppb in chemical and organic farms respectively. The heptachlor epoxide (3.93 ppb) and Endosulfan (17.1 ppb) were higher in fishes collected from chemical farms. Organochlorine residues reported in the present study will be compared with levels reported in Inland wetland fishes of India (Vijayan et al. 2004), and Tamil Nadu (Muralidharan et al. 2008).

**Crab:** Among the organochlorine residues detected in fresh water paddy field crab *Geothelphusa dehaani*,  $\alpha$ -HCH was recorded in higher concentration in those collected from organic farms (26.8 ppb). Levels of  $\beta$ -HCH were higher in crabs collected from organic farms.  $\gamma$ -DDT ranged from BDL to 2.64 ppb and BDL to 1.6 ppb in organic and chemical farms, respectively. Residues of Endosulfan (1.62 ppb) and heptachlor epoxide (0.1 ppb) were higher in the crabs collected from chemical farms. The  $\alpha$ -HCH levels are lower and  $\gamma$ -DDT levels are higher than the levels reported by Senthil Kumar et al. (2001) in fresh water paddy field crabs of South India. When compared with levels reported in China,  $\alpha$ -HCH and  $\gamma$ -DDT levels are lower and Endosulfan and HE levels are higher (Nakata et al. 2005). Organochlorine compounds measured in tidal sediments and crab eggs (*C. granulata*) collected from mangroves of Guanabara Bay, Rio de Janeiro, Brazil are higher than levels reported presently (de Souza et al. 2008).

**Molluscs:** To quantify organochlorine residues levels, were processed. Concentration of  $\alpha$ -HCH in soft tissues of mollusc, *Pila globosa* (n=10) was the highest (13.6 ppb) in samples collected from chemical farms.  $\beta$ -HCH was the highest (12.46 ppb) while  $\gamma$ -DDT and total endosulfan levels were 1.01 ppb and 1.35 ppb respectively. Heptachlor epoxide was detected in trace levels in chemical farms. Levels of  $\gamma$ -DDT and endosulfan were lower in molluscs of organic farms.  $\alpha$ -HCH levels are higher and  $\gamma$ -DDT levels lower in the present study than reported in mollusc collected from Southeast coast of India (Senthil Kumar et al. 2001).

**Frogs:** Concentration of  $\alpha$ -HCH in *Hoplobatrachus crassus* (n=4) and *Fejervaria limnocharis* (n=6) ranged from 7.89 to 38.06 ppb and 3.14 to 97.73 ppb in organic and chemical fields, respectively.  $\beta$ -HCH was the maximum (97.37 ppb) in chemical farms while  $\gamma$ -DDT and heptachlor epoxide residues were high in the frogs of organic farms (0.63 ppb and 2.90 ppb) than chemical farms (0.41 ppb and 1.44 ppb). Endosulfan was 4.79 ppb in chemical farms. The  $\alpha$ -HCH levels are higher and  $\gamma$ -DDT residue levels are lower than the levels reported in the Green Frog *Rana clamitans* from Southwestern Michigan, USA (Gilliland et al. 2001).  $\gamma$ -DDT residues are higher than the levels reported by Senthilkumar et al. (2001).

**Paddy grains:** In residues of two varieties of paddy Jothi (n=5) and Ashwaryam (n=5),  $\alpha$ -HCH ranged between 1.72 and 41.59 ppb, and 16.71 and 64.76 ppb in organic and chemical farms, respectively. In chemical farms  $\beta$ -HCH was found to be higher (49.97) than  $\alpha$ ,  $\beta$  and  $\gamma$  isomers.  $\Sigma$ -DDT ranged from 0.9 to 1.29 ppb and 4.94 to 25.99 ppb in organic and chemical farming, respectively. Residues of heptachlor epoxide (4.89 ppb) and Endosulfan (10.28 ppb) were found to be more in chemical farms. While residues of  $\Sigma$ -HCH and  $\Sigma$ -DDT are lower, Heptachlor epoxide levels are higher than the levels reported in grains (rice, wheat and corn) collected from Papua New Guinea (Kannan et al. 1994). Levels of  $\alpha$ -HCH and  $\gamma$ -DDT levels are comparable with the levels reported in Basmati rice, Dehradun (Suresh et al. 2002).

**Fodder:**  $\alpha$ -HCH (40.16 ppb) in two varieties, namely, Jothi (n=5) and Ashwaryam (n=5) was highest in organic than the straw from chemical farm. While  $\beta$ -HCH was the highest (34.33 ppb) in organic farms,  $\alpha$ ,  $\gamma$ ,  $\delta$  isomers were low. Heptachlor epoxide (4.69 ppb),  $\gamma$ -DDT (17.56 ppb) and Endosulfan (25.07 ppb) were higher in straw collected from chemical farms. *p/p*-DDT was the maximum (15.15 ppb) in chemical farms.

**Milk:**  $\alpha$ -HCH ranged from 4.13 to 144.84 ppb, and 0.25 to 151.8 ppb in organic and chemical farm milk, respectively. Average concentrations of  $\alpha$ -



endosulfan, ÓDDT and heptachlor epoxide were 1.53 ppb, 1.13 ppb and 0.98 ppb in chemical and 2.30 ppb, 0.88 ppb and 0.73 ppb in organic milk, respectively. Milma had the highest residues of all the pesticides studied. Concentration of Ó HCH, ÓDDT and Óendosulfan residue levels are lower than the levels reported by John et al., (2001) in dairy milk and buffalo milk collected from Jaipur and Ludhiana (Battu et al. 2004).

### Summary

To document pesticide usage in Padayetti village, questionnaire survey was conducted among the farmers. Of the 21 randomly chosen farmers interviewed, 11 are following organic farming and rests are using chemical, fertilizers and pesticides.

To quantify pesticide residues, samples of sediments, fishes, crabs, mollusks, frogs, paddy, fodder and cow milk were collected from both organic and chemical farms. Varying levels of total HCH, total DDT and total endosulfan residues were detected in all the samples. Organochlorine pesticides detected were higher in the samples collected from chemical farming than the organic farming

## 20. Surveillance of Waterfowl at Nalabana Bird Sanctuary, Chilika Lake, Orissa

Project Investigator : S. Muralidharan  
Co-investigator : B. Murali Manohar,  
Director, TANUVAS,  
Chennai  
Research Fellow : N. Saravana Perumal  
Technical Assistant : V. Vijayabharathi  
Project Period : One year  
Date of commencement : July 2009  
Date of Completion : July 2010  
Budget : ₹ 7.08 lakhs  
Funding Agency : MoEF. Govt. of India  
Status : Ongoing

### Background

During 2006 and 2007 in winter, hundreds of migratory birds died in Nalabana Bird Sanctuary, Chilika Lake, Orissa. Northern Pintail, Shoveller, Brown-headed Gull, Garganey Teal were the notable species among them. Our preliminary investigations on the role of certain chemical pesticides in the death of these birds did not result in any positive leads. Tests for New Castle Disease Virus (NDV) and a set of aflatoxins were also negative. Under these circumstances, it was essential to look at the possible role of certain diseases, such as Avian Vacuolar Myelinopathy (AVM) and Botulism in addition to other possible contaminants.

### Objectives

The present study was undertaken with the following objectives:

- i) Monitor mortality of birds and identify possible reasons for the same (chemical contaminants and disease factor).
- ii) Determine ways to contain and eradicate the problems, if possible.

### Methods

Number of species and individuals of birds was estimated using the direct count method. Bird mortality was monitored during field visits and information from field biologists, forest officials, farmers and local people. Multi residue extraction method was followed with suitable solvents for extraction and residues were estimated with Gas Chromatography fitted with Electron Capture Detector. Standard methods for investigating diseases were followed. Samples of blood from sick birds and all possible organs from dead birds were collected and preserved in formalin/EDTA or at -25°C to investigate possible diseases, cholinesterase activity and contaminants.

### Results and Discussions

**Bird Survey:** From December 2009 to March 2010 118 species of birds were observed, of which 83 were waterfowl and 35 were wetland dependant birds. The total population was the highest (499820) in January and lowest (114260) in March 2010. Gadwall was the most predominant species followed by Northern Shoveller 60,000 and Northern Pintail.

**Disease Diagnosis:**

a. Direct Microscopic Examination: Eight blood smears from 4 species of sick birds and 20 heart blood smears from 10 species of dead birds were stained with Grams and Leishman's stain for examination under light microscope. Investigations revealed cocobacilli and bipolar organisms, respectively.

b. Isolation and Identification of Micro-organism: Heart blood from 14 species of dead birds and tissues from three species were inoculated into different media such as Nutrient Broth, Mac Conkey Agar, Blood Agar, Robertsons Cooked Heart Media and Brain Heart Infusion Agar and incubated at 37°C for 24 - 48hrs, and growth patterns of the organisms were examined. Size, shape and grams staining pattern of individual organisms, such as *Pasteurella multocida*, *E. coli* and *Clostridium botulinum* were examined under microscope. .

c. Physical and chemical test for microorganisms: Altogether 17 organisms were isolated, motility pattern of the individual organisms were examined under light microscope and the organisms were inoculated

into different media for assessing the biochemical properties of *Pasteurella* and *E. coli* through biochemical tests such as Indole, Citrate, Urease, Triple Sugar, Iron Agar, Oxidase and Catalase.

d. Biological test: Four isolated organism culture and three digested tissue samples were injected into mice for isolation of pure culture of the organism and to assess the virulence of the organisms, namely *Pasteurella* and *E. coli*. While the test for botulism was negative, pure cultures of *Pasteurella* and *E. coli* were obtained from dead mice.

e. Histopathology: Ten buffered formalin fixed brain and two formalin fixed liver tissue were sliced into thin sections using microtome and then stained and mounted on slides as permanent slides for examination of Avian Vacuolar Myelinopathy lesions and pasteurellosis lesions under light microscope. Brain sections revealed no evidence of vacuolations in the white matter. However, liver sections revealed focal areas of necrosis.

Organochlorine pesticide residues in tissue of birds: Northern Pintail, Ruddy Shell Duck, Eurasian Wigeon, Gadwall and Garganey found dead were analyzed for pesticide residues in various tissues. Among OC pesticide residues analyzed, isomers of HCH were found the highest. Total HCH ranged between 11.21ppb in muscle of Garganey and 1679.55 ppb in brain of Northern Pintail. Heptachlor epoxide, total endosulfan, dieldrin and total DDT ranged from 1.20 ppb to 87.26 ppb, 0.86 ppb to 40.35 ppb, 0.40 ppb to 33.95 ppb and 0.18 ppb to 13.65 ppb respectively. Among the different species of birds, residues levels were more in Eurasian Wigeon followed by Northern Pintail and Ruddy Shell Duck.

Information generated to date on contaminants and disease factors are being compiled.

**Summary**

Regular field visits were made to monitor the bird mortality in Nalabana Bird Sanctuary. Field biologists, forest officials, farmers and local people were requested to inform whenever they come across any dead birds. To assess the pesticides contamination, dead birds were collected. During December 2009 to March 2010, 12 birds were collected. However, only five species of birds (Northern Pintail, Gadwall, Eurasian Wigeon, Garganey and Ruddy Shell Duck) were analyzed for organochlorine pesticides. Among the five species of birds analyzed, varying levels of residues were recorded in the tissues. The residues levels were lesser than the levels considered lethal. Twenty blood samples were also collected from nine different species for disease investigation. Data collected are being compiled.

## 21. Rapid Environmental Impact Assessment of proposed India Based Neutrino Observatory (INO), Bodi Hills, Theni district, Tamil Nadu.

Investigator	: P.A. Azeez
Research Personal	: M. Murgesan and P.P. Nikhilraj
Duration	: Five months
Date of commencement	: January 2010
Date of completion	: May 2010
Budget	: ₹ 7.2 lakhs
Funding source	: Institute of Mathematical Sciences (IMSc), Chennai
Status	: Ongoing

### Background

India is one of the pioneers in neutrino research. Premier institutions, such as Tata Institute of Fundamental Research (TIFR) and Institute of Mathematical Sciences (IMSc, Chennai) and at the instance of the Department of Atomic Energy (DAE), experts in the field formed a Neutrino Collaboration Group (NCG) with the motto of building an India-based Neutrino Observatory (INO). To begin with, the NCG has to find a fitting location for the INO laboratory. After a long and intensive exercise and deliberations with experts in various fields, a site was identified in the Western Ghats to establish the world-class laboratory. Upon the request from the IMSc, Chennai, coordinating the establishment of the INO, SACON carried out a rapid ecological assessment of the location.

### Objective

The major objectives of the present study involve the assessment of the proposed INO site at Bodi-west forest area in terms of its biological and ecological set-ups. This involves the following.

- Assess the flora in the project location and its environs
- Assess the fauna in the project location and its environs

- Examine the probable impacts arising from the execution of the project on biological and ecological environs
- Develop an Environmental Management Plan (EMP) for mitigating the impacts, if any

### Methodology

Study area: The location of the area has been identified using Survey of India (SOI) topographic maps. For ecological investigations, an area of 5 km radius keeping the portal to the cavern complex as the centre point was delineated. Thus, the area extends to the villages namely Pottippuram, Sankarapuram, Thevaram and Rasingapuram of Tamil Nadu on the north-eastern aspect and some part of Devikulam and Udumban Chola taluks of Kerala on the western side. Extensive field surveys were conducted during January- June 2010, using standard methods to document the ecological components of the area.

Data related to the hydrometeorology, wind patterns and physiography were obtained from the public domain. To obtain basic information on the socio-economic status of the people in the area, we depended entirely on data available in the public domain maintained by government agencies.

In order to study the flora of the project area in general and to estimate tree density in particular, 35 quadrats of 25 x 25 m size were used. The GBH (Girth at Breast Height) of trees (GBH > 20 cm) in the 25 x 25 m plot were recorded. In the middle of each 25 x 25 m quadrat, another quadrat of 5 x 5 m was placed for shrub density estimation. Similarly, a quadrat of 1 x 1 m was placed within the 5 x 5 m quadrat to record herbaceous species. All herbaceous species within the 1 x 1 m quadrat were counted and recorded. Information on flora available in previous work was also included. Taxonomic identification of species encountered in field was done consulting Hooker (1872-97), Gamble (1957), Jain and Rao (1983) and Matthew (1999). Unidentified specimens were preserved in 10% formaldehyde and brought to the Botanical Survey of India, Coimbatore for further identification by experts. The nomenclature given in the present study was based on the

Flora of Tamil Nadu Series 1: Analysis vols. 1-3 (1983-1989).

Vegetation data was analyzed to understand quantitative structure and composition of plant communities. Species richness and diversity of species in the stands were also estimated. Vegetation data was tabulated for frequency, density, abundance, relative frequency, relative density, relative abundance, relative dominance, IVI and composition of plant communities following Curtis and McIntosh (1950) and Philips (1959).

The fauna in the environs of the proposed project site was surveyed following standard methods, as mentioned in the table given below.

#### Sampling techniques used for the faunal study

Taxa	Sampling Methods
Amphibians	Visual encounter survey (search)
Reptiles	Visual encounter survey (search)
Birds	Random walk, opportunistic observations
Mammals	Tracks and signs, and visual encounter survey

#### Results and discussions

The forest types within the proposed study site according to Champion and Seth (1968) classification are i) southern tropical thorn forests (scrub jungles), ii) dry mixed deciduous forests, iii) tropical dry deciduous forests, iv) riverine forests, v) dry savannah forests, vi) tropical moist deciduous forests, vii) temperate forests (sholas), and viii) southern montane humid grasslands. The temperate forests (shola), southern montane humid grasslands are found exclusively on the Kerala side of the study area.

517 plant species belonging to 312 genera and spreading over 81 families were recorded in the proposed INO site, of which herbaceous plants are dominant (198 species) followed by trees (101 species), stragglers/climbers (86 species), shrubs (69 species) and grasses (63 species excluding *Bambusa arundinacea*, which is included under trees due to its arborescent nature). Of the 81 plant families reported, Poaceae is dominant (64 species) followed by Fabaceae, Asteraceae, Euphorbiaceae and Acanthaceae with 39, 28, 27 and 21 species each, respectively.

Twenty-six species of mammals, 27 species of reptiles, 14 species of amphibians and 78

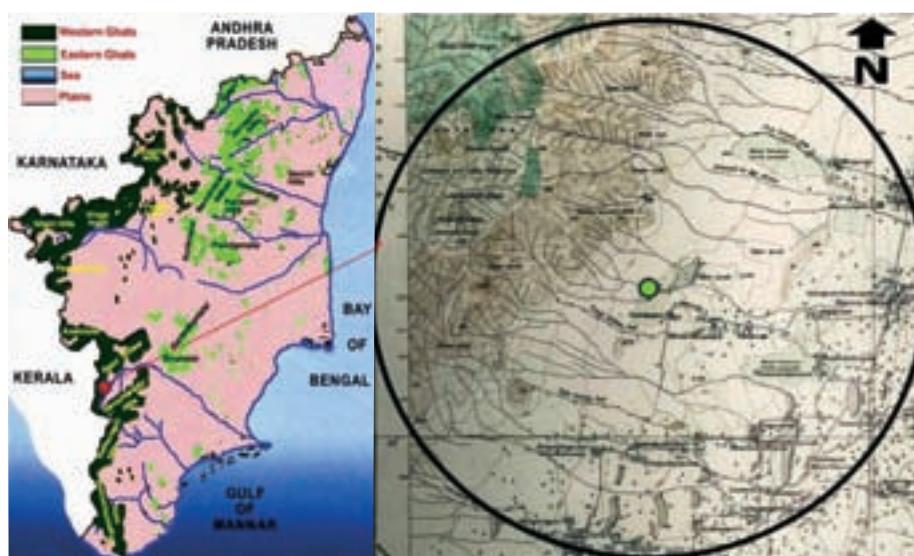


Figure : Location of the proposed INO Site

species of birds were observed. We have also compiled and presented the information available in the Forest working plan for Theni forest division on the presence of avian and Mammalian species. A total of 27 species of mammals (excluding small rodents and species belonging to the Order Chiroptera) were expected to be present in the proposed INO site. During the survey, only a few species were encountered. Sightings were of the bonnet macaque, Asian palm civet and black-naped hare whereas giant flying squirrel was heard. No mammal species was sighted within 1 km radius of the portal. Droppings of jackal, Asian palm civet, small Indian civet, black naped hare, sloth bear, jungle cat, common mongoose and elephants were seen. Elephant and sloth bear droppings were very old and few, which reveal that these species use the area only occasionally. Other species listed are generalist species, which are widely distributed in the country but as indicated by the fewer numbers of fecal matter in the explored area, are perhaps low in abundance.

Construction work of the proposed project will mostly be in the deep underground layers. However, activities such as blasting, muck dumping, clearing of vegetation, will have impact on the local environment, especially wildlife. A number of probable impacts are being identified and mitigatory measures are being listed.

### Recommendations

Most of the construction work of the proposed project will be carried out deep underneath the earth surface. The activities such as blasting, muck dumping and clearing the vegetation will have impacts on the local environment. However, noting that wildlife rarely is reported in the Portal area, the impacts of the activities on them will be effectively negligible. Proper work plan, plans for debris and waste disposal, restricting blasting activities to the minimum, controlled vehicular activities and limiting the number of workers residing in the project site may help to reduce the impacts.

### Summary

The IMSc, Chennai requested SACON to study the Ecological Impact of the proposed India-based Neutrino Observatory (INO). The proposed site is at Pottipuram Village, Theni district of Tamil Nadu. The present study explored the biological diversity of the area and the surrounding environment. In all, 517 species of plants and 145 species of vertebrates (14 species of amphibians, 27 reptiles, 78 birds and 26 mammals) and 59 species of butterflies were recorded from the study area.

Construction of the INO will mostly be deep underneath the earth's surface. However, activities such as blasting, muck dumping, and clearing the vegetation will affect the local environment. Probable impacts and mitigatory measures are suggested.

### 22. Monitoring the impact of urbanization on House sparrow (*Passer domesticus*) population, Coimbatore, India

Research Fellow	: Dhanya R
Research Guide/ Supervisor	: P.A. Azeez
Duration	: Five years
Date of Commencement	: April 2006
Expected date of completion	: April 2010
Budget	: Nil
Funding source	: Own funding
Status	: Nearing completion

### Background

Urbanization all around the country is in a fast pace. Urbanization has several positive outcomes on the life quality of human kind. It also have several negative impacts on the environment, local natural resources and biodiversity especially species composition. Several bird species are known to decline with the progress of urbanization. The present study was conceived to examine the impact of urbanization on the common bird species the house sparrow.

### Objectives

- Monitoring the breeding biology of House sparrow along an urban to rural gradient
- Study the roosting biology
- Identify the major threats to the population

### Methodology

The study was conducted along an urban to rural gradient. Intensive study points were taken from urban, suburban and village area. Nests were located by intensive search in suitable built areas, following behavioral cues of parental birds such as vocalization and the bird activity. Breeding biology of the species was monitored in the built-up environment from 2006-2007.

To identify the roosting sites of the species surveys were conducted along an urban to rural gradient. For the survey special thrust was given to areas where House Sparrows were present. Point counts were employed to record the roosting population, considering the roost tree as the centre of the 50m radius circle. In total, there were about 18 roosting points.

### Results and discussion

**Breeding biology:** The House sparrow breeds all around the year with a peak in April (total number of nests=114) followed by January (total number of nests=87). Sparrow nests were found on eight different substrata. Shutter hood (135) was the most commonly used followed by roof support (104), sign board (32), holes in the built area (30), ventilation (24), light cover (6) switch board (3) and pipe hole (1). The site preference was found to change from city to suburban and rural areas.

The nests were placed general at 01-03 m, followed by 03-06 m and 06-09 m. In the villages the mostly the nests were seen at 01-03 m heights. This can be due to the single storied construction in villages. In suburban areas, the preferred height is 03-06 m and in urban area, the birds occupied upto 03-06 m heights.

There were two peaks in the nest building activities (10 am - 11 am and 4 pm -5 pm). The female's contribution in nest building was more (64.96%) than males (35.04%). The nests are

predominantly made of plant matter (91%), animal matter (1%) and other (8%) lining materials like paper, plastic pieces. Females were incubating while males mainly assisted the females by cleaning the nest, providing food and in territory maintenance. It was noted that there were two peaks in the incubation activity of the house sparrow; the first peak between 11:00 am and 12:00 pm and the second one between 16:00 pm and 17:00 pm. In total 5 food items were provided to the chicks. They were cooked food, caterpillar, moth, grasshopper and other insects. The chick diet in the village area has more insect food contribution than in suburb and urban area. The nest success was high during 2006 followed by 2007 and 2008. Urban area had the least nest success compared to the suburban and village area.

**Roosting Biology:** The villages areas Kanuvai, Thadakam, Virapandi had four each roost points and Uchayannur, Alamaramedu had two each. In urban area, Gandhi Park and Ukkadam had one point each. While night roosting, sparrows were not found having any association with other bird species. No seasonal variations could be seen in the roosting population. House Sparrows typically formed flocks of 3 to 45 individuals. The roost population varied from 6-105 individuals. Plants such as *Thespesia populnea*, *Psidium guajava*, *Aegle marmolus* and *Azadirachta indica*, *Michelia chembaka*, *Pithecelobium dulce* were found to be used for night roosting by sparrows.

Sparrows roosted on comparatively smaller trees with mean canopy height (2.28m), mean crown radius of (2.16m), mean diameter at breast height (46.22cm) and with less crown density (53.06%). The roost trees were found comparatively closer to the buildings (2.45m) and to the road (1.72m). The roost trees were also found closer to the food source (2.21m) and to places having more feeding open areas. It is also noted that the roost tree is closer to other food sources like drainage (3.74m), bus stand (27.39m) and temples (13.47m). Use of small tree for the nocturnal roost may be to avoid other larger bird species like Crow and Myna. Generally, such species use tall trees with high canopy density for roosting and nesting.



### Summary

Urbanization and other anthropogenic factors may lead to direct and indirect impact on the House sparrow population. Urban development causes habitat loss, local extinction rates and frequently eliminates the large majority of native species. In the current study, we analyzed the breeding and roosting biology at different scales of urbanization.

The main reason observed for nest failure in the species is anthropogenic. Therefore, community awareness needs to be developed to sustain synanthropic bird like sparrows. The species is very parochial towards its nocturnal roosting trees / sites. It is very essential to save such patches in the urban area. Both nesting and roosting sites were very close to the food sources and is very important to identify such sites to conserve sparrows.

### Recommendation

The main reason observed for nest failure in the species is anthropogenic. Therefore community awareness need to be developed to sustain synanthropic bird like sparrows. The species is found to be very parochial towards its nocturnal roosting. Hence, it is very essential to save such patches in the urban area. Both nesting and roosting sites were very close to the food sources and is very important to identify such sites for conservation of sparrows.

### 23. An analysis of the environmental changes in the Bharathapuzha river basin, southern India

Research Student	: P.P. Nikhil Raj
Research Supervisor	: P.A. Azeez
Duration	: Five years
Date of commencement	: October 2005
Date of completion	: August 2010
Budget	: Nil
Funding Source	: Own Funding
Status	: Nearing completion

### Background

The River Bharathapuzha (10° 25' to 11° 15' north and 75° 50' to 76° 55' east) is the second longest (209 Km) among the west flowing perennial rivers in Kerala. Its peculiar geographical position slanting westward from the Palakkad gap of Western Ghats appropriate the river basin of 6,186 km<sup>2</sup> area between the adjacent states, Kerala (4,400 Km<sup>2</sup>) and Tamil Nadu (1886 Km<sup>2</sup>). The river, originating from various points in the Western Ghats as rivulets, join later to form four major tributaries namely the rivers Kalpathipuzha, Chitturpuzha, Gayathri, and Thootha. The main river finally discharges to the Arabian Sea at Ponnani on the west coast. The flow regime of the river covers highlands (> 76 m), midlands (76-8 m) and the low lands (<8 m). The river is the lifeline water resource for a population residing in four administrative districts, namely Malappuram, Trissur and Palakkad districts of Kerala and Coimbatore district of Tamil Nadu. There are nine irrigation projects in the river basin catering 493064 ha cultivations. Water diversion and over utilization of the river water for agriculture and encroachment of the basin for brick industries are very common in the basin. In the recent years severe dearth of water and drought conditions were reported from the river basin. In this context, we have under taken a study on the river basin to assess the environmental status of the river.

## Objectives

The major objectives of the study are to

- Investigate the morphometric characters of the river basin,
- Analyze the land use changes that happened in the basin during last three decades
- Examine the meteorological status of the river basin,
- Study the quality and quantity of surface water in the river course, and
- Examine major factors influencing the river discharge in the basin.

## Methodology

**Documenting morphometric characters of the river basin:** The flow regime of the river were delineated by taking survey of India topographic sheets (1: 50000; 1973) as the base map with the aid of ArcGis soft ware.

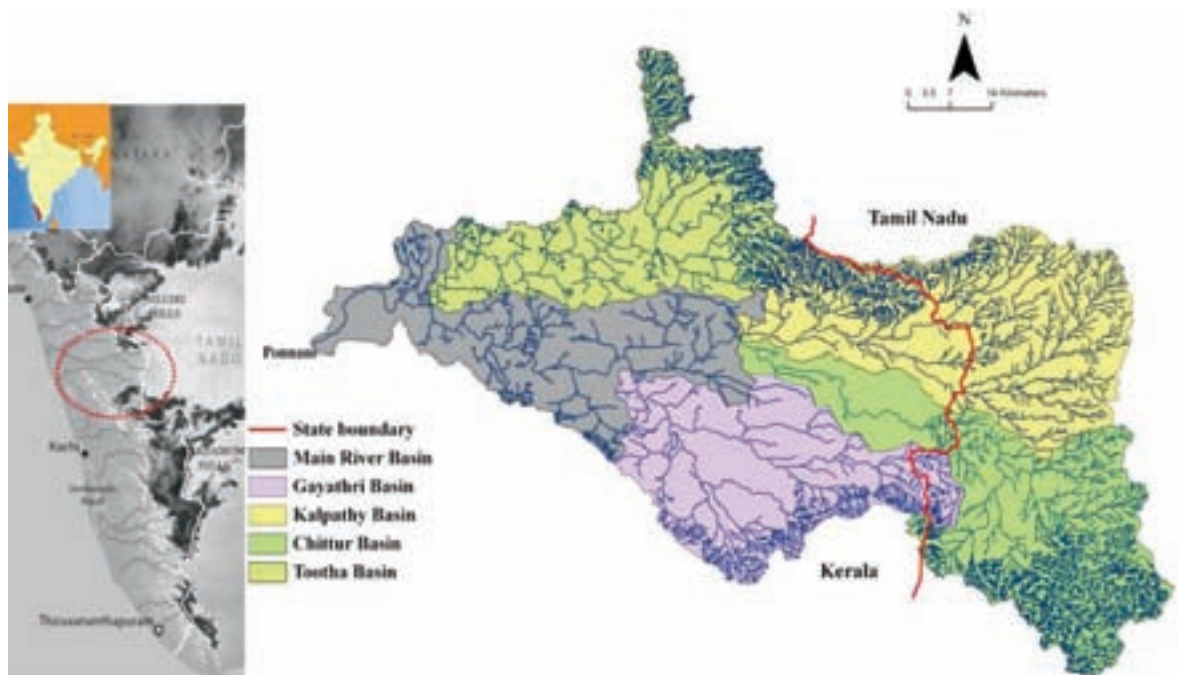
**Investigating the land use changes in the basin:** The land use changes were documented using LANDSAT imageries of different periods. We also analyzed the urban growth pattern and direction of urbanization of the major cities in the basin. We used ERDAS 9.1 and ArcGis 9.2 for analyzing various imageries.

## Understanding the meteorology of the basin:

The general rainfall trend in the basin and its anomalies were analyzed. We collected monthly rainfall data for 34 years from Irrigation Department, Kerala and other departments such as RARS, Pattambi, for 28 rain gauge stations all over the basin. We also collected daily rainfall gridded data for 50 years from India Metrology department (IMD), Pune. The daily temperature data for 37 years were collected from IMD, Pune and monthly temperature data for 50 years were collected from RARS Pattambi. We used Mann-Kendal's rank correlation statistics to examine the trend of rainfall and temperature in the basin.

## Assessing the hydrologic realm of the basin:

Water quality and quantity analysis were carried out using the historic data available at Central Water Commission (CWC, Coimbatore, and Cochin) and various river gauge stations in the basin. We have collected ten years data set (1991-2001) of water quality from CWC for five river gauge stations. The available discharge data for 38 years (1968-2005) were collected from the Irrigation Department, Govt of Kerala, for seven gauge stations. The spatial and temporal variations in water quality were analyzed using multivariate statistical tools.



Location of Bharathapuzha river basin

Similarly, Man-Kendall rank correlation analysis was used to test the temporal changes in annual discharge.

**Examining the major factors influencing the river discharge in the basin:** Using the data acquired from different government agencies, and multiple and partial regressions we prepared a rainfall run off model for identifying the most influential factors effecting the run off of the river basin.

### Results and discussion

The drainage pattern of the Bharathapuzha River basin is dendritic. The mean stream lengths of the river and its tributaries were found ranging 0.69 to 166.17 km. The drainage texture of the basin falls under 'fine' category. The elongation and circulatory ratios shows the elongative nature of the basin. The basin stretching to the Palakkad Gap in the Western Ghats with unique geological characteristics greatly influences the morphometry of the river basin. Other features such as slope, relief, and environmental factors such as rainfall also had considerably contributed to the basin morphometry.

The satellite data has been classified in to six major classes (agriculture, natural vegetation, plantation, roads, urban centers and water bodies) and accordingly the land use changes in the Bharathapuzha river basin during the time span of 1973-2005 were examined. During the early period (1973-1990) of the study in the basin land under natural vegetation cover (44%) dominated followed by area under agriculture. During the second half of the study period land under urban centers became important (32%) followed by the area under plantation. The area under agriculture remained almost same (26%), while the area under natural vegetation cover declined to considerably lower proportion in the total area of the basin. In 2005, the area under urban centers remains as the major land use type in the basin, followed by agriculture at the second position. In over all, the area under the natural vegetation cover consistently showed a trend of decline. On the other hand, the growing trend of urban centers was observed during the whole period.

The data extending for almost four decade shows the average discharge in Bharathapuzha river basin to be  $5.39 \pm 1.58 \text{ km}^3$ ). Man-Kendall rank correlation analysis shows a significant ( $p < 0.01$ ) decreasing trend in the discharge as the years proceeds ( $t = -0.604$ ). The average annual water discharge of the river at Kumbidi, the lowest location was  $3.94 \text{ km}^3$ , varying between 3.40 and  $10.83 \text{ km}^3$ . Among the tributaries, the highest average annual discharge was seen at Pulamanthole;  $1.67 \text{ km}^3$ . The spatial and temporal variations in water quality of the river basin were documented. Among the five stations, the water quality of Ampampalayam, Pudur, Mankara and Pulamanthole were relatively similar while the water quality at Kumbidi, the lowest station was different from all others.

The average annual rainfall in the Bharathapuzha river basin is 1828 mm with a standard deviation of 456.6 mm. Among the months, while July receives the highest (525 mm) which accounts for 29% of the total annual rainfall in the basin, January receives the lowest (3mm). Mann-Kendal test shows a significant decrease in the annual rainfall in the river basin. The decrement in the rainfall is very clear for pre-monsoon, and in the case of southwest monsoon. Mann-Kendal analysis of temperature data of the basin shows a statistically significant increment in the daily, seasonal and annual temperature.

Our examination of the discharge for more than three decade shows a decreasing trend in annual discharge in the basin. Among the variables, rainfall was found to be the factor with highest influence on the annual discharge. Rain days, forest cover and area under agriculture are other parameters with notable positive consequence on the discharge. While maximum, minimum and mean temperature, area under plantation, urban and road area expansion are negatively influencing the river discharge. The multiple regression model, attempted using all the possible factors reduced the factors functionally influencing the discharge as rainfall and water bodies.

**Summary**

The present study attempts to analyze the environmental status of the Bharathapuzha river basin, a medium sized river basin in Kerala. We compiled secondary data available with various departments and those in the published and unpublished reports to narrate the hydrological, meteorological scenarios of the river basin. The data available in the maps, topographic maps and imageries were used to plot the land use changes, and the urban pressure in the basin. We used different statistical tests and GIS / RS software to analyze and conclude our observations.

Our analysis shows spatial and temporal variation in quality and quantity of water flow in the river that is highly influenced by the dams. There is a significant decrease in general rainfall pattern, while the temperature found significantly increasing as the years proceeds. The study could find extensive changes in the Land use land cover (LULC) in Bharathapuzha river basin; in terms of reduction in the natural vegetation cover, increase in the urban area, decrease in area under wetland agriculture, and increase in road density. Multiple regression analyses and partial regression analyses show that the area under water bodies especially dams and manmade water ponds and annual rainfall shows highly significant relation with the annual discharge in the basin.

**Recommendations**

The present study reports major environmental changes happening in the river basin. The information generated during the study highlights the necessity of a scientific management plan for conserving the highly vulnerable medium river in rapidly changing global climatic conditions.

**24. Bioavailability of heavy metals in soils and select plant species in opencast mines**

Research Student	: Rachna Chandra
Supervisor	: P.A. Azeez
Project Period	: Initially for 2 years (1 year extendable)
Date of Commencement	: April 2009
Expected date of completion	: March 2011
Budget	: ₹ 2.33 lakhs (for 2009-2010) & 2.91 lakhs (for 2010-2011)
Funding source	: Council for Scientific and Industrial Research (CSIR), New Delhi
Status	: On going

**Background**

Most metal contamination occurs through anthropogenic disturbance, such as mining, where unnaturally high amounts of metals are released during various processes. Although aimed at improvement of the socio-economic well being of the people in the country, the flourishing mining industry has manifold environmental implications and repercussions. The first and foremost important effect of mining is on the land use pattern, vegetation and environment associated thereof, and changes in distribution of nutrients and minerals in soil. Due to stringent environment legislations, reclamation and reforestation of the mined out sites have become obligatory. Information on distribution of nutrients including toxic metals before and after opencast mining would provide valuable insights while developing and executing the strategy for reclamation and re-vegetation of the mined out sites. Some of the plant species have the ability to tolerate elevated levels of heavy metals and / or accumulate them in very high concentrations to levels that far exceed the soil levels.

The state of Andhra Pradesh, one of the mineral rich states of India, has considerable deposits of Bauxite. In recent years, some of the hill ranges

of this area and their neighborhoods have been identified as potential sites for mining bauxite. Certain plants are known to change the chemical forms of pollutants as a way of combating toxicity. Studying the levels and spread of toxicity by heavy metals as a result of mining and understanding the way some plants combat this, will help us understand and develop informed potential solutions. Thus, an attempt was made to assess the trace and heavy metal concentrations in dominant plant species and soils occurring in the area.

### Objectives

The present study was carried out at Araku (proposed bauxite mine), Visakhapatnam, Andhra Pradesh, India with the following objectives

- Assess the spatio-temporal variability in the vertical distribution of trace and heavy metals along the depth-wise soil profile.
- Assess the ability of the plant in translocating the metal species from roots to leaves.
- Examine time effect on the speciation of trace metals in soil: bioavailability and toxicity.

### Methodology

Soil and plant samples were/are collected on a quarterly basis from three sampling locations namely Raktakonda (sites; R1, R2 and R3), Galikonda (sites; G1, G2 and G3) and Chittamgondi (sites; C1, C2 and C3) at Araku Valley, Visakhapatnam, Andhra Pradesh. At each site, soil samples were collected in triplicates from four successive layers, i.e., 0-5 cm, 5-10 cm, 10-15 cm and 15-20 cm depth. Dominant plant species were directly uprooted. The samples after drying and sieving (<2mm in size) were acid digested and analysed for heavy metals. SPSS 11.0 version (Norusis 1986) was used for analyses of analytical data on soil and plants.

**Results and Discussion** In soil Cu concentrations ranged from 13.0 to 31.8 mg/kg. GLM -ANOVA ( $P < 0.05$ ) and post-hoc test (LSD,  $P < 0.05$ ) revealed that all the months and locations differed significantly. Ni ranged from 23.5 and 101.9 mg/kg and varied among the months, locations, sites and layers. The Ni distribution in

upper two layers was significantly distinct from others. Zn levels varied from 10.4 to 52.1 mg/kg. Zn levels in soil varied significantly in all the months and locations. Among the different soil layers top layer was distinct from the rest with respect to Zn level.

Concentration of Cu, Ni and Zn in plants varied from 3.4 to 76.7 mg/kg, 1.9 to 41.4 mg/kg and 1.5 to 52.2 mg/kg, respectively. Cu in the plants from Raktakonda ranged from 3.4 to 30.0 mg/kg, at Galikonda the concentration range was 4.0 to 34.0 mg/kg and at Chittamgondi 3.4 to 76.7 mg/kg. Ni in species from Raktakonda varied from 4.7 to 32.9 mg/kg, in those from Galikonda 3.0 to 39.6 mg/kg and in Chittamgondi from 1.9 to 41.4 mg/kg. Plant concentrations of Zn at Raktakonda ranged between 1.8 and 52.2 mg/kg, at Galikonda 2.1 and 38.5 mg/kg, and at Chittamgondi 1.5 and 50.8 mg/kg.

Metal concentration in species and organs showed significant spatial heterogeneity for Zn concentrations. Cu concentrations varied significantly among species and among organs. Cu levels varied significantly in roots. Ni concentrations varied significantly among the months with few exceptions. Ni concentrations at Chittamgondi were distinct from rest of the locations. Ni in leaf was distinct from rest other organs. Zn concentrations in root were distinct from other organs.

Though Ni concentrations were relatively high in soil it was least transported in plant body. Ti values for Cu varied significantly among months and species. Transportation index (Ti) values of Cu during February 2008 were distinct from the rest of the months. In the case of Ni, the Ti values varied significantly among months and locations. Ti values for Ni varied significantly during August 2008. Among the three hillocks, Ti values for Ni were distinct at Chittamgondi.

Concentrations of Cu, Ni and Zn in soils are dependent on a number of factors. Background concentrations of the metals chiefly are determined by local bedrock geochemistry, and may be supplemented to differing degrees by anthropogenic inputs. Location specific significant variations for metals in soils of Araku

**Summary**

Redox potential and pH in soil solution are the main agents for metal mobility in the soil layers in Araku. Marginally higher values of Cu were obtained from the soil system of Araku, which however were well within the safe limit.

may be attributed to the geology of the area, since no major anthropogenic source is known in the area except the slash and burn practice of agriculture. Researches show that redox potential and pH in soil solution are the main agents for metal mobility in the soil layers. Thus, in the acidic soil with redox potential between +25 and +209 mV, the higher rainfall and temperatures at the Araku hillocks, may lead to release of trace metals. Human disturbances such as forest fire might also causes variations in the metal concentrations in the soil samples. Ni occurs in the soil in more readily extractable forms compared to Cu and it may be more mobile. Seasonal variations in Zn concentrations at Araku are attributed to pH variations, Oxidation Reduction Potential and rainfall pattern. The differences in Zn concentrations among soil layers are attributable to pH variations.

Analyses of the three metals (Cu, Ni and Zn) in plant species in the three hillocks of Araku showed two main features; differences in the metal levels among species, and differences among plant organs (roots, stems and leaves). The differential accumulation of metals in plant organs in different months is an indication of effective utilization of specific metals for certain/specific metabolic activities. The heavy metal concentrations in the present investigation in various organs of species showed identical seasonal/month-wise variations with few exceptions, which are probably associated with the growth dynamics of the species. The site-specific differences with micro level variations result sometimes in notable variations in the mobility of metals in the plant parts.

**25. Nature Education Activities for Coimbatore**

Coordinator	: P. Pramod
Project Assistant	: P. Balakumar (October 2009 to February 2010)
Project period	: Long-term
Funding source	: SACON and sponsors for each program
Status	: Ongoing

**Background**

SACON has a separate nature education division with the major responsibility entrusted to spread the message of nature conservation to various segments of the society.

**Objectives**

The major objective of our nature education division is to plan and execute programs for inculcating nature awareness among the general public of Coimbatore district with special emphasis on school children as the target group.

**Activities**

Regular nature education programs such as guest lectures, one-day nature camps, Sálim Ali nature competitions, Wetland Day, Forestry Day celebrations were under taken by the division.

School and College Programs: 25 one-day camps, attended by 3000 school students, 250 teachers and 350 college students were conducted by the Nature Education Division. Activities in the camps include trekking and bird watching, slideshows, discussions and showing of films on nature.

A team of 20 school head masters from Coimbatore participated in a discussion meeting on nature education activities at SACON. The Chief education Officer and the District Education Officer of Coimbatore and a few headmasters visited and had a discussion with the Nature Education Officer.

**Special Nature camps:** One special nature camp was conducted for AIDS affected children. Twenty-seven children attended the program.



One day nature camp: A walk in the wilderness



Children undergoing training in the field

**Sálim Ali Trophy Nature Competitions 2009-10:** Sálim Ali Rolling Trophy for Nature Competitions was conducted on 24th of January 2010. About 2500 students from 75 schools participated in the event. Competitions were conducted in various categories of painting, pencil shading, elocution, essay writing, poetry writing, and short story writing in Tamil and English, and in a quiz and bird watching. 136 students from 31 schools won prizes. Kadri Mills Hr Sec. School, Ondiputhur, a government aided school from the suburbs of Coimbatore, won the Salim Ali Trophy for the year. State Bank of India sponsored the program.

**Sálim Ali Naturalist Forum:** SANF, a platform for nature education, initiated and supported by SACON, conducted 20 programs during this period. Every 2nd and 4th Sunday, bird watching sessions were arranged for the members of SANF. In addition, eight field trekking programs



Winners of Sálim Ali Trophy for nature competitions with SACON Scientists

were conducted for bird watching and nature exploration. The members shared their experiences, list of birds and animals recorded during the field trips, photographs and other details through an e-group.

The most important event was the Annual day celebration of SANF on 16th August 2009 held in 90 persons attended the program. The chief guest was Dr. N Krishnakumar (Director, Institute of Genetics and Tree Breeding, Coimbatore). Dr P.A. Azeez presided over the inaugural function. The programs included a guest lecture, film screening, quiz competition and a treasure hunt.

**Wildlife Week Celebration:** SACON participated in the Forest and Wildlife exhibition titled "VANA VISMAYAM" organized by the Kerala Forest Department from the 2nd to 8th October 2009 in Eranakulathappan Ground, Eranakulam, Kerala. Twenty-five stalls on various forest and wildlife issues were erected by various Government and Non-Governmental Organizations of South India in the exhibition. SACON displayed the activities and programs of its various divisions apart from this, bird pictures painted by school children were also displayed in the stall, which was appreciated by the visitors. About 40,000 persons visited the Hall and interacted with SACON research scholars.

**National Teachers Science Congress:** Two coordinators of Sálim Ali Nature Clubs, Ms. Selvi, Kadri Mills Hr. Sec. School and Mr. Rajagopal, Government High school, Devarayapuram

presented papers on nature education through the Sálím Ali Nature Club in the National Teachers Science Congress in Bhubaneswar conducted by the Department of Science and Technology, Government of India.

**Other Extension and Education activities:**

The following activities were also undertaken.

- Four batches of In-service forest officer trainees from SFSC visited SACON for an exposure to the conservation science and the works of SACON.
- Dr. Pramod participated as a Master Resource Person in the first southern regional training of National Children's Science Congress conducted by NCSTC, Department of Science Technology, Govt of India. The training was for state coordinators and evaluators as a preparation for the NCSC of 2010.
- Dr. Pramod also served as a judge in the intercollegiate documentary film competition conducted at Nirmala College, Coimbatore.

DBT's Natural resources Awareness Clubs for School Children-The DNA Clubs' is an initiative of the National Bioresource Development Board of the Department of Biotechnology, Government of India. It aims to promote deeper awareness among school students on the importance of environment, biodiversity, biotechnology and their relation to day-to-day life. DBT identified SACON as the Regional Resource Agency for Andaman to implement the DNA club program.

SACON started DNA clubs in five schools, on the Andaman Islands. The schools selected were the Government Sr. Sec. School (North Andaman), Government Sr. Sec. School (Mayabunder, North of Middle Andaman), Government Sr. Sec. School (Rangat, South of Middle Andaman), Kendriya Vidyalaya No.1 (Port Blair, South Andaman), and Government Sr. Sec. School (Hutbay, Little Andaman). After the inauguration, the program was initiated with a teacher's orientation program conducted at the Mini Zoo, Port Blair. Since then several programs have been arranged for the members of the clubs in these schools. The program primarily involves students as partners in collective learning in contrast to teaching in a conventional manner.

During 2009-10, laboratory experiments, projects and field trips were conducted for the students. Guest lectures by scientists were organized. The PI of the project visited schools twice during the period to inspect the progress of the project and gave lectures on ecology and biodiversity. Competitions on essay writing, painting and logo designing were also conducted for the students during this period. All the schools were provided essential equipment such as computer, printer, binoculars, field guides and laboratory equipment hygrothermometer, haematometer and digital balance.

This year we have identified and initiated the same program in five more schools in Andaman and similar activities are planned for all of them.

Laboratory experiments: The programs conducted in the schools between also include laboratory activities such as blood group testing,

**26. DBT's Natural Resources Awareness Clubs for Andamans**

Principal Investigator	: P. Pramod
Project Staff	: Rajan P., Magesh R. (October 2009 - January 2010) and K. Priya (February to March 2010)
Duration	: April 09 March 2010
Date of commencement	: 23 <sup>rd</sup> July 2007
Date of Completion	: 31st July 2012
Budget	: ₹ 16.00 lakhs (Phase I), ₹ 52.00 lakhs (Phase II)
Funding source	: Department of Biotechnology, Govt. of India
Status	: Ongoing





DNA Club members explaining biodiversity at Munda pahad beach

water quality testing, a study on mitosis and herbarium preparation.

Student Projects: The members of the club have undertaken the following minor student projects

- Diversity of wild flowers
- Medicinal plants of Andaman
- Diversity of leaf and leaf architecture
- Diversity of butterflies
- Shells and other life in coastal ecosystems
- Mushroom culture
- Making and maintenance of aquarium
- Pollution and spread of communicable diseases
- Importance of mangrove plants as costal defense
- Bird diversity
- Diversity of corals

- Diversity of plants in the region
- Insect diversity in residential areas
- Pesticide usage in agriculture fields
- Vermiform compost

Field Visits: Educational field trips assisted by scientists were conducted to nearby biodiversity rich areas. Students visited important conservation areas such as Saddle Peak National Park, Chidiyatapu Biological Park, Kalpong Hydroelectric project area, Ramnagar Beach, Forest area of Panchavati, and nearby sea shores to study and document the biodiversity of the area.

Other activities: Several other activities such as wildlife documentary shows, guest lectures by scientists were arranged for the benefit of the children. as part of the project program.



Bird watching in the Andaman Islands



## UNIVERSITY DEPARTMENTS

### Zoology

Lalitha Vijayan	N. Ezhilarasi	Ph D	Status and ecology of the Andaman crane	Awarded
	M. A. Rajamamannan	Ph D	Avifaunal diversity of the Andaman Islands	Ongoing
	N. Sheeba	Ph D	Ecology and conservation of spot-billed pelican	Ongoing
S. Bhupathy	J. Gokulakrishnan	PhD	Ecology of sea turtles along the Nagapattinam coast, Bay of Bengal	Ongoing
	G. Srinivas	Ph D	Ecology of amphibians in high wavy mountains, Western Ghats	Ongoing
	N. Sathish Kumar	Ph D	Ecology of reptiles in high wavy mountains, Western Ghats	Ongoing
	C. Ramesh	Ph D	Ecology of the Indian python in Keoladeo National Park, Bharatpur	Ongoing
	M. Kamalakannan	M Phil	Diurnal activity of the Indian python in Keoladeo National Park, Bharatpur	Awarded
P. Pramod	Manchi Shirish S.	Ph D	Breeding ecology of the Edible-nest Swiftlet <i>Aerodramus fuciphagus</i> and the Glossy Swiftlet <i>Collocalia esculenta</i> in the Andaman Islands, India.	Awarded
	L. Josheph Reginald	Ph D	Diversity and habitat preference of bats (Order Chiroptera) of Coimbatore	Ongoing
	Chetan Nag	Ph D	Addressing the issue of taxonomic position of peninsular Indian Hanuman langurs ( <i>Semnopithecus entellus</i> ) through a multidisciplinary approach	Ongoing
	A.P.Zaibin	Ph D	Insular biogeography of Nicobar Islands from a bird community perspective	Ongoing
	P. Rajan	Ph D	Ecology and distribution of two introduced bird species ( <i>Acredothres tristis</i> and <i>Passer domesticus</i> in Andaman Islands	Ongoing
	K. Priya	M Phil	Genetic diversity analysis of Andaman day gecko <i>Phelsuma andamanense</i> by DNA fingerprinting	Ongoing

**Botany**

P. Balasubramanian	E. Santhoshkumar	PhD	Studies on frugivory and Seed dispersal by Indian Grey Hornbill, <i>Ocyrceros birostris</i> in Sathyamangalam Forest Division, Eastern Ghats	Ongoing
	R. Aruna	PhD	Frugivory and seed dispersal by birds in mixed dry deciduous and scrub forests	Ongoing
	C. Anbarasu	PhD	Avian frugivory and seed dispersal in the shola forests of Nilgiris, Western Ghats, India.	Ongoing
	P. Nehru	PhD	Floristic diversity, dynamics and recovery of littoral forests of Nicobar Islands, India- a post Tsunami scenario	Ongoing
	K. Amirthalingam	MPhil	Studies on the flora of Minghigully Valley, Sathyamangalam Forest Division, southern Eastern Ghats	Awarded

**Environmental Sciences**

P. A. Azeez	M. Baladhandapani	Ph D	Techno economic evaluation of Common Effluent Treatment Plants in Tirupur	Awarded
	P. P. Nikhil Raj	Ph D	An analysis of environmental changes in the Bharathapuzha River basin, Southern India	Thesis submitted
	Rachna Chandra	Ph D	Nutrients and Metals in soils and Plants in Araku, AP, India	Thesis submitted
	J. Ranjini	Ph D	Adaptation and tolerance of birds to urbanization – a critical evaluation with emphasis on life strategy	Ongoing
	R Dhanya	Ph D	Urbanization and environmental transition: A study on the impact of developmental activities with special reference to EMR on the House Sparrows.	Ongoing
	P. Balakumar	M Phil	Avian Influenza in the context of diminishing ecology resources	Awarded
S. Muralidharan	V. Dhanajayan	Ph D	Impact of environmental contaminants in Indian avifauna	Awarded
	A. Alaguraj	Ph D	Organic contaminants in the marine fishes available in Coimbatore and their suitability for human consumption	Ongoing

	P. Jayanthi	Ph D	Organochlorine pesticides residues in the commercial marine fishes of Coimbatore and their suitability for human consumption	Ongoing
	S. Jayakumar	Ph D	Impact of agricultural pesticides on the population status and breeding success of select species of fish-eating birds in Tamil Nadu	Ongoing
	K. Ganesan	Ph D	Comparative study on pesticide residues in select components of an agro ecosystem adopting organic and chemical farming in Padayetti village, Palakkad District, Kerala-	Ongoing
	P. Navamani	M Phil	Poly Cyclic Aromatic Hydrocarbon (PAHs) in marine fishes collected from Cochin and Rameshwaram coasts and their suitability for human consumption	Ongoing



## WORKSHOPS, SEMINARS, SYMPOSIUMS, CONFERENCES AND TRAINING PROGRAMS



First memorial seminar held at SACON on 18/01/2010 in remembrance of Dr Ravi Sankaran, former Director of SACON

**Training Programs:** Two training courses on Instrumentation and Analytical Techniques were organized by the Division of Ecotoxicology during June 2009 and October 2009. Professor Dr. C. Namasivayam, Dean, Faculty of Science and Head, Department of Environmental Science Bharathiar University, Coimbatore and Dr B. Nagarajan, Head, Department of Biotechnology, Institute of Forest Genetics and Tree Breeding, Coimbatore inaugurated the programs respectively. Students (BSc, MSc, MPhil) from premier academic and research institutions, such as PSG College of Arts and Science, Mysore University, Bannari Amman Institute of Technology, Madurai Kamarajar University and research scholars of SACON attended. The course was designed to give students a theoretical and practical exposure to various analytical tools in qualifying and quantifying many inorganic and organic elements in a variety of biological and non-biological matrices.



One day Seminar on Conservation Biology: On the first Remembrance Day for late Dr Ravi Sankaran, the former Director of SACON, as a tribute, a one-day Seminar on conservation biology was organized on 18th January 2010. The seminar was attended by eminent scientists, staff and research scholars of SACON. Drs. Ajith Kumar (Wildlife Conservation Society); Sanjay Molur (Zoo Outreach Organization); P. A. Subramanian (Zoological Survey of India, Pune); E. J. James and Mathew K. Sebastian (Karunya University) and P. Pramod (SACON) delivered talks on various aspects related to conservation on the occasion.



**Service to academic institutions and industry:** We continued to extend our services to academic institutions and industries, such as KG Hospital, PSG College of Arts and Science, Coimbatore, Erode Arts and Science College, Erode, M/s Apparel Care Testing Services, Tirupur and IGCAR, Kalpakkam in analyzing their samples.

**Internship:** Ms Biatriz Lima (Brazil), graduate student under IAESTE internship program at Karunya University underwent training at Division of Ecotoxicology, SACON.

Mr. Jacob Karlin (Germany) a graduate student of University of Johann Wolfgang, Goethe University, Frankfurt, under IAESTE internship program at Karunia University undertook training in the Division of Nature Education of SACON. The topic of his study was 'Changes in land, life and living of River Noyyal Basin'. During the six months, he visited nine villages along the course of the River Noyyal and studied the present condition; ecological history of the areas and environmental problems based on a geographical and landscape ecology perspective.

## PUBLICATIONS

### I. JOURNALS

#### a. National

- Acharya, B.K. and Vijayan, L. (2010). Status and distribution of endemic and threatened birds of the Eastern Himalaya in Sikkim, India. *Journal of Threatened Taxa*. www.threatenedtaxa.org. February 2010 | 2(2): 685-689.
- Aruna, R., Balasubramanian, P., and Radhakrishnan, P. (2009). Role of frugivorous birds in seed dispersal in the mixed dry deciduous forests of Attappady and Anaikatty, Western Ghats. *Indian Forester* 135 (10): 1308-1316.
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- Chiranjibi Pattanaik and C. S. Reddy (2009). *Tetracera sarmentosa* (L.) Vahl subsp. *sumatrana* (Hoogl.) Hoogl. (Dilleniaceae) A new record for India. *Science and Culture*, 75(7-8): 303-304.
- Dhananjayan V, Muralidharan S and Jayanthi P. (2010). Distribution of persistent organochlorine chemical residues in blood plasma of three species of vultures from India. *Journal Environmental Monitoring Assessment*. DOI 10.1007/s10661-010-1424-5.
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- Reddy, C. S. and Chiranjibi Pattanaik, (2009). An assessment of the floristic diversity of Gandhamardan hill range, Orissa, India. *Bangladesh Journal of Plant Taxonomy*. 16 (1): 29-36.
- Reddy, C. S., K. Ram Mohan Rao, Chiranjibi Pattanaik and P. K. Joshi (2009). Assessment of Large-Scale Deforestation of Nawarangpur District, Orissa, India for its Sustainable Management: A Remote Sensing Based Study. *Environmental Monitoring and Assessment*, 154: 325-335.
- Reddy, C.S., Chiranjibi Pattanaik and K.N. Reddy (2009). Magnoliopsida, Gamopetalae, Gentianales, Asclepiadaceae, *Heeterostemma deccanense* (Talb.) Swarup and Mangaly: Distribution, extension and geographic distribution map. *Check list Journal*, 5(3): 468-470.
- Selvarathinam, T., Balasubramanian, P. and Kumaravelu, G. (2009). Nectar resource use by butterflies in a dry deciduous forest in Eastern Ghats, India, *Indian Forester* 135 (10): 1299-1307.
- Shreyas Krishnan, S. Bhupathy and Devi Prasad (2009). Monitoring of *Python molurus molurus* in Keoladeo National Park, Bharatpur, Rajasthan. *Hamadryad*. 34 (1): 28-33.

#### b. International

- Acharya, B.K. and Vijayan, L. (2010). The bird community of Shingba Rhododendron wildlife sanctuary, Sikkim, Eastern Himalaya, India. *Tropical Ecology*. 51 (2): 149-159.

- Azeez, PA., B Anjan Kumar Prusty and EP Jagadeesh (2009). Select alkali and alkaline earth metals in decomposing macrophytes in a wetland system. *Acta Ecologica Sinica*. 29 (1): 13-19.
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- Ecology and Sustainable Development*. 1 (1): 14-19.
- Nikhil Raj PP and PA Azeez (In press). Land use / Land cover changes in a tropical river basin: a case from Bharathapuzha river basin, Southern India. *Journal of Geographic Information System*.
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- Somasundaram, S. and Vijayan, L. (2010). Foraging ecology of the globally threatened Nilgiri Wood Pigeon (*Columba elphinstonii*) in the Western Ghats, India. *Chinese Birds*. 1 (1): 921. DOI 10.5122/cbirds.2009.0017.

## II. Papers in Conferences / seminar / proceedings / edited volumes

### a. National

- Anbarasu C and P. Balasubramanian Bird Pollinators and Seed dispersers in the Dry deciduous Forest of Pachamalai hills, Eastern Ghats. National Conference on Biodiversity Conservation and Management of Bioresources. Department of Zoology Andhra University, Visakhapatnam. October 2009.
- Azeez P A and R Chandra (2009). *Prosopis juliflora*, the tree of the poor: Challenges and Management Options. National Symposium on Prosopis: Ecological, Economic Significance and Management Challenges. Gujarat Institute of Desert Ecology, Bhuj, Gujarat, 20<sup>th</sup>-21<sup>st</sup> February 2009.
- Balasubramanian P (2010). Invasion of *Prosopis juliflora* and its management in the Great Vedaranyam Swamp, southeastern Coast of India. National Workshop on Ramsar Sites. Organized by the Tamil Nadu Forest Dept. and BNHS at Trichirapalli. 11 February 2010.
- Balasubramanian P (2009). Importance of Trees in Conservation of Avian diversity, M.S. University, Vadodara 13 September 2009. Two papers presented, a. Bird-plant interactions and b. Hornbills.
- Balasubramanian P (2010). National Seminar on Recent advances in Zoology, Govt. Arts College, Coimbatore. Lecture delivered on Conservation of Birds. 25 February 2010.
- Chandra R, BAK Prusty and PA Azeez (2009). Impact of *Prosopis Juliflora* on herbaceous diversity in Keoladeo National Park, Bharatpur. National Symposium on Prosopis: Ecological, Economic Significance and Management Challenges. Gujarat Institute of Desert Ecology, Bhuj, Gujarat, 20<sup>th</sup>-21<sup>st</sup> February 2009.





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- b. International**
- Chandra R and Azeez PA (2009). Bioaccumulation of metals in different parts of weed species at proposed bauxite mines. International Biohydrometallurgy Symposium 2009 (IBS-09). Bariloche, Argentina, 13 – 17 September 2009.
- Dhananjayan V and S Muralidharan (2009). Polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) in tissue of Pariah Kite *Milvus migrans govinda* in Ahmedabad, India. International Conference on Environment, Occupational and Life style Concerns- Transdisciplinary approach. 16-19 September 2009.
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- Nikhil Raj and PAzeez (2009). Historical analysis of the first rain event and the number

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### III. Newsletters

Pattanaik C., L. Vijayan, S. N. Prasad and P. A. Azeez (2009). SAROVAR SAURABH Newsletter, Vol-5, No-2, pp 1-8.

Pattanaik, C., L. Vijayan, S. N. Prasad and R. Shankar (2009). SAROVAR SAURABH Newsletter, Vol-5, No-1, pp 1-15.

### IV. Reports

Azeez PA, S Bhupathy, PP Nikhilraj and R Chandra (2010). Conservation of Kottuli Wetlands, Calicut, Kerala. Sálim Ali Centre for Ornithology and Natural History, Coimbatore, 66 pp. Report submitted to Tourist Resort (Kerala) Limited (TRKL).

Balasubramanian, P. Anbarasu, C., Aruna, R. and Silambarasan, K (2010). Study on pollinators and seed dispersers in scrub, dry evergreen and shola forest ecosystems of Tamil Nadu. Report submitted to the Tamil Nadu Forest Department. P.112

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### V. Talks Delivered

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Balasubramanian. P. "House Sparrows- An overview" at Tamil Nadu Agricultural University, Coimbatore. 20 March 2010.

Kumara, H.N. Conservation status of mammals in the rainforests of Western Ghats. In Scientists meet cum conservation workshop on "Linking research inputs with the conservation programs of the government in Western Ghats in Karnataka: Challenges and Opportunities", (28-29 January, 2010), Bengaluru.

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### VI. Popular Articles

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Madhuri R. and S. Manchi. Ravi Sankaran's Circle. Current Conservation

Nagabhatla, N., Chiranjibi Pattanaik, S. N. Prasad, S. S. Sellamuttu, R. Wickramasuriya (2009). Investigation of aquaculture dynamics in a Ramsar site using Earth Observation Systems in conjunction with socio-economic assessments. Lakes and Reservoirs: Research and Management, 14: 325-336.

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### VII. Chapter in books

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Chandra R, Prusty BAK and PA Azeez (2009). Impact of *Prosopis juliflora* on Herbaceous Diversity in Keoladeo National Park, Bharatpur. Pp. 09-13. In: *Proceedings of the National Symposium on Prosopis: Ecological, Economic Significance and Management Challenges* (Eds. Thivakaran GA, Kumar A, Prusty BAK and Senderraj SFW), Gujarat Institute of Desert Ecology, Bhuj, India. 115 pp.

Ezhilarasi, N. and Vijayan, L. (2010). Foraging ecology of Andaman Crane and its conservation. In Ramakrishna, Raghunathan C, and Sivaperuman (Eds). *Recent Trends in Biodiversity of Andaman and Nicobar Islands*, 415-422.

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Dr. Pramod at the 23<sup>rd</sup> International Conference of Conservation Biology, Beijing

Smith PN, Afzal M, Hasan RA, Bouwman H, Castillo LE, Depledge MH, Muralidhran S, Dhananjayan V, Fossi C, Kitulagodage M, Kylin H, Law R, Marsili L, Hara TO, Spinola M, Story B and Codding CG (2010). *Global Perspectives on Wildlife Toxicology: Emerging Issues*. In *Wildlife Toxicology: Emerging Contaminant and Biodiversity Issues*. Ron Kendall, et. al., (Eds) Taylor and Francis Group, London, pp vii+321

### VIII. Participation in seminars/ conferences/ meetings

International Congress for Conservation Biology: The 23<sup>rd</sup> International Congress for Conservation Biology was organized from 11th to 16th July 2009 in Jihua International Convention Centre, Beijing, China. Organizer of this conference, the Society for Conservation biology is one of the most important international professional organizations dedicated to the science of conservation. The theme of the conference was "Conservation: Harmony for Nature and Society" 1600 scientists from more than 100 countries attended the conference. Dr Pramod, Senior Scientist of SACON, who is also a member of this professional society attended the workshop and presented a paper on "Potential of People's Biodiversity Registers for Conservation Education and action". The congress was held in parallel sessions of working groups, members meeting (in which new office bearers of the society took charge), exhibitions, mid conference field trips, and social events.

## INFRASTRUCTURE



SACON office premises : A view from above

SACON's location at Anaikatty with the backdrop of the Western Ghats, one of the 'hot spots' of biodiversity in the world, offers great opportunities for long term studies on various aspects of its varied avifauna, other wildlife and on biological principles involved in the functioning of ecosystems. The tri-junction of Kerala, Tamil Nadu and Karnataka in the Western Ghats, one of the best wildlife areas in the country, is just a few hours drive away. SACON sets up field stations in various parts of the country according to the requirements of the research projects.

Shri Jairam Ramesh, Hon'ble Minister of State (Independent charge) for Environment and Forests, Government of India during his visit to



Visit of Shri. Jairam Ramesh, Honorable Minister for Environment and Forests, Govt. of India to SACON on 22/02/2009

SACON on 22nd November 2009, while appreciating the work done at SACON, promised financial assistance of Rs. 5.00 crores for the development of infrastructure facilities at the centre. A proposal for this has been submitted to the MoEF in this regard. The major items proposed are: (1) Hostel and Dormitory, (2) Auditorium, (3) Sálim Ali Nature Interpretation Centre, (4) Conservation Genetics and Bird Acoustics Laboratory.

Significant additions have been made during the year to the existing infrastructure of SACON. The construction of quarters for Director, SACON was completed during this reporting period. Since most visiting faculty would like to stay in the campus itself, for the time being the Director's quarters is being used as a Guest House. This facility has four furnished rooms and allied facilities such as drawing room, kitchen and dining room. A permanent arrangement to solve the long-standing requirement of drinking water supply to the SACON complex has been made by constructing a 10,000 liters sub-surface sump. Underground pipelines have been laid





with necessary pumping arrangement from the sump to various buildings. Now potable water is available in sufficient quantity to each building.

Similarly, underground electric cables for security lights have been laid as a permanent measure along the road to supply the lighting system in the campus.

**Laboratory Facilities:** Currently, the SACON laboratory is equipped with 1) UV Spectrophotometer, Perkin Elmer Model Lambda, (2) HPLC Agilent Technology Model 1100 series with DAD and Florescence detector, (3) Ultra Deep Freezer (-800 C), New Brunckwick, (4) Flame Atomic Absorption Spectrophotometer (AAS) Perkin Elmer, Model 3300 with 13 lamps for analyzing metal residues, (5) Graphite Furnace Atomic Absorption Spectrophotometer for analyzing metal residues, (6) Mercury Hydride Generator for AAS, Perkin Elmer for analyzing mercury and other hydride forming elements, (7) Gas Chromatograph, Hewlett Packard Model 5890 Series II with three detectors, (Electron Capture Detector - ECD, Nitrogen Phosphorous Detector -NPD and Flame Photometric Detector -FPD) for analyzing pesticide residues and organic pollutants, (8) Microwave Digestion System, Milestone Model 1200 for digesting samples for analysis in the AAS, (9) Instant Water Analyser (TROLL) (10) Dissolved Oxygen (DO) Analyzer, (11) Biochemical Oxygen Demand (BOD) Incubator, (12) Flame Photometer, (13) Vertical Laminar Flow Chamber, (14) Respirable Dust Samplers for sampling suspended particulate matters (SPM) and Respirable particulate matters, Oxides of Nitrogen (NOx) and Sulphur dioxide (SO<sub>2</sub>), (15) Ultra Centrifuge, (16) Walk-in cold room, (17) Rotary Flask Evaporator, (18) Micrometer, (19) Digital Camera, (20) Thermo-hygrometer, (21) All Quartz Double Distillation

unit, (22) Millipore water purification system, and (23) Water Quality analyzer- Multi Parameter TROLL - 9500, (24) Hot-air Oven, (25) Binoculars, (26) Induction Hot Plate, (27) Digital Caliper, (28) Deep Freezer, (29) Soxhlet Mantle, (30) Multi parameter PCS tester and (31) Desiccators.

**Computer facilities:** SACON has acquired round-the-clock uninterrupted Broadband (Dataone BSNL) internet connectivity with a speed of 512 kbps -2 mbps connected through a Local Area Network and inter-division wireless connectivity. Scientists of SACON have been provided with a laptop and desktop computer each. All research and administrative divisions of SACON are provided with desktop computers, printers, scanners and software. Three 10 KVA UPS having three hours power backup supports all Computers.

**Library and Documentation:** Resources available in the SACON library as on March 2010 is given below:

Total no. of books	: 3245
Total no. of Back Volumes	: 2508
Maps	: 2706
CD/DVDs	: 91
SACON Project Report	: 77
Ph.D. Thesis	: 29
Current Periodicals	: 65 (National - 40; International - 25)
Online Subscription	: JSTOR Archive: Biological Science.

Facility for literature searches through the internet has been provided to the staff and students. As in previous years, library facilities were also used by more than a thousand PG students, research scholars and scientists from other institutions.

## APPENDIX

### MEMBERS OF THE SACON SOCIETY

1	Mr. Jairam Ramesh President – SACON Society and Hon'ble Minister of State (IC) for Environment and Forests Government of India Ministry of Environment and Forests Paryavaran Bhavan CGO Complex, Lodhi Road New Delhi – 110 003		
2	Mr. Vijai Sharma, IAS Secretary to the Govt. of India and Chairperson, SACON (GC) Ministry of Environment and Forests Paryavaran Bhavan CGO Complex, Lodhi Road New Delhi – 110 003	8	Dr. R. Sukumar Chairman Centre for Ecological Sciences Indian Institute of Science Bangalore – 560 012
3	Mr. E. K. Bharat Bhushan, IAS Jt. Secretary and Financial Advisor Government of India Ministry of Environment and Forests Paryavaran Bhavan CGO Complex, Lodhi Road New Delhi – 110 003	9	Prof. Hafiz Shaeque A. Yahya Professor Department of Wildlife Sciences Aligarh Muslim University Aligarh- 202 002
		10	Prof. P. C. Bhattacharjee Department of Zoology University of Gauhati Guwahati – 781 014
4	Mr. A. K. Goyal, IFS Jt. Secretary to the Govt. of India Ministry of Environment and Forests Paryavaran Bhavan CGO Complex, Lodhi Road New Delhi – 110 003	11	Mr. R. G. Soni, IFS (Retd) 40/74, Swarn Path Mansarovar, Jaipur – 302 020 Rajasthan
		12	Dr. P. Pushpangadan Sree Sailam, T.C.X/910 Mannammoola, Peroorkada Trivandrum – 895 005, Kerala
5	Mr. P R Sinha, IFS Director Wildlife Institute of India P B No. 18, Chandrabani Dehra Dun – 248 001 Uttarakhand	13	Prof. C. K. Varshney 88, Vaishali, Pitampura Delhi – 110 034
6	Dr. C. Swaminathan Vice Chancellor Bharathiar University Maruthamalai Road Coimbatore – 641 046	14	Dr. S. K. Dutta PG Dept of Zoology North Orissa University Sriramchandra Vihar, Takatpur Baripada – 757 003, Mayurbhanj Orissa
7	Dr. A. R. Rahmani Director Bombay Natural History Society Hornbill House, Sálím Ali Chowk Shaheed Bhagat Singh Road Mumbai - 400 023	15	Dr. Krishna Kumar Director Indian Institute of Management – Lucknow, Prabandh Nagar, Sitapur Road Lucknow – 226013

16	Dr. Sundaramoorthy T Head Biodiversity Conservation Education CPR Environmental Education Centre 1, Eldams Road Chennai - 600 018	23	The Wildlife Warden Silent Valley National Park Mukkali P.O Mannarghat Palakkad Dist
17	Dr. Lalitha Vijayan Sr. Principal Scientist Division of Conservation Ecology SACON Coimbatore	24	Mr. Shantanu Kumar (DGP retd.) Firdauz Farms Kalwar Road Zone C Bypass, Jotwara Jaipur – 302 001
18	Dr. S. Bhupathy Principal Scientist Division of Conservation Ecology SACON , Coimbatore	25	Dr. R. Uma Shankar University of Agricultural Sciences Department of Crop Physiology GKVK Bangalore - 560 065
19	The Principal Secretary Department of Forest and Wildlife Govt. of Kerala, Secretariat Thiruvananthapuram – 695 001	26	Ms. Tara Gandhi A1 Uttaravedi No 7, 2nd Seaward Road Valmiki Nagar Chennai - 600 041
20	The Principal Chief Conservator of Forests (WL) and Chief Wildlife Warden Aranya Bhavan, Saifabad Hyderabad - 500 004, Andhra Pradesh	27	Dr. Mustafa Shah P.C Department of Zoology University of Kashmir Srinagar – 190 006 Jammu and Kashmir
21	Dr. Ramakrishna Director, Zoological Survey of India Prani Vigyan Bhavan M Block, New Alipore, Kolkata – 700 053	28	Dr. P. A. Azeez Member Secretary and Director SACON Coimbatore
22	The Director Wildlife Warden, Central Division Dachigam National Park P.O New Theed, Harwan Srinagar, Kashmir (J&K)		



