

Technical Session II

Terrestrial Biodiversity

L - 01

Forest Endemism in Relation to Hydrology of Western Ghats

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Parting from Madagascar (88-90 m.y.a) and from Seychelles (65 m.y.a) left the Indian sub-continent lone in the Tethys Sea, like an island, drifting northwards, paving way for biological evolution in isolation and development of higher endemism. Tropical rain forests flourished all over during the slow process of crossing the equator, through several million years. Merger with Eurasia resulted in the rise of Himalayas causing increased aridity and monsoonal climate with rain forests persisting in only small pockets, like the North-East and South Indian Western Ghats.

Western Ghats exhibits latitudinal decline in wetness, its south (8-10°N lat) closer to the equator, having higher humidity and 9-10 rainy months due to summer showers and monsoon rains. Progressively northward reduction in rainy months, down to 3-4 in northern Maharashtra (18-20°N), creating differential dryness, decisive in forest related endemism, is reflected in northward decline in tree endemism, viz. 250 tree endemics in 8-10°N lat, 222 in 10-12°N, 139 in 12-14°N, 79 in 14-16°N, 38 in 16-18°N and merely 22 tree endemics in >18°N lat.

As progressive desiccation northwards is a critical factor, the endemics tend to persist around hydrologically richer parts of forests. Agricultural beginnings in the Western Ghats three millennia ago, concomitant with use of fire and axe, affected primeval forests, causing decline in endemism and spread of secondary vegetation. However, relic primary vegetation persisted in higher altitudes, in gorges of rivers and in sacred forests preserved as part of local cultures. These relics were also badly affected beginning in European times with commercial forestry, monoculturing of trees and higher altitude plantations of tea and coffee.

Studies in the Sharavathi river basin of central Western Ghats reveal that higher evergreeness of forests, with higher tree endemism in the catchments of tributary streams, favour endemic fresh water fishes. Swamp and stream laced Kathalekan sacred forest in Sharavathi basin is a refugium for endemic plant species including threatened ones. The forest-swamp complex of Kathalekan, in just 2.25 sq.km area had 35 amphibian species, almost equal to the amphibians of the entire Maharashtra. Study in the coastal Honavar taluk of Sharavathi basin, on hydrological significance of endemism rich Karikan sacred forest on a hill top, in comparison with a nearby hill clad in secondary forests reveals





year-round recharge of ground water from the Endangered *Dipterocarpus indicus* dominated sacred forest, enabling the village community in the valley down to concentrate on highly remunerative garden crops. In contrast is the water scarcity hit, poorer farming community in the village below the secondary forest, where rain-fed rice and garden crops together yield only 50% income of the former. The studies highlight the need for urgent conservation of hydrologically rich forests which are also centres of endemism.

Keywords: *Western Ghats, Biodiversity, Endemism, Hydrology, Ecology, Sacred groves, Sharavathi river*

L - 02

Swarming of the Termite *Coptotermes Heimi* in Northeastern Puducherry Region

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Even though the main thrust of research on termites across the world remains on their control or 'eradication', interest on their lignin-digesting ability is also growing. Termites are among very few species of insects which can ingest lignin and have it decomposed either by the microflora (present in the guts of 'higher' termites) or by the protozoa (living symbiotically in the guts of 'lower' termites). Exploration of this lignin-digesting ability, hence the biology, of termites is aimed at finding ways by which lignocelluloses biomass can be decomposed into simpler sugars for the eventual liquid biofuel production. Compared to other insects with lignin digesting ability termites are much more widespread and numerous, hence the special attention on them.

Coptotermes heimi is a 'lower' termite which is very widely distributed in many parts of the world, including most of India. As in the case of most other termite species, *C. heimi* attains its dispersal by the process of alate emergence, forming of swarms away from the parent colonies, and the mating of dealates. It also has the relatively uncommon (among the termites) ability by which its workers can metamorph into reproductives when isolated from parent colonies but the main process of reproduction and colony initiation occurs via alate swarming.

In view of the above we have carried out studies over a four year span on the swarming behavior of *C. heimi*. Details are presented in this paper, which show in that four years *C. heimi* swarms occurred 17 times of which 14 occurred in June and the remaining three in the first half of July. All the swarming occurred after sunset and after rain. In 15 of the instances, the alates were in the air for 15 – 20 minutes, whereas in other two cases, the flight was for 35 minutes and 60 minutes. There was sharp year-to-year variation in the number of swarmings – 1, 7, 4, and 5 swarmings occurred in 2009, 2010, 2011 and 2012 respectively.

Keywords: *termites, Coptotermes, swarming, alates, Puducherry*





L - 03

Status of Forests in Shimoga, Central Western Ghats

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Western Ghats mountain ranges constitute the beautiful array of mountains along the western coast of India. It separates the Deccan Plateau from a narrow coastal strip along the Arabian Sea. This particular mountain range starts from the southern part of the Tapti River near the border area of the states of Gujarat and Maharashtra. Western Ghats mountain ranges cover a length of around 1600 km running through the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala finally terminating at Kanyakumari district, in the southern-most tip of the Indian peninsula. The Western Ghats is rich with different kind of vegetation and topographical features. This bioregion is highly rich with flora and fauna and is considered as one of the 34 biodiversity hot spots of the world. The stretch of Central Western Ghats ranges from 12° to 14° covering areas of Coorg district, Hassan, Chikmagalur, Shimoga upto south of Uttara Kannada. The status of forests in Shimoga was studied by reviewing the working plans, administrative reports, settlement reports and other available research papers. There are five types of forests in Shimoga district: - Southern tropical wet evergreen forests, Southern tropical semi evergreen forests, Southern tropical moist deciduous forests, Southern tropical dry deciduous forests and Southern tropical Scrub forests. The district comprises of three forest divisions- Shimoga, Bhadravathi and Sagar. The forests of the district, which yield rich and valuable products, covered an area of 4,34,516 hectares nearly 40.27 % of the land in the district. The areas of different types of Forests are as follows: Evergreen forests- 69459 hectares (16%), Semi-evergreen- 88135 hectares (20.28%), Moist deciduous- 130612 hectares (30.06%), Dry deciduous -109539 hectares (25.21%) and Scrub Forests-24111 hectares (5.55%). The Kan forests which are most often climax evergreen forests preserved through generations by village communities of Malnadu regions as sacred forests or sacred groves and were characteristic in Shimoga district. During the field investigations, it was observed these ecological sensitive habitats are being destroyed and encroached at Halmahishi and Kullundi villages. Kans jurisdiction is under revenue department instead of forest department is the prime reason for partial or complete conversion for alternative land use. Large amount of forest were allotted to the Mysore Paper Mills for raising of pulpwood plantations. The chief sources of forest revenue in the district were the hard and soft woods and sandalwood exploited for commercial purposes. Some forest areas were cleared and assigned to the landless and other needy persons to meet the continuous demand and more land for agricultural purposes.

The study in the Kurnimakki-Halmahishi *kan* of about 1000 ha reveals the vegetation of the *kan*, though heavily fragmented, due to ever increasing human impacts, nevertheless, is a mosaic of



various kinds of forests. The most significant is the discovery of swampy areas within this *kan* which have few individuals of large sized threatened tree species *Syzygium travancoricum*, classified in the IUCN Red List as “Critically Endangered”. The tree is on the verge of extinction, and for the Shimoga district, the only occurrence of this tree is the Kurnimakki-Halmahishi *kan*.

The Kullundikan of about 453 ha has a narrow belt of original tropical rainforest dominated by the tree *Dipterocarpus indicus*, considered ‘Endangered’ by the IUCN. The revenue department in control of this *kan*, being totally ignorant of its vegetation richness has made several grants within the *kan* for cultivation of coffee and arecanut. The grantees have also done encroachments within this climax forest area of high watershed value.

Keywords: *Forests, Western Ghats, Sacred Groves, biodiversity*

L - 04

Ecological Importance of Relic Forest Patches – From Species to Ecosystem

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Relic forest patches are often integral part of socio-religious life in rural India. These patches popularly known as sacred grove, are usually characterized by having assemblage of native species, regional and local endemics and provision for various ecosystem services. Ecological characteristics of the sacred groves are governed by their surroundings as well as human interaction with the system. The different nature of this interaction leads to varied ecological profile of the grove system which could be observed in both micro and macro level i.e. from species to ecosystem. This presentation deals with various examples drawn from sacred groves of central Western Ghats to illustrate the phenomena and contemporary issues challenging the age old tradition.

Keywords: *Relic forests, Western Ghats, Sacred groves, ecosystems*





L - 05

A Study on the Invasion of *Clidemia hirta* (L.) D. Don in the Ponthenpuzha Reserve Forest of Kottayam District, Kerala

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Invasive plants are the second largest threat to the biodiversity. The forests of Kerala are rich in biodiversity and at present more than 100 species of exotic plants were recorded from Kerala and among them most of them are invasive in character. *Clidemia hirta* (L.) D. Don is native of Tropical America introduced into India for ornamental purpose. At present there is no detailed study on the invasion of *C. hirta* in the biologically rich forests of Kerala. The present attempt is an ecological study of *C. hirta* in the Ponthenpuzha Reserve forest (PRF) area of Kottayam district, Kerala. The major hypothesis of the proposed work is that disturbances and canopy openings are the major factors for the luxuriant growth of *C. hirta* in the Ponthenpuzha reserve forest. The study also assumes that the invasion of *C. hirta* has a significant effect on the soil microflora and nutrient level of the study area. The density, frequency, abundance and relative density were studied in both infested and uninfested areas of PRF. Biomass production was also estimated by dry and weight method. Soil samples were collected from both infested and uninfected sites of *C. hirta*. Sub surface soil samples were collected in triplicate using an auger and also from the undisturbed areas. Soil parameters like pH, organic carbon, Total nitrogen, phosphorus, potassium and Total heterotrophic bacterial count were assessed as per standard methodologies.

From the analysis, a total of 76 species were identified in which 29 tree species, 14 shrubs, 12 herbs, 11 climbers including 5 endemic and 5 invasive species. During the present study, a total of 24 quadrats were laid down in the Ponthenpuzha reserve forest to determine the phytosociological characteristics of the study area. The quadrats were laid down in both disturbed and undisturbed areas of the forest. From the results, abundance, density, frequency, relative density, percentage frequency and Shannon-Weaver diversity index were also found out. Both density and abundance was higher for *C. hirta* followed by *Piper nigrum* (5.042), *Psychotria flava* (3.75), *Xanthophyllum arnottianum* (3.33), *Helicteres isora* (3.083). During the survey, the *C. hirta* plants were collected from different locations of the study area and the major physiognomic characters were recorded. From the analysis it was noted that the *C. hirta* plants has an average height of 102.66 ± 75.77 cm and the girth of 5.24 ± 1.06 cm. Each plant has an average number of 80 leaves with an average width of 6.88cm. During the study period, most of the fruits are un-ripened, which ranged from 4 to 30 numbers in each plant. The mean dry biomass of the area was 192.81 ± 121.42 g/m². The results of soil texture analysis showed that the disturbed area has silty loam soil whereas the undisturbed areas are sandy clay loam in nature. The pH of the study area is acidic in nature and there was no significant variation between disturbed and undisturbed areas. There was slight variation in organic carbon content of the soil was noted and the undisturbed sites have comparatively higher organic carbon content than the disturbed areas. The results of the total heterotrophic bacterial count showed significant variation from the soil



collected from the root zone of *C. hirta* of both disturbed infested and undisturbed uninhabited area. The population density of the microbes in the disturbed areas are 49×10^5 cfu/g, 78×10^5 cfu/g, 280×10^5 cfu/g, 130×10^5 cfu/g and for undisturbed uninhabited areas it is 445×10^5 cfu/g, 940×10^5 cfu/g. The population density is very high in undisturbed area compared to that of the *C. hirta* infested area. The correlation analysis and regression analysis of the soil parameters and the density of *C. hirta* showed that there is significant negative correlation (-0.81, $p < 0.05$) between *C. hirta* density and THB count. More scientific studies are essential for the management of *C. hirta* in the forests of Kerala. The eco-restoration of the forests by increasing the species diversity through planting of native plants in the open spaces and other disturbed areas will reduce the further establishment of invasive plants.

Key words : *Clidemia hirta*, biodiversity, invasive, soil quality, disturbances

L - 06

Association of a Mangrove Dwelling Euptycitime Oribatid Mite, *Rhysotritia ardua* (C.L. Koch, 1841) (Acari: Oribatei) with the Epiphytic Alga, *Microspora* Sp.

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Oribatid mites exhibit multiple roles in almost all types of soils, especially in the forest soils and litter accumulated regions. Their role in litter decomposition and enrichment of soil fertility, bioindication, biological control of parasites and pathogens, forensic science etc., has been well established in various countries. However, in India, these mites represent a less explored entity and records on their association with mangrove ecosystem are practically meager. In order to bridge up this lacunae, the present study was undertaken to gather knowledge on faunal diversity and functional impact of these mites in a mangrove ecosystem of North Kerala. Sampling of the mangrove plants / twigs / pneumatophores etc. was carried out from a constantly flooded mangrove ecosystem located at the Vallikkunnu – Kadalundi community reserve, Calicut, Kerala, where the dominant vegetation was comprised of *Avicennia marina*, *Rhizophora apiculata* and *Acanthus ilicifolius*. Samples were collected mainly from the bark of flooded trunks, twigs, pneumatophores etc. of mangrove plants by adopting various extraction methods. Live mites were collected from the twigs / bark through direct examination under a stereozoom microscope. The collected mites were reared in culture cells, based with plaster of Paris-charcoal mixture (4 :1 ratio) on their respective food item collected from natural ecosystem, *Microspora* sp. Appropriate moistening of the culture base was done with the saline water of $pH \approx 7.9$, collected from the natural habitat. Results of field sampling revealed the constant association of the oribatid mite, *R. ardua* with the filamentous green alga, *Microspora* sp. growing on the bark of *A. marina*. The species was found voraciously feeding on both fresh and decayed part of filaments of the alga and exhibited tunneling activity. Intensive feeding resulted in the deposition of large number of green and brown coloured faecal on the bark. The various life stages of this mite viz. the egg, larva, 3 nymphal stages and their quiescent phases could be recorded from the algal cushion grown on the twigs / bark of *A. marina* and tunneling activity could be recorded. The tunnels



produced inside the twigs by the feeding activity of the life stages of these mites were found packed with heaps of fecal pellets, formed of finely shredded woody elements. The mites were found highly adapted to resist the challenging floods by the possession of elongate, toothed claws and monodactylous condition, which would ensure firm grip on the substrate during regular tidal flooding. These mites thus would enhance the degradation process in the mangrove ecosystem. Through their active migratory movements, these mites would also help in the propagation of algal disseminules in the ecosystem by carrying them on their body setae and in faecal pellets. Further studies along these lines are in progress.

Key words: *Rhysotritia ardua, Microspora sp, mangrove, Avicennia marina, biodegradation.*

L - 07

Edible Biodiversity of Kurumba Tribes in the Buffer Zone of Silent Valley National Park, Kerala

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Forests have a large and indespensible role in protecting and improving food security of the country. Edible wild plants are important in the day-to-day life of forest dwellers and indigenous communities. There are more than 35 indigenous communities living in the forested regions of the Western Ghats of Kerala. Most of these communities are repositories of rich knowledge on various uses of plant genetic resources. Varieties of wild yams, roots, green leaves, flowers, fruits, nuts and seeds are either cultivated or gathered from wild and consumed by the communities living inside as well as on the fringes of forest tracts. Silent Valley is known for its conservation movement and rich biodiversity with many rare, endemic, threatened and important species. The forests in Silent Valley belong to the typical tropical evergreen rain forest category and are generally undisturbed, maintaining an ecological balance and equilibrium, thereby providing an ideal habitat to rare and important native species. The study was conducted in the buffer zone of silent Valley National Park (Bhavani Forest Range) which occupies an area of 94 km² and is the home of five Kurumba settlements viz; Thodukki, Mele Anavai, Thazhe Anavai, Thadikkundu and Palappada. There are about 170 families living in these five settlements and they practice a mix of shifting cultivation, hunting and gathering and work as wage labourers in nearby plantations and agricultural farms.

As a forest dwelling community, living closer to the Silent Valley National Park, the Kurumbas have rich knowledge about the multiple uses of wild plants and animals. They also cultivate various traditional coarse grains, pulses and vegetables through traditional farming practices. The edible biodiversity of Kurumbas in the buffer zone of Silent Valley National Park include more than 80 species of plant forms and 17 species of animals. Of the cultivated species six belong to cereals, two to pulses, four to root/tuber, eleven to vegetables and three to spices. Banana is the only fruit Kurumbas cultivate. Diversity of the species gathered or hunted for consumption is quite high. Of

these, majority is of plant origin and 17 are of animal origin. Of the 53 species of plant origin 15 are fruits, and twelve belongs to root and tuber.

However, it is observed that there has been a gradual decline in edible biodiversity of Kurumbas due to changing practices in cultivation and gathering and more dependence on wage labour and market economy. Further there is a loss of species/ varieties of traditional grain like millets and amaranth and shift in the diet from coarse grain to fine grain. The traditional methods of harvesting wild biodiversity by the Kurumba community does minimal harm to the natural diversity and richness. Moreover, their knowledge on harvesting, processing and various uses of these edible biodiversity can contribute to future food security and sustainability of mankind. Integration of these indigenous people with mainstream, market-oriented societies, growth of national and international markets, imposition of educational and religious systems through various developmental processes lead to the homogenization of world cultures, which lead to loss of traditional knowledge on edible biodiversity at local level. It is thus essential to document the knowledge on edible biodiversity and formulate conservation strategies before these indigenous beliefs, values, and customs are altered or rendered.

L - 08

Habitat Preference of Asian Elephant, *Elephas maximus* Outside the Protected Areas in the Fragmented Landscape of Munnar, Southern Western Ghats - A Geospatial Approach

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The anthropogenic impacts have fragmented once contiguous resource rich forest stretch of Southern Western Ghats into three forest complexes, Anamalai (5127 km²), Periyar (3678 km²) and Agasthyamala (2112km²). The Anamalai - Periyar and Periyar-Agasthyamalai landscape are the two intervening human – transferred landscapes which have witnessed extensive habitat loss and fragmentation over time. Fragmentation and conversion due to human activities has affected the extent and spatial configuration of habitats available for wide-ranging mammals such as Asian Elephants in human-dominated landscapes of southern Western Ghats. Understanding how elephants use such landscapes can reduce conflict incidence and foster human-elephant coexistence. In the present study, efforts have been made to develop geospatial model for the habitat preference of elephants outside the protected areas in the highly fragmented human dominated Anamalai - Periyar landscape of Southern Western Ghats.

The major vegetation type has been stratified into six habitat types. To assess the habitat usage of elephants, the elephant dung densities in these habitats were estimated by line transect method and elephant forage raster has been prepared by giving appropriate weightages computed from percentage of elephant dung density based on Analytical Hierarchy Process (AHP). Euclidean distance raster of





water bodies and streams has been computed in order to get the minimum distance of elephants to permanent source of water. The same principle has also been used to generate protected area preference raster. The Euclidean distance raster of water and protected areas were added with the forage preference raster. The impedance raster, a function of anthropogenic and topographical disturbance to elephant movement is generated from the landscape elements such as road, settlements and slope. The settlement impedance raster has been generated using the IDW (Inverse Distance Weighted) Interpolation technique for the given weightages. The weightages were assigned proportional to the increasing order of disturbances based on Analytical Hierarchy Process. Road Impedance Raster was generated by converting feature to raster. The major topographical barrier, slope was grouped in to two such as: terrain with more than 30° slope, which is difficult for animal movement and below 30° slope which is suitable for elephant movement. A Final impedance raster is generated by adding all the impedances. The preference raster is mathematically integrated to the impedance raster in order to generate cost surface which is a function of elephant preference and disturbance to elephant movement.

A spatial summary of the impedance layer with the land use and land cover classes show that eucalyptus, pine and wattle plantations have the maximum area under low impedances followed by grassland, open scrub, shola and tea plantation. The analysis of the elephant dung pile density shows that land cover which had high impedance to elephant movement is settlements and reservoirs. The managed ecosystems like agricultural areas and orchards showed moderate impedances to elephant movements. The elephant movement preference raster generated showed high preference around the protected areas and in the grasslands and fuel wood plantations. The spatial summary of the elephant preference with respect to the land use and land cover classes indicated the following order of priority the shola forests has maximum area followed by managed ecosystem (coffee plantation, raggy field and other agriculture area), grassland/open scrub, cardamom plantations, tea plantations and fuel wood plantations. The remnant shola forest, grasslands and eucalyptus plantations in the Munnar landscape acts as stepping stone and provide temporary shelter for elephants to move over the hindrance of settlements, roads and cash crop plantations. The vegetation type in particular the grasslands, open scrubs, eucalyptus plantations, permanent water source and the proximity to protected Mathikettanshola National Park make Anayirangal area as one of the highly preferred area for elephant habitat. But the settlements and upcoming resorts at Chinnakanal and the newly assigned tribal colonies at Anayirangal area, a major tract of elephant corridor make hindrance to elephant movement and leading high conflict with adjacent people inhabited here. Rehabilitation of some of these tribal families falling along the elephant corridor to other areas and preventing the conversion of natural habitats such as shola forests to cardamom plantations will help to retain forage, cover, and passage routes of elephants and may reduce human-elephant conflicts in the highly fragmented Munnar landscape.

Key Words: Cost surface raster, Geo-spatial modelling, Habitat usage, Human - Elephant conflict.



L - 09

Landscape Dynamics of Uttara Kannada District

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The land use, land cover (LULC) changes of a region and its interactions with climate, ecosystem processes, biogeochemical cycles, biodiversity provides insights to assess global changes. Remote sensing data with integration of Geographical Information System (GIS) provides spatially consistent data sets with high spatio temporal details which help in detecting and monitoring the drivers for change at various scales. The present study analyses spatio temporal changes in land use pattern of Uttara Kannada district from 1973 to 2010 and also accounts drivers for the rate of change in forest landscape. The monoculture forest management activities, adoption of a market economy crops diversified agricultural activities, such as growing cash crops, fruits and aquaculture. Spatial dependency of land use changes and variations of land development are witnessed in the region by loss of evergreen forest from 87.29% (1973) to 35.42% (2010) and increase in agriculture activities from 2.51% (1973) to 15.96% (2010). The landscape metrics analysis was considered to analyse changes and emphasise the better planning of the region. The outcome of metric analysis shows increase in number of patches (NP), decrease in class area (CA) of forest cover. Computing and defining land use land cover changes are crucial for assessing the effect of land management policies, essential for monitoring and implementation of effective management of the natural resources for environmental protection.

Key words: Land use, Land cover, Remote sensing, GIS, Vegetation indices, landscape metrics.



Technical Session III

Aquatic Biodiversity



L - 10

Diversity and Distribution of Aquatic Insects in Aghanashini River of Central Western Ghats, India

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Freshwater insects play important role in ecosystem functioning, nutrient cycles including primary production, decomposition and translocation of materials. The present study mainly deals with the diversity and distribution of aquatic insects sampled from nine stations in the Aghanashini River of South-west India. The aquatic insects were quantitatively sampled using a 1 m wide, 500 μm kick-net and random surveyed in different habitats of each station. Diversity at the genera level varies from station to station. *Ephemeroptera* (Mayflies) and *Trichoptera* (Caddisflies) appear to be more diverse taxon, indicative of good water quality. Different functional feeding groups of aquatic insects such as shredders, scrapers, collector-gatherers and predators are important links in nutrient recycling in streams. Among the functional feeding groups collector-gatherers were predominant followed by scrapers, predators and shredders. Presence of pollution sensitive genera like *Petersulla*, *Isonychia*, *Isca*, *Clypeoecaenis*, *Helicopsyche* etc. further stresses the conservation importance of few remaining natural riverine ecosystems such as that of Aghanashini. However, the occurrence of organic pollution tolerant genera like *Choroterpes*, *Baetis*, *Chironomus*, *Simulium* etc. in some of the downstream stations nearer to human settlements is a disconcerting factor. More work is needed to assign the genera *Isonychia* and *Platybaetis* from some of the hill streams of Western Ghats, including from Aghanashini, to species levels, which probably might be altogether new ones for India. Developing the practice of routine biomonitoring of hill streams and rivers using aquatic insect indicators will facilitate their better conservation.

Keywords: Aquatic insects, diversity, mayflies, bio-indicator and functional feeding group



L - 11

Seasonal Wetland Flora of the Laterite Plateaus of Coastal Uttara Kannada

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<http://ces.iisc.ernet.in/energy>

Low altitude (<100 m) flat topped laterite hills and plateaus abutting part of Central Western Ghats, in the coastal district of Uttara Kannada in Karnataka, are often considered a harsh, infertile and barren terrain covered with mostly scrub or isolated stunted clumps of bushes and hardy, dwarfish trees. All the while ignored was the rich seasonal life of rare herbal flora during the June to September period, when these plateaus on account of torrential rains turn into a network of seasonal pools and streams and slimy, algal covered shallow wetlands.

These seasonal wetlands seldom ever studied, where surveyed from floristic and ecological angles during the rainy weather of 2012. The fertility of the substratum is reflected in the predominance among the herbs of the insectivorous *Utricularia* spp. and to lesser extent *Drosera indica* and *D. burmanii*. Partial parasitic scrophulariace herbs like *Ramphicarpa longiflora*, *Striga lutea*, *S. gesneroides*, *Sopubia delphinifolia* etc. also indicate the prevailing nutrient stress situation. The laterite expanses are notable for several endemic herbs such as *Eriocaulon fysonii*, *E. lanceolatum*, *E. cuspidatum*, *Rotala malampuzhensis*, rare grasses like *Danthonidium gammiei* and threatened endemic hydrophyte *Wisneria triandra*, and many more interesting species. Whereas pockets of soils amidst rocks have perennating tuberous herbs like *Ceropegia* spp., *Euphorbia acaulis*, *Curculigo orchoides*, *Theriophorum dalzellii*, *Ophioglossum* spp. Etc. hardy perennial herbs like *Lepidagathis 17rostrate* persist alive on eroded and porous boulders. As these laterite formations adjoining villages and towns have been subjected to encroachments, quarrying, removal of brushwood and trees, overgrazing by cattle and conversions into monoculture of *Acacia auriculiformis*, we put forth proposal for conservation of some of the stretches of these unique formations, on the basis of their special biotic communities, into conservation reserves.

Keywords: Coastal Ecosystems, wetland flora, laterite plateau





L-12

Conservation Strategies for the Hygrophilous Pteridophytes of Central Western Ghats

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Pteridophytes, the most primitive vascular plants which originated in the Silurian Period 438 million years ago constitute a significant part of the vegetation next only to the angiosperms. They occur all over the lands barring snow-covered regions and many associated with water-bodies. *Acrostichum aureum* is a fern found in mangrove swamps of tropics. The Indian Western Ghats with about 320 species of ferns and fern-allies is one of the richest regions in pteridophytes. The pteridophyte richness in the Western Ghats tends to decline from southern to northern latitudes in correlation with progressive reduction in number of rainy months with higher latitudes. Thus the 8-12°N latitude, with 8-10 rainy months, shelters 230 species, the central Western Ghats (12-16°N) with 5-8 rainy months 174 species and northern portion (16-20°N) with 3-4 rainy months having just 64 species. Of the terrestrial ferns the species that tend to taper off towards more north are several epiphytic and lithophytic ones of shaded and damp forests, of cooler and shaded sholas, spray zones of waterfalls, of perennial water courses, swamps etc. Our study in central Western Ghats indicates that if humid microhabitats such as Myristica swamps, dipterocarp dominated relic primary forests, perennial waterfalls, sholas etc., most sought after for hydro-electric projects, expansion of coffee and tea plantations, betelnut gardens etc. are prioritized for conservation, the continuance of even relatively rarer pteridophytes like *Cyathea nilgiriensis*, *Psilotum nudum*, *Lycopodium squarrosum*, *Stenochlaena palustris*, *Lindsea odorata*, *Hymenophyllum polyanthos* and *Asplenium crinicolae* etc. will be reassured.

Key words: Western Ghats, pteridophytes, conservation, relic forests



L - 13

Preliminary Documentation of Aquatic Macrophytes of Kole Wetlands of Malappuram District, Kerala

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The Kole land, one of the rice granaries of Kerala, is a unique wetland ecosystem down south of India. It is a part of Vembanad-Kole, declared as Ramsar site in 2005, spread over Thrissur and Malappuram districts. The Kole wetland is rich in floristic and faunal diversity which is much higher than other freshwater ecosystems. Wetland flora includes representatives of all taxonomic groups including many medicinal plants. Knowledge on major plant communities and their relative importance in the Kole wetland is essential for evaluating ecological status of this ecosystem. Although Kole wetland is highly productive, it faces several anthropogenic pressures which result in loss of species richness, decrease in agriculture production, scarcity of portable water, variation in flooding pattern and depletion of aesthetic value. Reclamation of land and alterations in land use pattern are most serious problems, which can impart deleterious impacts on aquatic flora. In this context a study has been carried out for the preliminary documentation of aquatic macrophytes of Kole wet lands in lower stretches of Malappuram district. The survey was carried out from January 2011 to October 2011. 75 species of vascular plants under 53 genera and 31 families including vascular cryptogams have been identified. The plants were identified with the help of available keys, taxonomic revisions and monographs. In this group *Salvinia molesta* D.Mitch, *Alternanthera philoxeroides* (Mart.)Griseb, *Ludwigia adscendens* (L.)Hara, *Eichhornia crassipes* (C.Mrtius) Solms-Laub are the very frequent species where as *Floscopia scandens* Lour, *Mollugo pentaphylla* (L.)Hara, *Sphaeranthus africanus* L., *Lemna perpusilla* Torrey, *Utricularia reticulata* Sm., *Pistia stratiotes* L., *Aponogeton natans* (L.) Engl&Krause are less in frequency. Saline species include *Maricus javanicus* (Houtt.) Merr&Metcalfe, *Schenoplectus supinus* (L.)Palla, *Paspalum distichum* Linn, *Ipomea pes-caprae* (L.)R.Br., *Clerodendron inerme* Gaertn., *Acanthus ilicifolius* Linn. and *Avicennia officinalis* Linn. The database developed though the present investigation will serve as a preliminary document for the impact assessment of the area and also for the policy decisions for the management and conservation of the aquatic flora of this very important fragile ecosystem.

Key words: Kole wetland, Ramsar site, Macrophytes, Vascular cryptogams, Conservation





L - 14

Comparative Analysis of Morphometric Characters in the population of Golden Mahseer, *Tor putitora* (Hamilton) (Cyprinidae: Pisces) of a Man-made Wetland and a Natural Stream in Himachal Pradesh, India

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The golden mahseer, *Tor putitora* (Hamilton), contributes substantially to the commercial fishery in the Himalayan foothills. It is also a highly prized game fish. In the recent past, the stocks of golden mahseer have declined sharply possibly due to construction of dams on Himalayan rivers, illegal fishing by means of dynamite blasting in uplands and release of toxicants especially at lower elevations. Intensification of fishing during the pre-monsoon period, when water level is low in the rivers, adds to the problem.

The present investigations were undertaken to recognize the morphometric variants of *Tor putitora* in impounded and lotic waters for its breeding and commercial growth. The morphometric relationship between length and weight can be used to assess the vigour of individuals and to determine possible differences between separate stocks of same species. A total of ninety specimens, 30 from each site, were measured from pong reservoir (River Beas) and Seer stream (tributary of River Sutlej) under the Indus drainage system and River Giri under the Ganga drainage system. The samples were taken during pre-monsoon and post- monsoon period. Twenty one characters were measured as the percentage of total length except those of head depth, pre-orbital distance, post-orbital distance, inter-orbital diameter and eye diameter, which were calculated in the percentage of head length. An analysis of morphometric characters shows high degree of coefficients of correlation ($r>0.90$) which are significant at $p<0.01$ in all the variables from natural and reservoir populations.

Keywords: *Tor putitora*, morphometric characters, Himachal Pradesh, genetically control, environmentally control.



L - 15

Floristic Diversity in Wetland Rice Ecosystem of Thiruvananthapuram District

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Background:

To develop a database on the floristic diversity in the wetland rice ecosystem of Thiruvananthapuram district.

Methodology and Principal findings:

The field survey on floristic diversity was carried out in the rice fields of 30 panchayaths in Thiruvananthapuram district having more than 50 hectares of net sown area, covering all the four thalukks of the district viz., Thiruvananthapuram, Chirayinkizhu, Neyyattinkara and Nedumangadu during the first and second crop seasons, in both cultivated and fallow rice fields. The design adopted for conducting the floristic survey was stratified multistage random sampling. The flora were collected by census quadrat method using $0.5 \times 0.5 \text{ m}^2$ quadrat and identified species wise.

The results showed that in the cultivated rice ecosystem there were 46 weed species during the first crop season and 49 species during the second crop season. The flora spectrum of the rice fallows was found to be slightly different. During the first crop season there were 43 species while during the second crop season there were 54 species. The grass species diversity was more or less same in all situations with a slight edge during the second crop season under the fallows. The sedges were more diverse under the fallows. When compared to the other two classes, the broad leaved plants were richer in terms of species diversity except during the first crop season in the fallow situation.

Conclusion/Significance:

The results of the present study revealed substantial floral diversity in the wetland rice ecosystem in Thiruvananthapuram district. It was also evident that the floral diversity differed substantially with season and also agronomic practices followed in the field. The diversity was more during the second crop season whether the field was cultivated or left fallow. From the study it was evident that the flora diversity of the rice ecosystem was influenced greatly by the anthropogenic factors.

Key words: *Floristic diversity, Wetland, Rice ecosystem, Rice fallow, Thiruvananthapuram.*





L - 16

Ecology of Clam Bed - Hydrographic Conditions Influencing the Density and Distribution of Venerid Clam *Paphia malabarica* in Two Lake Systems

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The prevailing aquatic environmental conditions and their impacts on the density and distribution of the estuarine clam, *Paphia malabarica* were investigated in two lake systems in the south west coast of India. Water and benthic sediments were sampled monthly from the two Lake Systems, Ashtamudi Lake and Kayamkulam Lake, from June 2010 to May 2011. The water samples were analysed for hydrographic parameters such as salinity following Mohr- Knudsen argentometric titration method, P^H using portable p^H meter, dissolved oxygen following Winkler's method and temperature using mercury filled Celsius thermometer. The sediment samples (Quadrat) were used for assessing mean density and distribution of the clam. Significant seasonal changes occurred in the environmental conditions during the year. Salinity and water temperature were lowest in the monsoon season in both the clam beds (21.81 ‰, 27.31°C and 20.41 ‰, 27.28°C) of Ashtamudi Lake and Kayamkulam Lake respectively. Increased progressively in the post- monsoon season and reached maximum in the pre- monsoon season (25.28 ‰, 28.60°C and 25.32 ‰, 28.84°C). Dissolved oxygen was maximum in the monsoon season (5.17mg l^{-1} , 4.99mg l^{-1} respectively at Ashtamudi and Kayamkulam Lakes) in both the Lakes. The maximum p^H was recorded in the monsoon season(8.09) in Ashtamudi Lake and in Kayamkulam Lake the maximum p^H was recorded in the pre-monsoon season (7.99).The clam, *Paphia malabarica* was abundant during the pre-monsoon season with mean density of 294.88 no./ m 2 at Ashtamudi Lake and 105.01 number/ m 2 at Kayamkulam Lake. The abundance and density declined progressively during the monsoon season and reached minimum at the end of monsoon season 189.33 number/ m 2 at Ashtamudi Lake and 42.77 number/ m 2 at Kayamkulam Lake. The decrease in salinity gradient during the monsoon season stressed the estuarine clams leading to their heavy mortality. Significantly high species density was observed in high salinity regions in both the estuaries (928.3 number/m 2 and 154.9 number/m 2 respectively at Ashtamudi and Kayamkulam Lakes) than the low salinity regions (45.38 number / m 2 and 69 number / m 2 respectively at Ashtamudi and Kayamkulam Lakes).The hydrographic conditions of the two clam beds showed similar trends except the p^H of water. Bivalves are of remarkable interest with regard to their abundance and growing importance in fisheries. Human exploitation and environmental incompatibility causes destruction of the valuable seed stock. The increase in exploitation rate caused concern for planned development in sustainable fishery. The sustainability of molluscan fishery depends on the management of wet land and the prudent harvesting system practiced there.

Key words: Environmental Conditions, clam bed, density, abundance, *Paphia malabarica*.



L - 17

Phyto Diversity and Conservation of Pulicat Lake-Andhra Pradesh

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Pulicat Lake is the second largest brackish water lagoon after Chilika Lake of Orissa along the east coast of India. Estuaries and lagoons have brackish water which shows high biological productivity than fresh or sea water. Hence it has wide range of aquatic, terrestrial flora and fauna. The World Wide Fund for Nature declared it as a protected area. Present study aims to explore the flora and fauna of the lagoon along with the various threats for its eco-degradation which helps to plan necessary conservation methods.

Salt Marshes are abundantly occupied by halophytic species like *Aleuropous lagopoides*, *Etriplex repens*, *Cressa cretica*, *Crotaleria retusa*, *Cyperus haspan*, *Fimbristylis ferruginea*, *Salicornia brachiata*, *Sesuvium portulacastrum*, etc. *Halophila ovalis* popularly called sea grass belong to the family Hydrocharitaceae appear prominently all along the margins Buckingham canal. It grows above and below the ground level and provide a habitat for fish, shrimp and other aquatic species and also provide forage for waterfowl.

Common shrubs like *Azima tetracantha*, *Cassia auriculata*, *Excoecaria agallocha*, *Gmelina asiatica*, *Jatropha gossypifolia*, *Lawsonia inermis*, *Maytenus emarginatus*, *Pandanus tectorius*, *Salvadora persica*, *Zyziphus mauritiana* etc., grow on the margins of Marshes and along the canals. On the bunds of the canals trees like *Azadirachta indica*, *Borassus flabellifer*, *lepisanthus tetraphylla*, *sapindus emarginatus*, *Syzygium cumini*, *Thespesia populnea* etc., appear here and there. *Prosopis chilensis* is the dominated exotic species invaded in many areas of other islands in the lake due to lack of protection (Scott, 1989). Submerged macrophytes include species of Enteromorpha, Hypnea, Ulva, Halophila and Enhalus (Oswin, 1987).

At two places that is near vapenjeri canal close to Chandrasikuppam, and Chengalpalem small mangrove pockets are located. Four species of mangroves belonging to four families are prominent over here. They include *Aegiceras corniculatus* of Myrsinaceae, *Avicennia marina* of Avicenniaceae, *Excoecaria agallocha* of Euphorbiaceae and *Lumintza racemosa* of Combretaceae. They develop pneumatophores in response to oxygen deficient conditions. They are buffers between the land and the sea. They help in removing pollution, coastal erosion and protection from saline water intrusion and storms.

Common aquatic plant species like *Nymphaea* species, (Rooted floating) *Lemna* species, *Azolla*, *Eichhornia*, *Pistia* (Free floating, *Hydrilla* sp., *Ceratophyllum* sp., *Chara* sp., (submerged) and *Cyperus* sp., *Typha* sp., (Emergent) and *Merremia*, *Lippia*, *Phyla nodiflora*, *Oxalis*, *Hydrocotyl vulgaris* are identified in and around the lake.





Both State and Central Governments have been taken so many measures to protect the biodiversity of the lake. Pulicat Lake Bird Lovers Society (PLBLS) was established in Sullurpet town, Nellore District which mainly focused on the protection of the biodiversity of the lake and also on developing public awareness. Mangrove Pockets have to be developed along the north and north-west margins of Island which helps in soil binding. Exotic species have to be eradicated from Mangrove habitats to prevent the alteration of native habitats. Plants like *Baringtonia acutangula* serve as a nesting tree to meet the nutritional and breeding requirements of the birds have to be grown in large numbers to attract the migratory birds. The most important conservational aspect of Biodiversity of Pulicat lake is to be build up to create awareness in public through communication, cooperation and education.

Key words: *Phytodiversity – Pulicat Lake – Threats – Conservation*

L - 18

Phytoplankton Diversity for Monitoring Freshwater Reservoir of Belgaum District, Karnataka State

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Since many water bodies in the district are facing serious threat from human activities, there is a need to monitor the extent of pollution in these reservoirs and make an report to the governing authority, hence the present investigation was undertaken to biomonitor the health of Gullava reservoir of Belgaum district by studying phytoplankton diversity.

Measuring Physico-chemical parameters gives an idea about status of the lake ecosystem at given time but the impact of the pollutants remains for many days and alter the diversity of microbial community, since algae are primary producers they get affected by change in the environment. Monitoring algal diversity gives an idea about total health of the ecosystem. Hence surface water samples were collected and analysed for the Physico-chemical parameters and Phytoplankton were identified with standard monographs, the quantitative analysis of phytoplankton was done by Lackey's drop count method.

Elevated values of Physico-chemical parameters (Temp., pH, TDS, Alkalinity, Nitrate, Phosphate, DO etc.) supported by phytoplankton of the nutrient rich waters (Chlorococcales) give an idea about the trend of water body in the direction of eutrophication.

Key Words: *Biomonitoring, Phytoplankton Diversity, Physico-Chemical parameters, Eutrophication, Gullava Reservoir.*





L - 19

Preliminary Report on Physico-Chemical Characteristics and Algal Biodiversity of Temple Tanks of Belgaum and Dharwad Districts, Karnataka State

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Aquatic biodiversity is one of the most essential characteristics of the aquatic ecosystem for maintaining its stability and a means of coping with any environmental change. Water quality, habitat structure, flow regime, energy source and biotic interactions are the major environmental factors that determine water resource integrity. To study the influence of uncontrolled anthropogenic activities in the study areas the standard ISO methods were used.

Two temple tanks from Hubli and Savadatti were selected for the study of Physico-chemical characteristics and phytoplankton diversity. Present investigations were carried out from April-August 2012 as preliminary work. The study revealed the high Nitrate and Phosphates coupled with limited anthropogenic activities indicating the healthy aquatic environment of Hubli temple tank, where as uncontrolled activities of humans have completely degraded phytoplankton diversity of Savadatti temple tank. Low DO and High values of Physico-Chemical Parameters, presence of Coli form and MPN tests confirmed the aquatic pollution in Savadatti Temple Tank supported by stumpy diversity of phytoplankton.

It is alarming for us that the waters are becoming eutrophicated and impotable which would be very helpful for policy makers to take precautionary measures to save them.

Key words: *Phytoplankton diversity, Temple tanks, Physico-chemical characteristics, aquatic Pollution, eutrophicated and impotable.*

L - 20

Aquatic plant diversity in ponds of Palakkad District, Kerala

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Introduction



Ponds are the small area where the rain water is stored for the living things. It is a very good resource for human beings where they get water not only for drinking also for agriculture purposes. Ponds are the water or wetland ecosystem which provides the habitat for numerous plants, fishes, snails, etc. If such ecosystem disturbed the depended organisms will extinct from the world due to habitat lose.

Aim

Study the aquatic plant diversity of ponds in Palakkad district.

Materials and Methods

Visited many institutions and offices and collect the relevant information pertaining to the locality of ponds, number and the size of the ponds in Palakkad. Literatures were collected from various libraries regarding aquatic plants.

Work done

Visited 100 ponds in various panchayaths in palakkad district and has collected the plant specimens. Plants were identified with the help of available literature and matched with the herbarium specimens deposited in Madras Herbarium, Botanical Survey of India, Southern Regional Centre, Coimbatore, Tamil Nadu. The identified specimens were mounted on standard herbarium sheet for deposition in Karpagam University Herbarium.

Conclusion

The pond is maintaining very good species diversity and balancing the ecosystem. I have collected plants in both rainy and summer seasons. The plant collection, preservation of fresh plant materials and the literature collection is in progress.

L - 21

Abundance Patterns and Distribution of Annelids in Kundalika Estuary along the Northwest Coast of India

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Over 60% of the world's population lives along estuaries and the coast. Estuarine waters comprise highly variable ecosystems that are exposed to high levels of anthropogenic stress (Dauvin 2007) and suffer degradation by many factors. Benthic community in general and polychaetes in particular are considered as suitable bio-indicators of estuarine pollution (Macfarlane & Booth 2001; Cardoso et al. 2007). There is very little information on the polychaete diversity of estuaries on the north-west coast of India, most of them being highly polluted. The Kundalika estuary (18° 32'40.4" N; 72° 54'22.0" E), on the northwest coast of India, is one such estuary where information on its species diversity is nonexistent. It receives effluents after minimal treatment from the common effluent treatment plant (CETP) in the upper estuary within a weak tidal zone on the southern bank. Due to insufficient flushing, the estuarine waters downstream to the disposal point appear coloured dark green. Apart from the industrial waste, the estuary also receives around 1.4 mld of domestic waste. Near the mouth,



unloading operations of solid cargo (iron ore) are carried out at the Revdanda Port. The estuary is influenced by mixed semidiurnal type of tides with the spring range of 3.8 m in the mouth decreasing to 1.3 m at 35 km inland.

Five stations were selected and were designated as #K1 to #K5 and #K1' to #K5' for premonsoon and postmonsoon respectively for convenience. Sediment samples were collected with a van Veen grab of 0.04 m² area, at each station (4 replicates), and sieved through 500 µm sieve. Polychaetes retained were preserved in 5% formalin- Rose bengal solution which were later sorted and calculated for their density (ind. m⁻²). Taxonomic identifications were done up to species level wherever possible. Samples were collected for analyses of organic carbon (C_{org}) and sediment texture. At each station bottom water samples were collected for analyzing suspended solids, salinity, DO, dissolved PO₄³⁻-P, NO₃⁻-N and NH₄⁺-N. and were analyzed using standard methods (Grasshoff 1999). C_{org} by titration method (Walkey and Black 1934) and sediment texture by pipette method (Buchanan 1984). Data analyses using the statistical software, PRIMER v6 (Clark and Gorley 2006). Thirty-three polychaete species were reported in the premonsoon (26 species; 13 families) and postmonsoon (20 species; 11 families) samples. Maximum (13 species) were recorded at #K4 and minimum (3 species) at #K5 and #K5'. Species richness (Margalef's index, *d*) ranged from 0.3 at #K5 to 2.1 at #K4 to 0.2 at #K5'. Likewise evenness index (*J*) and Shannon Wiener diversity index (*H'*) were highest (*J*=0.9; *H'*=2.1) at #K3 and lowest (*J*=0.12; *H'*=0.13) at #K5' (Table: 1).

Table 1 Diversity values of premonsoon (K1-K5) and postmonsoon (K1'-K5') stations of Kundalika estuary

Station	Number of species (<i>S</i>)	Total number (no.)	Margalef richness (<i>d</i>)	Pielou's evenness index (<i>J'</i>)	Shannon diversity index (<i>H'</i>)
K 1	5	81	0.9	0.8	1.3
K 2	62	94	0.9	0.7	1.2
K 3	10	125	1.9	0.9	2.1
K 4	13	307	2.1	0.8	2.1
K 5	3	844	0.3	0.7	0.7
K1'	9	663	1.2	0.5	1.2
K2'	10	412	1.5	0.9	1.9
K3'	6	256	0.9	0.7	1.2
K4'	6	487	0.8	0.4	0.7
K5'	3	13375	0.2	0.1	0.1

The current results indicated that the water quality of the estuary varied widely and indicated considerable degradation of upper segment of the estuary due to poor flushing. However the lower estuary and coastal waters revealed normal water quality. Shannon-Wiener index of the polychaete fauna of the Kundalika estuary which ranged 0.13 to 2.1 was relatively less than that reported for other estuaries from India (Harkanta and Rodrigues 2004; Rao et al. 2009). Species diversity is considered to be a useful measure of environmental status and areas with *H'* values <0.1 in estuarine waters denoted heavy pollution while values between 1.0 and 3.0 indicated moderate pollution (Wilhm and Dorris 1966). By this yardstick, the upstream regions of Kundalika appear to be heavily

polluted while the downstream zone seems to be moderately polluted. The higher ammonia values ($>29.6 \mu\text{mol l}^{-1}$) in the upstream waters were due to discharge from the outfall of the effluent treatment plant of the industrial complex. #K5 was in a fresh water dominated low saline (<2‰) zone with low DO ($<4 \text{ ml l}^{-1}$) and high water temperature (23-35° C) and therefore, the impact of ammonia toxicity would be higher on the polychaete species.

The study indicates adverse environmental conditions for biota occurring at the upstream station due to the effluent outfall and a more balanced ecology in the downstream zone and adjacent coastal waters. A proposal to shift the existing discharge point to the lower estuary is on the anvil. Hence, the current work provides new baseline information on the ecological status of the Kundalika estuary based on hydro-sedimentological characters and resident polychaete taxa which would help environmental managers in planning and implementation of estuarine ecology restoration policy and also provide comparative data for measurement of ecological revival.

Keywords: *Polychaete. Estuary. Oligochaete. Northwest coast. India*

L - 22

Influence of Climate Variability on Productivity of Rice

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Since ages the weather has played an important part in the production of crops and influence food security system worldwide. With industrialisation and consequent increase in population, the pattern of weather & its effect on crop productivity is seeing a change. Weather in Punjab having assured irrigation is no longer a limiting factor in affecting yields but the overall implication of declining ground water situation in some blocks of Punjab is a serious concern. . In this study an attempt has been made to see the impact of climate variability on productivity of rice with respect to temperature and rainfall. Will the modern society be able to grow crops in increased temperature conditions? The question we are trying to address is how long can we sustain these practices of intensive agriculture. The precious land can sustain the burden of fertilizers, insecticides & pesticides to a limit. In this work we are trying to determine the role of climate variables on agriculture. Through our findings we will dissect the principle components responsible for the productivity of rice.

Key words: *Temperature, Rainfall, Yield, Correlation, Regression.*

L - 23

Diversity of Monocotyledonous Plants of the Water Bodies of Bangalore and Adjacent Areas

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Information regarding the diversity, distribution and availability of aquatic Monocotyledonous plants of water bodies of Bangalore city and adjacent areas is almost lacking. The present study was meant to fill the existing lacunae by preparing a list of aquatic monocotyledonous plants cited in the literature and comparison with the data gathered during the course of our survey. Seasonal studies have been conducted from May-June 2005 and December – January 2010 as part of our research work. The study deals with the distribution of Monocotyledons in and around 76 lakes of Bangalore and adjacent areas. The present survey revealed a drastic drop in the number of aquatic monocotyledons when compared with the data available from literature. Unless effective remedial measures are taken on a war-footing, the monocotyledonous plants of the water-bodies of Bangalore and adjacent areas face a bleak future!

Keywords: Bangalore lakes, Aquatic, Monocotyledonous plants, literature survey, diversity

L - 24

Seasonal Variation and Biodiversity of Phytoplankton in Parambikulam Reservoir, Western Ghats, Kerala

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Lakes, Rivers and Reservoirs are most important water resources with multiple human utilization and ecological relevance. Parambikulam Dam is an embankment dam on the Parambikulam River flowing through Western Ghats and located in the Palghat district of Western Ghats of Kerala with a reservoir area of 21.22 km² and 69,165×1000 cu.mt. capacity. The present study focuses on the seasonal variation, hydrobiology and biodiversity of phytoplankton of the Parambikulam reservoir during 2009-11. A total of 89 taxa of phytoplankton were recorded during the study. They belong to five different classes, viz Chlorophyceae, Desmidiaceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. Bacillariophyceae was the dominant group with 42 taxa followed by Desmidiaceae with 26 taxa. Members of Euglenophyceae were not recorded during monsoon seasons. The dominant genera were Pinnularia and Navicula and from Bacillariophyceae and Closterium and Cosmarium from Desmidiaceae. Shannon diversity index and Margalefs Species richness was found to be highest during post monsoon season ($H' = 6.09$; $d = 11.41$) and lowest during monsoon seasons ($H' = 3.8$; $d = 3.4$), while average taxonomic distinctness was similar during post monsoon ($\Delta+ = 69$) and pre monsoon ($\Delta+ = 69$) and lowest during monsoon ($\Delta+ = 65$). Variation in taxonomic distinctness was highest during post monsoon ($\Delta+ = 417$) and lowest during pre monsoon ($\Delta+ = 347$). Fluctuations of the hydrological variables such as pH, DO, nitrate, phosphate, silicate, calcium and chloride were also



presented. The result provides a primary documentation of the microalgae of the Parambikulam dam. Result also provides basic understanding of the trophic status of the reservoir.

Keywords: *Phytoplankton, Western Ghats, Hydrobiology, Biodiversity, Parambikulam Dam.*

L - 25

Phytoplankton Population of Wetlands Adjacent to Sea Food Processing Industries in Vembanad Lake Ecosystem

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A study was carried out to assess the impact of waste water discharge on phytoplankton population in the Vembanad-kol wetland adjacent to seafood processing industries. The phytoplankton samples were collected using plankton net for a period of six months (April 2011-September 2011) from ten pre selected sites (S1 – S 10). Nine of the selected sites were closely associates with the discharges mouth of seafood processing plants and one kept as the reference site which is free from the seafood plant discharge. The plankton samples were collected from the surface water, preserved at the collection sites in 4% formalin and were identified using standard keys. A total of 110 species of phytoplankton belonging to eight classes were identified. Among these 53 species belongs to Bacillariophyceae, 35 species to Chlorophyceae, 16 species to Cyanophyceae, 2 species to Rhodophyceae and one species each in Chrysophyceae, Haptophyceae, Eustigmatophyceae and Dictyophyceae. The plankton samples were also used to calculate Shannon Weiner index and Palmer index. Application of Palmer's Algal pollution index for rating water samples showed that all the sites (S1-S9) were polluted except the reference site (S10). *Nitzschia*, *Navicula*, *Scenedesmus*, *Lyngbya* were the dominant species reported during the study period.

Keywords: *Pollution, water quality, phytoplankton, Shannon Weiner index, Palmer index*



Technical Session IV

Waste Management

L - 26

Assessment of Impact of the Vermicompost Generated from Allelopathic Weed *Lantana camara* on Seed Germination and Seedling Growth

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We had earlier succeeded in generating vermicompost from the dreaded invasive lantana (*Lantana camara*) without any cowdung supplementation by following the high-rate vermireactor concept earlier developed by us. As lantana is known to exhibit allelopathic effect we have examined the possibility of plant toxicity of lantana vermicompost by assessing its impact on germination and early growth of a common food species.

Pots containing soil were amended with vermicompost to the extent of 5, 7.5 and 10 tonnes/hectare. Randomly picked 72 seeds were sown in each treatment run in duplicate. Seeds were considered germinated when they exhibited radical extension of >3 mm. Counts of germinated seeds were made daily up to eight days to determine the germination rate. Seedling growth parameters were recorded after one week with randomly collected samples.

Lantana vermicompost was seen to promote, rather than hinder, the germination and seedling growth. There was increasing trend of seed germination with increasing concentration of vermicompost. A maximum of 97 percent germination was recorded in pots treated with 10 t/ha of lantana vermicompost. Maximum seedling growth in terms of stem diameter, shoot length, root length, number of leaves and shoot fresh weight was also recorded in the same treatment. In contrast minimum growth was recorded in control. The findings of this study indicate that lantana vermicompost does not have adverse effect on the species studied. This opens up the possibility that vermicomposting might have transformed those chemicals in lantana, which are responsible for its allelopathic effect, into harmless ones.

Key words: Vermicompost, cluster bean, *Lantana camara*, allelopathic weed, seed germination



**L - 27**

Environmental Implications of Mismanagement of Municipal Solid Waste

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Solid waste disposal has become one of the major environmental threats of Indian cities, as large fraction of waste goes for open dumping in and around the city. Bangalore everyday generates around 3000-4000 t of waste. The total USW (Urban Solid Waste) generated in Bangalore and their per capita generation rate has increased in last three decades with increase in population and with change and development of lifestyle. City has quasi centralized collection facility with partial segregation of waste at house level. City waste management are in transition to change from centralized to decentralized waste management with increase of environmental awareness and unscientific waste disposal in centralized waste management. This paper presents a case study conducted in Bangalore to see how mismanagement of waste has caused environmental implications. Currently there are nine waste treatment and disposal sites are permitted from government, but 270 large open dump sites are present in outside the core city area and in the periphery of the city. These open dumps include plastics, organics, construction wastes, fresh indeterminate, old waste and rejects from recycling units. Waste quantity is determined based on visual estimation of area and average density of waste. A large part of it appears to be from the recycling units' rejects. A total of about 83557 t wastes is scattered around Bangalore city. This type of leakages and spillages in existing waste management leads to environmental problems such as GHG (Green House Gas) emission and blockages of drainage channels, which are discussed in the current study.

Key words: Environmental implications, Waste, Bangalore.



L - 28

Feasibility Studies of Selected Plants in the Treatment of Water Contaminants

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The greatest public health concern about water is directed to its ever increasing number of contaminants. Public distribution systems, even though accessible only to a limited population, mainly make use of chemicals in the treatment processes. Such water treatment systems overlay burden on the developing nation's financial resources. Moreover, reports state that such chemicals can cause severe health hazards. These points out the need for low-cost, replicable non-chemicals, which would be effective in the treatment of water contaminants.

In the present study, treatment potentialities of vegetative parts of certain hydrophytic / mesophytic plants like *Lagenandra toxicaria* Dalz, *Aloe barbedensis* Mill., *Canna indica*. L and *Bacopa monnieri* (L.) Wetst, on pH, Turbidity, Hardness, Iron and microbial count of contaminated water has been worked out. Batch treatment has been followed and the performance evaluation of plants under varying concentration of plant materials and retention time has been worked out. pH and turbidity of water samples were monitored instrumentally, whereas hardness and iron content were assessed using EDTA titrimetric method and thiocyanate method respectively. Total coliforms and E.coli were estimated using pour plate method of NIO (1998).

On an overall assessment, it has been noticed that the plants under experimentation showed differential responses to contaminants. *Lagenandra toxicaria* was noted to be effective in reducing turbidity at all concentrations of the plant material especially at higher retention time. The material was also noted to be effective in the removal of Iron and Total coliform content. Similarly *Aloe barbedensis* was found to be effective in the treatment of Turbidity. The decrease in turbidity was significant with increasing concentration and retention time. It was also noted to be effective in the treatment of Iron Total coliforms at initial stages. *Canna indica* was noted to be least effective in the treatment of selected water contaminants other than total coliforms and E. coli. *Bacopa monnieri* was effective in the treatment of Iron content, Total coliforms and E. coli content.

Key words: Batch treatment, *Lagenandra toxicaria*, *E.coli*





L - 29

Role of Phytoremediation Technique in Industrial Wastewater Treatment Using Constructed Wetland

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One of the main causes of industrial pollution is the discharge of heavy metals in nearby water bodies which causes serious health effects on humans and aquatic life. A low cost treatment technique is proposed in this study to treat this type of effluent by means of constructed wetland. The constructed wetland is an artificial set-up, consisting of a basin or channel with a barrier to prevent seepage, the bed contains the suitable depth of porous media. The filtration and phytoremediation mechanism play an important role in this type of arrangement.

A preliminary study was done on a pilot-scale constructed wetland planted with *Phragmites spp.* using electroplating wastewater. Since the concentration of heavy metal is too high, the industrial effluent is treated along with the domestic wastewater. In this study the electroplating wastewater and sewage water is mixed in 1:2 ratio and then it is used for irrigation in the pilot scale constructed wetland. It was found that there is a remarkable decrease in the concentration of heavy metals on an average of 98 % in 6 days treatment process in cell one and with a combined effect the concentration decreased to 99.5% .

As the concentration of Cr is very high, it causes toxicity to the plant and has influenced treatment efficiency of the setup, *Cicer arentinum* seed coat is used as an adsorbent of Cr with 91.64 mg/g adsorbing capacity. By the application of this adsorbent it is found that Cr concentration is reduced to 99.85 % in 2 days and is completely below the discharge limits when effluent is treated in wetland cell 2.

It was found that hybrid constructed wetland, vegetated with *Phragmites spp* is working very efficiently in removal of heavy metals in Indian climatic conditions.

Key words: Constructed wetland, Filtration, Phytoremediation, Electroplating wastewater, *Phragmites spp.*





L-30

E-Waste: An Ever-Growing Global Threat against Sustainable Development

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Electronics waste is becoming a crisis for the sustainable development of society. Electronic wastes, popularly known as e-waste, do not decompose or rot away. It is the discarded electrical or electronic devices. E-waste consists of waste from computer monitors, CDs, motherboards, cables, toner cartridges, television, light, bulbs, tube-lights and other electronic equipments. According to the United Nations Environmental study, around twenty to fifty million tons of E-waste is generated worldwide each year. Many people burn E-waste in open air along with garbage, releasing large amounts of mercury and lead into the atmosphere. The disposal of e-waste is a particular problem faced in many regions across the globe. Environment and human health is affected by E-waste. E-waste is of concern mainly due to the toxicity and carcinogenicity of some of the substances if processed improperly. To deal with the ever-growing issue of this new type waste various solutions and efforts are underway globally.

There is an urgent need to popularize scientific E-waste management practices all over the world. Education about this emerging issue among the growing younger generation will be a better solution for solving the threats created by E-waste towards our environment as well as public health. Through our education system we can do a lot to solve the problems created by E-waste in the society. In the present study the investigators made an attempt to study the need and significance of e-waste management initiative among the secondary level students. The objective of the study was to find out the need and significance of E-waste management initiative among the secondary level students. For the present study the investigators used survey method to study the need and significance of E-Waste management initiative among the secondary school students. Keeping in view the nature of the study, a sample of 240 secondary school students were selected for the study. Questionnaire on E-Waste Management Practices was used for collecting the necessary data from secondary school students. The collected data were analyzed by computing percentage analysis.

The findings of the study revealed that majority of the secondary level students were not aware about the seriousness of problems created by E-waste. The major suggestions offered by the investigators towards tackling the problem of E-Waste based on the study are the following. Government should take necessary steps to organize awareness campaign about E-waste disposal through education and various media. Teachers are social engineers. So teachers should be given proper training in E-Waste management practices through orientation programmes, refresher courses and in-service programmes. Every school authorities should take initiative to campaign about the scientific ways of E-Waste management among the students. Through this, the problems created by improper management of E-



Waste can be solved to a great extent. Problems of E-waste are increasing day by day. Considering the seriousness of the problems of E-Waste, educational policy makers and curriculum planners should take necessary steps to incorporate the various aspects related to E-Waste in the school curriculum. Government should campaign among the public about the scientific management of E-Waste through various media. E-Waste should never be disposed with garbage and other house hold waste. This should be segregated at the site and sold or recycled usefully.

Key Words: E-Waste, E-Waste Management Initiative

L - 31

Survival of *Eudrilus Eugeniae* in Oil Contaminated Soil

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Petroleum hydrocarbon continues to be used as the principal source of energy and hence forms an important environmental pollutant. Human activities in the production, transportation and storage of petroleum hydrocarbon releases large amount of contaminants inadvertently or deliberately into the environment. Accidental spillage of petroleum products causes serious damage to environment.

The main objective of the present study is to find out the survival and change in biomass earthworm *Eudrilus eugeniae* in oil contaminated soil with addition of different types of amendments. Avoidance test was conducted to determine the survival rate of *E. eugeniae* in oil contaminated soil collected from service station premises. Here the contaminated soil was precomposted for 15 days by mixing it with different additives such as cow dung in (6:1) ratio, cow dung in (6:1) ratio along with vermicompost tea, contaminated soil with inorganic fertilizer.

Avoidance test was conducted in round acrylic containers with five different chambers connected to a central chamber. The test chambers were filled with precomposted soil in different combinations namely contaminated soil with cow dung, contaminated soil with vermicompost tea, contaminated soil with fertilizer and contaminated soil only. After 48 hours all *Eudrilus eugeniae* worms were present in the chamber having contaminated soil and cow dung (CS+ CD). The other substrates were found to be avoided by the earthworms.

In the second phase the earthworms, *E. eugeniae* were introduced in the precomposted soil. Survival rate, mortality and change in zoe mass determined. High mortality rate, reduction in young ones production and change in biomass of earthworms were higher in those reactors with precomposted petroleum contaminated soil than garden soil. Maximum mortality of worms was observed with reactors run with CS - precomposted without any supplement of CD or VT. Studies with *E. eugeniae* indicates that earthworm preferred contaminated soil when it was mixed with some additives.

Key Words: *Eudrilus eugeniae*, contaminated soil, earthworms



L - 32

Sustainable Algal Scum Management and Wastewater Treatment in Bangalore

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Bangalore has been experiencing unplanned rapid urbanisation during the last two decades evident from natural resources utilisation and waste (solid and liquid) management. The wastewater generated in the city is either partially treated or untreated enters storm water drains and ultimately reaching cascading human-made water bodies (lakes). The wastewater with nutrients has been enriching the water systems and resulting in the contamination of water affecting local people's health. In the south-eastern part of Bangalore, two large lakes, the Bellandur and Varthur receive approximately ~40 % [500 MLD] of the sewage generated in Bangalore. A strategic analysis of the causative phenomena suggests that the water bodies firstly undergo an initial anaerobic stage of wastewater decomposition where the N is largely ammoniacal and higher P in the form of condensed phosphates. A nutrient balance assessment of the two lakes suggests that microalgae are the key agents that convert and capture organic N and P found in the wastewater. A mass balance estimated for the system suggests that a large part of the nitrogen is generally in ammoniacal forms that facilitate micro-algal absorption leaving little chance for nitrification. A substantial part of the N appears to be lost due to volatilization and to some extent denitrification. The lake accounts for about 60% N capture and recovery into reusable intermediates and is therefore a candidate for evolving methods for near-100% N recovery by algal systems. The SEM-EDXA studies showed higher phosphate accumulation in case the algae as a result of luxury P uptake. With a growth rates such algae tend to accumulate lipid in their cells. Experiments conducted in the lab have also showed the potentials of these algae in heterotropically removing organic C (90%). An investigation on C allocation pattern in biomass with all variability's in environment would pave essential path for C abatement and GHG emission from the anoxic regions. The study indicates that these water bodies do treat water, when lakes are not invaded with invasive water weeds. This study brings out the strategies to recover a large part of the C, N & P in urban wastewaters through algal systems at lower costs and higher energy efficiencies. Furthermore, it is possible to capture the nutrients as well as C in algal biofuel to achieve triple benefits-namely i) water purification ii). nutrients capture and iii). algal biofuel. This study shows that given the water spread area and the levels of nutrients released in Bangalore sewage, it is possible to devise a 7,000 tonnes per day (tpd) algal biofuel system to meet the growing need of liquid fuel.

Keywords: *micro algae, lakes, wastewater, treatment, nutrients, Bangalore*



L - 33

Phytoremediation of Leachate from Municipal Dump Yard in a Constructed Wetland Planted with *Colocasia Esculenta*

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Landfill leachate is wastewater drained out from sanitary landfills treating a variety of municipal and industrial solid wastes. Constructed wetlands are attractive alternatives for complex waste water treatment. In this present study, 3 constructed wetlands (CWs) were fabricated using plastic crates with 60cm X 45cm X 48.5cm (LxWxD) dimensions. Rock chips of charnakeite gravels were used as sole bed. The diluted leachate was allowed to flow through CWs filled with gravel bed in which the plants are grown, with the help of a peristaltic pump. The experiment was conducted in a subsurface flow mode in which, the flow of leachate was maintained below the surface of gravel bed. For each CWs 25 number of plants, *Colocasia esculenta* were planted in the CWs and allowed to grow remain till the end of the experiment. The plant samples were analysed for their dry weight, chlorophyll and other nutrient content at the starting and at the ending of each experiment. In the beginning of the experiment, 50 litres of the raw leachate was diluted to get the required COD of 400 – 700 mg/l. Thus in the present study 50 litres of diluted leachate was used for each CWs (30 litres in CWs and 20 litres in Reservoir Container (RC).

The study shows that *Colocasia esculenta* is a suitable bioagent in the subsurface constructed wetlands (SSF CW) for treating landfill leachate and this plant survived well in the CWs for a period of 20 days. The plant has tolerated 690 mg/l of COD and exhibited better growth in terms of biomass increase. This plant shows higher removal potential, as far as COD, Nitrogen and Phosphorus removals are concerned. The growth parameters such as biomass increase, chlorophyll content also indicate *Colocasia esculenta* as a better bioagent. Nutrient uptake by the plant used in this study has been recorded with an increase in the nutrient content of the plant tissues during the experimental period. Thus the plants do play a significant role in nutrient removal apart from microbial activity.

Keywords: Phytoremediation, *Colocasia esculenta*, Leachate, Constructed Wetland



Technical Session V

Avian Biodiversity

L - 34

Abundance, Distribution and Conservation of Wetland Birds in the Kole Lands of Kerala

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Wetland birds are excellent indicators of wetland function or as measures of success in wetland management, restoration and creation. This study on the ecology and conservation of wetland birds was carried out in the Kole lands of Thrissur, Kerala. The Kole wetlands lie between 10° 20' and 10° 40' N latitudes and between 75° 58' and 76° 11' E longitudes, with an extent of 13,632 ha spread over Thrissur and Malappuram Districts, Kerala State. The objectives of the study were to document the status and distribution of avian fauna in the Kole wetlands and to assess the threats to the Kole wetland birds. Community parameters of birds were studied based on direct observation. The waterbird population fluctuations were analysed in relation to rainfall and land use dynamics. Conservation awareness of local people was assessed through structured questionnaire survey by directly interviewing the respondents in the study area.

A total of 182 taxa of birds were recorded, these belong to 50 Families under 16 Orders. Of these, 100 were resident, 81 migrants and one straggler. Among the migrants, 49 species were trans-continental migrants and 32 local migrants

One vulnerable and five near threatened species were recorded, namely Spot-billed Pelican (*Pelecanus philippensis*), Darter (*Anhinga melanogaster*), Painted Stork (*Mycteria leucocephala*), Oriental White Ibis (*Threskiornis melanocephalus*), Ferruginous Pochard (*Aythya nyroca*), and Pallid Harrier (*Circus macrourus*)

Species richness of birds varied in different months and the highest recorded number of species was 97 during December 1999 and the lowest was 15 during June 1999. The species richness increased during the migratory season and decreased during the southwest monsoon. Total number of birds varied from 35 to 8,033 individuals in a month.

Out of the 82 wetland bird species observed, Whiskered Tern (23 per cent) was highest in dominance followed by Little Egret (13 per cent) and Little Cormorant (11 per cent). Important conservation problems identified from the area were habitat alteration, poaching, fire and fishing. Conservation problems and solutions to mitigate them were also discussed. The Kole wetlands showed high species richness and abundance of birds, and are comparable to other wetlands and protected areas in Kerala. The Kole wetlands are an ideal habitat for migratory and resident birds, especially for the winter visitors

The study indicated a strong positive correlation between the wader abundance and the benthic fauna.

The appearances of mud flats attracted large number of waders during the migratory season.

As the Kole wetlands come under the 'Central Asian - Indian flyway' and one of the Ramsar Sites in India, protection of migratory bird species is of the highest priority.

Key words: *Conservation, Distribution, Kerala, Kole wetlands, Wetland birds*

L - 35

Avifauna Across a Dying Water Body: From the Perspective of Bird's Diversity to Assess the Habitat of the Haihole Tank in Shettihalli Wildlife Sanctuary

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The Present study area, Haihole tank is situated in the Shettihalli Wildlife Sanctuary. It was constructed in the year 1977 for the purpose of irrigation. Dam length is about 668 meters with a gross storing capacity of $5100 \text{ } 10^3 \text{M}^3$. More than 50% of the water body is surrounded by human presence. With many threats like fishing, cattle grazing, partying and many more, the need to study the diversity of birds came into picture along with the entire sanctuary. Another reason for the study is because of insufficient data. The wetland is also facing problems of mud being extensively taken from the bed for the brick manufacturing by the local people.

An ecological survey of the backwaters and its surroundings was conducted from December 2011 to March 2012. Avifauna in and around the waterhole were documented by random walk and opportunistic observations in the early hours of the day and also in the evenings using equipments like Binoculars and Telephoto Zoom lens camera. Line transects were laid to quantify the abundance of the birds. The Birds of the Indian subcontinent from Grimmett *et al* was used for identification and classification.

A total of 96 species of both terrestrial and water birds belonging to 43 families were identified from the study area. Among them, 5 species were earmarked by 'The IUCN red list of threatened species' as Near Threatened which includes River Tern, Black-headed Ibis, Oriental Darter, Grey-headed Fish Eagle and Malabar Pied Hornbill. Meanwhile there were 25 species of water birds and 12 species of





water dependent birds. Among the 13 families of water birds Ardeidae family is more abundant both in species diversity and number of individuals. Red-wattled Lapwing and Indian Pond Heron were the most abundant among the water birds. The water body is prone to many anthropogenic activities which are making the bird diversity to decline considerably. Proper steps should be taken to control the activities mentioned above to give a healthy diversity in the Haihole back water. The wetland should not only be seen from the irrigation point of view but also from the ecosystem interest.

Keywords : *Haihole Tank, Back waters, Avifaunal Diversity, Water Birds, Anthropogenic threats*

L - 36

Santragachhi Jheel: A Migratory Birds Paradise Restored

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Santragachhi Jheel is one of the most prominent migratory bird habitat of West Bengal. As it is situated within 10 kilometer from the heart of Kolkata, it draws sincere attention from all the bird lovers across India. As this is a stagnant water body with no connections with any dynamic flow of water, water hyacinth creates a lot of trouble for this. Annually water birds start visiting the lake from late September and they stayed their till April first week. So maintaining the jheel during this time frame is not possible. With such limitations and resource shortage, the lake remained unclean till 15th October 2011. The entire lake of 32 acres were filled up with water hyacinth, without an inch gap. The media highlighted the panic stricken situation in a very prominent way. Then with introduction of heavy machineries, labours and other measures, it was cleared by mid November, and to our relief more than seven thousand birds of 45 species visited and stayed in the lake during the entire migratory season. Among this the Red Crested Poachard visited for the first time in the lake and two pairs of vibrant Baikal Teel joined the flock of other birds after seven years. As the cleaning was done with proper planning and with introduction of mechanical devices, this year the whole operation became much easier and the lake is already cleaned and cleared enough to host the migratory birds in time. An effort initiated by us and supported by the bird lovers and common people helped to save one of the most famous bird habitat of West Bengal. This effort also shows how peoples' participation and intervention of media can play positive role in conservation activities.

Keywords: *Santragachhil, Birds; Hyacinth; Machineries; Media, People*



Technical Session VI

Pollution - I



L - 37

Environmental Status of the Kavvayi Wetland System

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Kavvayi is the largest back water system of northern Kerala, lies in Kannur and Kasaragod Districts of Kerala State. Geographically it is located between the coordinates: $75^{\circ} 06' 48''$ to $75^{\circ} 15' 40''$ E longitudes and $11^{\circ} 59' 52''$ to $12^{\circ} 14' 36''$ N latitudes. Kavvayi Wetland System fed by five major rivers and several small canals originates from Eastern Ghats of Kerala and lateritic hills of midlands, covering an area of about 1312 sq km. The major rivers draining to the Kavvayi Wetland are Kariyankode, Nileswaram, Kavvayi, Perumba and Ramapuram. Most significant values of the wetland include flood control, rich biodiversity, fishery, mussels culturing, pollution control, inland navigation and back water tourism.

This paper reports the environmental status of the Kavvayi Wetland System. Water, sediment and biological monitoring of the wetland were carried out through standard procedures. A total of 42 water samples were collected from the Kavvayi Wetland System, in which 14 water samples were collected from the Kavvayi Lake and remaining 28 samples were collected from the 5 adjoining rivers. The physico chemical and biological characteristic of the wetland is directly influenced by the rivers draining into the wetland system. The various ionic concentration of the river reported comparatively high value in the downstream than upstream which is due to saline water intrusion. The average salinity value of Kavvayi back water is 26.8ppt, 0.2ppt, 28.3ppt during pre monsoon, monsoon and post monsoon seasons respectively. The quality of surface water is interpreted through the Canadian Council of Ministers of the Environment Water quality Index. The value of Canadian Council of Ministers of the Environment water quality Index of most of the sampling stations of the Kavvayi Lake was found to be less than 45, indicated poor water quality in the Lake. The organo chlorine pesticides such as aldrin and endosulfan were detected in selected sediment samples collected from the Kavvayi Wetland. Maximum detected concentration of endosulfan in sediment samples collected from Kavvayi Lake is $28.73\mu\text{g}/\text{kg}$. Heavy metal analysis of sediment samples indicated the presence of iron, manganese, copper, lead, cadmium, nickel and zinc in the surface sediments. As per United State Environmental Protection Agency sediment quality guideline, Ayittikadavu is a heavily polluted site with lead, nickel and copper. Mixing point of Kavvayi River to lake (KV-2) is heavily polluted with nickel (94.25 mg/kg) and lead (104.25 mg/kg). The concentration of lead in sediment samples varies from 17.0 mg/kg - 111.5 mg/kg. All the sediment samples except two stations (KV-9 and KVE-1) were found to be heavily contaminated with lead. The degree of contamination (Cd) of three stations, KV-2(mixing point of Kavvayi river and Lake), KV-6 (Ayittikadav), and KV-11(Mixing Point of Nileswar River and Kavvayi Lake) was 22.02, 20.58 and 17.02 respectively which indicate considerable degree of contamination. Sampling stations KV-1, KV-13, KVVP-1 were found to be moderately contaminated. All other stations showed low degree of contamination.



Kavvayi wetland supports large varieties of plants and animal species. The presence of sacred groves gives unique ecological characteristics in the wetland system. Biodiversity study was conducted through the direct identification method and quadrat method. A total number of 93 varieties of various plants including two species of *Nervilia* that are endemic to Malabar region are present in the Sacred Grove of Edayilakkad Island. The Wetland System supports abundant residential/migratory avian fauna which include an endangered species *Haliaeetus leucogaster* (White Bellied Eagle) *Labeo dussumieri* (Malabar Labeo), *Labeo fimbriatus* (Fringed lipped carp), *Etroplus maculatus* (Spotted etroplus), *Coregonus autumnalis* which are included in the IUCN Red Data Book are also found in the Kavvayi Wetland. Densely populated mangrove vegetations are seen in the Kavvayi Wetland System, the various mangrove species include: *Avicennia marina*, *Avicennia officinalis*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera cylindrica*, *Bruguiera conjugata*, *Sonneratia caseolaris*, *Excoecaria agallocha*, *Acanthus illicifolius*, *Kandelia candel*. The need for conserving the wetland as a nationally important wetland is highlighted in this work.

Key words: Kavvayi Wetland, Water Quality Index, Organochlorine Pesticide, Degree of Contamination, Biodiversity

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Atmospheric Pollution and its Correlation with Transportation Sector in South Kerala

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Atmospheric pollutants are present largely in the troposphere (0-11km) and lower stratosphere (11-50km). The air pollutants are added in the atmosphere from variety of sources that change the composition of atmosphere and affect the biotic and abiotic environment. In this context, the ambient air quality monitoring at Southern districts of Kerala such as Thiruvananthapuram, Kollam, Alappuzha, Kottayam, Ernakulam, Pathanamthitta, Thrissur, Palakkad and Idukki is carried out as per Central Pollution Control Board (CPCB) guidelines of IS 5182 Part 14; 2000. The primary pollutants included for monitoring are suspended particulate matter (SPM), respirable suspended particulate matter (PM₁₀), oxides of nitrogen (NO₂), oxides of sulphur (SO₂) and carbon monoxide (CO). The influencing factors of dispersion of air pollutants such as temperature, relative humidity, wind speed and direction are also measured. Traffic volume survey is conducted as per Indian Road Congress (IRC) to assess the vehicle population. The vehicular emission factors of Automotive Research Association of India (ARAI) are adopted for estimation of vehicular emission. It is observed that even though the average value of concentration of air pollutants is within the threshold limits of CPCB, higher levels are observed on certain days with increase in vehicle population. Implementing stricter emission levels on new vehicles, tighter fuel standards, use of alternative fuels such as bio-fuel, CNG and LPG, increasing green cover, implementing behavioral policies adopting transportation planning techniques and design are some of the measures which will reduce the concentration of air pollutants into the atmosphere.





Keywords: Atmosphere, air pollutants, air quality

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Pesticide Contamination and Bacterial Pesticide Resistance in the Soils of Selected Panchayats of Wayanad District, Kerala

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Plants on which we depend for food are under attack from insects, fungi, bacteria, viruses, rodents and other animals, and must compete with weeds for nutrients. To destroy unwanted populations living in or on their crops, farmers use pesticides. The first widespread insecticide use began at the end of World War II and included DDT (dichlorodiphenyltrichloroethane) and gammexene. Insects soon became resistant to DDT and as the chemical did not decompose readily, it persisted in the environment. Since it was soluble in fat rather than water, it also biomagnified up the food chain. The most important pesticides are DDT, BHC, chlorinated hydrocarbons, organophosphates, aldrin, malathion, dieldrin, furdan, etc. The remnants of such pesticides used on pests may get adsorbed by the soil particles, which then contaminate crops grown in that soil. The consumption of such crops causes the pesticides remnants to enter human biological systems, affecting them adversely. Pesticides not only bring toxic effect on human and animals but also decrease the fertility of the soil. Some of the pesticides are quite stable and their bio-degradation may take weeks and even months. In recent years, the influence of pesticides on microbial activities in soils has been studied by many investigators. Therefore in the present work we analysed the concentration of pesticides in the soils of Kottathara and Padinjarathara Panchayats of Wayanad District, Kerala to assess the contamination due to indiscriminate use of pesticides. We also isolated bacteria from the soil and evaluated the endosulfan resistance of the isolates. An additional aim of this study was to evaluate the socio-economic impacts of pesticide application.

Soil samples were collected at a depth of 15 to 20 cm from the soil surface of the selected study area. For each of the sampling sites, sub-samples of soil were collected from different locations, pooled together and homogenized so as to obtain representative sample. For pesticide analysis, the soil samples were extracted and analyzed using Gas chromatographic techniques (Shimadzu) coupled to an Electron capture detector. Isolation and enumeration of bacteria were carried by standard serial dilution plate technique. Resistance of the bacterial isolates to varying concentrations of endosulfan was determined by agar dilution method. Questionnaire method was used for socio-economic impact survey.

In the present study a total of 28 pesticide compounds in the soil samples were analysed and the results revealed that there was no pesticide residues in the soils of selected study area; it may be due to the high runoff and microbial degradation. As per the survey conducted the pesticide application is very high in the study area and the level of awareness among the farmers was very poor



regarding the method of application and its socio-economic and ecological impacts. A total of 9 bacterial strains were isolated with 50 μ g/ml of endosulfan in isolating media from the soils of banana plantations of the study area. The results showed that most of the bacterial strains were greatly resistance to endosulfan. Out of the 9 strains isolated 6 were highly resistant to endosulfan (500 - 700 μ g/ml) and the other 3 isolates showed the resistance of 250 - 500 μ g/ml. Pesticide resistant bacteria is widely distributed in the soils of selected study area and the tolerance varied between bacteria even though they were isolated from the soils of the same area.

Key words: *Pesticide, soil, bacterial resistance, endosulfan, socio-economic impacts,*

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Mercury Pollution in the Lakes, Rivers and Estuaries of India

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Mercury is a global pollutant that knows no borders and it cycles between air, water, soil, sediments and organisms. Once released into the environment it is highly persistent, undergoes a long range transport and chemical transformations as well. The pollution associated with mercury becomes more problematic when the conversion of inorganic form to organic form occurs. India is identified as one of the biggest consumers of mercury and is a hotspot of mercury pollution. India imports over 250 metric tons (mt) of mercury annually and releases more than 220 mt into the environment from known sources. Coal combustion and chloralkali plants are the major culprits in this regard. The contribution of India in the global mercury assessment report is much less and this inturn indicates that the published data on mercury pollution studies in India is very less. During the last decade more studies were carried out in India and are mainly focused on the total mercury content in various matrices of lakes, estuaries and river ecosystems. The mercury content in the water ranged from 0.058-0.0268mg/L, against 0.001mg/L as per WHO and Indian standards. The THg concentration shown by the fish samples collected from various aquatic systems in India is varied from 0 to 2.85 μ g/g where as in sediments it is ranged 0.001-43 μ g/g. The maximum THg concentration in water and sediment of vembanadu lake was found to be 130 ng/L and 12.2 μ g/g. Most of the Mercury methylation studies were carried out at temperate environments and studies were meager at tropics. This shows that the importance of studying the speciation and chemical transformation of mercury in our country. The atmospheric chemistry of mercury has not gathered attention in India even though we are second largest emitter of mercury in the world. Hence science behind the chemical transformation and transport of mercury in the humid tropics has to be investigated in detail for the better understanding of the risk to humans and other biota.

Keywords: *Pollution, Mercury, Vembanadu lake*



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Studies on the Effect of Crude Plant Extracts on the Control of Mosquito Vectors

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In epidemiological terms, vectors are organisms that transmit infections from one host to another. Nearly half of the world's population is infected by vector-borne diseases every year, resulting in high morbidity and mortality. Among diverse types of vectors, mosquitoes are the most troublesome one and is estimated that worldwide over one million people die annually due to the diseases caused by this haematophagous vector.

Mosquito menace in rural and urban India has reached alarming proportions in recent times. Uninhibited and unplanned rural / urban development has compounded the problem. Unmanaged canals, sewage systems, tanks, drains, septic tanks, irrigation canals, wells, overhead tanks, damp and marshy places etc. have resulted in the establishment of mosquito diversities.

Vector control envisages various physical, chemical and biological means of controlling vector populations. Even chemical control measures are facing setbacks as these vectors are gaining resistance. Moreover, such chemicals have given rise to serious environmental issues. This has led to the search for bio pesticides, which are having several advantages over conventional chemical pesticides / insecticides.

In light of the above, present study has been outlined to assess the feasibility of using phyto chemicals in the control of mosquito vectors belonging to various taxonomic groups. Thirty six species of plants were screened for this purpose. Aqueous extracts of selected plants were prepared and tested against mosquito larvae collected from breeding sites and reared from eggs under laboratory conditions. Mortality percentages and LC_{50} were calculated. Of 36 plants studied, 15 plants were found to be 100% effective in the control of mosquito larvae at varying concentrations and retention times.

Keywords: *Mosquito, phytochemicals*



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Geochemistry and Heavy Metals in the Soils of Kuttanad Agricultural Ecosystem, Kerala

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Paddy fields are considered as the largest anthropogenic wetlands. It is essential to carry out a study about the trace metals in such wetland as there is a significant chance of occurrence of trace metals through the application of agrochemicals. The present study focused on the paddy soils of Kuttanad, where the quantitative measurement of trace metals such as Zn, Cd, Pb, and Cu was carried out. In addition certain geochemical parameters like pH, conductivity, texture, organic carbon, total nitrogen, total phosphorus and their relation with the metals were also obtained. 42 samples were collected, air dried and ground to several granulometric fractions. The geochemical parameters and trace metals were analysed by adopting standard methods. Statistical analysis were carried out by using the software SPSS version 11. The result showed that Kayal Land soils were highly acidic while organic carbon was high in Vaikom Kari soils. The concentration of Fe, Total N and Total P were high in Kayal lands. The textural analysis showed that the soils of Kuttanad mostly come under the groups of sandy clay loam, sandy loam and loamy sand. Soils of Upper Kuttanad paddy fields has high mean Zn content where as minimum at North Kuttanad. Cd was detected only in the soils of Vaikom Kari and North Kuttanad. The comparative Pb content of the soils from six agro ecological systems of Kuttanad showed that high mean content of Pb was found in Lower Kuttanad soils and the least observed for Vaikom Kari. Kayal lands showed maximum copper content followed by Upper Kuttanad, Vaikom kari, North Kuttanad and Purakkad Kari. The copper was absent in the soils of Lower Kuttanad. The physicochemical parameters and heavy metals of entire Kuttanad soils undergone Pearson's correlation analysis. Among the heavy metals Cd was positively correlated with Cu and Fe. The correlations of Fe with Cu seem to be related to the formation of secondary iron oxides that have the capacity to strongly adsorb this heavy metal. The result also showed that the negative association of Cd with Pb. All the metals were positively correlated with pH and OC except Zn that showed negative correlation with OC. Among the metals only Zn was under highly polluted class of sediment quality guidlines. As per the standard sediment quality guidlines Kuttanad soil is non-polluted in terms of Cd and Pb where as Cu was under moderately polluted class. All the metals were under Threshold Effect Level concentration except Cu, which was in between Threshold Effect Level and Threshold Effect Concentration.

Keywords: Kuttanadu, Heavy metals, soil, physicochemical parameters





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Removal of Selected Heavy Metal Ions Using Metal Tolerant Bacterial Isolates

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Heavy metals include cadmium, lead, copper, chromium, nickel etc. are extremely toxic to biological and ecological systems. Furthermore, the metals cannot be degraded to harmless products and hence persist in the environment indefinitely. As a result, several methods have been devised for the treatment and removal of heavy metals. Conventional physico-chemical methods for heavy metal removal are being economically expensive and have disadvantages. Biological approach has the great potential that contributes for the achievement of this goal and is economical. Microbial populations in metal polluted environments adapt to toxic concentrations of heavy metals and become metal resistant. The response of microorganisms towards toxic heavy metals is of importance in view of the metal removal studies. So, in the present work, an attempt was made to study the heavy metal bioaccumulation potential of selected bacterial strains from Eloor-Edayar industrial belt of Kerala. In order to define the effect of pH on the bioaccumulation of heavy metal by bacterial strains the batch equilibrium studies at different pH values were carried out. The average abundance order of heavy metal contents in soil, water and sediments samples were Zn>Cu>Pb>Cd. Metal resistance studies of the bacterial isolates (165 isolates) revealed that about 45% of the isolates showed very high tolerance (>6000 μ g/ml) to lead. Tolerance to Cd and Zn were relatively low (<500 μ g/ml) among most of the isolates. Resistance to Ni and Cr were in between 1000 μ g/ml - 1500 μ g/ml. Heavy metal removal studies carried out with zinc, cadmium and lead. For heavy metal removal study we selected 3 isolates based on their high resistance to particular heavy metals. The bacterial isolates selected for removal studies are TCC 52 (*Bacillus sp.*) for lead, TCC 51 (*Bacillus sp.*) for zinc and TCC 50 (*Pseudomonas sp.*) for cadmium. Bioaccumulation studies showed that with increase in time, the biomass of the selected bacterial isolate increased. Correspondingly, with increase in biomass, the heavy metal bioaccumulation also increased. Maximum zinc bioaccumulation (50%) was recorded at pH 9 followed by pH 5 (40%) and pH 7 (25%). Around 50% of the lead in the experimental flasks was reduced by *Bacillus sp* while in control flask only 5% metal reduction occurs. Somewhat lead removal showed higher reduction in pH 5, about 10% increased reduction occurs in pH 5. In cadmium removal studies, about 40% of the cadmium in the experimental flask was reduced till the end of the experiment (74hours). Comparatively cadmium removal showed higher reduction in pH 7. The obtained results showed that the selected strains are good bioaccumulation medium for metal ions and had high adsorption yields for the treatment of wastewater containing lead, cadmium and zinc ions.



Technical Session VII

Climate Change and

Coastal Wetlands



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Mangrove Associated Molluscs of India

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Phylum Mollusca, the second largest of invertebrates, comprises of soft bodied animals. They inhabit very diverse habitats like marine, estuarine, freshwater, terrestrial and arboreal. They play important role in the function and productivity of coastal mangrove swamps. The mangrove molluscs are mainly gastropods and bivalves. The molluscs that live on surface of substratum and mangrove plants belong to a category called epifauna and another category that lives buried in the sediments belong to infauna. Epifauna inhabits the stems, canopy, roots, logs, stumps, leaf litter, water pool, muddy substratum, and rocky surfaces associated with mangrove swamps. The members of infauna (usually the bivalves) burrow up to 10 cm down from the surface. In India about 200 species of molluscs were reported from mangrove areas of east and west coasts. In fact the true mangrove molluscs are few most others being opportunists. The attempt here has been to provide comprehensive check list of molluscs found in the Indian mangrove areas, compiled from various sources. This has been found to be an important necessity for coastal biodiversity studies in India. In Uttara Kannada District of Karnataka State, where field studies were carried out during 2010-12 period, using both quadrat and opportunistic methods, about 12 genera of gastropods and four genera of bivalves were found by us. Our investigations mainly covered the mangrove areas of the estuaries of the west flowing rivers from the Western Ghats namely Aghanashini, Gangavali, Kali, and Sharavathi.

Key words: *Mangrove molluscs, India, Karnataka, Western Ghats.*



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Carbon Emissions due to Electricity Consumption in the Residential Sector

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Concentration of greenhouse gases (GHG) in the atmosphere has increased rapidly due to anthropogenic activities resulting in significant increase in the temperature of the earth causing global warming. Among the GHG's, carbon dioxide is the most dominant gas causing global warming which accounts for nearly 77% of global total CO₂ equivalent GHG emissions (IPCC 2007c). Carbon dioxide concentration in the atmosphere has been rising alarmingly in the post industrial revolution era and the current level is about 379 ppm (ppm = parts per million) compared to 280 ppm earlier (pre industrialisation). Concentration of greenhouse gases (GHG's) in the atmosphere has increased rapidly due to anthropogenic activities resulting in significant increase in the temperature of the earth. The energy radiated from the sun is absorbed by these gases making the lower part of the atmosphere warmer. The sources of greenhouse gases (GHG) come from various sectors including transportation, industrial processes, power generation for residential consumption, agriculture and deforestation. Sector wise analysis of annual GHG emission shows that electricity generation (21.3%), industrial processes (16.8%) and transportation fuel (14%) are the major sectors contributing primarily to GHG. In this backdrop, it is necessary to know the energy consumption structure to reduce carbon dioxide emission through shift in energy sources or end use efficiency improvements. Survey was conducted to know the energy consumption structure, also community and neighborhood of households of Bangalore. A total of 1967 households were surveyed from different wards of Bangalore. Survey data includes data about environment satisfaction, residential status, Building type, kind of facilities near the home and energy consumption behavior of households. Analysis was done according to ward wise and also for overall data. Analysis shows that more than 50% satisfied with overall environment, residential status of 70% household is local urban resident. 80% household uses LPG for cooking and 11% use both LPG and electricity. For water heating 40% uses electrical heater and only 24.76% uses solar water heater which is one of the source of reducing energy consumption and only 30% have installed solar appliances in home. Greater Quantification of emissions from domestic sector of Bangalore contribute about 4273.81 (9.65% of total emissions) Gg.

Keywords: *Global warming, carbon dioxide, energy consumption behavior, Household*





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Carbon Footprint of Municipal Solid Waste in Greater Bangalore

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Carbon footprint refers to the quantity of carbon emitted from anthropogenic sources. Municipal solid waste plays a significant role in carbon footprint of urban society. Municipal solid waste mainly consists of degradable materials and non degradable materials. The increasing municipal solid waste generation along with the high fraction of organic waste and its unscientific disposal is leading to emission of methane in the atmosphere. A questionnaire survey was conducted during August-December 2011 which has covered 1967 households in Bangalore city. The survey considered various parameters such as process of collection of waste, time, frequency number of persons involved in waste collection, bin size, distance of bin from house, bin clearance time, transportation of waste landfill site, distance of transportation of waste was investigated and analyzed. The outcome revealed that average household waste generated is in the range of 87.9 gm/per/day to 156.0 gm/per day. Survey reveals that organic fraction constitute about 80% of the waste generated in each zone. This suggests of strong recovery potential and conversion to energy or compost. This paper provides the information on both quantity and composition of residential waste is important to enhance the sustainable solid waste management and planning of household waste treatment and infrastructure.

Keywords: *Global warming; Solid waste; Methane; Greater Bangalore.*



Technical Session VIII

Green Technology



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Household Sanitation Device for Decentralized Sewage Treatment

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Decentralized sewage treatment is more and more considered to be a sustainable way of wastewater treatment, both in developing and developed countries as it creates possibilities to reuse treated wastewater.

Conventional septic tank essentially serves to condition the sewage and the effluent by no means safe and the ultimate disposal requires careful consideration. A Decentralized system developed by NIIST-CSIR aims to fill this gap. It has been developed in the context of environmental sanitation problems especially in areas with shallow water table, where the monsoons often sink septic tanks creating ground water pollution and associated health problems. This system is very much suitable in islands especially with sandy soils. This system provides complete sewage treatment at the household level. This system has the following special features –Modular design, seepage-proof, suitable for factory mass production, no moving parts, no power requirement & integrated odour treatment system using biofilter.

The final shape of the HSD was based on the finite element analysis. The analysis helped to arrive at the ideal thickness for a sturdy product capable of withstanding water and soil pressure as well as compactable for easy installation. The Process design was carried out using a anaerobic digestion simulation model. Structural, hydraulic and general aspects are considered to arrive at the sizing of various components

The HSD was fabricated in FRP and installed in a NIISU quarter for testing purpose. The system was continuously monitored for pH, Volatile fatty acid (VFA), alkalinity, Chemical oxygen demand (COD), Biological oxygen demand (BOD), Total suspended solids (TSS), Total dissolved solids (TDS) and nutrient content. The average result of pH, VFA, alkalinity, COD, BOD, TSS, TDS and total nitrogen are 6.2, 1.681 meq/l, 3.9 mg/l, 134 mg/l, 61 mg/l, 53 mg/l, 104 mg/l respectively. The treated discharge more or less meets the inland surface water standards.

Keywords: Decentralized, House hold Sanitation Device, biofilter

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Use of Raman microspectroscopy to detect changes in lipid pools of microalgae

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Raman spectropscoy was used to study the changes in lipid pools adapted by algae subjected to salinity dependent nutrient stress. The changes in the lipid in the algal cells cultured in varying salt concentrations were followed over a course of seven days. The Raman results showed prominent change in lipid pools. Raman spectroscopy demonstrates the potential to be an important technique in monitoring change in lipid pools due to salinity stress.

Keywords: Raman microspectroscopy, lipid, algae, salinity

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Nutrient removal of Secondary Treated Water through Algal ponds

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Freshwaters are becoming increasingly scarce. At the same time the existing freshwater resources are deteriorating both in terms of quality and quantity. The quality of such freshwater systems as ponds and lakes depends upon interaction of various biotic and abiotic componenets where the physico-chemical environment plays a major role. In ponds systems the nutrients decide the productivity where algae act as indicators of the nutrient status of water. The present study focuses on treatment of secondary treated water by algal pond systems and transitions in physico-chemical parameters. In the study water and algal samples were collected weekly from the wastewater treatment plant and the algal pond at IISc, Bangalore for two seasons. Inorganic parameters as major ions, dissolved metals





and organic parameters like biochemical oxygen demands were measured following standard protocols. The samples were also checked for temperature, pH, dissolved oxygen, electrical conductivity on site. During the initial phases of the study *Microcystis auregonosa* sp. were abundant indicating N limiting conditions. However, after the biomanipulation of introducing the duckweed sp., significant transitions in nutrient regime were observed. This led to the dominance of *Chlorococcum* sp. due to higher organic matter because of higher detrital C as a result of duckweed steeling and decay. Further changes in the inflow parameters aided in the prolific growth of chlorophycean members. This reveals the changes in the algal communities with the changes in the environmental parameters and nutrient regime. This study emphasizes the role of algal communities as indicators as well as agents of nutrient remediation that can be sustainably used for secondary wastewater treatment economically.

Keywords: Lake, physico-chemical parameters, freshwater algae, nutrients, wastewater

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Effect of Salinity Concentrations on Growth Rate and Lipid Concentration in *Microcystis* Sp., *Chlorococcum* Sp. and *Chaetoceros* Sp.

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Biofuels from microalgae is a viable alternative for replacing the global demand for petro-diesel. The two important desirable characteristics considered in a species to be used for biodiesel production are high biomass and lipid production. It is noted that the increase in salinity can increase the lipid content of microalgae, but lowers the growth rate of a species. Therefore, the effect of salinity on the growth and lipid content of microalgal species have to be investigated. Salt stress is a major abiotic environmental factor that limits plant growth and productivity. The salinity stress and unfavorable light conditions are the main limiting factors of plant productivity both in aquatic and terrestrial, natural and anthropically modified environments. Microalgae differ in their adaptability to salinity and other stress conditions. The ability of cells to survive and flourish in saline environment under the influence of osmotic stress has received considerable attention. Under favorable and unlimited growth conditions microalgae produce primarily polar lipids (e.g. glycolipids and phospholipids), which enrich chloroplast and cellular membranes. However, under unfavorable growth conditions microalgae accumulate neutral lipids in lipid droplets located in the cytoplasm. The study focuses on the effect of salinity concentrations on the cell growth and lipid content of three microalgae viz., *Chlorococcum* sp., *Microcystis* sp. (fresh water algae) and *Chaetoceros* sp. (marine alga), isolated and cultured in appropriate medium for a period of 7 days. The halotolerance of all the three algae were



determined by growing them in three different salinity concentrations. All the three microalgae were able to tolerate the salinity levels and showed different growth patterns and lipid accumulation rates. The cell growth of all the three algae did not show a definite pattern. The total lipid content was found to be higher on the 5th day of culture experiment in case of *Chaetoceros* sp (8.06 mg/ml at 35 ppt) and *Microcystis* sp. (8.4 mg/ml at 0.2 ppt) whereas, it was higher on 6th day for *Chlorococcum* sp (6.6 mg/l at 0.2 ppt). The increase in lipid content at higher NaCl concentration may be due to adaptation under stress conditions, which help in accumulation of lipid content in cells.

Keywords: Microalgae, NaCl, Lipid, Chlorococcum, Microcystis, Chaetoceros.

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Performance of *Salvinia* (*Salvinia molesta*, Mitchell) As a Bioagent for Very Rapid Treatment of Septic Tank Effluents in the Shefrol® Bioreactor

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SHEFROL® (SHEet Flow ROot level) bioreactor is a novel biotechnological system developed by Abbasi and co-workers (*Official Journal of the Patent Office*, 20 7611, 2012) at the Center for Pollution Control and Environmental Engineering. The distinguishing attributes of this system are its low installation, operation and maintenance costs, high efficiency, and negligible ecological footprint. SHEFROL® is capable of using a wide variety of vascular plants – terrestrial, amphibious, and aquatic – depending on the type of wastewater to be treated.

In the present paper the performance of the aquatic macrophyte *salvinia* (*Salvinia molesta*, Mitchell) has been assessed as a bioagent in a pilot-scale SHEFROL® bioreactor plant, treating 30,000 litres of septic tank effluent per day, at an HRT (hydraulic retention time) of 0.75 days.

The system was able to achieve effluent characteristics that complied with the CPCB standards for discharge on land for irrigation. Besides chemical and biological oxygen demands (COD and BOD₅) total kjeldahl nitrogen (TKN) was also removed to the extent of >80%.

Key words: Macrophytes, wastewater treatment, bioreactor, SHEFROL®, *Salviniamolesta*





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A Low-Energy Non-Polluting Process for the – Extraction of Volatile Fatty Acids from Ipomoea (*Ipomoea Carnea*)

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The proliferation of the weed *Ipomoea (Ipomoea carnea)* like other invasive plants, is the result of anthropogenic tampering with the environment. Most of such weeds resist attempts at eradication by chemical biological, mechanical, or hybrid means. A better way to tackle the problem would be to find a way to utilize the invasives for a gainful purpose. However studies that have been carried out to this end so far, across the world, reveal that while isolated parts of the weed can be used for obtaining chemicals, papermaking etc, the processes associated with such utilization are too expensive to be of any practical utility.

In this backdrop, the authors have embarked on a series of experiments aimed at the total utilization of ipomoea in a three-step process. In the first step volatile fatty acids (VFAs) are extracted from the weed in a reactor that operates at room temperature with very little energy input. In the next step, at one side, the VFAs are used to generate energy in the form of methane and, on the other side, the 'spent' ipomoea is vermicomposted into a fertilizer.

The results of studies on Stage I of this process are presented in this paper.

Keywords: *Ipomoea carnea*, weed eradication, weed utilization, Volatile Fatty Acids (VFAs), methane

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Post Harvest Treatment of Water Hyacinth Biomass for Biogas Production

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Eutrophication is a serious environmental problem originates from excess nutrient load in water bodies. Luxuriant growth of micro and macrophytes is one of the issues associated with



eutrophication that has many socio-economic implications in addition to unbalancing the ecosystem structure and function. Recovering value added products like biogas from water hyacinth biomass is a positive approach to address the issue in an environment friendly way.

In the present study anaerobic digestion of water hyacinth was conducted in lab scale anaerobic bioreactor system. An Anaerobic Leach Bed Reactor (ALBR) coupled with an Upflow Anaerobic Sludge Blanket Reactor (UASB) was used for the anaerobic digestion of the biomass and subsequent biomethanation process respectively. Regular analysis of the operational parameters such as pH, VFA, COD and alkalinity were done to closely monitor the performance of the system. Microbial community analysis of the ALBR and UASB were done by metagenomic approach. Mixed liquor suspended solids (MLSS) and Volatile suspended solids (VSS) of the reactor sludge are 21g/l and 12.5g/l respectively. Quantitative analysis of the hydrolytic enzymes cellulase, xylanase and pectinase in ALBR and UASB were also done.

On an average 140 ml biogas/g VSS (wet wt) of water hyacinth biomass was obtained during the process. Microbial analysis revealed the presence of flocculated and granular sludge in ALBR and UASB reactors. In addition to bacteria and archaea, higher trophic organisms (grazing fauna) like protozoa and micro-metazoa were also present in both ALBR and UASB reactors that supported in digestion and methanogenesis of the reactor system.

Keywords: Water hyacinth, ALBR, UASB, Biomethanation, Protozoa

L - 54

Heavy metal removal efficiency of a weed *Axonopus compressus* in a hydroponic system

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Heavy metal pollution is a major environmental problem facing the world today. Toxic metals are increasing in all compartments of the biosphere; including, air, water and soil, as a result of anthropogenic processes. Metal concentration in aquatic bodies/systems increased several thousand folds by effluents from industrial and mining wastes; and also from municipal wastes. In recent years there has been an increasing interest in the phytoremediation of heavy metals from wastewater and in most of the studies aquatic or semi-aquatic plants were used. In the present study a hydroponics experiment was conducted to examine the Cadmium accumulation capacity by *Axonopus compressus* grown in low-level Cd-contaminated water. For this, seedlings of *A. compressus* were collected from the field and allowed to acclimatise in the laboratory for a period of two weeks. The plants of equal size were selected and transferred to a hydroponic system spiked with three concentrations of Cd (0.5, 1.5, and 2.5 mg/L) in two different mediums (Tap water and 10% Hoagland nutrient solution).





The experiment was conducted for a period of twenty days. The percentage removals of Cd from three treatments in tap water were reached up to 98, 92 and 92% respectively at the end of twenty days. In the case of Hoagland nutrient medium it was 94, 87 and 79% respectively. As compared to the nutrient medium, the plant showed higher removal efficiency in tap water. The plants also showed increase in biomass at all the cadmium concentrations tested. The experimental results demonstrated that *A. compressus* is a suitable candidate for the phytofiltration of Cd from low-level Cd-contaminated water.

Keywords: Cadmium, Phytoremediation

Acknowledgement

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Technical Session IX

Limnology



L - 55

A Trophic Flow Model of the Karapuzha Reservoir, Wayanad, Kerala

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Karapuzha reservoir, located in the Wayanad District of Kerala was impounded in 1979 targeting for irrigation of about 9000 hectares. The total water spread area of this reservoir is 855 ha at FRL. In order to integrate available information on biomass, food spectrum and dynamics of the main species populations of the system, a trophic model of fifteen compartments which included non- living group, detritus was constructed by the use of the Ecopath software. Measurement of trophic flow, transfer efficiency, and dissipation of energy among the various ecosystem components can provide significant information on the fundamental structure and function of the whole ecosystem. The algorithms used for such measurements are collectively known as network analysis and are derived from input-output, trophic and cycle analysis and estimation of system properties. Using network analysis the system network was mapped into a linear food chain and five trophic levels were found with a mean trophic transfer efficiency of 7.4 %. The trophic flows primarily occurred in the first four TLs and the trophic structure in this reservoir ecosystem was characterized by the dominance of low trophic level organisms. Trophic level I in the reservoir included the primary producers (phytoplankton, macrophytes) and detritus. Trophic levels (TL), estimated from the weighted averages of prey trophic levels, varied from 1.0 for phytoplankton, macrophytes, and detritus to 3.36 for the top predator, aquatic birds. The trophic levels of zooplankton and planktivorous fishes ranged from 2.00 to 2.58. The trophic impact routine, a form of sensitivity analysis shows that the eels exert a high predation pressure on the most dominant fish, *Oreochromis mossambicus*. The eels has a negative impact on almost all fish groups. The snake heads negatively impacted the planktivorous fishes (minor carps and minnows). Plankton being a vital link in the food chain plays a significant role in the fish catch potential of the reservoir. The plankton group and detritus had significant positive impacts on other groups in the system suggesting 'bottom up' control of the food web. A Finns cycling index of 6.19 % of total system throughput and a mean path length of 2.71 were obtained.

Keywords: Reservoir, Trophic level, transfer efficiency, Finns cycling index, Network analysis



L - 56

Preliminary Work on Physico-Chemical Properties of Two Lakes of Navalgund, Dharwad District, Karnataka, India

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Physicochemical analysis is the prime consideration to assess the quality of water for its best utilization like drinking, irrigation and helpful in understanding the complex processes interaction between climatic and biological processes in the water.

In the present investigation the study of monthly variation in different Physico-chemical characteristics like pH, Temperature, Electric conductivity, Alkalinity etc. are analyzed from May-2012 to August-2012, to know the water quality of Arekurahatti Lake and Shetter Lake of Navalgund Taluk.

The surface water samples from fixed spots from each habitat were collected at an interval of one month for a period of four months. Polyethylene carbonyl cans of the capacity of one liter are employed for this purpose. Winklerization is made in separate 300ml BOD bottles for the estimation of dissolved oxygen.

During these four months study, considerable variations in pH, Temperature and also in other Physico-chemical parameters are observed.

The results are suggestive of the fact that both the Lakes water can be used for Domestic purposes.

Keywords: Preliminary work, Water samples, Physico-chemical properties, Water quality, Lakes.



**L - 57**

The Lentic Ecosystem of Two Lakes in Puducherry Union Territory

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An investigation has been made to carry out to know the precious plant species which are located in the two Lakes of Puducherry U T. In Ousteri Lake, dominant plant species is *Nelumbo nucifera*. This is known as sacred lotus abundantly being growing in the region. In and around the Puducherry, people and scientists who used to visit this lake since it have been declared as Wildlife sanctuary by Puducherry Government. It has decided to develop the 390 hectare lake to a full-fledged sanctuary. According to tourism department different migratory birds of golden oriole, openbill stork and tailor bird stork visit the water body particularly after November every year. At the bank of both the lakes, Innumerable varieties of plant species are growing naturally Examples like, *Delonix regia*, *Tamarindus indicus*, *Caesalpinia pulcherrima*, *Azadirachta indica*, *Jasminum* sp. *Leucas aspera*, *Morus alba*, *Cucurbita* sp. *Ricinus communis*, *Amaranthus spinosus*, *Croton bonplandianum*, *Acalypha indica*, *Solanum xanthocarpum*, *Calotropis gigantea*, *Morinda pubescens*, *Solanum nigrum*, *Coleus* sp. *Xanthium strumarium*, *Boerhaavia diffusa* and *Cardiospermum halicacabum*. The fast growing free floating weed *Eichhornia crassipes* commonly known as water hyacinth which are growing in both the lakes. Main objectives of this study is to know the diversity of the medicinal value of plant species in the wetland region and to acquire adequate scientific truths after comparing the distribution pattern and diversity of medicinal plants between Ousteri and Bahoor lakes. But in ousteri lake, in order to allow free movement of fish nets fishermen remove *Vallineria spiralis* one of the food plants of birds. Since antiquity, plants have been used by people for food, clothing, shelter, hunting, and as cosmetics and medicine. There is a reasonable chance that there are many number of undiscovered plants which have valuable medicinal properties. Based on the above it is concluded that the medicinal usefulness plant species of Ousteri and Bahoor lakes can be identified and bring to the scientific world in order to offer benefits to everybody.

Keywords: *Nelumbo nucifera*, *Eichhornia crassipes*, tourism, birds and lake



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A Threat of Sedimentation and Aquatic Weed Growth for Sustainiance of Some Lakes and Reservoirs in Maharashtra

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The soil erosion in the catchment accelerates the process of sedimentation in reservoirs. The sediment deposits in the reservoirs reduce their storage capacity and the useful life as well. Apart from the sedimentation effect, many reservoirs today are facing the problem of semi aquatic weed growth that of Ipomoea Carnea (Local name -Morning Glory, Water lilly, Besharam, etc) in the submergence area of the reservoirs. Such weeds are aggressive colonizer in the shallow water zone. Run off from agricultural fields carries loose soil particles along with the elements like phosphorus and nitrogen from the fertilizers applied to the agricultural fields. These Phosphorus and Nitrogen are nutrients for the weeds and enhances its growth in the reservoir. Moreover, untreated industrial effluent and effluent from domestic sewage which is discharged through the river are also instrumental in growth of such semi aquatic weeds in the reservoirs. Such vegetation grows and spreads profusely forming colonies over long stretches in the reservoir submergence area. Growth of such weeds traps the silt in the useful storage zone of reservoir, develops marshy areas which create favorable environment for mosquitoes causing spread of disease like Malaria. Sometimes the height of such vegetation can be about 2 meters and its density is such that it is difficult for a man to walk through. Decay of these submerged weeds in water reduces the dissolved oxygen content of the water which creates bad impact on fisheries. This vegetation is not edible for animals too nor is suitable as green manure.

Maharashtra Engineering Research Institute, Nashik has been regularly conducting sedimentation assessment studies of reservoirs. While conducting these studies in Deccan Plateau of the state, it is observed that many reservoirs, especially in the flatter areas of Marathwada and Vidarbha and north Maharashtra regions are affected by growth of such weeds in the submergence area. These are the reservoirs having agriculture as a major land use in their catchment areas. Ujjani, Jayakwadi, Manjara, Lower Terna, Hatnur, Nandur Madhyameshwar, Lower Pus, Arunavati, Lower Wunna (Vadgaon and Nand reservoirs), Navegaon Bandh reservoir etc are some reservoirs where growth of such weeds is observed especially near the peripheral shallow water area at the tail and on the banks.

It is also observed that the reservoirs located in Western Ghat area of the State where the reservoirs catchment areas are mostly woody, covered by forest and shrubs, having less percentage of agriculture land and where catchment areas have undergone little developmental activities only and are free from industrial effluent, are least affected by such aquatic weed growth viz. Koyna, Warna, Dudhganga, Dhom, Kanher, Bhatghar, Manikdoh, Dimbhe, Bhandardara etc.

The silt entry into reservoir should be controlled by applying suitable engineering measures like nalla bunding, plugging, contour trenches, constructing check dams etc. Similarly, eradication of semi





aquatic weeds like *Ipomoea carnea* also needs to be done regularly. Alternatively, the possibility of its use as fuel in baked form like that of baked coal should also be explored.

Keywords: *Aquatic weeds, Ipomoea carnea*

L - 59

Sediment Resuspension Driven Internal Phosphorous Loading in a Shallow Lake – An *In Situ* Mesocosm Study

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Various mechanisms determine the release and uptake of phosphorus from the sediment. Phosphorus gets bounded to a number of inorganic compounds that controlled by several chemical and physical mechanisms. The physical resuspension of material from the lake bottom is a factor of particular significance in shallow and wind-exposed lakes. The supply of phosphorus to the water column from sediment resuspension is potentially important in providing the nutrients required for phytoplankton production. The effect of resuspension on the aerobic release of phosphorus was studied in the field with experimental water columns. The study included four experiments that were conducted in September and January during the day and following night in a shallow lake, Kokilamedu Lake, in Kalpakkam. The experiments were conducted in four columns that enabled an *in situ* mesocosm and were disturbed to mimic the wind driven resuspension. In all the experiments, the concentrations of suspended solids (SS) and total phosphorus (TP) increased substantially, due to the 20-min resuspension treatment.

However, the concentration of soluble reactive phosphorus (SRP) was strongly affected only at night due to a fluctuation in pH, temperature and dissolved oxygen, mostly due to the release by ligand-exchange reactions. The results pointed out that coupling of resuspension and high algal biomass altered pH in the water column can liberate significant amounts of soluble P into the water column. The importance of this phenomenon for the lake studied was emphasized by the fact that the P pools susceptible to pH dependent P-release formed a large part of the total extractable P of the surface sediment. Applying an improved sequential extraction technique to surface sediments from the experimental and control columns revealed high concentrations of CaCO_3 authigenic biogenic fluorapatite bound phosphorus (45-55%).

Keywords: *resuspension, internal loading, aerobic phosphorus release, experimental Approach*



L - 60

Landscape dynamics, Rainfall and Stream Flow: Linkages

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Land use Land cover (LULC) and rainfall are critical for ecological stability of watersheds. The role of LULC on hydrological processes is crucial in many ways because they maintain catchment's water balance through interception and transpiration. Forests are important for hydrological systems as they aid in increasing rainfall and runoff, regulate water flow, reduce erosion and improve water quality. Soil with vegetation cover acts as a reservoir that store vast quantity of water used by plants and trees or released into streams and rivers. Increased reforestation on unstable land and around lakes, rivers and streams help to increase the water-retention capacity of land and improve water quality. However in recent times human activities have led to serious LULC changes, vegetation degradation, natural resource exploitation and wetland disappearance. To a large extent, afforestation and deforestation are major human activities responsible for these enormous environmental changes. Indiscriminate cutting of trees have decreased the storage of ground water sponge, leading to water shortages during dry seasons and, in wet seasons, to brief destructive floods, during which very little water is absorbed by the soil. Large productive land, where annual rainfall is relatively high, becomes desert when vegetation cover is removed. Therefore, there is a need to study the linkages between LULC, forest fragmentation, rainfall and stream flow (seasonal and perennial). In this context, remote sensing data coupled with other primary data such as rainfall, amount of green cover, type of forest, and other ground level information, etc. can be used to analyse this relationship in watersheds. In this study, we attempt to study the Kali river basin in Uttara Kannada district, Karnataka state, India. The river basin is divided into ten small subbasins to study dynamics of LULC change and establish a relationship between stream flow and other parameters. Land use analysis (agriculture, evergreen forest, plantation, built up, waste land and water bodies) is done basin wise and forest fragmentation is computed to assess the amount of patch, transitional, edge, perforated and interior forest. Finally a mathematical relationship is established between the number of streams as a function of LULC, rainfall and forest fragmentation to identify the important parameters that play a pivotal role in deciding the water retaining capacity of the streams (seasonal or perennial).

Keywords: Land use land Cover, forest fragmentation, Kali river basin, deforestation, stream flow



Technical Session - X

Vembanad Lake



L-61

Glimpses into the Evolution of Vembanad Lake: A Ramsar Site along the South West Coast of India

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Vembanad Lake, with an area of 204 km² is the largest among the 34 *Kayals* (estuaries/lakes) of Kerala, into which debouch rivers Periyar and Muvattupuzha from the north and north east; Meenachil Ar from east; and Pamba (together with Manimala Ar) and Achankovil Ar from the south. Synoptic aerial view suggests that the geometrical linearity of the south-western coast of India, where many rivers join with straight orientation, has a tectonic role in formation while many shear zones like Achankoil, Muvattupuzha etc. have extensions in offshore. Downwarping, faulting and uplifting are recorded in a number of places in the western coast and off shore. Scientists believe that the proto-basin of the shore-oblique *Kayals*, like Vembanad, should have appeared at the close of Neogene, though the formation of the modern *Kayal* basin started in the early Holocene and transgressed through the entire Holocene. Spatial disposition of the distributary system of rivers like Achankovil, Pamba and Manimala suggests of a single mighty stream prior to the Holocene sea level rise. Occurrence of relict carbonate sands and carbonate rocks in the form of algal and oolitic limestone of Holocene age in the outer shelf perhaps represent the westernmost limit of the then shoreline, prior to the Holocene sea-level rise and this is consistent with the above suggestion of a single mighty stream in the geological past as postulated for the Netravati-Gurupur river system. It is recognized that several factors like tectonic, epeirogenic, eustatic and climatic factors with several episodes have played significant roles in the evolution of the Vembanad Lake and the roles of low strandlines of sea level (11,000-9,000YBP), strongest monsoon episode (9000-7000YBP), prominent marine transgression (8000-6000YBP), climatic amelioration (5000YBP), marine regression (5000-3000YBP), Neotectonic event (4000YBP), increased NE monsoon (3000YBP), etc. are among the significant ones to discuss with.

Keywords: Tectonism, Holocene, marine transgression, climatic amelioration, marine regression



L - 62

Applying Principles of Deliberative Democratic Practices for the Conservation and Sustainable Management of the Heavily Used Vembanad Backwaters of Kerala, (India)

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One of the hopes of the conservation of heavily used Coastal backwaters and estuaries and inland water bodies lies in the active involvement of the dependent communities in its management. This can be made possible only by Institutionalizing community rights over protection and harvest of the natural resources. Vembanad Backwaters (Kerala, India) is the largest tropical wetland ecosystem on the southwest coast of India and a designated Ramsar site. The backwater is used for fishing, sand mining and lime shell deposits, harvesting live clams, and tourism related activities and the ecological health of the backwater is in a steady decline.

We are trying to address some of the conservation issues faced by Vembanad Backwaters by facilitating deliberative democratic conservation [DDC]. In the process of DDC, the conservation policies and prioritisation are done through consensus evolved through deliberations among various stakeholders and transfer of responsibility over its harvest and management to them.

Conventionally, conservation and management of the resources of Vembanad especially fishery resources were vested in the hands of the local fishing communities. These community management systems were evolved at the local or grassroots level, and hence, local communities were actively involved in the management of the resources they relied on for sustenance and livelihood security. But the conservation and management slowly changed hands and are now considered as the role of the state. We helped the traditional fishermen to organize themselves to village level grassroot democratic organizations named *Vembanad Kayal Samrakshana Samithy* [Vembanad Lake Protection Forum, LPF] and all LPFs are federated under Samyuktha Kayal Samrakshana Samithy [Federation of LPFs]. The LPFs bring together traditional ecological knowledge (TEK) as routine ecological management plans which can be handy in conservation programs and methods to suggest a general scheme for managing small scale fisheries. The LPF play active roles and make use of TEK for the sustainable management and conservation of the lake and its natural resources. The *Matsyathavalam* (Fish Sanctuaries) is one such example where the fishermen make fish breeding centers along the southern sector of the lake using their traditional wisdom.





Keywords: deliberative democratic conservation, ecological health, fish and fishery, community management systems, traditional ecological knowledge.

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An NGO'S Effort for the Conservation of Vembanad Wetlands

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Kottayam Nature Society is a voluntary organization centered at Kottayam and the prime obligation of the organization is the conservation of wetlands. This NGO is involved in conservation activities in the Vembanad Wetland region for the past 12 years. Vembanad is the largest estuarine system in the western coast of India and was declared as a Ramsar site in 2002. This is a high biodiversity area with its rich fish population, local and migratory birds, hydrophytes, mangroves and other wetland dependent plants, reptiles and amphibians, mollusks etc. This is one of the rare places where there is below sea level cultivation.

Now this ecosystem is under peril due to anthropogenic activities. The major threats are reclamation of the wetlands for tourism and other activities, sewage and other pollutants carried by the rivers, industrial effluents, pollutants from house boats, agrochemicals used for paddy cultivation and over exploitation of resources. At this juncture various conservation activities are being organized by the society by people's participation. One among them is the midwinter water fowl census being conducted for the past twelve years with the support of the Kerala Forest and Wildlife Department. This is a very effective programme to attract school students and other interested persons to wetland conservation activities. The society organized a fish count in Meenachil River, which is of its first kind in India, by local people's participation and supported by Kerala Agriculture University Regional centre. Another important activity organized was the distribution of incentive for people who protected roosting trees of wetland birds at different parts of the Vembanad wetlands. This was supported by Kerala State Biodiversity Board and Kerala Forest and Wildlife Department. The Nature Society also conducted wetland conservation awareness programmes in schools around the Vembanad wetlands. This organization also published a Hand book on wetland birds of the Vembanad region, supported by Kerala Forest and Wildlife Department. This is for free distribution among school children. Documentation of wetland plants of the Vembanad region was done and it will be published in book form soon. Preparation of management plan for Kumarakom Bird Sanctuary, survey and report preparation for Heronry Conservation activities supported by KSBDB, were also done by the society. Saving 415 ha. of Methrankayal paddy field from reclamation and Pathiramanal island from the hands of construction lobby are also because of the efforts of this NGO. Kottayam Nature Society is one of the partners of Dr.M.S.Swaminathan's proposal for declaring the Kuttanad region as World Agriculture Heritage Site.

Active participation of stake holders and other local communities are essential for conservation activities. Students are another potential targets for awareness creation. By utilizing these human resources NGOs can play a major role in wetland conservation activities.



Keywords: Wetland, Conservation, NGO, Biodiversity, Threat

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Participatory Mapping of Natural Resources in Vembanad Lake

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Introduction

Vembanad Lake, the largest Lake in the south west coast of India is renowned for its biodiversity as well as the ecstasy the lake create on the tourists from around the world. Extensive water and land remodelling efforts in Vembanad Lake has drastically changed the lake's water and landscapes, altering natural habitats of many terrestrial and aquatic fauna and flora. Decline in primary productivity and fishery resources, growth of aquatic weeds and degradation in water quality are the consequences of this intervention. The past and current trends of natural resource of Vembanad Lake has been mapped using Participatory tools and techniques, which is a popular methodology in community development planning. Participatory approaches have involved the primary stakeholders of the Lake such as fishermen, clam collectors, local people, and tourism operators etc. who make their livelihood from the lake.

Objectives

1. Facilitating better understanding of the resources of the lake, together with their management, dynamics and related challenges, with potential solutions to those challenges.
2. Help the communities to identify their needs, priorities, opportunities and constraints and to evaluate development interventions.
3. Empower Panchayat raj institutions to be more involved in natural resource management and environmental protection.
4. Strengthen community-based natural resource management plans and convergent action plans for the conservation of the lake and its biodiversity.

Methodology

Resource mapping has been done in the southern part of the Vembanad Lake, beyond Thanneermukkom barrage. Mapping exercise was conducted with the involvement of the primary stakeholders of nine Grama panchayat viz Muhamma, Vechur, Aymanam, Kumarakom, Kainakary, Punnappa, Mannancherry, Thanneermukkom, Aryad Panchayats and Alleppey municipality, the areas adjoining the lake. Mapping will be undertaken at appropriate sites in the southern sector of Vembanad Lake, beyond Thanneermukkom barrage. The participants were provided with a large map of the southern section of the Vembanad Lake which can be spread out on the floor for the mapping exercise. The map has 1km grids with various landscape features for locating the spots. The natural resources intended to be mapped includes Clam, Fish, Mangrove, Otters and Birding Area. The past





and current trends can be captured using separate maps. Semi structured questionnaires were developed to facilitate focus group discussions and interactions.

- (1) The salient features, natural and man-made, of the territory being mapped (with land marks identified)
- (2) zones used for subsistence activities (fishing, sand mining, clam collection, gathering of fodder, house boats /resorts / tourism activities in the lake, weed covered areas and any other significant use of the lake)
- (3) Areas of resource availability-past and present tracks and areas of special importance.

Preliminary Findings

1. Stakeholders and local communities role in management of the natural resources
2. Natural resources in each panchayat
3. Past and Current trends in fishing and clam collection methods
4. Panchayats role in management of Natural Resources and the efforts taken to protect the Natural resources

Conclusion

Conservation and management of natural resources is a challenge worldwide due to the lack of baseline data combined with the need for their ongoing contribution to livelihoods. The setting in Kerala is no different. Although locals report about the decline of these resources a paucity of data regarding status and trends has hampered management decisions. Knowledge on the status and trends is hence a research priority to develop management action plans for a sustainable management of Natural Resources in Vembanad Lake.

Keywords: *Participatory Rural Appraisal, Resource Mapping, Vembanad Lake*

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An Assessment of Heavy Metal Accumulation and Their Dynamics in Water, Sediment and Different Aquatic Edible Species in Vembanad Lake, Southwest Coast of India

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Assessment of heavy metal pollution in Vembanad Lake of Kerala from Eloor to Thanneermukkom Bund and quantify the heavy metals (copper, lead, zinc, manganese, chromium and cadmium) on two fish species (*Etroplus suratensis*, *Arius arius*), one prawn species (*Penaeus indicus*) and a bivalves (*Villorita cyprinoides*). The accumulation of six heavy metals in the water body, sediment, and muscle tissues of the aquatic organisms were measured using atomic absorption spectroscopy. The results of



heavy metal values of this study were compared with the threshold values in the guidelines of water, sediment and food which given by different national and international agencies. The extent of contaminations on sediment was examined by calculating Enrichment Factor, Index of Geo Accumulation, and Contamination Factor. Metal Selectivity Index shows Zn (96.97, 93.88, 90.25, 75.60, respectively in *Arius arius*, *Etroplus suratensis*, *Penaeus indicus* and *Villorita cyprinoides*) had much accumulation in organisms. We found the mean concentrations of Cu, Pb, Zn, Mn, Cr and Cd in water, sediment, and muscles of aquatic organisms were far below the values of guidelines. We also found that this type of heavy metal present and their concentrations varied in different aquatic species. The results suggested that Cu, Pb, Zn, Mn, Cr and Cd did not contaminate this aquatic ecosystem severely and did not threaten the safety of human consumption in the Vembanad Lake but daily consumption of these species will lead to the accumulation of heavy metals in human body and leading to serious health problems.

Key words: *Aquatic organisms, Atomic absorption spectroscopy, Heavy metal pollution, Metal Selectivity Index, Vembanad Lake.*

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A Study on Accumulation of Heavy Metals (Zn, Cd, Pb and Cu) In Fishes and Associated Community Health Risk from Estuary Cochon

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Fish are most indicative factors in aquatic systems for the estimation of trace metal pollution and risk potential of human. Fish consumption information is essential for assessing the human health implications associated with the consumption of chemically contaminated fish. The current study is an investigation of heavy metals (Zn, Cd, Pb, Cu) in the selected edible fish species collected from Cochon Estuary and a preliminary survey on the fish consumption pattern and health problems associated with contaminated food consumption among the local people. Fishes were collected and tissues were separated and processed according to standard procedures. Zn, Cd, Pb and Cu in the digested samples were detected with Anodic stripping voltammetry. For the dietary survey, questionnaire was designed according to standard survey methods.

Zn, Cd, Pb and Cu were detected from all the fishes. Among that Zn showed maximum accumulation followed by Pb, Cd and Cu. Heavy metals from the muscle were detected in four species, *M. cyprinoides* (Zn, Cd and Pb), *T. mossambica* (Zn, Cd, Pb and Cu), *G. giuris* (Zn) and *S. argus* (Zn, Cd and Pb). The high accumulation of heavy metals was observed in the tissues of *M. cyprinoides* and *G. giuris* indicating their potential as a tool for biomonitoring heavy metal pollution. The fish consumption rate observed from the survey was 34 g/day, which was slightly above the Indian average of 30 g/day. The Estimated Weekly Intake (EWI) and Estimated Daily Intake (EDI) calculated in the study shows that the Cd and Pb content in the fishes may pose significant health risk





to people in this region. Even though the preliminary survey observed no visible symptoms in the community, more studies are needed to assess the actual health risk.

Keywords: *Heavy metals, human health, edible fish*



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Spectral Discrimination and Characterisation of Aquatic Macrophyte Communities in Part of a Ramsar Site of Kerala State, India Using World View-2 Satellite Image

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Detailed understanding of spatial and temporal dynamics of aquatic macrophytes (AM) and the aquatic environment is essential for the better management of any wetland. To study this geospatial tools such as remote sensing, GPS and GIS proved to be the best because most of the wetland areas are inaccessible and vast enough not to be covered by field work. The present study analysed how best the data from the different spectral bands of Worldview-2 can be used for the discrimination and characterisation of aquatic / wetland plant species assemblages and communities. The study was conducted in a small portion of Vembanad Lake near Kumarakom where luxuriant growth of AM is noticed. The spectral response of aquatic plant species was studied using a hand-held spectroradiometer along with supporting software like RS3 and ViewSpec. A hand-held GPS receiver was used to record the exact geographic coordinates of the locations. The study used WorldView-2 (WV-2) acquired on 4 January 2011 image with 8 multi-spectral and 1 panchromatic bands of 1.5 and 0.5 m spatial resolution respectively. Image processing techniques such as resolution merging, band ratioing and visual interpretation was employed to characterise and map the AM communities in the area. Five communities were identified from the field and the image. Spectral characterisation of the identified communities using the spectro-radiometer and the different bands in the image showed high variation among different communities. The difference is quite evident between submerged communities and the other types. Emergent and Free-floating communities have similar trends. Curve fitting of the spectral reflectance DN values from spectro-radiometer and WV2 showed similar pattern except in the case of coastal blue in most of the communities. NDVI of red-edge to red bands showed better separability of communities than the NDVI of NIR and red. Out of the four pan-sharpening methods tried Modified IHS yielded the best result compared to all other methods. Visual interpretation of pan-sharpened multi-spectral image resulted in better discrimination of communities at species level. For visual interpretation various band combinations of the pan-sharpened image were used interactively. Combinations with red-edge and green bands were found good for the discrimination of submerged communities.

Key words: Aquatic macrophytes, remote sensing, NDVI, resolution merge, visual interpretation





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Vembanad Wet Land As a Source of Livestock Feed

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Increased cost of commercially available feeds make livestock rearing uneconomical. This is more important when the animals are in the growing stage or in dry stage. In growing stage, they require feed rich in protein and in dry condition more of crude fibre. The increased cost of rearing discourages farmers from rearing animal that do not give daily income. So majority of the calves are sold at a very young age for meat purpose. Even if maintained, the plane of nutrition will be very poor. Incorporation of locally available feeds reduces cost of rearing. Vembanad wetland contains so much of plants, of which water hyacinth (*Eichhornia crassipes*) and kadakal (*Ischaemum travancorens*) are very much useful to livestock, especially cattle. Water hyacinth is an exotic weed that grows in plenty in majority of rivers where water flow is slow. It is one of the most productive plants in the world and can double their population in two weeks. Water hyacinth causes lot of environmental problems including occlusion of water canals and reduced aeration of water. Pests like rats inhabit these plants leading to spreading of zoonotic diseases like leptospirosis. Hindrance of water flow cause growth of mosquitoes and transmission of diseases like malaria. Kadakal is a grass variety that can grow on top of water and is already used by farmers as fodder. At present water hyacinth is not used because of poor palatability. Scientific studies prove that these plants contain all the nutrients required for cattle and are free from any toxic materials. The presence of crude fibre and nitrogen free extract in both the plants suggests that they are most suited for cattle of all ages. Local Self Governments spend plenty of money every year for removing these plants from water canals. The removed plants are not at all used for any purpose and cause air pollution due to decaying. More over, the plants that are dropped out multiply faster and the condition is repeated. Instead, the collected plants are washed, and chopped to smaller size after removing their roots. These chopped plants are sun dried for two consecutive days to remove moisture. Ensiling is a process of preserving plants, to be used as feed later. It is done by adding molasses or jaggery. The plant portion and jaggery/molasses are mixed together and filled in inert containers by exerting pressure to avoid air getting trapped in between. Kadakal is also rich in minerals. Ensiling of chopped and sun dried water hyacinth for 12 days using 10% molasses or jaggery in 200 litre capacity plastic containers and mixing with kadakal increases the intake. This is a very low cost technology and can be easily adopted by live stock farmers and there by cost of live stock rearing can be reduced. This also helps to alleviate the environmental problems caused by the plants.

Keywords: live stock, feed, water hyacinth, kadakal, ensiling.



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Spatial and Temporal Variations of Water Quality and Heavy Metal Concentration in Vembanad Lake, Kerala

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Vembanad Lake, one among the three Ramsar sites in Kerala, is under immense pressure due to anthropogenic influence especially discharge of chemicals from industries, agricultural fields and urban waste from nearby cities from its catchment area. The present study monitored the spatial and temporal monitoring on the distribution of selected nutrients and associated parameters and heavy metals.

Water samples from the Vembanad Lake were measured for physico chemical parameters over different seasons. The samples were analysed for different water quality parameters like temperature, Transparency, Salinity, Total Dissolved Solids (TDS), Conductivity (Cond), pH, Colour, Turbidity, Chloride, Total hardness, Calcium hardness Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Ammonia-Nitrogen (NH₃-N), Nitrite-Nitrogen (NO₂-N), Nitrate-Nitrogen (NO₃-N), Total Nitrogen (TN), Inorganic Phosphorous (IP), Total Phosphorous (TP) and Inorganic silicate using standard methods. Heavy metal like Zn, Cd, Pb and Cu were also estimated using a voltammetric trace metal analyzer (797 VA Computrace, Metrohm, Switzerland) with a Hanging Mercury Drop Electrode (HMDE).

The results showed that prevalence of unnatural concentration of metal than the back ground value in industrial areas of Eloor region. Heavy metal concentration gets diluted when it approaches the southern part. The parameters such as nutrients, salinity, TDS, conductivity, pH, and chloride were shown high values during the premonsoon season. Spatial patterns of the pollutants indicated that northern part of the Lake, where the industrial activities are high, is more vulnerable. This area provides high suspension time for sewage and effluents from the Cochin City and agricultural runoff to adhere on sediments. This settled nutrients and other chemical complexes may get back to overlying waters during the resuspension of sediments by tidal influence, which is a common phenomena to all estuarine systems. This study draws special attention because the lake supporting livelihood of a large number of people and water-fowls population. The influence of the fresh water from rivers especially Muvattupuzha river is critical in the productivity of lake as well as the nearby Kuttanad agricultural lands.

Keywords: *Vembanad Lake, Heavy metal, nutrients*



**L - 70**

Mercury Pollution in the Vembanad Lake

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Mercury content in the environment has been increased during the past few decades. India has been identified as one of the 'hotspots' of mercury pollution and has become the biggest consumer of this metal. Mercury concentration in various environmental compartments of Vembanad Lake has been quantified in the present study. Mercury was analysed by Cold vapour atomic fluorescence spectrophotometer followed by standard sample preparations. Mercury was high in sediments than water especially at the industrially polluted northern region of the Lake, where it was higher than the prescribed limits. Core sediment analysis showed that a subsurface accumulation of mercury in the sediments and it might be due to the past industrial releases. The geochemical and speciation of mercury showed the potential methylation capacity of the Vembanad Lake environment. Organic matter, sulphides and salinity determines the transformation and transport of mercury in the Lake. The pattern of fractionation of mercury in the sediments revealed the high anthropogenic influence on mercury pollution in the Vembanad Lake as the least quantity observed in the residual mercury fraction. Major portion of mercury was present in the elemental mercury fraction and organic matter bounded fraction. Even though the easily available fractions were comparatively less, the absolute values were high due to the high total mercury content. The fractionation studies showed the potential availability of mercury for methylation. Mercury in the pore water samples were showed a positive relation with the bottom water mercury content and sediment mercury. Bottom water showed high concentration mercury than surface water. Fish and other aquatic organisms were analysed for the total and methyl mercury content and observed a high accumulation pattern especially in the carnivorous and omnivorous species. Mercury accumulation dynamics was analysed through tissue-mercury content. It was noticed that along with liver, gill and muscle, kidney can be also used in monitoring of mercury contamination. The tissue concentrations were also used for analysing the suitability of collected fishes as bio-indicators. Total mercury accumulated in the aquatic organisms in the Lake was in the order crabs>omnivorous fishes>benthic-carnivorous fishes >carnivorous fishes >bivalves>prawns. The hazard index was >1 and therefore continuous consumption of fishes may pose a significant threat to the human health. The MHg intake ($2.85\mu\text{gMHg/kgbw/week}$) observed was higher than the limit suggested by FAO/WHO ($1.6\mu\text{g MHg/kgbw/week}$). Based on the mercury speciation and other physical and chemical properties of the water and sediments, a schematic diagram of various chemical transformations and transport of mercury in the Vembanad Lake has been prepared. Also the different processes, which influencing mobility and cycling of mercury in the estuarine region and near shore region were compared and it showed that the estuarine processes of mercury are mainly controlled by the anthropogenic forces. The remobilisation of mercury if any occurred by developmental activities will enhance the potential risk due to mercury pollution. The risk to human cannot be excluded while considering the fact that a large number of people residing along the banks of this Lake and feed on the fishes of the Lake.

Keywords: mercury, speciation, water, sediment, biota, Vembanad Lake



Technical Session XI

**Application of GIS in Wetland
Management**



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Resource Information System for Kundapallam (Kd-1) Watershed in the Nilgiris District Using Remote Sensing, GPS and GIS

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For watershed management at microlevel, maps on 1:5000 scale or larger are needed with contours of 5-m interval. In this respect, aerial photos taken during 1996 on 1:8000 scale for the entire Nilgiris district were used for preparing large-scale maps. Global Positioning System was used for establishing ground control points. The orthophotos and IRS I-C Liss-III + PAN merged special satellite data were used for the generation of thematic maps such as landuse/landcover, soil cover, drainage *etc.* Slope map was derived from 5-m interval contour using Arcview 3D analyst. Action plan for sustainable resource management was prepared using GIS. Cadastral map showing parcel boundaries on 1:7920 obtained from Survey and Land Records Department was brought into 1:5000 scale and superimposed on thematic and action plan maps. Other socio-economic data pertaining to the watershed were collected and cadastral level resource information database was generated. Cadastral level database is customised in the GIS environment which is made interactive and user-friendly, so that monitoring and further updation shall be easier for the field officers.

Key Words: Cadastral map, Resource Information system, Kundapallam (KD-1) watershed, Nilgiris.

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Status of Wetlands in Urbanising Tier II cities of Karnataka: Analysis using Spatio Temporal data

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Urbanisation is the irreversible and most dramatic transformation of land affecting ecology and natural resources. Urbanisation being a global and highly sensitive issue is in a rapid pace in developing countries such as India, especially down south where urban areas have experienced an humogenous growth potential with several supporting factors (eg: economic, climate, availability of natural resources etc.,). Karnataka has been a prime destination which has attracted the sectorial developments at various parts of the state. These sectorial developments have led to an uncontrolled growth in past decade, which has to be visualised and monitored by the decision makers and city planners. In this context evolution of Multi -temporal remote sensing has gained importance in providing required data to analyse and visualise the changes to plan and effectively use the available resources for the effective city management. This communication uses satellite data sources in order to understand the urban growth pattern and its footprints temporally in eight growing tier II cities of Karnataka. A multi-scale analysis aims to identify spatiotemporal urban types, combining gradient and directional analysis along with landscape metrics to understand the absolute parameters for the growth and to quantitatively estimate the growth of these cities. The results paint a characteristic picture of spatial pattern, and thus illustrate spatial growth and future modeling opportunities of sustainable wetlands management with urban development in Karnataka. The outcomes of this communication would illustrate the growth pattern and quantified urban growth using spatial metrics considering the 1km gradient and zonal approach. The results indicate that these has been a haphazard development in increasing gradients from the city center leading to fragmented outgrowth and aggregated growth at the center of each city. This analysis would help urban planners to understand the growth and plan for sustainable cities.

Key words: Wetlands, Urbanisation, urban sprawl, Karnataka, Tier II cities, Landscape metrics

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Multi-Sensor, Multi-Resolution Image Fusion for Monitoring of Wetlands

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Earth observation satellites provide data covering different portions of the electromagnetic spectrum at different spatial, spectral, temporal and radiometric resolutions giving a more complete view of the



observed objects. However, two major factors limit sensor's ability to collect high spatial resolution (HSR), Multispectral (MS) data. First, the incoming radiation energy to sensor is limited by optics size. Second, the data volume to be collected and stored by the sensor increases exponentially with HSR. With physical and technological constraints, some satellite sensors supply the spectral bands needed to distinguish features spectrally but not spatially, while other satellite sensors supply the spatial resolution for distinguishing features spatially but not spectrally. For many applications, combination of data from multiple sensors provide more comprehensive information. Thus, satellites such as QuickBird, IKONOS, IRS bundle a 1:4 ratio while Landsat and SPOT bundle a 1:2 ratio of a HSR Panchromatic (PAN) band and low spatial resolution (LSR) MS bands in order to support both colour and best spatial resolution while minimizing on-board data handling needs. A critical consideration is how to integrate spatial information present in the PAN image but missing from the LSR MS data. Therefore, for full exploitation of increasingly sophisticated multi-source data, advanced analytical or numerical image fusion techniques are required.

Image fusion{xe "Image fusion"} refers to combining the geometric detail of a HSR PAN image and the spectral information of a LSR MS image to produce a final image with the highest possible spatial information content while preserving good spectral information quality. It describes a group of methods and approaches using multi-source data of different nature to increase quality of information contained in the data. Fused images provide increased interpretation capabilities, more reliable results as data with different characteristics are combined, reduces ambiguity, improves reliability, improves classification, substitutes missing information and are also used for flood monitoring, ice/snow monitoring, geological applications, etc.

However, for a particular application, it is necessary to have apt spectral and spatial resolution, which is a constrain by availability. Availability depends on the satellite coverage, operational aspects, atmospheric constraints such as cloud cover, economic issues, suitable fusion level, geometric model, ground control points, re-sampling method etc. Considering all these aspects, an attempt has been made to evaluate the performance of five image fusion techniques such as SFIM (Smoothing Filter), COS (Component Substitution), High Pass Fusion (HPF), High Pass Filter (HPF) and High Pass Modulation (HPM) when applied on different resolution ratios (PAN and MS obtained from different sensors), such as (i) Fusion of 1:4 resolution ratio (IRS PAN 5.8 m + LISS-III MS 23.5 m), (ii) Fusion of 1:2 resolution ratio (Landsat ETM + PAN 15 m + MS 30 m), (iii) Fusion of 1:50 resolution ratio (IRS PAN 5 m + MODIS 250 m), (iv) Fusion of 1:100 resolution ratio (IRS PAN 5 m + MODIS 500 m), (v) Fusion of 1:250 resolution ratio (IKONOS PAN 1 m + MODIS 250 m), and (vi) Fusion of 1:500 resolution ratio (IKONOS PAN 1 m + MODIS 500 m).

The results indicated that HPM is the most suitable technique for merging IRS MS and PAN images. COS is best for fusing 1:2 Landsat ETM+ PAN and MS bands. HP Filter performed best on the fusion of 1:50 and 1:100 resolution ratio data. Visual appearance of fused images (IKONOS PAN and MODIS, 1:250 and 1:500) did not bring any sharpness and one may not see significant improvement in the pixel's appearance before and after image fusion. However, statistical properties of the fused images revealed that HP Filter retained all the properties after fusion. From the above study, it may be concluded that fusion of high and moderate spatial resolution MS band with HSR PAN band retains the spatial and spectral properties of the fused bands. However, as the spatial resolution decreases, fusion of images does not facilitate image quality enhancement for object identification. In such cases, spectral unmixing techniques can be employed on low spatial resolution data.

Keywords: Multi-resolution, multi-sensor, image fusion, Multispectral, Panchromatic

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Temporal Analysis of Water Bodies in Ten Mega Cities of India

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Wetlands play an important role in recharging aquifers and stabilizing urban ecosystem. Wetlands attenuate the severe floods by storing water, provides habitat to different kinds of flora and fauna and improves water quality. Thus wetlands play a vital role in urban ecology. In recent years, many of these wetlands are being threatened due to increased landuse activities. Thus the study highlights the landuse analysis of ten mega cities of India that substantially showed decline in lakes and tanks of the city due to urbanization process. As a result of rapid urbanization, many of the water bodies have been lost and some are totally polluted. Urban sprawl is the major cause for the environmental degradation, makes greater demand on natural resources and hence associated with loss of wetlands. Medium and high-rise buildings have come up on some of these lakes and show the deterioration in the natural catchments flow and degrade the water quality. Unplanned urbanization and development activities have effected tremendously on these wetlands led to substantially decline in the storage capacity of the aquifers. The prime objective of this study is the wetlands dynamics of ten cities using remote sensing dataset and also to understand the rate of change in spatial extent of these wetlands during last four decades. Landuse analysis was done to show the changes in four major categories- urban, vegetation, water bodies and others that revealed drastic increase in urban category with sharp decline in the water bodies.

Keywords: Water bodies, wetlands, remote sensing and GIS, urbanization.

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Spatio-Temporal Distribution Mapping of Aquatic Macrophyte Communities in Kuttanad Wetland Ecosystem

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Limited field accessibility in wetlands often hinders the surveys of aquatic macrophytes. Hence remote sensing is a valuable tool for the assessment of macrophyte communities. Geospatial tools are used for many other studies in India but seldom used for the study of aquatic macrophytes. The present study was carried out in the Kuttanad Wetland Ecosystem (KWE) with objectives such as 1) to map the landscape ecological units or habitat systems, 2) to map and monitor the spatio-temporal distribution of major aquatic macrophyte (AM) communities and 3) to assess the spectral characteristics of major AM communities and monitor the aquatic vegetation cover density in different seasons. A hand-held GPS receiver was used to record the exact geographic co-ordinates of the plant assemblages located in the field. Seasonal changes and the ecosystem conditions was noted and recorded in each field work. Survey of India topographic maps at 1:50,000 scale were used as the base maps. The distribution mapping of the macrophyte communities was done in two different scales one covering the entire area at 1:50,000 scale based on medium resolution image (23.5 m) beamed by LISS III sensor of IRS-P6 (Resourcesat-I) satellite and detailed mapping of selected locations based on high resolution image (5.8 m) of LISS IV sensor of the same satellite. The macrophyte communities were identified through visual interpretation employing the interpretation elements and incorporating the ground truth collected during the field survey, delineated and vectorised through on-screen digitization. The ground truth collection from the field was done near real-time. All the digital processes and on-screen visual interpretation were done in ERDAS Imagine and ArcGIS software packages. Spectral profiles were created by picking up the mean reflectance values of all the major communities from the LISS IV MX image. Band ratioing techniques were employed to generate the NDVI images using the spectral bands 3 (Red) and 4 (Infrared) of LISS III data.

Out of the four habitat systems, cultivated rice fields (76%) and abandoned rice fields (5%) together constituted major portion of the wetland area of KWE. 13 AM communities could be mapped with the help of satellite images. Other community assemblages were not detected from satellite images due to their small extent. The cultivated rice fields are mainly occupied by two major communities during the off-season inundation, one composed of the floating leaved *Nymphaea pubescens* and another comprising the submerged *Hydrilla verticellata* and *Najas minor*. Increase in the area of *N. pubescens* during December 2006 (off-season before the cultivation) and April 2007 (off-season after the cultivation) showed the abundance of this species in cultivated rice fields during off-season fallow period. The steady increase in the area occupied by *Eichhornia crassipes* and *Cabomba caroliniana* from February 2004 to April 2007 shows the increasing invasion of these exotics. The spatial pattern of the distribution of the communities was highly dynamic except those of the abandoned rice field communities such as *Ischaemum travancorensis* and *Hymenachne acutigluma* and other emergents such as *Phragmites karka* and *Typha elephantina* proving the temporary biotic climax. The total wetland area occupied by aquatic vegetation has increased considerably over the years. Altogether 15 communities were detected and mapped from 8 selected locations in the detailed mapping. The high-resolution images helped to resolve the communities better and to detect more communities. The spectral reflectance values showed high IR values in case of free-floating, emergent and floating stemmed or floating leaved communities except the young community of *Salvinia molesta* and a mixed community of *Eleocharis dulcis* and *Nymphaea nouchali*. The submerged communities of *H. verticellata*, *N. minor* and *C. caroliniana* showed high reflectance in the green band compared to the IR and red bands. The pattern of aquatic vegetation cover density generated from medium resolution images through NDVI during the same periods showed the same patterns of spatial and temporal distribution. It was revealed that the spatio-temporal distribution of aquatic macrophytes is mainly

controlled by the distribution of the different wetland habitat systems and their hydrological regime proving their ecological relationship.

Key words: Aquatic macrophytes, Kuttanad, remote sensing, band ratioing, biotic climax

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Applications of GIS and Remote Sensing for Mangrove Management in Uttara Kannada, Karnataka State

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The estuaries including mangrove habitats of most of the Indian west coast are much smaller compared to such along the east coast, with the overwhelming presence of Sundarbans and Orissa mangroves. The west coast estuaries, despite their high productivity and biodiversity, faced neglect regarding mangrove conservation and development programmes, probably on account their smallness. These estuarine regions, densely populated due to high productivity, are prone to rising human pressures causing greater mangrove fragmentation and losses. The lack of spatial quantitative maps on mangroves for the west coast has often crippled restoration programmes. In the Uttara Kannada district of Karnataka State, mangrove planting works in the small estuaries attempted during the recent years have raised high hopes of better ecology and higher biological production. Yet the local forest departments, which manage most mangrove areas, are to be equipped with spatial, quantified data on mangroves and potential area for mangrove planting. Using open source GIS software (QGIS) and remote sensing software (GRASS) and IRS imageries mangrove areas and potential areas available for planting in four river estuaries and some minor creeks in the Honavar Forest Division of Uttara Kannadawere mapped. Mangrove species associated with different salinity regimes are appropriately recommended for planting in suitable areas. Whereas *Rhizophora apiculata* and *Avicennia marina* are exclusive to high salinity (>15 ppt.) areas, *R. mucronata*, *Sonneratia alba* and *Excoecaria agallocha* are good for high to medium salinities (5-10 ppt) and *S. caseolaris*, a fairly large mangrove tree thrives in low salinity conditions (<5 ppt). The RS data using 2010 IRS p6 L4 MX 5M having resolution of 5 m, was useful in finding out distribution of only tree mangroves and not juveniles and shrubby forms, which need more higher resolution. The study of this nature, using GIS and remote sensing are handy tools for scientific planning and management of mangroves even at a micro-level. These tools are helpful in finding out alienation of potential mangrove areas for shrimp farming or other alternative uses. For instance in the Aghanashini estuary 2973 ha of intertidal areas have been diverted for shrimp farming, rice cultivation and salt production. The applicability of such modern techniques to micro-level mapping of mangroves, for depicting potential mangrove areas,





assessing threats to mangroves through diversion of mangrove areas etc., for the relatively smaller west coast estuaries and creeks, is expected to pave way for increase in area under mangroves and improve the efficiency of mangrove management even at the village level.

Keywords: Coastal ecosystems, Mangroves, Estuaries

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Spatio-Temporal Dynamics of Raichur City

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Land use changes are irreversible changes and directly influence the regional and global environmental quality. Urbanisation is one of the major driver of land use land cover (LULC) changes. Planned urbanisation would help in maintaining the environmental quality and sustenance of natural resources while meeting the demand of population in cities. However, unplanned urbanization in most of the rapidly urbanising cities has caused serious concerns in both environmental quality and on human's livelihood due to urban sprawl. Urban sprawl refers to the uncoordinated land use resulting from lack of integrated and holistic approach in regional planning. Information related to the rate of growth, pattern and extent of sprawl is required by urban planners to provide basic amenities. This paper discusses land cover and land use dynamics of Raichur a tier II city in Karnataka. Spatio-temporal land use changes have been analysed for Raichur city with a buffer of 2 km. Land cover changes have been analysed using distance based vegetation indices, which indicated vegetation to be 45.43% through MSAVI2 in 2009. Land use analysis show during the period from urban area has increased from 3.14 to 8.87%.

Keywords: Raichur, Land use, Land cover, Urbanisation.



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Disasters



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Societal Risk Assessment of Toxic Chlorine Gas Release Scenario – A case study for Incident Modeling with ALOHA Software

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A societal risk assessment study has been carried out for recent chlorine gas release scenario in Mumbai. Significant quantities (about 141 Numbers) of chlorine gas tonners were stored in an open yard, out of which one tonner leaked chlorine gas into the environment. Considering the toxic and corrosive nature of chlorine as a study has been carried out on chlorine leak scenario and its subsequent dispersion along with its effect distance. Chemical Exposure Index (CEI) is calculated to find out Hazard distance (HD) for the release for various levels of concern as per Emergency Response Planning Guidelines (ERPG-1, ERPG-2, ERPG-3).

The chlorine gas release scenario is simulated using Areal Locations of Hazardous Atmospheres (ALOHA) Software. Weather data has been considered based on the atmospheric data on early morning (3 am) 14th July 2010 (i.e. day of release incident) obtained from meteorological data. Various Scenarios of releases are assumed and different wind speeds and stability classes are considered to simulate the scenarios. Based on the site map of the incident spot (point Source of release) threat zones are generated. The effect distance and postulated exposures on population and inhabitants around the vicinity of the site of release is studied. The emergency preparedness and disaster mitigation measures to handle such emergency situation are assessed from the above study. It is estimated from the analysis that around 270m is the most affected distance (ERPG-3) due to the release which is matching with actual release scenario.

Key words: *Societal Risk, Chemical Exposure Index, Hazard Distance, Chemical Disaster, Chlorine leak, wind stability,*

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An Appraisal of Community Based Coastal Hazard Management

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Barrier coasts are one among the most vulnerable coastal stretches due to the proneness to sea and backwater, the low elevation, increasing sea level rise and the relatively of recent origins. Most of



such regions in kerala are occupied by the fishermen community, the most marginalized groups in the State. The current study conducted at Mayyanad, a coastal panchayath in Kerala along the southwest coast of India, aims to identify the potential coastal hazards of Mayyanad and its impact on coastal community, along with mapping the vulnerable zones of the barrier coast and develop appropriate disaster management strategies to the area. Primary information on land use, morphology and the impact of potential hazards were collected through field mapping, toposheets and satellite imageries. The extracted information and field data were presented in map form using GIS analysis.

The coastal areas of Mayyanad are at risk from natural, coastal and ocean triggered hazards due to its characteristic morphological and demographic set up. The manmade hazards are in addition to these. The major coastal hazards that have occurred or have the potential to occur along the Mayyanad coast are, severe monsoon waves, coastal erosion, coastal flooding, sea level rise, tsunamis, storm surges/cyclones, coastal earthquakes, saline intrusion, epidemics and other anthropogenic activities. Among these monsoon waves, coastal erosion and coastal flooding being very frequent coastal hazards. The study area was divided into four ecological zones according to the geomorphology and the zone 3 and 4 were found most vulnerable to coastal hazards. The study suggests the strict implementation of CRZ rules for de-congesting the barrier beaches and other hazard zones. Coastal MIA (Morphological Impact Assessment) should precede the construction of any coastal protection measures.

Key words: *coastal hazard, vulnerability, MIA, Disaster management, CRZ.*

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Identification of Accident-Prone Areas Through Sinuosity Index for the Management of Road Disasters – A Study of the Major Roads to the Sabarimala Pilgrim Destination, Kerala, India

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The development of public transport system in Kerala has not kept pace with the demands of traffic both in terms of quality and quantity. Road accidents claim the lives of well over a million people per year around the world and has become a serious problem for a developing country like India. The motor vehicle population in Kerala almost doubles every 5 to 6 years and the state has the dubious distinction of having the third highest road accident risk amongst the Indian states. The number of pilgrims visiting the Sabarimala temple in Pathanamthitta district of Kerala during the pilgrim season is almost equal to the population of the state. A series of road accidents are reported from the routes to Sabarimala, every pilgrimage season. The unique geographical condition of the terrain including steep



slopes and hairpin bends in the roads increases the vulnerability. The present study evaluates different factors in road accidents in these stretches and identifies the accident-prone stretches through Sinuosity Indexing Method (SIM) in a GIS platform. The main accident prone areas are identified in 500 and 50 m stretches from the sinuosity values. From the study it is concluded that the Sinuosity factors such as (i) restricted visibility around the curves, (ii) speeding vehicles not being able to negotiate the curves, and (iii) exhaustion induced by negotiating recurrent curves are responsible for road accidents especially in the hilly areas. An effective hazard management strategy for preventing the road accidents in the area is suggested.

KEY WORDS: *Road disasters, Sinuosity index, GIS, Hazard Management Strategy.*

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Soil Piping in Idukki District: Chemical or Physical?

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Soil piping (tunnel erosion) is a soil related natural disaster. It is a type of subsurface erosion involves the hydraulic removal of subsurface soil causing the formation of an underground passage in landscape. It takes several years to develop and visible when the roof of the soil collapse. The objective of the study is to assess whether the soil piping in Idukki district Kerala is physical or chemical, analyze the factors influencing the phenomena, and to suggest the management strategies. Four sites (Peringasserry, Thattekkanni, Udayagiri, and Kulamavu) were selected for the study. Soil samples were collected and analysed for physical (texture, bulk density, moisture content, infiltration rate and pH) and chemical parameters (available nitrogen, available phosphorous, sodium and potassium). Soil piping reported from these four sites have significant difference in terms of physical and chemical properties. Thattekkanni, Kulamavu and Peringasserry, are structurally controlled hence the piping is physical but in Udayagiri it is chemical because of the presence of high concentration of sodium has attributed to the development of piping. In the sodium affected soils of Udayagiri, the water percolates down significantly at the beginning and after that its permeability attains stagnancy within a short span of time. While at Kulamavu, the percolation rate is very less and it follows a steady manner due to the difference in chemical characteristics of soil. Along with soil texture and infiltration rate the degree of soil column development, slope and relief of the area and the occurrence of incessant rainfall over a short span of time are the common factors, which had influential contribution to soil piping. The result clearly suggestive of the influence of the nearby lineament in the development of soil pipes at Thattekkanni, Peringasserry, and Kulamavu especially when the recent earthquake records are taken in to consideration. Pipe collapse in these sites may be due to the stress induced dilatation found associated with the subsurface aquifer. Various management strategies were also put forward to reduce the phenomena.



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Impact of Wetland Reclamation on Local Groundwater Levels in and Around Kottayam, Kerala, India

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The western parts of Kottayam district in Kerala is gifted with the Vembanad lake and the surrounding low and upper Kuttanad wetland-cum-agrarian ecosystem. The area is the habitat of numerous endangered aquatic species, both plants as well as birds. Due to the scarcity and high land value owing to increased tourism activities, reclamation activities are rapid here. The present study includes the estimation of soil-water balance of selected locations to estimate the loss of soil water. Seventeen soil samples were collected from reclaimed areas, locations close to water bodies and locations distant to water bodies. A ground water survey of water levels from open wells was also conducted. The results were used to assess the effect of reclamation on the local water levels and aquifer properties of the soil. The reclaimed area in the different parts of the study area has been plotted on maps prepared with Survey of India Toposheets 58C/6 and C/10. The study has revealed that (1) Storage capacity of the aquifer is decreasing (2) Water levels open wells are lowering. (3) The drainage system of the area has been anthropogenically modified resulting in flash floods and water logging (4) The areal extend of paddy field has decreased.

Key words: *Aquifer, Reclamation, Soil properties, Vembanad lake, Water balance*

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An Assessment on Intrinsic Vulnerability to Flood Hazard of River Killiar in Thiruvananthapuram District

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Background: The high intensity rainfall on 30th December 2011 resulted flash flood in various parts of Trivandrum city of Kerala. The present study focuses on the assessment of the flood vulnerability of one of the affected locations, the Maruthankuzhy area of the District.





Methodology: The vulnerability assessment was carried out through the analysis of the primary and secondary data. The primary data collection has been done through direct observations interviews and questionnaire surveys in the flood affected area. The secondary data has been obtained from census reports, rainfall statistics and small scale hazard zone maps. Survey of India Topo Sheets (1:50000 scale) and watershed atlas of Centre for Water Resource Development & Management, have been used to prepare the base map of the area, with the help of the GIS Platform.

Principal findings: The study revealed that the river Killiar posses an intrinsic vulnerability to flood in the Maruthankuzhy area. The month of December in the year 2010 and 2011 witnessed high intensity rainfall, in the catchment of Killiar watershed, resulting water inundation in the study area. The annual rainfall statistics of past 5 years supplemented the inference that the heavy rainfall is the main causative factor of the flood. The people have the tendency to live in the urban area of the district, without considering the environmental risk factors or the vulnerability aspects. It is the reason behind the high population density of the study area which is a low lying - flood prone region. In general, natural disasters are said to affect more on the economically weaker section of the community. But the affected people in the study area are economically sound. The congested buildings without proper garbage disposal facilities could raise the issues of waste management, which may cause for the public health problems, in the post disaster phase. The basic needs like drinking water supply, transportation facilities etc were also seemed affected in flood situation. The awareness level towards mitigation practices or pre disaster preparedness to flood hazard seems very low in the study area.

Conclusion: The risk factor associated with a society can be reduced by minimizing, either the vulnerability or the exposure. In order to reduce the risk of the people residing in the Maruthankuzhi area, it is recommended to have the mitigative measures such as floodwall construction, channel straightening, channel widening or embankment construction which may inculcated with the developmental activities of the Local Self Government, depending on the geomorphology of the location. The Community Based Disaster Preparedness would be the apt methodology for the induction of awareness on preparedness, as part of developing the non-structural mitigation practice, which caters the enhancement of the knowledge base of the people to cop up with future flood hazards.

Key words: *Flash Flood, GIS, Intrinsic Vulnerability, Inundation, Rainfall*

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Multipronged Community Risk and Disaster Management: A Study on Public Safety, Governance and Corporate Social Risk Reduction Initiatives in the Vypin Island, Kerala, India

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Kerala State is highly prone to diverse types of hazards especially the coastal areas. As part of the Kerala State Disaster Management Policy, it is envisaged to deal with disasters in a multi-hazard perspective with interagency cross-sectoral cooperation. It aims to identify the hazards, vulnerability and the possible risks in a proactive manner and prepare the communities, administration, the government and all other stakeholders against the consequences of disasters and equip them with emergency resources as well as mechanism for implementing these plans. The present project study would help in focusing on the hazard risk scenario of the coastal belt of the Kerala State and would make recommendations / suggestions for reducing these risks. It will also emphasize on role of local communities in identification and prevention / control of disaster incidences as well as impacts in these areas.

In most cases, the developmental activities will stop at the middle of the path or it will finish without a proper plan of sustainable development. Especially in the study area, the urgent need of the community is in public health, sanitation, livelihood, shelter etc. Vypin Island is one of the significant area which was affected by the 2004-Tsunami and still struggling due to many manmade and natural disasters which need location specific scheme for disaster management. Awareness creation, education and sustainable basis of job opportunities are possible ways to manage the situation. Sanitation and waste management is another threatening problems, housing colonies like 'Tsunami colony', the people using the canals to disseminate the septic tank waste. Due to the particular kind of geology of this area, instead of pipe water supply and other underground water supply systems, this area need rain water harvesting facilities. Houses within the CRZ are experiencing coastal flooding throughout the year. Improper drainage systems and damaging of existing canals by manmade constructions are the main reasons. The Rs.10 Lakhs being spent by the government for mosquito control each year is only as the temporary measure. The fund has to be convert to make a workable plan to reduce flooding and mosquito in a tenable manner. Butcheries and Food catering facilities need certification otherwise they will continue working without proper systems in waste management. Women empowerment activities in this area should develop in order to make a sustainable source of income in the family. Media can help to report the exact situation to the outer world, and it can make certain impacts that can help to make aware of state and central government in these matters. Corporate community can be a good stakeholder in Disaster Management activities. It needs proper communication, information data basis, information dissemination and updating of information. The work had won its objectives by creating certain changes in governance system by putting forward the major problems in the area. It also achieves its goal in making corporate social risk reduction initiatives and awareness creation in most densely populated Island of Asia.



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Pollution-II



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Soil Heavy Metal Human Exposure Risk- A Case Study from Coal Mining Area

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Coal and allied industries are backbone for industrial development, especially for a developing nation like India. A major portion of Indian coalfields are situated in the north eastern states –Jhrakhand, West Bengal, Odisha, and Chattisgarh. A coal mining area of Damodar Valley, Jhrakhand is studied for the human exposure risks due to mining operations. Soil samples were collected and analysed for toxic metals like As, Be, Cd, Co, Cr, Cu, Mn, Ni, Pb, Se and Zn. 29 soil samples of Open cast mine (OCM) and 14 underground mine (UGM) soil samples were collected and analysed. Among the heavy metals Mn was found to be in the highest concentration (1494 mg/kg in OCM and 1238.8 mg/kg in UGM) then Cr (345.8mg/kg in OCM and 93.54mg/kg in UGM). Other metals of high concentrations in mine soils were Co, Ni, Pb, As, etc. These concentration values were used for calculating the target hazard quotients (THQs) which entails on the possible health risks to nearby inhabitants. For OCM soils high THQ value was observed for Cr, followed by Co, As and Pb. The lowest THQ was observed for Se. In UGM also the pattern was found to be the same.

Even though the inhabitants in the surroundings of both underground and open cast coal mining areas are exposed to the toxic heavy metals as shown by the results, the risk values are below the dangerous values ascribed by USEPA reference dose exposure assessment. Risk assessment values for both the underground and open cast mines were showing almost the same values. But before coming to a solid conclusion, overall health assessment is to be conducted by considering other pollutants of concern like POPs (persistent organic pollutants). It can be achieved through site specific analytical operations and target oriented health survey.



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Rapid Assessment of Persistent Organic Pollutant, Sulfamethoxazole in Aquatic Ecosystems, Using Surface Plasmon Resonance Based Biosensors

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One of the main sources of persistent organic pollutants in the aquatic environment is antibiotics. Sulfamethoxazole (SMX) is an antibiotic that is resistant to environmental degradation, hence widely found in the environment. The conventional methods of detecting SMX use the principles of spectrophotometry and chromatography which are laborious and time consuming. This paper describes the modified version of strip biosensor that could rapidly assess the presence of SMX in water samples. Noble metal nanoparticles exhibit unique optical properties due to the existence of surface plasmon resonance (SPR). Several applications such as surface-enhanced spectroscopies, lithography, biological and chemical sensing has emerged based on this phenomenon. The colour (optical transmission) of transmitted light from an array of gold nanoparticles depends sensitively on the size, shape and the dielectric environment surrounding the nanoparticles. Owing to the SPR phenomenon that gold nanoparticles exhibit, it finds a place in the field of making novel biosensors. Antibodies that specifically bind with SMX (analyte) are immobilized in gold nanoparticles which are in turn immobilized on to the inner surfaces of two transparent plates that are placed vertically parallel to each other. When the water sample is introduced, the analytes bind to the antibodies. White light is then transmitted from other side of the plates. The analyte-antigen binding excites the surface plasmons that cause a shift in the SPR wavelength which is reflected as a colour change of the transmitted light. The size of the gold nanoparticles is tuned such that the human eyes could capture even subtle variations in the colour. This method of biosensing is rapid and portable, hence could be extensively used in monitoring pollution caused by SMX in aquatic environments.

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Lake Water Quality and its Interaction with Aquifers in Warangal City

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Good quality of water is required for all living organisms. Water is one of the most abundantly available resources in nature, which man has exploited more than any other purposes for sustenance of life. Nowadays due to increased human population and human intervention, the water quality is deteriorating everywhere. The quality of water provides current information about the concentration of various solutes at a given place and time. These parameters provide the basis for judging the suitability of water for its designated uses and to take corrective measures to improve its quality. Unequal distribution of water on the surface of earth and fast declining availability of usable fresh water are the major concern in terms of water quality and quantity. The study of different water quality parameters is important for understanding the metabolic events in aquatic ecosystem. The studies when done from time to time may indicate the favorable or unfavorable changes occurring in the ecosystem.

There are three major lakes in Warangal city namely Dharmasagar lake, Waddepalle lake and Bhadrakali lake. These three lakes are prime sources of drinking water to city people. The paper presents the study carried out on physico-chemical analysis of lake water and its surrounding aquifer system. The study is a part of satellite research project sanctioned to National Institute of Technology Warangal by CWRDM, Kerala and Department of Science and Technology, Government of India, for the period 2010-2013. A case study of Waddepally lake is presented here.

The Waddepally lake is situated near Kazipet Town in Hanamkonda Mandal of Warangal city in Andhra Pradesh. The Warangal city is located between $79^{\circ} 32' 4''$ E to $79^{\circ} 25' 13''$ E longitude and $17^{\circ} 59' 10''$ N to $17^{\circ} 55' 11''$ N latitude. The catchment area of Waddepally lake is about 44 km^2 and its elevation ranges from 275 to 300 m above mean sea level (MSL). The watershed receives an average rainfall about 900 mm. A 15 MLD capacity of water treatment plant is constructed on the bank of Waddepally lake by Municipal Corporation of Warangal for the supply of treated water for the part of Kazipet and Hanumakonda region for drinking purpose. The lake, in addition to its own catchment, is filled with River Godavari water which is carried from Lower Manair dam through the Kakatiya Canal, flowing over a distance of almost 80 km. The geological formations of the watershed area include granites and granite gneisses with intrusion of dolerite dykes, shales and sandstones with intermittent coal formations. Water samples from the lake and surrounding wells are collected on monthly basis before and after monsoon periods to observe the spatial and temporal variations of environmental isotopes and hydro-chemical parameters. Temperature, pH, EC, etc., of the water samples are measured on site. The major chemical ions, viz., sodium (Na), potassium (K), calcium



(Ca), magnesium (Mg), iron (Fe), chloride (Cl), fluoride (F), sulphate (SO_4), nitrate (NO_3), carbonate (CO_3), bicarbonate (HCO_3) in the groundwater samples are measured using spectrometric, electrode-specific and titrometric methods. It is observed that quantity and quality of water in the lake is being affected due to urbanization. The lake also has an impact on the groundwater quality in the neighbourhood of the lake.

Key Words: *Lake, Groundwater, water quality, major ions, isotope techniques.*

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Agrochemicals and Their Impacts on the Environmental Health Status

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Grand entry of agrochemicals especially pesticides, has been a major step in agroeconomy towards the growing demand for crops along with population explosion and amelioration of pest attack and diseases, thereby meeting the productivity demand. With credits, agrochemicals have brought many debits along with, in the form of adverse impacts on the entire ecosystem where it has been employed. Much of the debits came into being because of their lack of target specific action, making it lethal to non targeted species including human beings. Health risk gradient of environment by the agrochemical used gets magnified when it comes to ill trained users. When applied to any of the environmental compartment they tend to pass to other adjacent compartments. Persistence and mobility from the site of application of agrochemicals has been made evident by its presence in various environmental matrices, such as soil, water and air. Mobility of agrochemicals from the site of application to non targeted environmental compartments, their accumulation in those compartments are major concerns due to its potentiality in causing negative impacts on the environmental sustainability and health of ecosystems. Severity of adverse effects depends on the residue level present which in turn is determined by the degradation potential of that specific compound present. Bioaccumulation and biomagnification that occur has even worsened the adversities. Probability of agrochemical movement, accumulation and off-target effect varies mainly with the changes in physical and chemical properties of the compounds used, chemical handling practices and the site characteristics such as soil, geology, vegetation type and density, prevalent environmental conditions at the time of application and thereafter and crop management systems. Unscientific as well as greater intensity of usage has affected the quality of commodities produced.



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Impact of Hydroelectric Dams on Fisheries in the Sharavathi Estuary of Uttara Kannada District, South-West India

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Power generation or multipurpose dams can cause various impacts downstream. The impact of hydroelectric projects on estuaries, rated among highest productive ecosystems, is not much documented more so from Indian west coast. The start of the Linganmakki hydel project in 1964, with an installed capacity of about 1000 MW, in the river Sharavathi flowing westwards into the Arabian Sea from the central Western Ghats of Karnataka, is known to have caused widespread downstream ecological changes due to yearlong releases of fresh water after power production, affecting mainly estuarine salinity and tidal conditions causing alterations in mangrove flora and decline in fisheries. The addition of another smaller dam at Gersoppa further downstream exacerbated the problems. Most such impacts went almost undocumented until the current study.

The impact on fisheries in the Sharavathi estuary consequent on dam discharge related salinity reduction is discussed here in comparison with the adjoining dam unaffected Aghanashini river estuary within 20-25 km north. Prevalence of typical natural estuarine conditions in Aghanashini accounts for about 90 species of fishes, in addition to shrimps, crabs and edible bivalves. These conditions include gradual reduction in salinity from the river mouth towards the upstream areas, seasonal and daily fluctuations in salinity favour entry of several marine species into the estuary at suitable times for breeding and feeding. Whereas input of vast quantities of organic nutrients, especially from Western Ghats, characterise Aghanashini, bulk of such inputs are blocked by dams in Sharavathi. Stretches of multi-species mangrove swamps and food and nutrient-rich mudflats favour higher fish diversity and catches in Aghanashini. Sharavathi estuary has barely half the number of fishes, most of low brackish water conditions or those tolerant of wider fluctuations in salinity like *Arius arius*, *Sardinella fimbriata*, *Mugil cephalus* etc. Sharks and rays and other marine fishes like kingfishes and Indian anchovies avoid Sharavathi altogether. The occurrence of fishes of fresh water or nearly fresh water conditions, like *Puntius filamentosus*, *Terapon jarbua* etc. are result of dam related fresh water flow into the estuary. Gathering of edible bivalves, a major economic activity in Aghanashini estuary has gone extinct in Sharavathi.

Whereas the open estuarine part of Aghanashini, measuring 1977 ha, excluding saltpans, rice, and aquaculture, has annual fisheries (including bivalves) to the tune of estimated Rs.1,095,072,000, at Rs.553,905/ha, in Sharavathi, 977 ha of open estuary produces only Rs.12,852,500 worth, at an abysmally low of Rs.13,155/ha in comparison. Shrimp aquaculturing is widespread in Aghanashini, while practically non-existent in Sharavathi. The study highlights the need for caution on execution of



hydroelectric projects in the west flowing rivers from Western Ghats to avoid fisheries collapse and dislocations in local livelihoods and economy.

Keywords: *Coastal ecosystems, livelihood, fishery, estuary*

L - 90

A Statistical Modeling Approach for Forecasting of Tourism Developments and Its Impacts on Biodiversity on the Largest Wetland Ecosystem in South India

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Tourism has become a significant source of foreign exchange revenues for many countries including some least developed countries and island economies. *Tourism 2020 Vision*, published by the World Tourism Organization, forecasts that international arrivals will reach nearly 1.6 billion annually by the year 2020. The quality of the environment is essential to tourism. However, tourism's relationship with the environment is complex. It involves many activities that can have adverse environmental effects. At the Rio Earth summit in 1992 loss of biodiversity was recognized as one of the major environmental challenges faced by humankind. While recognizing the fact that tourism should certainly be part of the efforts for sustainable use of bio-resources, it has to be acknowledged that the impact of tourism on bio-resources can be detrimental in several ways. The need for the proper management of tourism is thus essential for its development.

During the last two decades Kerala has been experiencing consistent growth in the case of tourist arrivals with corresponding changes in infrastructure and supporting facilities. Kumarakom, located on the eastern bank of Vembanad Lake in central Kerala is a fast developing tourist centre, falling within $9^{\circ} 33' & 9^{\circ} 40'$ N latitudes and $76^{\circ} 22' & 76^{\circ} 30'$ E longitudes. It covers a total area of 234.6 km². The village of Kumarakom is a cluster of small islands on the Vembanad Lake, and is part of the Kuttanad region - the rice bowl of Kerala. Most of the area has been reclaimed from the Vembanad lake and hence it is an interface of alluvial and estuarine systems.

Methodology/Principal findings:

Forecasting the demand for tourism is essential for tourism planning at all levels in the tourism industry, from the government right down to the small operators. In order to provide satisfactory services to tourists, reliable forecasts of future demand are necessary so that appropriate levels of accommodation, transportation and service personnel can be acquired and other critical infrastructure like airports and seaports can be built, upgraded and maintained. Time series models only need the variable being forecast. Therefore, the required information is minimal. This is useful when the required data for such analysis tend to be scant or incomplete.

Data for the analysis in this study was collected from various sources such as Panchayath and Municipal development reports, data collected from interviews and questionnaire surveys among





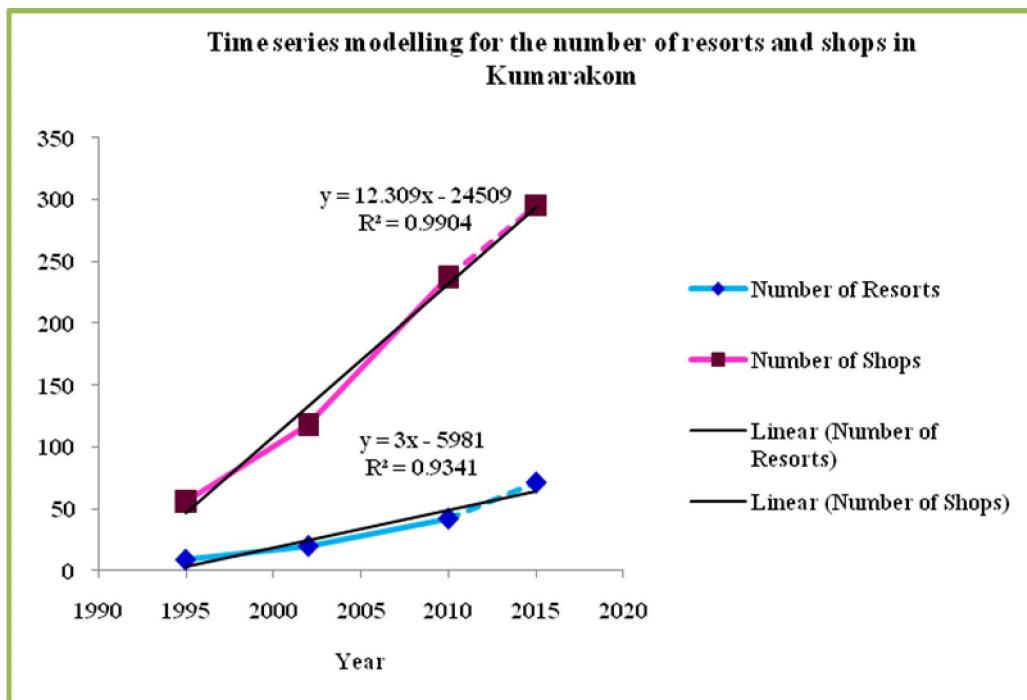
different age groups of resident population and local government authorities. A time series model was fitted for the number of resorts in Kumarakom as dependent variable. The model was found to be very good since R^2 is 0.93 using this model. The study has predicted the number of resorts in 2015 to be 71. The model was found to be very good for shops since R^2 is 0.94 using this model. The number of shops was predicted to be 292 in 2015. Time series model for resorts in Kumarakom ($R^2 = 0.99$) indicated a highly significant growth (71 resorts in 2015). A similar trend was also shown by shops (295 in 2015, $R^2 = 0.93$).

Conclusion/Significance:

Vembanad lake was identified as one of India's Important Bird Areas; the heronry covers 0.45 km² (112 acres), which is 14 km west from Kottayam. Vembanad - Kol - Wetland – System, one among the three Ramsar sites of Kerala (November 2002), is the largest estuarine system of the western coastal wetland system. The floristic diversity of the study area includes 14 mangroves and more than 30 mangrove associates. Wetlands support diverse fauna, including a large variety of fishes, prawns, clams, reptiles and birds and offers habitat for both anadromous and catadromous fish species. 102 species of fishes were identified which mainly consist of mullets. Molluscs including black clam, mussels and brackish water oysters occur abundantly in backwaters and river mouths. Vembanad-Kol form nursery for shrimps like *Penaeus indicus*, *P. monodon*, *Metapenaeus dobsoni*, *M. monoceros*, *M. affinis*, *Macrobrachium rosenbergii*. Marine prawns (Penaeidae) are being exploited both in the marine and estuarine waters. The crustaceans include edible crab *Scylla serrata*. Vembanad supports the third largest population of more than 20,000 waterfowls in India during the winter season. The area has its own unique eco-hydrological features; hence developmental activities should take cognizance of these unique features, which will otherwise lead to ecological disaster.

At present there is high pollution status in the lake because of heavy discharge of sewage from hotels and house boats. The new resort constructions also demands more fresh water, which leads to over exploitation which may further increase salt water intrusion resulting in water scarcity. Thus the present time series model and forecasting clearly point out that the future developments to the area should be under further studies and analysis.





L – 91

Conservation and Management of Akkulam - Veli Lake for Inland Navigation and Tourism

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Akkulam-Veli Lake is located 5 km northwest of Thiruvananthapuram, and comprises of two lakes, separated by a ridge. The lake on the east is connected to the sea through an outlet called Pozhi, which remains closed except during monsoon season. The lake is having an area of about 75 ha. The lake system has no perennial inflow but receives runoff from a small catchment of about 1089 sq km from eastern side of Akkulam Lake. Amayizhanjan Thodu brings considerable waste water, primarily domestic. The marshy, swampy and sandy areas around the lake have been extensively reclaimed. The lake is now highly degraded because of the inflow of waste water; high levels of siltation, extensive weed growth as well as the lack of flushing sea water due to sand bar formation at the Veli mouth. This lake is highly important for its navigability mainly due to the Trivandrum-Shornur (T S) Canal which passes through it, which on development forms part of the proposed extension of National Waterway -3 connecting entire Kerala.

The water quality in the lake is extremely poor as is evident from high BOD, COD and microbial contamination. The sewage system of Thiruvananthapuram covers only 40% of the total area, which has become obsolete. Out of the 112 mld sewage generated in the lake catchment, 90 mld is diverted to Valiathura sewage farms and the rest enters the lake. Water weeds are another problem for use of the lake for recreation and transportation purposes.





The assessment of navigation through the lake region was done through various methodologies including inventory, secondary data collection along with personal observations, site visits which were conducted in order to get data related to various aspects of wetland degradation of the lake and to understand the existing conditions and to assess the possibility of navigation. In addition to this, tourism related data has also been analyzed to understand the eco-tourism prospects. The water quality parameters included Water Conductivity, Dissolved Oxygen, Free Carbon Dioxide, Water pH, Turbidity, and Total Alkalinity and were studied through standard methods.

Conservation of natural resources through sustainable ecosystem management and planned development is the key to our secured future. The human settlements, negligence of the concerned authority, land reclamation, lack of maintenance and public effluent sources are the chief factors for the degradation of Akkulam Veli Lake.

The restoration program with an eco-system perspective through best management practices help in correcting point and non-point sources of pollution. This along with regulations and planning for wildlife habitat and fishes helps in arresting the declining water quality and the rate in loss of wetlands. These restoration goals require intensive planning, leadership and funding with active involvement from all levels of organization through inter-agency and inter-governmental processes instrumental in initiating and implementing the restoration programs. A wetland conservation strategy should therefore have an extensive bias of participatory process. The proposed restoration measures includes dredging/desilting of the lake bed for making it navigable, sewage and other solid waste management system, Opening of the sand bar at Veli, Lake shore development for tourism, Mangrove protection and a biodiversity park.

Apart from governmental regulations, better monitoring mechanism is needed to increase the knowledge of the physical, chemical and biological characteristics of wetland resources, their values and a better understanding of wetlands dynamics. Management based on accurate knowledge and increased awareness of wetland issues involving all stakeholders and all components of ecosystem help in long term sustenance involving restoration and conservation.

Key Words – Akkulam- Veli lake, Thiruvananthapuram, conservation, inland water transport, tourism)

L – 92

Environmental Issues in an Around Loktak Lake for Sustainable Environmental Management

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Wetlands are widely considered to be one of the most biologically productive ecosystems of the biosphere. The state of Manipur is known for Loktak Lake (wetland) the largest fresh water lake in North east India covering an area of 40 km² is one of the Ramsar sites in the country located between 93° 46' - 93° 55' E and 24° 25' - 24° 42' N. The Keibul Lamjao National Park is world's only floating



national park and last natural habitat of Manipur Brow antlered deer *Cervus eldi eldi*, locally known by “Sangai” has its natural habitat in floating wetlands locally known as Phumdis. However, for the last few decades the lake has been facing all round destructions due to both natural and anthropogenic activities which led to severe pressure on the wetland ecosystem which has threatened the lake to survive. Wetland restoration has received great attention from urban planners and managers, and many wetland restoration projects have been implemented including the Loktak Lake. However, comparing with the other elements of urban ecosystem, such as urban landscape, urban rivers system, and green space system, research on wetlands planning has been lagging. There is generally a need for detailed technical guidance, specification and/or codes for wetlands planning. The restoration of wetlands is important to the development of a livable city. The Ramsar Convention on wetlands has long recognized the need to develop techniques that can fill gaps in baseline inventory and has supported the development and application of inventory techniques including the application of remote sensing and GIS. Applying remote sensing information is a useful tool for studying how land use change affects wetland distribution. Remote sensors couple with GIS provide a powerful systematic, synoptic view of earth cover at regular time intervals, and have been indicated as useful. The advantage of Remote sensing information is that they not only saves time but also enhances the possibility of classifying the vegetation through spectral and texture analyses. The integrated approach of Spatial and Biotechnology can be effectively used for the conservation and restoration of Loktak Lake.

Keywords: *Loktak Lake, Keibul Lamjao National Park, Phumdis, spatial technology*



Technical Session XIV

Environmental Education,

Sustainable Agriculture, Sustainable

Consumption

L - 93

An Economic Analysis of Food Consumption Pattern in India and Kerala

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The study on food consumption pattern is very important as it is related to poverty and standard of living of our society. Food being the foremost basic need gets the priority in the pattern of expenditure of people. It is necessary to study the changes in food consumption pattern under the changing situations of liberalization, modernization, privatization and globalization. The analysis of changing food consumption pattern over time would help in designing appropriate policies related to food production and distribution.

Food expenditure pattern is an excellent indicator of economic well being of people. If the society is wealthy proportionately high expenditure will be made on secondary necessities, comfort, luxury products and conspicuous consumption. On the other, if the society is at subsistence level, people will spend proportionately more on food.

The present work is a modest attempt to analyze changes in food consumption pattern and estimate the expenditure elasticities of demand for food in rural and urban India and Kerala. The household consumer expenditure data of the 50th round of the NSSO conducted in 1993-94 and 66th round 2004-05 was used as the main source of secondary data for the study. Percentages were calculated to analyze the changes in the pattern of food consumption over years.

The monthly per capita expenditure on food was Rs.286.1 during 1993-94 in rural India and it increased to Rs.927.7 during 2009-10, showing an increase of about 224 per cent over the two periods in rural India. The monthly per capita expenditure in urban India increased from Rs. 464.3 to Rs. 1785.8 witnessing about 285 per cent change over the two periods.

The monthly per capita expenditure (MPCE) on food was Rs.236 during 1993- 94 in rural Kerala and it increased to Rs.843 during 2009-10, showing an increase of about 257 per cent over the two periods in rural India. In urban area, the MPCE increased from Rs.266 to Rs.970, witnessing about 265 per cent change over the two periods. This was because food is basic necessity of life. Kerala food consumption is much higher in both localities rural and urban than national figures.

The data on quantity wise food consumption at two points of time for rural and urban India and Kerala was analysed only for cereals. Hence, the monthly per capita food consumption for cereals in terms of physical quantities was analyzed. The monthly per capita cereal consumption has declined from 13.4 kgs to 11.35 kgs in rural India, while the corresponding decrease in the urban India was





from 10.6 kgs to 9.37 kgs. In physical quantities, the monthly per capita cereal consumption has declined from 10.2 kgs to 8.7 kgs in rural Kerala, while the corresponding decrease in the urban Kerala was from 9.5 kgs to 8.1 kgs. From this, it was clear that the consumption of cereals has declined in both localities rural and urban of India and Kerala over the period.

Key words: *Consumption pattern, National sample survey organization, Monthly Per Capita Expenditure, expenditure elasticity, food consumption*

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Household Consumption of Water in Three Districts of Kerala- A Comparative Analysis

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Water plays an important role in the welfare of societies through its widespread linkages.

Water needs are complexly linked with the daily life and can be an obstacle to economic growth. The important aspects in this regard are (i) the availability of water for production and income generation; (ii) water for domestic needs, which have a significant role in maintaining human health; and (iii) sustainable environmental management. Many social, economic and environmental pressures threaten the sustainability of water resources over the last decade. As population increased and development intensified, water became scarce and assumed economic value as well. In addition, lowering quality of the available water resources has been aggravating the problem. In the last few decades, increasing demand for water led to inter-state and international frictions over water and competition among different sectors.

Kerala, having a population of 31.8414 million as on 2001, has an urban population of 82, 66,925 and 16, 53,385 households. There are 5 Corporations and 60 Municipalities catering to 26% of the state population. Therefore, the challenge lies in providing adequate safe drinking water to the urban population without affecting the rural sector. In Kerala, the rural sector resembles the semi-urban pattern in any other state. There is hardly any barrier between urban and rural except the revenue boundaries.

This paper examines the water consumption patterns for selected rural areas of Kannur, Ernakulam and Alappuzha districts in kerala. For the sample collection, Kerala has been divided into 3 regions for the present study. North Kerala (Kannur), middle Kerala (Ernakulam) and south Kerala



(Alappuzha). Each of these villages has its own agroclimatic and socio-economic conditions and hence, the sample selected also reveals these socio-economic features. From the 3 districts selected rural areas were selected for survey studies and were analysed statistically for the water consumption pattern of the areas. The method uses datasets were collected and allow water consumption patterns to be analyzed and examined.

Among the water users in different sectors, consumption by households has very specific Influence on human well-being. Even though the household consumption constitutes only eight per cent of the total water usage, the value of water for household purposes is reckoned much higher than the value of it for industrial use and farming. Hence, the providing potable water to all sections of the society becomes one of the major concerns of the governments in many of the developing countries.

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Distribution of Nutrients in the Soils of Kuttanad Wetland Agroecosystem, Kerala

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Kuttanad agroecosystem, once the rice bowl of Kerala, is facing a serious threat from human activities. The present study assessed the nutrient status of Kuttanad paddy soils and the spatial distribution of Nutrients using GIS technique. 117 soil samples were collected from the six agroecological zones of Kuttanad. Out of the 117, 92 were from paddy fields and 25 from canals. The soil samples were analyzed for pH, organic Carbon (%), available nitrogen (kg/ha), available phosphorous (kg/ha) available potassium (kg/ha). The results showed that, out of 92 sites, 77 showed high available nitrogen content, with a mean of 771.91 kg/ha, 75 sites exhibited high values of potassium with a mean of 326.41 kg/ha. Whereas the mean available phosphorous value was found to be 0.708 kg/ha indicating low fertility in terms of phosphorous content. The pH ranged from 2.47-5.16. The minimum and maximum value of organic carbon is 0.9-16.6%. In canals Out of the 25 sites, 20 sites showed high available nitrogen content, with a mean of 781.2 kg/ha, 9 sites exhibited high values of potassium with a mean of 326.41kg/ha. Whereas the mean available phosphorous value was found to be 0.710 kg/ha indicating , low fertility in terms of phosphorous content. The pH ranged from 1.64-4.74. The minimum and maximum value of organic carbon is 1.74-13.03%. The spatial distribution of nutrients showed that, high available nitrogen content was observed at various parts of the Kuttanad agroecosystem except Vaikom Kari, northern part of North Kuttanad and western part of Kayal Lands. A cluster of area including southeast region of Lower Kuttanad, northern part of Purakkad Kari and north east regions of Upper Kuttanad as well as north east part of Vaikom Kari has showed the highest concentration of phosphorous. The central portion of Kayal Lands, North Kuttanad, northeast and southeast corner of Purakkad Kari and Lower Kuttanad respectively where the high intensity of potassium occurred. It can conclude that monsoon flooding has a major role in the regulation of nutrients in the Kuttanad paddy fields. N and P are taken away from the soil by the inundated water where as potassium is deposited in these areas. The high concentration of nutrients





observed at the sites which are having more than one time cultivation and watering and dewatering has a significant role in regulating the nutrient status of the Kuttanad agricultural wetland ecosystem.

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Temporal Variation of Fish Fauna in Veli Lake, Kerala: A Historiacl Perspective

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The lacustrine ecosystems are increasingly transformed by human activities and the contemporary variations and loss in biodiversity are primarily due to habitat loss, pollution, climate change and introduction of exotic species. Coastal ecosystems are some of the most productive ecosystems in the world providing essential ecosystem goods and services such as high quality protein from fish.

We assessed the fish diversity of the Veli Lake situated in the southwest coast of India based on primary data collected during 2008 to 2010 and historical data available since 1976-1977. A total of 35 species of freshwater and marine fishes, classified under 9 orders, 26 families and 30 genera were recorded from the lake. Among the fishes collected during the present study, 20 were resident species and 15 marine forms, which migrate into the estuary while the sandbar is open. Comparing historical data on fish diversity of the lake, the variations were recorded both in species diversity and dominance of resident species. Eleven species, *Anguilla bengalensis bengalensis*, *Puntius ambhibius*, *Puntius dorsalis*, *Chela laubuca*, *Amblypharyngodon meletinus*, *Amblyceps mangois*, *Wallago attu*, *Clarias batrachus*, *Plotosus canius*, *Macropodus cupanus*, and *Hyporhamphus xanthopterus* recorded during earlier studies were not observed in our survey. The cichlid *Etroplus suratensis*, which once supported the fishery and the most dominant species in the lake was now replaced in dominance by the introduced cichlid *Oreochromis mossambicus*. The presence of exotic African catfish *Clarias gariepinus* was also recorded for the first time from the lake during the study. The number of active fishermen in the lake declined from over 200 to about 50 over the last three decades, primarily due to the decrease in fish fauna.

The paper explains the possible reasons for the temporal fluctuations in ichthyofaunal diversity of Veli Lake, including the dominance of invasive alien fish species, massive infestation of the water hyacinth *Eichhornia crassipes* and consequent silting of the lake, and pollution from different sources, and also proposes remedial measures for the sustainable management of fish diversity.

Key words: Fish diversity, exotic species, eutrophication, pollution, conservation



L - 97

Livelihood in the Wetland of Pulicat Lake, Spsr Nellore District, Andhra Pradesh

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Wetlands are the most productive ecosystems of the world occupying only 6% of earth's surface. They have important role in the ecological, economic, cultural and recreational aspects of livelihood. Both the socio-cultural and ecological aspects control the interrelationships between the wetlands and the people surrounding it. Pulicat Lake is the second largest brackish water lagoon after Chilika Lake of Orissa along the east coast of India. Estuaries and lagoons have brackish water which shows high biological productivity than fresh or sea water. Hence it has wide range of aquatic, terrestrial flora and fauna. Present paper aims at the livelihood of the people near and around the pulicat lake.

Pulicat Lake derived its name from a vernacular name 'Palaverkadu' means plants with many number of roots namely mangroves. The lagoon's boundary limits range between 13.33° to 13.66° N and 80.23° to 80.25°E, with a dried part of the lagoon extending up to 14.0°N.; with about 84% of the lagoon in Andhra Pradesh and 16% in Tamil Nadu. Pulicat lake extends in five mandals of Nellore district namely Tada, Sullurepeta, Doravarisatram, Chittamur and vakadu. The large spindle-shaped barrier island named Sriharikota separates the lake from the Bay of Bengal. Three major Rivers which feed the lagoon are Arani river, Kalangi river and Swarmukhi river. The Buckingham Canal, a navigation Channel is part of the lagoon on its western side. It is connected to the sea through three tidal inlets, one each at Tupilipalem, Rayadoruvu and Pulicat villages respectively, from north to south. Many visits and extensive surveys along with interviews of local people were employed to know the diversified livelihood of the local people.

The lake produces fish, prawn, crabs which are the major source of animal protein for surrounding populations and to other parts of the country and world also. The daily survival and livelihood of local people depend largely on fish catches from the lake. Livelihood comprises the capabilities, assets including both material and social resources and activities required for a means of living. Nearly 1 00,000 people depend on pulicat lake either directly or indirectly. Most important livelihood is fishing. Poor people, schedule castes and schedule tribes mostly yanadis are involved in fishing. 60% of them are permanent fishermen and remaining go for fishing only in the season. During non season they go for agricultural works. Fishing is largely done by men. Women are highly involved in trading fish in the near by villages and towns but their trading volume is small. Men dominate large volume, distant fish trading. Most of the long distance fish traders are not local but are people from other parts of the district whom are called as meddle men. Some are involved in drying of the fishes, prawns crabs etc. Other livelihood activities are agricultural labour, labour in sriharikota construction works, salt farmers, coal makers, toddy cappers, collectors of natural resources like molluscan shells etc.





Natural resources collected are exported to nearest towns or cities. Utilization of natural resources like shells, fame wood etc does not occur here.

Pulicat lake faces several anthropogenic, developmental, industrial and environmental issues threatening not only the livelihoods of fisherfolk and also the very survival of this ancient lake itself. Major threat for Andhra Pradesh part of the lagoon is pollution from sewage, pesticides, industrial wastes from numerous fish processing units and oil spills from mechanized boats carries through Arani and Kalangi rivers draining in to the lagoon. Siltation and complete closure of Mouths at Tupilipalem and Rayadoruvu leads to fluctuation in salinity and water level of the lake. It has maximum effect on Biotic component of the ecosystem. Hence pulicat lake is constantly threatened by both anthropogenic factors as well as natural factors. This results in the shrinkage of the lake area from 461 Sq.Km to 350 Sq.Km. and the depth of the lake also reduced from 3m to 1m. It has a lot of impact on the livelihood of the people around the lake. This ecological degradation of the lake has disrupted fish ecology hence decreasing livelihood opportunities. This study examined the changing livelihood and environment along Pulicat Lake. Many innovative programmes have to be developed to improve the livelihood of local communities.

Key words: Wet lands - Pulicat Lake – Livelihood – Fishing – Conservation.

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Reclaiming Paddy Cultivation and Reviving Natural Capital: The Cultural Logic and Social Process in a Kerala Village

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This paper is the summary of the author's experience with the small farming agrarian community in the upper Kuttanadu wetland region of Kallara, Kottayam district, Kerala. The paper in broad terms informs a multi-level social strategy for sustainable farming and other related activities, evolving in the region for the last few years. The collective of small farmers/tenants have organized around a principle of "**Reclaiming agriculture**" as a life strategy. This life strategy is in part denotes to the "reclamation" of a paddy culture of the past, with direct and immediate implications for ensuring sustained livelihoods to marginalized people, healthy environment, democratic dialogue among people of the region and reframing the state-people relations for bettering the land-people relations in this wetland region. At the outset, the need for uninterrupted supply of organically grown food at affordable price was the channeling force of the collective. Further, on a wider level, it also indicates to the role of the small cultivators as agents of new thinking on localizing remedies to serious questions relating to food security. Thus, explaining the local perception of reclamation through the stand point of the practitioners of this agrarian collective is the major task of this paper. The cultural capital of the fallow land cultivation movement and its later activities is key to the alternate local



initiative. The paper will address the ways in which the community creates an argument and inventory for the preservation of the natural capital in this wetland region and how the cultural capital is significant in this effort..

This paper will deliberate in detail on the cultural-social dimensions of the new-agrarian strategy of “reclamation”. Starting from the large scale cultivation of fallow lands (which remained uncultivated for around three decades), the initiative made frequent efforts for clean environment and making the water bodies free of pollution and suitable for transportation. This collective has successfully demonstrated the need for maintaining wetlands for better human, plant and animal life as well as sustaining livelihoods to a large number of people belonging to marginalized sections of the society. This development, in another way indicates to the importance of local wisdom and collective human activity in favour of protecting a wetland life system. It is also about a local perspective that emphasizes maintenance of inalienable factors of physical environment of wetlands. *Inter alia*, it also offers a critique of the dominant mode of human activity in the region and proposes an organic alternative model to revive the abandoned wetland systems in different parts of Kerala.

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Ecosystem Goods and Services in Uttara Kannada

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Forests provide various services classified as supporting services, provisioning services, regulating services and cultural services. Most of these services are underestimated or not estimated and are thus undervalued in policy decisions. This paper is based on the quantification of various provisioning services from forests such as timber, fuel wood, fodder, green leaf manure, medicinal plants and NTFP. The area under different types of forest is derived from remote sensing data. Quantification of forest goods has been done based on the data compiled from the division offices of the Forest Department and micro level studies (productivity, etc.). Market prices were used for valuing the goods. The valuation of forest goods and services at micro level is expected to explore the possibilities for more effective micro level planning. This helps in integrating the environmental services with the economic goals of the region while ensuring the sustenance of natural resources and maintaining intergeneration equity.

Keywords: Valuation, forests, Western Ghats, Provisioning services, Market price



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Scope for Solar Energy in Kerala and Karnataka

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Solar energy incident on the earth's surface primarily depends on parameters like geographic location, earth-sun movements, tilt of the earth's rotational axis and atmospheric attenuation due to suspended particles. The intensity of solar energy/insolation quantifies the solar resource potential or availability of a region. A techno-economic analysis of the solar power technologies and a prospective utilization of wasteland in each state demonstrate their immense power generation as well as emission reduction potential. Karnataka and Kerala are the neighbouring states located in south India which receive the annual average solar insolation over 5.5 KWh/sq.m/day. Since both the states are power deficit states where the annual energy consumption is more than the energy generated. Kerala state is located in Malabar coast which is a part of western coast of the country, which has a good potential for solar energy harvesting. Karnataka has a mixed geographical area including Konkan coast and Western Ghats with a very good solar potential. State witnessed for major power crisis from last few years and hence power harvesting from renewable energy sources could be the solution for this problem. Since both the states have similar energy using culture and increasing power mismatch every year, scope for solar energy is prominent. Also states have very good potential and favoring energy policies for various solar energy harvesting methods such as roof top solar photovoltaic plants, grid connected plants in wasteland, decentralized wind-solar hybrid plants, off grid solar plants etc.

Keywords: *Renewable sources, Energy, Solar Energy, Wastelands*



POSTER



P - 01

Household Consumption Pattern in Pathanamthitta Districts - An Assessment

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Kerala, the southernmost state in India, is widely acclaimed for its unique pattern of social development. Significant progress accomplished by the state in many spheres of social life, serves as a model to many other societies. Education, health and demographic indicators are but a few examples of the nature of social development in Kerala. No similar development has been witnessed in any other Indian States so far. The state has several distinct socio, economic and demographic features. Very often Kerala is equated with developed countries. The development experience of Kerala has been unique and reflects among several other things in its consumption patterns as well. It has received worldwide acclaim for its unique features often hailed as the "Kerala model of development". Admittedly, Kerala's development experience is unique in the sense that a high level of quality of life co-exists with a relatively low per capita income. The quality of life of people in Kerala is much above the average for the country. Kerala is at the top in the country in human development.

The present work consists an extensive questionnaire survey conducted among people of Pathanamthitta district of Kerala in order to assess the consumption pattern of various resources. In this work the consumption of various resources at household levels are assessed. The resources studied in this work are grouped in to two major classes: Food and Non-Food categories. Under food category, the expenditure incurred at each family/household level on purchase of food items or raw materials purchased for preparing food have been included. Under non-food items, this study mainly focuses on energy and water. However, the study has collected and presented the data on other non-food items like education, entertainment, communication, medicine, clothing etc. 180 households were surveyed in Pathanamthitta districts. The consumption pattern of the above mentioned resources among the population belonging to different income levels and living at urban and rural localities were carried out in order to assess any difference exists between these variables with respect to the consumption of resources.

The improvement in quality of life and the increase in consumption patterns have an unintended and negative impact on the environment causing generation of wastes far beyond the handling capacities of urban and rural governing agencies. The Cities and Municipalities in India are now struggling with the problems of high volumes of waste, the costs involved in collection and transportation of the



wastes, the disposal technologies and methodologies, and the impact of wastes on the environment.

Urban and rural household income data and consumption are highly correlated, as both variables are jointly affected by a host of other variables related to overall growth conditions—in the present study potential variables usually omitted in such studies were given considerable attention. The present study is aimed to find answers to the following questions: How much better off are urban households compared to rural households that consume more monotonous diets? How important are income effects in explaining differences in the range of goods consumed by households? These questions lie at the centre of attempts to measure consumer welfare, growth and inequality.

P - 02

Landuse as a Determinant in Carbon Source or Sink Capacity of Soil from a Climate Change Perspective: A Case Study

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Present work explores the role of landuse and landuse change as a determinant of the soil's ability to sequester and store carbon. Changes in landuse are foreseeable for serving the societal needs which alters the soil carbon stock. Delineating the aspect that determine the extent of the current soil carbon stock and the balance between carbon inputs and soil carbon losses and also the soil- landuse functional system is decisive in predicting the effects of future landuse change on the net greenhouse gas stability, and to the development of a strategy for 'carbon conscious' management of the land surface. A scientific basis for the understanding of the role of landuse and landuse change and current management aspects in carbon sequestration is therefore crucial to the sustainable management of the carbon reservoir.

We discuss the essential elements of what is known about soil organic matter dynamics that may result in enhanced soil carbon sequestration with changes in land-use and soil management. This data summary provides an understanding on the rates of SOC sequestration that are possible with management, and indicates the relative importance of the combination of specific soil types or series and landuse- as a functional system that influence the rates of organic carbon sequestration in soil.

The study is conducted in selected landuses of Kottayam district ($9^{\circ} 23'$ - $9^{\circ} 52'$ N latitude and $76^{\circ} 21'$ - 77° E longitude) of Kerala, India. The major soil series are: S1-Thapto-Histic Tropic Fluvaquents; S2-fluventic Dystrusteos; S3-Ustic Haplphumults; S4-Oxic Dystrusteps; and S5-mixture of Oxic Dystrusteps and Typic Tropofluvents. The results of the implication of various landuse categories on these soil series revealed that in S1, the paddy cultivation recorded maximum SOC (4.59%) whereas a reduction of 67 to 87 % were observed when this landuse is changed to mixed cultivation and plantation crops respectively. In S2 series also maximum SOC was sequestered under paddy cultivation (4.85%) and the SOC loss was recorded more under plantation (38%) than mixed category (34%). In S3, the variation was quite notable, as maximum SOC sequestered was under the mixed





landuse category (3.59%), whereas as the paddy and plantation land came under this series recorded as loss of 6.4 and 42.6 % respectively. In S4 series, a shift in the sequestration capacity was observed under various landuse categories. Maximum SOC storage was observed for forest land (5.5%) where the forest occurrence is unique and restricted to this series only. Apart from this conserved forest patch the remaining land were reverted to mixed land category which recorded a higher SOC (5.37%). The maximum loss was recorded under plantation (35.9%) followed by paddy cultivation (14.5%) when compared to mixed land category. In S5 series, grass land is the major category unique and restricted to this particular series and recorded the maximum SOC (5.86%). Conversions to plantations sites considerably reduced the SOC by 30% and that of mixed land were negligible (3.4%). The C turn over value computed as C_{Min}/SOC_{in} the S1 series ranged in the order: Paddy(3.002) < Mixed(8.54) < Plantation(13.44); S2 series: Paddy(2.767) < Plantation(4.34) < Mixed(4.71); S3 series: Mixed(3.43) < Paddy(4.58) < Plantation(6.06); S4 series: Forest(2.24) Mixed(4.02) < Plantation(4.48) < Paddy(5.73) and S5 series: Grassland(2.74) < Mixed(3.15) < Plantation(3.45) respectively. Variations were also recorded in the Nitrogen value and C/N ratio for each landuse category under various series.

The study revealed the significance of particular landuse category when employed under soil series with various characteristics. In S1 and S2 series, maximum SOC sequestration is found under paddy cultivation with minimum C turn over whereas the suitable landuse category for S3 is mixed cultivation. Native forest land recorded the maximum SOC sequestration potential (considering the SOC storage and Low C turn over) in S4 category, followed by mixed landuse. In S5 series, the native grass land category recorded maximum SOC storage and low C turn over and hence higher sequestration capacity. The implication of landuse change is clearly evident in this series as the conversions considerably reduced the SOC content. The study also reveals the negative implications of plantations on soil carbon storage since none of the series, sequestration was observed under this specific category.

Thus the study throws a light on the current landuse and landuse change scenarios, resulting in the net soil carbon sequestration and loss, emphasising the importance of decision making and appropriate landuse management strategies for making soil a better C sink rather than source by assigning apposite landuse to each soil types.

Keywords: Soil carbon, Landuse, soil carbon sequestration, soil series, carbon turnover.



P - 03

Survival Chances of Colony Forming *Microcystis* Sp and *Scenedesmus* Sp in Fresh Water Lake and Pond.

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Aim of the study was to understand the diversity and distribution pattern of micro algae in fresh water system represented by a closed pond and an open lake in the tropical region. This was an all season study inclusive of pre-monsoon, monsoon and post-monsoon in the year 2011 with sampling and analysis. Totally 10 genera of phytoplankton were identified and quantified in this study. Significant variations in hydrology were not observed with respect to seasonal changes. The nutrients were present in moderate level. There was species diversity of unicellular micro algae with respect to the season but the colony forming cyanobacteria *Microcystis* sp and green algae *Scenedesmus* sp were present throughout the study period. Colony forming *Microcystis* and *Scenedesmus* were found in the open lake and closed pond are quite often surviving and predominating. Gas vesicles of *Microcystis* sp and spines of *Scenedesmus* sp are helping these organism to float near surface water and get more advantage to carbon dioxide sequestration and photosynthesis. The floating mechanism of these two organisms is leading to the survival and predominance in fresh water system.

Keywords: *Scenedesmus*, *Microcystis*, colony forming microalgae, fresh water, floating mechanism

P - 04

Geochemical Signature of a High Altitude Wetland in Kerala

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Pookot Lake situated on the Western Ghat regions, is one of the major ecologically fragile wetland. To elucidate the quality of lake water, the samples were collected during pre and post-monsoon (2011), whereas grab samples were collected only during pre-monsoon. The physical and chemical parameters of water were found within the permissible range, as per BIS. The pH of the lake water and sediment found to be acidic in nature. The total organic carbon estimated from the sediment analysis is in the range of 1.6 to 4.4 % which is above the permissible limit. The correlation between





clay and organic matter ($r= 0.75$) in the study area depicts, the adsorption of organic matter by the finer fractions of the sediments which envisages the fact that clay is having more surface area for adsorption than the sand particles. The texture analysis along the study area reveals the extensive presence of mud having higher capacity for adsorption of organic matter, which may lead to organic pollution in this ecologically fragile freshwater lake. The Total Organic Carbon of the lake sediments validates the presence of organic pollution. As the lake is surrounded by different agricultural lands, it can lead to eutrophication. The result reveals that Dissolved Oxygen content of the lake water decreases with respect to temperature and depth and Biochemical Oxygen Demand is varying inversely with temperature and depth. The presence of organic matter and the decline in Dissolved oxygen level, the lake can be considered as Mesotrophic. Further analysis is needed to evaluate the extent of pollution in terms on toxic heavy metals.

Keywords: *Geochemical Signature, Dissolved Oxygen, Biochemical Oxygen Demand, Sediment characteristics, Pookot Lake.*

P - 05

Estuarine Bird Conservation in Uttara Kannada

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Uttara Kannada district towards centre of India's west coast, with over 410 bird species, accounts for 82% bird species of the Western Ghats-west coast region. The reason for such exceptional bird diversity is due to the richness of habitats that range from coastal and marine areas to evergreen to dry deciduous forests of the Western Ghats, scrub and grasslands, rivers and lakes and so on. Of the coastal habitats the estuaries, mainly of four important rivers account for about 170 bird species. The estuaries are richly productive areas, abundant in food reserves for the birds, in the form of various invertebrates, fishes etc. The mangrove vegetation, growing in dense entangled patches makes ideal homes for birds. The mudflats produce huge quantity of bivalves and gastropods. About 50% of these birds are winter migrants from Eurasia and Himalayas and local migrants. Some of these birds like parakeets, doves, Indian koel, crow pheasant, Indian jungle myna, Indian tree-pie etc. are relatively common ones and not habitat specialists. Of the winter migrants may be mentioned European kestrel, brown headed and black headed gulls, slenderbilled gull, sandpipers and plovers, ducks and teals. Of the resident water associated birds are cormorants, herons, storks and egrets. The rare mangrove-inhabiting kingfisher (*Halcyon pileata*) and rare visitors to the salt pans such as the black stork



(*Ciconia nigra*) and brahminy duck (*Tadorna ferruginea*) are notable of the estuaries. More than 5000 ducks, including pintails (*Anas acuta*) and garganey (*Anas querquedula*), over-winter in the reed covered marshes of Aghanashini. The bird population and diversity of estuarine areas had suffered serious setback over last few decades due to abandonment of cultivation of estuarine rice in favour of shrimp farms, steady destruction of mangroves and various other human activities. However the situation is reversing due to intense efforts over the last few years by the Forest Department on mangrove planting, formation of local committees for protection of mangroves and the spread of general awareness among the local population.

P - 06

Roadside Trees of Uttara Kannada District, Karnataka

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Road making is associated with destruction of natural areas. Roads criss-crossing through forests create fragmentation and disturbance to the wildlife. However road-making may be considered a necessary evil for humans. Roadsides are often neglected places used for dumping of wastes and not much care given for beautification or planting except in some places. Wherever plantings are done in the usual manner there is not much regard for ecological conditions or consideration of local demands. This study is about how best roadsides can be made more eco-friendly through well-designed tree planting using appropriate native tree species than exotic ones.

Uttara Kannada district has very varied topography and climate. The district has a coast of sand and alluvium and rocky areas, a lateritic stretch of low hills and plateaus, the range of Western Ghats and the eastern portions merging with the Deccan plains. The coastal areas and west-facing portions of Western Ghats receive rains often more than 3000 mm/yr; the rainfall is down to 1500 mm or less in the rain-shadow eastern parts.

Considering all these factors we propose in this poster a more useful design for tree planting in the district, the salient features of which are as follows:

- Roadsides of sandy or low lying coast will have species like *Calophyllum inophyllum*, *Pongamia pinnata*, *Artocarpus heterophyllus* and *Lagerstroemia flos-regiae*.
- Lateritic terrain roads are good for *Sapindus emarginatus*, *Mangifera indica*, *Artocarpus heterophyllus*, *A. lakoocha*, *Garcinia indica*, *Cassia fistula*, *L. flos-regiae*, *Michelia champaca*, *Mammea suriga*, *Zanthoxylum rhetsa*, *Ficus* spp., *Terminalia bellirica*, *Caryota urens* etc.





- Narrow roads passing through forests need not have any additional planting. Wider roads can be considered for planting according to the rainfall and soils. In heavy rainfall areas, with non-lateritic soils wild mangoes (Appe-midi varieties), *Artocarpus heterophyllus*, *A. lakoocha*, *Corypha umbraculifera* (talipot palm), *Caryota urens*, *Mimusops elengi*, *Strychnos nux-vomica* etc. are good.
- Roads through eastern low rainfall areas are ideal for *Mangifera indica*, *Tamarindus indicus*, *Madhuca indica*, *Pongamia pinnata*, *Corypha umbraculifera*, *Ficus* spp., *Terminalia bellirica*, *Aegle marmelos* etc.

The planting prescriptions are based on the ability of the species to survive in varied habitats. The more elaborate list will cover decorative plants, shade trees, utility trees (fruits, medicine, fodder leaves etc.) nectar species, etc. and of ecosystem services.

P – 07

In Situ Conservation of Traditional Rice Varieties of Uttara Kannada

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Before the start of Green Revolution there were over 100,000 native varieties of rice in India. These were the results of selection and propagation by the indigenous farmers through 5000 years of efforts. It is feared that over the last few years, due to the introduction of high yielding new varieties from elsewhere and hybrids bulk of Indian varieties have gone extinct. This is unbelievable loss for the gene pool of rice, prime staple food-grain of the world. There is still hope that through field surveys, especially in places of high landscape heterogeneity, the remaining native rice varieties can be located in farmers' fields and saved from extinction through promotion of *in situ* conservation. As a preliminary exercise we carried out a field survey in about 300 villages of Uttara Kannada to prepare an inventory of rice varieties grown, through interviews with the farmers. Data was gathered also about the notable characteristics and desirable features of these varieties. Out of about 178 rice varieties inventorised about 95 were native varieties. Most of these are taller to hybrids and other new varieties, over 5-6 in height and yield more fodder for cattle. Though their yields are relatively lower they have more resistance to pests and diseases. Their grains are bolder and longer and the rice comes in white, red and brownish colors. Some like Sannakki and Jeerigesali are fragrant. Doddabatha and Kagga are good for making rice flakes. Chitagya, Doddagya, Halaga, Hasadi etc. are attributed with medicinal properties. Salinity tolerance is found in Bilikagga and Karikagga grown in estuarine fields.



Lot of choice exists for selection of rice of different durations, such as Jaddubatha and Kannuru of 90-100 days, Bantwala, Mullarya and Mysore Sanna of 100-120 days, Dibanasale of 120-140 days and Aloorsanna, Honnekattu etc. needing over 140 days. Long duration varieties are good for places with prolonged rainy periods and short duration for lower rainfall areas and irrigated fields. As most of native varieties are grown with organic manure and least or no use of pesticides they are good for human health and their fields ideal for fishes and frogs and other aquatic fauna as well as for birds which feed on them. In this poster GIS maps on the distribution of the native varieties are given along with pictures of many of them. The poster highlights the need for encouraging the growers of native varieties through honouring them and providing subsidies for conservation of rare ones.

P - 08

Toxicity Study due to Accumulation of Heavy Metals in Sediment Ecosystem of Bhavan's College Lake of Andheri, Mumbai

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The increasing trend in concentration of heavy metals in the water bodies like lakes, creeks, and rivers has created considerable attention amongst ecologists globally during the last decades. As compared to other water bodies, the lakes have a complex and fragile ecosystem, as they do not have self-cleaning ability and therefore readily accumulate toxic heavy metal pollutants. The continuous accumulation of heavy metals and other pollutants will create toxic effect on sediment dwelling organisms and fishes, resulting in decrease survival, reduced growth, or impaired reproduction and lowered species diversity. Today it is realised that accumulation of these toxic pollutants will bring about the loss of biodiversity and the effects of this loss will be greater for aquatic ecosystems than for terrestrial ecosystems. Therefore, we initiated a study to understand the accumulation of toxic heavy metals in sediments of Bhavan's College Lake of Andheri, Mumbai. The study was performed for a period of one year starting from April 2011 to March 2012 to quantify the toxic heavy metals like Cu, Pb, Cr, Ni, Fe, Hg, As and Cd. It was observed that the yearly average concentrations of these heavy metals were 0.53, 0.25, 0.42, 0.43, 127.9, 0.11, 0.12 and 0.20 ppm respectively. These heavy metals may enter the lake water leading to rise in their concentration level above the permissible limit thereby creating threat to aquatic life. They may further enter the food chain through biomagnifications and may create adverse effect on human health. It is expected that in addition to the water analysis which is practiced for years, sediment analysis performed in the present investigation will help in evaluating quality of the total ecosystem of the lake. It will also provide environmentally significant information about natural and anthropogenic influence on the water body.



P - 09

Microhabitat influence on diatom distributional pattern in diverse ecosystems

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Macrophytes provide microhabitat for diatoms and also aid as biological filters as they uptake nutrients. We examined diatom community from submerged macrophytes in restored (Ulsoor and Kothanur) and unaltered (Ramasandra and Yelahanka) lakes of Bangalore urban region. We also collected diatoms from rock scrapings aiming to determine the importance of macrophytes for abundant species growth. Water samples were collected concurrently to analyze diatom environment relationship. Diatom taxa belonging to genus *Nitzschia*, *Fragilaria*, *Staurosirella*, *Gomphonema*, *Cymbella*, *Cyclotella* and *Achnanthidium* were recorded during the study period. *Ulnaria ulna* (Nitzsch) Lange-Bertalot dominated in Ulsoor lake while *Staurosirella pinnata* and *Cyclotella meneghiniana* structured diatom community of Yelahanka lake. Kommaghatta lake showed high species diversity (27 species) on macrophytes before restoration and low species diversity (13 species) in post-restoration sample due to lack in macrophyte availability in later sample. Even though, epiphyte (*Eichornia crassipes*) covered Yelahanka lake, diatom community structure revealed polluted water condition. This highlights diatom-habitat relationship with respect to water conditions. However, appropriate species of macrophytes are to be chosen while deciding management and restoration of lakes.

Keywords: Bangalore lakes, Biomonitoring, Restoration, Macrophytes



Technical Session XIV

My Village Biodiversity

MVB - 1

A study on the biodiversity of Aymanam village in Kottayam district, Kerala

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Biodiversity is an integral part of humanity and which helps to sustain life on earth. The biodiversity of 5, 6, 7, 8, 9 and 10th wards of Aymanam Panchayath of Kottayam District Kerala was assessed in the present study. Different landscapes like sacred groves, wetlands and roadside vegetation were surveyed for the estimation of flora and fauna of the area. Farmers were interviewed for getting the primary information on the agro-biodiversity of the area. A total of 120 species of plants were identified during the survey of which 52 species of plants are having medicinal properties. 35 species of birds including Barn owl and the migratory Paradise flycatcher were recorded during the survey. 13 species of reptiles, 18 species of fishes, 30 species of butterflies and several other insects were identified in this village. The mammalian fauna includes Mongoose, Palm civet and Bats. There are three sacred groves of which two are conserved by the temple authorities and one is private owned. The three have rich biodiversity, but are under threats because of the expanding human population in this area. The major threats to the biodiversity are extensive quarrying, mining, reclamation of natural wetlands and indiscriminate application of chemical fertilizers and pesticides in the agriculture field.

MVB - 2

An assessment on the biodiversity of selected wards of Arpookara Grama Panchayath, Kottayam, Kerala

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The biodiversity assessment of 4th and 6th wards of Arpookara panchayath of Kottayam district Kerala, was conducted during August to September 2012. A detailed survey of biotic and abiotic resources, geographic characters and agro biodiversity were conducted. The study area is bordered by two streams but, the water is polluted due to the waste discharge from Medical College, Kottayam.





The topography is undulating with many laterite quarries. In the present study, a total of 50 species of medicinal plants including *Santalum album* and *Pterocarpus santalinus* were recorded. The village has high agro biodiversity with native varieties of *arecanut*, *banana*, *mango*, *spinach* etc. Organic farming is practiced in the kitchen gardens. 34 species of butterflies and 22 species of birds were reordered. The *darter*, a globally threatened water bird is also recorded from the study area. 8 species of fishes were observed which include *Karimeen*, the state fish of Kerala. The major wild animals in the study area are Palm civet, Otter, several species of bats and *Varanus spp*. Native species of cow, poultry and goats were rearing in the village by the farmers. The pollution due to waste disposal, sewage from domestic and hospitals and agrochemicals from the cultivation areas are the major threat to water resources.

MVB - 3

Biodiversity assessment of selected wards of Ramapuram including a threatened sacred grove

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Natural resources are inevitable wealth of a region for its sustainable development. Sacred groves are the repositories of rich biodiversity, help in the ecosystem integrity. A detailed survey on the biodiversity of 2, 16 and 17th wards of Ramapuram Panchayath, Kerala was conducted during August to September, 2012. Field observations and surveys were conducted in wards including *Kurinji kavu*, the sacred grove of the village. The information on agro biodiversity were collected by direct interview with farmers by using a questionnaire and field surveys. In the present study, 27 species of medicinal plants were identified from the location. 24 species of trees, 3 species of herbs, 2 species of epiphytes and 5 species of climbers were recorded. Evidences of the presence of Porcupine and jungle cats were noted in the sacred grove and the adjoining areas. A small group of wild bonett macaque was also noted from the study area. 4 species of birds including Honey buzzard and 14 species of butterflies were recorded from the area. As per the opinion by the aged people of the area, the entire village was rich in biodiversity and the sacred grove was a conducive habitat for small wild mammals. But due to the severe anthropogenic pressures like expansion of rubber and other cash crops, most of the areas were converted into plantations, which ultimately affect the availability of water. The sacred grove and the adjoining hillock in the area is under the threat of quarries and effective legal measures have to be taken for its conservation and management.



MVB - 4

A report on the biodiversity of the 18th ward of Kottayam Municipality

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Biodiversity plays a major role in the development of humanity and the urbanization pose serious threat to the biodiversity. The present study is an attempt to assess the biodiversity of the 18th ward of Kottayam municipality, Kerala. Detailed field surveys were conducted among the elders, traditional healers and farmers. Direct interview and field observations were done as the part of the study. *Koprathukavu*, a sacred grove and its adjoining area were also included in the study for assessing the flora and fauna. In the present study, a total of 22 species of medicinal plants were identified of which some of them are used by the local people for economic benefit. The major agriculture crops in the study area are Coconut, Tapioca, Vegetables, Banana, Elephant yam, Rubber etc. Both native and improved varieties of crops are cultivated. Few species of birds, mammals, fishes and reptiles were recorded.

MVB - 5

A study on the biodiversity of selected wards of Neelamperoor Grama Panchayth in Alappuzha district, Kerala

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Biodiversity and its loss is a global matter of concern. Wetland ecosystems are the rich repositories of biodiversity and are facing serious threat due to various anthropogenic pressures. The present study was conducted in the 1st and 2nd ward of Neelamperoor grama panchayath in Alappuzha district. The study area is a part of Kuttanad wetland ecosystem (Vembanad-Kole), one of the three Ramsar sites in Kerala. The topography includes water bodies such as ponds, canals and river channels. The study aims to understand the status of biodiversity in the village, its major threats and to document traditional agricultural practices and knowledge of medicinal plants. The study methods include direct observation, interview with farmers and field survey. A total of 23 different species of medicinal plants were observed in the study area and their uses were listed. 8 different species of trees were



observed along 1 k.m. stretch of the village road. A total of 19 species of birds were observed, including migratory birds like sandpipers, wagtails, terns etc. The present study recorded 19 species of fishes from different habitats such as ponds, rivers and canals. The commonly observed species were *Karimeen* (Pearlspot), *Varal* (Striped Snakehead), *Kaari* (Stinging catfish), *Paral* (*Puntius sp.*) and *Manjakkori* (Yellow Catfish). Local fishermen opined that *Karimeen*, *Cherumeen* (Cobra Snakehead) and *Aarakkan* (Spiny eel) species have decreased over the years due to overfishing, destructive fishing practices like electrocution and poisoning. Four sacred groves in the study area namely *Olezhamkavu*, *Kalathilkaavu*, *Pallitharakavu* and *Kaikarakavu* were also studied. Rare trees like Kanjiram (*Strychnos nux-vomica*), Karinjotta (*Quassia indica*), Koovalaam (*Aegle marmelos*), Pathiri (*Stereospermum colais*) were observed in these grove. Wild animals like mongoose and toddy cat are rarely encountered in the village by the local people. Major agricultural crops in the area include paddy, coconut, arecanut, plantain, yam, colocasia and tapioca. The interview with farmers gave us information about farming practices, crop and seed preservation techniques etc. Chemical fertilizers and pesticides are being heavily used in Nelamperoor village. The study revealed that the unscientific usage of these chemicals just for higher economic major returns is one of reason for causing biodiversity loss of the village.

MVB - 6

Village biodiversity assessment – A case study from Chempu village in Kottayam

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Kottayam

The present study was conducted in the Chempu village of Chempu grama panchayath in Kottayam District. Chempu panchayath lies in the northern boundary of Vaikom, which has cultural significance in Kerala history. The village shares its boundary with Vembanadu Lake on west and Muvattupuzha River on Northwest. The study aims to record the biodiversity of the region and efforts were made to understand the causes of biodiversity loss. The study methods include field observation, interview with village people and secondary data collection from biodiversity register of the village. The soil type in the village is lateritic and alluvial. Our study recorded about 70 species of medicinal plants. We observed rare forest trees like Marotti (*Hydnocarpus pentandra*), Kumbil (*Gmelina arborea*), Potama (*Trema orientalis*), Kulirmav (*Persea macrantha*) etc in the village. Six species of trees were observed along 1 km stretch of village road. We visited three model agricultural farms which cultivate 26 different crop varieties. Three sacred groves were identified in the village namely Kandamkulangara, Chittezhathumana and Kothakulam. Our observations revealed the presence of 4 mammals, 16 birds and 13 butterfly species in the village. We were excited to spot rarely observed Black-naped Hare (*Lepus nigricollis*) during our field study. We found that activities like clearing of road side vegetation as part of NREG programme pose a serious threat to the biodiversity of our village. Lack of awareness about the importance of biodiversity among the people in the village is also a concern. A detailed assessment

on the natural resources of the whole area and giving appropriate awareness programmes on its importance can help to conserve the biodiversity of our village.

MVB - 7

Report on the village biodiversity of Vallichira, Kottayam district, Kerala.

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The present study was conducted in the 12th ward of Karoor Panchayath, Kottayam. The study aims to record the biodiversity and its threats in the Vallichira village and adjoining areas. Field work was conducted and the farmers were interviewed for recording the agro biodiversity including domesticated animals. Direct observations on roadside vegetation patches and sacred groves were conducted for recording the flora and fauna. 22 species of medicinal plants were recorded from the area. We also recorded rare forest trees like *Holigarna arnottiana*, *Terminalia arjuna*, *Wrightia tinctoria* etc. The study could observe 11 different species of trees along one kilometer length of road side. The major agricultural crops of the area are banana, tapioca, paddy, cardamom, coconut, vegetables etc. Few farmers practice the organic farming in the village. 25 species of birds, 20 species of butterflies, 11 species of snakes and 16 species of fishes were identified from this village. Mammals like hare, wildcat, mongoose and palm civet are the major wild animals in the study area. Hare, bats and birds are poached occasionally by the local people. The major threat to the biodiversity of the area include reclamation of wetlands, poaching, destruction of suitable habitats such a sacred groves, application of chemical fertilizers and pesticides. The study could give awareness to the local people about the significance of biodiversity and conserve the endangered flora and fauna.

MVB - 8

An investigation on the biodiversity of Koovappally village in Kottayam district

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The Village biodiversity assessment of 10th and 11th wards of Koovappally village, Kanjirappalli was conducted during September 2012. Detailed survey was conducted to assess the agro resources of the village. Agriculture fields were visited and farmers were interviewed. Visual observation and interview method was employed to assess the wildlife of the area. Different ecosystems like sacred groves, wetlands, hills etc. were surveyed for the study. The study area has an undulating terrain with laterite quarry and soil mining sites. The village has sufficient water resources like streams, wetlands, wells etc. In the study, a total of 33 species of medicinal plants were recorded from the area. Several forest tree species and weeds such as *Pueraria spp.*, *Parthenium hysterophorus*, *Lantana camara*,





Chromolaena odorata etc. were identified. The major agriculture crops are tapioca, several native and improved varieties of colocasia, yam, banana, cardamom, zingiber, peas, tomato etc. 5 species of butterflies, 20 species of birds, 9 species of fishes, 5 species of mammals including Palm civet, Hare and endangered Slender lories and 17 species of reptiles were also reported from the area. The natural resources and biodiversity of the area were threatened from different sources such as discharge of effluents from a nearby latex factory, quarrying, removal of road side vegetation as a part of NREGP, expansion of rubber cultivation and unscientific soil management etc. The biodiversity rich sacred groves namely *Njarkalakavu*, the remnant of evergreen vegetation of the area is also under threat. Effective management strategies are essential for the conservation of the natural resources of the area.

MVB - 9

A study on the village biodiversity of Balgadde village near Sirsi in Karnataka

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The present study was conducted in Balgadde village near Sirsi in Karnataka. The village is located in the bank of Kanjery River. The village has 496.55 ha of semi evergreen and semi deciduous forests along with grass lands. About 24.8 ha land is used for agriculture. Forest trees include *Terminalia*, *Shikakai*, *Amla*, *Strychnos-nux-vomica*, sandal wood tree etc. Champaka, Peepal, Mango Acacia and Mangium constitute the roadsides trees. Medicinal plants such as *Terminalia*, *Rauvolfia*, *Brahmi*, *Amala* etc. are also found in the village. Agriculture crops include *arecanut*, *coconut*, *paddy*, *sugarcane*, *pepper*, *banana*, *cardamom*, *jackfruit*, *cocoa* etc. According to the farmers about 25-30% of crops are destroyed by monkey and other wild animals every year. Most of the farmers follow organic farming practices. The present study could reveal that the polluted water from Sirsi town is discharged in to the Kanjery River. Illegal blasting of rocks using dynamites is releasing harmful chemicals into the river, causing decrease in fish and other species. During the study, most of the villagers opinioned that even though hunting is prohibited, wild animals are hunted for their skin and meat.

MVB - 10

A study on the village biodiversity of Dodnalli Village in Sirsi Taluk in Karnataka

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A study on biodiversity of Dodnalli Village in Sirsi Taluk is presented in the project. The study was conducted through field visits and personal interviews with villagers. The village lies in semi



evergreen forest stretch and extend to 577 acres and 7 gunatas, out of which forest area is 110 acres betta land is 99 acres, cultivable land is 178 acres and gountana is 11 acres. The soil of the village low textured and coarse sand with good permeability is seen here. Water resources are composed mainly of tanks and ponds. Rice and Sugarcane are the major crops. Black gram, Green gram, cowpea, ground nut etc. are grown as secondary crops. Even though traditional methods of seed treatment and practices like 'Savayava Palekar' methods are being followed, heavy use of chemical fertilizers and pesticides were also observed. Other plantation crops are arecanut, coconut, banana, pepper, cocoa, cardamom, cashew nut, jackfruit and mango. Plant diversity includes *Honne*, *Sagavani*, *Neralu*, *Murugalu*, *Mathi*, *Muttukalu*, *Honnalu dadsalu guddde geru*, *hebbacasu*, *Surgi*, *Shrigandha jalli*, *baffi*, *Challe*, *Boorsalu*. Medicinal plants are used for treatment of various diseases. Monkeys, pigs and rabbits account to the wildlife of the village. Snakes, frogs, turtles leaches are also found. The village people have taken steps to protect the environment which includes afforestation, building bounds, organic farming etc. Government recognized this village as 'Savayava Grama'.

MVB - 11

A study on the village biodiversity of Kakkalli Village in Sirsi Taluk in Karnataka

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The biodiversity of Kakkalli villages near Sirsi in Karnataka is presented in this project. The village lies in the slope of Sahyadri Mountains and has a great shelter for very delicate biodiversity of Western Ghats. The village is surrounded by hills, thick woods and beautiful grass lands. The village has precious trees like sandal wood, Rose wood, Teak *Calophyllum*, Deodar, *Terminalia tomentosa* are present. This village is blessed with abundant medicinal herbs with which indigenous ayurvedic medicines are prepared. Crops like paddy, arecanut, pepper and banana are cultivating in the village. Most of the people follow traditional way of agriculture. Natural waterfalls and drinking water sources are present in the village. The inhabitants of the villages belongs to *Havyaka brahmins*, *Okkaligas* and tribal communities like Siddis and Kunabis, and they mostly depends on forests for their livelihood. The main threat to the biodiversity is Kaiga nuclear centre, which destroys the major portion of the forest.

MVB - 12

A study on the village biodiversity of Niranalli Village in Sirsi Taluk in Karnataka

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The present study area, Niranalli is a village in Karnataka state spread over 357.28 ha out of which 277.56 ha are covered by forest. This village is enriched by farmers, horticulture, apiculture and lives stock etc. The village belongs to Kengre watershed area, which has three *nalas*, viz., Pandavara Hole, Andhalli Hole and Nirnalli Hole. The soil of the area is a mixture of sand and red soil, in which reddish in colour is boon to the farmers. The village have semi evergreen forest, deciduous forest, and savannas. The study could find trees like *Atti*, *Haiga*, *Honne*, *Rose wood*, *Sandle wood*, *Teakwood*, *Nandi*, *White Matti*, *Ceylon oak*, *Casuarinas* etc. *Banana*, *Ilachi*, *Cocoa*, *Ananas*, *Coffee*, *Papaya*, *Cinnamon*, *Clove*, *Turmeric*, *Ginger*, *Vanilla*, *Lemon* etc. and plantation trees like arecanut, coconuts etc are growing in the village. Mango, Jackfruit, Guava and other fruit bearing trees are grown on the boundaries. Different types of medicinal plants like *sacred basil*, *black myrobalan*, *drum sticks*, *antaragange*, *shivane*, *bilvapatre* are found. Apart from snakes like Indian cobra and King cobra small animals like snails, butterflies, leeches, earthworms, tortoise, crabs etc are regularly seen. Birds like peacock, sparrow, bulbul, woodpecker, duck etc. are also present in this village. Wild animals like deer, wild buffalo, wild pig, porcupines, squirrels, rabbits and monkeys etc. are also found. Villagers are using different varieties of flowers for decorating the houses. Artists, craft men and folk medical practitioners are contributing to the society. The major threat to the biodiversity are poaching, quarrying and other developmental activities like road construction.

