ANNUAL REPORT 2009-10

Centre for Earth Science Studies

Akkulam, Thiruvananthapuram - 695 031, India

Contents

Preface

It is with great pleasure that I present the Annual Report of the Centre for Earth Science Studies (CESS) for the year 2009-10. The report is a summary and a mirror to the achievements of CESS in its efforts to remain as a leading Earth Science research institute in the country. Multidisciplinary research activities with balanced importance to basic and applied research work is the pillar of strength of CESS, strongly supported from the time of our founder Director through many succeeding Directors to the present. This uniqueness of CESS is the reason for its position as one of the premier science and technology Institute in the country. In order to maintain this position and to be in the forefront of research and development, CESS is continuously upgrading infrastructure facilities with state of the art laboratories. The fruits of these initiatives are reflected in the increase in requests from universities and premier organisations for laboratory support. Core focus of CESS in research and development (R&D) activities with as many as 26 R&D projects, funded by various state and central government departments/agencies, and 35 R&D projects, funded through internal resources, is reflected in the report. Our programmes in applied disciplines of earth sciences and consultancy projects, mostly in the field of CRZ status report preparation, are generating resources that continue to accelerate and support various establishment, maintenance and developmental needs.

As part of the programme on continental magmatism and lithosphere evolution, studies on Cretaceous mafic dyke swarms and the Precambrian mafic dykes continued with funding from the Indo-French Centre for Promotion of Advanced Research (IFCPAR) and the Department of Science and Technology (DST), Government of India. Decade long research and modern upgraded paleomagnetic laboratory have helped in generating credible database on mafic dyke swarms and in tracing the position of India within the schemes of super continental assembly. Under the granulite studies program, a project on petrology and geodynamics of the rocks of the Kerala Khondalite Belt (KKB) sponsored by the DST presented new hitherto unknown evidence for Proterozoic magmatism and crustal growth in KKB. To maintain the momentum in our KKB studies, a new project on tectonothermal history of the KKB was initiated with the primary goal of understanding redistribution of chemical elements, particularly the heat-producing elements Th and U, and channelling of fluids liberated during the crystallization of the melts.

CESS scientists continued to work on Quaternary coastal evolution. We initiated during this period a collaborative DST sponsored project with Anna University, Chennai, to document the spatio-temporal shore changes in the Ashtamudi region and to study the transgressive/regressive cycle's signatures from sediment facies analysis. Our study on Quaternary sediments of Cochin revealed the presence of decayed peat/wood beds at Vaduthala, Panampally Nagar, several kilometres landward from the present shoreline, occurring at depths in the range of 20-65 m below the MSL. C14 datings of the Quaternary sediments collected from various depths indicated an early Holocene to middle Pleistocene age. Carbon accumulation studies conducted in the Polachira wetland of the Paravur estuary near Kollam reiterated the fact that wetlands of Kerala are efficient sinks for detrital matters of both organic and inorganic origin.

CESS programme on atmospheric dynamics, measurement of cloud parameters and cloud modelling received further impetus with the procurement of dedicated software for the Ceilometer that records laser back scattered information of particles in the atmosphere. Studies recorded diurnal variation in cloud condensation particle counts that follows atmospheric pressure variation and served in understanding nucleation of water droplets leading to cloud formation. Our studies on the nature of solar UV-B variation and minor constituents such as total ozone and water vapour were found to be important parameters that control climate change in this region. Experiments conducted with the Micro Rain Radar were able to classify and understand the coalescence mechanism of rain drops.

CESS has been engaged in district level Natural Hazard Zonation Mapping and in addressing societal issues. The hazard proneness of Kerala state has been brought out in the form of multiple hazard maps (flood, landslide, coastal erosion, earthquake and lightning) at the district level and a composite map at the state level. Our digital Broadband Seismic Observatory (Station code: PCH)

in the campus of the Kerala Forest Research Institute (KFRI) at Peechi continued to record high quality data and contributed to the national grid for studying local, regional and global seismic activities. CESS scientists studied many landslide incidents that occurred in Kozhikode, Wyanad and Malapuram districts to assess the damages caused and examine the reasons for the widespread landslides and recommend mitigation measures. On another front CESS activity in tsunami inundation modeling demonstrated that the north Kerala coast may not be that vulnerable to tsunami inundation for both Sumatra and Makran sources when compared to south Kerala. The year also witnessed the initiation of work on numerical modeling of trajectories of oil spill for selected locations of Kerala coast.

As part of coastal processes and management studies, field measurements and numerical model studies were carried out by our scientists with a view to understand the wave transformation, circulation and sediment transport processes of the nearshore region of Muthalapozhi and Munambam-Chettuwa sectors of Kerala coast and Kavaratti island of Lakshadweep. Our scientists were able to model the beach formation south of the Muthalapozhi inlet and severe erosion north of the inlet. Studies along the Munambam-Chettuwa sector showed the significant role played by mudbanks in the erosion/accretion processes of the coast. The study for Kavaratti highlighted the need to consider the use of semi-permeable coastal structures which will allow bypassing of alongshore sediment very effectively.

Natural resources management is an integral programme of CESS, covering different components of natural resources, environmental impacts of resource use and their management. CESS continued to embark on these activities especially in areas of rainwater harvesting and ground water recharge, drinking water potential of springs and hydro-geochemical characteristics, and interstitial water chemistry. Land resources programmes continued on aspects concerning terrain analysis, geomorphology and land use studies, characterisation of laterites, and monitoring of land quality. Many projects were executed in the realm of environmental studies and impact assessment covering various aspects like vulnerability of coastal cliffs, myristica swamps, sand mining, degradation of river system, desiltation of reservoirs and environmental management plans for cities, rural areas and coastal systems. Human environment relationships were examined by analysing interrelationships between incidence of poverty and environmental degradation, settlement pattern and drinking water distribution and trends of urbanisation.

The consultancy projects were mainly related to the demarcation of High Tide/Low Tide Line and the preparation of Coastal Regulation Zone Status Reports for different coastal locations of the country. In addition, we provided consultancy to different Government Departments and agencies on issues relating to natural hazards management, natural resources management, coastal zone management etc. Our academic activities continued to improve during the year. There were 21 research students enrolled in Ph.D. programmes, out of these 2 have received Ph.D., during the reporting year. CESS scientists also provided guidance to 47 PG students for their dissertation work and 11 among them obtained CESS scholarships of Rs.2000/- per month for the period of their dissertation work. I have great pleasure in reporting that Mr. S. Arjun, one of our research students received the Young Scientist Award in the 22nd Kerala Science Congress held at KFRI, Peechi in January 2010.

On the publications front, we published 33 papers in peer reviewed journals out of which 23 were in international journals. In addition 28 papers were published in proceedings/books and 25 Technical/Project Reports were brought out.

The reporting period witnessed organization of a few workshops/conferences. The first one was the National Conference on Coastal Processes, Resources and Management which was attended by nearly 200 delegates from across the length and breadth of the country. The second one was the National Workshop on Natural Hazards, Disaster Mitigation and Management where the District Level Multi Hazard Zonation Maps prepared by CESS were released. In addition, a Panel Discussion on Climate Change, a Workshop on Land Quality and Sustainable Agriculture and a couple of other outreach programmes were also conducted.

This period also witnessed the retirement of Dr. M. Baba on superannuation, from the office of Director of CESS, after an illustrious career that made remarkable contributions to the institute. As a fitting tribute to his contributions to CESS and ocean science a Special Issue of the Indian Journal of Geo-Marine Sciences, encompassing research papers presented at the National Conference on Coastal Processes, Resources and Management, was brought out. I am sure CESS is poised to make much more progress in the coming years. The guidance and support we are receiving from the KSCSTE, the Research Council and the Management Committee, and co-operation and support of my colleagues and administrative staff in this endeavor is worth recording.

Dr.N.P.Kurian
Director

November 25, 2011

1.1 Crustal Evolution and Geodynamics

1.1.1 Metasedimentary rocks of the Kerala Khondalite Belt: Petrology and geodynamics of their formation

Data available on the lower crustal segment of the Kerala Khondalite Belt (KKB) is not enough to constrain tectonomagmatic framework as it lacks comprehensive field and geochemical datasets (major- and trace-element data and REE systematic) on major lithounits of the belt. Due to this and absence of reliable structural and geochronological data geodynamic models on the Proterozoic and the Pan-African evolution of the KKB have remained speculative. This project was initiated as part of a comprehensive research programme specifically to understand and characterize the formation of the KKB which is one of the largest granulite-facies supracrustal sequence in southern India. The present project was also to bridge the data gap with a multi-disciplinary effort of detailed field studies, detailed sampling and petrography and to integrate the same with geochemistry as well as isotope studies. During the last two years of implementation of this project, vast data pertaining field and geochemistry have been generated. We have also succeeded in carrying out a very detailed quarry scale study in over 300 fresh stone quarries and collected samples at 1 km interval for high resolution geochemical classification of the debated sodic and potassic gneiss across the belt. Analytical work on over 300 samples for trace and REE analysis and over 100 samples for REE have been completed. During the current year of report main focus was on the mineral chemistry and metamorphic aspects. The published data suggest that theKKB has suffered granulite-facies metamorphism (T ~ 900°C, P ~ 5 kbar) during the Pan-African orogeny a 550 Ma ago. Our aim was to find mineral chemical variation across gneissic variants and to recognize tracer minerals, if any, suggesting magmatic origin for the potassic type of gneisses.

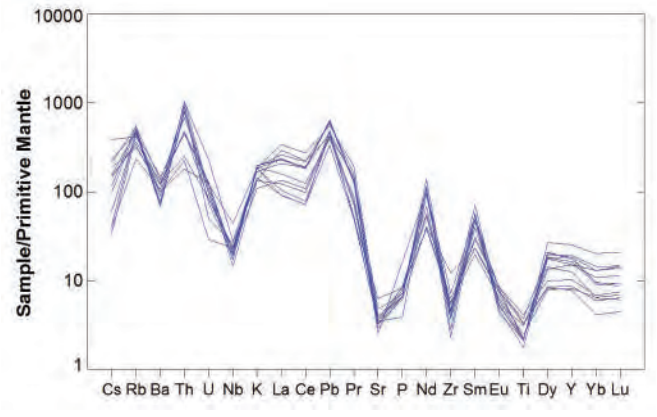

Fig.1.1.1.1 Mantle normalized trace element pattern for the granitoids of KKB

All the existing information on P-T evolution, and geochemical data available from published papers, reports were compiled to identify data gaps. Following this, we carried out Electron probe microanalysis study of samples from selected and representative geochemical gneissic domains at the National Geophysical Research Institute (NGRI), Hyderabad. Detailed studies have been initiated on selected sites on the basis of petrographic and geochemical classification of each lithounit. The new sets of mineral chemical data are in conformity with the published data and reports constraining the P-T conditions of metamorphism. However, a notable variation observed in mineral composition with respect to whole rock composition is interesting and more detailed mineral chemical studies were taken up. Utilising EPMA data along with the petrographic and geochemical data, composition of biotites from different groups of granitoids (variants of gneiss and charnockites) were evaluated as a potential indicator of nature of the magma and the physical conditions of crystallization vis-à-vis their igneous parentage (Fig. 1.1.1.1). Distinct variation in composition of biotites from sodic group with Mg^{2}+–rich (XMg:0.47–0.63) in contrast to those from potassic groups, which are Fe^{2}+–types with much lower XMg (0.37–0.44) were found to be significant. Based on the compositional variation of biotite we are speculating on the nature of the host magmas of sodic and potassic granitoids of KKB. Some of the interesting outcrops with mixed association of metaigneous and metapelite restites have been taken up for further investigation. We consider our systematic approach and comprehensive dataset as robust to help in proposing a more reliable model for the tectono-metamorphic evolution of the KKB.

G. R. Ravindra Kumar & C. Sreejith
Funding: DST, Government of India

1.1.2. Geochemical and palaeomagnetic studies of mafic dykes

Understanding the igneous petrogenesis and nature of continental magmatism in the Indian shield, tracing the nature and development of mantle sources, determining reliable palaeomagnetic directions and pole data and to interpret the tectonic setting, tracing the India's position in the supercontinental assembly constitute a long term geodynamic study program. During this year, our studies are continued on the Proterozoic mafic dyke intrusions of Bundelkhand and Bastar cratons and on the Cretaceous dykes along the west coast of India, St Mary island volcanism and the Deccan flood basaltic province.

Proterozoic dyke intrusions

The work on Proterozoic dykes is a joint project with the Bundelkhand University, Jhansi funded by the Department of Science and Technology, Government of India. Characteristic magnetisations of all oriented cores collected from individual sites (dykes) of Bundelkhand and Bastar cratons have been determined. Generally, the characteristic magnetisations have been determined using principle component analysis of the directional data in the range of 20-50 mT comprising mostly 5-7 steps and the origin. Despite some within-site scatter, many sites have shown a reasonably good within-site grouping. From Bundelkhand craton, 17 dykes (sites) have yielded good within-site grouping with N = 5-7 and $\alpha 95$ = 6-17°. These sites fall into three ChRM groups. ChRMs of four dyke sites are so widely scattered that no coherent grouping can be attempted. The three ChRMs recognised fall into (i) steep upward/downward (ii) east-southeast to east shallow and north-northwest shallow directions. In the remaining seven dyke sites, one site has yielded northeast shallow direction with N = 5 and

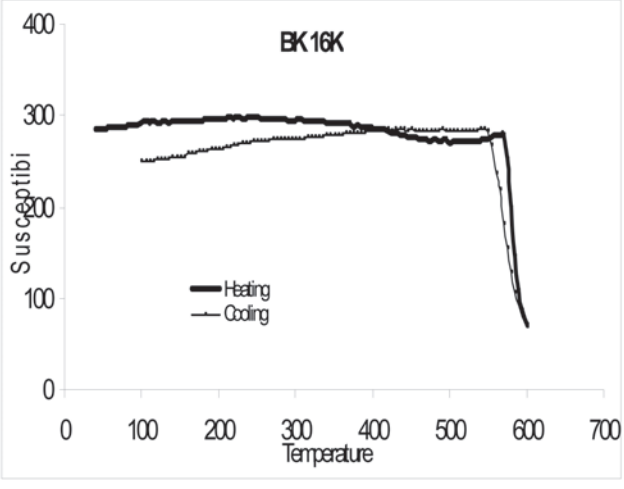

Fig. 1.1.2.1 Temperature dependent magnetic susceptibility of a representative dolerite dyke sample (BK 16K)from Bundhelkhand craton (temperature in °C)

$\alpha 95$ = 15°. In other dyke sites a less coherent direction that is comparable to one of the above groups could be identified with N = 3-5 or $\alpha 95 > 20°$

In the case of Bastar craton, 13 dyke sites have obtained significant within-site coherence with N = 5-10 and $\alpha 95$ = 7-17°. One dyke site did not yield stable directions. In four dyke sites, although stable ChRNs are achieved in 4-9 samples, the ChRMs display large scatter that no coherent direction can be determined. Two dyke sites have obtained less coherent ChRMs with N = 4 and

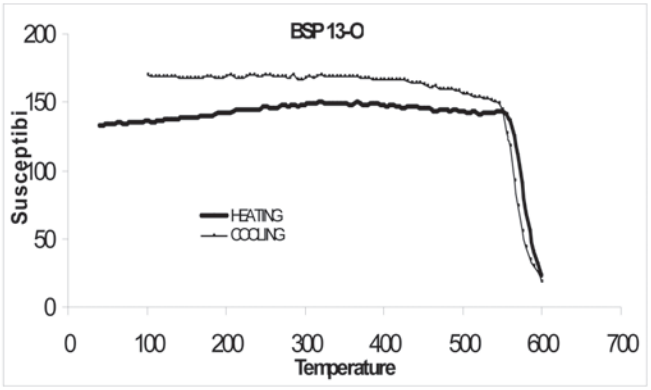

Fig. 1.1.2.2 Temperature dependent magnetic susceptibility of a representative dolerite dyke sample (BK 16K) from Bastar craton (temperature in °C)

large errors ($\alpha 95$ = 35° and 39°). The coherent ChRMs constitute clearly two distinct group of directions of steep upward/downward and east-eastsoutheast shallow magnetisations. The third direction (northwest shallow) may also be present, but could not be clearly established.

Temperature dependant susceptibility experiments were performed on representative samples in RT-600°C range covering all the ChRM groups of Bundelkhand and Bastar cratons (Fig. 1.1.2.1 and Fig. 1.1.2.2). The thermo-remanent magnetization studies have shown that susceptibility mainly maintains at nearly constant values during heating and cooling of the samples. It sharply drops at about 540-560°C in all samples. The reversibility of the heating and cooling curves of the samples reveal that there is no distinct mineralogical changes and that titano-magnetite is the chief magnetic carrier.

Major and trace element (Ba, Rb, Sr, Ni, Co, Zr, Y, Nb, Zn, Sc, Hf, Th,, Ta and RE elements) chemistry of the Bundelkhand and Bastar cratons is being further analysed to trace the petrogenetic history. It is observed that the dykes belonging to different field trends or different characteristic magnetizations are not clearly distinguished in their chemistry. Irrespective of differences in field trends or ChRMs, the dykes are characterised with similar chondrite REE patterns and incompatible element ratios. Fuerher interpretations of major and trace element data are in progress.

T. Radhakrishna, G. Balasubramonian (CESS) & Ram Chandra (Bundelkhand University, Jhansi)
Funding: DST, Government of India, New Delhi

1.1.3 Cretaceous dykes and related magmatism

The work on Cretaceous magmatism forms a part of an international project **"**Paleointensity and Reunion/Marion plume activity in India' funded by the Indo French Centre for the Promotion of Advanced Research (IFCPAR). Demagnetisation experiments have been completed for all the site samples collected during the first Indo-French joint fieldwork. Mean ChRM directions for the sites have been computed using zijdervield plots and stereographic projections. Documenting detailed petrography continued. Chemical and palaeomagnetic data available with us on the late Cretaceous dykes in Kerala have also been analysed.

A third joint fieldwork was carried out by the Indo-French team for about a month during August-September, 2009. The main aim of this field visit was to jointly examine the outcrops in the light of available results and make best choice of final sampling for palaeointensity measurements and for Ar/Ar isotopic work. As our initial work on dykes could not be very successful, the main focus of this fieldwork had been on the Deccan volcanic flows, expecting their fine grained texture would be a better choice for the palaeointensity measurements. We examined the outcrops of gabbros, granites and granophyres with dolerite dykes in the Ezhimala area. Palaeomagnetic sampling was carried out from the Ezhimala granophyre and the NNW trending dolerite dyke cutting across the

Fig. 1.1.3.1 A baked contact with red bole development underlying the basaltic flow of the Mahabaleswar Formation near Kojhapur

granophyre near Paruthikkadu in north Kerala. In the Deccan trap volcanics, our focus has been on the youngest and oldest flows. Seven sites were sampled from the youngest Dessur and the Panhala formations. Alkaline and tholeiitic flows in the Rajpipla area are reported in literature to constitute the older formations of the Deccan volcanic pile. Twelve sites were collected from this area. Baked contacts which are usually promising for palaeointensity measurements could also be sampled from both the younger and older formations (Fig.1.1.3.1).

Palaeodirectional data analysis has been completed on the 20 sites collected during the earlier joint fieldwork. Two sites from the St. Mary island volcanic rocks and one site from Agali-Coimbator area which are regarded as related to the Marion plume event have yielded characteristic magnetisations. Six sites from younger set of samples regarded as Reunion plume related have yielded characteristic magnetisation. The older set of samples all have yielded normal polarity whereas the younger set of dyke sites have yielded both normal and reverse polarity. Temperature-susceptibility experiments at low (-192°C to room temperature) and high temperatures (RT to 600°C) have been conducted on one sample from each site as part of thermoremanent magnetisation studies to identify the magnetic carrier in the samples and to understand the nature of alteration. Magnetite appears to be the main magnetic carrier in the samples from the volcanics, whereas the dykes contain mostly titanomagnetites. Most of the sites have yielded good reversible curves up to 300°C.

Twelve representative samples have been analysed for major elements and for many trace elements (Rb, Sr, Ba, Y, Zr, Nb, Cs, Hf, Ta, Pb, Th, U and REE). Nd isotopic data are obtained on the same set of samples and Sr and Pb isotopic work is in progress. Normative compositions have been calculated and normalised plots have been prepared to characterise the magma types and to make comparisons between the samples to bring out distinctions. All samples can be classified into continental tholeiites. The MgO content varies from 7.9 to 0.6 wt % suggesting variable degrees of differentiation of magma and the St. Mary island volcanic rocks representing the most differentiated rhyolitic lavas. The samples can be distinguished into two distinct groups, particularly in terms of trace element contents. Within group coherence is very conspicuous in terms of parallelism of the chondrite normalised REE patterns and also primordial mantle normalised patterns, with more fractionated samples occupying higher levels of abundances. Similarly, the older set of samples also possess enrichment of large ion lithophile elements (K, Rb, Ba, Sr), high P2O5, and TiO2 with their Fe contents always lower than 13 wt% and more fractionated REE patterns. The younger set of samples show minor depletion of Rb, Ba and K with low contents of P2O5 and TiO2 contents and are Fe-rich (>15 wt%) tholeiites. These samples display near flat rare earth element patterns. Detailed petrogenetic aspects are significant to characterise the late Cretaceous magmatism and the Marion and Reunion plume activity in southern India.

T. Radhakrishna, G. Balasubramonian, Jossina Punoose (CESS)& Mirellie Perrin, H. Maluski and Jean Marie Dautri, Mathew Joseph (University of Montpellier, France)

Funding : IFCPAR, New Delhi

1.1.4 Quaternary geology and geomorphic evolution of the coastal lands of Kollam district, SW India

The coastal areas of southern Kerala in the Kollam and Thiruvananthapuram districtsshow many unique changes compared to rest of the coast. The most noteworthy feature is entrenchment of estuarine / wetland basins over the Tertiary sediments. The basins that evolved during the Last Glacial Maximum (LGM) were responsible for the evolution and development of the associated wetland systems of south-western coast of India.

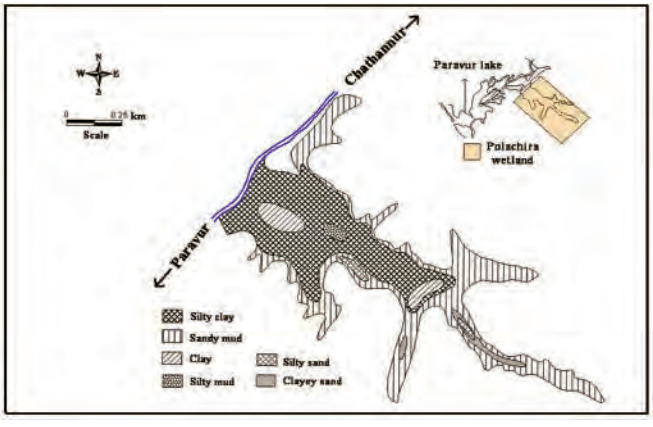

Fig. 1.1.4.1 Surface sediment distribution of the Polachira wetlands

Sedimentation in the basins has begun in Early Holocene with a sequence of peat / subfossil wood which is covered by brackish – marine sediments deposited in the rising spells of sea levels and heavy rainfall. The marine – terrestrial contributions were well recorded in the palynological and non-pollen palynomorphic contents of the sediments. Progradation of alluvial sediments and river meandering over its own deposits during Early – Middle Holocene and down cutting during lowered sea levels of ~ 4000 yr BP were instrumental in the cut- off of some of the arms of the Pre – Holocene basin into separate wetlands like Sasthamkotta and Chelupola lakes and Chittumalachira wetland in the Ashtamudi estuary and Kotta lake in the Paravur estuary.

Among the various wetlands in the Kollam coast, the Polachira wetland of the Paravur estuary has been subjected to detailed carbon accumulation studies (Fig. 1.1.4.1). Organic carbon and $CaCO_3$ contents in the sediments of the Polachira wetland varies from 0.28 to 12.93% (av. 4.11%) and 0.12 to 10.82% (av. 0.98%), respectively. The sand dominant sediments account for comparatively low concentrations of organic carbon. However, certain samples that contain fragments of decomposed vegetal matters register slightly elevated concentrations of carbon. The central zone of the wetland with high content of silt and clay are effective in trapping a substantial quantity of organic carbon. Among the different sediment types, clayey silt (11.88 %) and silty mud (8.29%) accommodates higher concentrations of organic carbon compared to the rest of the sediment types (clayey mud: 5.58%; silty clay: 5.1%). Estimates show that the system holds an amount of 30.94 million tonnes of sediments up to a level of 10m bgl (on dry basis) which, in turn, contain 1.24 million tonnes of C-org and 0.31 million tonnes of C-inorg. Thus, the present study reiterates the fact that wetlands of Kerala are efficient sinks for detrital matters of both organic and inorganic origin.

D. Padmalal

1.1.5 Quaternary evolution of the Coastal Plains of Central Kerala

Quaternary evolution studies pertaining to the coastal plains of Ernakulum district is attempted in this project. The study will provide an insight to understand the different sedimentological processes, sea level changes and the evolutionary history of the coastal plains of SW coast of India. The Quaternary sediments of Ernakulum district occur as discontinuous patches and their *in situ* surface exposure is rarely seen. This is because of large scale reclamation, dredging and reworking of these sediments due to the urbanization and other developmental activities. The major objectives of the project are to map the study area systematically on 1:50,000 scale, using satellite images, aerial photos and SOI topo sheets, to identify the geomorphic features, and generate a data base, to reconstruct litho/chrono-stratigraphic sequence of the Quaternary formations along selected locations in the study area and to develop a GIS based coastal evolution model. Geomor-

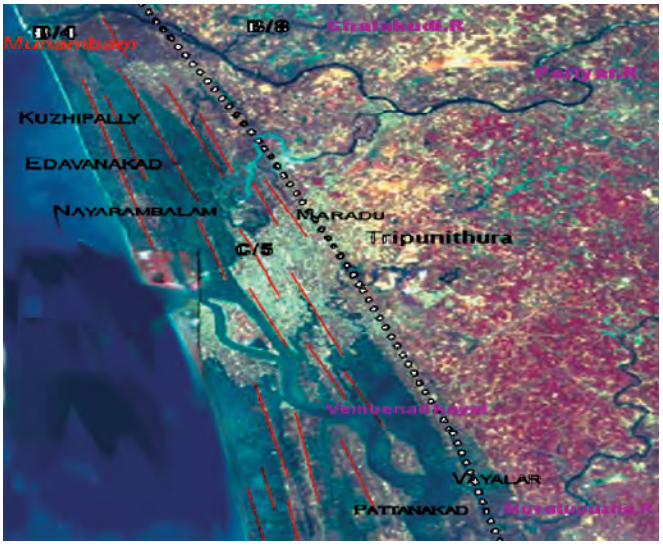

Fig. 1 1.5.1 Beach ridges/present and palaeo shore line limit of study area

phologically the study area is under the influence of different geomorphic processes. Marine processes are presently dominating. The other processes such as fluvio-marine, estuarine, fluvial and weathering also occur.

About five successive beach ridges and swales aligned parallel to the present shoreline were identified (Fig. 1.1.5.1). These beach ridges occur 3 to 4 km landward from the present shoreline. At some places these ridges/swales truncate abruptly. This is an indication of the change in process in the depositional environment. Textural and statistical analyses of surface and sub surface sediments collected from various locations ranging from 0-75m below MSL are progressing. Chemical analysis using standard titration method (Walkey-Black) revealed that the percentage of organic matter lies between 0.4% and 8.2%.The study has revealed the presence of decayed peat/wood beds at Vaduthalla, Panampally Nagar, Willington island and Vallarpadam, several kilometers landward from the present shore line and occurring at depths ranging from 20-65 m below the Mean Sea Level. C14 dating of the Quaternary sediments collected from various depths provided an early Holocene to middle Pleistocene age. The presence of peat beds and truncated beach ridges indicate the occurrence of abrupt changes in the climate and oscillations in sea levels in the study area.

John Paul

1.2 Atmospheric Processes

1.2.1 Rainfall validation and characterization and cloud physics studies using Megha –Tropiques Data.

Rain intensity, drop size distribution and its vertical profile, and radar reflectivity factor were measured using a Joss-Waldovgel impact type Disdrometer, Micro Rain Radar (MRR) and Parsivel Laser Disdrometers (Fig. 1.2.1.1) and manual rain gauges (MRG) during 2009-10.

Daily measurement of liquid water from rain was done using a MRG. Liquid water content and microwave attenuation were recorded using the MRR. Highlights are given below.

a) Experiments conducted with MRR concluded that a radar bright band signature, non-bright band signature and simultaneous transition of the slope of the Z-R relation together give a clear method for classification of tropical precipitation as stratiform or convective origin.

Fig. 1.2.1.1 RD-80 Disdrometer, Micro Rain Radar, Optical Disdrometer

b) TRMM satellite rainfall data agree well with MRG, Disdrometer and MRR data. The correlation coefficients are 0.9 and 0.6 for monthly and daily averaged data respectively.

c) Altitudinal and temporal evolution of rain drop size distribution studies using MRR revealed that as rain drops come down, the number of smaller drops decrease and number of larger drops increase simultaneously; ie., coalescence mechanism seems to dominate and

d) Empirical model for rain drop size distribution showed a high correlation (0.7) between the theoretical derivation and actual measurements.

G.Mohan Kumar

Funded by: Space Applications Centre, Ahmedabad

1.2.2. Continuous measurement of ambient carbon monoxide in a tropical coastal station

A comparative study between the satellite measurements of carbon monoxide (CO) during the period 2004-09 and ground-based continuous monitoring of ambient CO at Thiruvananthapuram using the Analyzer Monitor (Europe 9830 B) were carried out. The research highlights are listed below:

Vertical distribution of carbon monoxide in the tropical troposphere:

Vertical distribution of CO over Thiruvananthapuram (8^{o}29' N, 76^{o}57' E) were examined using the satellite instruments, like Measurements of Pollution in The Troposphere (MOPITT) and Tropospheric Emission Spectrometer (TES). Vertical profiles of CO at different pressure levels (1000-100mb) over this region for a period of 2004-09 were monitored. The study results showed that CO mixing ratio decreases with increase in altitude (decrease in pressure) as vertical mixing occurs between the polluted boundary layer and the cleaner free troposphere. CO mixing ratio is maximum at the surface (1000mb pressure), decreases with increase in altitude up to 400mb, peaks at 300mb and again decreases up to 100mb (~16000m altitude). A high degree of seasonal variability in tropospheric CO with altitude is also observed (Fig. 1.2.2.1). MOPITT and TES CO data compare well with the ground based measurements from the non-dispersive IR analyzer (Monitor Europe 9830B) installed at the measurement site.

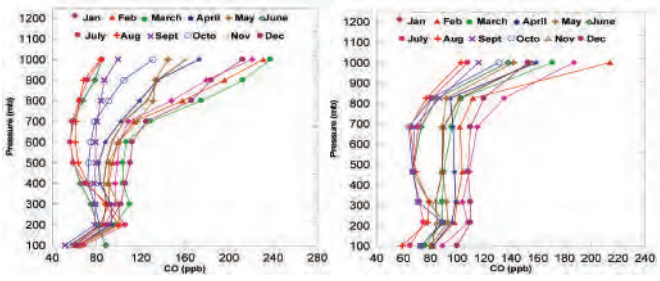

Fig. 1.2.2.1 CO vertical profile from (a)MOPITT and (b) TES

Comparison of satellite and ground-based CO measurements:

Comparison between the satellite (MOPITT) and ground-based surface CO measurement data is excellent with correlation coefficients better than 0.95. In order to reduce errors due to difference in resolutions, we have applied MOPITT averaging kernels to smooth ground-based CO data. After applying the MOPITT averaging kernels to the ground-based CO measurement data the comparison is excellent (Fig. 1.2.2.2). The analyzer profile now resembles the MOPITT profile much more closely and the two profiles are similar in both shape and magnitude. The original ground-based data shows low CO during monsoon but this is largely removed when the MOPITT averaging kernels are applied. Though MOPITT uses cloud detection methods in the current retrieval scheme, only cloud-free pixels are included, and retrievals are not performed on cloudy pixels. This could be the possible reason for large differences in the CO mixing ratio between MOPITT and ground based CO measurements during monsoon.

Carbon monoxide – a precursor of surface ozone:

In a clean atmosphere, tropospheric carbon monoxide (CO) acts as a precursor of surface ozone (O_3). Correlation of CO and surface O_3 over Thiruvananthapuram during the period 2004 -2007 was examined using the ground based as well as satellite (TES) measurements. Study results showed that diurnal variations in CO and surface O_3 were distinct with almost opposite diurnal patterns. Statistical analysis between diurnal CO and surface O_3 variation also showed an anti-correlation. Unlike diurnal variations, CO and surface O_3 showed similar seasonal variations with high values in winter and low during summer and monsoon. Statistical analysis between seasonal variations of CO and surface O_3 showed a high positive correlation in winter ($r > 0.60$) compared to summer ($r > 0.55$) and monsoon ($r > 0.50$). Satellite measurements (TES) and ground-based measurements showed a U–shaped annual pattern for CO and surface O_3 (Fig. 1.2.2.3). Annual variations of CO at different altitudes (1000-316 mb) in the troposphere also showed a U- shaped pattern like in surface CO, but the mixing ratio was found to be decreasing with increase in altitude (Fig. 1.2.2.4). O_3 mixing ratio was found to be decreasing with increase in altitude

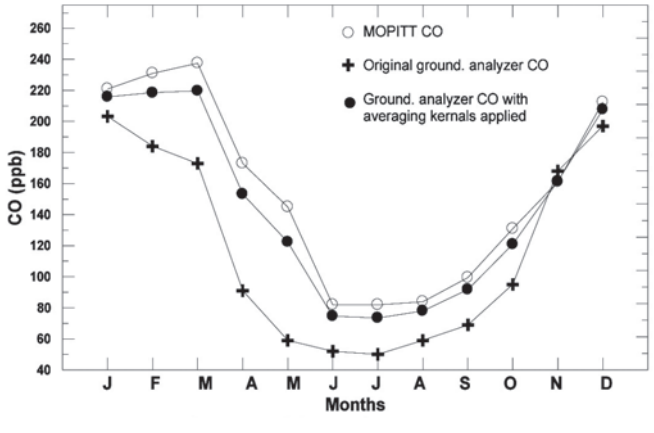

Fig. 1.2.2.2 Comparison of MOPITT and ground based CO measurements

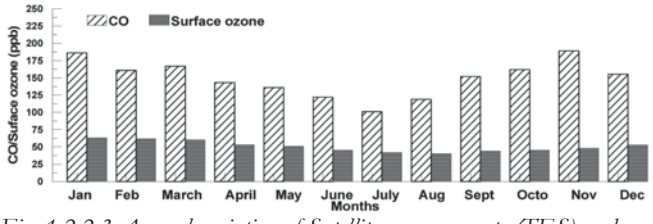

Fig. 1.2.2.3 Annual variation of Satellite measurements (TES) and ground-based measurements of CO and surface O_3

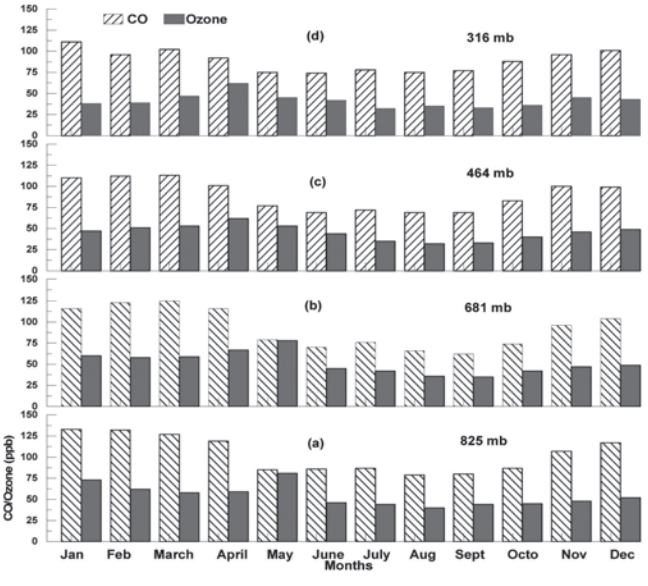

Fig. 1.2.2.4 Annual variations of CO and O_3 at different altitudes (825-316 mb) in the troposphere.

(1000-316mb) during winter but during summer, O_3 mixing ratio at higher altitudes (681-316mb) was high compared to surface and 825mb pressure level.

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Funded by: ISRO

1.2.3 Measurement of cloud parameters and cloud modelling

Ceilometer measurements

Ceilometer installed at CESS provides data on cloud base heights, its diurnal variation for all seasons, levels of maximum occurrence and other parameters. Using the dedicated Ceilometer software that was procured, with the sampling interval as 2s, continuous information on the sky particles that get scattered by the laser beam is available on the display screen. Cross section of the atmosphere up to 7.5 km is continuously obtained; Fig.1.2.3.1 a and b are screen shots of Ceilometer display. Due to the presence of large amount of water vapour from heavy rain on the previous evening Fig 1.2.3.1a shows continuous back scattering below the clouds present, which is indicated in blue colour. Fig.1.2.3.1b screen shot shows absence of clouds and relatively high visibility. Fig.1.2.3.2 is a display of Ceilometer laser scattering during a rain event on 3/12/2009. The angled path of rain due to the approaching cloud can be seen in the display. The scattering information during rain is useful for understanding the characteristics of particle distribution during dry and humid conditions. The scattered signal strength is shown on the right hand side of the display.

For a cloud base that does not have rain associated with it, the scattered signal has a sharp peak at the height of cloud base. In this case the cloud that crossed the Ceilometer was raining. The scattering signal shows two broad peaks indicating rain with large number of particles scattering the signal. The light blue patch came near

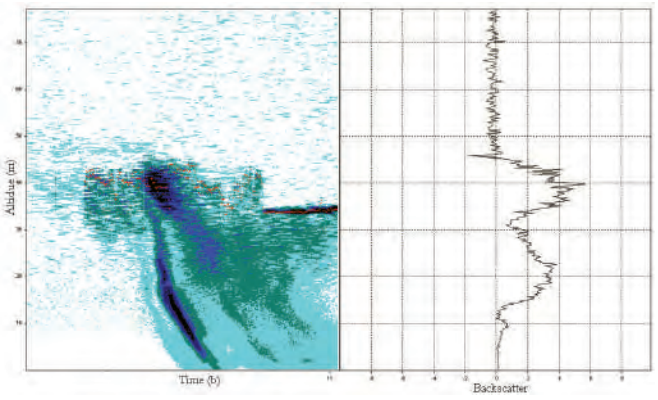

Fig. 1.2.3.2 Ceilometer display shows cloud base at a height of about 4 km and rain below it. Deep blue colour indicates strong scattering indicating the relatively high density of water in liquid or ice phase. At the centre of the display visibility is low due to rain up to ground level. On the right is the scattering window showing the back scattered signal strength.

the cursor when rain drops were reaching the ground (personal observation). The time at which rain drops reached ground was at 10:45h. With passage of time the scattering pattern widens towards lower levels indicating scattering by rain drops. The corresponding automatic weather station (AWS) data is shown in Fig. 1.2.3.3. At about 11:00 h 0.2mm of rain was recorded . The change in air temperature, humidity and solar radiation are clearly seen.

Cloud condensation nuclei counter measurements

A water based cloud condensation nuclei counter was operated in CESS during the year. The data from the instrument is valuable as there is no data on the condensation particle count from India. The measurement has yielded two important data. One is on the magnitude of particle concentration. This is found to be of the order of 10^4/cc. Another aspect is the diurnal variation of the particle count. Fig. 1.2.3.4 shows diurnal variation of particle count measured on 31st December 2009. The significance of the measurement and pattern is that these particles aid in the nucleation of water droplets leading to cloud formation.

Another important aspect to be noticed in the pattern is that the pattern follows the well known diurnal pattern of atmospheric pressure variation. This points to the possibility that the cloud formation may not be a totally independent phenomenon controlled only by temperature, Rh and the like. The

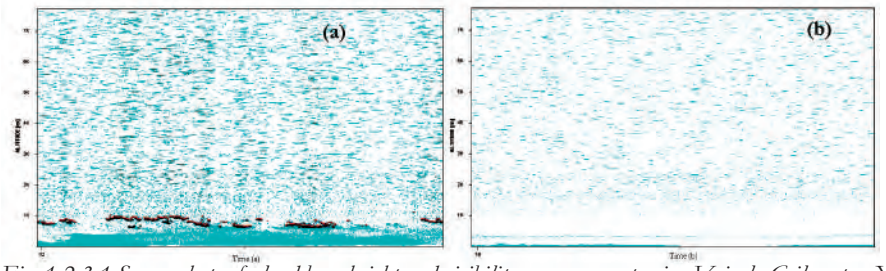

Fig. 1.2.3.1 Screen shots of cloud base height and visibility measurement using Vaisala Ceilometer. X axis is time and Y axis is height in multiples of 1 km. Red lines indicate cloud base showing that the cloud base is below 1000 m. Visibility is low because of presence water in liquid phase. a) is recorded at 10:30 h on 04-12-2009 and b) is the display between 18:00h and 18:30h on 02-12-2009 where no clouds are detected in the time span 18:00h – 18:30h. The number of particles is low and hence, the visibility is relatively high.

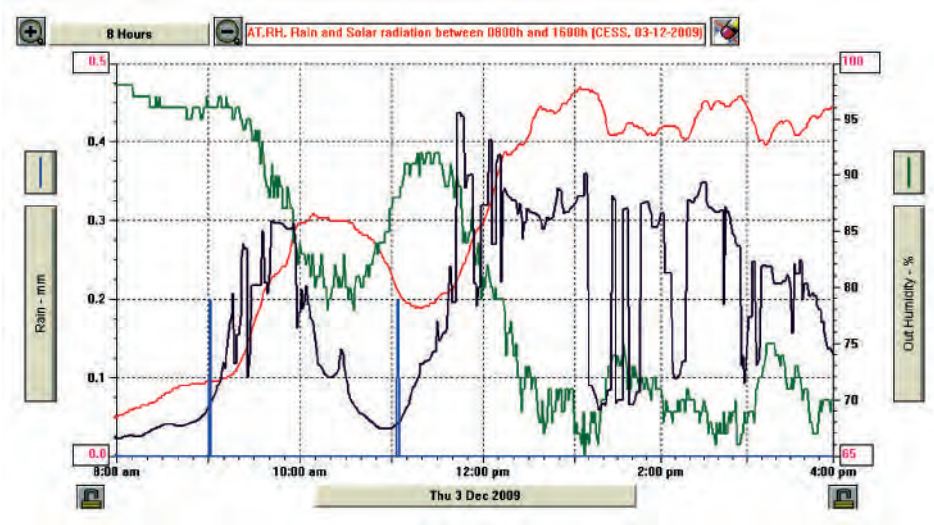

Fig. 1.2.3.3 Weather data collected at the time Ceilometer detected cloud and rain. Red line is the air temperature and brown line is the solar energy received. Green line is the relative humidity. Rain is indicated by blue color.

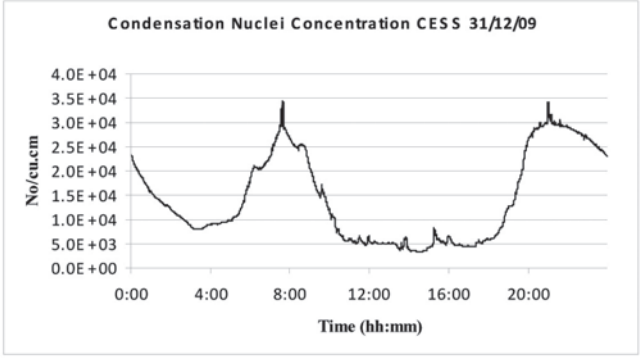

Fig. 1.2.3.4 Condensation nuclei concentration measured for 24 hours at CESS, a coastal site

significance of the particle count variation is seen in the Ceilometer data also. This is shown in Fig. 1.2.3.5 . Liquid phase water particles within 2 km altitude follow the condensation particle concentration variation indicating the chance of cloud formation. This is seen pronounced after solar heating hours (12:00 to 19:00 h) which is a noticeable finding of the project.

Monitoring at a mountain station

Ceilometer along with an AWS was set up at Braemore, a location on the western slope of Western Ghats. The height of the station is 400m AMSL. This location has weather conducive for formation of thunderclouds. Ceilometer observations started here in April 2009. Automatic Weather Station was also installed here. Fig. 1.2.3.6 (a) & (b) are weather data at CESS and Braemore on 15th January 2010, the Solar Eclipse day. There is half an hour difference in the occurrence of RH peak (green colour) and AT (red colour) depression relative to minimum in solar radiation between CESS and Braemore.

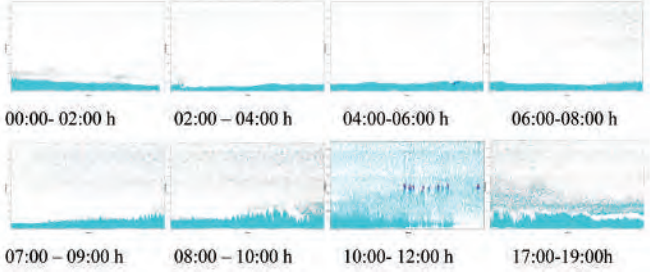

Fig. 1.2.3.5 Visibility displayed by Ceilometer below 2 km on 31st December 2009. Particle concentration at different timings shows the influence of condensation particle concentration

Field Mill measurements

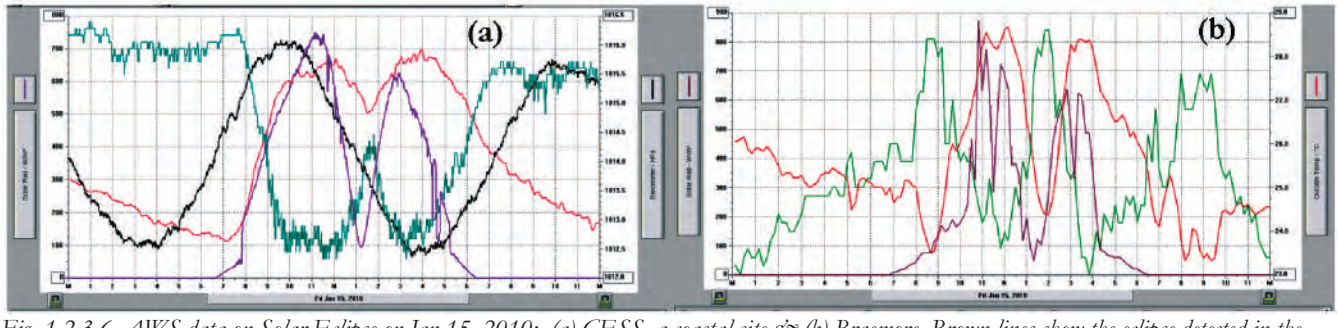

Fig. 1.2.3.6 AWS data on Solar Eclipse on Jan.15, 2010: (a) CESS, a coastal site & (b) Braemore. Brown lines show the eclipse detected in the solar radiation detector

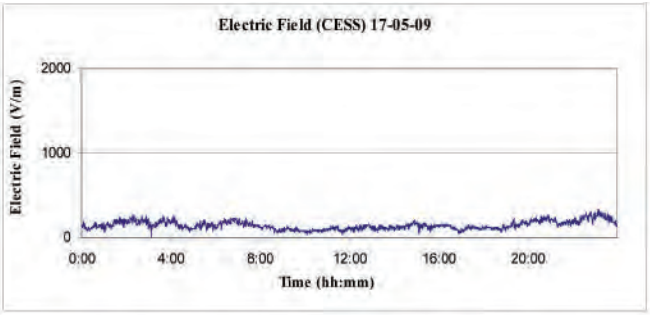

Fig. 1.2.3.7 Electric field measured using Electric Field Mill on a day of no electrical activity

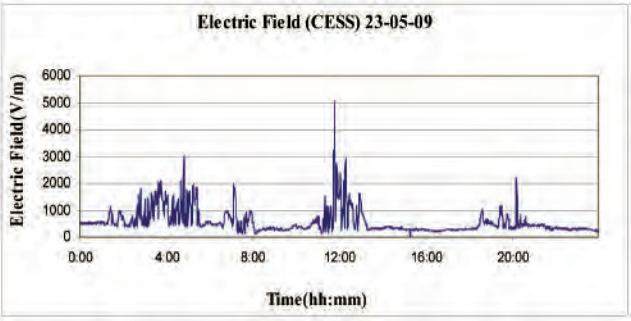

Fig. 1.2.3.8 Cloud electric field measured on a thunderstorm day during SW monsoon. At 04:00, 12:00 & at 20:00h thunderstorm activity with thunder at a distance was present

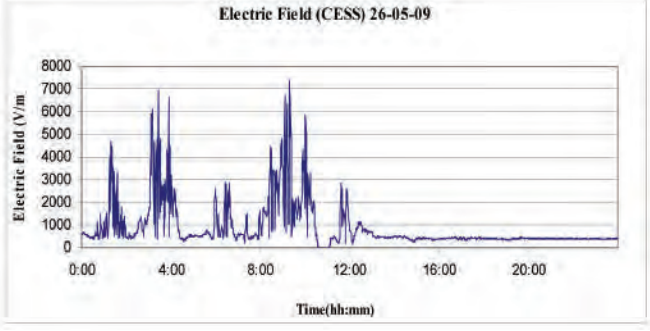

Fig. 1.2.3.9 Cloud electric field measured on another thunderstorm day during SW monsoon. At all times of high electric field thunderstorm activity with thunder at a distance was present

At the beginning of the year 2009 an electric Field Mill available with the Atmospheric Sciences Division was modified by introducing a fourth electrode and the same was set up at CESS for measuring cloud electric fields. The electric field monitoring is expected to differentiate charged and uncharged clouds. This information is useful in identifying convective activity and could also help in identifying Cb clouds. Fig. 1.2.3.7 is the record of electric field on a day when there was no electrical activity or thunderstorm. Fig. 1.2.3.8 shows the electrical activity (cloud electric fields) recorded at Thiruvananthapuram on 23rd May 2009, the day of setting in of SW monsoon in India. Transient signal observed is due to the change in cloud electric field variations and all batches of signal were accompanied by thunder at a frequency of about one per minute. Shown in Fig. 1.2.3.9 is the cloud electric field recorded on 26th May 2009.

On the same day the electrical activity of clouds was followed by thunder indicating the presence of charged Cbs during SW monsoon. Charged Cbs are not frequently seen during SW monsoon and the electrical activity indicates the presence of another system or thermal convection leading to Cb formation. However the dates of electrical activity were very close to the date of setting of SW monsoon and so the possibility is that the frontal activity caused by setting in is the reason for electrical activity. The possibility of using electrical activity as an indicator of SW monsoon setting in is being looked into. The modified field mill that is used in this study was very useful in testing and evaluation of data during operations.

S. Muralidas and G. Mohan Kumar

1.2.4 Solar UV-B radiation and atmospheric trace constituents in relation to climate change

Nature of variation of solar ultraviolet-B radiation and minor atmospheric constituents, viz., total ozone and water vapour at a coastal station, Thiruvananthapuram where both the SW and NE monsoons are active are important parameters that control climate change in this region. Towards this solar UV-B radiation and minor constituents will be monitored for 4 years, which is the minimum period for estimating a long-term trend. Solar UV radiation and measurements of total ozone and atmospheric water vapour columns will also be monitored simultaneously at this site to decipher the changes in them. The study is expected to provide an insight into the differing atmospheric water load in the tropical troposphere, a vital component of climate change. Satellite data on ozone and water vapour and relative humidity for this region will be accessed for the study period.

Solar UV-B radiation at 305, 312 and 320 nm, total ozone column, condensable water vapour, single wavelength Aerosol Optical Depth at near IR (1046 nm) and erythemal UV-B radiation in 280-320 nm band are the parameters measured using Microtops II & Solar UV-Biometer. Solar UV radiation at 3 wavelengths from Microtops on a typical fair weather day is shown below (Fig. 1.2.4.1) with that on a total solar eclipse day (Jan 15, 2010).

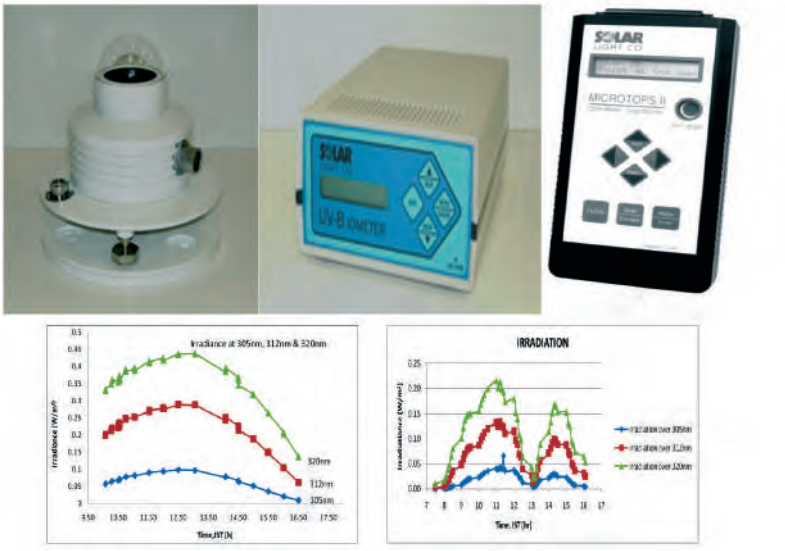

Fig. 1.2.4.1 Solar UV radiation at 3 wavelengths from Microtops on a typical fair weather day is shown with that on a total solar eclipse day

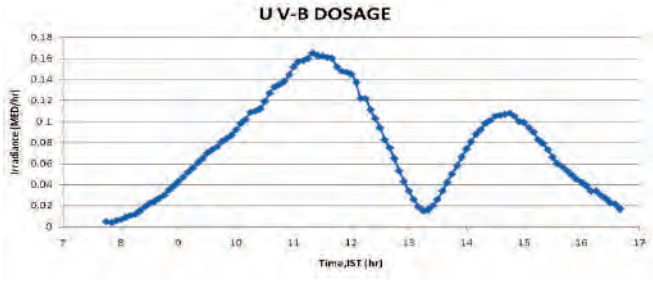

Fig. 1.2.4.2 Biometer output in MED/hr is shown for a solar eclipse event on 11th January 2010 at CESS.

Microtops measures condensable water vapour. But it did not show much variation on the solar eclipse day compared to fair weather days (Fig 1.2.4.1). Comparison with satellite data (MODIS, MOPIT, TRMM, SCIAMACHY etc.) with these ground measurements in the same spatial and temporal scale may point to the relationships between the UV enhancement and water vapour column dwindle. For comparison between water vapour and solar UV highs, instantaneous data match is essential as the solar UV photo-dissociates water vapour to the evanescent short-lived hydroxyl (OH) radical.

G. Mohan Kumar

1.3 Coastal Processes

1.3.1 Shoreline management plan for Kerala coast

The coast of Kerala has been considered highly eroding and efforts to protect the coast through coastal protective measures were being made for the last 60-70 years. Still the problem continues and the length of seawalls along the coast is increasing continuously. Groynes and 'groynes with seawalls' are also in place to protect the coast. But these have not served the purpose and in many locations cause adverse impacts on the stability of the coast. Therfore, it is proposed to have a comprehensive analysis of the problem of erosion through a Shoreline Management Plan (SMP) and suggest better and more effective coastal protection measures. SMP studies were taken up along selected highly eroding locations identified by the Central Water Commission/State Irrigation Department during the 10th and 11th Plan periods by the Centre for Earth Science Studies, which are being supported by the ICMAM Project Directorate, Ministry of Earth Sciences. The present study is to develop Shoreline Management Plans recommending appropriate sustainable coastal protection measures for Muthalapozhi, Vadanappally and Kozhikode.

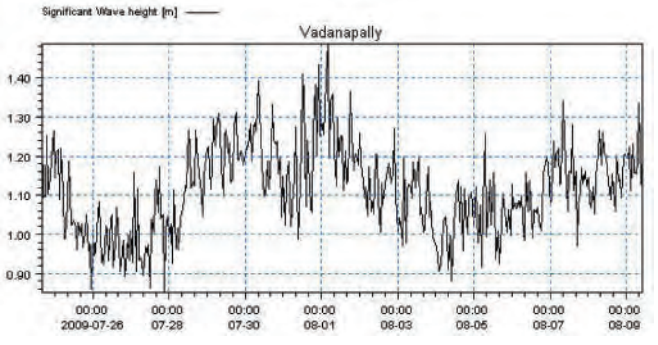

Fig. 1.3.1.1 Significant wave height (measured) at Vadanappally (26 July to 9 August 2010)

Numerical model studies were carried out using various modules of MIKE 21 model to understand the coastal processes and to compute sediment transport and shoreline variation within the sector. Model has been calibrated and validated for Muthalapozhi coast with the wave, current and shoreline variation data collected during pre-monsoon, monsoon and post-monsoon. Waves, nearhsore circulation and sediment transport have been simulated for the entire study area. Significant beach formation, south of the inlet/breakwater and severe erosion north of inlet/breakwater have been modelled. Southern sector is stable and prograding in certain sectors. Siltation within the harbour is found to be due to the beach sediment being transported from south and getting deposited within the harbour during the beach building period of September-December.

Fig. 1.3.1.2 Mudbank formation along Munambam-Chettuwa coastal sector over different years

Sediments also get transported from north towards the harbour mouth during monsoon season. It is proposed to control the siltation of the harbour by controlling the above sediment transport through appropriate interventions. Protection of the highly eroding coast immediately north of the breakwaters is now attempted through seawalls. Beach nourishment during beach building period is proposed for this sector. This has to be supported through control of southward sediment transport along this sector.

As a continuation of the above studies, data on driving forces such as waves and currents were collected from the coastal and nearshore waters along the Munambam-Chettuwa sector for monsoon, post monsoon and premonsoon seasons. Variations in significant wave height during 26 July to 9 August 2009 are given in Fig. 1.3.1.1. It is observed that the shoreline changes and erosion/accretion process are significantly controlled by the occurrence, nonoccurrence and migration of mudbanks that form along this sector. Mudbanks are features that surface during monsoon season in different sectors along the Kerala coast. Here waves get dampened in an area which otherwise would have been very rough due to monsoon waves. Mudbanks have migrated and formed in different locations inducing significant shoreline changes along the Munambam-Chettuwa sector (Fig. 1.3.1. 2). Along this sector, it is found that the beach sediment accumulates north of the mudbanks causing beach accretion. Severe erosion is observed along the coastal stretch south of the mudbanks. Along the coastal stretch under study, mudbanks have been reported to have formed at Nattika, Edamuttom and Kaipamangalam during different years. During 2009 monsoon the mudbank has formed at Arattukadavu-Bhajanamadom about 10 km north of the Munamabam inlet.

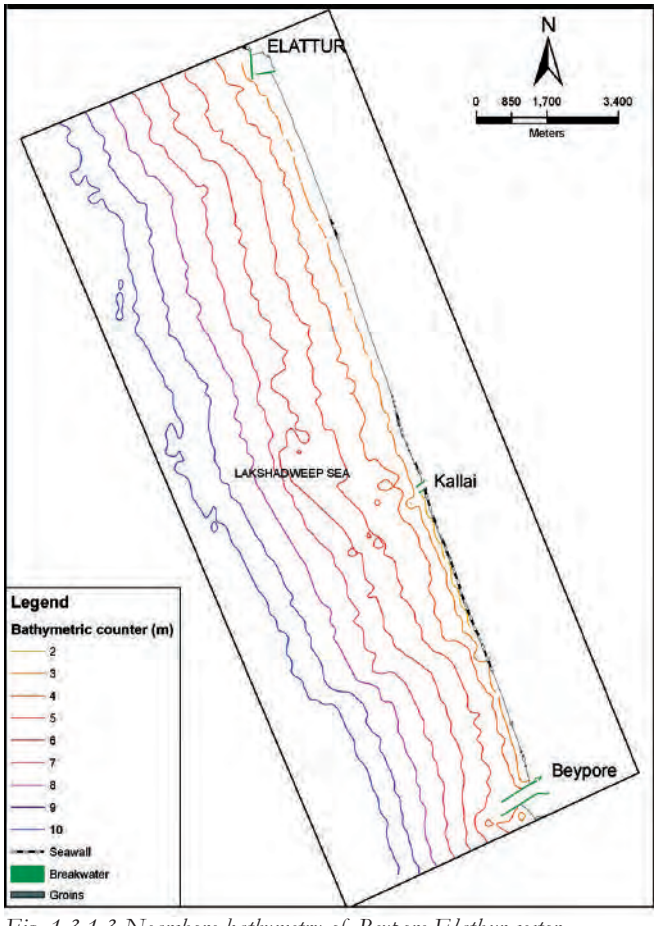

Fig. 1.3.1.3 Nearshore bathymetry of Beypore-Elathur sector, Kozhikode

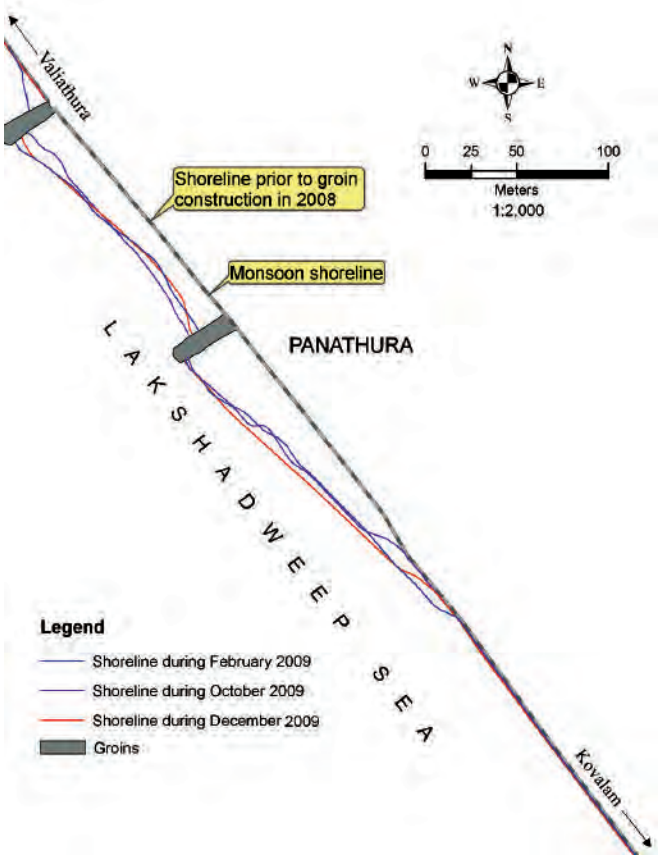

Fig. 1.3.1.4 Beach formation during different seasons at Panathura groynes.

The close grid bathymetry of the nearshore is one of the prerequisites for modeling nearshore processes including sediment transport. The close grid bathymetry of Kozhikode extending from Beypore to Puthiyapa has been generated from nearshore profiles and bathymetric survey (Fig. 1.3.1.3)

Performance of Groynes at Panathura

Kovalam-Panathura-Poonthura is a small coastal stretch along the Southwest coast of Kerala which is situated at latitude 8° 25' 22" and longitude 76° 57' 32". The entire Kovalam-Panathura coastal stretch has been affected by severe erosion which caused a shoreline retreat of about 75 m over the last 30 years. This coast had wide sandy beaches which were being used by a large fisher community, till erosion caused retreat of the shoreline. The efforts to protect the coast started in 1970s' with seawalls having frontal beaches seaward of the seawalls. Over the years the frontal beaches disappeared and no significant beach now exists seaward of seawalls in this region. There is the need of a coastal protection option which could regenerate beach and offer protection to the coast. Based on the recommendations of a detailed study conducted jointly by CESS, IITM (Chennai) and ICMAM (MoES), a 'transitional T-groyne' field was proposed for the protection of the coast through facilitating beach development. The design for the same was provided by IITM. As a pilot programme 2 groynes were built. Shoreline variations with the 2 groynes in place were continuously monitored to assess the performance of the groyne field and propose any modifications, if required. It was observed that beach gets reformed south of the groyne and in between the groynes (Fig. 1.3.1.4). During monsoon the entire beach disappears and again reforms during fair season indicating the groynes do help to generate beaches during fair season. Observations and studies are continued to understand the modifications to coastal processes in the presence of groynes and to propose modifications to the recommended 'groyne field'.

K.V.Thomas, N.P. Kurian, T.S.Shahul Hameed,
L Sheela Nair, Regi Sreenivas
Funding: Ministry of Earth Sciences, GoI

1.3.2 Nitrous oxide and methane in coastal ocean and estuaries

Methane (CH_4) is a strong greenhouse gas, which is about 23 times more potent than carbon dioxide (CO_2) in global warming. The relative contributions of CH_4 and CO_2 in global warming are estimated to be 18 % and 50 % of the total. Coastal oceans are known to hold significant quantities of CH_4. Continental shelf regions that represent only 15% of total oceanic area are estimated to contribute 68% of global oceanic CH_4 emission. Arabian Sea which constitutes only 0.43% of the global ocean cover has been estimated to contribute more than 1.3% of the global oceanic CH_4

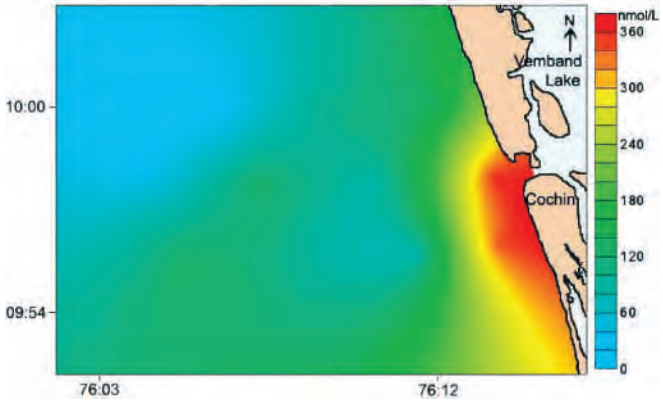

Fig.1.3.2.1 Dissolved methane in the surface waters off Kochi

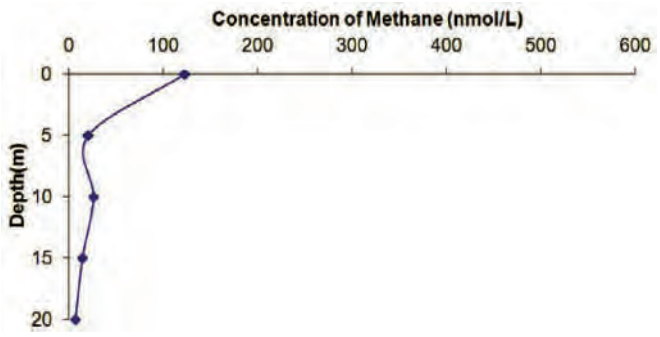

Fig.1.3.2.2 Vertical distribution off dissolved methane at a coastal location off Kochi

fluxes to the atmosphere. Nitrous oxide (N_2O) is another greenhouse gas whose global warming potential is estimated to be 230 times that of CO_2, though its atmospheric concentration is low. N_2O is produced during nitrification and de-nitrification processes taking place in low oxygen environments.

A programme with support from the Ministry of Earth Sciences was initiated to monitor CH_4 and N_2O in the coastal ocean off Kerala coast. The concentration of these gases in the estuaries and their discharge to the coastal ocean, as well as water to atmosphere fluxes of these gases are studied. The distribution of dissolved CH_4 in the surface waters off Kochi coast during the pre monsoon period of 2010, and its vertical distribution at one location in this area are shown in Fig.1.3.2.1 and Fig.1.3.2.2 respectively

E. J. Zachariah

Funding: Ministry of Earth Sciences, Govt. of India

1.3.3 Coastal Ocean Monitoring and Prediction System (COMAPS)

This is an ongoing programme funded by the Ministry of Earth Sciences (MoES), to identify the ecologically sensitive areas and to assess the seasonal variation of pollutants in the coastal segment of India. Towards this, periodical estimation of chemical, biological and microbiological aspects of water and sediment are monitored along the designated coastal regions. The major hotspot (ecologically sensitive areas) transects included for coastal monitoring during the pre-monsoon and post- monsoon seasons of the year 2009-10 were Veli, Cochin, Mangalore and two research cruise sampling programme extending from Karwar to Veli. Hot spot sampling work were carried out by employing hired fishing boats and cruise sampling programmes were carried out by making use of the MoES coastal research vessels (CRV) Sagar Purvi and Sagar Paschimi. An annual monitoring work at Kavaratti Island, Union Territory of Lakshadweep also was undertaken. Sampling included collection of water and sediment samples from shore, near shore and offshore at distances of 3, 5 and 10 km respectively. The samples were analyzed for chemical, biological and microbiological characteristics. The estimation of physical parameters such as temperature, transparency, conductivity, dissolved oxygen and salinity were carried out *in situ*. Other samples were kept frozen until the analysis started. The biological samples were preserved in 4% formaldehyde solution and rose Bengal stain for the identification and enumeration purpose. The biological productivity characteristics such as estimation of primary productivity were done using dark and light bottle by deck incubation method. Pigments such as chlorophyll a, phaeophytin were estimated by acetone extraction techniques. Microbiological populations were impregnated using spread plate techniques, incubated for 24 hrs at 37±2^{0}C. The bacterial colonies were counted and expressed in colony forming units/ml (CFU/ml).

Though the Veli region was heavily influenced by the presence of untreated acidic effluents from chemical industry, which deteriorated the water quality during the previous period, its effect was found considerably reduced during the post-monsoon period. Towards offshore the concentration of nutrients was reduced due to increased uptake by photosynthetic community leading to an increase in the oxygen saturation in surface waters. Microbiological indicators seemed to be closely accompanied by changes in physical and chemical characters of the water column in such a way that many indicator bacterial groups (Escherichia coli, salmonella spp, Faecal coliforms and Pseudomonas aeruginosa) were comparatively low or even absent towards offshore, due to limited supply of nutrients and increase of salinity values towards offshore region. The absence of such simultaneous groups of bacteria also indicated a healthy environmental condition in the region. Compared to the previous studies, increase in the viable bacterial population in the nearshore regions were observed which may be due to the pragmatic reduction in acidic influence. The nearshore biological productivity was found low due to the limited presence of phyto and zooplankton. The zoobenthos was not observed in the shore region throughout the study period indicating a shift of

Fig. 1.3.3.1 Sampling points of hot spot studies in south west coast of India

the community from shore to offshore. This shows that the near shore pollution effect was not fully recovered for the reestablishment of this sediment inhabitant. The empty bivalve molluscan shell obtained in grab operations supported the same and also revealed that the sediment bed act as sink for the pollutants entering the surface water column of coastal waters.

During the post-monsoon period, the estuarine waters and coastal waters of Vallarpadom area, were well influenced by the inflow of fresh water from six major rivers that carry bulk amounts of industrial, anthropogenic and sewage pollutants from the metropolitan Kochi city. This enhanced the productivity up to a marked level. It was observed that the tidal influence flushes the estuarine system up to a water exchange of 75% which in turn clean up the estuary to a large extend. The fresh water dominated estuary resulted in decreasing of salinity and pH. The BOD values at higher level (> 3.0mg O_2/l) revealed that the water was contaminated with organic load brought by six fluvial systems and the nutrient level was showing an increasing trend. The increase in values of ammonia indicated an upward trend in the inflow of organic wastes of urban origin as well as contaminants from industrial origin. Indicator bacterial groups recorded comparatively higher concentrations throughout the study period which correlated with the domestic wastes carried by rivers. The engineering modifications' including dredging promotes the re-suspension of sediment bound bacteria. The higher incidences of Faecal colforms and Vibrio cholerae also has linkages to the domestic sewage disposal into the area. Biological productivity was observed high. Variations of phytoplankton count showed the grazing habit of the zooplankton groups over it. Among zooplankton group, copepods and fish larvae dominated more. The presence of fish larvae indicated that this estuarine system is a breeding ground for many commercially available fish species. The benthic community was found very much affected by the engineering modifications, especially the periodic dredging carried out in the estuarine and coastal waters.

In Kochi, the hourly measurements at the barmouth region showed low salinity, except at 06:00 hrs. There was no indication of any oxygen gradient and depletion of oxygen during the semidiurnal study. Pattern of distribution of suspended solids was different, with higher values observed when the salinity was low. This can be attributed to resuspension of sediments by fresh water runoff and strong tidal action. BOD values were > 3.0mg O_2/l at certain intervals indicating the heavy influence of domestic wastes. In the case of nutrients, low N:P ratio revealed an increase in the utilization of nitrogen forms. As such their concentration was low compared to inorganic phosphate, with nitrogen is acting as the limiting nutrient in the bar mouth region. Towards offshore there was also not much difference in oxygen gradient. Low nutrient content and high dissolved oxygen in surface waters can be correlated with the uptake by phytoplankton. Indicator bacterial groups were comparatively very high throughout the study period.

Generally all indicator bacterial groups showed an inshore increase and offshore decrease, may be due to the higher nutrient concentration towards inshore. Salinity also plays a major role in this concern, towards offshore where the salinity increase resulted in the reduction of microbial population. The higher incidence of enteric pathogen especially VCLO and VPLO, with increase towards inshore suggested that the area is under threat. The productivity was in an increasing trend in the bar mouth compared to shore and offshore transect. The enhancement observed in phyto and zooplankton counts from earlier studies conducted confirmed the eutrophication state of the estuarine water. The zoo benthos especially macro types was in a decreasing trend which can be correlated with the dredging activities carried out frequently.

Various types of small, medium and large size industries are located along the coastal belt of Mangalore. The two rivers, Gurupur and Netravati, are the main sources of sediments and flood water discharges into the coastal sea. Salinity stratification was observed during the semi diurnal study due to fluvial flow and was extended up to 1.0 km offshore. Nutrients showed wide variation, inorganic silicate concentration was high in surface water due to river water influence with a concomitant increase in inorganic phosphate values. The concentration of nitrite and nitrate was found to be low in near shore as well as towards offshore region. Well aerated waters with higher DO in surface and lower in bottom water are evident in near shore and off shore region. There was not much wide difference in BOD values in surface and bottom waters and the values were less than 2.0 mgO_2/l. Phytoplankton genera indicated that Asterionella, Chaetoceros and Skeletonema were in majority and among zooplanktons Copepods dominated. The percentage composition of zoo benthos was represented by Molluscans. The zoo benthos groups inhabiting the study area can be considered as an industrial pollution indicator, even if large quantities of industrial as well as sewage pollutants responsible for the alteration in the ecosystem structure are amalgamating day by day. By interpreting the biological tools it was observed that a chance of eutrophication was prevailing in the coastal waters in a short period. Indicator bacterial groups reported were high towards inshore region, especially the presence of Escherichia coli and Faecal Coliforms, which suggested the presence of anthropogenic discharges.

Kavaratti (U.T of Lakshadweep)

The marine bio diversity of Lakshadweep Islands, the 'Coral Paradise' with sea grass bed, 104 species of Scleractinian corals, mangroves and 603 species of fishes was supported by the physico-

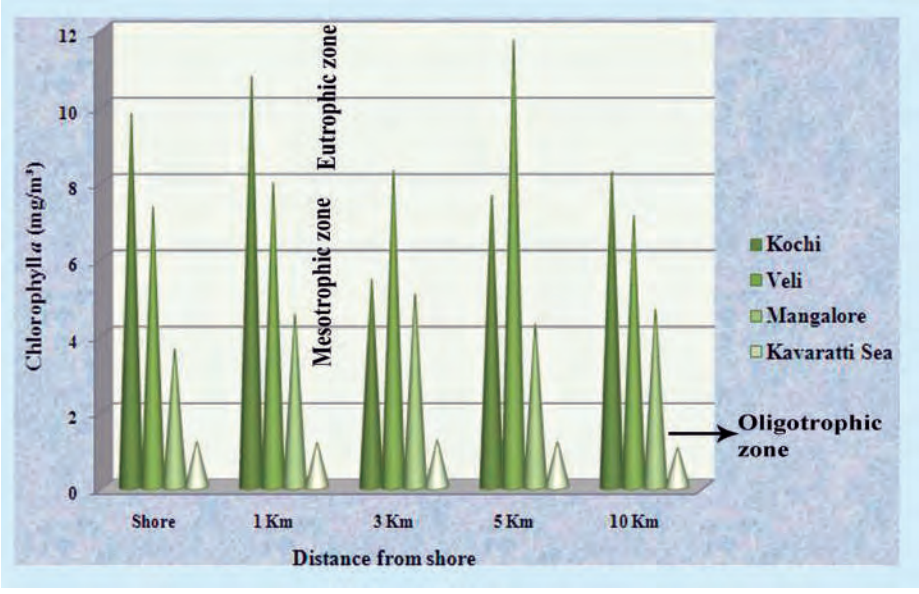

Fig. 1.3.3.2 Across-shore variation of chlorophyll at different coastal locations

chemical, biological and microbiological characteristics of the surrounding sea. The lower concentration of nutrients observed inside the lagoon waters with a corresponding increase in dissolved oxygen is attributed to the active contribution by the thick growth of benthic algae especially sea grass and sea weeds. The water chemistry, the inorganic phosphate and the total phosphorus content of these waters showed that much of the phosphorus present is bound organically. This higher concentration of organic phosphorus observed is due to the influence of high metabolic activity of the coral reef. Inside the lagoon the sea grass bed is playing an important role in the recycle of nutrients. No wide variation of water temperature and salinity between surrounding sea and lagoon area was observed. The nutrient concentration diminished towards offshore. The analysis of biological tools such as primary productivity and the phytoplankton pigments revealed that the productivity of the lagoon in near shore waters was found high compared to the lagoon centre, reef and the surrounding sea. The chlorophyll a concentration in the surface water of lagoon showed very low values and recorded a maximum of 0.65mg/m^3.

The phytoplankton count was also expressed in a minimum count limited to two genera- Skeletonema and Coscinodiscus. The submerged flora of near shore lagoon is flourished by sea grasses and sea weeds. It was clear that the photosynthetic activity carried out by these submerged macrophytes may be the reason for the increased biological productivity prevailing in the lagoon waters. In terms of chlorophyll a concentration, the Kavaratti lagoon is termed under the trophic state of "oligotrophic". The dominant species of zooplankton consisted of gastropod larvae, decapod larvae and brachyuran larvae. Copepods showed their maximum presence in the lagoon during 12:00 and 15:00hrs. But in the surrounding sea of Kavaratti atoll Copepods were the predominent ones. The zoo benthos in the Kavaratti atoll transect were represented by coelenterates and crustaceans. Indicator bacteria and enteric pathogens were comparatively low throughout the study except the nearshore region off helipad where the nutrient concentration also reported the maximum, probably due to the sewage disposal in the area. Generally microbial parameters in the water column followed a decreasing trend in values from the onshore to offshore, as might be expected. However the reduction in population dynamics of indicator bacteria varies from species to species.

Cruise Programme- 2009 (Veli to Karwar)

Chemical characterization revealed low concentration of nutrients in offshore region signifying its increased utilization. In most of the transects the oxygen saturation was found to be 80 % or more in the surface water towards offshore signifying an enhanced photosynthetic activity compared with respiration rate. Metal enrich-

Fig. 1.3.3.3 Locations of study off Kavaratti Island

ment due to cadmium was found in sediments of Cochin region (well above the global average shale value of 0.3ppm). High Organic Carbon in sediments of Cochin and Mangalore is due to the increased inflow of domestic wastes. The microbial pollution was found more towards the shore region than the offshore except in the case of Veli. In all the stations, especially estuarine region of Mangalore, Cochin and Neendakara reported high bacterial population of FC, TC, VPLO and VCLO. E.coli like organisms was isolated from a few stations, especially from the nearshore regions which might have originated from the land based sources and transported seaward through rivers. PALO were almost absent in most of the stations. The productivity in terms of phytoplankton production was found to be in an increasing trend compared to previous cruises. Zooplankton grazing doesn't affect the phytoplankton standing crop. In most of the stations copepod group dominated among zooplanktons. The distribution of fish eggs and fish larvae at Mangalore, Kasargod, Calicut, Kochi and Neendakara promised a natural breeding ground for pelagic fishes concentrated in relation to their food availability and feeding regime. The incidence of anthomedusae (Jelly fishes) among zooplankton collected from nearsore and offshore waters of Veli made little panic. Recently their count increased and the adults in dead stage were washed ashore. A "foaming sea phenomenon" produced in the sandy beaches near Veli resulted by the strong wave action upon the gelatin released from the decayed jelly fishes was noticed during the period.

K. Narendra Babu

Funding: Ministry of Earth Sciences, Govt. of India

1.3.4 Laser-induced Fluorescence studies of Corals

Fluorescence is a non-destructive, intrinsic tool that can reveal information on various aspects of corals and coral reefs. In situ laser-induced fluorescence (LIF) measurements were carried out in corals from Palk Bay, near Rameswaram in TN. It was observed that corals differed in their host pigments, which can be used to identify different species. The study has shown that spectral characteristics are a good indicator to identify the different species in the reefs and can also be used to detect the impact of various stresses on corals and coral mortality.

In situ studies in Palk Bay:

LIF measurements of different varieties of corals such as Porites lutea, Montipora foliata, Acropora digitifera and Goniastrea rectiformis were carried out in a boat cruise at a depth of 0.5-1.5m with the LIF point monitoring system developed in the Biophotonics Laboratory of ASD. This system consisted of a 404 nm diode laser for excitation of fluorescence and a miniature fiber-optic spectrometer for recording of emission from corals. The system has a 3-m long fiber-optic probe has a central fiber of 400 microns diameter to deliver the excitation beam and six surrounding fibers (each of 400 mm dia.) to collect the LIF emission from corals. During the boat cruise, the fiber-optic probe and cable were tied to a 6m long PVC pole to keep the probe tip steady over the coral surface while LIF was recorded on the laptop computer connected to the spectrometer using the OOI Base32 software. Fig. 1.3.4.1 shows the mean spectral characteristics of different species, normalized to the peak intensity at 685 nm.

Emission from host pigments were found to change according to the constitutional differences in each of the species studied. The emission around 494 nm was found to be strongest in Goniastrea rectifomis as compared to Acropora digitifera, Montipora foliosa and Porites lutea. In Acropora digitifera the blue-green emission was observed as due to two host pigments at 498 and 574 nm where as in Montipora foliosa these peaks were seen at 497 and 578 nm. Goniastrea rectifomis and Porites lutea exhibited a single host pigment emission at 494 nm and 496 nm.

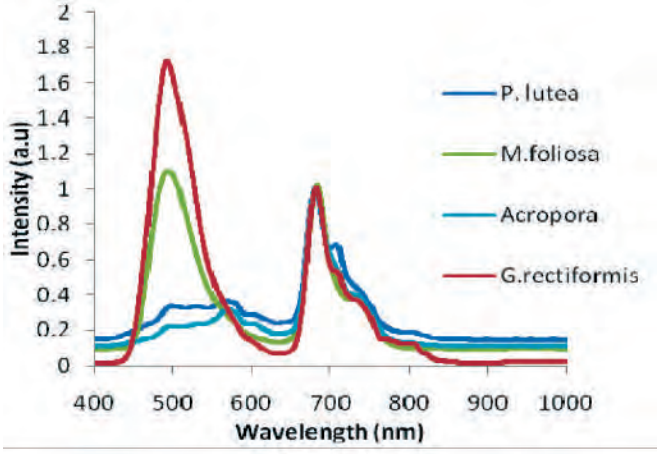

Fig. 1.3.4.1 Averaged LIF spectra from different varieties of corals normalized to the intensity of the chlorophyll peak at 685 nm.

The LIF spectral data was analysed by curve-fitting to identify the emission peak position and the contribution of each peak in the overall spectra (Fig. 1.3.4.2). In P.lutea the blue-green emission was observed as due to two host pigments at 499 and 572 nm where as in M.foliosa these peaks were seen at 501 and 504 nm. In comparison A. digitifera showed the presence of three host pigments at 491, 519 and 589 nm. On comparing the LIF spectra from the species P.lutea growing in well lit and shaded region it was found that the species growing in the shaded region lacked the chlorophyll peak at 730 mm.

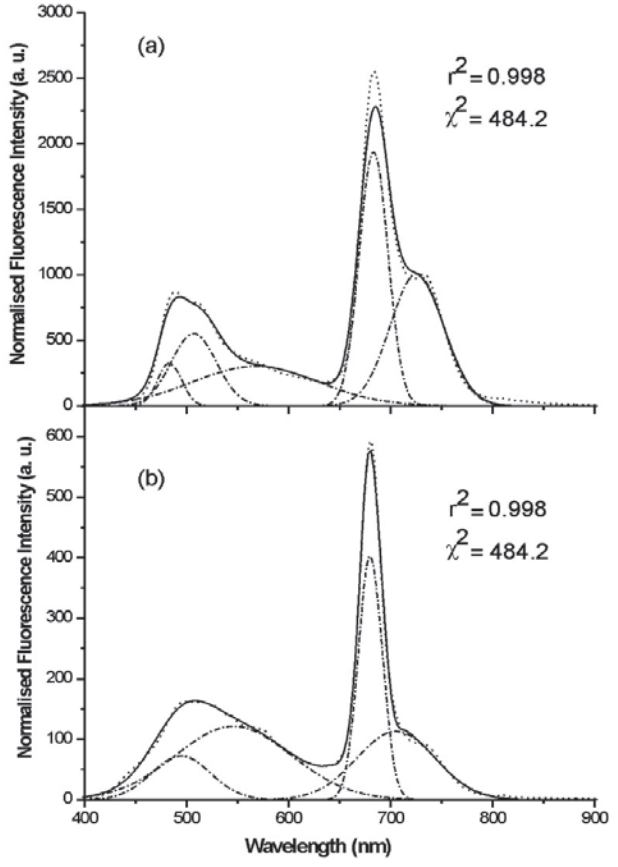

Fig. 1.3.4.2 LIF spectra of (a) healthy and (b) bleached samples of Acropora formosa deconvoluted by curve fitting. Dotted lines represent the data points, the solid line is the curve-fitted spectrum and the dot-dashed lines represent the constituent bands.

Development of LIMFIS:

Laboratory prototype of the laser-induced multi-spectral fluorescence imaging system (LIMFIS) was built. The system consists of a diode pumped solid-state (DPSS) laser (Dream Lasers, PRC) emitting at 457 nm both under cw (200 mW) and pulsed modes (upto 20 KHz repetition rate), an intensified CCD (ICCD) camera (Andor Technology, UK, Model:DH-734-18-F03) with 1024x1024 pixels and solis software, a liquid crystal tunable filter (LCTF) of 10 nm bandwidth (CRI, USA, Model: Varispec MK-50014 VIS-10-D), laser beam expander and image collection optics. Fluorescence images of different biological systems were recorded to test the performance of the system and to fine tune and synchronize the gating of the ICCD camera with laser repetition rate.

N. Subhash, T. N. Prakash & Anu Baburaj
Funding: DST, Govt. of India

1.3.5 Spatio-temporal shore changes during Holocene and tracing the evolutionary history of the Ashtamudi estuary, Southern Kerala

This is an inter-institutional collaborative project between CESS and Anna University, sponsored by the DST, Govt. of India. The objectives are planned with an integrated approach to document the spatio-temporal shore changes and to study the transgressive/ regressive cycle's signatures from sediment facies analysis with faunal tool. During the period under report we have collected sediment cores of <2m length using Hand Auger along two transects in the northern and southern sector of the Ashtamudi estuary representing the flood plain, ridge, runnel, and barrier beach (Fig.1.3.3.1). The cores were cut and sub samples were subjected to sedimentolgical and foraminiferal studies. Here we present the sedimentological and foraminiferal characteristics of the core samples for two transects where there were indications of transgressive/ regressive phase during the Holocene. Since this area encompasses Holocene sediment thickness of > 10 m the future programme involves the collection of sediment cores using Rotary drilling.

The textural analysis of down core sediment sections reveals the variations in sediment size along different geomorphological units. The barrier beach sediments are composed of fine sand with enrichment of heavy minerals, where the sediments are moderatley well sorted with symmetrical skew and are platykurtic. The runnel sediments are clayey sand with mean size coarsening downward. Sorting becomes better with platy to extremely leptokurtic down the core. The sediments of the ridge area are of fine sand which are poorly sorted, fine skewed leptokurtic and enriched with heavy minerals. The sediments in the floodplain of the northern sector shows mixed variety with muddy sand at the top, sandy mud at the middle and clayey sand at the bottom. The mean size of the sediment indicates entrapment of coarse silt between fine sand and very fine sand along the core. The sediments are poorly sorted, very fine skewed and lepto to very leptokurtic along the core length. Along the southern sector of the flood plain, downcore sediment grain size variations reveals the fining of sediments at the top and bottom with less coarse sediments at the middle of the core. The sediments are platy to mesokurtic and fine skewed.

The organic matter is lowest (0.26%) in the ridge whereas it varies from 0.61 to 0.87 % in the runnel, 1.02% in the barrier beach and from 1.48 to 2.29% in the flood plain except at the middle part of the core with an amount of 12.67%. In the flood plain of Sasthankotta the organic matter varies from 5.61 to 7.66 %.

The kaolinite, chlorite and gibbsite are the predominant clay minerals with quartz in the flood plain of the area.

Thirty nine sediment samples were processed for foraminifera

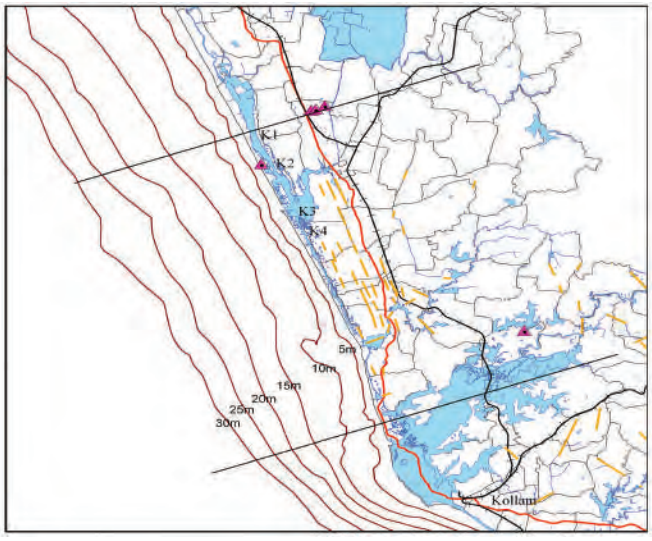

Fig. 1.3.5.1 Study area

studies and the litholog was prepared . The litholog samples lack fauna. But the estuary sediment samples have yielded 32 foraminiferal species, such as *Ammonia beccarii, Ammonia detata, Ammobaculites* sp., *Bolvina earlandi, Bulimina marginata, Carbeanella polystoma, Cancris oblongus, Cibicides lobatulus, Dyocibicides* sp., *Elphidium crispum, Elphidium excavatum, Elphidium discoidale, Elphidium hispidulum, Eponides repandus, Globigerina bulloides, Globorotalia angulata, Globigernoides ruber, Globulina gibba, Loxostomum lobatum, Nonion boueana, Nonion grateloupi, Nonion scaphum, Nonion* sp., *Pararotalia nipponica, poroeponides lateralis, Quinqueloculina agglutinans, Quinqueloculina boueana, Quinqueloculina seminula, Rolshausenia rolshauseni, Textularia agglutinans and Virgulina riggii.* Q-mode factor analysis was carried out to establish the distribution pattern of faunal assemblages in the estuarine sediments.

The preliminary analysis has indicated that there is a significant variation in the sedimentological characteristics of southern Kerala associated with sea level changes. Occurrence of chlorite in the transgressive phase along the northern part is deciphered. The anomalous enrichment of organic matter in the floodplain is related to the standstill of sea level. Further studies are in progress to ascertain the transgressive/regressive phase in the study area. Quantitative study has been attempted from the results of faunal assemblages of the study area. Q-mode factor analysis was carried out to establish the distribution pattern of faunal assemblages in the estuarine sediments. Four biotopes were identified using the cluster analysis.

T.N.Prakash, M Samsuddin & R. Nagendra

Funding: DST, Govt. of India

1.3.6 Conservation and nourishment of selected beach tourism locations for Kerala

Kovalam is one of the most popular international tourist destinations. There are two embayed beaches between the headlands at the Vizhinjam light house and Kovalam. The light house beach is bounded by a rock outcrop and a tombolo at the north end and a rock headland where lighthouse is situated at the south end. Coastal

Fig. 1.3.6.1 Lighthouse beach with artificial reef in place

erosion and loss of beach has been very critical for the coastal systems and tourism potential of Kovalam. Under the project on 'Conservation and nourishment of selected beach tourism locations for Kerala' a multipurpose 'artificial surfing reef' was proposed for lighthouse beach and Udayasamudra beach north of

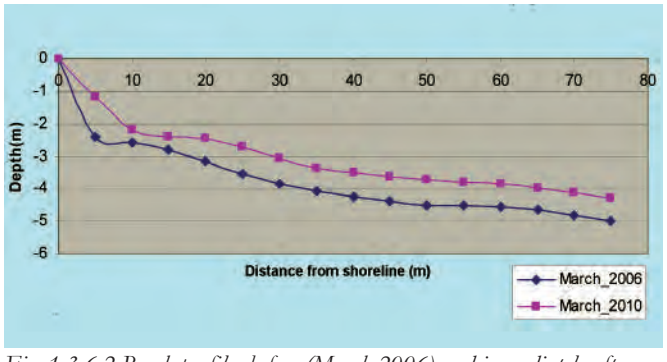

Fig. 1.3.6.2 Beach profiles before (March 2006) and immediately after the construction of reef (March 2010)

Kovalam headland. It was expected that the artificial reef would sustain a minimum width of the beach even during the eroding monsoon season and provide a minimum number of high quality

surfing days. It was also expected that the fishery habitat will be enriched once the reef is in place. The project was implemented by the Harbour Engineering Dept through ASR Ltd and the reef was in place by February, 2010 (Fig. 1.3.6.1). The CESS has been monitoring and assessing the morphological modifications due to the artificial reef including the sustainability of the beach.

Shoreline positions were periodically tracked using DGPS/GPS surveys and cross shore variation of beach profiles monitored using dumpy level and staff. Sediment characteristics were also monitored. A comparison of beach profiles before and immediately after the construction of the reef indicates a tendency of beach build up (Fig. 1.3.6.2). The observations are further continued for understanding the morphological modifications in the coming years.

K.V. Thomas, N. P. Kurian, T.S.Shahul Hameed & L. Sheela Nair

Funding: Department of Tourism, GoK

2.1 Landslides

2.1.1 Field investigations of land disturbances in various parts of Kerala

During the SW monsoon of 2009, most of the districts in Kerala experienced wide spread land disturbances in the form of landslides, floods and subsidence due to piping. Heavy to very heavy rains accompanied by strong winds contributed to the wide spread damages that occurred at various localities. In northern Kerala, Wayanad, Malappuram and Kozhikode were the worst affected by this hazard. Continuous rains also caused flooding at many places, destroying crops and cultivated lands worth lakhs of rupees. Among the southern districts Idukki experienced severe damages on account of land disturbances.

The Government of Kerala has constituted an Expert Committee with G Sankar of CESS as Chairman to assess the damages due to land disturbances in Wayanad and Malappuram districts and to examine the reasons for the wide spread landslides.

The Committee visited the affected areas in Wayanad, Malappuram

Fig. 2.1.1.1 Debris flow at Kanthanpara

and the worst affected Pasukkadavu area of Kozhikode district during 20-23 July 2009 and submitted a report to the Government. The Committee also visited following areas affected by landslides:

Debris flows at Pulinjal and Perumkulam localities in Vellamunda Panchayat, Mananthavady Taluk, Wayanad, Chembra Peak road Meppadi gram Panchayat, Muppainad (kanthanpara) in Vythiri Taluk, Kurumbalakotta, Vythiri taluk, Kunnamangalam Vayal Meppadi and Neelimala, Vythiri taluk in Wayanad district. The experts also visited a rotational land slide at Kunnamangalam Vayal at Meppadi also belonging to Wayanad district. The other debris flows investigated by the Committe includes Nilambur-Nayadumpoyil road, Pullippadam in Malappuram District and the

Fig. 2.1.1.2 Nilambur –Nayadumpoyil road affected by debris flow

landslide at Pasukkadavu in Vadakara Taluk of Kozhikode district.

The Expert Committee has made short term as well as long term recommendations in its report submitted to the government. The highlight of the recommendations includes creation of awareness and rehabilitation / relocation of the people living in the vulnerable areas, scientific management of natural drainage channels and infiltration pits, prevention of unscientific slope modification for construction of roads and buildings, etc. The long term recommendations of the Committee include encouragement of Community based Disaster Management, installation of Automatic Weather Stations in all vulnerable panchayats, controlling rock blasting and quarrying during monsoon season, use of Ground Penetrating Radar (GPR) for identification of land subsidence due to piping and micro-level hazard zonation mapping by geological survey

Fig. 2.1.1.3 Rock fall at Double cutting locality in the Idukki-Kattapana Road

Field investigations were carried out in the Double cutting locality on the Idukki – Kattappana road on June 9-11, 2010. This section of the road was affected by a massive rock fall. Vehicular traffic along this road was affected for a couple of days due to this landslide in the form of rock fall. Field investigations revealed that toe disturbances in the form of excavations, without giving adequate protection for road widening, was the main reason for the failure.

G.Sankar

2.1.2 Human-induced land modifications and its impacts: A study in Thodupuzha Taluk, Idukki district, Kerala

Growth of population and the consequent demand for land are very high in Kerala and per capita availability of land is very low. The indiscriminate use of available land causes the emergence of several environmental issues in many parts of the state particularly in fragile areas, and Thodupuzha taluk form one of such environments. The area experienced steady and substantial of population growth from 1900 onwards (Fig.2.1.2.1). In 1921 total population was 48163 which increased to318379 in 2001 with the density increasing from 49 to 327 persons per km^2. This growth rate was not uniform throughout the area. While the western areas show massive increase in historical population, the eastern areas witnessed the opening of new settlement areas.

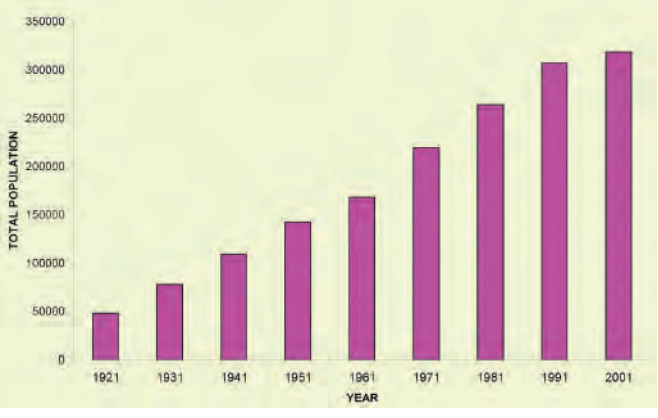

Fig.2.1.2.1 Decadal variation of population of Thodupuzha Taluk

The human population growth can be considered an ultimate cause of many land-use changes. One of the most prominent modes of anthropogenic change has been the land transformation from natural ecosystems to agricultural lands. Most current agricultural lands were formerly primary forests, grasslands, and wetlands. While humans are capable of destroying species and their habitat in certain areas, they are also capable of introducing new species to region. These introduced species are called exotic species. Human activity like construction of buildings and roads can have a major impact on the vulnerability of hill slopes. In many cases, human settlement on the slopes alters the original surface drainage of that area, eventually rendering it hydrologically unstable.

One of the simplest ways to monitor human modification of the environment is to examine land use change. Appraisals of the land use/land cover maps for the periods of 1912 and 1977 reveal large modifications in land cover. In 1912 about 70 per cent of area was covered with forest and grasslands which has shrunk to 33 per cent in 1977. A major change was noticed in the transformation of natural ecosystem to settlement areas (Fig.2.1.2.2). Organization of Participatory Rural Appraisal (PRA) programme in Vazhathope, one of the fragile areas within Thodupuzha taluk revealed the constraints among local people in the appreciation of various environmental issues.

Relative relief map of the study area was prepared for evaluating the

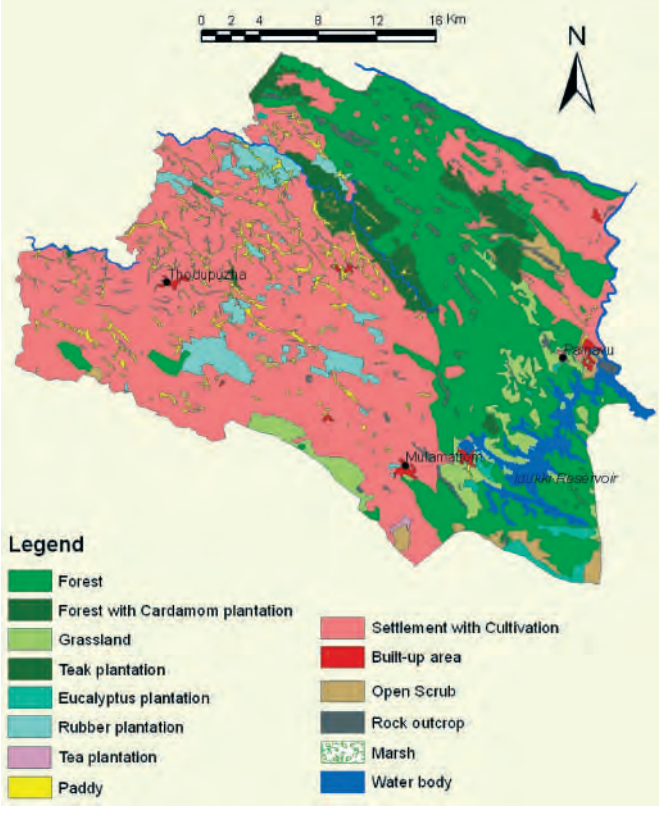

Fig.2.1.2.2 Landuse/Landcover map of Thodupuzha Taluk (1977)

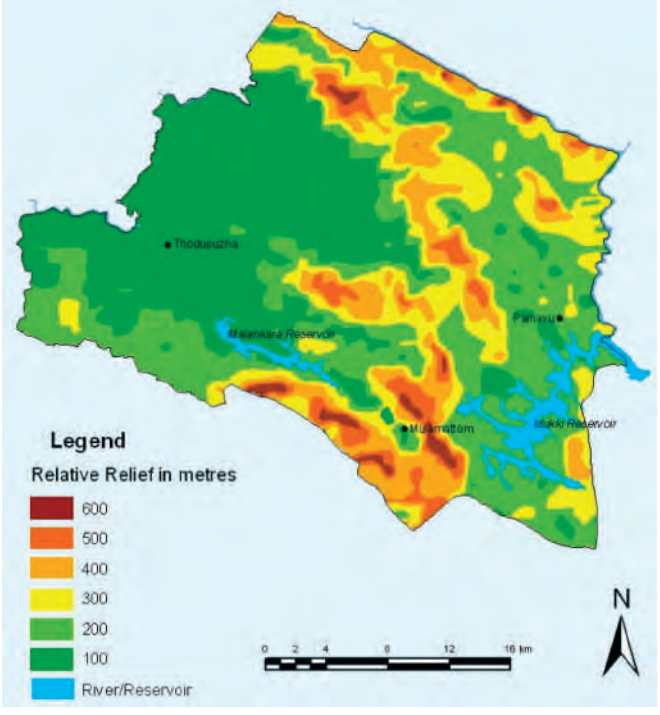

Fig.2.1.2.3 Relative relief map of Thodupuzha Taluk

constraints of various landscapes. Relative relief map (Fig.2.1.2.3) clearly shows the ruggedness of the terrain and forms one of the decisive factors which determine the possibility and intensity of land disturbances. Study area has been classified into six categories and it is seen that about 70 per cent of the terrain have some chances of land instability.

K. Raju

2.2 Earthquakes

2.2.1 Seismic monitoring in Kerala State and the broadband station at Peechi.

The broadband observatory at Peechi, operated by CESS in the campus of the Kerala Forest Research Institute (KFRI) was established in 1999, as a part of strengthening of earthquake monitoring in the peninsular India and improving the detection and location capabilities of earthquakes in the shield region. The station at Peechi (PCH) started functioning in September 1999, as one of the 10 BB stations set up by the DST. The station has been recording regional, local and teleseismic events since then. Today, the observatory at PCH is generating high quality data that is being used for studies of local and regional earthquakes as well as crustal structure changes. The project "Continued operation of the Broad Band seismological observatory, Peechi, Kerala" is funded by MoES. Upgradation of the firmware of Tarus and Seisan was done in July 2009. V-SAT connection and BSNL broadband connection were also installed in July. Data upto July 2009 was sent to IMD on CDs. Now the data is sent online to NGRI, Hyderabad. The information provided by the observatory was used by the district administrators to communicate with the people and provide updated details. IMD uses the earthquake data recorded at Peechi for preparing report for answering the question on Kerala eartquakes in 2009-2010 in the parliament. The observatory plays host to a remarkable number of visitors,

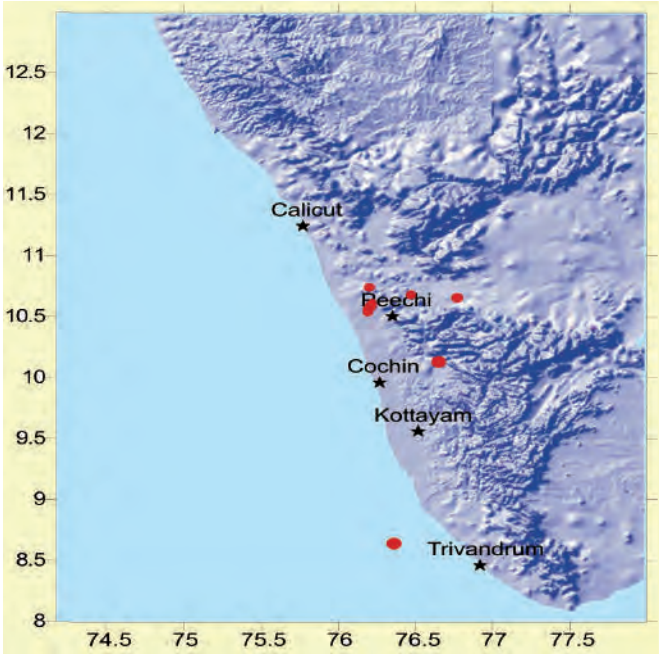

Fig. 2.2.1.1 Tremor events recorded during 2009-10

including students and participants of various seminars and workshops that are being conducted at KFRI and thus provides a good education facility for the public. To sum up, the data recorded here are used for monitoring local, regional and telesismic events continously. The observatory serves to provide information on earthquakes to government agencies as well as media and general public.

A total of 1489 events were recorded during 2009-2010. Of this sixteen were from Kerala, seventy eight from Andaman Nicobar Islands, one from Andhra, fifteen from other parts of India and 1382 from other parts of the world. Most of the local events were from Peringadur near Athani, Thrissur District but having very low magnitude (range magnitude 2.3 to 0.6). The 3.3 magnitude event from Makarachal on 8th May 2009, 3.5 magnitude event in the sea on 26th June 2009 west of Attingal and 2.3 magnitude event at Chittur, Palaghat on 10th Feb 2010 were felt by many people.

The digital accelerometer which was installed at the Peechi Observatory on 7th September 2005 is functioning well. However, in the absence of any ground shaking events this instrument has not recorded any events since installation.

Late K.R. Unnikrishnan and Sreekumari Kesavan

Funding: Department of Science and Technology, GoI

2.3 Oil Spill Modelling

2.3.1 Oil Spill Modelling for selected locations along the Kerala coast

The major objectives of the project are to set up habitat specific oil spill trajectory models for selected locations along the Kerala and Lakshadweep coasts. Information containing biological, infrastructural, social and environmental aspects of the area also will be compiled.These data would be used further for the demarcation of ecologically, economically and archeologically sensitive areas like breeding places of sea turtles and other marine organisms, tourist beaches, archeologically sensitive areas like forts, ancient monuments etc .

Even though the entire coastal stretch of Kerala from Thiruvananthapuram in the South to Kasargod in the North is sensitive to oil spill, initially three different sites along the Kerala coast and an island in the Lakshadweep group of islands have been selected for the study. The criteria for selection of these areas were based on the importance of the location in terms of the volume of ship/boat traffic and criticality of the coastal environment. The locations identified are Vizhinjam, Neendakara and Cochin in the Kerala coast and Kavaratti in the Lakshadweep group of islands.

The work under the project was initiated in July 2009. Setting up of site specific numerical models for the three selected locations in Kerala using the MIKE21 modelling system of DHI were in progress. Separate models were being set up for each of the three distinct seasons of Kerala – pre-monsoon, monsoon and post-monsoon. Hydrodynamic measurements for collection of site specific hydrodynamic data for the monsoon season which include waves, tides and current data for the monsoon season were carried out during September 2009. The model calibration was being done by adjusting the tuning parameters like bed friction and comparing the simulated data with the measured data.

N.P.Kurian, Sheela Nair, T.S.Shahul Hameed and K.V.Thomas

Funding: Ministry of Earth Sciences, GoI

2.4 Tsunami

2.4.1 Tsunami and Storm Surge Inundation Modelling and Mapping for the Coasts of Kerala, Karnataka and Lakshadweep

This project is a part of National Project onTsunami Inundation Modelling co-ordinated by the ICMAM Project Directorate (ICMAM PD), Ministry of Earth Sciences in which the main objective is the inundation modelling and mapping of storm surges and tsunami waves for the coastal areas of the country including Andaman and Lakshadweep islands. CESS has been entrusted with the task of numerical modelling of tsunami inundation for the coastal stretches of Kerala, Karnataka, Goa, Maharashtra (upto Mumbai) and Lakshadweep group of Islands.

For tsunami inundation modelling, high quality fine grid elevation data is required. Since the collection of field data is tedious, laborious and time consuming, alternative sources of topographic data were sought. The ALTM and Cartosat derived elevation data are the

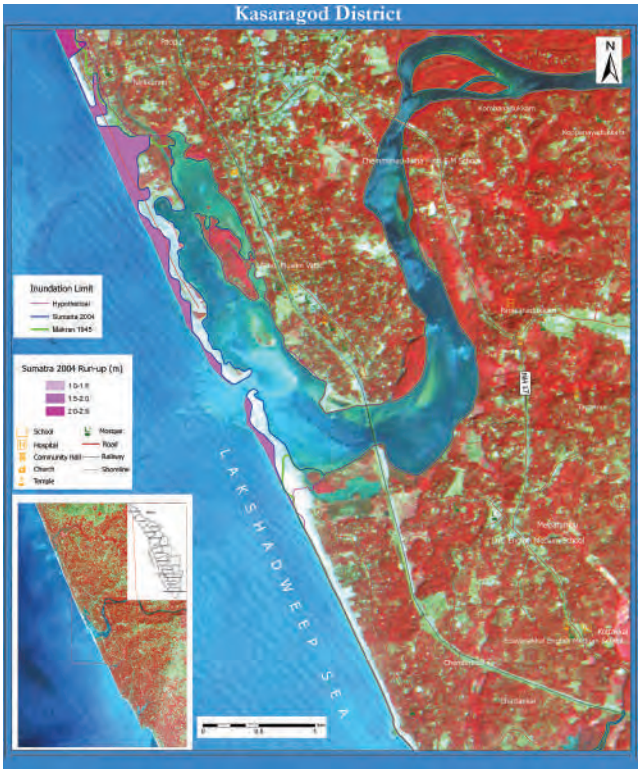

Fig. 2.4.1.1 Inundation map for Chattankai-Padpu sector of Kasargod district, Kerala (Source earthquake: Sumatra 2004/Makran 1945/ Hypothetical potentially worst case)

possible sources of such data. The ALTM and Cartosat data available for the 44 km long coastal stretch of Neendakara -Thottappally region of southern Kerala were checked for their accuracy using field measurements. It was found that ALTM gave reasonably good correspondence with field data while the correspondence was poor in the case of Cartosat. In order to bring out the spatial and topography-wise anomalies cross-shore as well as alongshore transects were taken and comparisons made. From these analyses it was seen that on higher elevations the Cartosat data corresponds fairly well while the correspondence was comparatively poor for the lower elevations. Since tsunami inundation modelling requires lower elevation data also, the ALTM data was found better. Hence it was concluded that ALTM data can be used with confidence for tsunami inundation modelling.

Numerical modelling of tsunami inundation using Tunami N2 model, hazard assessment and vulnerability mapping for the coastal stretch of northern Kerala for the tsunamis of 1945 Makran, 2004 Sumatra and a hypothetical worst-case was completed. The simulations in general showed run-up generally in the range of 0.5-2.0 m for Sumatra and Makran while run-up of 2.0-2.5 m was commonly observed for the hypothetical case. The run-up was progressively increasing towards the northern districts in the case of the Makran and hypothetical case simulations. Even in the case of Sumatra, occasional pockets of higher run-ups of 2.0-2.5 m are observed in the northern districts of Kerala. In potentially worst cases, inundation was observed in some pockets which increase towards the northern districts of Kannur and Kasargod. It is pertinent to note that the north Kerala coast, in general, is not vulnerable to tsunami inundation due to both 2004 Sumatra and 1945 Makran earthquakes.

N.P.Kurian, T.S.Shaul Hameed, K.V.Thomas &T.N Prakash
Funding: Ministry of Earth Sciences, GoI

3.1 Water Resources

3.1.1 Rainwater Harvesting and Groundwater Recharge in Chadayamangalam Block

Integrated Watershed development programme-Hariyali- is under implementation in the Chadayamangalam block under the technical guidance of CESS. As part of this programme rainwater harvesting and groundwater recharge was attempted in selected twenty watersheds. Activities like harvesting rainwater from roof top and recharging domestic wells, recharging shallow aquifer through deep pits, arresting surface flow through contour bunds, arresting stream flow in first order streams through check dams, enhancing groundwater recharge through percolation ponds, sub-surface dykes to arrest base flow and to maintain elevated water table conditions etc. are under implementation. Domestic well recharge and recharge pits (over 300 numbers) implemented in elevated areas with deep laterite sections have shown positive results with most of the wells yielding in summer. These recharge structures ensures that rainwater percolates into the deeper aquifers and holds it as groundwater for extraction in lean periods. Major structures like check dams and sub-surface dykes are constructed as model structures in three watersheds. Income generating activities like homestead farming, planting of trees in marginal lands, apiculture, pisciculture and promotion of innovative agricultural practices are also planned. The detailed project report on all the twenty watersheds are prepared with detailed estimates. Implementation of the structures is in progress.

Fig.3.1.1.1 Rainwater from the roof is led into a collection tank for filtration. For this purpose, it is provided with a bed of gravel, charcoal and sand

Fig.3.1.2 From the collection tank, the filtered water is led into the well. The summer rainfall of about 30 cm has enhanced the water availability in the well.

John Mathai

Funding: Hariyali, Govt. of Kerala

3.1.2 Hydro-chemical characterization and drinking water potential of coastal springs of Southern Kerala

Conventional water resources of Kerala State are facing maximum strain due to increased water demand resulting from the rise in population, industrial and agricultural development, overall environmental degradation and changing climatic conditions. The coastal areas of Thiruvananthapuram and Kollam districts of Kerala State are endowed with plenty of partially tapped springs. Direct and indirect human interferences have caused degradation in the quality and quantity of these natural water source. A total of 204 springs were identified and mapped in the study area. These springs are concentrated in six cluster regions; four in Thiruvananthapuram district and two in Kollam district.

Sixty two springs belonging to both flow type and pond type categories were selected for detailed water quality and quantity evaluation. All flow type springs were found to be perennial in nature with very high water potential even in the summer season. The seasonal discharge of the flow type springs are in the range of : 0.94-162 lpm in monsoon, 1.03- 239 lpm in post-monsoon and 0.59- 144 lpm during pre-monsoon seasons. The highest flow rate is observed in post-monsoon season and the lowest in pre-monsoon. Ayiroor-Hariharapuram spring cluster recorded the maximum annual water discharge and Kariavattom - Chirayinkeezhu the minimum. The chemical quality of spring water from all sources satisfies BIS/WHO drinking water specifications except in the case of pH, which showed acidic nature in general. Majority of the springs have conductivity values less

than 100µS/cm and this indicated the low range of dissolved salts in spring water. The concentration of major ions are in the order Ca (0.6-16.6mg/l), Mg (0.2-10.5mg/l), Na(3.5-22.8 mg/l), K(0.1-3.8 mg/l), Fe (26.0-218µg/l), Cl (6.6-38.5mg/l), NO_3 (216-3681µg/l), etc., indicating that water quality is well within the drinking water quality standards. Presence of pathogenic *coliform* bacteria is noticed in a few springs that can be attributed to the prevailing unhygienic conditions. Piper diagram is used to interpret the chemical evolution of spring water which depends on pattern recognition techniques and the dominant water types evolved are Na-HCO3/Na-Cl, rich with subordinate Ca and Mg.

The spring resources are spread over 38 panchayats/municipalities in12 rural blocks with a total population of 11.7 lakh persons. The combined water potential of the springs is about 125 lakh litres per day that is sufficient to meet the drinking water needs

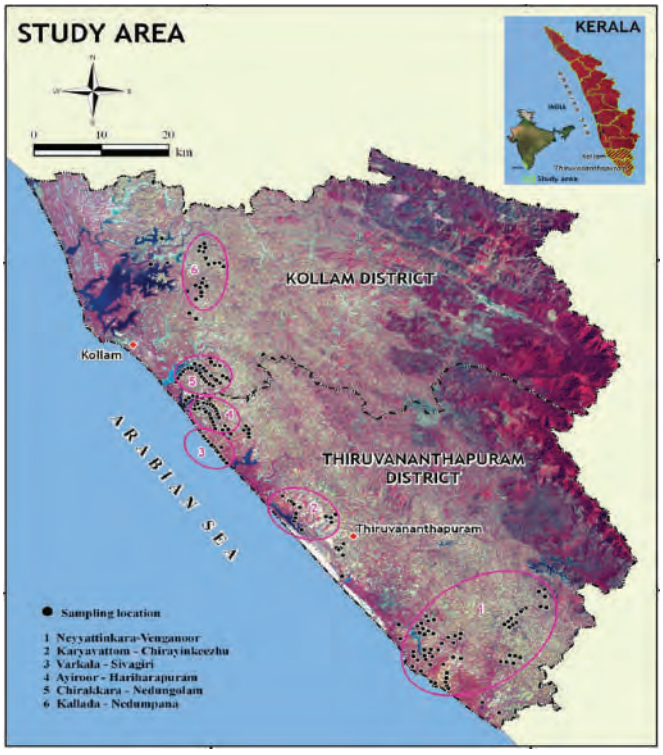

Fig. 3.1.2.1 Map showing clusters of spring resoures in the study area

of nearly 1.8 lakh people at the rate of 70 liters of water/person/day. In other words the spring sources are adequate to satisfy the water requirement of 15.6% of prevailing population in the spring locations. With the ever increasing population, which has quadrupled between 1950 and 2000, the requirement for land and water is also mounting up. Unscientific landuse changes have resulted in the deterioration of existing water resources including

Table 3.1.2.1 Distribution of springs, water potential and percentage of population that can catered etc. in the study region

Name of Block	Number of springs	Water potential (liters per day)	Total population	% of Population that can be served by spring water
Nemom	13	1021400	105045	13.89
Athiyannoor	27	194400	121371	2.29
Parassala	4	76900	64772	1.70
Vamanapuram	2	55700	30144	2.64
Perumkadavila	22	656700	112654	8.33
Kazhakkuttom	12	616900	80665	10.93
Chirayinkeezhu	7	155800	56456	3.94
Varkala	49	4347000	87047	71.34
Ithikkara	35	2263300	222193	14.55
Mukhathala	3	153200	45983	4.76
Chittumala	22	905700	108331	11.94
Sasthamkotta	8	278400	78000	5.10
Total	204	12474900	1112661	15.62

springs. In the present study, it is observed that 18% of the spring resources are on the verge of destruction due to developmental activities and other human interferences. Flow discharge direction, decline in water quality particularly with regard to nutrients and micro organisms enrichment are noticed. So management of this nature's gifts is very urgently warranted. Timely and efficient implementations of management programmes are essential for the restoration and preservation of the world-class springs that are part of Nation's unique natural heritage.

K. Narendra Babu

3.1.3 Impacts of urbanization on soil and water resources of some selected cities of Kerala

Ground water and surface water resources of Thiruvananthapuram, Kochi and Kozhikode, the major cities of Kerala are severely stressed due to rapid urbanization, population growth and migration of people from other parts of the state as well as the country. The conversion of wetlands / agricultural lands to impervious buildings, roads etc, increase the rate and volume of highly contaminated urban run-off with nutrients, toxic

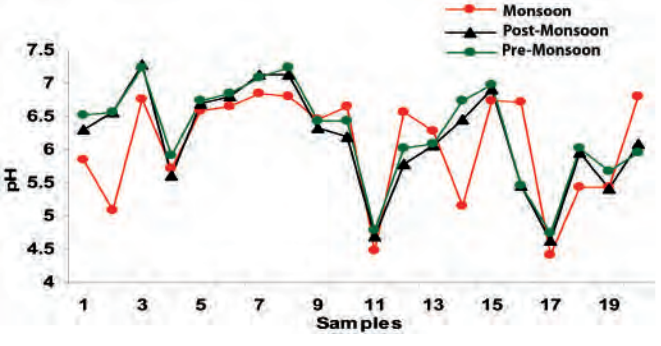

Fig. 3.1.3.1 Low ground water pH of Thiruvananthapuram urban region during all three seasons

metallic elements and organic carbon materials deteriorates the water resources. The impact is very severe in Kochi followed by Thiruvananthapuram and Kozhikode cities. The study revealed that ground water quality of urban areas of all the three cities is significantly poor with respect to the adjoining non-urban areas. Within an urban area it is found that the degree of water quality deterioration is related to density of population, soil texture,

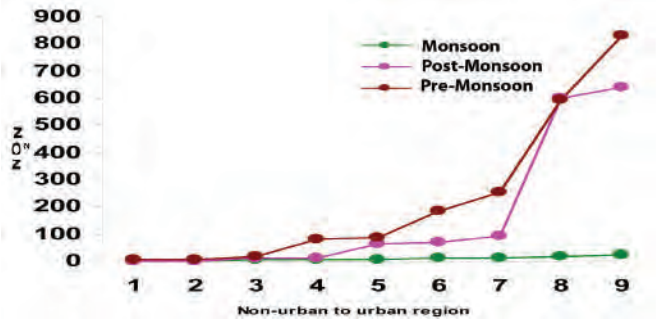

Fig. 3.1.3.2 Increased variation of nitrite from upstream to downstream of Karamana river due to urbanization in the downstream area

landuse pattern, elevation of land etc.

During the monsoon, post-monsoon and pre-monsoon season the groundwater resources of the three cities recorded wide variation in pH. The pH value of ground water in Kochi city is higher than the other two urban regions, where the ground water samples recorded low pH than the required minimum value of 6.5 as per drinking water standards (Fig. 3.1.3.1). Comparatively high conductivity values are obtained for ground water samples of Kochi region. During monsoon period also the well water from Kozhikode recorded high conductivity values. The groundwater samples of Thiruvananthapuram and Kozhikode exhibit considerable regional variation of dissolved oxygen while in Kochi urban area, it is found to be very low in all samples during all seasons. The well water of Kochi and Kozhikode showed higher chloride concentration than that of Thiruvananthapuram during post monsoon. However, in monsoon period, Thiruvananthapuram urban region recorded significantly higher concentration of chloride.

Nitrite nitrogen, an indicator of pollution is noticed in all well samples of the three urban regions. The concentration is significantly high in low lying and thickly populated regions of Thiruvananthapuram as well as in all regions of Kochi city. At the same time groundwater samples of Kozhikode recorded relatively low values. The other nutrient species of N and P also recorded higher concentrations in groundwater of Kochi compared to that of Thiruvananthapuram and Kozhikode city regions, probably due to the high density of population, sandy soil and low topography of Kochi.

Large numbers of well water samples collected from all three cities showed the presence of pathogenic bacteria. During the monsoon and post-monsoon periods 15% of well water in Thiruvananthapuram indicated *Feacal Coliform* (FC) in groundwater whereas nearly 70% of the well water is contaminated by *E.Coli* during monsoon. *E.Coli* is widely present in the ground water of Kochi region. Around 75% of its well water during monsoon and post-monsoon period recorded the presence of *Feacal Coliform* while none of the samples in pre-monsoon period indicated FC. On the other hand more than 75% of ground water sources and 75-100% of surface water sources of Kozhikode region indicated the presence of EC during all three seasons. Compared to *E.Coli*, *Feacal Coliform* is very low in groundwater of Kozhikode.

The study revealed wide water quality variation among the surface water resources also. Both Akkulam lake and Parvathiputhanar of Thiruvananthapuram received wastes of complex nature from several sources and the result of water and sediment characteristics reflected the alarming nature of the two water bodies. The high enrichment of nutrients with depletion of dissolved oxygen leads to the eutrophication of Akkulam lake. The fresh water lake, Vellayani lying in the peripheral area of Thiruvananthapuram city on the other hand is relatively less contaminated. The water quality of upstream and down stream stretches of Karamana river showed drastic differences with high concentration of contaminants in the lower stretches of the river which indicated the grave situation of river deterioration due to unprecedented urbanization in Thiruvananthapuram where the Karamana river carries all the dirty and filthy materials produced by the Thiruvananthapuram City (Fig. 3.1.3.2). The comparatively non-contaminated upstream areas of the river mixed with all urban pollutants transformed it into a mere drainage channel in the lower stretches of the river. Preventive steps should be taken against the discharge of direct and untreated contaminants to the river system. The highly contaminated wastes form hospitals and manufacturing units should never be allotted to discharge into the river.

The two water bodies of Thiruvananthapuram, Vellayani Lake and Karamana River are important fresh water bodies that are closely linked with the life of people. Vellayani Lake is the second largest fresh water lake in Kerala with untapped potential. At the same time it is to be noted that drinking water shortages, especially during summer, are experienced throughout Kerala. Hence precious fresh water bodies like Vellayani Kayal should be scientifically conserved and managed.

K. Narendra Babu

3.1.4 Interstitial water chemistry of aquatic environments and its significance in nutrient dynamics: A case study

Early diagenesis of aquatic sediments generates many chemical signals, migration of which to interstitial water and thereby to the overlying water may impart significant changes in the chemical composition of water column. Through this DST funded project a detailed study was undertaken on the transfer of nutrients and trace metals between sediment / interstitial water phases and overlying water column in three lake systems of different geochemical setups. Sediments are the ultimate recipients of particulates originated from various sources. The chemical, microbiological, and physical transformations that occur in areas close to the sediment water interface are extensive, particularly the geochemical reactions due to decay of organic matter in the upper few millimeters of sedimentary deposits. The chemical transformation in these sediments, which are recently deposited, results in pronounced near – surface chemical gradients of dissolved species especially nutrients and trace metals to the overlying water column affecting the water quality as well as the productivity of water bodies. The knowledge on the mobility/ dynamics of nutrient elements across sediment-water interface can throw light on many aspects of recently deposited sediments including the sequence of oxidation, nature of oxidants and finally the movement of chemical signals during the early diagenetic decomposition of organic rich sediments. Such studies on the marine environment are vast when compared with the estuarine and fresh water environments particularly in the Indian scenario. In order to fill the gap a systematic study on the chemical composition of interstitial waters in three selected aquatic systems in Kerala comprising of the fresh water Vellayani lake and brackish bodies of Kadinamkulam and Paravur lakes was carried out.

Surface water, bottom water and core sediments from 21 locations of Paravur, Vellayani and Kadinamkulam lakes were collected. Interstitial water was extracted from core sediments and analyzed for physico-chemical constituents. The textural composition, organic carbon content and geochemical characteristics of core sediments were also determined along with different species of phosphorus. Wide differences in concentration between water column and interstitial water were noticed in both fresh water Vellayani lake and brackish water Paravur and Kadinamkulam lakes. The nutrient concentration of water column in freshwater lake is marginally higher than that of brackish water lakes. The interstitial water pH of brackish water lakes are lower than that of corresponding bottom water values whereas in fresh water lake the interstitial water pH is higher than bottom water value. Salinity of interstitial water of both lake systems decrease with core depth. The concentration of NH3-N, reactive P and dissolved Fe of interstitial water of both lake systems showed several times enrichment than the corresponding values in water column. The interrelation between OC and Fe is stronger in saline water body (r = 0.925) compared to fresh water lake (r = 0.755). Among the different P species loosely bound P showed very little concentrations in brackish as well as fresh water lakes. Low Fe/Al bound P is found in Vellayani lake but high value is noticed in marine influenced western area of Paravur lake compared to its river water affected eastern region (Fig. 3.1.4.1).

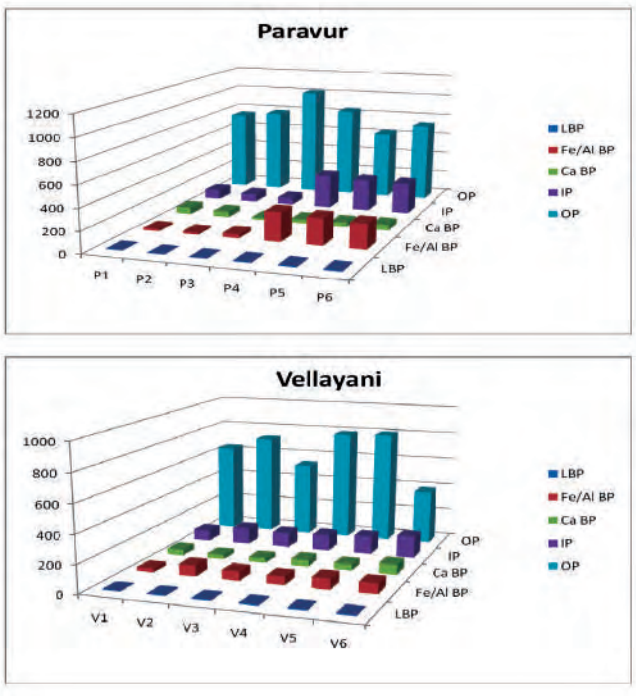

Fig. 3.1.4.1 Different species of phosphorus in core sediments of Paravur and Vellayani lakes

Ca bound P showed identical values in both types of lakes. Sum of inorganic P components is low in both lake sediments compared to the organic and residual P components.

The Fe/Al bound P can be used to estimate both short term and long term availability of P in sediment and possibly the major fraction that could be released to the water column when anoxic conditions prevail at the sediment–water interface. Sediment inorganic P showed affinity with interstitial water Fe (r = 0.914) which is also related to the salinity of interstitial water. The anoxic sediment interact with oxygenated water resulting in the increased concentration of P in overlying water; however, its strong adsorption on ferric hydroxide under oxic conditions may affect the flux towards the overlying water. Within the water

column, due to the flux of nutrients from interstitial water, the bottom water showed enrichment of Fe and P. The migration of phosphorus from interstitial water to overlying water depends upon the toxic conditions due to the binding of phosphorus with ferric hydroxides.

K. Narendra Babu

3.2 Terrain Analysis and Landuse Studies

3.2.1 Landscape evaluation in relation to fluvio-estuarine and denudational systems: A case study of Periyar basin, Kerala.

The study area pertains to the Periyar basin, encompassing Idukki, Ernakulam and minor portion of Thrissur districts. It has attempted to establish relationship with the morphogenetic processes and landscape formation through morphometric analysis of river and preparation and depiction of terrain maps in basin and sub-basin levels.

The Periyar is an 8th order stream with considerable development of tributary network. It drains a catchment area of 5398 km^2. The average drainage density of the basin is 2.46 km/ km^2 with a total number of first order streams of 15773. Total stream length inclusive of all order is 13291 km of which 11219 km is being contributed by the three major sub-basins (Idamalayar, Muthirapuzha and Provenance) amounting to 84% of the total stream length of the basin. The Periyar river has been originated from the high hills of the Western Ghats and influence of tectonism can be evidenced from the stream pattern and presence of structural valleys etc. Interrelationship between morphogenetic processes, landform and landuse pattern has been established through analysis of different morphological parameters within the bounds of the Periyar basin. For the Periyar basin, morphogenetic processes are mainly exogenetic in nature. Within the basin, geomorphic processes are operative in the backdrop of the major landform units, viz, the Western Ghats, Munnar, Periyar plateau and the coastal plain. Nine landform units could be deciphered for the entire basin. Landform developed within the basin accompanied by the processes of lateritisation and weathering is mainly the product of these morphogenetic processes which are marine, fluvial and denudational to aggradational in nature. Cross profiles drawn on various sections of the main river and the tributaries indicate influence of local geologic and climatic controls in modifying valley shapes. Hypsometric analysis of the Periyar basin and its sub-basin level analysis points towards the evolutionary history of the landscape and longitudinal profile analysis indicates towards different stages of river maturity and the knick points marked along the stream points towards history of rejuvenation or tectonic influence in shaping the river valleys. Forest occupies nearly 1500 km^2 (28%) of the basin area whereas cardamom and settlement with mixed tree crops occupy an area of 322 and 2176 km^2 respectively. Periyar basin is ecologically sensitive and nearly 80% of the total area situated in the high ranges are susceptible to erosion and mass movements. There is further scope to fine tune the work incorporating components of detailed geological mapping and identifying evolutionary history of the river basin. Future studies can concentrate on the relationship and establishing link between morphogenesis and pedogensis; eustatic changes and its far reaching consequences on the riverine ecology and its surroundings.

Mahamaya Chattopadhyay

3.2.2 Geomorphic setting, landscape alteration and fluvial regime change in the Western Ghats provenance of southern Sahyadri.

The project primarily aims at mapping of physical parameters, analysis of drainage network, time-series landuse mapping and relating them with the ecological set up of the region and studying the impact on the fluvial regime and landscape system for the southern Sahyadri region. Hypsometric analysis for the southern Sahyadri was completed. Digital terrain model was prepared (Fig.3.2.2.1) and geomorphological mapping was undertaken. Out of the total 2130 sq.km, 1415 sq.km has been categorized as hilly terrain, while composite floodplain accounts to107 sq.km. Planation surfaces (40-100 m) occupy an area of 27 sq.km.

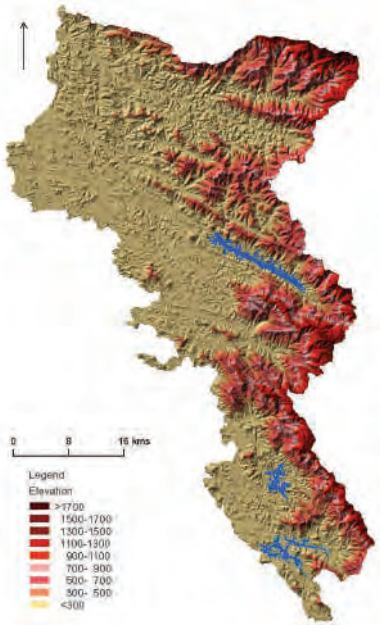

Fig. 3.2.2.1 Digital Terrain Model of the study area

Mahamaya Chattopadhyay

3.2.3 Study of landuse/land cover change linked to climate change in Kerala

This project has been taken up as a part of climate change programme initiated in CESS. The first phase will cover the central part of the State extending over the districts of Alappuzha, Ernakulam, Thrissur, Palakkad, Idukki, Kottayam and Pathanamthitta. Under this programme it is proposed to assess land use change since 1905 and change in agricultural crop since 1958. Besides it is also planned to compile all climatic data available for the existing stations monitored within this area. High

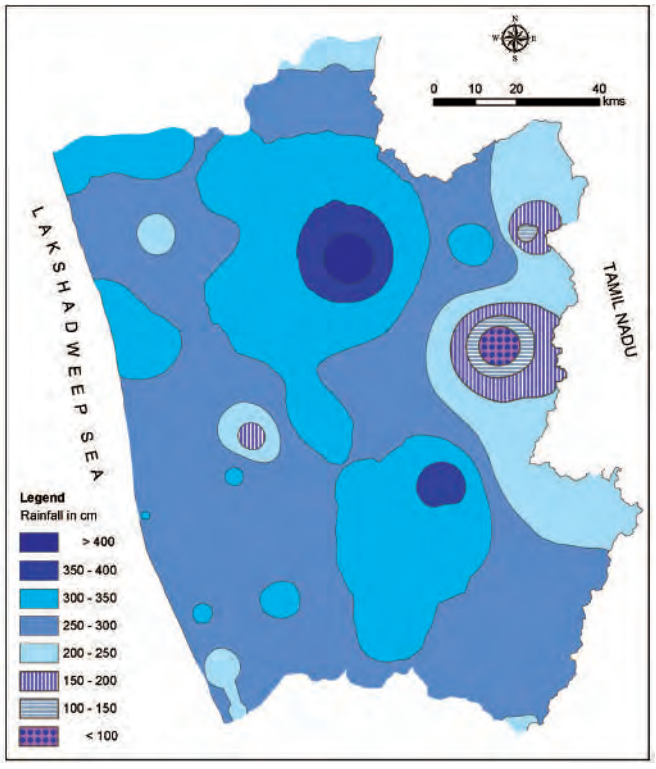

Fig. 3.2.3.1 Distribution of rainfall in Central Kerala

rainfall is recorded in the foot hill zone (Fig 3.2.3.1). Works accomplished during this year include the preparation of landuse change map around Vembanad lake, preparation of digital terrain model of central Kerala, base map, road map and land use map of Greater Cochin Area(1967). The work has been initiated to compute land use change in Ernakulam district. It is found that there are significant changes in paddy land and area under concentrated settlements in this district. Computation of production data of all major crops (triennial average) from 1958 to 2007 for the entire State and the concerned districts is also in progress.

Srikumar Chattopadhyay

3.2.4 Landuse/landcover change and its impact on biophysical system.

The study area covering 5297 km^2 spreads over seven river basins. It encompasses three wild life sanctuaries and one biosphere reserve. The study focused on the nature of land use change during the time period from 1967/68 to 2004/05, drivers of land use change, impact of landuse change on biophysical system especially land and water and societal consequences of the land use change. Natural vegetation cover in the study area reduced from 57% in 1967-68 to 28% in 2004-05 and plantations grew from 3.5% to 23.8% during the same period. There are five major reservoirs in the study area impounded since 1959. River basin yield index of 1.15 recorded for the Pamba basin is the highest among seven river basins draining the study area. Terrain character, thick vegetation cover and high rainfall contribute in this high yield. River valley projects, forest plantations, rehabilitation of Sri Lankan-Tamil refuges, and market forces are major drivers of land use change. Average rainfall in the study area declined by 10% to 15%. Soil erosion increased by 75% under degraded tea plantation compared to natural vegetation. Organic carbon and nutrient content in soil varied with land use. Interior parts forests are getting thinner over the years. Even the reserve forest area experience land use change. Displacement of tribal settlements to impound reservoirs, land shaping leading to land instability and land slides, higher fertilizer use due to fall in soil nutrient, shift from food crops to cash crops, and water quality problem due to nutrient loading and attended reduction in fresh water availability are some of the societal consequences associated with land use change. Sample investigation in five segments brought out site specific change and associated factors. Local level land use change can have far reaching impact, therefore site specific intervention measures are suggested for amelioration.

Srikumar Chattopadhyay

3.2.5.1 Rejuvanating lateritic areas of Neyyar of Western Ghat region in Thiruvananthapuram using natural rock powder as geonutrient for sustainable agriculture- a technological intervention.

As part of the research projects that focus on laterites of Kerala, the following work was carried out. Based on the physico-chemical characteristics of laterites developed over different rock types in Neyyar watershed region, 3 locations were selected for intervention technology using rock powder, chemical fertilizer and organic manure to assess the use of rock powder as geo-nutrient to rejuvenate the lateritic soil in 10 cents of land. These soils were deficient in micro nutrients which were estimated. The base preparation was done by adding cow dung in all the plots. After one month Tapioca was planted. Rock powder, chemical fertilizer and

organic manure were added after one month of the planting. Regular monitoring was carried out to assess the growth of Tapioca. Soil samples were collected regularly for determining the chemical composition of the laterites and the micro nutrient content for comparison before and after adding the rock powder, chemical fertiliser and organic manure. Second round of rock powder, chemical fertiliser and organic manure were added after 3 months. Samples of lateritic soil from all the plots were collected for determining the chemical composition and nutrient content. A reference plot adjacent to the experimental site was also selected for comparative studies. The results were being processed. From the physical appearance it is found that the plot with rock powder application is having good growth compared to chemical fertliser and organic manure fed plots. Final results with yield of tapioca in each plot will show the significance of usage of rock powder as geo nutrient and will also help in demonstrating the use of rock powder among the farmers.

Narayanaswamy

Funding: Western Ghat Cell, Kerala State Planning Board

3.2.5.2 Characterisation of laterites of Kerala and Preparation of laterite distribution map

In another study to characterize the laterite developed over crystalline rocks and Tertiary sediments with varied physicochemical properties and also to prepare laterite distribution map of Kerala, field work was completed in Ernakulam, Trichur, Kozhikode, Malappuram districts. The results show that the laterites are brick red to purplish in color. The texture is compact in case of laterites developed over crystalline rocks and non-compact in case of laterites developed over tertiary sediments. The maturity index of laterites shows that they are moderately to strongly lateritised. Laterite distribution maps of Ernakulam, Trichur, Kozhikode, Malappuram districts were prepared and finalization of these maps are in progress.

Narayanaswamy

3.2.6 Assessment and monitoring of land quality for sustainable agriculture in Kannur District: A GIS based approach coupled with technology implementation

The objective of this project is to assess and monitor land quality by collecting physical aspects of land, climate, soil geochemistry, socioeconomic aspects of farmers, and demographic aspects and integrate in GIS environment for sustainable agriculture by technology implementation. During the period under report sixteen thematic maps depicting relief, drainage, density of drainage,slope, aspect, landform, geology, soil, NDVI, soil moisture (January 2006), landslide prone areas, flood prone area, agriculturally drought prone area, panchayats, watershed and density of population were prepared in 1:50,000 scale and digitized in ArcGIS format. Delineation of priority area for sustainable agriculture using a GIS modeling for Pervumba river basin in Kannur district was also completed. Other maps derived are soil moisture zones of Peruvumba river basin and ground water potential regions of Kattampally Puzha river basin by weighted overlay analysis by considering various parameters in GIS environment. Distribution maps were prepared in ArcGIS format for pH, Total Organic Carbon, Electrical Conductivity, and elements NaCl, Sc, V, Cr, Ni, Cu, Co, Zn, Ga, Rb, Sr, Y, Zr, Nb, Cs, Ba, la, Ce, Pr, Nd, Sm, Eu, Dy, Gd, Tb, Ho, Er, Tm, Yb, Lu, Hf, Ta, Pb, Th, and U. Analysis for other elements were under progress.

Rainfall data has been obtained for (1) Kannur (1987-2004), (2) Irikkur (1987-2004), (3) Tellicherry (1987-2005) and (4) Taliparamba (1987-2005).Water balance, rainfall probability and rainfall intensity have been worked out.

B. Sukumar

3.3 Environmental Assessment

3.3.1 Environmental management plan for Alappuzha-Sherthalai canal and Kanjikuzhy grama panchayat

The project aims to prepare a management plan for the A-S canal and Kanjikuzhy Gram panchayat by involving local people. Revisit of some of the environmental issues identified during a survey conducted in 2003 also forms part of this project. It is expected to develop a guideline for environmental management at the micro level. Analysis of water samples for seven parameters (DO, Conductivity, pH, Nitrate, Phosphate, Silica and total hardness) have been completed. Besides computation of land use and asset data at the plot level for Kanjikuzhy panchayat and maps on drainage, area under paddy, road, and contour have also been completed. An environmental appraisal map for the Kanjikuzhy panchayat has been worked out (Fig 3.3.1.1). Demographic data have been collected and analysed. Qualitative environmental assessment of canal segments has been completed. Transfer of land use data in the resurveyed cadastral map was in progress

Srikumar Chattopadhyay

Funding: KSCSTE

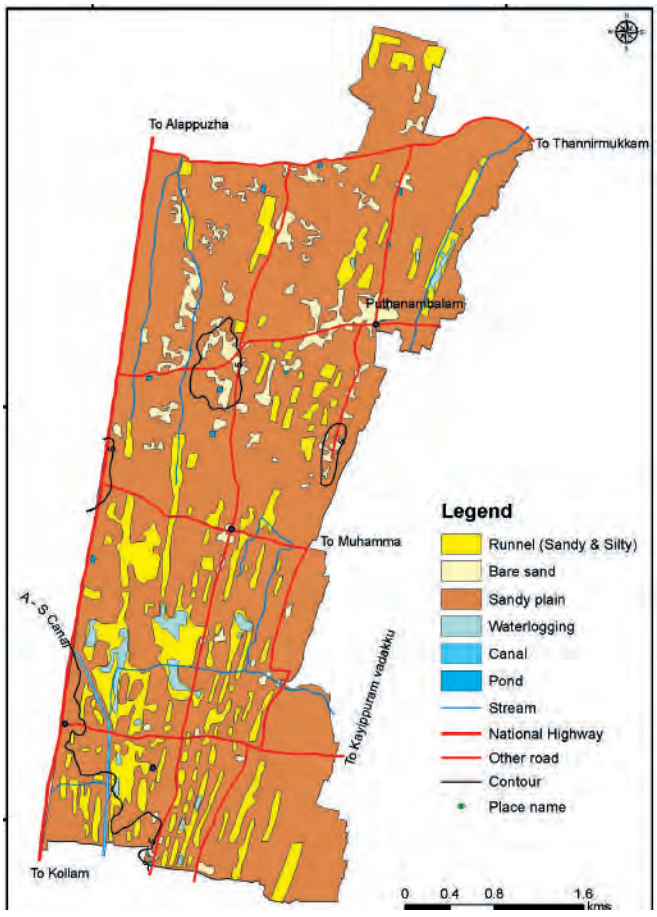

Fig.3.3.1.1 Environmental appraisal map of Kanjikuzhy panchayat

3.3.2 EIA for the desiltation of Malampuzha Reservoir

Government of Kerala took a policy decision to desilt some of the major reservoirs in the State as a part of reservoir management. CESS was entrusted with the job of conducting EIA for desilting operation in Malampuzha reservoir and to prepare a plan for desilting operation. Malampuzha reservoir spreads over an area of 23 sq. km at full reservoir level (115.6m) and is fed by 148 sq.km of catchment area. It is a multipurpose project catering to the needs of irrigation and drinking water. KERI estimated total sediment deposits in the reservoir is a little over 30Mm^3 and observed rate of sedimentation is 4.156mm/year against the designed rate of 0.163mm/year. Our study has pointed out that there are two distinct zones of sediment accumulation. The main and tributary channels within the reservoir lying under water for most part of the year constitute the core sedimentation zone dominated by

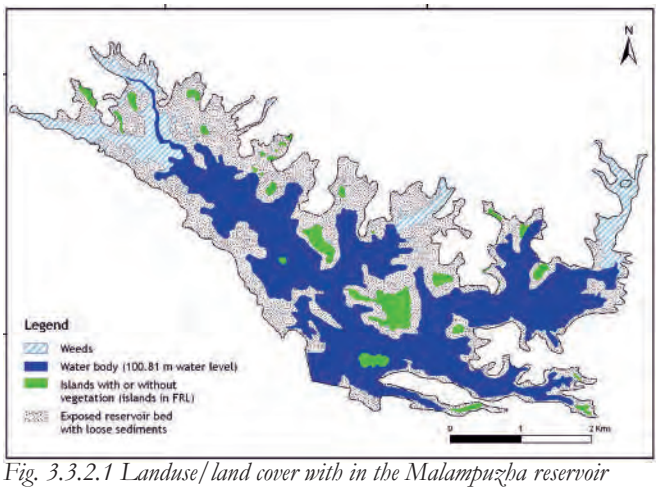

Fig. 3.3.2.1 Landuse/ land cover with in the Malampuzha reservoir

fine particles. The other zone is the peripheral area seasonally inundated for limited times composed of alluvial fan deposits and minor sand banks adjoining the islands within the reservoir (Fig. 3.3.2.1). The main operations related to desiltation are: removal of material from the seasonally exposed reservoir bed, dredging of the permanently inundated part, transportation of desilted materials from the reservoir bed, disposal of dredged materials and transportation of the disposed materials. Key issues arising out of all these operations have been identified to work out environmental impact assessment. We used Rapid Environmental Assessment Matrix (RIAM) for the purpose of EIA. Considering

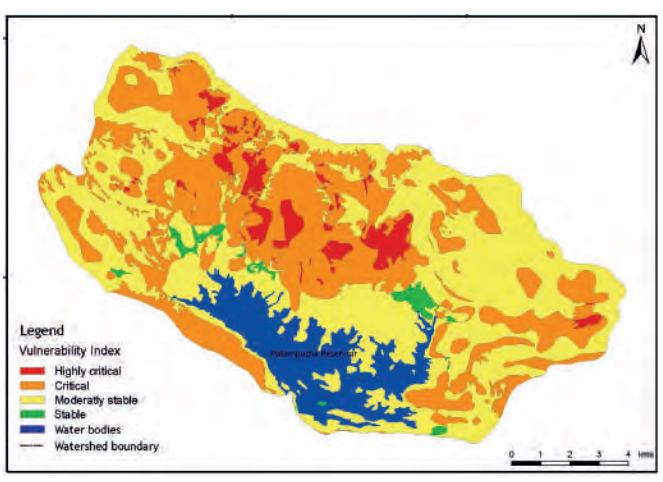

Fig. 3.3.2.2 Erosion vulnerability of Malampuzha Reservoir catchment

these operations, components have been identified for physical and chemical impacts, biological/ ecological impacts, economic and operational impacts and sociological and cultural impacts.

Our study suggests that the desilting operation can be initiated from the seasonally exposed reservoir bed along tributary streams,

that bring sediments. As a part of environmental management plan vulnerable areas in the catchment have been identified (Fig3.3.2.2). The recommendations were accepted by the Government and accordingly desiltation has been initiated. Subsequently CESS was instructed to conduct studies on Chulliar, Aruvikkara and other reservoirs and prepare specific work plans for silt removal. Desiltation work is in progress in Aruvikkara, Malampuzha, and Chulliar.

Srikumar Chattopadhyay

Funding: Water Resources Dept., Govt. of Kerala

3.3.3 EIA of major settlement distribution patterns and the infrastructural development with an emphasis on drinking water infrastructure facilities in Thiruvananthapuram.

This project attempts to analyze drinking water availability and supply in the Panchayats and their linkage with environmental parameters. Data were collected form various organizations, Blocks and Panchayats. Questionnaires were prepared for primary survey. All information were put into GIS format for further analysis.

V. Shravan Kumar

3.3.4 State of the environment and action plan for Kochi urban area

The State of Environment (SoE) report provides information on the environmental status of a region, trends and changes and their importance in effective and efficient environmental planning and management. The study addressed the overall status of environment of the region, delineated and evaluated the environmental issues, integrated the existing and evolved environmental management plans and arrived at a comprehensive action plan for Kochi city and surrounding region. This study had analysed the supportive and assimilative capacities, where the developmental interventions has been concentrated possibly leading to preferential zoning for desirable activities and assist the planners and decision makers to evaluate future development propositions within the adaptability limit of the environment. The study considered Kochi as most urban in its core, surrounded by urban enclaves in the peripheral belt consisting of 6 Municipalities and 48 suburban Panchayaths linked to the core through transportation corridors. The trends of city expansion have lead to undesirable urban sprawl to neighbouring Panchayaths, but no aspect of the development has kept pace with this urban expansion. The natural resources like the coastal zone, land, water, biodiversity, heritage and culture are the major assets of the region that affected the most.

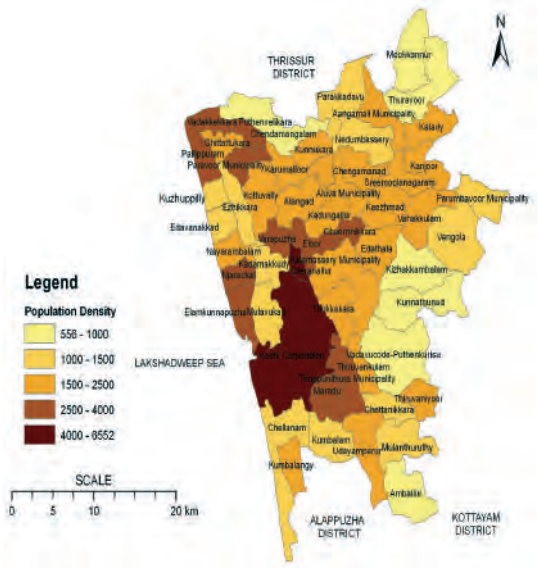

Fig. 3.3.4.1 Occupational pressure at Kochi region

The land is the platform for all physical developments. Land in north, north eastern and western parts of the city are very significant as the western portions comprise of islands surrounded by water bodies and land fragmented by rivers, canals and back waters. Due to large scale interventions these water bodies have been reduced, and silted up considerably to shallow stretches unsuitable for navigation. Most of the water bodies lie contiguous to paddy fields and filtration ponds which are subjected to reclamation/developed land. Therefore, all major development projects of large scale investment in sectors like infrastructure, industries, shipping etc. have its impact on space and consequently on the land and water body.

The study concluded that occupational pressure, safe drinking water shortage, saline water intrusion to coastal aquifers, air pollution due to industries and automobiles, poor sewerage network, solid waste management, drainage congestion and water logging, unscientific wetland reclamation, unsustained river sand, clay and lime shell mining and hard rock quarrying, traffic congestion, non compliance of CRZ rules, violation of other environmental laws, building rules, spatial planning guidelines etc are hampering the healthy development of the region (Figures 3.3.4.1-3.3.4.4). The SOE report highlighted the present status of the environment encompassing both natural resources as well as the related activities that affect the resource base through prioritization matrix approach and resource activity impact matrix.

Prioritization matrix: In the prioritization matrix approach all problems including interlinking problems have been categorized

into high, moderate or low. Problems which need to be addressed urgently are given high priority. Providing safe drinking water, implementation of the coastal zone management plans, management of wastes, and improvement in atmospheric quality are in the priority list. Discharge of partially treated effluents from various industrial and domestic sources are the cause of pollution of the water bodies. Land degradation due to industries, solid waste disposal, sewerage, quarrying, and wetland degradation, etc. are more pronounced. Large scale reduction in vegetation cover of mangroves in Vypin and destruction to wild life and fishery are noticed in and around Vembanad lake and adjacent water bodies. Salinity intruded into surface water sources up to Pathalam and beyond is affecting the fresh water availability. Water logging and salinization in coastal aquifers are common in low-lying areas. Loss of top soil and severe soil degradation towards the midlands are other concerns.

Resource activity impact matrix: The conservation of the resources

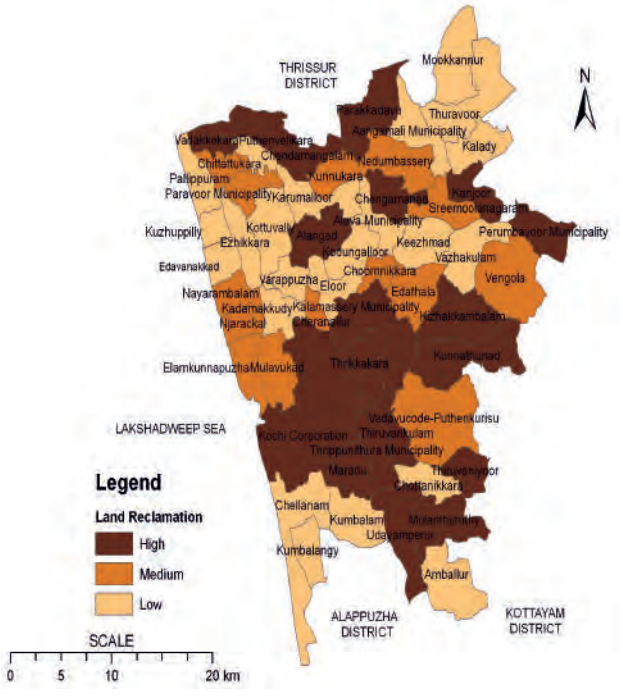

Fig. 3.3.4.2 Land reclamation trends at Kochi

like the coastal zone, air, water, biodiversity, etc. are the prime concerns and are depicted as in the resource activity impact matrix (Table-3.3.4.1).

The biggest asset of Kochi is the vast expanse of backwaters, rivers and inter-connecting network of canals. This special asset is never considered in the spatial planning process and area devel-

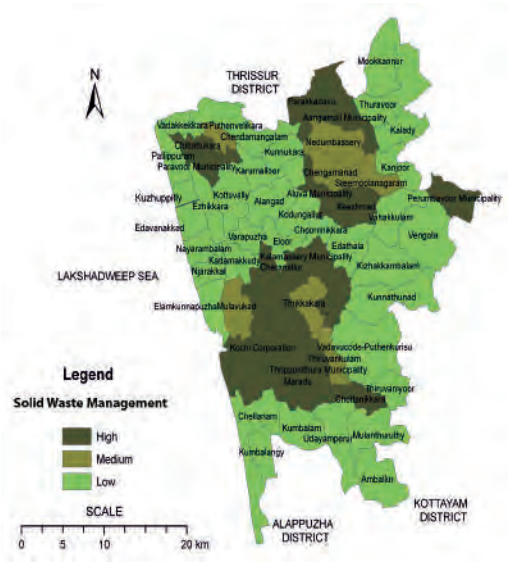

Fig. 3.3.4.3 Sewage system and solid waste disposal at Kochi

opment plans. By proper conservation of the backwaters the cityscape can be developed and put to efficient and economic use. Though, Vembanad is declared as a *Ramsar* site, no action has been taken in these lines. Any development without conservation of the wetland system is unsustainable. Proper water front development, preventing reclamation and encroachment and control of pollution are essential for a healthy and sustainable habitat.

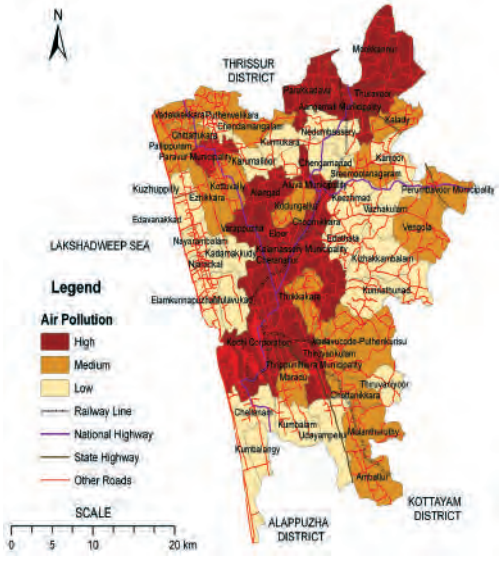

Fig. 3.3.4.4 Air and noise pollution along major traffic corridors in Kochi

Table 3.3.4.1 Resource activity impact matrix for Kochi

Resources / Activities	Coastal Zone	Land	Water	Atmosphere	Biodiversity	People and Culture
Occupational pressure	H	H	M	M	H	H
Water supply and sanitation	H	H	H	M	M	H
Waste management	H	H	H	M	M	H
Transport	M	H	M	H	M	M
Industries	H	H	H	M	M	H
Mining and quarrying	M	H	M	L	M	L
Reclamation	H	M	H	L	H	M
Agriculture	M	M	H	L	M	M
Fishery	H	M	M	M	H	H
Tourism	H	M	M	L	L	M

H= High M= Medium L = Low

Therefore, a major drive is required to enforce provisions of Environmental Conservation Laws, implementation of CRZ rules and regulations in letter and spirit along with implementation of proper spatial development controls in tune with UDPI guidelines for Kochi urban area development.

C. N. Mohanan

3.3.5 Tropical freshwater myristica swamps of Kerala and its ecological and evolutionary significance

The study on sediment core from Myristica swamps shows sedimentation sequence such as sandy layer (0-27 cm), alternate with dark blackish carbonaceous soil (27-50 cm), and light green silty-sand soil (50-64 cm) and bottom layer with orange yellowish laterite deposition (65-70 cm). Therefore, from top to bottom the sediment core revealed four distinct zones. There is a 4 to 5 cm thick sand zone at 25 cm depth from the top possibly due to the high sediment supply of frequent seasonal fluctuations in water table. In all the samples, organic matter positively correlates with clay contents. The surface sand layer appears light brownish due to less organic matter and more alluvial deposition. The bottom silt clays contain abundant roots but percentage of organic matter decreases. Moderately acidic soil prevails with high organic carbon content in the middle clay-rich zones at 30-50 cm depth (0.857%). The OC content of 0.314% in the surface soil progressively decreased to 0.174% in the deepest layer studied. There are remarkable variations in other properties such as pH (6.33-5.74), conductivity (88-48 µS/cm), organic matter content, etc. The major oxides present are generally in the order of SiO2> Al2O3> Fe2O3> K2O> TiO2> CaO> Na2O> MgO> P2O> MnO (Fig.3.3.5.1a & b).

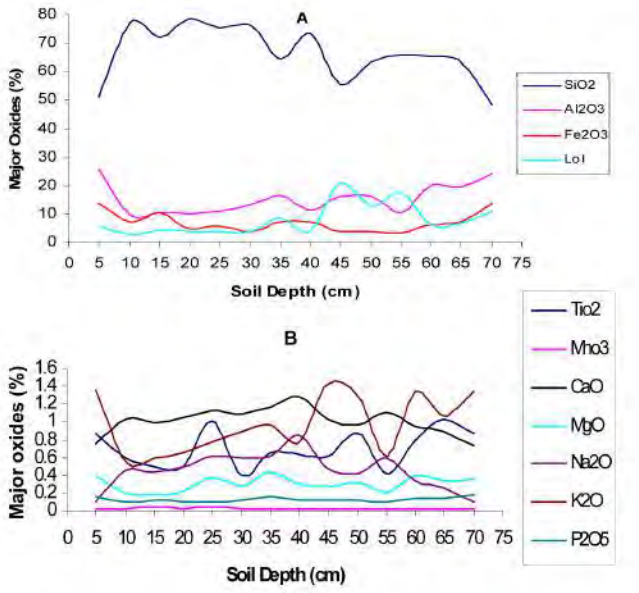

Fig. 3.3.5.1 Distribution of major oxides in the core sample

C. N. Mohanan

3.3.6. Environmental degradation of Muvattupuzha river basin, causes, consequences and strategies for river restoration

The study deals with the various issues related to mining/ quarrying of non-living resources like hard rocks, instream, floodplain sand, soil, laterite and graphite; unscientific solid waste (MSW) disposal, etc. in the Muvattupuzha river basin. The study reveals that the resource extraction and waste generation activities not only cause deterioration of the quality of the river system but also significantly affect its riparian zones. Indiscriminate quarrying of top soil and hard rocks, cutting of laterite blocks, extraction of sand from instream and floodplain areas, filling of wetlands for various non-agricultural uses, deforestation, etc. in many of the occasions, created serious environmental problems in the Muvattupuzha river basin.

Quarrying of hard rock and soil, laterite block cutting, sand extraction from instream and floodplain areas etc., are the major resource extraction activities noticed in the river basin. Spatial distribution of mining/quarrying locations reveals (Fig. 3.3.6.1) that the midlands and the lowlands are the most affected due to mining and quarrying than the highlands. The haphazard mining activities impose severe pressure to the environmental settings of the area. The major driving force behind indiscriminate mining and quarrying activities is the rising demand of building materials. The waste generation is also raising exponentially in accordance with the resource extraction activities. It is computed

that the total solid waste generation in the area amounts to 201 tonnes/ day of which the 4 municipalities such as Vaikom, Muvattupuzha, Kothamangalam and Thodupuzha together contribute about 26 tonnes/ day. Lack of prudent solid waste disposal system is another problem that degrades the land and water systems close to the urban local bodies. An analysis of the extent of degradation of riparian lands reveals that Muvattupuzha River channel is significantly affected by various human interventions. The riparian land of Muvattupuzha main channel, the Murinjapuzha and Ittupuzha distributaries have degraded substantially (79%, 89% and 69% respectively) compared to the rest of the regions. Based on the study a set of restoration and management plans are suggested for overall improvement of the envi-

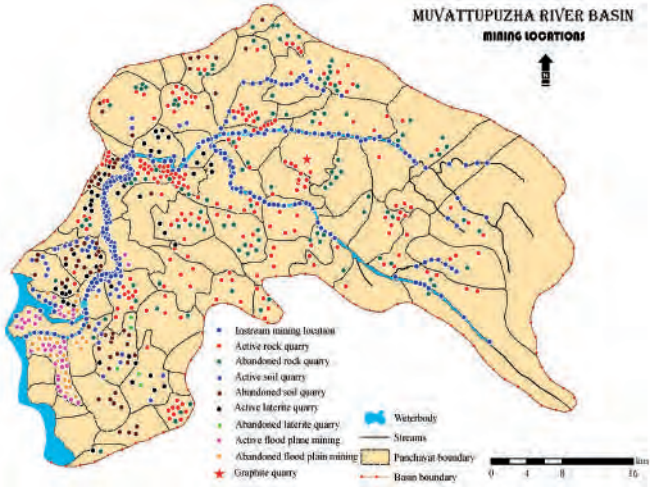

Fig. 3.3.6.1 Mining locations in the Muvattupuzha river basin

ronmental quality in the river basin. Study reveals that the areas close to Kochi City and its satellite townships are under immense stress due to rampant mining and quarrying activities widespread throughout. The midland and lowland areas of Ernakulam district, where clandestine mining and quarrying activities are prevalent have became hot spots. The study recommends several corrective measures to reconcile the adverse effects in the Muvattupuzha river basin.

K. Maya

3.3.7 Strategies for sand mining from Periyar river in Ernakulam district

River sand is widely used as an aggregate material in civil construction industry. In Kerala, the need for sand is mounting exponentially in the past few decades to meet its ever increasing demand in construction sector. But unlike the rivers in the neighboring States, the rivers of Kerala are small and with limited river bed resources in its instream and floodplain areas. It is now well understood that continued and uncontrolled mining of sand from rivers and related aquatic environments imposes severe impairments to the very existence of these ecosystems. This warrants the imminent need for regulating the mining activities on an environment - friendly basis.

Taking a serious note on the adverse impacts of river sand mining, the Government of Kerala enacted the legislation 'The Kerala

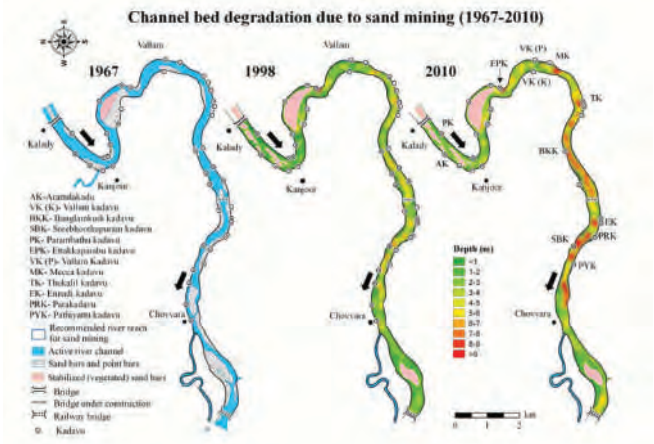

Fig.3.3.7.1 Creation of deep excavation pits in the river channel due to indiscriminate sand mining- a case of Periyar river.

Protection of River Banks and Regulation of Removal of Sand Act, 2001', with an aim to protect the physical environment of rivers from large scale extraction of sand from its active channels. This act also envisages provisions for periodical sand auditing so as to ensure river health and to ascertain the feasibility of future sand mining. In this connection, as advised by the Hon'ble High Court of Kerala, CESS has undertaken a sand audit study of Periyar river draining through Ernakulam district with the financial support of the District Administration, Ernakulam.

The study revealed that the river has degraded considerably due to the uncontrolled mining of sand over the past 3-4 decades. Many exposed sand deposits mapped in our previous survey in 1998 were vanished from the river channel. And, whatever remaining is turned partly or completely into grassy plains. The pit excavation of sand mining is responsible for channel incision of the river to the tune of 19.28cm/y during 2005- 2010 period. All these reiterate the need for stringent efforts to protect the river and its biophysical environments from further degradation.

D. Padmalal

3.3.8 Exploring the interrelationship between incidence of poverty and environmental degradation- A micro-level case study of Wayanad district of Kerala

This plan project, initiated in December, 2007 aims to document incidence of poverty and condition of the surrounding environment in selected eight panchayats. Field level data are being generated through questionnaire survey. Levels of resource use, environmental degradation and distribution of poverty have been

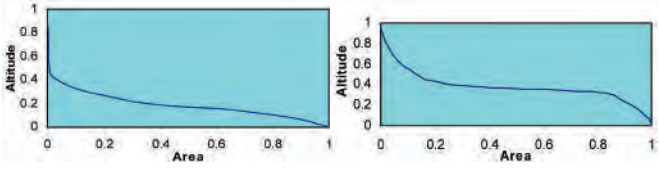

Fig.3.3.8.1 Hypsometric curves of Panchayats

studied. Outcome of this project is expected to help in understanding linkages between poverty and environmental degradation. Eight Panchayats, four each in Wayanad and Kannur districts, have been selected for detailed studies.

Works accomplished during this year cover preparation of environmental geomorphology, relief, slope, drainage and land use maps of the selected eight panchayats and Thirunelly watershed in Wayanad district. Analyses of drainage parameters of Thirunelli drainage basin including rose diagram have been attempted for developing landscape indices. Hypsometric curves were drawn for Meppady, Thondarnad and Noolpuzha Panchayats (Fig.3.3.8.1). Processing of panchayat wise data on natural resource and environmental issues are in progress. Drainage ordering of Kabbini river has been completed. Sample survey covering selected households in the Panchayats of Wayaand district are in progress.

Srikumar Chattopadhyay

3.3.9 Developing an integrated framework for science policy integration towards enhanced management of coastal systems in south Asia- a case study on Vembanad estuary

Objective of the project is to develop local case study around the Vembanad lake following DPSIR (Driver-Pressure-State-Impact-Response) methodology. Study covered compilation and analysis of existing data available from secondary sources and detailed field work to conduct sample survey enquiring environmental condition and livelihood opportunities. The study began with analysis of biophysical characteristics and tried to identify drivers of change, human intervention, impact of interventions, response to the changes and livelihood opportunities. Issues related to institutions and empowerment has also been discussed. The report has been finalized and dispatched to the funding agency.

Srikumar Chattopadhyay

Funding : Asia Pacific Netwrok for Global Change, Sri Lanka

3.3.10 Urbanisation between Kochi and Thrissur

The aim of the project is to study urbanisation between Kochi and Thrissur, its impact and the future trend of urbanization. During the year under report digitized drainage, contour, roads based on topographic maps; digitized and prepared relief, slope, aspect, drainage density, road density and land use/ land cover maps and occupational structure and their change maps were prepared based on Census 2001 data. In addition, modeling has been done on future urbanization of Kochi and growth map of Thrissur from 1967 to the present using GIS was prepared.

Ahalya Sukumar

3.3.11 Mapping of coastal cliffs and their vulnerability between Kanyakumari and Mangalore, South West coast of India

Sea cliff erosion and slumping is a common phenomenon seen on permeable and rocky cliffed shorelines of the world and Indian coasts are of no exception, which needs protection. These cliffed shorelines and their adjoining beaches (if any?) are one such area, which attracts large number of settlements/livelihood activities for coastal communities, developmental activities and domestic/foreign tourists. Indian coastline is privileged by suitable natural setup in many stretches. Studies on the identification, delineation, eroding/slumping behaviour and classification of permeable/rocky cliffs and their vulnerability to monsoonal wave attack and sea level rise are scanty. This project aims to fill the gaps and supplement more scientific inputs for solving the above problems. The main objectives are (i) identify and delineate different cliffed shorelines in the study area, (ii) generate a database on the physical parameters of these cliffed shorelines, (iii) document the characteristic behaviour of these cliffs with a suitable classification. (iv) develop a 'Cliffed Shoreline Atlas' and (v) prepare local specific land use control plans for vulnerable areas on a cadastral scale (1:4000). The study identified, delineated and classified the different permeable/rocky cliffed shorelines between Kanyakumari and Mangalore. Cliffed Shoreline has been classified into very stable (vs), moderately stable (ms), stable (s), unstable (us) and very unstable (vus). The structural failures of Vettur-Varkala-Edava cliff section (7 km long and 2 to 30m in height) and permeable cliffed shoreline (Coastal Landmark No:CP 5639 to CP 5670) commonly called 'Varkala Cliff' were documented.

A.S.K.Nair

3.4 Coastal Zone Mangement

3.4.1 Studies on Shore Protection Measures for Lakshadweep Islands

This project was successfully completed and its final report was prepared during the period under report. In the island the coastal protection measures adopted till now were mostly temporary and low-cost ones, such as placing of hollow concrete blocks, coir bags filled with stones, timber piles and tetrapods. Though it was quite effective at certain locations it had led to the permanent loss of beachfront. With this background we have undertaken the studies with the objective to develop an eco-friendly and at the same time, effective shore protection measures based on the results of numerical modeling of wave transformation, circulation and sediment transport in the nearshore region. The highlights of the

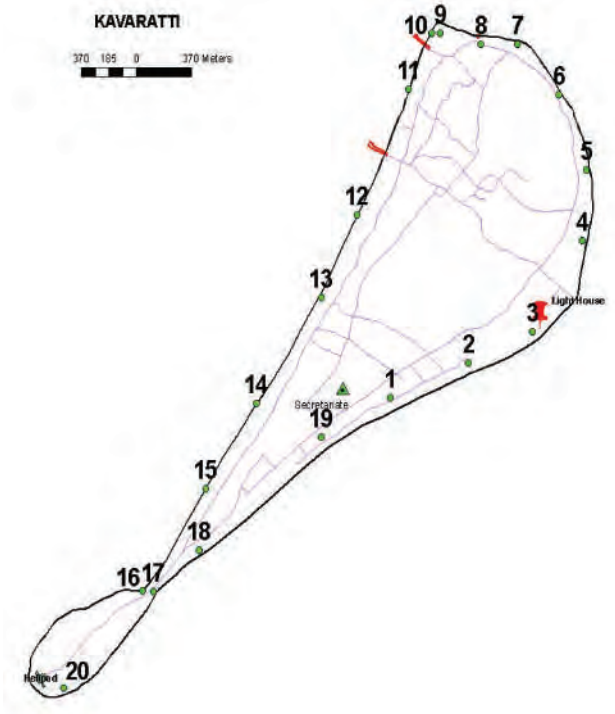

Fig. 3.4.1.1 Location map of the beach monitoring station at Kavaratti island

results from the field measurements and numerical model studies are briefly given below:

The beach morphological changes in the island were monitored for a period of one year with reference to monitoring stations established around the island (Fig. 3.4.1.1). The short term erosion/accretion pattern in the island indicates that the majority of

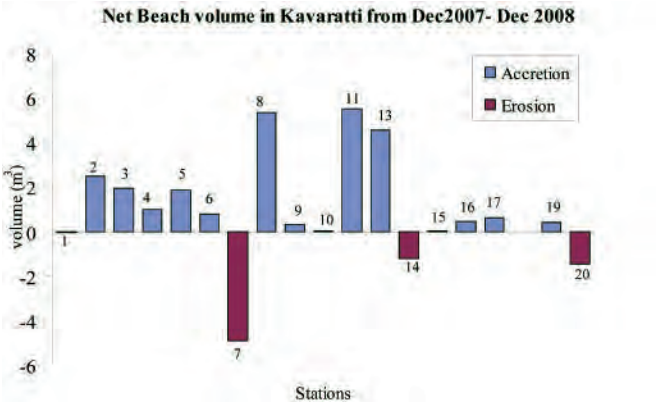

Fig. 3.4.1.2 Erosion/Accretion pattern in the island for a period of one year

the stations on the eastern and lagoon coast have stable type beach with moderate accretion except to the south of Katchery jetty (Station-14) and near the Children's park (Station-7) where moderate erosion is observed (Fig.3.4.1.2).

The long-term shoreline changes for a period of 30 years in the island has indicated that 4.15 km (35 %) of the shoreline was affected by erosion and is mostly seen along the stations 3 to 8, i.e. on the NW part of the island. But in the case of lagoon coast, erosion is observed mostly towards south of Katchery jetty, i.e. between stations 13 and 14 (Fig.3.4.1.1). In a nutshell, the erosion at any location along the island coast is more or less compensated by accretion at another coastal location within the island.

The recorded hydrodynamic data have been processed to understand the coastal processes operating in the island coast. Comparison of recorded wave and current data clearly indicated that the wave activity in the lagoon area which is surrounded by coral reefs, i.e. along the western coast is very less as compared to the other regions of the coast. This is mainly due to the natural protection provided by the coral reef, which separates the shallow lagoon from the surrounding deep water.

The significant wave heights for three principal seasons have been simulated using MIKE 21 hydrodynamic model. The significant wave height is in the range of 0.1 to 1.2m during the pre-monsoon, 0.2 to 1.8 m during monsoon and 0.1 to 1.4m during post-monsoon.

The effect of wave diffraction was studied for the dominant wave direction and period. The results indicate that the southern part and the western part of the island are subjected to higher wave activity. But the impact on the western coast is comparatively less due to the presence of coral reefs that separate the lagoon from the deep sea. The reefs essentially act like submerged breakwater reducing the wave intensity drastically especially during the monsoon season when the offshore waves approach the island almost normally.

The alongshore current analysis has indicated that the alongshore

transport is the dominant mode compared to offshore transport except near the entrance channel.The simulated mean current pattern during the three seasons – pre-monsoon, monsoon and post-monsoon indicates that the northern part of the island, especially the region extending from CSK 5 to CSK 8 experiences relatively higher current during all the three seasons. The current in the north-western region (Sector adjoining CSK 9 and CSK 10) is also high during all the three seasons with the monsoon season showing the maximum impact (Fig. 3.4.1.3).

The seasonal variation in the current direction is more pronounced on the eastern part as compared to the lagoon coast. The along shore current direction inside the lagoon is predominantly towards north during monsoon whereas it is towards south during the post-monsoon season.

The bed level changes for the three seasons were computed using the Sediment Transport Module while running the Flow Model. The east coast of the island is subjected to negative bed level change compared to the west coast indicating higher erosion in this region. The beach in front of CSK 8 is invariably an accreting beach even though there is a slight reduction in the accretion during pre-monsoon and post-monsoon. The maximum accretion is seen during post-monsoon season and the minimum during monsoon.

Field observations near the jetty have indicated that these man made structures have an impact on the coastline, as they hinder the alongshore sediment transport to the northern part of the island. Study of the circulation around the island indicates that the nearshore currents are mostly alongshore. This highlights the need to consider the use of semi-permeable coastal structures which will allow bypassing of the alongshore sediment very effectively especially in areas where shore connected structures have been provided in the island.

Placing of submerged geo-tubes very near to the shoreline within the low tide line is found to be a better coastal protection strategy, as it not only helps in reducing the wave intensity but also assists the beach building process.

In addition, a separate numerical modeling study was conducted to explore the feasibility of strengthening the existing reef from the children's park to the entrance channel tower for an approximate length of 400 m on the northern part of the island.

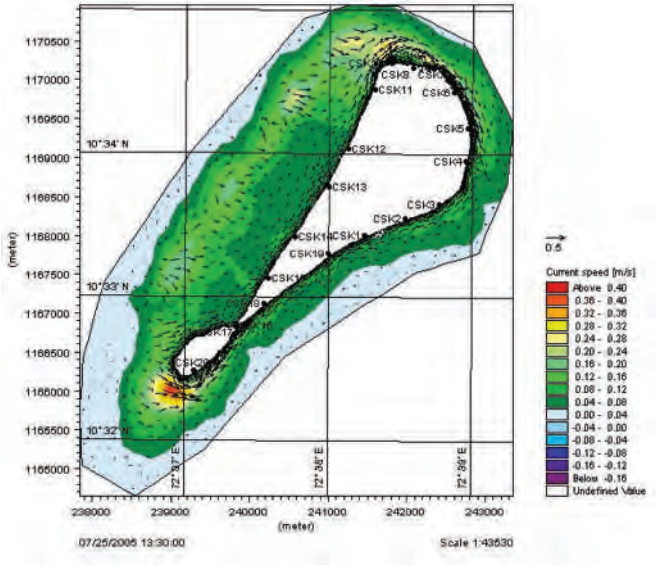

Fig. 3.4.1.3 Simulated current pattern during the monsoon period. Note the high current in the south and NNW part of the island

T.N.Prakash & L.Sheela Nair

Funded by: DST, GoI & Union Territory of Lakshadweep

3.4.2 Coastal Zone Studies- Kerala and Lakshadweep Islands

In order to study various aspects of the Indian coast primarily using satellite data, the MoEF, Govt. of India has sanctioned a project which encompass mapping and monitoring of the coastal zone, preparing local level map on 1:5000 scale for CRZ mapping and monitoring of the marine protected areas and vital/critical coral reef habitat. This is a collaborative programme involving many organizations/university departments in the country and is coordinated by the Space Application Centre, Ahmedabad. The studies pertaining to the Kerala and Lakshadweep coasts are being done by CESS.

Coastal landuse map of the Kerala State was generated using the IRS P6 LISS IV, fused product of LISS III and PAN or LISS III data. A methodology for parcel-level demarcation of CRZ in 1:5000 scale has been developed using CARTOSAT data. One toposheet area in the Thiruvananthapuram District was selected for the study. For accurate georeferencing of cadastry, latitude and longitude were measured accurately using the dual frequency GPS. Static and short-static measurements were made in the PRPs and GCPs respectively and the data was post-processed for computing the WGS-84 spherical coordinates in sub-metre accuracy. Cartosat and QuickBird image (both MSS and PAN) were re-referenced using the GPS coordinates. The georeferenced image was then used as reference frame for registering cadastre. Seamless spatial representation of the cadastre and images were carried out. Sensor merging 0.60 m PAN and 2.5 m MSS QuickBird satellite image was carried out for obtaining a hybrid product at 2.5 m resolution. The georeferenced cadastry was vectorised and a seamless cadastral map was reproduced in 1:4000 scale. The attribute information was geo-linked to the data base. Thematic layers derived from the satellite image were integrated with the cadastral layer, survey fields and survey numbers in GIS domain.

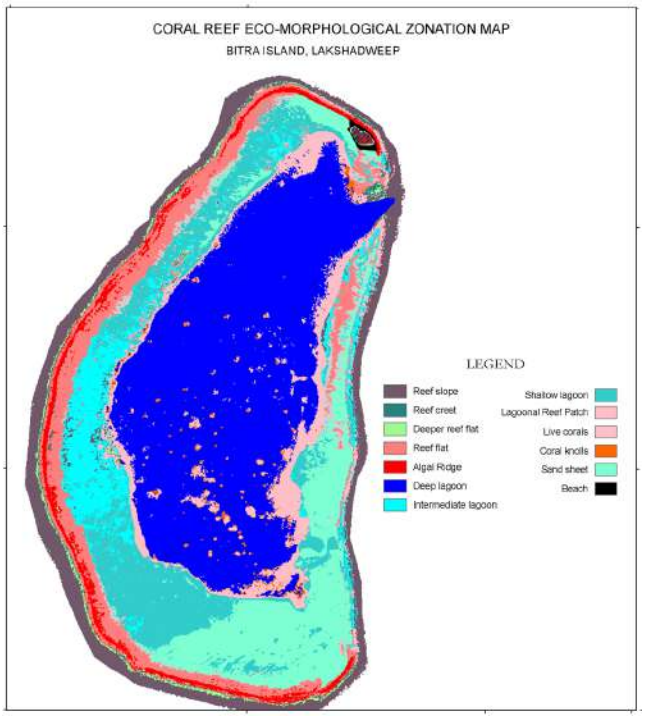

Fig. 3.4.2.1 The eco-morphological zones of Bitra Island, Lakshadweep

Landuse inventory of the Ashtamudi and Vembanad wetlands RAMSAR sites has been made. The Pazhayangadi wetland, which is an exquisite wetland ecosystem has been mapped and recommended to be included as RAMSAR site.

Multi-date satellite data viz. IRS P6 LISS III/LISS IV Mx was used for the classification of the coral reefs at eco-morphological level. The following methodology was adopted: a) generation of classification system for zoning the eco-morphological components of the coral reef, b) supervised classification of image for zoning the coral reefs eco-morphologically, c) ground data collections to fine tune the classified image, d) contextual editing and e) area estimations. The eco-morphological zones (Fig. 3.4.2.1) such as, coralline shelf, windward reef front, outer reef flat, inner reef flat, boulder zone, sanded reef flat, algal ridge, lagoonal reef patch, coral knolls, algae and sea grass are identified. Lagoon was classified based on depth like deep lagoon, intermediate lagoon, shallow lagoon and sand sheet. The classified image has been vectorized and projected by setting polyconic projection, and datum Indian 1975. The work has been completed and report submitted

M.Samsuddin & T.N Prakash

Funding: Space Applications Centre, Ahmedabad

3.5 Remote Sensing of Environment

3.5.1.Laser-induced fluorescence studies of plants

Chlorophyll fluorescence analysis offers an approach to identify stress effects early at a fundamental functional level, which may result in visual symptoms at a later stage. Sunlight as a light source for inducing plant fluorescence and for passive remote sensing of vegetation characteristics through field and space missions is gaining acceptance. Vegetation fluorescence helps in the classification of plants, identification of vegetation characteristics, physiological and nutrient stress detection, decision for optimal harvest time, vigor and vitality, weed infestation identification and related developments. The major objectives of the proposal are to develop a multi-spectral fluorescence imaging system to record sunlight induced fluorescence images of plants and to study the linkages

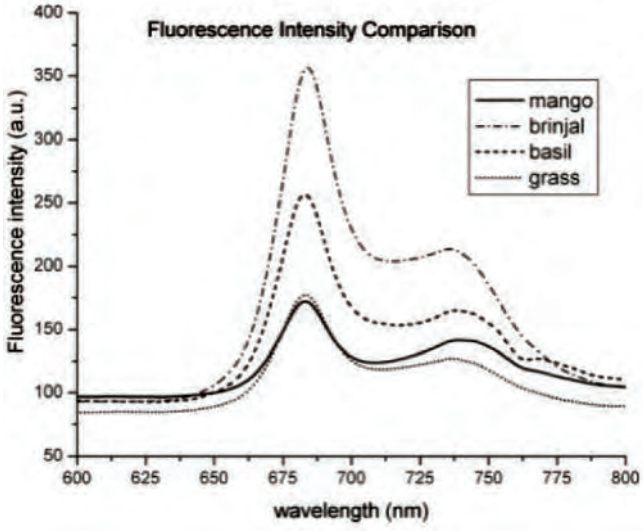

Fig. 3.5.1.1 LIF spectra of mango, brinjal, basil and grass leaves.

between stressors and photosynthetic activity of vegetation under differing environments.

The LIFRS system developed in the Biophotonics laboratory was used for point monitoring plant fluorescence with excitation at 404 nm from a diode laser. It was observed that the fluorescence intensity ratio F687/F735 varies with the chlorophyll content of leaves (lower/upper side of leaf, yellow /green leaf, and variegated /green leaf) and also during vegetation stress due to drought or infections.

Using the point monitoring device the chlorophyll fluorescence emission and leaf reflectance spectra were recorded from different

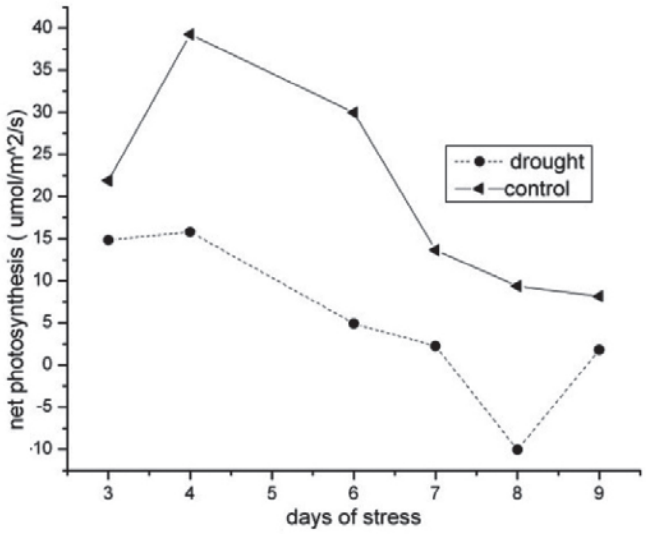

Fig. 3.5.1.2 Pn responses to 9 days of water stress

plants with varying leaf maturity (Fig.3.5.1 1). The shoulders of chl a and chl b fluorescence falls at around 685 nm (PS II) and 735 nm (PS I) respectively. Our studies have shown that the F685/F735 ratio varies with respect to the extent of stress and can be used an indicator of early symptoms of plant stress.

Quantitative study of water stress in potted mango saplings was carried out by comparison with a control. Along with the reflectance images, photosynthetic parameters and soil moisture were recorded. The control plant was watered everyday at 10:30 hrs and images were taken between 12:00 and 13:30 hrs. The change in photosynthetic rate of control and water stressed mango leaves for 10 days of stress is shown in Fig.3.5.1.2. The decrease in net photosynthesis, Pn, of the stressed plant with respect to the control is due to the closure of the stomata which reduces the amount of carbon dioxide necessary for photosynthesis.

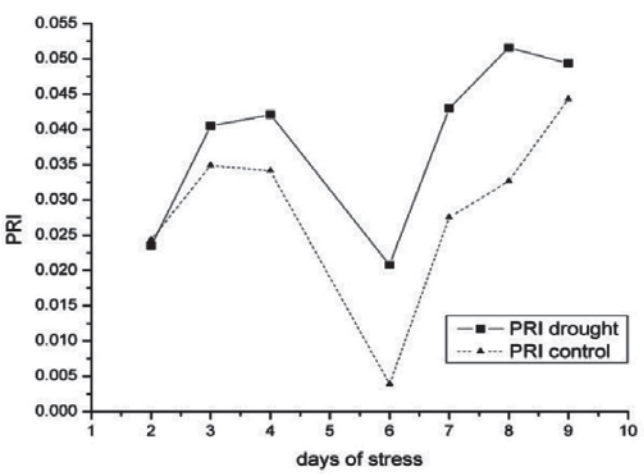

Fig. 3.5.1.3 Variation in PRI during prolonged water stress in mango saplings stress

Physiological reflectance index (PRI) is sensitive to the de-epoxidation state of the xanthophylls cycle pigments and the efficiency of photosynthesis. The xanthophylls cycle is associated with diurnal reductions in photosynthetic efficiency as the xanthophyll cycle pigment violaxanthin gets converted to zeaxanthin under excess light conditions, which is a reversible process under limiting light. The interconversion of the xanthophyll cycle pigments is detected in leaves through a change in the absorbance at 505-515 nm or in the reflectance at 531 nm, which is affected by xanthophyll de-epoxidation, and at 570 nm, which is the reference waveband. The PRI for water stressed plant is greater than that of control plant (Fig.3.5.1.3), which is expected as PRI values decrease as the xanthophyll de-epoxidation state increases.

N. Subhash, Aparna G N and Raji S N

3.5.2 Antimicrobial photodynamic therapy (PDT)

As part of the ongoing Indo-Bulgarian collaborative project 'Inactivation of pathogenic bacteria in periodental diseases-Fluorescence diagnosis and Photodynamic Therapy' at the Biophotonics Laboratory, in vitro PDT studies were carried out in Enterococcus Faecalis and Aggregatibacter Actinomycetem comitans using methylene blue and toluidine blue as photosensitizers. Laser irradiation at 655 nm was carried out for a period of 10 min for three concentrations (1.01, 0.1, 1 µM) of the photosensitizer (Fig.3.5.2.1). The number of colony forming units of bacterial suspension was determined by plating on ME agar plates at appropriate dilutions.

P***hotodynamic inactivation using methylene blue:*** For concentrations of 1 and 0.1 µM of photosensitizer, effective bacterial reduction of 99.8% and 99.9% were obtained respectively for an incubation time of 5 hours.

Photodynamic inactivation using toluidine blue: Effective bacterial load reduction of 99.67% was obtained for a concentration of 0.01 µM of photosensitizer in an incubation time of 5 hours. In comparison, a reduction of 99.96% in bacterial load was observed for a concentration of 0.1 µM toluidine blue with the bacterial substrate incubated for 2 hours. Whereas, the bacterial load reduced by 99.99% when the substrate was incubated for 3 hours at 1 µM photosensitizer concentration.

Photodynamic inactivation of Aggregatibacter Actinomycetem comitans using methylene blue: In vitro studies were also carried out on facultative aerobic Aggregatibacter Actinomycetem comitans which is a major causative agent of destructive diseases like periodontitis. Subgingival plaque samples were collected from aggressive periodontitis patients using sterile curettes and were transported to the microbiology laboratory on media consisting

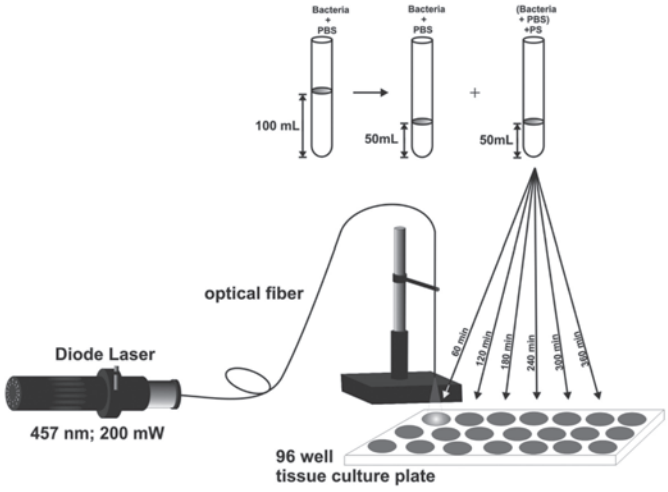

Fig.3.5.2.1 Experimental setup for antimicrobial PDT

of Tripticase soy agar with bacitracin. A. A. comitans was isolated and cultured for 72 hours at 37°C in the presence of 5-10% CO_2. The bacteria were diluted in solution. 100µl of adjusted suspension were taken in four groups in flat bottomed 96 well microtitration plate. In group 1, no treatment was given whereas group 2 was subjected to laser treatment. Group 3 was subjected to photosensitizer and group 4 was subjected to photosensitizer and laser radiation of 655 nm wavelength was used for irradiation. It was observed that PDT leads to significant reduction in the viability of the bacteria (log% reduction = 45.165) when compared to laser alone (log% reduction = 35.024) and photosensitizer alone (log% reduction = 32.665)

N. Subhash, Prasanth C S, Ajaykumar and E Sreekumar (RGCB), K. Nandakumar (ADC) & Latchezar Avramov (Inst. Electronics, Bulgaria)

Funding Agency: Dept. of Science and Technology, GoI

3.6. GIS and Remote Sensing Applications in Natural Resources Management

3.6.1 Geo-spatial Survey and Assessment of Munnar and Adjoining Panchayats

This project is aimed at creating spatial and non-spatial digital data base of the Munnar, Chinnakkanal and Pallivasal panchayats in the Idukki District for implementing various planning activities for eco-friendly and sustainable development of the region. Cadastral/village maps, CARTOSAT I stereo PAN data and QuickBird satellite data (with spatial resolution of 0.60 metre the Mx and 2.5 metre PAN) was used in conjunction with Global Positioning System for preparing the database. QuickBird satellite data was precisely ortho-corrected using DGPS values and the Cartosat stereo data. Various thematic layers such as land use/ land cover, road network, water bodies, settlements, building foot prints etc. were derived (Fig. 3.6.1.1). The individual cadastral sheets were scanned, cleaned and a mosaic of individual estates was made. Georeferencing of inter-estates was made for obtaining final mosaic of KDH Village. The mosaic image was then integrated with the ortho-corrected QuickBird image. Vectorization of the cadastre was done and linked with the survey parcels. The spatial/non-spatial data was linked to geodatabase in WGS84 Datum and UTM Zone 43 projection. The spatial and non-spatial information thus derived were integrated with cadastre in 1:3960/1:5000 scale and plot level area covered by different categories were computed and presented in a tabular form. The area of original and the vectorized cadastry was compared and accuracy level assessed. The data base was integrated as per the original number of estates recorded in the original cadastre.

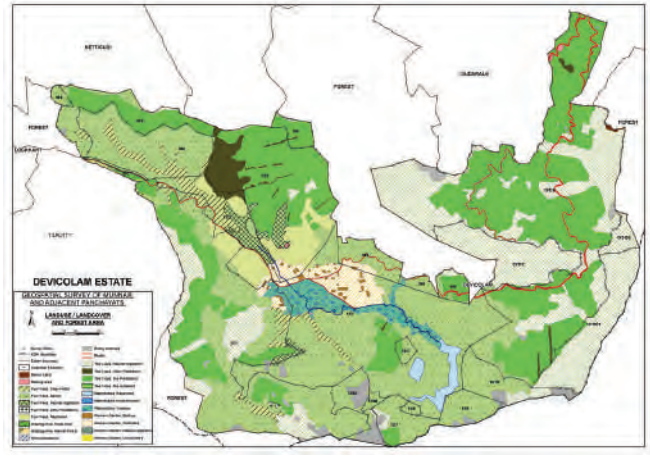

Fig. 3.6.1.1 Landuse/ landcover and forest map of Devikulam estate

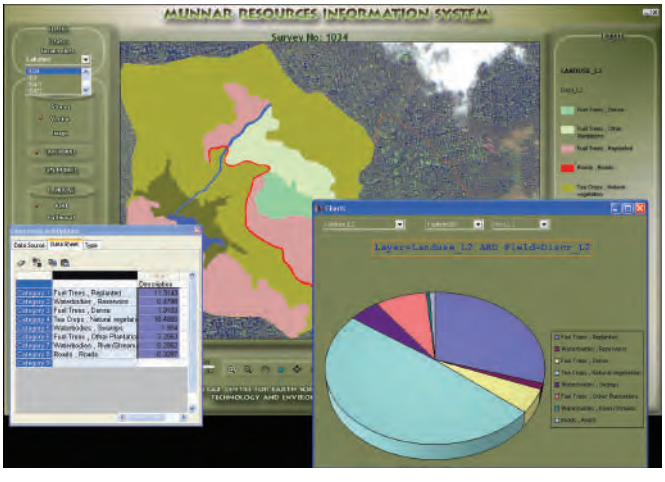

Fig. 3.6.1.2 A screen shot of the information system developed for Munnar

As per the original cadastry there are 46 estates/estate parts. The survey parcels (the area of those cadastries that were not recorded in the hard copy) which do not form part of any estate were categorized as others and area calculations were presented separately. The land board data was also integrated to the digital database and the area corresponding to the original cadastry compared.

The forest boundaries as shown in the original cadastry are reproduced in the present study. As good-quality cadastral map of Chinnakkanal and Pallivasal was not provided, the present landuse of these Panchayats only has been extracted from the QuickBird satellite data. Cadastral-level integration of the thematic layers could not be carried out.

M. Samsuddin

3.6.2 Cadastral Level Decision Support System for Management of Natural Resource in Thiruvananthapuram District.

The objectives of the project are district level integration of land and water resource information in a cadastral base, through integration of geoinformatics with particular focus on local-level development, development of attribute as well as spatial information base for various levels of urban/rural planning, development of standards with regard to database data exchange format and providing decision support system for planning by establishing resource information centre with the support of Panchayat functionaries/peoples' representatives.

As part of the programme for establishing GPS observation points in the project, 28 Principal Reference Points (PRPs) were established in seven districts by making 72 hours static observation and documented. In addition to PRP survey 316 Ground control points have been established in the Thiruvananthapuram District. Positions of the PRPs and GCPs were verified and documented. The final GPS survey report was submitted in 4 volumes.

With respect to the GCPs, georeferencing of the complete Thiruvananthapuram cadastry was completed. Integration of cadastry with that of georeferenced Cartosat satellite data(with the coordinated obtained from the GPS survey) for the Neyyattinkara taluk (4 blocks and one Municipality) has been completed. Thematic layers were transformed for final GIS customization. Detailed land use classification based on the Cartosat and IRS P6 images are currently progressing.

B. K. Jayaprasad

3.6.3 NREDB Data Updation and Utilization for Local Level Planning in Kerala – Database infrastructure Support

Under the State Planning Board's scheme on 'Application of Space Technology for the Development of Kerala' the proposal for Database Infrastructure Support by CESS was sanctioned as follow up action for utilization of the spatial database for district planning. Major thematic layers incorporated into the database of DRIS are administrative divisions (districts, blocks, Panchayats and municipalities), revenue divisions (taluks and villages), major transport network, watersheds, major rivers (watershed-based), drainage, slope, relief, relative relief, hill shade, major and micro landforms, geology, soil texture and erosion, soil productivity and slope, land use, land cover (forest), landslide hazard zonation, ground water prospects and socio-economic parameters such as, population density and distribution, population 0-6 age group, occupational structure, distribution of scheduled caste and scheduled tribe population, percentage of scheduled caste and scheduled tribe population to total population, distribution of literates, percentages of literates to total population, percentages of male and female literates to total literates.

After QA/QC of the resource database at the district level, the data has been has been integrated into the respective information systems developed using ESRI MapObjects and Visual Basic software in order to retrieve information based on user-specific queries. Detailed report on district-level natural resources and a training manual for use in the resource centers of the above districts has been completed.

V. N. Neelakandan

Funding: Kerala State Planning Board

3.6.4 Kerala State Spatial Data Infrastructure (KSDI)

Government agencies and other organizations are frequently asked for quick responses to natural disasters, industrial accidents, environmental crises, planning, watershed-based development planning infrastructure development etc. Much of the information needed to make sound decisions in such cases is based on detailed geographic information. There is constant pressure to make wise decisions in a more cost effective and efficient manner. The availability of accurate and current geospatial data are critical in this decision making processes. In spite of various geo-spatial related activities and data availability, decision making process is getting affected mainly due to the following reasons:

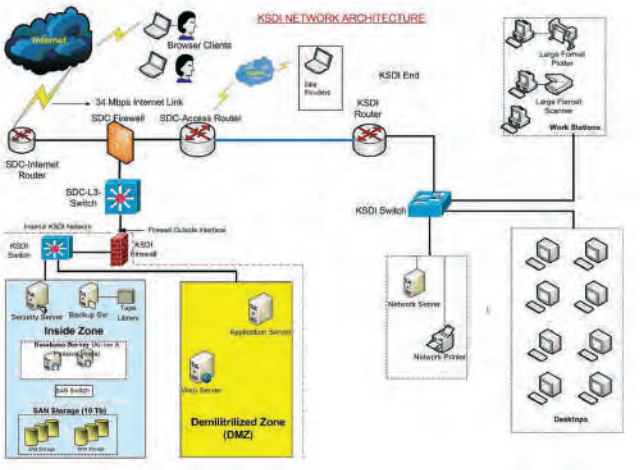

Fig. 3.6.6.1 KSDI Network Architecture

No data catalogue is available, thus, we do not know which organization has what data. Due to unavailability of metadata in a centralized platform, it is difficult for users to know about the quality of the data and ways and means to access the available data. There is no mechanism so that users can access available data from different sources according to their requirements. The available and accessible data cannot be used in conjunction with others, since they follow multiplicity of standards in terms of scale, projection, standard, content, formats and quality. Even if the data gets standardized, there may be reluctance to share among organizations or there may be restrictive policies.

CESS has taken a lead role in establishing the KSDI, which is designed to create, maintain and deliver geospatial data in real time. Based on a proposal submitted by CESS, KSREC, NIC and KSCSTE the Kerala Government has established an institution, named, Kerala Spatial Data Infrastructure (KSDI) at Technopark under the Information Technology Department. Spatial Data Infrastructure (SDI) is facilitation and coordination of the exchange and sharing of spatial data between stakeholders from different jurisdictional levels in the spatial data community. SDI comprises of four core components: an institutional framework SDI and data providing agencies, technical standards, fundamental data sets, and clearing house networks.

The portal is used as a starting point and frequent gateway to access web resources and geospatial data content. The geoportal thus developed must have capability to handle data storage, retrieval and update. It also has to support automatic and manual form based input/update of metadata using required services. Clearing house is a decentralized system of servers located on the internet that contain descriptions of available digital geo-spatial data. This descriptive information, known as metadata, is collected in a standard format to facilitate query and consistent presentation across multiple participating sites.

The purpose of KSDI is to create, maintain and deliver geospatial data and metadata to their external clients, in real-time and independently from the software they use. Access to and maintenance of the underlying master database will be done by uploading data from remotely available spatial data generating agencies and survey agencies. A clearing house uses readily available web technology and uses standards for query, search, and presentation of results to the web. The data/metadata/ services will initially be accessed by the concerned staff from the designated centres or the line departments. These services will eventually be extended to beneficiaries of various developmental schemes/programmes and the general public with certain restrictions under provisions of the prevailing rules and regulations of the Government of India.

The existing and new authored data will be created and maintained in the KSDI, which would centrally be stored in an RDBMS database. This data (spatial, non spatial and metadata) from Oracle would be published to the Central Live Server. All the services and the raster data would be published as per OGC standards, so that the overall solution is always interoperable. The web portal allows the users spread across the internet, to view and query the spatial information and the related maps. This information shall be picked from a central server repository. The central repository will be on standard RDBMS package. The portal would cater to WMS/WFS/WCS/CS-W and other portal services (Fig. 3.6.6.1).

Each Data Providing Agency (DPA) functioning as KSDI node will have a front end server connected to the KSDI with Dedicated Leased Line. The DPA will also have back end server for storage of data. The DPA that have the required facilities adopt suitable metadata as per the OGC standard and attend and process all requests for spatial data that emanate from the KSDI protocol as per the user demand. Once all the data is published to the server by the data providers, various clients would be able to download the required data and perform various spatial and non spatial functions and analysis on the data through the KSDI. All that a user need would be a client as thin as an internet explorer and a network connection. An organization does not have to be dependent on any one particular format and neither has to buy multiple products to access the data.

M. Samsuddin

3.6.5 Kerala Resources Information System & Services (KRISS)

Over the years, CESS has generated spatial/non-spatial data on a variety of themes related to land, water and air pertaining to Kerala prepared under various R&D projects. The digital data available in CESS are mainly in shape file format. Apart from, this data is also available in MapInfo TAB format, Geomedia DGN format and Autocad DXF format. Part of the digitized map layers in CESS has been organized as layers of information in GIS core.

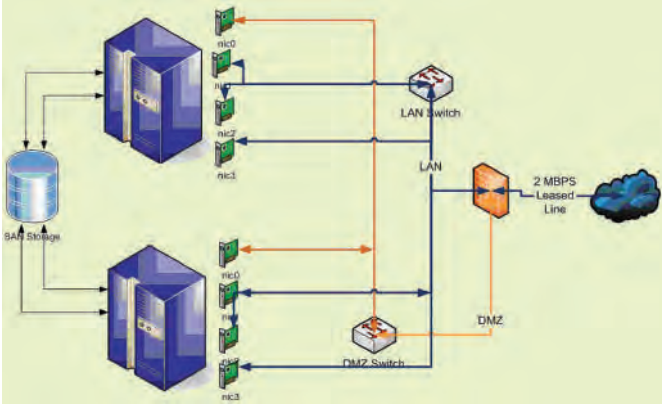

Fig.3.6.5.1 Flow diagram of Kerala Resources Information System & Services (KRISS)'

Standardization of data, wherever possible, is on the lines of proposed National (Natural) Resource Information System [NRIS] and National Spatial Data Infrastructure (NSDI).

The on-going institutional projects in CESS would generate considerable amount of digital data in the coming years. A rough estimate of current volume of data is about 3 TB and it can grow at the rate of 1-2 TB per year in the coming years. There is a need to archive the spatial/non-spatial data and to make it available to different users within and outside CESS through the internet.The Kerala Resources and Infomation System and Services (KRISS) will organize the digital data using the state-of-the-art technology for efficient storage and retrieval as well as for secured web access.

An attempt has been made to archive part of the data and disseminate it through CESS intranet under a CESS plan project. A prototype WebGIS has been developed using UMN Mapserver, HTML, ASP.NET and C# to enable visualization of maps and images in CESS intranet. Besides Geomatics Laboratory, CESS has seven other divisions engaged in R&D activities. Spatial and non-spatial data from these divisions and from other sources need to be archived. Under the PLAN project it is proposed to establish a modular data centre, which can provide complete physical infrastructure for data processing, data analysis, data storage, data warehousing, data mining, and data dissemination. Once made operational, the data centre can function as a data providing agency to KSDI.

For dissemination of resources information through secured web access, a proposal for establishing 'Kerala Resources Information System & Services (KRISS)' was approved. This involves setting up of state-of-the-art Information & Communication Technology (ICT) infrastructure facilities for data processing, data storage, data warehousing, data mining, data dissemination and intranet and internet based user interaction at CESS. This facility needs a compact and modular data centre built on standards that help reduce cost, achieve operational efficiency and enhanced security with facilities for efficient management and retrieval of information on natural and environmental resources of Kerala. It will also function as a node of the proposed Kerala State Spatial Data Infrastructure (KSDI).

For identification of a total solution provider, Notification for a Expression of Interest (EoI) was published in Newspapers. Clarifications requested by prospective bidders on data centre were provided. In response to our EoI invitation, proposals from 14 firms were received. Based on EoI a Request for Proposal (RFP) for establishing Data Centre for KRISS has been finalized and floated.

V.N. Neelakandan

3.6.6 Digital Resource Atlas of Kerala

The objective of this project is to revise the Resource Atlas of Kerala published by the Centre for Earth Science Studies in 1984 and bring out in CD as well as hard copy. During the period we collected data, processed, prepared and digitized maps of Kerala-Administrative Divisions, Relief, Drainage, Demographic aspects (Census 2001), area under banana, turmeric, cardamom, cocoa, food crops, non foodcrops, drumstick, ginger, pepper, sugarcane, lemongrass, rubber, coffee, paddy, fodder grass, papaya, sweet potato, pine apple, tamrind, mango, jack, tapioca, plaintain, cashew, tea, sesamum and coconut from 1985-1995, 1995-2005 and percentage to the total cropped area from 1985-1995 and 1995-2005 respectively. Demographic aspects includes total male and female population, percentage to the total population, density of population, sex ratio, total workers (total male and female)

main workers (total male and female), cultivators (total male and female), agricultural labourers (total male and female),literates (total male and female), SC Population (total male and female), ST population (total male and female) and households.

B. Sukumar

3.6.7 Application of Artificial Neural Network in Pattern Classification of Remotely Sensed Images

IRSP6 AWiFS satellite data, taken during the period March 2007 were collected from NRSA. The study area for the present work is Idukki district, where variety of land cover classes can be seen. Image of Idukki is extracted from the image. Geometrically corrected image was used for further classification process (Fig. 3.6.5.1).

Ground truth GPS survey was conducted in the study area during March 2009 and locations of major land cover classes were identified in the area. The classes identified are water, agricultural land, forest, settlements, tea, eucalyptus, cardamom, grass land, open shrubs, mixed plantations and rubber. In training data set, the multispectral parameters were extracted for 11 classes from

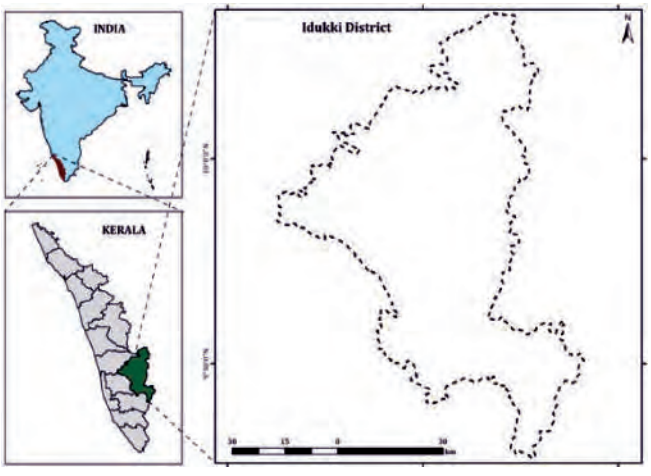

Fig. 3.6.7.1 Map showing the study area

the training sites identified in the image.

Preparation to train and classify satellite imagery was completed. Selection of remote sensing data, image processing, ground truth survey and training data set preparation were over. Simulation of artificial neural network and classification can be done with MATLAB software. An Artificial Neural Network model has to be created to train the collected data.

K.J.Mathew

3.7 Energy Studies

3.7.1 The Social impacts of energy technologies: two case studies at different environs of Thiruvananthapuram district.

Energy is the prime mover of economic growth. Hence energy occupies the central stage in developmental issues. For the fructification of the concept of inclusive growth, energy has to be provided to the needy in manner and form required by them. The optimum management of the energy resources forms an integral component of any natural resources management system. Also micro level energy studies are per se requirement for any meaningful energy planning. Hence the necessity for this study.

The project envisages the study of household energy consumption pattern in two panchayats of Thiruvananthapuram district situated in different environs namely one in rural area and other one in urban area. The rural panchayat selected is Kilimanoor as this panchayat has the maximum number of persons employed in agricultural sector among the panchayats of Thiruvananthapuram district. The urban area selected is the Pattom ward in Thiruvananthapuram city. A detailed and comprehensive questionnaire was formulated using a randon number table and 100 households have been selected in each of Kilimanoor panchayat and Pattom ward for detailed household survey. Survey was being conducted and preliminary analysis of data was in progress.

K.Vijayakumar

3.8. Climate Change Studies

3.8.1 Monitoring Climate Change impacts in Sahyadri

'Monitoring Global Change in Sahyadri Mountain Ranges' is a study started for the southern Western Ghats (WG) in Peninsular India. Being one of the global hotspots of biodiversity in the tropics, with a continuous chain of mountains, generating and strengthening the knowledge about the ecology and sustainable development of these mountain ecosystems are of paramount importance today. The project is conceived to concentrate on major themes that provide a minimal set of research and monitoring requirement to study global change impacts in a cross section of area south of Palghat gap and the Achenkovil shear zone. The transect study selected the Eravikulam National Park (ENP), the highest plateau in Western Ghats with montane cloud forests as the undisturbed core area and moist forests of Idamala Puyankutty valleys in the western slopes and the dry deciduous

Muthirapuzha- Chinnar valleys in the eastern slopes of ENP as relatively disturbed due to natural and manmade causes. The priority themes identified are the minimal set of research and monitoring requirements to study global change impacts in mountain regions such as climate/weather parameters, biodiversity changes, land use changes, hydrological systems and change in mountain/ forest economies. In due course the programme is expected to cover the entire southern Western Ghats.

C. N. Mohanan

3.8.2 Urban Heat Island in Kochi

A large proportion of the global population live in urban regions and the trend is intensifying. The percentage of global urban population is expected to reach 60% by the year 2030. The urban population in India is projected to increase from its 2008 value of 30% of the total to 40% by the year 2030. The urban climate and the impact of urban growth on the climate thus affect vast majority of the global population. The warmer temperature in the urban setting, a feature known as the Urban Heat Island (UHI), is a major urban modification to climate. Urban geometry, sky view factor, reduction in vegetation cover, heat storage by building and pavement, metabolic heat generated by urban population, modification of wind pattern, etc. are other major factors. UHI is caused primarily by differences in heat storage capacities and cooling rates within the urban and adjoining rural areas. UHI leads to heat stress suffered by the population, increased energy consumption for space cooling and refrigeration, etc.

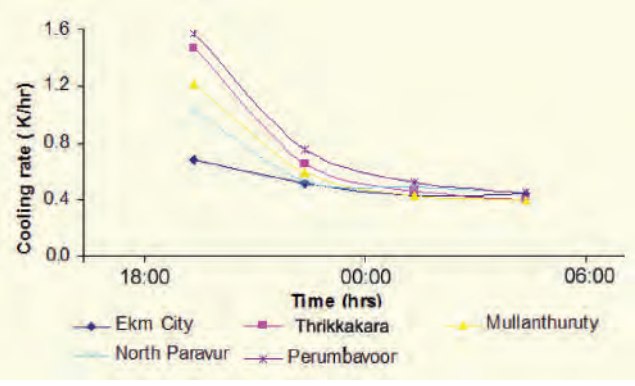

Fig 3.8.2.1 The cooling rates at different location in the Study Region

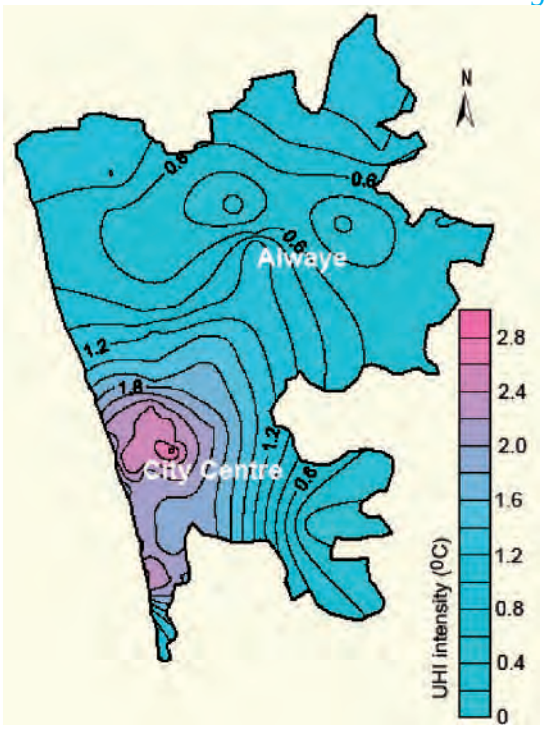

Fig 3.8.2.2 UHI intensity during winter in the study region

As part of the project to study of the UHI in Kochi, continuous recording of air temperature, humidity, wind, rainfall, soil moisture, etc. at selected locations, as well as data on surface temperatures, urban geometry, vegetation, energy consumption, have been initiated. Mobile traverses with sensors mounted on automobiles were also employed. The cooling rates at different location in the region and the UHI intensity during winter season are shown in Fig. 3.8.2.1and Fig. 3.8.2.2 respecrively.

E. J. Zachariah

4 Consultancy Programmes

4.1 Costal Regulation Zone Status Reports

Various research initiatives in the coastal zone during the last few decades had indicated imminent sea level rise, large scale morphological modifications and biodiversity degradation in the coastal zone. Resource depletion and deterioration in the quality of life of coastal communities due to coastal pollution and landuse changes are resulting in serious socioeconomic issues. Adverse impacts on beaches, dunes, mangroves, creeks and rivers due to anthropogenic interventions are getting increasingly evident. In view of these factors, the Government of India realised that the most cost-effective long-term solution to protect endangered coastal zone, is to set aside spatial buffers around coastal ecosystems which would preserve coasts for posterity, mitigate forces of the ocean and allow any future marine transgressions. Subsequently, the Ministry of Environment and Forests (MoEF) enacted the Coastal Regulation Zone (CRZ) notification issued under the Environment Protection Act of 1986. Its major objectives are to control, minimize and protect environmental damage to sensitive coastal stretches from unplanned human interference and ensure protection to life and property. Coastal Regulation Zone (CRZ) comprises of the intertidal zone between High Tide Line (HTL) and Low Tide Line (LTL) and the coastal stretches extending 500 m landward of the HTL of seas, bays, estuaries, creeks, backwaters and rivers which are influenced by tidal action. CRZ is categorized into different activity zones such as CRZ I, CRZ II and CRZ III taking into consideration its geomorphology, ecosystem and landuse for regulating activities to ensure sustainable development and conservation of beach and other sensitive coastal ecosystems. Being an agency authorised by the Ministry of Environment and Forests, Govt of India for the demarcation of the HTL and LTL, Centre for Earth Science Studies has taken up a number of studies on CRZ in different coastal states of the country.

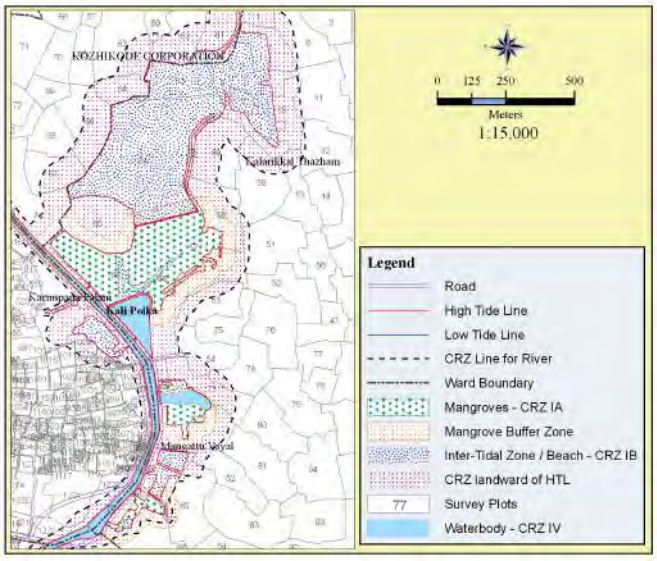

Fig. 4.1.1 Model CRZ Map of Kalipoika area in Kozhikode district

The CRZ maps were prepared in cadastral scale for easy interpretation by implementing agencies. Information collected from field mapping combined with information derived from high resolution satellite imageries were used for demarcating the HTL, LTL and CRZ categories. DGPS control points were relied upon for rectification and data input. The extent of influence of tidal action in the water bodies was determined based on its salinity. The HTL and LTL were determined from geomorphologic signatures such as berm crests, tidal flats, cliffs and coastal protection structures. The sensitive coastal ecosystems such as mangroves, sand dunes, tidal flats, fish breeding grounds, etc were identified and their spatial extent demarcated. Based on an analysis of geomorphology, ecosystem, landuse and administrative set up, the Coastal Regulation Zone was classified into different activity zones. These form the basis for the CRZ maps and reports for a region. The CRZ report and maps help the decision making authorities to identify the areas for conservation and protection and for development in the coastal zone.

CRZ mapping has been undertaken for different departments and public undertakings in the State such as Kerala Coastal Zone Management Authority, Harbour Engineering Department, Local Self Government (Urban Development) Department, Revenue Department, Tourism Department, Police Department, Goshree Island Development Authority etc. The Indian Oil Corporation Limited, National Highway Authority of India, Technopark and Matsyafed are some of the public sector undertakings for which CRZ mapping has been undertaken. In addition to this, CRZ mapping programmes have been carried out for several private sector agencies as can be seen in Table 4.1.1

Table 4.1.1 List of CRZ reports during 2009-10

Sl. No.	Funding Agency	Location of Study
1	M/s. CISO Institute of Oceanic Studies, Thrissur	Punnayur, Thrissur
2	M/s. Adelie Builders & Developers Pvt. Ltd., Ernakulam	Vyttila, Kochi
3	M/s. Puravankara Projects Ltd., Kochi	Marine Drive, Kochi
4	M/s. Asset Homes Pvt. Ltd., Kannur	Payyambalam Cliff, Kannur
5	The Superintendent of Police, Thrissur	Azhikode, Thrissur
6	M/s. Indian Oil Corporation Limited, Kochi	Puthu Vypeen, Kochi
7	M/s EQMS India Pvt. Ltd., Delhi	Versova, Mumbai
8	M/s. DLF Limited, Ernakulam	Marine Drive, Ernakulam
9	M/s. Puravankara Projects Ltd., Ernakulam	Marine Drive, Ernakulam
10	M/s. Centrurious Housing & Constructions Pvt. Ltd., Ernakulam	Marine Drive, Ernakulam
11	National Highway Authority of India	Kazhakuttom-Kanjiramkulam Sector
12	Architecture Incorporated, Trivandrum	Vizhinjam, Trivandrum
13	Tata Power Company Ltd	Dehrand/ Shahapur, Maharashtra
14	M/s. Nazeer, Karunagappally	Karunagappally, Kollam
15	Dr. Akhtar Hassan Rizvi, Mumbai	Bandra, Mumbai
16	The Superintendent of Police, Kannur	Azhikkal, Kannur
17	M/s. MIR Realtors Pvt. Ltd., Kannur	Pallikunnu & Chirakkal, Kannur

18	M/s. Rajah Islands Ltd., Thrissur	Akalad, Thrissur
19	MATSYAFED, Thiruvananthapuram	Valiazheekal, Arattupuzha
20	Revenue Department, Govt. Of Kerala	Wadi Kadapuram, Kollam
21	M/s. Carnoustie Resorts Pvt. Ltd., Mumbai	Mararikkulam, Alappuzha
22	M/s Smile Direct Resort Pvt Ltd	Kulathur, Thiruvananthapuram
23	M/s. Bhasuram Resorts Pvt. Ltd., Thiruvananthapuram	Kulathur, Thiruvananthapuram
24	M/s Aquaplast, Ernakulam	Maradu, Ernakulam
25	M/s. Muthoot Hotel & Infrastructure Ventures Pvt. Ltd., Thiruvananthapuram	Kanhangad, Kasargod
26	TECHNOPARK , Kollam	Technopark, Kundara, Kollam
27	Harbour Engineering Department	Veli, Thiruvananthapuram
28	Greater Cochin Development Authority, Cochin	Kochi
29	NHA Kuttipuram-Edappally Sector	NH-17 Kuttipuram - Edappally Sector
30	M/s Berggruen Hotels Pvt Ltd, Mumbai	Thevara, Elankulam Village, Ernakulam
31	M/s Synthite Industries Ltd., Ernakulam	Kumbalam, Ernakulam
32	M/s Goodwill Investment Company Pvt Ltd	Bandra, Mumbai

K. V. Thomas, N. P. Kurian, D. Raju, S. Mohanan & M. Rameshkumar
Funding: Various Agencies

5 List of Projects

5.1 External Grant-in-aid Projects

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay (Rs.in lakh)	Fund received during the year (Rs.in lakh)
1	Landslide stabilization schemes of Agricultural Department	Soil Conservation Unit, Dept. of Agriculture	Sri. G.Sankar	Geosciences		2009-10	0.19	0.19
2	Detection of thunder clouds	Kerala State Council for Science Technology & Environment	Sri. R. Vishnu	Atmospheric Sciences		2009-11	0.30	0.15
3	Oil Spill Modelling for selected locations of Kerala and Lakshadweep	Ministry of Earth Sciences, GoI	Dr.N.P.Kurian	Marine Sciences	Ms. Sheela L.Nair, Dr.T.S.S.Hameed, Dr.K.V.Thomas	2009-11	75.00	49.91
4	National Conference on Coastal Process, Resoruces and Management	Various Agencies	Dr.N.P.Kurian	Marine Sciences		2009-10	13.50	13.41
5	River Sand auditing-Periyar	Revenue Dept., GoK	Dr.D.Padmalal	Environmental Sciences	Dr.K.Maya	2009-10	24.66	24.66
6	NREDB Data Updation of service facilities in the Ernakulam District	Kerala State Planning Board, GoK	Sri.B.K.Jayaprasad	Central Geomatics Lab	Dr.M.Samsuddin	2009-10	3.26	3.26
7	Monitoring the impact of environmental changes in coral of Lakshadweep archipelago by fluorescence imaging	Dept. of Science & Technology, GoI	Dr.N.Subhash	Atmospheric Sciences	Dr.T.N.Prakash, Dr.M.S.Syed Ismail Koya (DST, UTL)	2008-11	34.44	2.09
8	Inactivation of pathogenic bacteria in periodontal disease: Fluorescence diagnostics and photodynamics therapy	Dept. of Science & Technology, GoI.	Dr.N.Subhash	Atmospheric Sciences	Dr. Ajayakumar & Dr.E.Sreekumar (RGCB) Dr.N.Nandakumar (ADC), Dr.L.Avramov (BAS, Bulgeria)	2008-11	5.27	0.00
9	Interstitial water chemistry of aquatic environments and its significance in nutrient dynamics : a case study	Dept. of Science & Technology, GoI	Dr.K.Narendra Babu	Chemical Sciences	Dr.D.Padmalal	2008-11	5.27	0.00

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay (Rs.in lakh)	Fund received during the year (Rs.in lakh)
10	Spatio-temproal shore changes during Holocene and tracing the evolutionary history of the Ashtamudi estuary, Southern Kerala	Dept. of Science & Technology,GoI	Dr.T.N.Prakash	Marine Sciences	Dr.M.Samsuddin **Prof.R.Raghavendra** Anna University	2009-12	30.38	0.00
11	Lanslide Stabilisation schemes Vella-Poolakutty of Kannur District	Soil Conservation Unit Dept. of Agriculture, GoK	Sri.G.Sankar	Geosciences	Dr.P.K.Omana	2009-10	0.08	0.00
12	Coastal ocean monitoring and prediction system along the coast of Kerala, Karnataka and Lakshadweep islands.	Ministry of Earth Sciences, GoI	Dr. K. Narendra Babu	Chemical Sciences		2008-13	222.50	49.23
13	Developing an integrated framework for Science Policy Interactions towards enhanced management of Coastal systems of South Asia-case study on Vembanad estuary	Asia Pacific Network for Global Change (APN) through LOICZ Regional IPO Node for South Asia, National Science Foundation, Sri Lanka	Dr.Srikumar Chattopadhyay	Resources Analysis	Dr.Mahamaya Chattopadhyay	2009-10	3.47	0.00
14	Environmental Management Plan for Alappuzha-Sherthalai Canal and Kanjikuzhy Gramapanchayat-A participatory action research programme	Kerala State Council for Science, Technology and Environment	Dr.Srikumar Chattopadhyay	Resource Analysis		2008-10	7.50	0.00
15	Application of Space Technology for the development of Kerala	Kerala State Planning Board	Sri.V.N.Neelakandan	Central Geomatics Lab	Sri.B.K.Jayaprasad	2008-11	12.62	5.62
16	State of Environment of Lakshadweep islands	Kerala State Council Science, Technology and Environment	Dr.C.N.Mohanan	Environmental Sciences	Dr.T.N.Prakash, Dr.K.V.Thomas, Sri.S.Sidharthan	2009	1.00	0.00
17	Workshop on CRZ Notification	Kerala State Council for Science, Technology and Environment	Dr.K.V.Thomas	Marine Sciences	Sri.D.Raju, Sri.M.Ramesh kumar, Sri.S.Mohanan	2009-10	2.00	0.00
18	Shoreline Management Plan for Kerala	Ministry of Earth Sciences	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian, Dr.T.S.Shahul Hameed, Mrs.Sheela Nair L, Dr.Reji Sreenivas	2008-12	176.63	51.19

Sl. No.	Project Title	Funding Agency	Principal Investigatior	Division	Co-Investigators	Project Period	Total Outlay (Rs.in lakh)	Fund received during the year (Rs.in lakh)
19	Megha Tropiques – Utilization programme.	Space Applications Centre	Dr.G.Mohan Kumar	Atmospheric Sciences	Dr.S.Sampath	2007-10	31.82	0.00
20	Optical characterization of coral reef diversity for understanding the impact of changing environmental conditions	Space Applications Centre	Dr.M.Samsuddin	Central Geomatics Lab	Dr. T. N. Prakash	2009-13	15.00	0.00
21	Physical, chemical & biological monitoring study at dredging site in Vembanad lake	Travancore Chemicals Ltd.	Dr.P.K.Omana	Chemical Sciences		2008-10	1.15	0.29
22	Shore Protection Measures for Lakshadweep Islands	Dept. of Science & Technology, UT, Lakshadweep, GoI	Dr.N.P.Kurian	Marine Sciences	Mrs.Sheela L Nair	2008-10	25.48	
23	River sand Auditing Manimala	Revenue Dept., GoK	Dr.D.Padmalal	Environmental Sciences	Dr.K.Maya, Dr.K.Narendra Babu	2008-09	34.53	0.00
24	Environmental Impact of Reservoir desiltation	Water Resources Dept, GoK	Dr. Srikumar Chattopadhyay	Resources Analysis		2009-10	5.75	5.75
25	Nitrous Oxide and methane in coastal ocean and estuaries	Ministry of Earth Sciences, GoI	Dr. E.J. Zachariah	Atmospheric Sciences		2007-10	18.48	14.18
26	Monitoring of soil moisture under bare cropped conditions of tapioca and pinpple in the mid land highlands of western ghats areas of Kerala	Western Ghat Cell, Kerala State Planning Board	Dr. P.V.S.S.K.Vinayak	Atmospheric Sciences		2009-10	10.25	10.25
27	Rainfall validation & characterization and cloud physics studies using megha tropiques data	Dept. of Space, GoI	Dr.G.Mohan Kumar	Atmospheric Sciences		2007-10	31.8	18.57

5.2 Consultancy Projects

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay (Rs.in lakh)	Fund Received during the year (Rs.in lakh)
1	CRZ Status Report	CISO Institute of Oceanic Studies, Thrissur	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.63	
2	-do-	Adelie Builders & Developers Pvt. Ltd., Ernakulam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
3	-do-	Puravankara Projects Ltd., Kochi	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
4	-do-	Asset Homes Pvt. Ltd., Kannur	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.49	
5	-do-	The Superintendent of Police, Thrissur	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.10	0.10
6	-do-	Indian Oil Corprn. Limited, Kochi	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	4.5	
7	-do-	EQMS India Pvt. Ltd., Delhi	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	3.75	
8	-do-	DLF Limited, Ernakulam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
9	-do-	Puravankara Projects Ltd., Ernakulam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
10	-do-	Centurious Housing & Constructions Pvt. Ltd., Ernakulam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
11	-do-	National Highway Authority of India	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
12	-do-	Architecture Incorporated, Trivandrum	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.98	
13	-do-	Tata Power Company Ltd.	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	6.6	
14	-do-	Nazeer, Karunagappally	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.68	0.68
15	-do-	Dr. Akhtar Hassan Rizvi, Mumbai	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	7.50	
16	-do-	The Superintendent of Police, Kannur	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.10	0.10
17	-do-	MIR Realtors Pvt. Ltd., Kannur	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	1.5
18	-do-	Rajah Islands Ltd., Thrissur	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	2.1	2.1

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay (Rs.in lakh)	Fund Received during the year (Rs.in lakh)
19	-do-	Matsyafed, Thiruvananthapuram	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.62	0.62
20	-do-	Revenue Department, Govt. of Kerala	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10		
21	-do-	Carnoustie Resorts Pvt. Ltd., Mumbai	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
22	-do-	Smile Direct Resort Pvt. Ltd	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.97	
23	-do-	Bhasuram Resorts Pvt. Ltd., Thiruvananthapuram	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.93	
24	-do-	Aquaplast, Ernakulam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.65	
25	-do-	Muthoot Hotel & Infrastructure Ventures Pvt. Ltd., Thiruvananthapuram	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
26	-do-	Technopark, Kollam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.99	0.99
27	-do-	Harbour Engineering Department	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.62	0.62
28	-do-	Greater Cochin Development Authority, Cochin	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	4.05	3.04
29	-do-	NHAI	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	7.5	
30	-do-	Berggruen Hotels Pvt. Ltd., Mumbai	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
31	-do-	M/s Synthite Industries Ltd., Ernakulam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	
32	-do-	M/s goodwill Investment Company Pvt.Ltd.	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.97	0.97
33	-do-	Mundra SEZ Ltd.	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	25.5	0.57
34	-do-	NHAI	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	7.35	
35	-do-	Niyama Ayurvedic Beach Resorts Pvt. Ltd., Thrissur	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	1.5
36	-do-	NHAI- Kasargod-Kannur	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	7.5	7.5
37	-do-	Maharashtra JSW (Ratnagiri) Ltd.	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	6.75	6.75
38	-do-	Apple a day Properties (P) Ltd.	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	2.1	2.1

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay (Rs.in lakh)	Fund Received during the year (Rs.in lakh)
39	-do-	Goshree Islands Development Authority (GIDA), Moolampilly-Chathanad	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.94	1.94
40	-do-	Marari Beach Resorts (P) Ltd., Alappuzha	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	1.5
41	-do-	The Kerala Minerals & Metals Ltd.	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	7.35	7.35
42	-do-	DHI Water & Environment	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	3.45	3.45
43	-do-	Larsen & Toubro Limited, Gujarat	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	6.75	6.75
44	-do-	Ellora/Orchid Infra Developers Pvt.Ltd., Bandra	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	3.67	3.67
45	-do-	Immaculate Conception Church, Kollam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.62	0.62
46	-do-	Mantra Beach Resorts Pvt. Ltd.,Ozhinjavalap, Kasaragod	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	1.5
47	-do-	Tourist Resorts (Kerala) Ltd. Veli	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.62	0.62
48	-do-	Holiday Mantra Hotels & Resorts Private Limited, Alleppey	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.2	1.2
49	-do-	TRIF Kochi Pojects Private Ltd. Ernakulam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.62	0.62
50	-do-	Kuruvi & Kuruvi Hotels Private Ltd., Alleppey	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	1.5
51	-do-	Edava Grama Panchayat	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.5	0.5
52	-do-	Harbour Engineering, Manjeswaram	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.67	0.67
53	-do-	M.Y.Chouhan, Mumbai	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	3.75	3.75
54	-do-	EQMS India Mumbai	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	3.97	3.97
55	-do-	Moosa, Uppala	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.5	1.5
56	-do-	Aegis Logistics	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	3.97	3.97
57	-do-	Madre De Deus Church, Vettucad	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.67	0.67
58	-do-	Harbour Engineering Dept	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	1.95	
59	-do-	Air Travel Enterprises, Bakel	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.15	

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay (Rs.in lakh)	Fund Received during the year (Rs.in lakh)
60	-do-	JNPT BPCL Urban LPGPlant	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	9	
61	-do-	NPCIL Kundankulam	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	4.05	
62	-do-	Pritam Nair	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	7.5	7.5
63	-do-	Indian Rare Earths Ltd	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	4.30	1.95
64	-do-	Kottukal Grama Panchayat	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	0.10	0.10
65	-do-	Indian Garnet Sand Co.Pvt. Ltd.	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2009-10	14.25	14.25
66	CRZ Report for coastal police station at Alappuzha	Police Department	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian	2008-09	0.11	
67	CRZ Report for Marad Police Station	Police Department	Dr.K.V.Thomas	Marine Sciences	Dr.N.P.Kurian,	2008-09	0.10	

5.3 Plan Projects

Project Code	Project Title	Principal Investigator	Division	Co-investigators	Project Period	Total outlay (Rs. in lakh)	Expenditure during the year (Rs. in lakh)
PLAN 211	Creation of digital data bank at CESS	Sri. V. N. Neelakandan	Central Geomatics Lab	Dr. C. M. Harish, Sri. B. K. Jayaprasad	2005-2009	12.10	0.66
PLAN 231	A cadastral level decision support system for management of natural resources in Thiruvananthapuram District	Sri. B. K. Jayaprasad	Central Geomatics Lab	Dr. M. Samsuddin, Sri. John Mathai	2005-2009	59.64	6.46
PLAN 232	State of the Environment and Action Plan for Kochi Urban Area	Dr. C.N. Mohanan	Environmental Sciences	Dr. Ajay Kumar Varma, Dr. M.N.M. Nair, Dr. E.J. Zachariah, Sri. B .K. Jayaprasad Dr. S. Muraleedas Sri. C.K.Sasidharan Sri. K. R. Unnikrishnan Dr. P.V.S.S.K Vinayak	2005-2009	52.12	0.37
PLAN 233	Development of Integrated Coastal Zone Management Plans	Dr. K.V. Thomas	Marine Sciences	Dr. Srikumar Chattopadhyay, Dr. T.N. Prakash	2005-2009	21.95	0.46

List of Projects

Project Code	Project Title	Principal Investigator	Division	Co-investigators	Period	Total outlay (Rs. in lakh)	Expenditure during the year (Rs. in lakh)
PLAN 234	Measurement of cloud parameters and cloud modeling	Dr. S. Muralidas	Atmospheric Sciences	Dr. G. Mohan Kumar	2005-2010	187.37	47.03
PLAN 240	Study of coastal processes and hazards along Kerala coast with particular reference to disaster preparedness	Dr. N.P. Kurian	Marine Sciences	Dr. K.V. Thomas, Dr. T. S. Shahul Hameed, Dr. T.N. Prakash	2005-2009	13.04	0.00
PLAN 241	Geo-spatial survey and assessment of Munnar and adjoining panchayats using modern tools of geomatics	Dr. M. Samsuddin	Central Geomatics Lab	Sri. John Mathai, Sri. V.N. Neelakandan, Sri. B. K. Jayaprasad	2008-2010	51.80	9.18
PLAN 250	Exploring interrelationship between environmental degradation and poverty: selected micro level case studies across Kerala	Dr. Srikumar Chattopadhyay	Resources Analysis	Sri. C. K. Sasidharan, Mrs. C. Sakunthala	2007-2010	24.28	5.78
PLAN 251	Geomorphic setting, landuse alterations and fluvial regime change in the Western Ghats provenance of southern Sahyadri	Dr. Mahamaya Chattopadhyay	Resources Analysis	Mrs. C. Sakunthala	2008-2010	25.06	4.02
PLAN 252	Mapping of coastal cliffs and their vulnerability between Kanyakumari and Mangalore sough west coast of India	Dr. A. S. K. Nair	Marine Sciences	Sri. G. Sankar, Sri. John Paul	2007-2010	06.60	1.14
PLAN 253	Impact of urbanization on soil and water resources of some selected cities Kerala	Dr. K. Narendra Babu	Chemical Sciences	Dr. D. Padmalal, Dr. K. Maya, Dr. K. Raju	2007-2009	3.72	3.04
PLAN 254	Quaternary geology and geomorphic evolution of the coastal lands of Kollam district, SW India	Dr. D. Padmalal	Environmental Sciences	Dr. K. Narendra Babu, Sri. B. Sukumar, Dr. K. Maya	2007-2010	6.84	4.10
PLAN 255	Tropical Freshwater Myristica swams of Kerala and its ecological and evolutionary significance	Dr. C.N. Mohanan	Environmental Sciences	Dr. D.S. Suresh Babu,	2007-2009	3.80	0.97
PLAN 256	Hydrochemical characterization and drinking water potential of the coastal springs of Southern Kerala	Dr. K. Narendra Babu	Chemical Sciences	Dr. D. Padmalal, Dr. K. Maya	2007-2009	1.75	1.07
PLAN 257	Study of urban sprawl – stretch between Kochi and Thrissur Corporations	Ms. Ahalya Sukumar	Resources Analysis	Sri. B. Sukumar	2008-2010	6.61	0.42

Project Code	Project Title	Principal Investigator	Division	Co-investigators	Period	Total outlay (Rs. in lakh)	Expenditure during the year (Rs. in lakh)
PLAN 259	Application of neural network in pattern classification of remotely sensed images	Sri. K. J. Mathew	Atmospheric Sciences		2008-2010	2.20	2.01
PLAN 260	Sunlight-induced multi-spectral fluorescence imaging system for vegetation assessment	Dr. N. Subhash	Atmospheric Sciences	Dr. C.N. Mohanan	2007-2010	14.10	13.40
PLAN 261	Human-induced land modifications and its Impacts: A study in Thodupuzha taluk-Idukki district, Kerala	Dr. K. Raju	Training & Extension	Sri. G. Sankar, Dr. V. Nanda Kumar	2007-2010	2.57	2.34
PLAN 262	Environmental degradation of Muvattupuzha river basin causes, consequences and strategies for river restoration	Dr. K. Maya	Environmental Sciences	Dr. D. Padmalal, Dr. K. Narendra Babu	2007-2009	5.44	2.83
PLAN 263	Solar ultraviolet-B and atmospheric trace constituents in relation to climate change	Dr. G. Mohan Kumar	Atmospheric Sciences		2007-2013	12.28	1.08
PLAN 265	Characterization of laterites of Kerala and preparation of laterite distribution map	Dr. Narayanaswamy	Geosciences		2007-2010	2.09	4.16
PLAN 266	Quaternary evolution of the coastal plains of southern Kerala	Sri. John Paul	Marine Sciences	Dr. A.S.K. Nair, Dr. D.S. Suresh Babu,	2007-2010	4.50	1.49
PLAN 267	Digital resource atlas of Kerala and environment atlas	Sri. B. Sukumar	Resource Analysis	Smt. Ahalya Sukumar Dr. E. Saravanan, Sri. V. Shravan Kumar	2008-2012	21.03	5.67
PLAN 268	Agricultural atlas of Kerala	Dr. E. Saravanan	Training & Extension	Sri. B. Sukumar, Sri. V. Shravan Kumar	2008-2010	27.48	5.94
PLAN 270.	Water, sediment quality monitoring and assessment of estuaries of Kerala: A case study from Kochi estuary and Periyar River	Dr. P.P. Ouseph	Chemical Sciences	Dr. P.K. Omana	2008-2010	4.66	3.28
PLAN 271	The social impacts of energy technologies: two case studies at different environs of Thiruvananthapuram district	Sri. K. Vijayakumar	Atmospheric Sciences		2008-2010	1.77	1.17

List of Projects

Project Code	Project Title	Principal Investigator	Division	Co-investigators	Period	Total outlay (Rs. in lakh)	Expenditure during the year (Rs. in lakh)
PLAN 272	Environmental impact assessment of major settlement distribution patterns and the infrastructural development with an emphasis on drinking water infrastructure facilities in Thiruvananthapuram	Sri. V. Shravankumar	Resources Analysis	Sri. V. Muralidharan	2008-2010	5.05	2.22
PLAN 273	Assessment and monitoring of land quality for sustainable agriculture: A GIS based approach coupled with technology implementation	Sri. B. Sukumar	Resources Analysis	Dr. A.S.K. Nair, Dr. G. Mohan Kumar, Dr. E. Saravanan, Sri. G .Sankar, Dr. P.V.S.S.K Vinayak, Sri.. V. Shravan Kumar, Smt. Ahalya Sukumar, Sri. V. Vasudevan, Sri. K. Vijayakumar, Dr. Ansom Sebastian, Sri. K. J. Mathew, Sri. John Paul.	2008-2010	8.82	9.19
PLAN 274.	Kerala Resources Information System & Services (KRISS)	Sri. V.N. Neelakandan	Central Geomatics Lab	Dr. K. K. Ramachandran, Dr. M. Samsuddin,	2009-2012	-	1.13
PLAN 275	Study of land use/land cover change linked to climatic change in Kerala	Dr. Srikumar Chattopadhyay	Resources Analysis	Dr. P.V.S.S.K Vinayak, Sri. C. K. Sasidharan	2009-2012	-	1.08
PLAN 276	Effect of urbanization on the buildup of urban heat island in Kochi	Dr. E. J Zachariah	Atmospheric Sciences	Dr. P.V.S.S.K Vinayak	2009-2012	-	0.22
PLAN 277	Solar ultraviolet-B radiation and atmospheric trace constituents in relation to climate change	Dr. G. Mohan Kumar	Atmospheric Sciences		2009-2013	-	0.01
PLAN 278	Monitoring climate change impact in Sahyadri	Dr. C. N. Mohanan	Environmental Sciences	Dr. G. Mohankumar, Dr. E. J. Zachariah, Dr. P.V. S.S. K Vinayak, Dr. P. K. Omana, Sri. B. K. Jayaprasad, Dr. K. Raju, Dr. A Krishna Kumar	2009-2012	-	0.60
PLAN 280	Tectonothermal history of the Kerala Khondalite Belt	Dr. V. Nandakumar	Geosciences		2009-2012	11.56	6.32
PLAN 281	Climatological features of Kerala- A Ready Reckner	P.V.S.S.K. Vinayak	Camp Office, Kochi	Smt. Sreekumari Kesavan	2009-2011	2.90	0.01

5.4 R & D Infrastructural Projects

Project Code	Project Title	Co-ordinator	Division	Expenditure during the year (Rs. in lakh)
PLAN 101	XRF Facility	Director Dr. G. R. Ravindra Kumar (SIC)	Geosciences	7.95
PLAN 102	Upgradation of Geosciences laboratories	Head, GSD	Geosciences	5.72
PLAN 103	Strengthening of Ecological laboratory	Head, ESD	Environmental Sciences	1.10
PLAN 104	Upgradation of Atmospheric Sciences laboratories	Head, ASD	Atmospheric Sciences	16.63
PLAN 105	Upgradation of Chemical laboratory	Head, CSD	Chemical Sciences	13.84
PLAN 106	Upgradation of Library facilities	Head, TED	Training & Extension	24.54
PLAN 107	Publication of monographs / memoirs / annual report/newsletter	Director	Publication Committee	1.85
PLAN 108	Upgradation of training / extension /exhibition/LAN and other technical facilities	Head, TED	Training & Extension	2.55
PLAN 110	Seminars/workshops/meetings	Director		4.16
PLAN 111	Marine laboratory infrastructure development	Head, MSD	Marine Sciences	17.69
PLAN 112	Geomatics laboratory infrastructure development	Head, CGL	Central Gemoatics Lab	8.37
PLAN 117	Upgradation & maintenance of CESS LAN	Director Dr. C. M. Harish (SIC)	Central Geomatics Lab	0.00
PLAN 100	Research & Development general expenditure	Director		93.81

5.5 R & D building Infrastructure Projects

Project Code	Project Title	Co-ordinator	Allotment for the Year (Rs.in lakh)	Expenditure during the year (Rs.in lakh)
PLAN 109	Construction of SAF building	Registrar	1.00	0.00
PLAN 119	Recreation facilities at CESS	Secretary, Recreation club	0.30	0.00
PLAN 120	Upgradation of centralized Air Conditioning & facilities of CESS buildings	Registrar	3.05	1.45
PLAN 123	Upgradation/repair and maintenance of toilets	Registrar	2.00	0.00
PLAN 124	Upgradation of EPABX	Registrar	0.80	0.61
PLAN 126	Garden development and landscaping	Dr. C. N. Mohanan	4.50	0.00
PLAN 128	Upgrading electrical installations and facilities	Registrar	36.00	63.99
PLAN 150	Construction of Water tank and modification to the WSS	Registrar	25.00	4.42
PLAN 151	Replacement of damaged cast iron stair case in the administrative building	Registrar	1.50	0.00
PLAN 152	Upgradation of computer facility in the administrative block	Registrar	1.50	0.12
PLAN 153	Upgradation of security area and rooms	Registrar	1.00	0.00
PLAN 154	Upgradation of path way to canteen	Registrar	1.00	0.00
PLAN 155	Upgradation of the canteen	Registrar	4.50	0.02

6 Honours & Awards

6.1 Honours Received

In the Valedictory Session of the National Seminar on Coastal Processes, Resources and Management, held at CESS during 5-7 February 2010,Dr. M. Baba was honoured for his illustrious career and remarkable contributions to institution building by wraping a 'Ponnada' by Dr. T. Radhakrishna, Director-in-Charge, CESS. A special issue of the Conference Proceedings entitled 'Coastal Processes, Resource and Management' published by the Indian Journal

of Geo-Marine Sciences was dedicated to Dr. Baba for his valuable contributions to science and its management.

Mr. S. Arjun, Research Fellow, Marine Sciences Division won the Young Scientist Award during the 22nd Kerala Science Congress held at the Kerala Forest Research Institute, Thrissur for the paper 'Numerical Validation of Kallakkadal-Flooding due to Remote Forcing'. The paper was co-authored by Ms. L. Sheela Nair and Dr. N. P. Kurian, Scientists, CESS.

6.2 Ph.D Awarded

Rupananda Mallia J. has been awarded Ph.D Degree under the Faculty of Science, Cochin University of Science and Technology, Kochi for his research thesis entitled 'Photodignosis of oral malignancy using laser-induced fluorescence and diffuse reflectance spectroscopy'. Dr. N. Subhash, Head, Atmospheric Sciences Division was the supervisor of Dr. Mallia.

Harikumar R, a full time research scholar, who worked under the guidance of Dr. S. Sampath of the Atmospheric Sciences Division has been awarded Ph.D Degree for his thesis entitled 'Study of tropical rain with special reference to rain drop size distribution and integral rain parameters using ground based and satellite measurements', by CUSAT, Kochi.

6.3 Participation in Training Programmes

Dr. K.K. Ramachandran attended the Hyperspectra-2010, a DST short-term course on Emerging trends in remote sensing: Imaging spectroscopy and natural resource mapping held at IIT Bombay during January 12-16, 2010.

6.4 Visits Abroad

Dr. T. Radhakrishna, Head, Geosciences Division and Sri. Balusubramanian, Scientist-in-Charge, Training and Extension Division visited University of Montpelier, France under the Indo-French Centre for the Promotion of Advanced Research (IFCPAR) project during 14 May – 12 June 2009.

On an invitation form ITC Netherlands, Sri.G. Sankar, Scientist, CESS visited the Post Graduate Institute of Sciences (PGIS), University of Peradeniya, Kandy, Sri Lanka from 19 - 30 October 2009 and participated in the Refresher Course on 'Innovative approaches to multi-scale landslide hazard and risk assessment'. The course was organized by the ITC Netherlands in association with United Nations University. The course covered spatial prediction modeling of landslides, knowledge driven landslide susceptibility modeling, Data

driven modeling of landslide susceptibility, evaluating the performance of a landslide, dynamic modeling using PC RASTER etc. A field visit was also conducted in the landslide affected regions of the central province of Sri Lanka.

Sri. C. K. Sasidharan presented a paper entitled 'Ecotourism for inclusive growth: A case study of Ashtamudi lake' in the 13th World Lake Conference held during 1-5, November 2009, in Muhan (China). His presentation was adjudged the best in the session and was given a memento. The conference was jointly organized by the Chinese Society for Environmental Sciences (CSES), Chinese Research Academy of Environmental Sciences (CRAES) and Wuhan Municipality. More than 1000 stakeholders from all over the world attended the conference that presented the latest strategies on lake protection and the sustainable application of these strategies, facilitating the sharing of best practices in the filed.

6.5 Membership in Committees

Dr. M Baba

Member of the Review Committee on the Shoreline Management Programme, Ministry of Earth Sciences, Government of India.

Member of the National Coastal Zone Management Authority constituted by the Ministry of Environment and Forests, Government of India

Dr. N. P. Kurian

Member, Project Management Board, Coastal Engineering Division, National Institute of Ocean Technology

Dr. T. Radhakrishna

MOES Nominee of the Management Board of OASTC at Mangalore University

Member of the Executive Council, Geological Society of India,

Member of the Editorial Board, Indian Association of Geochemists,

Chairman for a session on Earth System Sciences, Kerala Science Congress, Peechi

Member of the Organising Committee of the sixth International dyke conference (IDC 6)

Dr. C.N.Mohanan

Member, Ecological fragile land identification and verification committee, State forest department.

Member, Wetland Technical Unit, and KSCSTE

Sri. G. Sankar

Leader of the expert team constituted by the Government of Kerala to study the impact of natural calamities in the State and to suggest mitigation measures.

Member of the special team for preparing river basin master plan for Chaliyar river, Kozhikode district.

Dr. Srikumar Chattopadhyay

Expert member in the committee constituted for detailed study to start a community College for Specific Vocational Graduate Programme at Nedumkandam under M.G. University.

Dr. K. V. Thomas

Member of Lakshadweep Coastal Zone Management Authority constituted by the Ministry of Environment & Forests, Government of India

6.6 Training Imparted

CESS conducted 'Awareness Training Programmes on CRZ' for the officials of the coastal panchayats of Thiruvananthapuram and Kollam districts on 18 December 2009 at Thiruvananthapuram and for the officials of Alapuzha and Ernakulam districts on 30 December 2009 at Town Hall, Ernakulam.

6.7 Ph. D Students

Student	Topic	Research Guide	University
Abhilash P P	Charcterization of marine pollution along the southern coast of Kerala using the macrobenthic assemblages	Dr. P. P. Ouseph	CUSAT
Anjali R	Study of ambient atmospheric carbon monoxide in the tropics	Dr. G. Mohan Kumar	Kerala
Arjun S	Numerical modelling of tides and coastal flooding	Dr. N. P. Kurian	CUSAT
Arun J John	Tracking the anthropocene in the sedimentary basin of Kerala, SW coast of India	Dr. T. N. Prakash	CUSAT
Balachandran K P	Investigation of the relationship between atmospheric electrical conductivity and meteorological parameters	Dr. S. Muralidas	MG
Dhanya V	Environmental resource management in achancovil river basin- a watershed based approach	Dr. Srikumar Chattopadhyay	Kerala
George Thomas	The development of urban heat island in a tropical coastal city	Dr. E. J Zachariah	Kerala
Jayanthi J L	Laser induced fluorescence imaging for cancer diagnosis	Dr. N. Subhash	Kerala
Prasanth C S	Fluorescence monitoring of periodontal bacteria and treatment of periodontal infections by photodynamic therapy	Dr. N. Subhash	Kerala
Prasanth M	Physico-chemical characteristics and speciation of heavy metals in the selected reservoirs of the periyar river basin: Western Ghats, Kerala	Dr. M. N. M. Nair	CUSAT
Praveen. M N	Geological aspects of the eastern part of betal belt, Central Indian tectonic zone	Dr. G. R Ravindra Kumar	CUSAT
Praveen S S	Numerical modelling of tsunami inundation	Dr. N. P. Kurian	CUSAT
Ranikrishna L	Tropical freshwater myristica swamps of Kerala and its ecological and evolutionery significance	Dr. C. N. Mohanan	Kerala
Shamji V R	Coastal morpho dynamics	Dr. N. P. Kurian	CUSAT
Sreejith C	Evolution of the lower crust in the neo-proterozoic Kerala Kohndalite Belt (KKB) southern India: petrological and geochemical constraints and implications for Gondwana assembly	Dr. G. R. Ravindra Kumar	Kerala
Sreekanth T S	Characterization of tropical rain fall in terms of drop size distribution at surface, its variation with altitude and comparison of rain rates with satellite measurements	Dr. G. Mohan Kumar	Kerala
Sudhanandh V S	Studies on pathogenic enteric bacteria and their seasonal distribution with special reference to public health along the southern Kerala coast	Dr. P. P. Ouseph	Kerala
Tiju I Varghese	Beach and estuarine evolution of Kollam coast during holocene	Dr. T. N. Prakash	CUSAT
Udayakumar P	Distribution of heavy metals in marine environment and its bioaccumulation along central and northern coast of Kerala, India	Dr. P. P. Ouseph	CUSAT
Vandana M	Land system analysis of Kabani river basin	Dr. Srikumar Chattopadhyay	Kerala
Vishnu R	Electrical charcteristics of thunderstorms and lightning	Dr. S. Muralidas	Kerala

6.8 P.G Studentship Programme

CESS supports post graduate students by awarding studentships, to improve research aptitude among students in different areas of Earth Science. During the academic year 2009-10, 42 applications were received from meritorious students from different parts of Kerala and eleven of them were awarded studentship of Rs. 2000/ month during the period of their P.G dissertation work in CESS. The details of students awarded the studentship are given in the table below:

Name of student	Affiliation	University	Topics of Dessertation	Supervisor
Anantha Krishnan R	S. N. College, Chempazhanthy	Kerala	Soil fertility status in different regions of Sreekaryam panchayat; effect of fertilizers and soil characteristics on soil nutrients	Dr. K. Narendra Babu
Anjali S	CUSAT	Cochin	Circulation in Lakshadweep sea	Dr. T. S. Shahul Hammed
Bijimol S	S. N. College, Chempazhanthy	Kerala	Impacts of coconut husk rettingon water and sediment characteristics in Kadinamkulam estuary, Trivandrum district	Dr. P. K. Omana
Brilla Balsam J	University College, Trivandrum	Kerala	Spatial dimension of Cancer disease: a case study of Kerala	Shri. B. K. Jayaprasad
Chirstabel Rose C R	University College, Trivandrum	Kerala	Terrain Evaluation of Amboori grama panchayat	Shri. B. K. Jayaprasad
Dijith K S	S. N. College, Kollam	Kerala	Impacts of Vilappilsala garbage treatment factory leachate over the quality of ground water in Chowaloor region-Trivandrum district	Dr. P. K. Omana
Neena C. Miranda	S.N. College, Kollam	Kerala	Effect of urbanization on the ground water chemistry of a coastal segment of Thiruvananthapuram	Dr. K. Narendra Babu
Reshma K	Govt. College Ksaragod	Kannur	Mass movements in the form of debris flows- A case study in parts of Idukki district	Shri. G. Sankar
Shine A	S. N. College, Chempazhanthy	Kerala	Physico-chemical characteristics of leachate from Vilappilsala garbage treatment plant and its effects on water quality: A case study from an upper stream of Karamana river	Dr. P. K. Omana
Shykha C	M.E.S. College Ponnani	Calicut	Genesis and geochemistry of laterite around Akkulam, Veli, Trivandrum	Dr. Narayanaswamy
Surya R	S.N. College, Kollam	Kerala	Hydrochemical charcterisation of well water of a thickly populated coastal region of Kollam city	Dr. K. Narendra Babu

6.9 M.Sc/B.Tech/M.Tech dissertations

Name of student	Affiliation	University	Topics of Dissertation	Supervisor
Akhila G	Govt. College, Kasaragod	Kannur	Lateritization processes and their relation to the formation of clay deposits at Pudukkai, Nileswaram, Kerala	Dr. Narayana Swamy
Anju S O	S N College, Varkala	Kerala	Variation of phosphorus and iron with organic carbon in surface sediments of Kadinamkulam lake and its controlling effect of textural composition	Dr. K. Narendra Babu
Anoosha S L	S.N. College, Kollam	Kerala	Hydrochemistry and dissolved nutrient flux of Bharathapuzha river, Kerala, India	Dr. D. Padmalal
Arjun J K	M.G.University, Kottayam	MG	In-vitro antibacterial screening of selected folklore Indian medicinal plants against clinically significant human pathogens	Dr. K. Narendra Babu
Arun R	PSNA College of Engineering & Technology	Annamalai	Identification of potential sites for water harvesting structures in Bhavani river basin, Palakkad district, Kerala wing GIS and Remote Sensing	Shri. B. Sukumar
Arun Prasad. K	Madurai Kamaraj University, Tamil Nadu	Madurai Kamaraj	Urbanization and its impact on environment in Ernakulam district with special reference to Kochi town using remote sensing and GIS	Shri. B. Sukumar
Arunima A J Nair	ER& DCI-IT, C-DAC, Trivandrum	C-DAC	Query with Spatial database using NET frame work	Shri. V. N. Neelakandan
Ashitha V C	Environmental Sciences	Kannur	Impact of laterite mining in Keezharakunnu region of Kannapuram Panchayath, Kannur	Dr. C. N. Mohanan
Aswathy S Dharan	S N College, Varkala	Kerala	Relation of organic carbon with phosphorus, iron and textural composition of surface sediments in Paravur lake	Dr. K. Narendra Babu
Athira A U	Department of Earth Sciences	Annamalai	Geology, mineral resources and river morphometry: a few case studies from the coastal lands of Thiruvananthapuram district, Kerala State	Dr. D. Padmalal
Chinchu S V	Department of Earth Sciences	Annamalai	Geology, mineral resources and river morphometry: a few case studies from the coastal lands of Kollam district, Kerala state	Dr. K. Maya
Dawn K R	Annamalai University	Annamalai	Sedimentological analysis of sediment samples	Dr. T. N. Prakash

Name of student	Affiliation	University	Topics of Dissertation	Supervisor
Deeja G B	Department of Earth Sciences	Annamalai	Geology, mineral resources and river morphometry: a few case studies from the coastal lands of Kollam district, Kerala state	Dr. K. Maya
Dhanya C S	S N College, Varkala	Kerala	Chemistry of interstitial water of Vellayani lake and its relation with overlying water	Dr. K. Narendra Babu
Dhanya G	Anna University, Tirunelveli	Annamalai	Study on urban hydrology for Trivandrum city using GIS and Remote sensing	Dr. K.K. Ramachandran
Divya Nair	Madurai Kamaraj University	Madurai Kamaraj	Landuse and landcover changes in Kollam Taluk using GIS and Remote sensing	Shri. B. Sukumar
Eswari. K	Bharathidasan University	Bharathidasan	Shoreline changes and landuse/landcover pattern: Munambam-Chettuva coast, Kerala	Dr. K. V. Thomas
Gopakumar P G	Annamalai University	Annamalai	Sedimentological analysis of sediment samples	Dr. T. N. Prakash
Hiran Nazir K	Annamalai University	Annamalai	Sedimentological analysis of sediment samples	Dr. T. N. Prakash
Jisha. T R	M.E.S. College, Ponnani	Calicut	Environmental impact of sand mining – A case study of Bharathapuzha river from Kuttippuram to Ponnani	Dr. D. Padmalal
Jithendra Dev T C	Central Institute of Fisheries, Nautical and Engineering Training (CIFNET)	CIFNET	Dendrogram model for hierarchical clustering of microalgae assemblages and hydrochemistry, influenced upon the distribution of phytoplanktivorous pelagic commercial fishes along Veli coast, India	Dr. K. Narendra Babu
Juvairiya C V	Environmental Sciences	Kannur	Impact of China clay mining in Madayipara, Kannur	Dr. C. N. Mohanan
Kavitha P	Bharathidasan University, Tamil Nadu	Bharathidasan	Shoreline changes and landuse/landcover pattern: Neendakara-Kayamkulam coast, Kerala	Dr. K. V. Thomas
Lekshmy O	S N College, Varkala	Kerala	Distribution of phosphorus fractions manganese and iron in two depths of surface sediments of Vellayani lake	Dr. K. Narendra Babu
Manukamal M K	S N College, Varkala	Kerala	Relation between major cations and anions in interstitial water and Kadinamkulam lake	Dr. K. Narendra Babu
Midhun P	SN College, Varkala	Kerala	Depth wise variation of nutrients in interstitial water of Paravoor lake	Dr. K. Narendra Babu
Neena S Pillai	S.N. College, Kollam	Kerala	Water quality and dissolved nutrient flux of Chaliyar river basin, Northern Kerala, India	Dr. D. Padmalal

Name of student	Affiliation	University	Topics of Dissertation	Supervisor
Nirosha S	Department of Earth Sciences	Annamalai	Geology, mineral resources and river morphometry: a few case studies from the coastal lands of Kollam district, Kerala state	Dr. K. Maya
Rahul Jayan	Govt. College, Kasaragod	Kannur	Geomorphometry of Chandragiri river with special reference to historical migration of channels and bars	Dr. K.K. Ramachandran
Rani G D	Department of Earth Sciences	Annamalai	Geology, mineral resources and river morphometry: a few case studies from the coastal lands of Kollam district, Kerala state	Dr. K. Maya
Raseela. A.	M.E.S. College, Ponnani	Calicut	Environmental impact of sand mining – A case study of Bharathapuzha river from Pattambi to Kuttippuram	Dr. D. Padmalal
Regil R	PSNA College of Engineering & Technology	Annamalai	Land suitability analysis for sustainable agriculture in Anjarakandi river baisn , Kannur district Kerala using Remote Sensing and GIS	Shri. B. Sukumar
Reshma K	Govt. College, Kasaragod	Kannur	Land degradation in the high land region of Kerala- A case study in the Udumbannoor Panchayat, Thodupuzha taulk, Idukki	Shri. G. Sankar
Reshma R	Govt. College, Kasaragod	Kannur	Mass movements in the form of debris flows- A case study in parts of Idukki district	Shri. G. Sankar
Sandhya S	Madurai Kamarai University	Madurai Kamaraj	Landuse and landcover changes in KottarakaraTaluk using GIS and Remote sensing	Shri. B. Sukumar
Shamila Arulakath	Environmental Sciences	Kannur	Environmental impact of super thermal power plant at Chennai	Dr. C. N. Mohanan

7 Library

7.1 Library

CESS library plays a crucial role in facilitating research by making available the latest books and journals. It is considered as the one of the good libraries in the field of Earth Sciences and related subjects. Collection building is one of the important functions of the Library that support the academic and research activities of the Centre.

Comprehensive collection in the Library consist of books, journals, back volumes, CDs, VCDs, CD ROM Database, Maps, Atlas, Theses, Project Reports, reference books, annual reports etc. Besides the scientific community here, this Library is used by other R&D Centers and Universities.

During this year, 42 books were and added to the collection. Four new International journals and three Indian journals were subscribed to enrich the collection. In addition to this, many journals are being received as gratis. Library actively engages in creation of digital contents. The Digital Content of the library includes electronic journal article, VCD films, CD ROM Data base, Conference Proceedings etc. The CD ROM Database GEOBASE published by Elsevier contains abstracts of articles spanning from 1994-2005.

Library offers reference service, literature search, library membership, reprint service, press clipping service and document delivery service

to users. An e-mail alert is sent to the scientists who request new arrival of books and publications related to their fields. Besides, the library also provides facility for internet browsing. In addition, it offers current awareness service show casing the list of new additions, display of CESS publications, useful article display, fellowship information, forthcoming Conferences, Seminars etc. in its premises.

Library has taken institutional Membership in various reputed libraries to enable users to visit such libraries and use the resources available there.

The Library is using the software SOUL, which is an integrated multiuser Library Management System that supports all inhouse operations of the library. The software has different modules like Acquisition, Catalogue, Circulation, Serial Control, OPAC and Administration. Bibliographic records of books available in the library can now be accessed through this OPAC module. Search can be done by using different access point like title, author, accession number, subjects, ISBN, publisher, class number etc. The database of books is being updated on a day to day basis with details of recently acquired books. Details of all inhouse project reports in the library are also included in the database. Books are arranged according to the subject and DDC schemes has been followed.

Dr. G. Mohankumar
Scientist-in-Charge

8 Publications

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9 Conference, Seminar, Workshop

9.1 CESS Releases District Level Multi Hazard Zonation Maps

CESS released the district level multi hazard zonation maps for the entire Kerala and made available the hard copy and digital version to all the user departments in the State. The maps were released by Sri. K. P. Rajendran, Hon'ble Minister for Revenue on 25 August 2009 by handing over the copies to Dr. Nivedita P. Haran, Principal Secretary (Revenue), Government of Kerala at a function presided over by

Sri. K. P. Rajendran, Hon'ble Minister for Revenue, Government of Kerala, addressing the gathering during the release of the district level Hazard Zonation Maps and the inauguration of the National workshop on 'Natural Hazards, Disaster Mitigation and Management on 25th August 2009 at CESS

Sri. M. Vijayakumar, Hon'ble Minister for Law, Government of Kerala. The State being multi-hazard prone, the zonation maps at the district level is the first step in crisis management. Spatal distribution of hazard prone areas indicated in the maps will help the planners in preparing the Disaster Management Plans at the State and district levels. The Hon'ble Minister for Revenue inaugurated the two day 'National workshop on natural hazards, disaster mitigation and management' organized on the occasion. The Hon'ble Minister for Law released the proceedings volume of the workshop and inaugurated the exhibition on research activities of CESS related to disaster management. The function was followed by the technical sessions of the workshop. The workshop was attended by the all the key functionaries of the government of Kerala related to disaster management, officials from the district administration involved in the preparation of disaster management plans, representatives of various NGOs, research scholars and students from universities, scientists from research organizations etc.

Sri. K. P. Rajendran, Hon'ble Minister for Revenue, Kerala releasing the hazard zonation map by handing over a copy to Dr. Nivedita P Haran, Principlal Secretary Revenue, Govt. of Kerala. Sri. M. Vijayakumar, Hon'ble Minister for Law and Dr. M. Baba, Director, CESS are also seen.

Twenty three research papers were presented including keynote presentations by Dr. A. D. Rao, IIT, Delhi and Dr. P. V. Joseph, Emiratus Professor, Cochin University of Science and Technology. The team of scientists from CESS who developed the hazard zonation maps made presentation for the benefit of the users.

9.2 Climate Change: CESS initiates integrated multi-institutional regional study

Climate change, especially the changes since the last 100 years for which recorded data are available, and its possible implications on human civilization more particularly on food security, fresh water availability, livelihood of forest dwellers, human health, sea level rise and vulnerability of coastal settlements and biodiversity and

Dr. E. P Yesodharan Executive Vice-President, KSCSTE delivering the inaugural address of the 'Panel Discussion on Climate Change'. Dr. M. Baba, Director, CESS and Dr. R. V. G. Menon, eminent Scientist and social activist who presided over the function are also seen

natural ecosystem are subject matters of serious concern. Intergovernmental Panel on Climate Change (IPCC) in its fourth synthesis report observed "warming of the climate system is unequivocal as it is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level". Adaptation to climate related changes, reduction in vulnerability, mitigation of underlaying causes like production of green house gases and remediation are significant strategic issues.

With its sub-continental dimension, India has many climatic zones with multiple modifying factors. It is therefore necessary to embark upon regional level studies to understand the nature of climate change, its fallout and to develop area specific adaptation and mitigation strategies. Climate induced changes will affect Kerala's physical configuration, trigger rehabilitation problem in the densely populated coastal stretches, alter the nature and distribution of natural resources in all forms (rain, surface water, soil moisture and ground water), induce ecological stress, modify plant growth, affect agricultural productivity and human health.

Realising importance of the topic and at the behest of Research Council, CESS formed a core group with the Director as the coordinator and initiated the process of formulating climate change project. After several rounds of discussion it was resolved to take up the climate change project with the vision (i) to prepare a comprehensive regional data base on climate change, (ii) to examine the global models and to apply them in regional context, (iii) to provide required technical inputs for policy formulation and (iv) to suggest necessary guidelines for mitigation.

CESS proposed a transect for the study covering central Kerala and extending over the sea up to the Lakshadweep islands. However, at present the Kerala part is being taken up for the study. It streches from Achankovil basin in the south to the southern boundary of the Bharathapuzha basin. The river basins proposed to be covered are Achankovil, Pamba, Manimala, Meenachil, Muvatupuzha, Periyar, Chalakudi and east flowing Pambar. Around 15,000 sq.km area will be covered. As many as 16 projects undertaken by CESS, completed or ongoing are related to this area and also have components of climate change. As a fresh initiative, CESS has initiated four projects viz, (i) Study on land use/land cover change, (ii) Effect of urbanization on the buildup of urban heat island in Kochi, (iii) Solar ultraviolet-B radiation and atmospheric trace constituent in relation to climate change and (iv) Monitoring global change impacts in Sahyadri mountain ranges.

These projects are being taken up in a mission mode in consonance with the Government of India mission on "Strategic Knowledge for Climate Change" which has long range implications on nation's

A view from the Panel Discussion on Climate Change

development. As envisaged by the IPCC our projects will strive to study (i) science of climate change-scientific investigation, understanding the processes, modeling, projections etc, (ii) impacts, vulnerability and adaptation to climate change at the area level and community level and (iii) mitigation and policies- from the State Government to local bodies.

The study frame intends to address four issues: (i) Is climate change taking place in Kerala? What are the nature, magnitude and manifestation? (ii) How are these changes taking place? What are the drivers of change? (iii) What are the impact of these changes on society, economy and human well being? and (iv) How can the present practices be oriented to address the emerging issues? Preliminary analysis of rainfall data indicate decreasing trend of rainfall in some parts of the State.

CESS identified several gaps in the existing studies and felt that additional expertise was required to address some of the components in the gap areas. Two inter-institutional meetings were held on 8th and 25th May, 2009 with experts from CWRDM, KFRI, TBGRI, Kerala Agricultural University, CUSAT, MG University and Centre for Development Studies. A steering committee was formed to coordinate the activities. Finally a panel discussion was held on 9 June, 2009 in which the outline of the project on 'Integrated Regional Studies on Climate Change in the Western Ghat-Lakshadweep Transect' was presented. Presentations were made by other Institutes in Kerala, the National Institute of Oceanography (NIO), Goa and the Indian Institute of Tropical Meteorology, Pune. Panelists drawn from all major institutes raised various issues ranging from study components, economic implication to modalities of data dissemination etc. Drawing from the discussion and with the inputs from other institutes, CESS is now formulating a multi-institutional and multidisciplinary project on climate change.

9.3 National Conference on Coastal Processes, Resources and Management

The National Conference on Coastal Processes, Resources and Management was organized at the Centre for Earth Science Studies during 5-7th February 2010 to provide a platform for sharing of scientific knowledge, information and experience among the various groups/agencies directly or indirectly involved with the coast. This Conference was conducted on the line of the International Coastal Symposium and was sponsored by the Ministry of Earth Sciences and Department of Science & Technology, Govt. of India; Kerala State Council for Science, Technology & Environment and co-sponsored by a host of other agencies. The conference had an overwhelming response from professionals who are working towards solving various coastal problems from across the length and breadth of the country. Nearly 200 delegates participated in the deliberation.

Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, Government of India, delivering Keynote address during the inaugural session of the National Conference on Coastal Processes, Resources and Management. Dr.Anjan Chaki, Director, Atomic Minerals Division, Department of Atomic Energy, Government of India, Dr. E.P. Yasodharan, Executive Vice President, KSCSTE , Dr. T. Radhakrishna, Director-in-Charge and Dr. N.P Kurian, Organizing Secretary are also seen.

The Conference was inaugurated by Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, Government of India. In his keynote address Dr.Nayak dealt with the problems affecting the vast coastline of the country. He emphasized that detailed studies are essential to remove the uncertainties in understanding coastal processes. Dr.Anjan Chaki, Director, Atomic Minerals Division, Department of Atomic Energy, Government of India offered felicitations. The inaugural session was followed by 21 Technical Sessions that covered eight themes: Coastal Hydrodynamics, Coastal Resources, Coastal Geology and Geomorphology, Coastal Resources, Coastal Hazards and Pollution, Modeling and Monitoring, Coastal Zone Management and Coastal Engineering. As many as 29 invited papers were presented by leading scientists from premier institutions of the country such as Indian Institutes of Technology (Delhi, Madras, Kharagpur, Bombay), National Institute of Oceanography (NIO), Indian National Centre for Ocean Information System (INCOIS), Naval Physical and Oceanographic Laboratory (NPOL), Central Water and Power Research Station (CWPRS), National Institute of Ocean Technology (NIOT) and Goa University. In addition, 71 contributed papers covering all the conference themes were also presented.

The valedictory session of the conference was held in the afternoon of 7th February, presided over by Dr. T. Radhakrishna, Director-in-charge, CESS and attended among others by Dr. M. Sudhakar, Advisor, Ministry of Earth Sciences and Dr. M. Prithviraj, Director, Department of Science & Technology. A report on the proceedings of the Conference was presented by Dr. T. N. Prakash, Secretary (Technical). The Conference was rated high by all those who spoke including representatives from the audience. Dr. N. P. Kurian, Organizing Secretary mooted the proposal that the national coastal conference should become a regular event in the lines of the International Coastal Symposium. It was well received by the audience and Dr. Ramesh Kumar, Scientist, NIO announced that the they would be hosting the next Conference at Goa. Rich tributes were paid to Dr. Baba (on the occasion of his superannuation from service) for his three decade long contributions to coastal science. The Valedictory Session was followed by a field visit to Kovalam beach near Trivandrum where the first Artificial Surf Reef in the country was being built.

The Conference was a big success in that it provided an opportunity for nearly 200 delegates from the length and breadth of the country to interact with one another. The Conference provided a rare forum for the youngsters to get exposed to the emerging areas of research in coastal science through 29 invited papers from leading scientists of the country. The conference witnessed the reporting of some of the latest contributions in coastal processes including research methodologies. There were important contributions

A view of the delegates of the National Conference on Coastal Processes, Resources and Management

in the field of coastal resources like the finding of huge offshore sand reserve by GSI. Methods for mitigation of coastal erosion/ hazards and management of the vast coastal zone of the country were topics that received due importance in the conference. It is hoped that the coastal conferences will accelerate the R&D efforts within the country on coastal issues, provide regular platform for interaction of various stakeholders and ensure sustainability in coastal use.

9.4 Workshop on Land Quality and Sustainable Agriculture

CESS initiated a project entitled "Assessment and monitoring of

Additional District Collector, Kannur ,Sri.Sudheer Babu inaugurating the Workshop on Assessment and Monitoring of Land Quality for Sustainable Agriculture in Kannur district: A GIS Based Approach Coupled with Technology Implementation. Dr. T. Radhakrishna, Director in Charge, CESS, Sri. B. Sukumar and Sri. V. Vasudevan, Scientists, CESS are also seen.

Land quality for sustainable agriculture in Kannur district: A GIS based approach coupled with technology implementation". It is a multidisciplinary project initiated by the involvement of scientists from different disciplines on experimental basis in Kannur district.

A half day user interaction workshop was conducted in the Collectorate conference hall, Kannur district on 19th January 2010. Director-in-charge and the investigating scientists of the project from the Centre, representatives from farmers of the district, NGO's and officials from various line departments participated in the workshop. Additional District Collector, Sri. Sudheer Babu inaugurated the workshop and presided over the workshop. The details of the project and the maps prepared by the project team were presented before the participants. An interactive session was conducted to take note of suggestions.

9.5 Invited Lectures

Dr. M. Baba

Delivered a talk on 'New trends in coastal engineering' in the National Workshop on 'Recent Trends in River and Coastal Protection Works' organized by Indian Society for Hydraulics on 11th June 2009 at CWRPS, Pune.

Presented the Lead Paper titled Coastal Zone Mangement - a myth or reality? in the National Conference on Coastal Processes, Resources and Management held at the Centre for Earth Science Studies during 5-7th February 2010.

Dr. N. P. Kurian

Delivered a keynote address in the function organized by the Department of Science and Technology, Union Territory of Lakshawdeep in the seminar in connection with the Science Day on 17th March 2010 at Kavarati

Delivered a talk on 'Tsunami wave propagation in the Arabian Sea and its effect on run-up/inundation characteristics along the south west coast of India' in the National Conference on Coastal Processes, Resources and Management held at the Centre for Earth Science Studies during 5-7 February 2010.

Sri. John Mathai

Delivered a talk on 'Rainwater harvesting and ground water recharge in Kerala- some experiences' in the Training course on Traditional water harvesting organized by National Institute of Rural Development at SIRD, Kottarakkara.

Delivered a talk on 'Environmental disasters' in the Training Programme on Disaster Management for Engineers, at Highway Research Institute on 30th October, 2009.

Delivered a talk on 'Natural Hazard zonation maps of Kerala' in the workshop on Landslides and Development of early warning systems organized by ISRO and Amritha Institute of Science and Technology in September 2009

Dr. K.K.Ramachandran

Delivered a lecture on High Resolution Images in Urban Mapping on 18th November 2009 at College of Engineering Trivandrum in connection with the short term course 'Remote Sensing Application in Civil Engineering'.

Delivered a lecture on Application of Remote Sensing and GIS with special reference to Urban Planning and Development on 7th March 2010 in the technical session on Geospatial Applications in connection with Conseintia-2010 organised by Indian Institute of Space Science and Technology, Trivandrum

Dr. N Subhash

Delivered a talk on 'Autofluorescence and diffuse refectance spectroscopy for inviro evaluation of oral malignancies' in the Indo-French Workshop on Biomedical Applications at Mumbai on February 14, 2010.

Dr. E. J. Zachariah

Delivered a talk on 'Methane Emissions from Wetlands in Kerala' at the National Symposium on Impact of Climate Change on Aquatic Ecosystems at CUSAT, Kochi.

Dr. C. P. Rajendran

Delivered a talk on ' Exploring the coastal geology for past tsunamis: A global excursion with focus on the Bay of Bengal shores' in the National Conference on Coastal Processes, Resources and Management held at the Centre for Earth Science Studies during 5-7 February 2010.

Dr. Ajayakumar Varma

Delivered a lecture on 'Critical Environmental Factors for Impact Assessment of Development Projects in Coral Islands Terrain' in the National Conference on Coastal Processes, Resources and Management held at the Centre for Earth Science Studies during 5-7 February 2010.

Dr. Srikumar Chattopadhyay

Delivered a lecture on'Geomorphology for Integrated Coastal Zone Management: A Theoretical Approach with Examples from Kerala' in the National Conference on Coastal Processes, Resources and Management held at the Centre for Earth Science Studies during 5-7th February 2010.

Dr. K. V. Thomas

Delivered a lecture on 'High Tide Line and morphological signatures for Coastal Regulation Zone' in the National Conference on Coastal Processes, Resources and Management held at the Centre for Earth Science Studies during 5-7 February 2010.

Dr. G.R.Ravindra Kumar

Delivered a lecture on 'Tracing the source to sink link in the development of placer deposits of Southern Kerala: Constraints from chemistry of Garnets' in the National Conference on Coastal Processes, Resources and Management held at the Centre for Earth Science Studies during 5-7 February 2010.

9.6 Conference / Workshop / Symposium / Seminar

Name	Conference/Symposium/Seminar	Title of the Paper
Dr. M. Baba, Dr. K. V. Thomas	Workshop organized by Ministry of Environment and Forest, ENVIS and the Kerala State Council for Science Technology and Environment at Munnar during 2-3 April 2009	Coastal Regulation Zone
Dr. R. S. Baiju	Young Environmental Researchers Conference conducted by CWRDM, Kozhikode	Hydrochemical characterization of the Unique spring resources of Coastal southern Kerala: An integrated environmental approach
Dr. N. P. Kurian, Dr. K. V. Thomas	Indo Brazilian Workshop organised by ICMAM at Chennai during 23-25 March 2010	Shoreline Management Plan for a critically eroding sector of the Southwest Coast of India Morphological changes due to coastal structures along the southwest coast of India
Sri. K. J. Mathew	IGU Convention, Dehradun, 2009.	Application of Artificial neural network (ANN) in pattern classification of Remotely Sensed Data
Dr. G. Mohan Kumar, Smt. Anjali R	Kerala Science Congress at Kollam, during January 28-31, 2009	Atmospheric carbon monoxide pattern and its local enhancement during biomass burning events
Dr. G. Mohan Kumar, Dr. S. Muralidas, Sri. R.Vishnu	AGU Chapman Conference on Complexity and Extreme Events in Geosciences, organised by National Geophysical Research Institute, Hyderabad, India during 15-19 February 2010.	Investigations into cause of high lightning incidence and accidents by it in a region with relatively special characteristics
Dr. G. Mohan Kumar, Smt. Anjali R, Sri. Sujith P.S.	National Space Science Symposium at Rajkot, Gujarat, during February 24-28, 2010	Vertical distribution of carbon monoxide in the tropical troposphere
Sri. G. Sankar	Orientation Programme for the Hon'ble Judges of Kerala High Court organized by the Kerala Judicial Academy during 11-13 September 2009	Landslides of Kerala at Munnar
Sri. B. Sukumar	National Workshop on Natural hazards, disaster mitigation management held in CESS during 25-26 August 2009	Need for mapping agriculturally drought prone areas in Kerala.
Sri. V Shravankumar	National seminar conducted by the Department of Environmental Sciences, University of Kerala during 8-9 October 2009	Impact of climate change on drinking water sources in Thiruvananthapuram district, Kerala

Name	Conference/Symposium/Seminar	Title of the Paper
Sri. B. Sukumar	Annual Conference of Maritime History Society at Mumbai during 8-9 October, 2009	Historical and geomorphological evolution of Korkai in Tamil Nadu.
Sri. B. Sukumar, Smt. Ahalya Sukumar, Smt. Diji V, Smt. Jyothirmayi P, Smt. Divya U M, Smt. Deepthi P, Smt. Savitha Vijayan, Sri. Sulfikkar M	International Conference on Disaster Management and Mitigation ICDMMM-2009 during 16-18 December, 2009 at PSNA college, Dindigal	Application of Geomatics in Disaster Management and Mitigation. Urban flooding and Mitigation in Kozhikode town: a GIS base approach. Mitigation and Management of hazard prone areas- Valapattanam River Basin, Kannur District, Kerala using Geospatial tools. Mitigation measures for agricultural drought prone areas in Palakkad District, Kerala using Satellite imagery and GIS. Mitigation and Management of Landslide prone areas in Iritty blocks of Kannur District, Kerala using GIS and Remote Sensing.
Ms. Anu Baburaj	National Conference on Coastal Processes, Resources and Management held at the Centre for Earth Science Studies during 5-7 February 2010	Fluorescence Spectroscopy in Monitoring of Reef Health and Composition
Sri. B. Sukumar, Smt. Ahalya Sukumar, Smt. P. Deepthi, Smt. Savitha Vijayan, Sri. M. Sulfikkar, Smt. V. Diji	XXX INCA International Congress organized by SOI at Dehra Dun during November 10-12, 2010	Morphometric analysis of Chandragiri River Basin of Kasaragod district, Kerala using digital cartography and GIS. Anaysis of Urban growth pattern of Kollam Town using remote sensing and GIS. Prospects and problems of Agriculture in Kattampally Puzha Basin in Kannur district, Kerala: a study using GIS and remote sensing. Identification and delination of suitable sites for water conservation in Kuppam River Basin, Kannur district, Kerala. Delineation of ground water potential zones in Thalassery River Basin in Kannur district of Kerala using GIS and Remote sensing.

Name	Conference/Symposium/Seminar	Title of the Paper
Sri. B. Sukumar Sri. M Prasanth Smt.Savitha Vijayan Smt. V. Diji V	National Seminar on Trends in Geospatial analysis for Resource and Environmental management organized by the School of Earth and Atmospheric Sciences at Madurai Kamaraj University during 29-30 March 2009	Geospatial analysis: A few examples from the studies in Kerala State Mapping Geochemical properties in the Northern part of Kannur District, Kerala Integrated Remote sensing and GIS based approach for assessing ground water potential in Kattampally River basin, Kannur district, Kerala Geospatial analysis of Hazard prone areas Panchayat wise in Kozhikode district, Kerala
Sri. B. Sukumar	International Workshop on Geomorphological hazards at Kaniyakumari organised by IAG. Working Group on Geomorphological Hazarads(IAGEOMHAZ)and the Centre for Geotechnology, Manomaniam Sundaranar University, Thirunelveli.	Geomorphic hazards due to anthropogenic process – A study between Thrissur and Ernakulam districts of Kerala Hazard zonation mapping Valapattanam River basin in Kannur district of Kerala using GIS and Remote sensing
Dr. M .N. Muraleedharan Nair	-do-	Salinity Criterion for Determining the Influence of Tidal Action in Rivers and Backwaters (for Coastal Regulation Zone)
Sri. B. Sukumar	-do-	A study of demographic aspects along Kerala coast
Smt. Jyothirmayi P	-do-	Mitigation and management of agricultural drought prone area in Kannur district, Kerala using GIS
Sri. K. O Badarees	-do-	Coastal Regulation Zone and Urban Development
Sri. V. Noujas	-do-	Numerical wave height distribution off a medium energy coast in Southern Kerala
Sri. V. Shravan Kumar	-do-	Drinking Water Resource Development Management along the Coastal Regions of Thiruvananthapuram District, in the Light of Changing Environmental and Economic Developmental Scenario

Name	Conference/Symposium/Seminar	Title of the Paper
Dr. K. K. Ramachandran	National Conference on Coastal Processes, Resources and Management held in CESS during 5-7 February 2010	Geoinformatics approach for extraction of multi-temporal vector coastlines along the Kerala coast
Dr. Srikumar Chattopadhyay	-do-	Flood management: Mitigation and adaptation lessons from Kerala
Dr. T. N. Prakash	-do-	Resuspension and Enrichment of Placer Minerals During Monsoon, SW Coast of India
Dr. Srikumar Chattopadhyay	-do-	Geomorphology for Integrated Coastal Zone Management: A theoretical approach with Examples from Kerala, India
Dr. S. Muralidas	-do-	Lightning Hazard in Kerala, a Special case
Ms. L. Sheela Nair	-do-	Numerical Model Simulation of Coastal Processes and Shoreline Changes along Alappad Coast in Kerala
Ms. G.L. Lekha	-do-	Chemistry of interstitial water and its impact on overlying water: a case study of Paravur Lake sediment, West Coast of India
Sri. L.G. Sarath,	-do-	Beach and sediment characteristics within sediment cells along the southwest coast of Kerala.
Mr. S. Arjun	-do-	Numerical Modelling of the Effects of Remote Forcing on Nearshore Coastal Processes
R. Shibu, J	-do-	Biological Productivity of Kavaratti Lagoon-Macrophytes versus Micro Algae
Dr. T.N. Prakash	-do-	Numerical Modelling for Reconstruction of Reef at Kavaratti Island, Lakshadweep Archipelagio

10.1 Earth Day 2009

CESS observed Earth Day 2009 on 22nd April with the theme 'Green Generation'-the focal theme of the World Earth Day 2009. Students from Schools in and around the Thiruvananthapuram city, numbering around 300 along with their teachers visited CESS. The laboratories were kept open for them and scientists interacted with the students. Another attraction of the day was a painting using a single canvas on the topic 'Green Earth'('Haritha Bhoomi'). About 80 painters, young and old, participated in the event. The "Gurukulam" programme in the open air conducted by the senior scientists for more than an hour was a great opportunity for the students to interact with them. An Earth science centric quiz competition was also conducted for students and the winners were given trophies and certificates of merit. The quiz competition was followed by a lecture on 'Remote sensing and GIS application'. Dr. M. Baba, Director, CESS gave away the prizes to winners of competition.

Earth Day 2009: Students interact with scientists, participate in competitions and the winners given certificates and trophies.

Scientists and Technical persons explain the activities of the different Divisions and laboratories in CESS

Scenes from the painting competition held during Earth Day 2009

10.2 Awareness Programme on Coastal Regulation Zone

One day awareness training programme on Coastal Regulation Zone was organized for the officials of Local Self Governments in Kasargod and Kannur districts at Kannur on 18th January, 2010. The training for the officials belonging to Kozhikode, Malappuram and Thrissur districts was held at Kerala Institute of Local Administration, Thrissur on 20th January 2010. The programme for officials of Ernakulam, Alappuzha, Kollam and Thiruvananthapuram districts was conducted at CESS Campus on 18th December 2009.

Dr. M. Baba, Director, CESS addressing the participants of the training programme

10.3 Exhibition

CESS participated in the Science and Technology Exhibition, 'Swasraya Bharat-09' organized by the Swadeshi Science Movement at Ernakulam during 12-16 June 2009

CESS participated in the exhibition conducted in connection with 'Aavishkar 09' at College of Engineering, Trivandrum as part of its 70th anniversary celebrations during 10-13 September 2009

CESS participated in the exhibition organized to commemorate the contributions of Dr. C. V. Raman at the Sree Narayana Central School, Nedungolam, Kollam during 19-21 November 2009

CESS participated in the exhibition conducted as part of "Wildlife Week Celebration-2009" public awareness forest fair organized by the Forest Department, GoK, during 02-08 October 2009 at Ernakulam.

CESS participated in the All India Co-operative Exhibition at Kanakkakunnu Palace, Thiruvananthapuram during 30th November -9th December 2009

CESS participated in the Kerala Science Congress Exhibition held at KFRI, Peechi during 28-31 January 2010.

10.4 Earth Science Forum Lecture

Prof. M. Santhosh, Department of Natural Environmental Science, Faculty of Science, Kochi University, Kochi, Japan delivered a talk on 'The Evolving Earth'.

10.5 Radio talks

All India Radio broadcasted a talk by Sri. G. Sankar, Scientist on the 'Influence of land use on the occurrence of landslides'.

10.6 Popular Article

A popular article titled 'Urban Climate and Urban Forestry' written by Dr. E.J. Zachariah was published in 'Aranyam' Vol.23 (11) pp. 12-13,June 2009, a Malayalam News letter of the Kerala Forests and Wildlife Department.

10.7 Other Activities

10.7.1 Sports Day

CESS Recreation club celebrated Sports Day on 24th April 2009 at the Loyola School grounds, Sreekariam. All the staff members including project personnel and students particpated in the event.

10.7.2 Onam Celebration

All members of the CESS family participated in the celebration of the Onam festival with traditional gaiety and fervor on 28th August 2009. *'Athappokkalam'* competition, *'Puli Kali'* and enactment of the visit of *'Mahabali'* were the highlights among the various entertainment programmes. Variety of dances, skits, songs etc. added to the charm of this cultural evening organised by the CESS Recreation Club

10.7.3 Christmas and New Year Celebrations

CESS Recreation Club, as in the previous years, celebrated Christmas and New Year Eve on the last working day of 2009. Distribution of sweets and prizes to children and staff members by 'Santa Claus', variety entertainment programmes by children, enactment of dramas and skits etc. created cheerful atmosphere to welcome the New Year 2009

11 Committees

11.1 Statutory Committees

11.1.1 Research Council

Dr. Shailesh R Nayak Director Indian National Centre for Ocean Information Services, Hyderabad	Chairman
Dr. Prithvish Nag Director, National Atlas & Thematic Mapping Organisation Kolkatta	Member
Prof. V. Sundar Head, Department of Ocean Engineering, IIT, Madras	Member
Dr. V. S. Hegde Deputy Director ISRO, Headquarters, Bangalore	Member
Dr. P. V. Joseph Visiting Professor Cochin University of Science & Technology, Kochi	Member
Dr. V. Prasannakumar Head, Department of Geology University of Kerala, Thiruvananthapuram	Member
Dr. M. Baba Director Centre for Earth Science Studies Thiruvananthapuram	Ex-Officio Covenor

11.1.2 Management Committee

Dr. M. Baba Director Centre for Earth Science Studies Thiruvananthapuram	Chairman
The Director Centre for Water Resources Development & Management, Kunnamangalam, Kozhikode	Member
Sri. G. P. Ramachandran Additional Secretary General Administration Department Government of Kerala	Member
Dr. T. Radhakrishna Head, G S D Centre for Earth Science Studies Thiruvananthapuram	Member
The Controller of Administration Kerala State Council for Science, Technology & Environment Thiruvananthapuram	Member
Sri. P. Sudeep Registrar Centre for Earth Science Studies Thiruvananthapuram	Member Convener

11.2 Internal Committees

11.2.1 Heads of Divisions

Dr. M. Baba Director	Chairman
Dr. N. Subhash Atmospheric Sciences Division	Member
Sri. G. K. Suchindan Training & Extension Division	Member
Dr. N. P. Kurian Marine Sciences Division	Member
Dr. K. Soman Resources Analysis Division	Member
Dr. P. P. Ouseph Chemical Sciences Division	Member
Dr. T. Radhakrishna Geosciences Division	Member
Dr. M. Samsuddin SIC, Geomatics Laboratory	Member
Sri. C. N. Mohanan SIC, Environmental Sciences Division	Member
Sri. P. Sudeep Registrar	Member
Sri. C. K. Sasidharan SIC, Technical Cell	Convenor

11.2.2 Editorial

Dr. N. Subhash	Chairman
Dr. G. R. Ravindra Kumar	Member
Sri. Abdunnasar	Member
Sri. S. Sidharthan	Convenor

11.2.3 Purchase

Dr. N. P. Kurian	Chairman
Sri. V. N Neelakandan	Member
Sri. P. Sudeep	Member

11.2.4 Library Management

Director	Chairman
All Heads of Divisions	Members
Deputy Registrar, Accounts	Member
SIC, Technical Cell	Convenor

11.2.5 Library Stock Verification

Sri. G. Sankar	Chairman
Sri. John Paul	Member
Sri. Rajesh	Member
Sri. K. Eldhose	Member

11.2.6 Canteen

Sri. V. Vasudevan	Chairman
Dr. K. K. Ramachandran	Member
Dr. K. Maya	Member
Smt. Femi R Sreenivasan	Member
Sri. Rajesh	Convenor

11.2.7 Plan Project Evaluation & Monitoring

Dr. S. Chattopadhyay	Chairman
Sri. John Mathai	Member
Dr. K. V. Thomas	Member
Dr. K. Narendra Babu	Member
Dr. M. Samsuddin	Member
Sri. G. Balasubramonian	Member
Dr. G. Mohankumar	Member
Sri. C. K.Sasidharan	Convenor

12 Staff Details

12.1 Director's Office

Dr. M. Baba	Director
Sri. N. Rajasekharan Nair	P. A to Director
Sri. C. K. Sasidharan	Scientist-E1 & SiC, TC
Sri. S. Sidharthan	Scientist-E1 & SiC, WIC
Sri. V. Krishnan	Typist (Gr. II)
Sri. V. Chandran Nair	Helper (Gr. II)
Sri. G. Krishnan Nair	Driver (Gr. I)

12.2 Atmospheric Sciences Division

Dr. N. Subhash	Scientist-F & Head
Dr. E. J. Zachariah	Scientist-F
Dr. S. Muralidas	Scientist-F
Dr. G. Mohan Kumar	Scientist-F
Sri. V. Muralidharan	Scientist-E2
Sri. K. Vijayakumar	Scientist-E1
Sri. K. J. Mathew	Scientist-E1
Sri. Mohammed Ismail	Technical Officer(G2,Gr.4)
Ms. P. Prabhavathy	Stenographer (Gr 1)

12.3 Chemical Sciences Division

Dr. P. P. Ouseph	Scientist-F & Head
Dr. K. Narendra Babu	Scientist-F
Dr. M. N. Muraleedharan Nair	Scientist-E2
Dr. P. K. Omana	Scientist-E2
Smt. T. M. Liji	Technical Officer (Gr. I)

12.4 Environmental Sciences Division

Dr. R. Ajaykumar Varma	Scientist-F & Head (Executive Director, Suchithwa Mission on deputation)
Dr. C. N. Mohanan	Scientist-E2 & SiC
Dr. D. Padmalal	Scientist-E1
Dr. K. Maya	Scientist-E1

12.5 Geomatics Laboratory

Dr. M. Samsuddin	Scientist-F & Head
Dr. V. N. Neelakantan	Scientist-F
Dr. K. K. Ramachandran	Scientist-F
Dr. C. M. Harish	Scientist-F
Sri. B. K. Jayaprasad	Scientist-C

12.6 Geosciences Division

Dr. T. Radhakrishna	Scientist-F & Head
Sri. John Mathai	Scientist-F
Dr. C. P. Rajendran	Scientist-F (Ramanujam Fellow, IISc)
Dr. Narayanaswamy	Scientist-F
Sri. G. Sankar	Scientist-F
Sri. G. R. Ravindrakumar	Scientist-F
Dr. V. Nandakumar	Scientist-E1
Sri. S. S. Salaj	Technical Officer
Sri. N. Nishanth	Technical Officer (Gr.I)
Sri. K. Eldhose	Technical Officer (Gr.I)
Sri. R. Karunakaran Nair	Helper (Gr.II)

12.7 Marine Sciences Division

Dr. N. P. Kurian	Scientist-F & Head
Dr. K. V. Thomas	Scientist-F
Dr. T. N. Prakash	Scientist-F
Dr. T. S. Shahul Hameed	Scientist-F
Dr. X. Terry Machado	Scientist-F
Dr. A. S. K. Nair	Scientist-E2
Sri. V. Vasudevan	Scientist-E2
Ms. L. Sheela Nair	Scientist-E1
Sri. John Paul	Scientist-E1
Dr. D. S. Suresh Babu	Scientist-E1(On long leave)
Sri. S. Mohanan	Technical Officer (G2,Gr4)
Sri. A. Vijayakumaran Nair	Technical Officer (G2,Gr.4)
Sri. M. Ajith Kumar	Technical Officer (G2,Gr.4)
Sri. M. Ramesh Kumar	Technical Officer (G2,Gr.4)
Sri. Louis William	Helper (Gr. II)

12.8 Resources Analysis Division

Dr. K. Soman	Scientist-F & Head
Dr. Srikumar Chattopadhyay	Scientist-F
Sri. B. Sukumar	Scientist-F
Sri. Shravan Kumar	Scientist-E2
Ms. Ahalya Sukumar	Scientist-E2
Dr. Mahamaya Chattopadhyay	Scientist-E1
Ms. C. Sakunthala (G2,Gr.4)	Technical Officer
Sri. K. Surendran	Stenographer (Gr. I)
Sri. P. C. Sasikumar	Helper (Gr. I)

12.9 Training & Extension Division

Sri. G. Balasubramonian	Scientist-F & Head
Dr. E. Saravanan	Scientist-E1
Dr. Ansom Sebastian	Scientist-E1
Dr. K. Raju	Scientist-C
Sri. R. Sivaraja Pillai	Tech. Asst. (Draftsman)
Ms. Najumunniza	Tech. Asst. (Draftsman)

12.10 Library

Sri. A. Abdunnasar	Scientist-B (Librarian)
Sri. P. M. Gopakumar	Clerical Assistant

12.11 Camp Office, Kochi

Dr. P. V. S. S. K. Vinayak	Scientist-F& S iC
Sri. K. R. Unnikrishnan	Scientist-F
Ms. Sreekumari Kesavan	Scientist-C
Sri. D. Raju (G2,Gr.4)	Technical Officer
Sri. K. P. Bhaskaran	Stenographer (Gr. I)
Ms. M. K. Radha	Typist (Gr. I)

12.12 Administration

Sri. P. Sudeep	Registrar
Sri. R. Renganathaswamy	Internal Audit Officer
Sri. M. P. Sivakrishnan	Deputy Registrar (Accts)
Sri. K. Ravikumar	Deputy Registrat (Stores)
Sri. K. Sreedharan	Asst. Registrar (Admn.)
Sri. A. Gopinathan	Section Officer
Sri. M. A. K. Haroon Rasheed	Section Officer
Ms. K. V. Padmaja Kumari	Section Officer
Sri. R. Haridas	Section Officer
Sri. P. Ramachandran Nair	Driver (Gr. I)
Sri. S. Krishnakumar	Office Asst. (Gr. II)
Ms. K. Viswabharathy	Office Asst. (Gr. II)
Sri. C. M. Yousuf	Office Asst. (Gr. II)
Sri. M. Madhu Madhavan	Office Asst. (Gr. II)
Ms. R. Jaya	Office Asst. (Gr. II)
Ms. G. Lavanya	Office Asst. (Gr. IV)
Ms. Femi R. Sreenivasan	Office Asst. (Gr. IV)
Sri. Rajesh P	Office Asst. (Gr. IV)
Ms. Rasi P. C	Office Asst. (Gr. IV)
Mr. Shensha C	Office Asst. (Gr. IV)
Mr. Siju V	Office Asst. (Gr. IV)
Sri. T. D. Besherdeen	Stenographer (Gr. I)
Ms. N. J. Saramma	Typist (Gr. I)
Ms. K. Prasanna	Typist (Gr. I)
Ms. K. Nirmala	Clerical Asst. (Gr. I)
Sri. N. Jayapal	Clerical Assistant
Sri. K. R. Satheesan	Clerical Assistant
Sri. M. Parameswaran Nair	Skilled Assistant
Sri. K. P. Thulaseedharan	Skilled Assistant
Sri. C. Surendran	Skilled Assistant
Sri. R. Karthikeyan Nair	Helper (Gr. I)
Sri. N. Unni	Helper (Gr. I)
Ms. S. Vimala Kumari	Helper (Gr. I)
Sri. P. S. Anoop	Helper (Gr. I)
Smt. P. S. Divya	Helper (Gr. I)
Sri. B. Rajendran Nair	Helper (Gr. II)
Sri. P. Saseendran Nair	Helper (Gr. II)
Sri P. Rajendra Babu	Helper (Last Grade)

12.13 Retirements

The following staff members of the Centre retired during 2009-10

Dr. M. Baba

Dr. M Baba, Director, retired on 28 February 2010

Dr. K. Soman

Dr. K. Soman, Head, Resource Analysis Division, retired on 31 May 2009

Dr. P.P.Ouseph

Dr. P.P. Ouseph, Head, Chemical Sciences Division retired on 31 May 2009

Dr. M.N.M. Nair

Dr. M.N.M Nair, Head, Chemical Sciences Division retired on 30 June 2009

Dr. Terry Machao

Dr. Terry Machado, Scientist F, Marine Sciences Division, retired voluntarily on 15 October 2009

Sri. K. Ravikumar

Sri. K Ravikumar, Deputy Regstrar, retired on 31 January 2010

Sri. V. Krishnan

Sri. V. Krishnan, Typist Grade II, retired on 30 April 2009

Sri. K.P. Thulaseedharan

Sri. K. P. Thulaseedharan, Skilled Assistant, retired on 28 February 2010

Sri. R. Karunakaran Nair

Sri. R. Karunakaran Nair, Helper Grade 2, retired on 28 February 2010

Balance Sheet

CENTRE FOR EARTH SCIENCE STUDIES

(An Institution of Kerala State Council for Science, Technology and Environment)

Balance Sheet as at 31st March 2010 (without excluding inter-unit balances of CESS and External Projects)

Liabilities	***SCH***	***31.03.2010***	***31.03.2009***	***Assets***	***SCH***	***31.03.2010***	***31.03.2009***
		Rs. Ps.	Rs. Ps.			Rs. Ps.	Rs. Ps.
General Fund	*I*	*59932708.00*	*54724763.00*	*Fixed Assets*	*VI*	*59932708.00*	*54724763.00*
				Current Assets	*VII*	*1827705.85*	*7447621.85*
Current Liabilities and Provisions	*II*	*12860424.00*	*11468466.00*				
				Loans & Advances	*VIII*	*27434123.00*	*20082535.00*
Unspent balance of Grant from GOK		*16401404.85*	*16061690.85*	***Grant-in-Aid Research & Service Component Projects***			
				Current Assets	*IX*	*30791809.71*	*22718398.71*
Unspent Balance of Grant-in-Aid Research & Service Component Projects	*III*	*32080854.71*	*22784439.71*	*Loans & Advances*	*X*	*1289045.00*	*66041.00*
Unspent balances of Consultancy Projects	*IV*	*25248792.50*	*30952655.00*	***Consultancy Projects:***			
				Current Assets	*XI*	*14624002.50*	*19547531.00*
				Loans & Advances	*XII*	*10624790.00*	*11405124.00*
Corpus Fund	*V*	*42092268.50*	*34560906.50*				
				Corpus Fund			
				Balnce with SBT			*1460906.50*
				Term Deposits		*42092268.50*	*33100000.00*
Total		**188616452.56**	**170552921.06**	**Total**		**188616452.56**	**170552921.06**

Significant Accounting Policies and Notes on Accounts forming part of Accounts - Schedule-XIV

Sd/-
Dy. Registrar
Sd/-
Registrar
Sd/-
Director

AUDITORS' REPORT

As per our report of even date attached

Thiruvananthapuram
Date: 30.09.2010

For Jayakumar George & Associates
Chartered Accountants
Sd/-
U. Jayakumar, B.Com., FCA
Membership No. 208958