ANNUAL REPORT 2008-09

Centre for Earth Science Studies

Akkulam, Thiruvananthapuram - 695 031, India

Contents

Preface

In accordance with its stated objectives CESS continued to play a significant role in the study of earth and its processes for a sustainable development of our natural resources, environment conservation and natural hazards management. Balanced approach of CESS by giving equal importance to basic, applied and consultancy programmes is recognized by 74 projects CESS implemented during the period. Out of these, 40 projects were grant-in-aid projects sponsored by the Central and State government agencies. Among the externally funded projects, one was an Indo – French collaboration project on the Cretaceous dykes. The 34 consultancy projects taken up all across the country during the period helped CESS to stride its research findings to the developmental sectors and generate necessary funds to bolster the establishment and infrastructure front.

CESS contributions on the three basic components of the earth system, viz. lithosphere, atmosphere and hydrosphere continued to make impact. Our research findings on the Kerala Khondalite Belt (KKB), paleomagnetism and the Quaternary evolution of the south Kerala coast are worth mentioning. Some basic observational studies on the characteristics of the rain and clouds using advanced equipments such as disdrometer, micro rain radar, laser ceilometer, electric field mill, etc. were of great significance in understanding the weather phenomena. In the area of marine research CESS made noteworthy progress through its studies on tides, tsunami and coastal erosion. Advanced field equipments and modeling suites such as the MIKE-21 and LITPACK were successfully employed in these studies. Initiation of a DST sponsored study on the coral health using laser induced multi-spectral fluorescence imaging and another initiative, with CESS Plan funds to monitor parameters, that have bearing on climate change in the Sahyadris, were two noteworthy developments.

The State depends heavily on CESS for several of its developmental and hazard mitigation projects. CESS studied a large number of landslides that occurred during the year and helped the government in evolving mitigation measures. CESS scientists also shared their expertise in supporting the State in management of other hazards like coastal erosion, lightning and floods. In addition to Kerala State, Karnataka, Tamil Nadu and Lakshadweep also requested the services of CESS in tackling coastal erosion. A big team of CESS scientists was involved in mapping, interpretation of data and giving recommendations for natural resources management using latest mapping and analytical tools like DGPS and GIS. Some of the major achievements include the geospatial survey of Munnar, contributions for establishment of the Kerala State Spatial Data Infrastructure, landscape evaluation of the Periyar basin, and the rejuvenation of the laterite areas using natural resources. Apart from these activities, CESS conducted a few training programmes for government officials and those who sought our help during the year.

Being one of the back bones of research the CESS library added a substantial number of new books and journals during the year. CESS initiated several efforts to attract bright young students to take up PhD programmes in challenging areas of Earth Sciences. There were 20 students enrolled for PhD. As always a large number of M.Sc, M.Tech and B.Tech students carried out project work successfully at CESS. The introduction of studentships with stipend to meritorious students attracted many post-graduate students to CESS. More than 100 project fellows in various projects made substantial contribution to the different ongoing projects. Though there were a sizable number of papers published during the year, further efforts are required to qualitatively and quantitatively improve the contributions.

CESS scientists and students were selected for some awards. To mention a few Dr. C. P. Rajendran received the prestigious Ramanujam fellowship of the DST (Govt. of India) for a period of 5 years to work in the Indian Institute of Science, Bangalore. Sri. S. Arjun, SRF received the second best paper award in OSICON-2009. Congratulations to all of them!

A review of the activities of CESS was carried out by a Committee under the chairmanship of Prof. M. Ravindran. I take this opportunity, on behalf of the scientists and on my personal behalf, to thank the distinguished members of the committee for their valuable suggestions and inputs to improve the performance of CESS. Finally, I take the privilege of acknowledging the support and guidance provided by KSCTE, the Research Council and members of the CESS Management Committee in taking CESS and its vision forward.

Dr. N.P. Kurian
Director

1.1 Crustal Evolution and Geodynamics

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

The southern granulite terrain (SGT) is an important lower crustal segment exposed in the southern part of India. Over the years CESS has been studying various aspects in these regions to understand thermal gradients, chemistry and processes that are active in the deeper portions of the continental crust. The aims of most of these studies have been to understand the lower crustal processes and place constraints on the origin of granulites. Continued efforts in the last few decades have lead to collection of a large amount of data on several selected zones of the SGT. These results (geology, mineral and whole rock chemistry, and isotope characteristics) have lead us to more intensive studies, from broad-based regional approaches to specific problems. One such programme taken up by CESS in recent years is on origin of the metasedimentary rocks of the Kerala khondalite belt. Following is the progress of report of this programme.

Detailed field studies were continued into the third year of the project by sampling and data collection for documenting the lithological variation and petrographic and geochemical charactereisation across the entire KKB. The field programme performed in five different phases has helped in quarry-scale studies in over 275 fresh quarried exposures. So far 300 fresh samples, each weighing about 2-4 kilograms, giving homogeneous representation of each units have been collected. Three-fourth of the total number of collected samples have been prepared for petrographic observations and geochemical analysis. The spatial resolution of sampled outcrops is very high (~1km interval in most cases) indicating close association between adjacent sample locations. Such voluminous data has the potential to provide clarity on the petrogenesis of lower crust in the KKB rather than selective case studies.

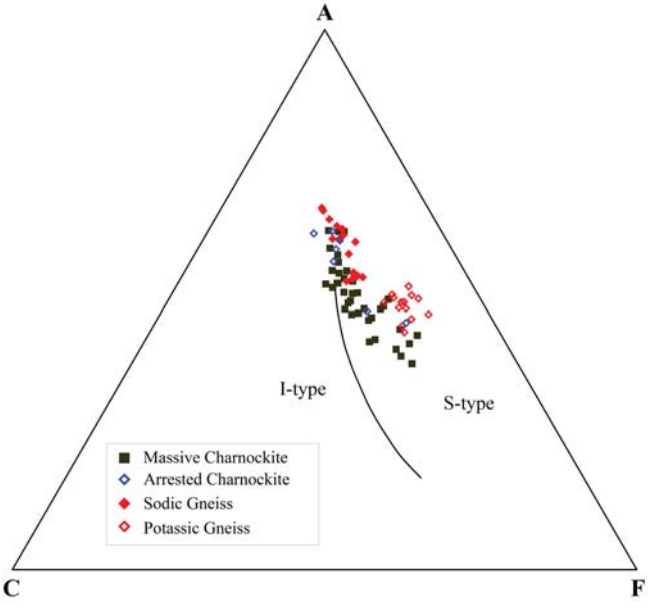

Fig. 1.1.1.1 ACF diagram showing the chemical composition of different rock types of KKB. S and I - type field from Chappel and White (1974)

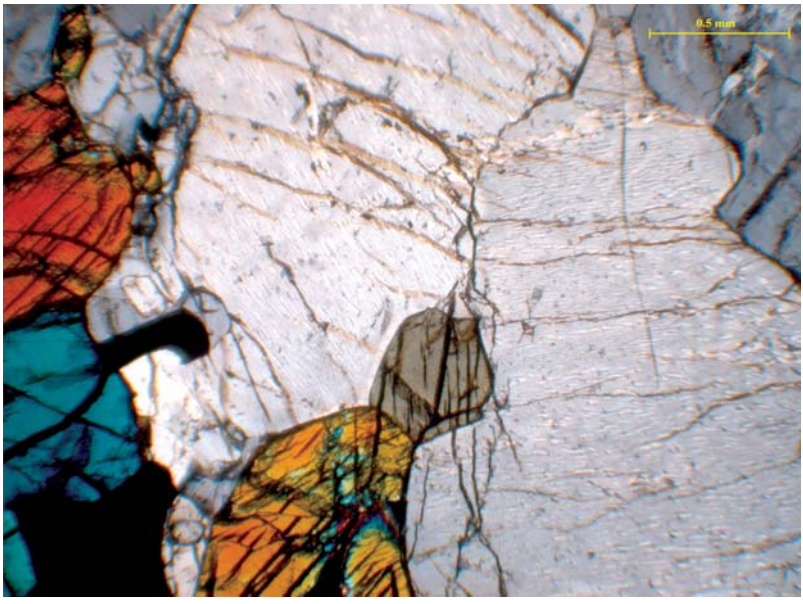

Fig. 1.1.1.2 Potash feldspar-perthite and clinopyroxene assemblage in syenite.

The detailed field, trace and REE geochemistry, and U-Pb zircon studies indicate a deviation from previous observations about the metasedimentary nature and observed abundance of supracrustal lithology in KKB. Our data present ample evidence to show that metaigneous rocks constitute a significant component of KKB. The metasedimentary rock association seems to be a minor constituent compared to gneiss and their orthopyroxene bearing equivalents. We have carried out petrographic and geochemical analysis on a large number of samples. Most of the collected samples have been analysed for major and trace element chemistry at CESS XRF facility and REE for selected samples at NGRI. Tringular diagram summarises major element results for a variety of samples of KKB (Fig. 1.1.1.1).

It may be noted that this is the first project, which initiated detailed petrological and geochemical study of the entire terrain of the Kerala Khondalite Belt (KKB). The detailed field observations and geochemical investigation so far completed has enabled documenting of disposition of diverse lithological units in the KKB.

The study has produced excellent petrological and geochemical evidences to show for the first time the existence of a magmatic crust (of Late Archaean or Early Proterozoic??) in KKB.

During the course of field investigation new occurrences of potassic syenites were also recognised. A note entitled "Petrological and Geochemical Characteristics of New Occurrences of Potassic

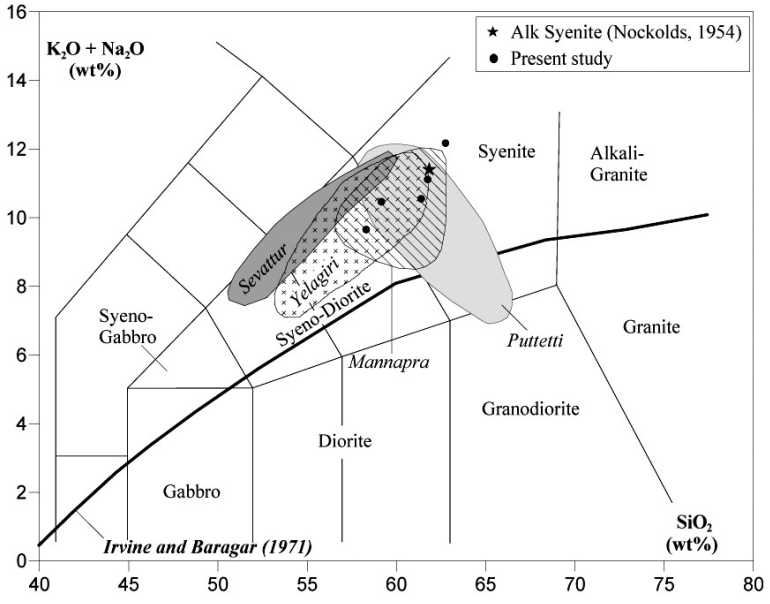

Fig.1.1.1.3 Total alkali vs silica diagram (Le Maitre, 2002). Thick line is the boundary of Irvine and Baragar (1971) distinguishing between alkali and sub alkali rocks

Syenites in the Kerala Khondalite Belt (KKB), Southern India" reporting this new occurrences was prepared and published (Sreejith and Ravindra Kumar, JGSI, 2009, v.73, pp.386–392). Petrological (Fig. 1.1.1.2)and geochemical studies (Fig. 1.1.1.3) suggest that the syenites have a pronounced A-type affinity, metaluminous characteristics with high concentrations of alkalies, Rb, Sr, Zr, and high K_2O/Na_2O ratio. Miaskitic nature (agpaitic index<1) of syenite suggest involvement of CO_2 related phase in their genesis. The petrological characteristics signify crystallization of the pluton at shallow levels within the crust. Geochemistry favours mantle origin of the magma and enrichment of Ba and Sr are indicative of involvement of carbonatite melt in the source region. The petrological and geochemical data also suggest spatial and temporal association with plume activity. The study envisages the presence of a juvenile CO_2 enriched upper mantle below the southern Indian continental crust during the Pan-African time.

Dr. G. R. Ravindra Kumar

Funding: DST, Government of India

1.1.2. Geochemical and palaeomagnetic studies of mafic dykes

The studies on mafic dykes is a long term program for understanding the igneous petrogenesis and nature of continental magmatism in the Indian shield, to trace the nature and development of mantle sources, to determine reliable palaeomagnetic directions and pole data and to interpret the geodynamic setting, tracing the India's position in the supercontinental assembly. During this year, our studies are concentrated 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. Detailed step-wise alternate field demagnetization experiments at close intervals have been completed on all earlier collection of samples to delineate characteristic remnant magnetizations. A series of orthogonal and stereographic projections have been generated using computer programs to ascertain stable magnetic component. Principle component analysis have been employed to compute the characteristic magnetizations. Petrographic studies reveal that plagioclase, clinopyroxene and opaques are essential constituents preserving igneous textures, occasionally exhibiting clouding appearance of plagioclase. Although variable degrees of alteration is present, majority of samples display typical ophitic to subophitic igneous

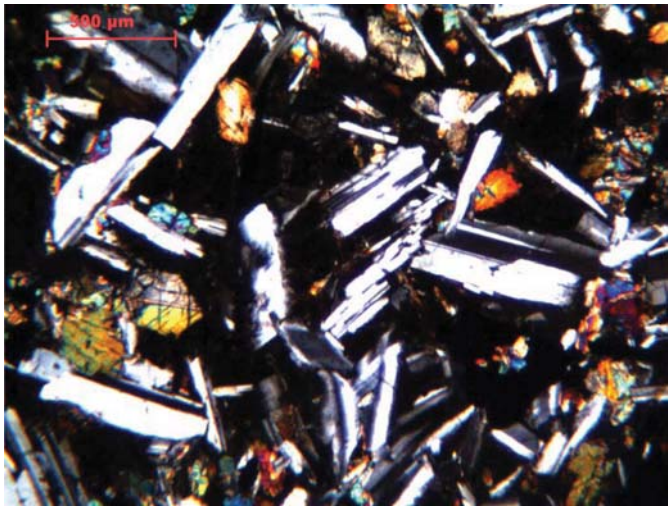

Fig. 1.1.2.1 Photomicrograph of a Palaeoproterozoic dolerite dyke at Nibri Narayanpur village, Bundelkhand craton. It can be seen that typical ophitic igneous textures are well preserved

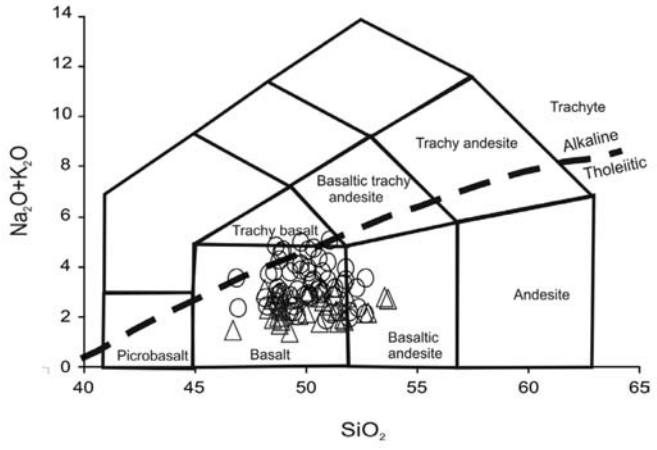

Fig. 1.1.2.2 Plot of mafic dyke samples from the Bundelkhand and Bastar cratons in Total Alkali-Silica (TAS) diagram of Le Maitre, (2002)

textures as illustrated in figure 1.1.2.1 Deuteric alterations or uralitisation are generally common.

Palaeomagnetic and petrographic observations have been used to identify three dyke samples (BK-17; BK-19; BK-22) for radiogenic isotopic (Rb/Sr and Sm/Nd) dating. Radiogenic isotope runs performed on TIMS at Pondichery University on the whole rock-mineral separates (plagioclase, pyroxene and magnetite) did not yield any meaningful regression lines for the Sm/Nd isotopic data allowing estimation of age. However, the Rb-Sr results yielded a regression line corresponding to 1656±22 Ma. In light of the observed alterations in these dykes, this age is regarded to date the hydrothermal event and the actual crystallization age could be higher than 1.65 Ga. More isotopic work is needed to ascertain the actual crystallization ages of different dyke intrusion phases in Bundelkhand craton.

Representative samples chosen based on major element chemistry have been analysed by ICPMS methods at National Geophysical Research Institute for trace elements (Ba, Rb, Sr, Ni, Co, Zr, Y, Nb, Zn, Sc, Hf, Th, Ta and RE elements). The dyke intrusions from both the Bundelkhand and Bastar cratons compositionally range from tholeiitic basalts to basaltic andesites (figures 1.1.2.2 and 1.1.2.3). However tholeiitic basalts are more predominant. Different degrees of fractionation is evident with Mg- values ranging from 0.64 to 0.39. Iron, titanium and phosphorus show incompatible behaviour with coherent increasing trends, whereas the potash (also Rb and Ba) shows high scatter which suggests that measured concentrations of LIL elements may not always reflect the original values of magmas and petrogenetic interpretations have to rely on HFS and RE elements. Principle component analysis for determination of each site characteristic magnetization (ChRM) and interpretations of major and trace element data are in progress.

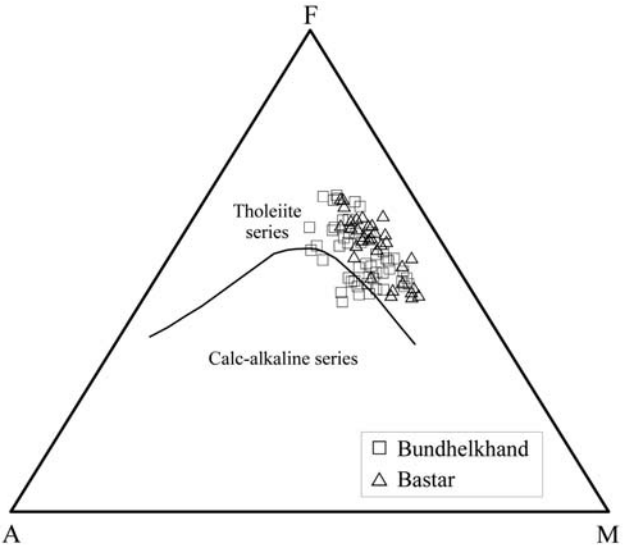

Fig. 1.1.2.3 AFM (alkali-FeO-MgO) plot of dyke samples from the Bundelkhand and Bastar cratons. The demarcation line between alkali and tholeiitic suites is after Irvine and Baragar (1971).

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 dykes 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). This work is also aimed at palaeointensity determinations to understand Mesozoic low-Neogene high transition. The demagnetisations have been completed for all the site samples collected during the first Indo-French joint fieldwork. Mean ChRM directions for all the sites have been computed using zijdervield plots and stereographic projections. Documenting detailed petrographic characteristics continued and typical igneous textures as example is shown in figure 1.1.3.1. Chemical and palaeomagnetic data available with us on the late Cretaceous

dykes in Kerala have been analysed in terms of petrogenetic processes and tracing the plume activity in Indian Ocean region.

A second joint fieldwork was carried out by the Indo-French team for about a month during January-February, 2009 with the participation of Dr. Mirelle Perrin, the Principle Collaborator from France and Dr. Mathew Joseph, the post doctoral Fellow of the project. More focus has been laid on the St Mary islands volcanics and Deccan trap region and also collected dykes in north/central Kerala. In St Mary group of island, the sampling has been made (figure 1.1.3.2.) from other than coconut islands, where we sampled in the first joint fieldwork. Both palaeomagnetic and geochemical sampling was done from Black island, Dharia-Bahadyrgarh island, one small unnamed island, north island and Mulki islands, the southernmost extension of St Mary group of islands. Only geochemical sampling was done on the outer rock island and another island just north of Coconut Island. In Deccan trap region, a long traverse, Belgaum-Narayanapur-Igatpuri-Panval, was made covering nearly all Deccan formations. The palaeomagnetic sampling during this field is of reconnaissance in nature to test the suitability of the samples for palaointensity study and also for polarity determinations as several studies have been done earlier for palaeodirection determinations. We have done 2-7 samples for palaeomagnetic study and a block sample for geochemical study. Our sample collection from Deccan traps includes Panhala, Ambenali, Mahabaleswar, Poladpur, Bushe, Kandala, Bhimasankaram, Thakurwadi and Jawahar Formations. We also collected feeder dykes from three locations: northeast dyke within middle Thakurvadi Formation between Narayanpur and Igatpuri (site 09-IN30 and 31), and a northwest dyke within Igatpuri Formation in the Poshir river bed (site 09-IN34). In addition we could sample red boles from Mahabaleswar Formation on Belgam-

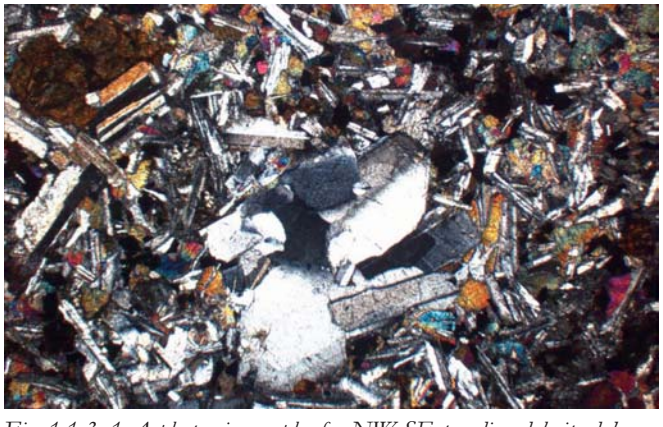

Fig. 1.1.3 .1 A photomicrograph of a NW-SE trending dolerite dyke near Vazhakulam Engineering College showing typical ophitic intergrowths (site 07-IN06)..

Fig. 1.1.3 .2 Drilling for collecting oriented core samples for palaeomagnetic study in South Islands of the St Mary's islands during a joint fieldwork by the Indian and French Collaborators

Kholapur road (site 09-IN16). We have collected six new dykes. These include three northwest dykes from Goan region (from Querim beach: site 09-IN12; Arambol beach: site 09-IN13: Morjim beach: site 09-IN14), one northwest dyke in north Kerala (near Dharmadam: site 09-IN37) and two northwest dykes from central Kerala (near Perumbavur: site 09-IN04; near Kuvapoika; site 09-IN38). In addition three sites of our earlier collection (site 07-IN06 near Vazhakulam and site 07-IN02 near Pudupalli, both in central Kerala; on the Vigotor beach of Goan region; site 07-IN15) have been resampled.

The mid-year progress report has been presented before the IFCPAR Council. The IFCPAR Council has rated the progress to be very good and also sanctioned eight months extension, i.e., up to February, 2010.

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

1.1.4 Archeaomagnetism

During this period we have taken new initiative to employ rockmagnetic techniques in the field of archaeomagnetism. The work is done in collaboration with Department of Physics, Annamalai University for determining palaeomagnetic field strength that are useful for understanding palaeosecular variations of Earth's magnetic field in the Indian subcontinent region. For the present study, the archaeological pottery samples (broken pieces of red and blackware) belonging to Iron Age from Mayiladumparai (MPI) (lat. 12°32'N, long. 77°32'E), Krishnagiri district, Tamilnadu have

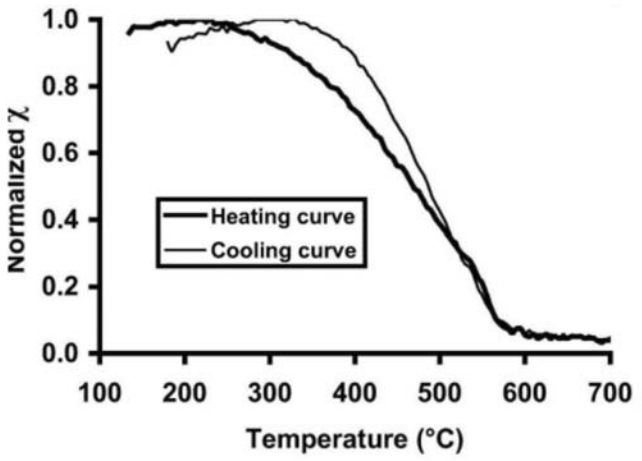

Fig. 1.1.4.1 Temperature dependent magnetic susceptibility of sample MPI-1 from Mayiladumparai, Tamilnadu

been used. The type of magnetic remanence carriers, their concentration and domain states are important guiding factors to asses the suitability of the artifacts for palaeointensity determinations. Samples were subjected to Fourier Transform Infrared (FTIR) and archaeomagnetic studies. Rockmagnetic studies include magnetic susceptibility, frequency susceptibility- temperature experiments and isothermal remanent magnetisation (IRM). Temperature susceptibility experiments were carried out at 2°C interval up to 700°C covering both heating and cooling cycles using Bartington Apparatus (UK). ASC scientific impulse magnetizer (USA) has been used for IRM measurements. Typical temperature-susceptibility curves and IRM plots are given in figures.1.1.4.1 and 1.1.4.2 Infrared spectroscopy analysis of the samples shows that the shreds were fired above 600°C under reducing/oxidising atmosphere and constitute disordered type of clay. The main ferrimagnetic iron oxide minerals responsible for the magnetic susceptibility of burnt clay are magnetite with significant amount of superparamagnetic or single domain magnetite (or titanomagnetite) particles. The Curie temperature range within 550-580°C and magnetic saturation attained at about 300 mT. The heating and cooling curie temperature curves are mostly reversible and no significant chemical alteration of magnetic particles is evident. The palaeointensity measurements on suitable samples yielded mean paleointensity value of 48.71±0.16μT.

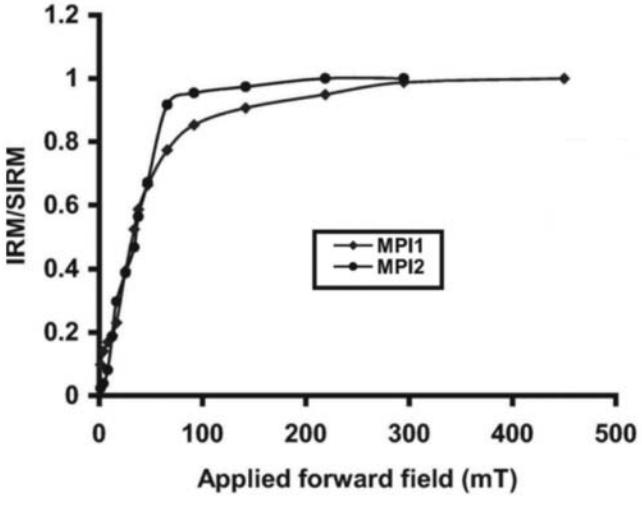

Fig. 1.1.4.2 Typical IRM acquisition curves of the pottery samples from Mayiladumparai, Tamilnadu

T. Radhakrishna, CESS &
C. Manoharan, K. Veeramuthu, R. Venkatachalapathy, and R. Ilango, Department of Physics, Annamalai University, Annamalainagar - 608 002.

1.1.5 Tectonic and hydrologic control on late Pleistocene-Holocene land forms, palaeoforest and non-forest vegetation: Southern Kerala

The Project aimed at clarifying the role of tectonics and hydrology in moulding the landforms, forest and non-forest vegetations in the South Kerala Sedimentary Basin (SKSB), extending from Kollam in the south to Kodungallur in the north. The basin is located in the western side of the Western Ghat, an important orographic feature stretching between the River Tapti in the north and Kanyakumari in the south. Studies reveal that the river catchments of the SKSB were thickly forested during Late Quaternary period, especially during the Holocene Climatic Optimum. The sea level was at ~150m (Last Glacial Maximum – LGM) below the present. Thereafter, the sea level rose in stages till Middle Holocene. The sedimentary deposits of SKSB comprise lagoon – littoral marine – beach and mangrove swamps. In most cases the investigated sequences show influence of marine waters. On detailed comparative study of SKSB and adjoining offshore, it is found that Ernakulam and the areas ENE thereof are more prone to earth movements. Similarly, there may be movements associated with longitudinal ridge along the middle parts of the midland where the rivers meander greatly. It is also quite possible that marine embayments or channels between open sea and SKSB could be maintained to aid in providing the marine influence to sediments of Quaternary times. Similar picture had existed during Early Miocene too, facilitating the deposition of Vaikom and

Quilon Formations. This picture seems to have been repeated in Late Quaternary times as well. In the absence of detailed investigation of shelf sediments the picture cannot be made clearer.

This is an inter institutional project between Vakkom Moulavi Foundation Trust (VMFT), Thiruvananthapuram, Agharkar Research Institute (ARI), Pune and CESS.

D. Padmalal

Fundings: KSCSTE, Thiruvananthapuram

1.1.6 Late Quaternary environmental changes in the coastal plains of southern Kerala, SW India

The South Kerala Sedimentary Basin (SKSB) is the landward extension of the Southwest sedimentary basins of India and is located between 8 ^{0} 45' and 10^{0} 15' N latitude. The SKSB has a maximum width of ~ 25 km around 9^{0} 30' latitude and a sediment fill of ~700m. The sedimentary deposit consists of ~600m of Neogene deposits and the remaining is Quaternary sands, clays and laterites. The study of the Quaternary sediments in the SKSB reveals that the datable sediments range from Late Pleistocene to Early Holocene (>40000-2580±100 ybp). More than half the thickness of Quaternary sediments at the deeper part of the basin is beyond the range of carbon dateable limit. The samples of Takazhi at an interval of 19-28m; Ayiramthengu 22.9-25.5m and Thottappally 39-42.5m bgl are found to be Late Pleistocene and are above the carbon dateable limit. However, the C^{14} dates of the samples of Thakazhi borehole at 10m level (35180±2850 ybp), Pathiyur at 9m level (28830±2330), Panavally at 40.8mlevel (11010±170) are within Late Pleistocene. Holocene sequence range in age from (9630±170 ybp to 2580±110ybp. Both the Late Pleistocene and Holocene sequence consist of basal continental section overlain by marine-marginal sediments. The marine-marginal marine sequence consist of carbonaceous silty clay, often with an abundance of *ostracods*, benthic and planktic foraminifera and mollusca. The non-marine sediments include highly carbonaceous clay, peat, fossil wood and highly ferruginous sands and clays. Palynological analysis reveals heavy accumulation of organic matter probably contributed by mangrove vegetation when the palaeocoastline was further away from the present coastline. Heavy accumulation of organic matter in marine sediments indicates extremely shallow water condition along the coastline. Heavy organic input probably due to a high sedimentation rate at lower intervals may be attributed to relatively high rate of weathering and erosion in the hinterland as a result of high rainfall since a more intense SW monsoon was prevailing during Late Pleistocene – Early Holocene.

This is an inter institutional project between Agharkar Research Institute (ARI), Pune, Vakkom Moulavi Foundation Trust (VMFT), Thiruvananthapuram, and CESS

D. Padmalal

Funding: CSIR, GoI

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

The coastal lowlands of Kollam district comprise a spectrum of coastal landform. Features such as barrier beaches, estuaries (Paravur and Ashtamudy kayals), fresh water lakes and palaeo – strandlines indicated by ridge-runnel systems in the northern part. Among these landform features, the estuaries and its overbank areas are, perhaps, the best repositories of Late Quaternary sediments. A total of 14 drilled boreholes and several shallow auger cores were collected from the study area for unfolding the Late Quaternary events to which the region has been subjected. The age of the sediments varies from Late Pleistocene to Late Holocene. The oldest sediments (41788±574 ybp) occur in the northern part of the study area, especially around Thevalakkara. The youngest date (1130±60 ybp) is from the Polachira wetland at a depth of 1 m below ground level.

The sedimentological, palynological, geochemical and stable isotopic studies (δ^{13} C and δ^{15} N) of a few borehole cores collected from the river confluence zones of Kallada river with the Ashtamudi estuary reveal highly varied climatic and sea level conditions during the deposition of sediments. The radiocarbon dates obtained at various levels show that early Holocene witnessed heavy rainfall and was responsible for the high influx of terrigenous sediments under a rising spell of sea level. This was responsible for the fast deposition of sediments in the river mouth areas. The similarity in the ages of a wood sample (7490±90 Ybp) in the Pangod borehole core and the embedding sediments (7480±80 Ybp) at 5m bgl supports the phenomena. This was followed by a regressive phase in the Middle Holocene with comparatively low rainfall and a dry spell at around 5000-4000 yrs. bp. The yellowish brown coloration of the surface layer in borehole cores at Pangod and Sasthamkotta might have formed during this period due to oxidation of iron containing minerals under subaerial conditions. The enhanced level of δ^{15} N isotope in the surface sediments as compared to the lower organic rich layers points to degradation and preferential consumption of lighter isotopes and subsequent en-

richment of heavier δ^{15} N. The deposit has prograded in the Late Holocene further seaward filling up almost half of the Ashtamudi lagoon leaving of its prominent upper arms into a discrete wetlands like Chittumalachira, Chelupola and Sasthamkotta lakes.

Apart from this, an attempt has been made to study the geological evolution and carbon loading of the Polachira wetland in the Paravur estuary that forms the southern part of the coastal lowlands in Kollam district. The wetland is blanketed by a spectrum of textural classes namely silty clay, sand, clayey sand, mud, clay, silty sand and silty mud. An overall analysis reveals that out of the total samples studied, about 47% falls in the clay dominant facies. The core sediments distribution also shows dominance of the silty clays, in the central Zone and sand dominance in the arms and peripheral areas. The observed textural diversity indicates a high-energy regime in the boundaries and tributary confluence zones and, an almost quiet depositional environment towards the central part of the basin. Fungal spores, fruiting bodies, pteridophytic spores and foraminiferal linings mark the palynological contents. In general, the palynological records indicate a fluctuating environmental condition, from fluviomarine to marine. Geochronological studies reveal that Holocene sedimentation began at 8920±110 ybp. The Middle Holocene period is marked by tidal influence and low terrigenous contributions because of the prevalence of a dry climate in the catchments as indicated by the presence of calcareous nodules in the sediment column. Organic carbon and $CaCO_3$ content 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 slit and clay are effective in trapping substantial quantity of organic carbon. Among the different sediment types, clayey slit (11.88%) and slity mud (8.29%) accounts for higher concentrations of organic carbon. The carbon loading in clayey mud and slity clay are 5.58% and 5.1% respectively. It is estimated 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 0.031 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. The laboratory analysis of the remaining bore hole sediments collected under this project and their interpretation are progressing.

Dr. D. Padmalal

1.2 Atmospheric Processes

1.2.1 Rainfall Validation & Characterization and Cloud Physics Studies using Megha –Tropiques Data.

Monitoring of rain rate, drop size variation and its vertical profile was continued during 2008-09 using an impact type RD-80 Disdrometer, Micro Rain Radar (MRR) and manual rain gauge (MRG). Daily measurement of liquid water from rain was carried out using a MRG. Radar reflectivity factor (Z) and microwave attenuation were recorded using the MRR. Major results of the study are:

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.

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 studied using MRR revealed that as rain drops come down the number of smaller drops decrease and number of larger drops increase simultaneously, indicating the predominance of a coalescence mechanism.

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

Dr.G.Mohan Kumar

Funded by: Space Application Centre, Ahmedabad

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

Continuous monitoring of ambient carbon monoxide was continued during the year. The amount of carbon monoxide released into the atmosphere from the massive biomass burning events near the measurement site in January 2006 was estimated. A 30-fold enhancement in CO was inferred on fresh biomass burning (mean CO= 6.16 ppm) while a 27-fold increase in CO (mean CO=5.74 ppm) was seen on dry biomass burning compared to a normal day in winter (mean CO=0.206 ppm). Empirical estimates of CO showed 0.287 kg/m^{2}emission from fresh biomass burning and 0.198 kg/m^2 from dry biomass burning. CO measured

and estimated were both high on fresh biomass burning compared to the dry biomass burning. The highs in CO did not persist on the successive days of burning due to strong dispersal by the sea and land breeze at this coastal site. CO concentration from January 15 , 2006 to January 31, 2006, including the burning days, is shown in Fig. 1.2.2.1

CO variations associated with meteorology at a tropical coastal site

As CO in winter is high compared to the other seasons, correlation of CO levels with meteorological parameters, like relative humidity (RH), rainfall (RF), temperature (T), pressure (PRS), wind direction (WD) and wind speed (WS) were investigated during winter

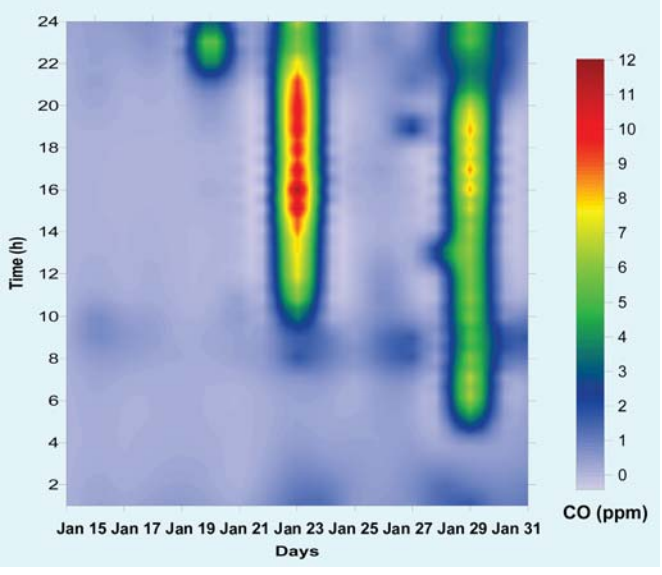

Fig. 1.2.2.1 A 17-day CO concentration including the biomass burning days

months (November-February) from 2005-07. Correlation and multiple regression analyses were carried out for examining the possible dependence of CO on meteorology. Statistical analyses indicated that CO changes significantly with RH and P by high positive correlation and with T by strong negative correlation. Correlation analyses also yielded negative relation between CO and WD. A weak-negative correlation between CO and RF indicated an insignificant link. Multiple Regression Analyses indicate 66.6% dependence of CO variation on meteorological parameters in winter.

Dr.G.Mohan Kumar
Funded by: ISRO

1.2.3 Measurement of Cloud Parameters and Cloud Modelling

The Ceilometer installed in CESS has been acquiring cloud base height data from which some features of cloud occurrence are obtained for different rainy seasons.

Vertical Distribution of Cloud Occurrence

Cloud occurrence is found to be high in the lower layers below 2.5 km in all the seasons. Relatively fewer clouds were noticed in a layer between 2.5 and 4 km. As the observation station, Thiruvananthapuram, is a coastal tract it has the advantage of measureing heights of cloud occurrence at heights at which they exist before reaching/entering the land during SW monsoon. Fig.1.2.3.1 shows the cloud occurrence for the three rain seasons, namely pre- monsoon of April and May, SW monsoon comprising of months from June to September and post- monsoon or the North East (NE) monsoon comprising of October to November in the years 2006 and 2007.

Dominance of cloud occurrence between 500 and 1000 m height is distinctly seen in all rainy seasons. Another aspect that can be seen is the higher cloud occurrence below 500 m for post monsoon and SW monsoon season and lowest at this altitude range for the pre

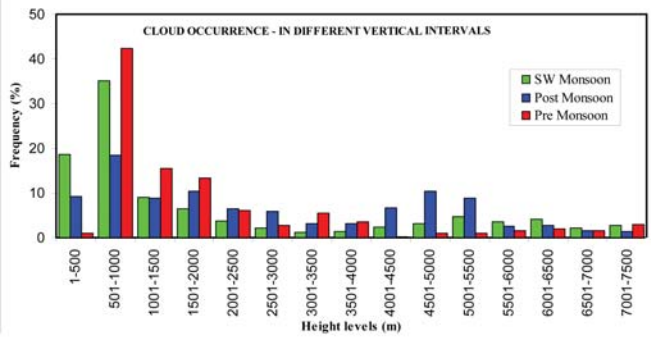

Fig. 1.2.3.1 Distribution of cloud occurrence in vertical intervals of cloud base height for different rainy seasons, at Thiruvananthapuram, for varying seasons in 2006 and 2007. It is seen that for all rainy seasons the maximum percentage of cloud occurrence is between 500 and 1000 m.

monsoon season. Above 2.5 km, cloud occurrence is relatively high in the altitude rangebetween 4.5 km and 5.5 km.

Cloud Base Height and its Diurnal Variation below 2.5 km

The diurnal variation of cloud base height at levels below 2.5 km for the South West (SW) monsoon, post monsoon season and the pre monsoon season is shown in Fig. 1.2.3.2

The SW monsoon clouds seem to be occurring at about an average height of 0.75 km. The height of clouds occurrence seem to be maximum during the pre-monsoon months of April and May.

The frequency of occurrence of clouds as a percentage of total number of observations, at levels below 2.5 km for the three seasons in Fig. 1.2.3.3 clearly shows that the frequency of cloud occurrence is high in the noon during SW monsoon. On the other hand the frequency of occurrence is high between 1500 h and 2100 h during the other two monsoon periods. This, relatively high

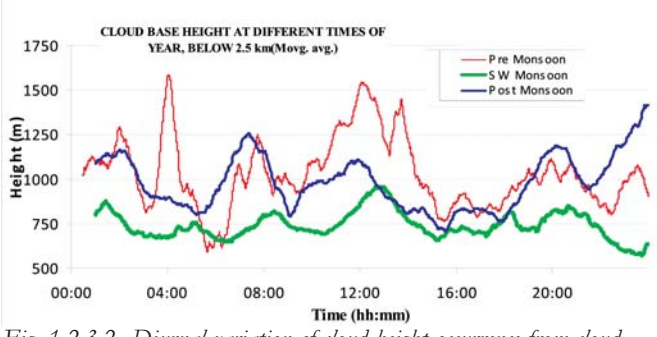

Fig. 1.2.3.2 Diurnal variation of cloud height occurrence from cloud base height, below 2.5 km, for different rainy seasons in a year. The data presented is the moving average.

occurrence in the evening hours, possibly indicates the formation of convective Cumulonimbus clouds (Cbs) which cause lightning in the region comprised of the monitoring station. It is known that most of the lightning in Kerala is due to convective thunderstorms which form in the evening hours.

Cloud Occurrence Characteristics above 4 km

Percentage of occurrence of clouds above 4 km is shown in Fig. 1.2.3.4. The pre monsoon and SW monsoon clouds show an increase after about 1200 h. In comparison, the post monsoon cloud occurrence show an increase in the morning hours and in the late evening hours.

In addition to the station operational in CESS, one more is to be set up soon at a distance of about 40 km from the present station on the western slope of the Western Ghats. This is expected to give an insight into the convective cloud formation on the mountain slope and also about the behaviour of south west monsoon clouds at the coast and near the mountains. A portable field deployable inverted Electric Field Mill designed and fabricated by CESS for monitoring vertical electric field due to charged clouds will also be installed at the mountain station. The Field Mill has an output sensitivity of 0.75 V/1000 V/m field. As the design of the Field Mill is for monitoring field of the order of hundreds of volts per meter it does not decipher fair weather electric field variations. A modification useful in field operation for test and single value calibration is effected in this Field Mill. This is achieved by introducing an additional electrode which becomes active only during field test and calibration.

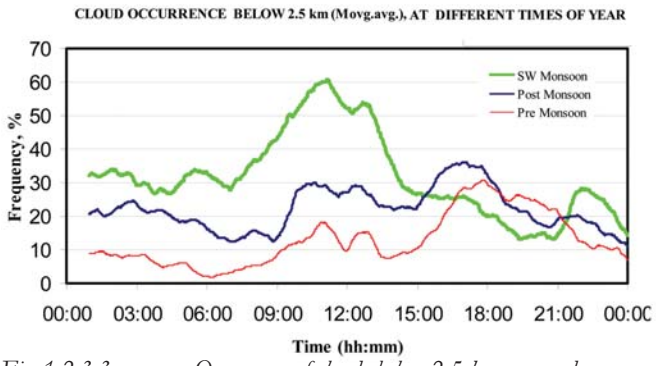

Fig. 1.2.3.3 Occurrence of clouds below 2.5 km over a day as percentage of the total number of days for which data was collected. The graph shows data for the three seasons

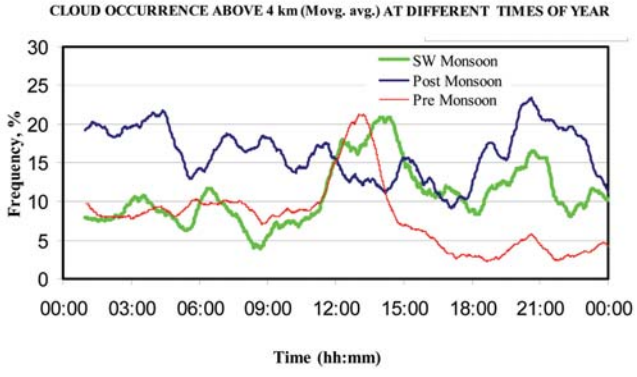

Fig. 1.2.3.4 Diurnal variation of cloud occurrence above 4 km for three seasons

Dr. S. Muralidas

1.3 Coastal Processes

1.3.1 Study of coastal processes and hazards along Kerala coast

A study of the spatio-temporal variations in the shallow water tidal constituents in the innershelf of a stretch of the southwest coast of India was taken up through numerical modeling using

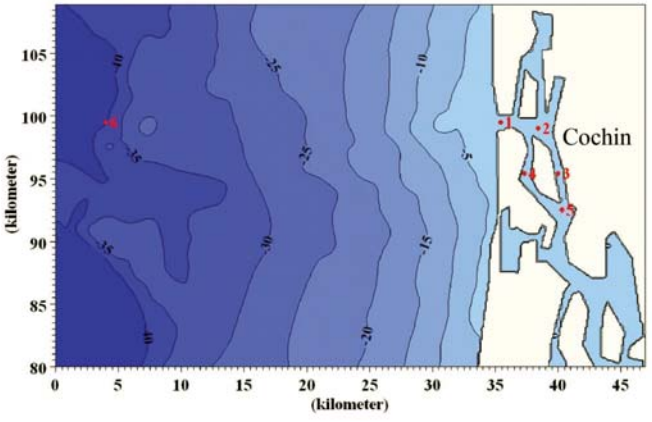

Fig. 1.3.1.1 Stations selected for study in the Harbour area of Cochin estuary

the MIKE21 Hydrodynamic Model (HD). The model was set up for the west coast of India and its performance and reliability was tested by comparing the results with the data available for different coastal locations. The spatio-temporal variation of the tidal constituents for a 110 km stretch of the Kerala coast was then studied by setting up a fine grid local model. The model successfully reproduced the water level variations along the Kerala coast. Variability in the shallow water constituents and their selective amplification in the coastal waters have been brought out by the study. Within the Cochin estuary (Fig. 1.3.1.1), the amplitudes of almost all the major tidal constituents show a gradual reduction in amplitude from the mouth further upstream (Fig. 1.3.1.2). This dampening of the major constituents in the estuary is found to be in contrast to the results available for other locations of the west coast of India. The shallow water constituents show significant amplification and Z0, the constituent related to mean sea level, shows five-fold amplification within the estuary.

The work under the present project has paved the way for more research, particularly on tides, tidal amphidromes and its role on coastal hazard amplification. It was felt that the infrastrucrtuaral facilities available right now at CESS are not sufficient to undertake the extensive modelling required for the envisaged study. Hence

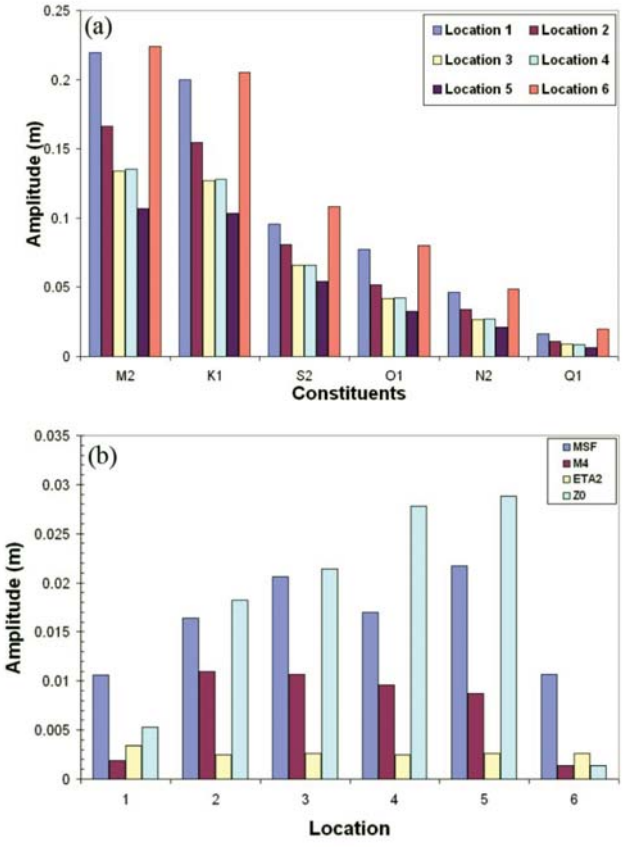

Fig. 1.3.1.2 Comparison of tidal constituents at different stations with that of the offshore station: (a) major; (b) minor

the work is proposed to be continued further under a new project with external funding.

Dr.N.P.Kurian

1.3.2 Nitrous oxide and methane in coastal ocean and estuaries

Distribution of methane and nitrous oxide in the coastal ocean and estuaries were studied. Water to air fluxes of these gases and related water and sediment parameters were also measured. The discharge of estuarine water to coastal ocean was modeled to estimate the quantity of methane being discharged into the ocean. Studies were carried out in the Ashtamudi and Kadinamkulam estuaries and the coastal ocean from Anjengo to Neendakara.

The distribution of dissolved methane in the surface waters of the

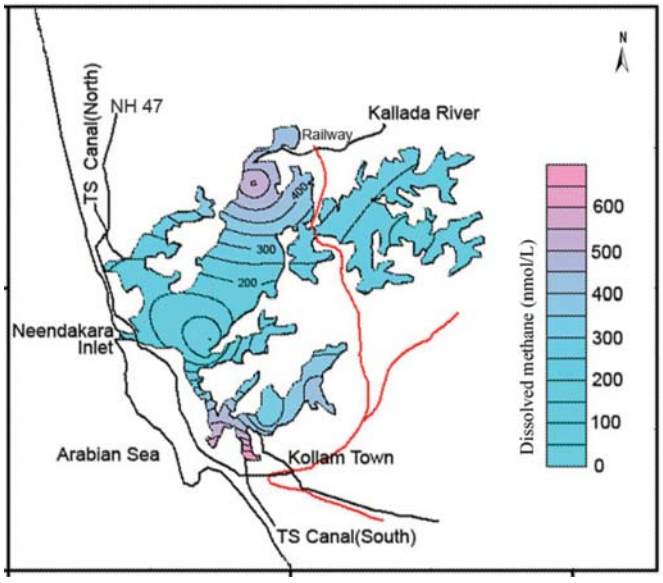

Fig.1.3.2.1 Dissolved methane in the surface waters of the Ashtamudi estuary

Ashtamudi estuary is shown in Fig. 1.3.2.1 The water to atmosphere fluxes of methane from the Ashtamudi estuary is estimated at 270 x 106 g annually, whereas the methane discharged into the coastal ocean from the estuary is 42 x 106 g.

Dr. E. J. Zachariah

Funding: Ministry of Earth Sciences, Govt. of India

1.3.3 Coastal Ocean Monitoring and Prediction System (COMAPS)

COMAPS programme funded by the Ministry of Earth Sciences, Govt. of India has been an ongoing programme for the past several years with the objective of identifying ecologically sensitive areas by monitoring of coastal pollution and assessing the seasonal variations of chemical, biological and microbiological aspects. The major hotspot (ecologically sensitive areas) transects included for coastal monitoring during the pre-monsoon, monsoon and post monsoon seasons of the year 2008-09 were Veli, Cochin and Mangalore. Two research cruise sampling extending from Karwar to Veli were also carried out. Sampling included collection of coastal waters and sediment from shore, nearshore (at distances of 1, 3 and 5 km) and offshore (at distance of 10 km from shore) regions. An annual monitoring work at Kavaratti Island, Union Territory of Lakshadweep also was undertaken. The samples were analyzed for chemical, biological and microbiological characteristics. The estimation of physical parameters such as temperature, transparency, dissolved oxygen and salinity were carried out in situ. The biological productivity characteristics were done using dark and light bottle deck incubation method and pigments such as chlorophyll a, phaeophytin were estimated by acetone extraction techniques. Microbiological samples were impregnated up on the concerned sterilized agar media petriplates using spread plate techniques, incubated for 24 hrs at 37±2°C. The bacterial colonies were counted and expressed in colony forming units/ml (CFU/ml).

The Veli nearshore region was heavily influenced by the presence of untreated acidic effluents discharged from the nearby chemical fac-

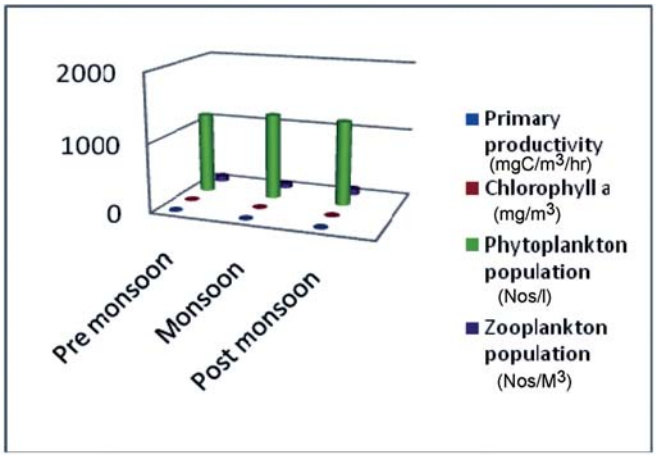

Fig.1.3.3.1 Variations of biological characteristics at Veli Shore

tory which resulted in high turbidity deteriorating the water quality. The pH of the shore water was recorded low and hence this acidic nature directly affects the biological and microbiological characteris-

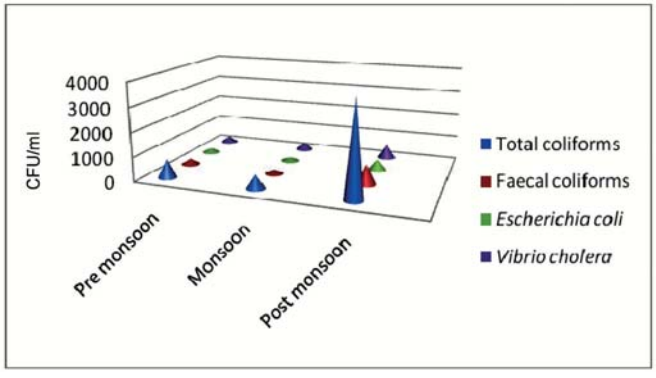

Fig.1.3.3.2 Variations of microbiological characteristics at Kochi barmouth

tics of this region. The biological productivity indicator tools such as chlorophyll a and primary productivity was found low (Fig. 1.3.3.1) indicating an oligotrophic water. The nutrient factors showed an increasing trend during monsoon season which may be due to the heavy inflow of land runoff carrying the nutrient rich elements into the coastal shelf. The zoobenthos was observed nil throughout the study indicating a shift from shore to offshore. 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 column of coastal waters. The nearshore and offshore waters were not much affected by the organic pollutants.

At Kochi the estuarine and coastal waters are well influenced by the inflow of six major rivers that carry industrial, anthropogenic and sewage pollutants from metropolitan city. This enhances the productivity to a marked level. It was observed that tidal influence flushes the estuarine system up to a water exchange of 75%, which in turn clean up the estuary to a certain extent. The nutrient level showed an increasing trend throughout the year. Biological productivity was also high. Variations of phytoplankton count showed the grazing habit of the zooplankton groups over it. Among zooplankton groups copepods and fish larvae dominated. The presence of fish larvae indicated the estuarine system as 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 of the estuarine and coastal waters. A shift of benthic community to new localities was also recorded. The variations in the microbiological characteristics revealed that the anthropogenic wastes are entering the estuarine system in unlimited quantities and this is confirmed by major indicator groups such as total coliforms and faecal coliforms. During the post-monsoon study period microbiological indicator species were present in large numbers (Fig. 1.3.3.2).

Although Mangalore region receives heavy industrial effluents through the rivers Gurupur and Netravati, the concentration of petroleum hydrocarbon, dissolved oxygen, salinity and nutrients in all three seasons showed a declining trend while the biological oxygen demand (BOD) showed a slight increase. These chemical factors in the coastal waters influence the abundance of planktons and zoo benthos. Nonetheless, their variation was negligible during all three seasons. Similarly the changes in Escherichia coli and Faecal Coliforms indicated the presence of anthropogenic discharges. Among phytoplankton, Asterionella, Chaetoceros and Skeletonema were in majority and among zooplankton, Copepods dominated in all seasons. The results imply that planktonic and zoobenthos groups inhabiting the study area can be considered as industrial pollution indicators although large quantities of industrial as well as sewage pollutants exist.

Kavaratti (U.T of Lakshadweep):

Kavarattti the head quarters of the Union Territory of Lakshadweep, the 'Coral Paradise', is a major destination of tourists, marine biologists and ichthyologists. The island has a unique marine biodiversity with sea grass bed, 104 species of Scleractinian corals, mangroves and 603 species of fishes. The physico-chemical, biological and microbiological characteristics of the surrounding sea are also very interesting for researchers. It is observed that the sea water has higher inorganic phosphate, salinity and sea water temperature. In certain sampling spots higher turbidity was observed due to stronger wave action. These low lying islands are very sensitive to sea level rise. The productivity was not varied much in all stations, which was supported by the standing crop of phytoplankton. Lagoon productivity was mainly by the bottom macro flora represented in majority by seaweeds and sea grasses. The chlorophyll *a* recorded < 2.5 mg/m^3 indicating the status of lagoon as oligotrophic. Among zooplankton epiphyte including larval forms of Euphausids and Hyperiids dominated more. In shore, bacterial population was found higher which may be due to the entry of anthropogenic wastes in connection with the development of tourism activities.

Salient findings and interpretation of Cruise Sampling Programme:

The cruise sampling programme was conducted to assess the level of pollutants dissolved in the coastal environment of the south west coast of India. During the time of sampling south west monsoon was prevailing along the entire Kerala coast and this has resulted in lower pH. Study on chemical characteristics revealed that certain stations reported low oxygen saturation and the near shore region of most of the stations were polluted with respect to anthropogenic sources. The level of nitrite and nitrate was found to be low in all the stations which were more pronounced in the offshore regions. It leads to a conclusion that the denitrification occurs in the Arabian sea. The biological characteristics study showed that Neendakara, Ponnani, Kozhikkode, Mangalore and Karwar were comparatively more productive than other stations. Fish larvae and Fish eggs which dominated in these productive stations revealed the major breeding habits of pelagic species. Microbial pollution was comparatively very high in Mangalore and Kochi especially towards the shore region which clearly indicates the influence of anthropogenic activity.

Dr. K. Narendra Babu

Funding: Ministry of Earth Sciences, Govt. of India

1.3.4 Coral Health Studies by Laser-induced fluorescence

Coral reefs are one of the most productive ecosystems on Earth. They are also the most sensitive among ecosystems to long term climate change. Around the world, corals are under threat from a multitude of sources. Depending on their location, reefs have been damaged directly through harmful practices such as coral mining, overfishing, pollution, haphazard coastal development and even by careless pleasure diving by tourists. Lakshadweep archipelago, which consists of 12 atolls and 3 reefs, is also threatened by the change in environmental condition due to alterations in salinity, rise in seawater temperature, rise in carbon dioxide content of the seawater, pollution, overfishing etc. Understanding the impact of environmental changes on coral reefs by fluorescence imaging enables us to obtain knowledge on coral growth and their adaptation under ambient conditions, without disturbing their natural habitat.

The project aims to develop a laser-induced multi-spectral fluorescence imaging system (LIMFIS) for studying the changes in coral health with environmental degradation. Exploratory studies on coral fluorescence were carried out ex situ using a fiber-optic fluorosensor on samples collected from coral reefs off Kavaratti Island in Lakshadweep. Pieces of corals chipped from the coral head were immediately placed in zip lock plastic bags containing seawater and transferred to the laboratory for LIF measurements.

Ex situ measurement of coral fluorescence

Ex situ laser-induced fluorescence (LIF) was measured from four common species of corals viz. Acropora formosa, Acropora hyacinthus, Goniastrea rectiformis and Millipora using the portable fiber-optic fluorosensor shown in Fig. 1.3.4.1 that consists of a 404 nm diode laser for excitation of fluorescence and a miniature fiber-optic spectrometer (Ocean Optics Inc, USA, Model: USB2000FL) for recording of coral fluorescence. LIF measurements were taken within 2 hours of sample collection. In order to study the physiological stress due to detachment of corals from their colony, the samples were transferred to large seawater container and LIF measurements were repeated after a gap of 9 Hrs.

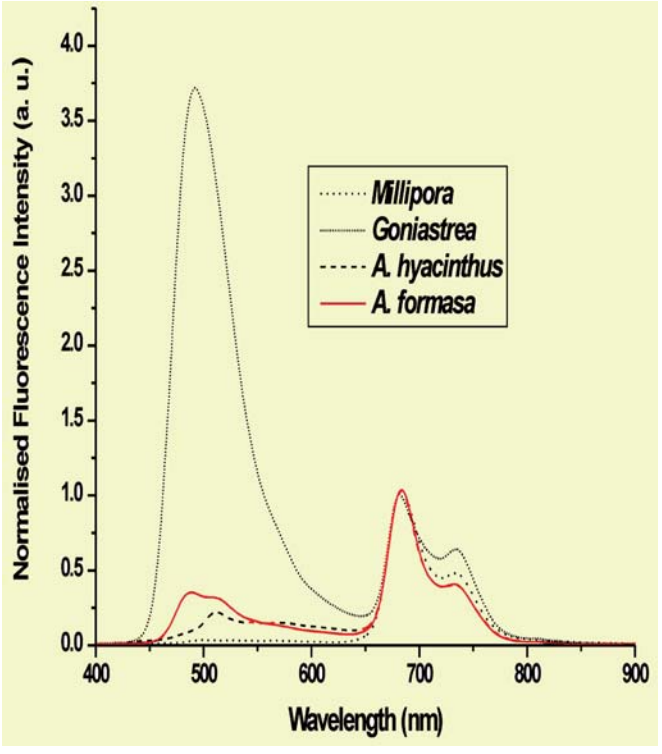

Fig. 1.3.4.2 LIF spectra of corals normalized to the 685 nm peaks

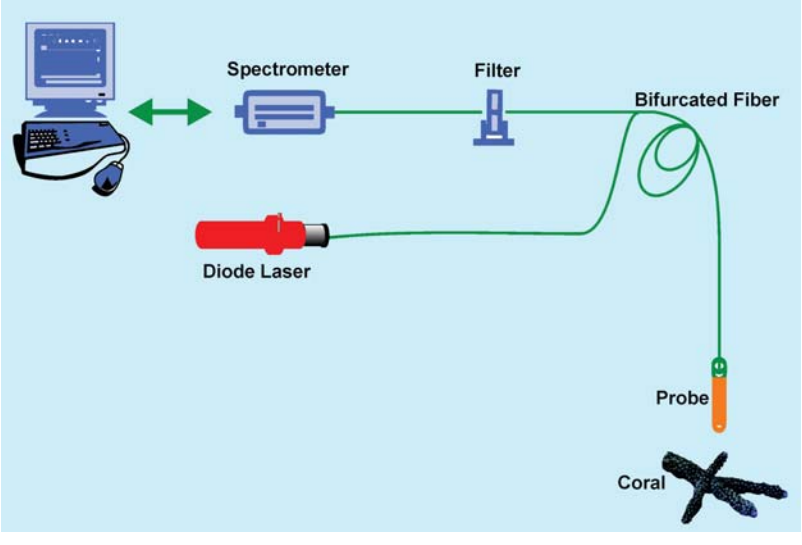

Fig. 1.3.4.1 Schematic diagram of the portable fiber optic fluorosensor

The fluorescence spectra of healthy corals was found to consist of prominent peaks at 485, 550, 575 nm from host-pigments and two chlorophyll peaks at 685 and 730 nm from photosystem (PS) II and PS I respectively, which are common to all species. Fig. 1.3.4.2 shows the mean LIF spectra of four different species of corals normalized to the intensity of the 685 nm peak. The emission peak wavelength as well as the peak intensities was found to vary between different species.

In order to precisely locate the position of the constituent peaks in each species, the mean LIF spectra were curve-fitted using Gaussian spectral functions (Origin 7.0). The fluorescence emission from Acropora hyacinthus showed the presence of host pigments with emission peaks at 511 and 567 nm, whereas Acropora formosa

ontained the highest number of host pigments with emission peaks at 483, 506 and 567 nm along with the chlorophyll peaks at 685 and 735 nm. A well pronounced peak at 502 nm was observed

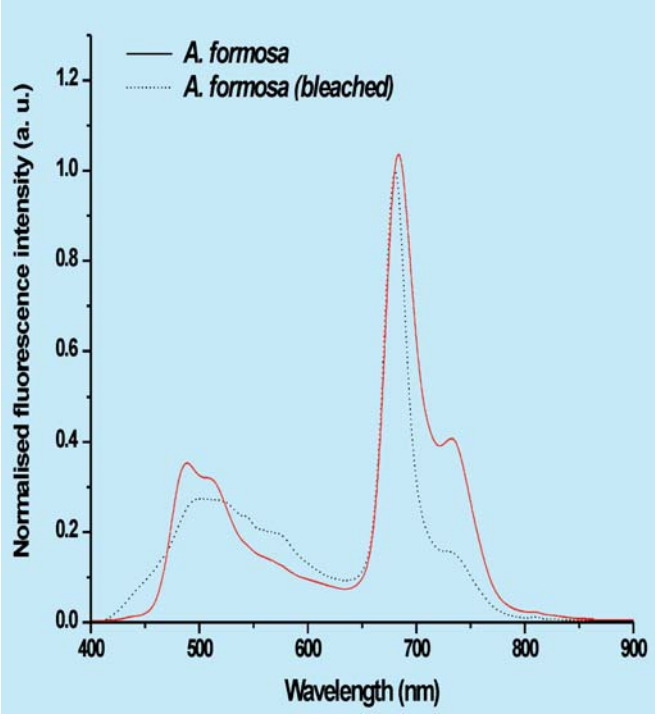

Fig. 1.3.4.3 LIF spectra of healthy and bleached Acropora formosa.

in Goniastrea rectiformis whereas Millipora exhibited a host pigment emission at 551 nm. It is possible that these spectral characteristics could be used to identify different groups of corals in situ.

Changes in LIF emission with stress

The LIF spectra from stressed corals were compared with those of healthy species to study the impact of prolonged stress. The mean LIF spectra of the stressed corals were also analyzed by curve fitting. The contribution from the 567 nm peak is absent in the LIF spectra of stressed Acropora specie. With stress, the peak seen at 511 nm in A. hyacinthus was found red-shifted by 18 nm to 529 nm while the peak at 483 nm in A. formosa was found red-shifted by 8 nm to 491 nm. In G.rectiformis the chlorophyll emission at 734 nm was seen shifted to 747 nm with stress.

Spectral characteristics of bleached sample

The LIF spectra of bleached Acropora formosa was also recorded. Fig. 1.3.4.3 shows the LIF spectra of healthy and bleached samples of Acropora formosa normalized to the intensity of the PS II peak at 686 nm. In bleached corals the 725 nm chlorophyll peak shifts towards the blue wavelength by 20 nm, which could be due to an energy transfer mechanism from PS II to PS I during bleaching process.

The fluorescence ratio of 680 and 730 nm emission intensity (F680/F730) was determined from the Gaussian curve-fitted peak intensity for healthy and bleached Acropora species. With bleaching event the F680/F730 ratio was found to increase by 129.6% from 2.43 to 5.59. It would be interesting to see whether this ratio has the potential to detect early stages of coral bleaching events in situ.

The study shows that LIF spectral signal serve as a good indicator of coral health. Further studies are required to assess the impact of typical stressors on different species of corals to take this technique forward to remotely detect stress under field conditions.

Dr. N. Subhash

Funding: DST, Govt. of India

2.1 Landslides

2.1.1 Field investigations of land disturbances in various parts of Kerala

The year 2008 also witnessed land disturbances in the form of landslides in many parts of the state. In Thrissur district the sloping banks of National Highway 47 in the Kuthiran locality experienced multiple landslides and rock falls(Fig. 2.1.1.1) that forced to suspend road traffic for four days. The towers of the Udumalpet – Thrissur 400KW transmission line are erected on the side slopes of the Kuthiran hill where the landslides have taken place. The Power Grid Corporation has requested CESS to undertake a geological assessment of the situation and offer comments on the following: (a) stability of the existing tower location, (b) protection measures feasible for the existing location and (c) suitability of a new identified location in the close proximity. Field investigation carried out by CESS has indicated that the failed slope is likely to propagate towards the tower in the near future and has recommended to relocate the towers to the nearby saddle area which was found to be stable because of strong basement.

Fig. 2.1.1.1 Landslide near Kuthiran in Thrissur district

Another programme undertaken during the year was a collaborative work with the soil conservation unit of the Department of Agriculture on the stabilization of landslide affected localities. During the SW monsoon a landslide in the form of debris flow occurred in the Vellara- Pulakutty water shed in the Kanichar Grama panchayat in the Thalassery taluk of Kannur district. The incident occurred on 1 July, 2007 in the Vellara area, in ward 9 of the Kanichar Panchayat. According to the Agricultural department's (SC unit) report two houses were fully damaged and many had suffered partial damage. According to the report about 5 acres of land became uncultivable due to the deposition of debris material. The debris flow has created new stream indicating the presence of a topographic hollow. The Soil Conservation unit of the Agricultural department proposed a restoration programme at this site to control the soil erosion problems due to the debris flow with the technical assistance of CESS to evaluate the geological aspects. The geo-environmental factors suggest that the area is landslide prone. Chances of recurrence of debris flow and rock falls cannot be ruled out. Careful handling of the terrain is required to overcome such eventualities. In this context the landslide stabilization work proposed was evaluated along with the officials and field staff of the Soil Conservation unit. The stress has been given to dewatering of the affected slopes and modifications were suggested accordingly.

G.Sankar

2.1.2 Preparation f District level Natural Hazard Zonation Maps for Kerala

Kerala state, located in the southwest part of Indian peninsula, often experiences the fury of some of the natural hazards like floods, draughts, landslides, coastal erosion, lightning and earthquakes. Information on natural hazards, prediction capabilities and to certain extent disaster preparedness require inputs from the R&D sector so as to crystallise viable management plans that can be translated into specific action programmes. The primary objective of the present programme is to document the hazard proneness by evaluating historical records of natural hazards and by carrying

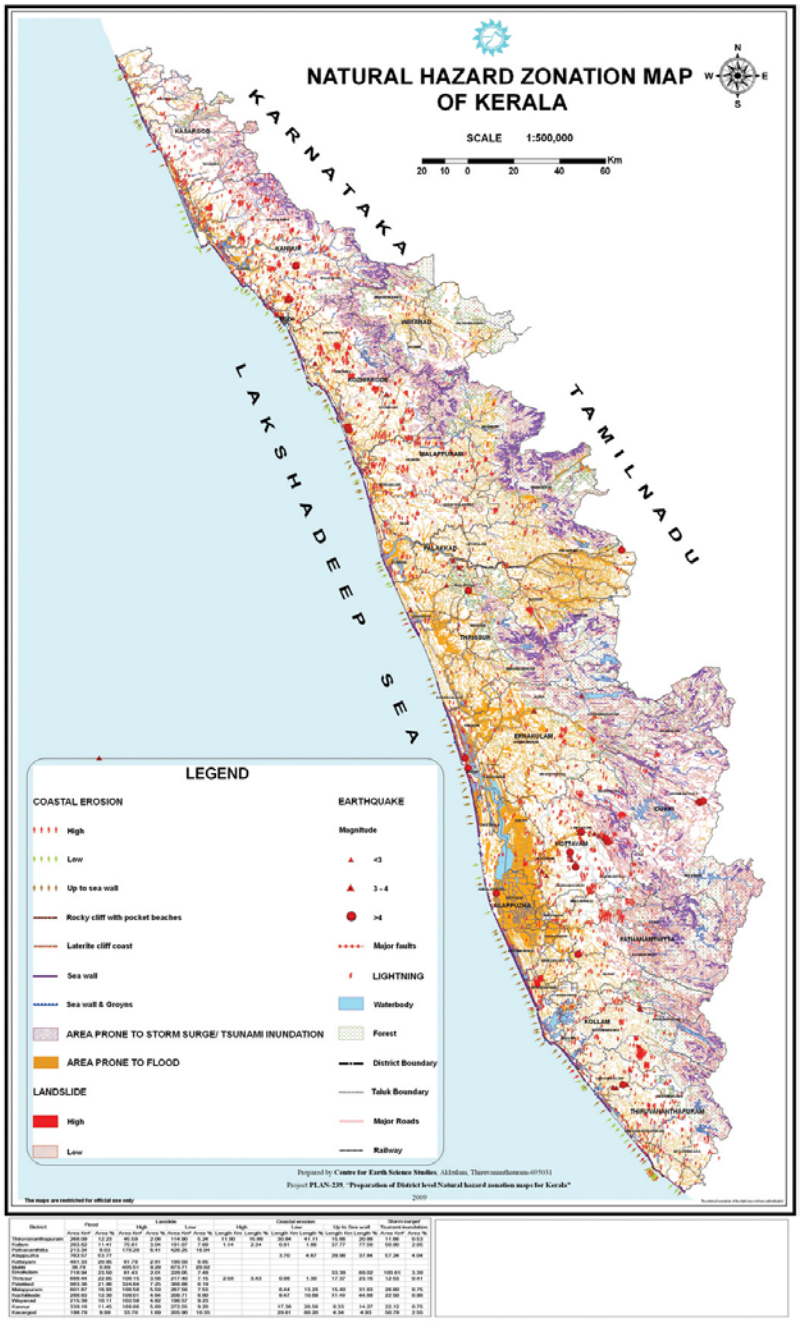

Fig. 2.1.2.1 Multi hazard zonation map of Kerala

out investigations to identify areas that are critically disposed. As part of the efforts of the state in pre-disaster preparedness, multiple hazard zonation maps pertaining to natural hazards like flood, landslide, coastal erosion, earthquake and lightning is prepared on 1:50,000 scale for each district and the output is provided as maps in 1lakh scale. In addition to the maps, a table is attached to the map giving the total area prone to landslide and flood and the length of coast prone to erosion for each taluk and district. Another table is provided with the list of villages and the common natural hazards likely to be felt in that village.

Landslide hazard zonation map has been prepared following the method of weights as per Bureau of Indian Standards taking slope, landform, relative relief, lithology, landuse, proximity to lineaments and drainage as the major parameters. Areas with high and low categories are shown in the map. Flood plains that are seasonally flooded and clearly discernable from IRS images have been demarcated as flood prone zones. Entire coastline of the state has been mapped for demarcating areas prone to erosion. A comparison of the coastline has been made from airphotos of 1986-1990 period with the present to delineate long term changes and eroding sectors. In addition the location of the coastal protection measures like seawall are given in the map. The epicenters of all earthquakes reported from the state and major faults/lineaments are given in the map. The locations of reported occurrences of lightning in each district are also plotted. The map gives a comprehensive picture of the district with reference to the probability of natural hazards.

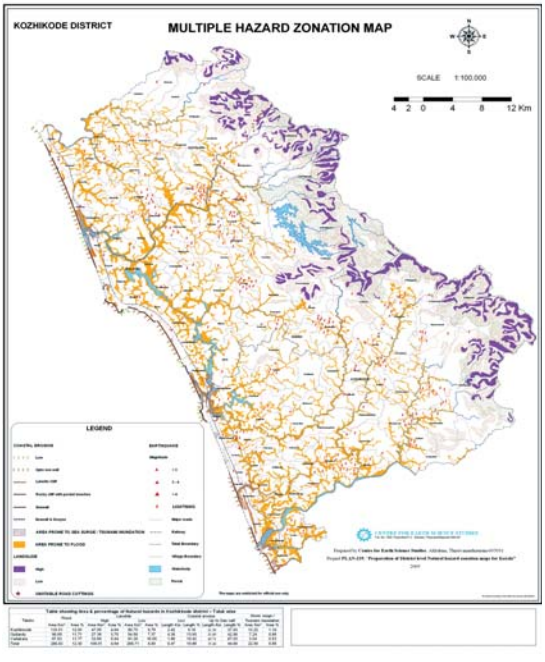

Fig. 2.1.2.2 District hazard zonation map of Kozhikode.

John Mathai

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

The indiscriminate landuse practices cause several environmental issues in many parts of Kerala State particularly in fragile areas like Thodupuzha taluk in Idukki district. During the last one hundred years, the population of the state has increased about 4 times, and in the study area in Idukki District witnessed a growth of about 23 times. This abnormal growth in population was due to the migration of people from the neighbouring regions to grab land which was available mostly in the form of forests or grasslands. Infrastructure developments and the construction works of Idukki Project also resulted in migration of people towards this area.

Major objectives of the study are - analysis of the spatial and temporal growth of population and the resultant land use changes and land degradation, delineation of the degraded areas prone to

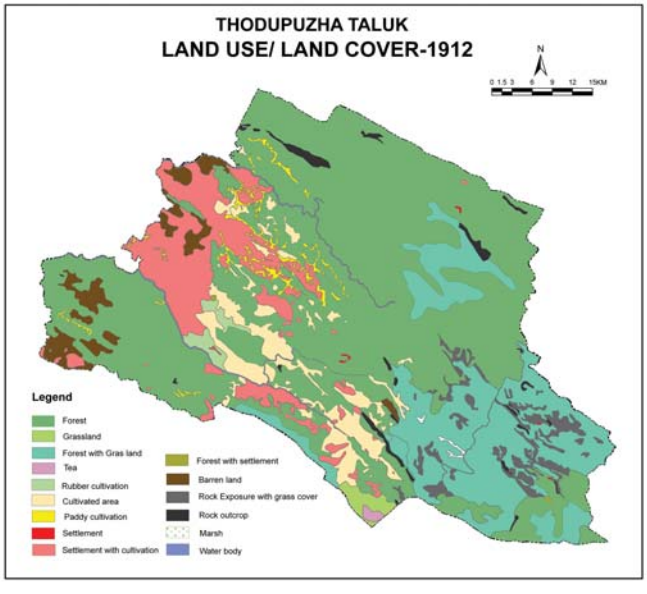

Fig. 2.1.3.1 Land use/ land cover of Thodupuzha taluk (1912)

hazards like landslides, find out measures for the restoration of the degraded land areas and suggest suitable interventions to minimize the risk of natural hazards. The extent of environmental degradation in an area can very well be estimated through the assessment of spatial and temporal changes in land use pattern. In 1912 about 70 per cent of the area was covered with forest and grasslands (Fig. 2.1.3.1). Settlement and cultivation were mainly

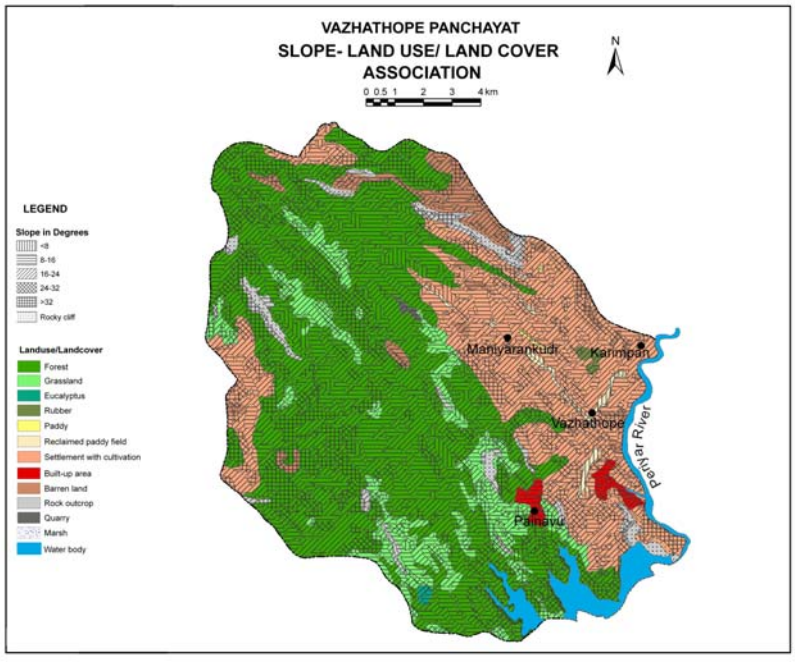

Fig. 2.1.3.2 Slope-landuse/landcover association - Vazhathope Panchayat

restricted towards the western areas having favorable terrain conditions and the eastern areas showed only natural land cover units like forest and grasslands.

In the later years these areas were densely settled and even the critical slopes were occupied and cultivated (Fig.2.1.3.3). Among the various geoenvironmental parameters, slope plays a decisive role for the various land use decisions. Disregard of this characteristic of land have posed several environmental issues in the fragile areas. A pilot study carried out in Vazhathope panchayat, eastern border of the study area reveals the implication of slope- land use association in land stability and cautions towards the necessity of adopting

Fig.2.1.3.3 Land use activities on the steep slopes – a common scene in Vazhathope panchayat

land use controls in high slope areas. During the past 8 years, four shallow land slips/ debris flows were noticed within the broad land use unit of settlement with cultivation and the angle of slope in three cases were in the range of 16-25 degrees and the remaining one incident in the >32 degree class. In all these events site specific land use/ land cover indicated that settlement with mixed crops and the landscape which was terraced with water harvesting pits are responsible for the failure.

Dr. K. Raju

2.2 Earthquakes

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

CESS is operating a broadband Seismic observatory at Peechi; in the campus of the Kerala Forest Research Institute (KFRI). It was established in 1999 as a part of strengthening earthquake monitoring in the peninsular India and for improving the detection and location capabilities of earthquakes in the shield region. The Peechi (PCH) station is one of the ten Broadband stations set up by the Department of Science and Technology, Government of India. The station has been recording local, regional and teleseismic events

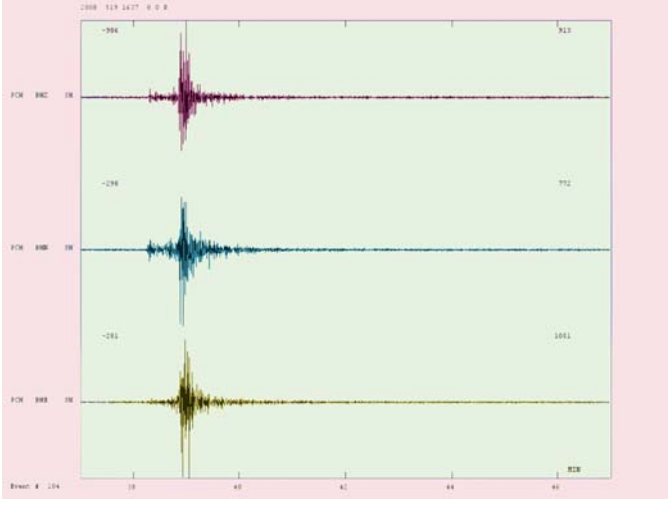

Fig. 2.2.1. Seismogram showing the 3.4 magnitude event on 19 May 2008, near Kanyakumari in the sea

and is generating high quality data. Initially, the seismograph suite was supplied by the REFTEK, USA. In May 2007, this system was upgraded, by more compact – TAURUS seismograph. A digital accelerometer was also installed at Peechi Seismic Observatory soon after, but has not recorded any ground shaking event during the period. Continuous archived data, phase picks, wave form files and catalogue of events recorded here are sent to IMD every six months (IMD being the National Seismic Data Centre). The observatory serves to provide information on earthquakes to government agencies as well as media and general public. The observatory attracts a remarkable number of visitors, including students and participants of various seminars/workshops at KFRI and thus served to be a good educational facility for the public. The IMD had used the 2008-09 data from Peechi station to answer the Parliament question.

A total of 1311 seismic events were recorded during 2008-2009. Of them, sixteen events were from Kerala, sixty four were from Andaman Nicobar Islands, one was from Tamil Nadu, two were from Andhra Pradesh, twenty six were from other parts of India (mainly from Koyna- Warna region). 1202 events were teleseismic events - occurred in other parts of the world. The local events have a magnitude ranging from 0.6 to 3.4 in magnitude. The 3.4 magnitude event occurred on 19th May 2008, off Kanyakumari in the sea (seismogram shown above). The tremor of 2.6 magnitude on 3rd October, 2008 located near Peechi dam and a 2.5 magnitude tremor on 19th Feb,2009 located between Idukki and Cheruthony were felt by many people but had no effect on life/property.

K.R. Unnikrishnan & Ms. Sreekumari Kesavan

Funding: Department of Science and Technology,GoI

2.3 Coastal erosion

2.3.1 Studies on Shore Protection Measures for Lakshadweep Islands

As part of the project, numerical model studies were taken up for Kavaratti island to examine the effect of reef reconstruction of ~400 m length on the northern part of the island. Model studies have been used as an effective tool to have a better understanding of the coastal processes of the island particularly during the various seasons. The hydrodynamic and sedimentological data already available were used. The effects of reconstruction of reef from the children's park to the entrance channel tower on the northern part of Kavaratti island (Fig.2.3.1.1) as proposed by UTL were studied using MIKE-21 modeling suite developed by DHI.

The model could also predict the nearshore wave climate for the various seasons clearly indicating the dominant wave direction and period. The modeling of shoreline changes has also been carried out using the LITLINE module of LITPACK.

Based on the results of the numerical modeling studies it is concluded that the proposed artificial reef structure is not likely to have

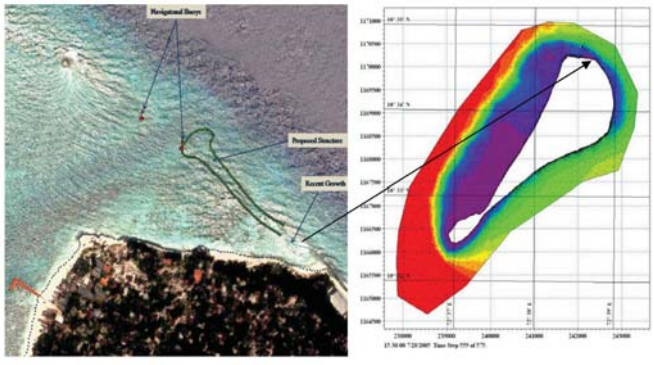

Fig.2.3.1.1 The effects of reconstruction of reef on the northern part of Kavaratti island

any negative impact on the adjoining coastline. However, the high wave activity seen on the northwest corner of the island facing the entrance channel is likely to continue. The other location where there could be higher rate of erosion as indicated by the model studies is towards the northeastern part of the island, i.e. the region to the immediate east of the proposed structure. This is mainly due to the stoppage of alongshore movement of sediments coming from the lagoon coast during various seasons. Making suitable provision for sand-bypassing during the construction of the artificial reef is recommended.

Dr. T.N.Prakash

Funding: Department of Science & Technology, UT Lakshadweep

2.4 Tsunami

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

This is a part of the national project, coordinated by the ICMAM Project Directorate (ICMAM PD), Ministry of Earth Sciences and the main task assigned is inundation modelling and mapping of storm surges and tsunami waves for the coastal areas of the country including the Andaman & Nicobar and Lakshadweep group of islands. CESS was originally entrusted with the implementation of the project for the coasts of Kerala, Karnataka and Lakshadweep which was subsequently modified to cover the coasts of Goa and Maharashtra (southern sector upto Mumbai) also.

The tasks of modelling and mapping involve prediction of tsunami wave and storm surge at source, propagation of tsunami and storm waves from deep sea to shallow waters, propagation of these waves through shallow waters to coastal land and plotting of predicted inundation in fine scale maps. The three stage modelling with appropriate inputs of bathymetric and topographic data, and mapping for the coastal areas of the country is a mammoth task and thus the project is being implemented by ICMAM PD as a multi-institutional project.

The work at CESS involved different stages, like pre-field laboratory work, field measurements for GCPs using DGPS, elevation measurements using dumpy level and DGPS, mapping of infrastructure and assets using GPS, processing of field data and preparation of grids, etc. Simulation and preparation of inundation map is the last stage of the work. The simulations were done for two scenarios: (i) the Andaman - Sumatra earthquake of December 2004 and (ii) the 1945 Makran earthquake. The output file got as a result of simulation was converted to shapefile and plotted in ArcGis. The inundation shape file was overlaid on the geo-referenced satellite image for the area. The inundated area landward of the shoreline was demarcated. The amplitudes in the inundated area were grouped in 0.5m interval for easy perusal. The inundation maps were prepared in 1:10,000 scale. For the Neendakara-Thottappally sector north of Quilon, the inundation maps were prepared in cadastral scale (1: 5000) too. The inundation map in respect of the Sumatra 2004 earthquake for the Kayamkulam inlet region is given in the figure 2.4.1.1.

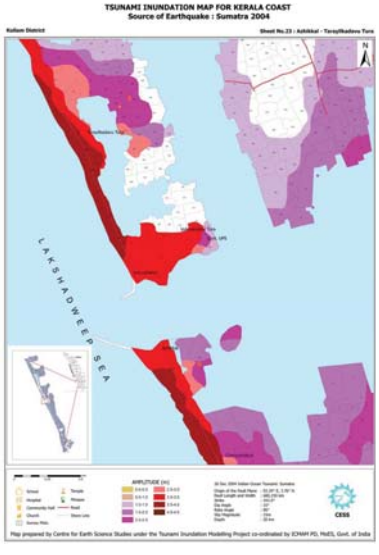

Fig.2.4.1.1 The simulated inundation map in respect of the 2004 Sumatra tsunami for the Kayamkulam inlet region

During the year under report, preparation of inundation maps for

the 1945 Makran and 2004 Sumatra tsunami was nearly completed for the inhabited islands of Lakshadweep. A problem with the logistics of the model, delayed the timely completion of work for the whole Lakshadweep. Relating to work for Kerala coast, preparation of inundation maps was completed for the southern districts of Trivandrum, Quilon and Alleppey covering a total distance of 197 km. A major part of the work covering another 170 km has been completed for the central Kerala districts of Ernakulam, Trichur and Malappuram.

Dr. N. P. Kurian

Funding: Ministry of Earth Sciences, Govt. of India

3.1 Water Resources

3.1.1 Rainwater Harvesting and Groundwater Recharge in Chadayamangalam Block

Fig.3.1.1.1 Construction of sub-surface dyke in progress in Parankode watershed

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 is 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 planned. Domestic well recharge and recharge pits are located in elevated areas with deep laterite sections and where the wells almost dry in summer. Sub-surface dykes are planned in valley head region. A few model structures (Fig.3.1.1.1 & Fig. 3.1.1.2) made at the end of NE monsoon period have harvested the pre-monsoon showers and have shown positive results.

Fig. 3.1.1.2 Check dam at Erappupara in Peruvanthode watershed

Shri. John Mathai

Funding: Hariyali, Govt. of Kerala

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

The conventional water resources like fresh water lakes, rivers, wells etc are under maximum strain due to changing climatic conditions and overall environmental degradation. At the same time, there are reports that a good number of springs having enough water potential are available; especially in the coastal belt of Kerala. However, no background information is available about the locations and quality of spring resources which are still unexploited in the State.'Spring' is a concentrated discharge of groundwater appearing at the surface as a current of flowing water. Utilization of spring water and its direct impacts are often critical to the health of spring ecosystems. Landuse changes and population growth around springs are other reasons adversely affecting the health of a spring. A number of studies have already been done about the hot water springs of India. But no serious attempt has been made to study the Hydro-geochemical characterization of cold water springs, particularly along cliffed coastal zone of Kerala.

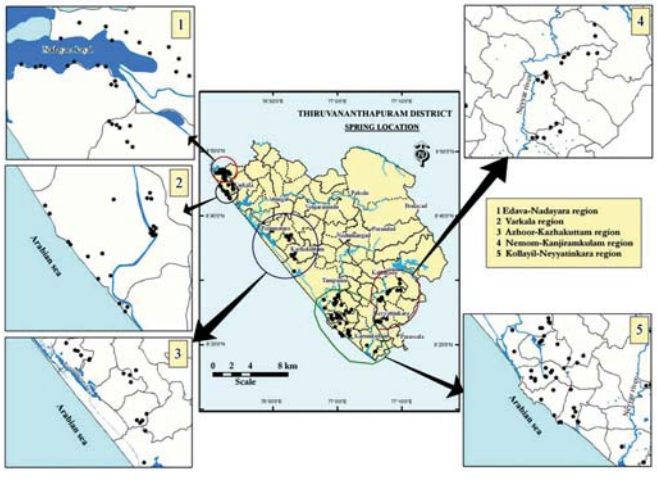

Fig 3.1.2.1 Study area showing the location of springs

An attempt has been made to map the geographic position, water discharge and the evaluation of hydro-geochemical characteristics of springs of coastal and midland regions of the southern districts of Kerala-Thiruvananthapuram and Kollam. Study area is between latitude 08° 17' 00"N and 09° 10' 00"N and longitude 76° 27' 50"E and 76° 17' 00"E. The major geological formations of the area are Archaean crystallines (Charnockites and Khondalites) and the Tertiary Succession of Kerala. The

dominant rock types of Achaean crystallines are Garnetiferous biotite /Garnet-biotite gneiss with migmatites. The Tertiaries are represented by Warkalli and Quilon Formations of Neogene (Mio-Pliocene) age. The youngest geological units comprise of Recent to Sub-Recent coastal sand and alluvium. The sandy/silty alluvium is found bordered the entire coastal margin and also occurs as linear patches along the river courses. The coastal region consists of geomorphologic units such as beaches, coastal cliffs and coastal plains, which together constitute 6% of the study area is within an altitude of 20 m (MSL). The valley floor with associated flood plain and lower lateritic plateau comprise 57%. Mixed crops are the dominant land use. Nearly 40 % of the area is coming under the category of gentle to moderate sloping. The dominant portion of the study area is deep, well drained gravelly clay soil with moderate erosion.

Fig 3.1.2.2 Photograph showing a typical spring in Thiruvananthapuram district

Natural spring sources with rich water potential are abundant in the coastal and midland regions of Thiruvananthapuram and Kollam (Fig. 3.1.2.1). More than 200 spring sources are located in the region and about half of them are perennial in nature with very high water potential. Forty three springs are selected and evaluated for seasonal flow rates and hydro-chemical characteristics. The combined flow rate ranges in monsoon; 2200 lpm, post-monsoon; 2574 lpm and pre-monsoon; 1610 lpm. The highest flow rate in majority of the springs is in post-monsoon and lowest in pre-monsoon season (Fig. 3.1.2.2). Annually, the springs from Hariharapuram-Ayiroor recorded the maximum water flow and Kariavattom -Chirayinkeezhu recorded the minimum. The chemical quality of the water in all locations is superior and satisfies BIS/WHO drinking water standards except the pH, which shows acidic characteristics. Majority of the springs have conductivity values less than 100µS/cm indicating low range of dissolved salts. In all the spring clusters, the dominant water types are Na-HCO_3/ Na-Cl, rich with subordinate Ca and Mg (Fig. 3.1.2.3). The majority of the Neyyattinkara-Vengannur spring waters fall within Na-Ca-Mg-$HCO_3$with low TDS type waters, which are more or less similar to the source of highlands and escarpment groundwater. In Kariavattom-Chirayinkeezhu, the water type (Na-Ca-Cl-HCO_3) with low TDS represents early stage of geochemical evolution of young meteoric or recharge area waters/ground waters have undergone a relatively pronounced degree of groundwater chemical evolution with likely contribution of salts from lacustrine deposits. In Varkala-Sivagiri, Ayiroor-Hariharapuram, Chirakkara-Nedungolam and Kallada-Nedumpana clusters discharge Na-Cl (water type) dominant groundwater with subordinate Ca/Mg/HCO_3 These spring clusters discharge ground water that is strongly influenced by the dissolution of limestone in the coastal margin / hydrolysis of silicate minerals inland of the coastal transition zone, mixtures of fresh and saline groundwater are produced. High chloride may be contribution from the salts of lacustrine sediments; might be another reason for the groundwater evolution in Chirakkara-Nedungolam, Ayiroor-Hariharapuram and Kallada-Nedumpana spring clusters. Groundwater discharging from these spring clusters is generally dominated by Na- HCO_3except along the coast where the coastal transition zone becomes an important influence on water quality (Na-Cl water type). Presence of pathogenic coliforms is noticed in certain spring locations which may be due to the prevailing unhealthy environmental conditions.

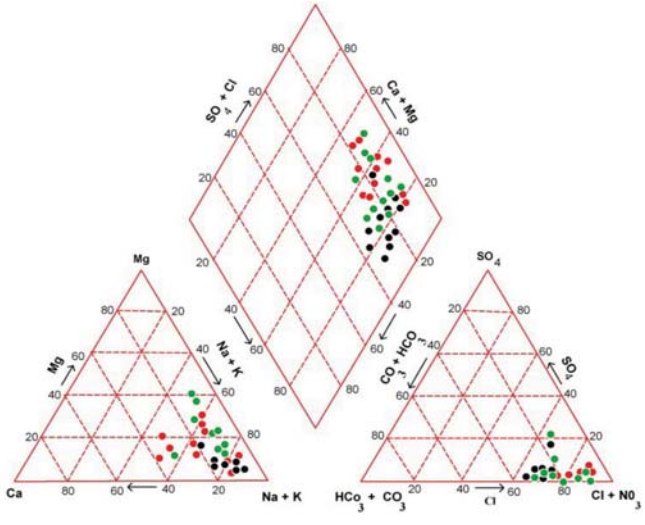

Fig 3.1.2.3 Piper plot of spring water

In the present study more than 200 springs of both flow type and pond type were identified and located in the lowland-coastal segments in two districts. The combined water potential of all these will be about 125 lakh liters per day which is sufficient to meet the requirement of nearly 1.8 lakh people, at the rate of 70 liters of water per person per day, and the percapita water availability from spring sources is 10.7 liters. All these spring resources are spread in 12 blocks (38 panchayats/muncipalities) with a total population of 11.7 lakhs. In other words it can be concluded that these spring water sources are sufficient to satisfy the water needs of 15.2% of the total population of the spring bearing blocks (panchayats). These spring resources can therefore be developed as an alternative drinking water source through proper maintenance and preservation.

Between 1950 and 2000, the human population more than quadrupled, and our population continues to increase. With this growth, the demand for water raised to a tremendous level, as well as extensive land use changes also occurred. It causes in the destruction of most of the springs in both private and public lands and it comes around 18%. Consequently, flow discharge reductions have been resulted in many of the spring resources and also documented a decline in water quality, particularly in regard to nutrients enrichment. So management of these nature's gifts is very urgently warranted. This strategy will spread awareness to the people to protect and restore the spring water quality and quantity.

Dr. K. Narendra Babu, Dr. D. Padmalal & Dr. K. Maya

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

This study aims to assess the physico-chemical and bacteriological quality of surface and ground water resources, to delineate the difference of nutrient and trace element concentration in urban and non-urban areas, to correlate the gravity of urbanization in terms of contamination in water, soil and sediment characteristics and to suggest strategies and management action plans for reducing the impacts of urbanization on water and soil/sediment systems, in the lowland regions of Thiruvananthapuram, Kochi and Kozhikode. The study area forms part of the Pre cambrian rocks of the Kerala region and blanketed unconformably by Tertiary sedimentary exposures. In Thiruvananthapuram and Kochi, the major land uses are coconut plantation, built-up land and paddy while mixed crops dominate in Kozhikode. Study showed that, during all seasons, the surface and groundwater resources recorded high values of physico-chemical parameters in urban centers compared to that of non-urban areas. The groundwater samples of Thiruvananthapuram and Kozhikode exhibit significant regional and spatial quality variation, but in Kochi the entire urban area recorded high values for all parameters. The important urban scenarios observed are; the SO_4 concentration is higher in the well waters of Kochi, high concentration of NO_2 is found in well waters of low-lying coastal regions of Thiruvananthapuram, wide spatial variation of NO_3 is found in groundwater samples of urban and non-urban areas of Thiruvananthapuram, there is a wide range of seasonal variation of Inorganic Phosphorus (IP) in both surface and groundwaters in all three urban centers; among well waters, the maximum concentration of IP is recorded in Kochi urban area. In addition, presence of TC was noticed in all seasons in all well waters samples from Thiruvananthapuram, E.coli is widely present in well waters of Kochi while no growth of FC as well as low count of E.coli is recorded in Kozhikode ground water samples. The water type of ponds/temple ponds in urban area with low TDS represents meteoritic or recharge area waters. Path of Chloride in well waters may be explained due to leachate percolation and sewage pollution. Other than pollution, geology plays a dominant role on hydrochemical quality of various hydrologic regimes of these urban centers.

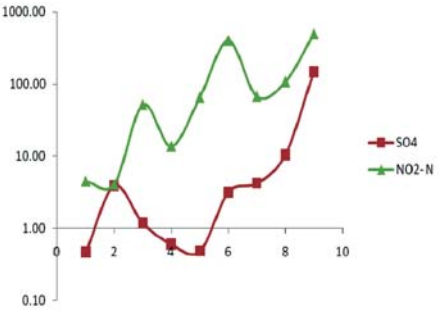

Fig. 3.1.3.1 Increase of SO_4 and NO_2 - N in Karamana river water from a non-urbanized segment

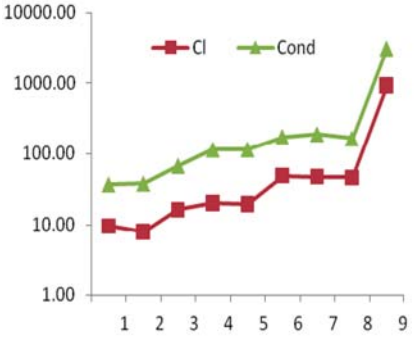

Fig. 3.1.3.2 Graph shows the high level of Cl and conductivity in an urbanized segment of Karamana river at Thiruvallom

Study revealed that ground water quality of urban areas is drastically poor with respect to non-urban segments and noticed wider quality variation in the surface water resources also. (Fig. 3.1.3.1) The river water that flows through urban segments shows drastic quality differences, with respect to non-urban segments. For example the lower stretches of Karamana river which flows through the urban centers of Thiruvananthapuram city showed wide quality differences be-

tween upstream and downstream areas. (Fig.3.1.3.2) Thiruvallam and downwards generates foul smelling due to the direct disposal of solid and liquid wastes of urban origin into the Karamana river.

The high rate of migration and rapid population growth with limited infrastructure and other facilities resulted in unhealthy living conditions in cities. The poor unsanitary conditions contaminating ground water aquifers, or washed into surface water bodies often results in the spread of waterborne diseases. Anthropogenic activities, climatic and catchment characteristics together adds to the complexity of the inherent issues. Therefore due to the quantitatively inconclusive nature of research outcomes, the management of water quality impacts in urban areas has proven to be an extremely challenging task. A holistic approach is needed to safeguard the quality of receiving waters in urban areas. Since the current approach is piecemeal and the benefits are only be marginal and even be counterproductive.

Dr. K. Narendra Babu, Dr. D. Padmalal & Dr. K. Maya

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

Geochemical reactions that take place between interstitial water and sediments in aquatic environments impart significant changes in the chemical composition of the overlying waters, especially through migration of interstitial fluids from sediments to the overlying water column. Under the project a detailed study on the migration pattern of nutrients and trace metals between sediment / interstitial water phases and overlying water column in different geochemical setup are envisaged. Sediments are the ultimate recipients of particulates which are either biogenic or detrital in nature.

Extensive chemical, microbiological, and physical transformations occur in areas close to the sediment water interface. The geochemical reactions such as decay of organic matter are at enhanced rates 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. Many attempts have been made to study the chemical composition of interstitial waters trapped in marine sediments but the same on the interstitial water chemistry of estuarine and fresh water environments especially on Indian scenario are meager. In order to fill the gap a systematic study has been initiated on the chemical composition of interstitial waters in three selected aquatic systems in Kerala – (i) a fresh water body (Vellayani lake), (ii) a water body with restricted saline water mixing (Kadinamkulam lake) and (iii) a water body having free connection and interaction with saline waters (Paravur lake). Since interstitial waters are potential sources of nutrients and metals derived during post depositional phase (ie, early diagenetic phase) its study become most important for the better understanding of the chemical quality of water bodies. Further, these studies will throw light on to the mobility of nutrients and trace metals between interstitial water and sediments and also its diffusion with the overlying water column.

Surface water, bottom water and core sediments from 21 locations of Paravur, Vellayani and Kadinamkulam lakes are collected. Interstitial water is extracted from core sediments of two 5 cm intervals at the top and 10 cm intervals below it. Both water and interstitial water are analyzed for physico-chemical constituents. Wide concentration differences are noticed between interstitial water and overlying water. The pH and salinity of interstitial water of all the three lakes are slightly higher than that of overlying water. The concentration of different species of nitrogen and phosphorus and that of Si and Fe are several times higher in interstitial water compared to water column. It implies that migration of nutrients and metallic elements from interstitial water to overlying water alters the quality of lake waters.

Dr. K. Narendra Babu & Dr. D. Padmalal

Funding: DST, Govt. of India

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.

This project completed during this period aimed to link up landscape evolution and morphogenetic processes operating within the Periyar basin through morphometric analysis and terrain mapping at basin and sub-basin level. The Periyar is an eighth order stream with total first order drainage segments of 15773 and average drainage density of 2.46 km/Km^2. Detailed analyses have been attempted for three 7th order sub-basins. Nine landform units could be deciphered for the entire basin. Around 57% of the basin area falls under three categories of moderately undulating terrain, highly undulating terrain and steep slope. This is well manifested through digital terrain model (Fig. 3.2.1.1). Forest and settlement with mixed tree crops dominated the landuse pattern. Downstream segments of the basin is characterised by settlement with mixed tree crops and water bodies. Morphoconservation map (Fig. 3.2.1.2) has brought out that there are areas with more than 85% slope angle distributed in various parts of the basin. Hypsometric analysis of the basin indicated different stages of river maturity and tectonic influences in shaping the landform.

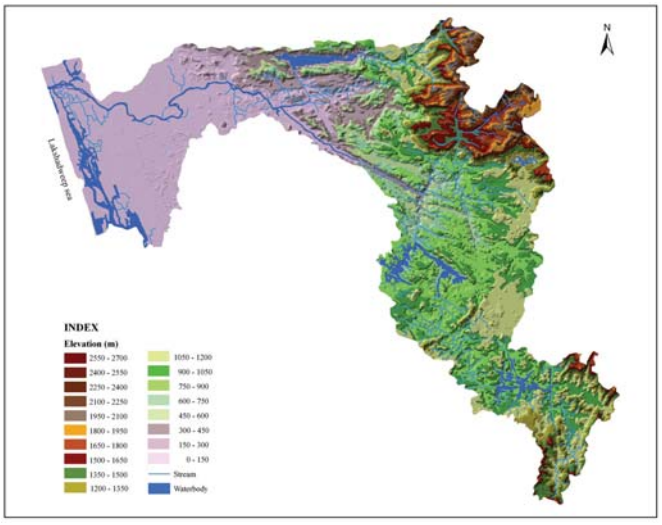

Fig. 3.2.1.1 Digital Terrain Model of the study area

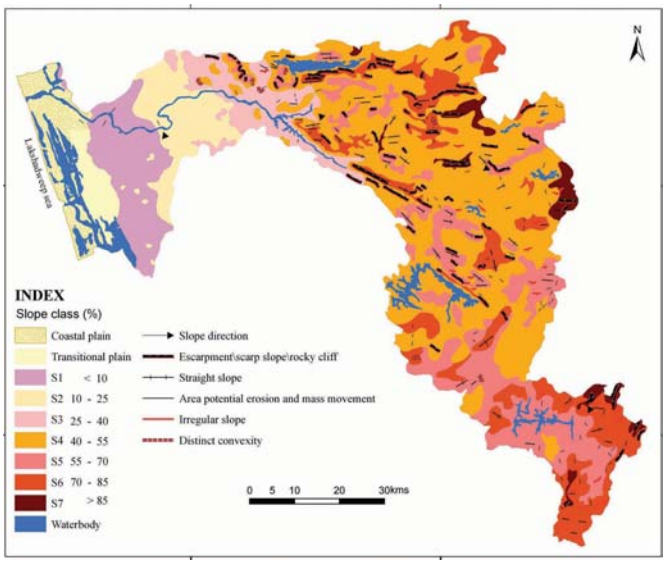

Fig. 3.2.1.2 Morpho-conservation map of the study area

Dr. Mahamaya Chattopadhyay

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

During the period, landuse maps (1967 and 2008) of the study area particularly within Kulathupuzha, Amboori, and Kuttichal panchayats were finalised. Field work was undertaken to detect landscape alteration and landuse changes. Digital terrain model was created. Digitization of thematic maps especially on terrain determinants was undertaken.

Dr. Mahamaya Chattopadhyay

3.2.3 Landuse / landcover change and its impact on biophysical system: A case study in Pamba - Agasthamalai hill tract

The study area of this project spreads over seven river basins from the Neyyar in the south to the Pamba in the north covering an area of 5297 km^2. Forest vegetation reduced by 28% in a span of 37 years from 1967 /68 to 2004/05. Plantation has grown by almost six times during the same period. There are five major reservoirs impounded in this area since 1959. Catchment yield index varies from 0.48 in Neyyar river basin to 1.15 in the Pamba river basin. Terrain character, thick vegetation cover and high rainfall contribute to this high yield of the Pamba basin. River valley projects, forest plantations, Government policy and market forces are major drivers of landuse change. Time series rainfall analysis for 5 stations indicated that rainfall during south west monsoon declined by 10% to 15% (Fig. 3.2.3.1). Soil erosion increased by 75% under degraded tea compared to natural vegetation cover.

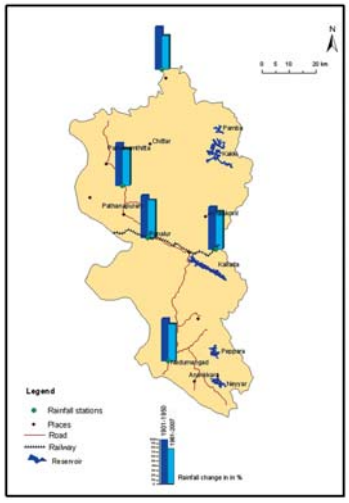

Fig. 3.2.3.1 Change in rainfall in Pamba - Agasthamalai hill tract

Soil sample analysis under different landuse categories brought out that organic carbon and nutrient content vary with landuse (Table 3.2.3.1). Interior of the forest area is getting thinner over the years. Even within the reserve forest area there is a change in landuse pattern.

Depth in cm	Land use types							
	Forest	Grass land	Teak	Acacia-mangium	Tea	Rubber	Eucalyptus	Settlement with mixed tree crops
<20	2.89	1.93	2.24	1.41	0.41	2.20	0.73	1.22
20-60	2.10	0.48	1.33	0.97	0.71	1.68	-	-
60-100	0.71	0.46	0.93	0.97	0.37	1.62	0.85	0.32

Table 3.2.3.1 Distribution of organic carbon under different land use types along depth, Kallada Basin

Dr. Srikumar Chattopadhyay

3.2.4 Rejuvenating lateritic areas of Neyyar region in the Western Ghat region of Thiruvananthapuram using rock powder as Geonutrient for sustainable agriculture : A technological intervention

During the period, field works were undertaken to collect the laterite samples developed over different litho-units to determine major and trace element composition, nutrient status and landuse. Major portion of the study area is covered by khondalites (Garnet - biotiote -sillimanite gneiss with graphite) and Garnet – sillimanite - biotite gneiss (without graphite) Charnockite-gneiss intercalations also occour in many places . Discontinuous patches of pyroxene. granulites were also noticed at many places. Tertiary sediments occur as narrow band parallel to the coast. Numerous pegmatite veins cut across the study area. All these rock types are lateritised. Representative laterite samples developed over different lithounits were collected for geochemical characterization and also for nutrient status evaluation. The profile schematic sketches showing the various zones in the insitu laterite profiles developed over different rock types.

Physical Properties of the laterites:

Laterite is brick-red to purplish in color which has typical vermicular structure and the cavities are completely or partially filled with grayish white clay passing to ocherous. The sides of the vesicles are usually ferruginous and are deep brown in color. Studies on the physical properties of laterite soil reveals that the bulk density and particle density in most of the cases were uniform in different depths showing more or less equal weathering for all the depths. Water holding capacity and volume expansion show a clear increase with increase in depth, showing a positive influence of clay. The pH of the laterite soils vary from acidic (pH 4.5) to nearly neutral (pH 6.0). In general the acidity is lowest in the upper layers, increasing towards a certain depth and decreasing towards the B or C horizon. The laterite soils have a low CEC and high AEC. The CEC of laterite soils ranges from 2-10 Cmol (p+) Kg-1 soil. Due to the climatic conditions (high temperature and high rainfall) prevailing in the region, the organic matter accumulation is rarely encountered.

General characteristics of laterite soil

The laterite soils found in this region are typical weathering products of gnessic and granitic rocks developed under humid tropical conditions. Heavy rainfall and the high temperature prevalent in this region are conducive to the process of laterisation. The insitu laterites in this region has been formed by the leaching of bases and silica from the original parent material, with concurrent accumulation of oxides of iron and aluminium. The laterites seen in this region are generally observed a few feet below the surface and are acidic in reaction and the surface layer often consist of an appreciable proportion of gravel. These soils are porous, well drained and respond to good cultural and management practices.

Morphology

The surface soils of laterite origin are mostly reddish brown to yellowish red in colour. The surface texture mostly ranges from gravelly loam to gravelly clay loam. The depth of the plinthite (soft laterite) layer varies depending upon the topography. The profiles have abundant ferruginous and quart gravels. The content of coarse fragments varies from 30 to 60% in this region. The plinthite is characterized by the compact, vescicular mass below the B horizon, composed essentially of a mixture of hydrated oxides of iron and aluminum. The plinthite encountered in this region is of non quarriable type which breaks into irregular lumps. The most important visible feature of laterite soils is

the accumulation of the oxides and hydroxides of iron which impart yellow, pink, brown and red colours to the matrix and earthy clay.

Fertility of lateritic soils - an overview

Lateritic soils in this region are inherently acidic and have very small amount of calcium and magnesium. When the pH is below 5.5, exchangeable aluminium is the predominant cation in the soils than exchangeable hydrogen. Among the basic cations magnesium deficiency is a very serious problem in the lateritic soils because no magnesium appears in the surface layers and it is found to concentrate in the deeper layers. Phosphorus deficiency is one of the most widespread soil constraint in the lateritic soils. When applied in soil , they react with oxides of iron and aluminium and form sparingly soluble reaction products. The clay and organic matter largely influence the relative phosphorus sorbing index of these soils.

Due to the characteristic terrain and physical properties, lateritic soils in this region have been subjected to intensive leaching and hence have low levels of labile potassium. The organic carbon status of lateritic soils ranges from 0.2 to 0.5% in most cases and hence it supply only small quantity of nitrogen. The surface layer of lateritic soils have very low sulphate adsorption and sulphate build up is very little in these soils. The sulphate ion leaches from the surface horizon and build up in the sub surface layers. The micro-nutrients are generally low in laterite and among the micro-nutrients, zinc and boron are often deficient.

General fertility status of soils of Neyyar river basin

With a view to identify and estimate the general fertility status of the region, surface samples were collected from different locations at random and analysed for the major nutrients. The general fertility status of a series in a region shows wide variation depending upon the management practices including the application of nutrients in the form of fertilizers or organic manures etc, the crops grown and the land use pattern prevailing in that region etc. Hence this has to be checked periodically . General fertility status of the study area is given in Fig.3.2.4.1. The major soil series encountered in Neyyar river basin are Ponmudi, Kottur, Kallar, Chempakathippara, Palode, Kodithooki, Nedumangad, Vizhinjam, Neyyattinkara, Vilappil, Mukkunni, Amaravila, Kuttichal, Karamana and Vellayani.

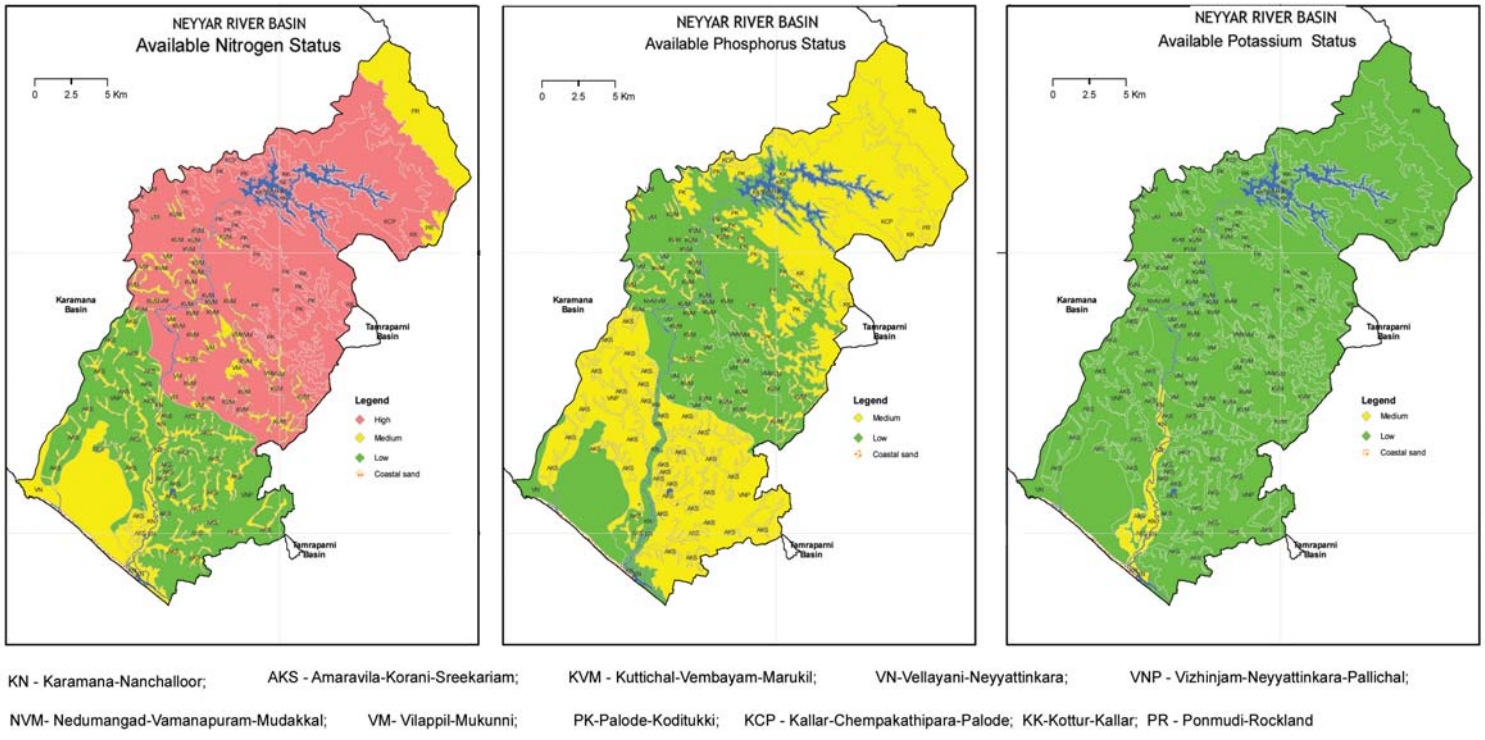

Fig. 3.2.4.1 General fertility status of Neyyar river basin

Dr. Narayanaswamy

Funding: Western Ghat Cell, Kerala State Planning Board

3.2.5. Characterisation of laterites of Kerala and Preparation of laterite distribution map

As a part of the studies to characterize the laterite developed over crystalline rocks and tertiary sediments with varied physico-chemical properties and also to prepare laterite distribution map of Kerala, field work has been completed in Kollam, Kottayam, Idukki, Pathanamthitta districts to document the physical properties and aerial distribution of laterites. The results show that the laterites are brick red to purplish in color, the texture is compact over laterites developed over crystalline rocks & non compact over laterite developed over tertiary sediments. The maturity index of laterites in Kottayam district show moderate to strong lateritisation and in Pathanamthitta district lateritisation is weak to moderate. Prepared laterite distribution maps of Kollam, Kottayam, Pathanamthitta and idukki districts.

Base maps of Kollam, Pathanamthitta, districts, demarcating water bodies, sheet rocks, river, paddy fields, forest loam, coastal sand and alluvium prepared in 1: 50000 scale based on Survey of India topographic sheets. Laterite distribution maps for the above two districts were prepared after the field work. Finalisation of these maps will be done after cross checking with recent satellite imageries. Mineralogical analysis of few laterites from Kottayam district were studied using XRD and Thin section. Composition of major, minor and trace elements of laterites developed over

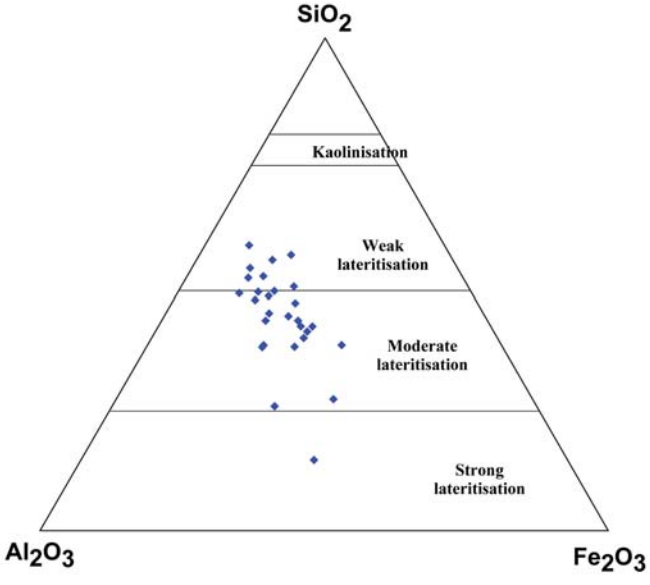

Fig. 3.2.5.1 Maturity Index of Laterite in Pathanamthitta District

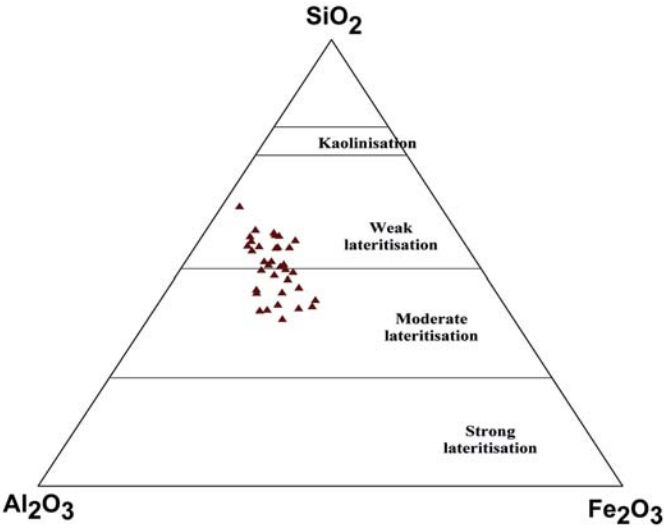

Fig. 3.2.5.2 Maturity Index of Laterite in Kottayam District

different rock types from Kottayam and Pathanamthitta districts were analysed using XRF.

Mineralogical – Geochemical studies

Mineral assemblages of few laterite samples from Kottayam were completed through a combination of different techniques such as petrographical studies and X-ray diffraction analysis.

X-ray analysis using powder diffraction method was carried out on Phillips PW 1730 X-ray generator. The 420 mesh fraction of the laterite samples were scanned from $5^{O}$to 65^{O} (2θ) with CuK_2 target and Ni filter operated at 40 KW and 20 mA with a chart speed of 2^{O}/ minute and then interpreted using ASTM charts. Kaolinite, gibbsite, quartz, goethite, vermiculite form the major mineral assemblage in the laterites.

Petrographical studies of the laterites revealed that all the silicate minerals have been transformed to a mixture of goethite, hematite and kaolinite. Alteration begins along cleavage planes, grain boundary and cracks. It is further observed that pyroxenes have been altered to goethite while feldspars gave rise to kaolinite. Quartz is cracked, eroded and disintegrated. Alteration of pyroxenes precedes that of feldspars in charnockite. X-ray diffractograms substantiate the presence of kaolinite, goethite, quartz, gibbsite, dickite and illite.

Geochemical analysis - major,minor and trace elemental compositions of laterite samples developed over crystalline rocks and

Tertiary sediments from Kottayam and Pathanamthitta district were carried out. The major rock types found in Kottayam district are charnockite, granite and Tertiary sediments viz. sandstones and in Pathanamthitta district the major crystalline rocks found are granite gneiss, charnockite, garnet biotite gneiss, and diorite.Tertiary sediments consist of sandstone clay intercalations. All these rock types are extensively lateritised. Field and geochemical studies indicate that two types of laterites (1) Primary laterites developed over crystalline rocks and (2) Secondary laterites developed over tertiary sediments are found in Kottayam, Pathanamthitta districts. Charaterisation of laterites using geochemical analysis in ternary diagrams of Al_2O_3-Fe_2O_3-SiO_2 indicate that the laterites developed in Pathanamthitta district (Fig. 3.2.5.1) are lateritised moderate to weak and that of Kottayam, district (Fig. 3.2.5.2) are lateritised weak to strong.

Physical description and colour of laterites

Laterite is a brick red to purplish material, which has typical vermicular structure and the cavities are completely or partially filled with greyish white clay passing to ochreous. The sides of the vesicles are usually ferruginous and are often deep brown in colour. The hardest variety duricrust is the darkest colored and is ferruginous in nature. The surface of soft varieties presents a variegated appearance and exhibits yellow and white patches intersected by a network of red, purple or brown colours. The softness of the laterite is such that it can be cut with any sharp iron instrument like a spade. It hardens on exposure to sun and air and withstands any climatic changes. Laterite owes its colour to iron oxides in various states of hydration and hence the estimation of colour gives a rough idea of composition.

Specific gravity

The specific gravity estimates of laterites developed over different rock types in Kollam, Pathanamthitta, Kottayam, Idukki, Allapuzha, Ernakulam, Trichur and Kozhikode districts varies from 1.64 to 2.94. The variation is consistent with the chemical composition. The specific gravity of oxidized form is higher than that of hydrated form. Comparison of apparent density is useful in estimating the intensity of leaching of elements. It is also observed that, the compact the structure of the laterite, lower is the density.

Dr. Narayanaswamy

3.3 Environmental Assessment

3.3.1 Environmental management plan for A-S canal and Kanjikuzhy Gram Panchayat

This project funded by KSCSTE is of two years' duration. It has been initiated in the month of June, 2008. Preliminary works covered compilation of a bibliography, literature review on works done in the Vembanad lake, procurement of maps and reconnaissance field visits. Twenty one water samples from different canal segments have been collected and are being analyzed. Field mapping has been conducted to demarcate flood affected area.

Dr. Srikumar Chattopadhyay

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

State of environment study covers, 55 local bodies including Kochi city and adjacent local bodies (Fig. 3.3.2.1). The study followed the methodology adopted for state of the environment preparation as practiced world over. The appraisal of the climatology of Kochi area was based on 80 years (1901-'80) climatic data collected from IMD. Further data on rainfall up to the year 2005 has been collected, and analysed. Data on rainfall, temperature, humidity and wind from the Naval Meteorological Station at Wellington Island and Cochin International Airport at Nedumbasseri were also analysed. In addition, five sets of instruments were continuously monitoring temperature and humidity at different locations of the study area. Sample monitoring of methane emission has been carried out at 15 stations in the Vembanad backwater region as part of this study.

Landform analysis has been carried out for the entire area using topographic sheets of 1960 and 1980. This has been subjected to field verification for preparing the landform appraisal at present. Geological appraisal of the study area has been carried out from secondary data, mainly from GSI records. The temporal and spatial change in landuse has been carried out for the years 1910 (1:63,360), 1960 (1:50,000) and 1984 (1:25,000). The earlier study on seismic hazard microzonation of Kochi city has been incorporated for the study. An inventory of hard-rock quarries in the area has been made with the help of information obtained from the Department of Mining & Geology and further field verification.

Water quality data has been generated for surface and ground water samples from the north-western and south-eastern portions

of Vypeen Island and near shore. CESS has been monitoring water and sediment quality parameters in the backwaters around Kochi Port since 2001. Recent data from the study has been incorporated. The status of the physico-chemical parameters, plankton community, benthos primary productivity, chlorophyll a and microbiological characteristics of the near-shore waters of Kochi has also been prepared based on the studies of CUSAT and CESS.

An appraisal of the mangrove ecosystem and other natural vegetation and sacred groves of the area has been carried out based on available literature and field verification. An inventory of the aquatic resources, both marine and estuarine, and marine fish landing has been made and information compiled. Data on the area under traditional pokkali cultivation, aquaculture and fishermen population has been collected and incorporated as study components.

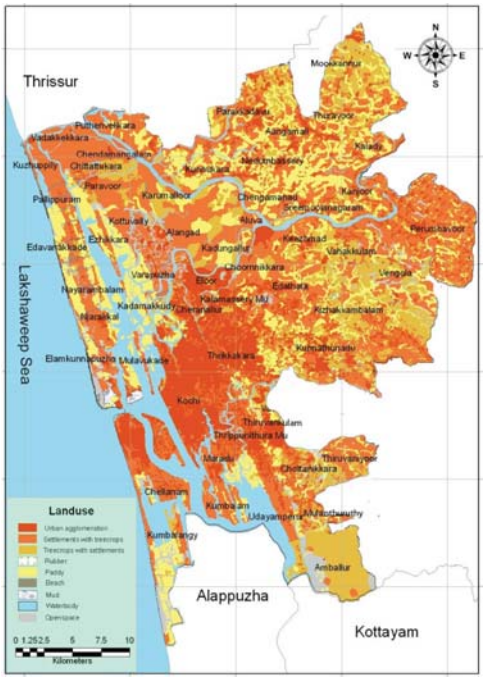

Fig. 3.3.2.1 Land use of Kochi study area during 2004

The noise level was monitored in Kochi and surrounding region. Considerable information on air quality data has been generated for certain pockets of the study area. Data for other regions generated by NEERI and other agencies were also utilized for providing spatial information on the air pollution status and pollutant dispersion pattern.

An analysis of the socio-economic data has been carried out based on 2001 Census data. The development reports of all the local bodies in the study area have been consulted and the major issues of respective local bodies identified. The issues so prepared have been discussed with local body officials, elected representatives and experts. Based on the discussion, compilation on the development sectors, occupation and environmental concerns of each local body has been prepared. Delineating key environmental issues and hotspots, evaluating the issues in terms of driving force or causative factors, pressures, state and impacts due to each issue and response of community or government to each issue, suggesting action plans for the management of the issues and integrating the action plans are the common procedures followed.

The study addresses the dispersal pathways and flux of nutrients in river systems and estuaries, productivity status, methane emission flux in wetland regions, thermal distribution over the urban areas etc. Special emphasis was given on the coastal ecosystems, waste management and health in human settlements and reduction in wetlands and its functional aspects. The methodology also involves organizing the complex information in GIS framework. In order to communicate the major problems and their degree of concern, prioritization matrix based on the impacts of the problems on public health, biodiversity, vulnerable population groups, productivity loss, critical ecosystems etc and the nature of impacts such as reversibility/irreversibility, urgency etc. determined.

The stakeholder consultation workshop organized for Kochi urban area as a follow up of the study 'Carrying Capacity based Development Planning of Greater Kochi Region' was also useful in the identification of major environmental issues of the area. The hotspot location thus identified was also subjected to detailed study, discussion and analysis. The environmental issues of each local body have been further verified onsite, enquiry with the help of field works and meeting with elected representatives and officials of the local bodies before finalization of the findings.

The common issues found in most of the local bodies pertain to the following: heavy dependence of the population of the region on commercial activities and money received from outside the state and gulf countries for economic growth, diversion of agricultural land for rubber production towards the eastern parts for more economic gain, net loss in the realization from agricultural sector, particularly, from the pokhali and filtration ponds, environmentally incompatible mining practices with respect to hard rocks, lime shells and river sand. Inadequacy of water supply in many regions, especially towards the coastal zone is more evident; so also the increasing pressure on water and land resources, throughout the region. Inadequate transportation network often creates hours of traffic jam and pollution. Disruption in power supply and increasing gap between supply and demand is evident. Migration of population for better avenues, and poor quality of life particularly in slums and those with more people below poverty line (BPL) are noticed. Inadequacy of Institutional resources for skills upgradation, tremendous pressure on existing infrastructural facilities, amenities, transportation network etc, particularly by the floating population is on the increase. Managerial failures and regional imbalances in the coastal belt and interior

areas are common and inadequate attention to protection of natural heritage and cultural resources are predominant.

The conclusions are mainly based on the above problems identified under major headings such as ; Occupational pressure; Safe drinking water shortage and saline intrusion; Air Pollution due to low ventilation coefficient and mixing height; Poor sewerage and solid waste disposal; Drainage congestion and water logging; Wetland reclamation; Unsustained river sand, clay and lime shell mining and hard rock quarrying; Traffic congestion and air pollution; Non compliance of CRZ, environmental and building rules, etc. The key issues to be addressed for the region are spatial and functional fragmentation that hampers better integration and coordination of Kochi Corporation, the nearby Municipalities and Panchayats for planning and service delivery. The identified key sectors immediately needed improvement are; Water supply, Sewerage, Solid waste management, Storm water drainage, Traffic and transportation, Urban poverty alleviation, Heritage conservation and responsible tourism expansion, strict spatial growth trends and Land utilization policy..

Dr. C. N. Mohanan

3.3.3 Heavy metal and REE abundance in edible plants of Kollam and Alapuzha district

The project aims to precisely quantify the heavy metal and REE abundance in the edible plants grown in beach placer deposit areas of Kollam and Alappuzha districts of Kerala to bring out correlation, if any, between soil and heavy metal & REE concentrations. During the period, field work has been carried out and plant and soil samples were collected at 3kms intervals east of Vembanad lake from Kundara to Changanassery to serve as control samples. Analysis of the samples were carried out at the National Geophysical Research Institute for REE and Heavy metals.

G. Balasubramonian

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

The Agasthyamalai Biosphere Reserve of Kerala-extending from the Agasthyar Hills to the Kuluthupuzha valley supports luxuriant vegetation, comprising of tropical evergreen forests and its derivatives. The significant ecologically adapted vegetation types seen within these tracks are the Tropical Freshwater Swamps-due to the large presence of members of primitive Angiosperm family Myristicaceae (nutmeg family), particularly two species viz. *Myristica magnifica* and *Gymnacranthera farquhariana*. Other species found are *Myristica malabarica* and *Knema attenuata*. These swamps are well represented by elements from other primitive families like Annonaceae, Anacardiaceae, Arecaceae, Ebenaceae and Dipterocarpaceae tolerant to various degrees of flooding. The swampy microhabitats provide favorable conditions for survival and procreation of many annelids, arthropods, molluscs, fishes, amphibians, reptiles, birds, and mammals. Many of these animals are endemic and some are in the red- list of IUCN. Myristica swamps are "virtually live museums" of ancient life of great interest to biologists and geologists alike and have high watershed value and terrain evolutionary significance. Several questions remain unanswered about the biological sensitivity and fragility of the ecosystem with particular reference to the evolution of the fresh water swamps along the foothills of Western Ghats.

Systematic field work has been carried out from the study area for the collection of water, sediment samples and pollen grains. For identifying present pollen spectra flower buds of many species were collected from inside and outside the swamps. At the time of collection, the samples were preserved in 4% formaldehyde solution. All collected water and sediment samples were taken to the laboratory and analyzed for various physico- chemical parameters. Standard methods were applied for estimations of water and sediment characteristics. The 50 mm diameter and maximum 75 cm long cores were cut longitudinally into two equal halves and each half was cleaned, photographed and examined for sedimentary features. The cores were sub sampled on board at 0-5 cm intervals, a total of 27 sub samples were collected and preserved in pre-cleaned polyethylene containers. The part of the core to be dried in the oven at 80-90^{0}C and to be powdered in an agate mortar. Texture, major elements (Si, Ti, Al, Mn, Fe, Mg, Ca, Na, K, P), trace elements (V, Cr, Co, Ni, Cu, Zn, Ga, Rb, Sr, Y, Zr, Nb, Ba, Ce, La, Nd, Sm, Pb, Tn), XRD analysis and carbon contents of the powders were estimated, following El-Wakeel (1957). The other halves were preserved for pollen and 14C with the collaboration of The French Institute, Pondicherry.

Further study and analysis is in progress to address the issues within the framework of geomorphic evolutionary history of these swamps, the suspected paleo-link of the two river basins Ithikkara and Kallada, and their geological and biological history.

Dr. C. N. Mohanan

3.3.5 *Environmental impact assessment of major settlement distribution pattern and the infrastructural development with an emphasis on drinking water facilities in Thiruvananthapuram district*

The major objectives of the project are (a) to assess the environmental factors such as relief, geomorphology, climate, weather and their impact on major settlements with special reference to drinking water availability, (b) to collect, compile and process relevant data and analysis for water resource availability and environmental impacts using GIS and Remote Sensing and to prepare detailed report in GIS environment on the status and bring out the projected trends for future utilization, in thematic map form with viable suggestions taking into account environmental factors and technological advancements.

During the period 2008-09, collection of secondary data on water resources and preparation of base maps of the study region was initiated. Demarcation of watershed boundaries and processing of block, panchayats and municipality and corporation level statistical data are in progress. Data pertaining to rainfall, drainage discharge and depth to ground water level and water quality of ground water data are also in processing stage.

Initial analytical results show that Athiyannur block of Thriruvananthapuram district is a water scarce zone. Natural resource data pertaining to drinking water resources will be further analyzed in GIS format using remotely sensed data.

Sri. V. Shravankumar

3.3.6 *State of Environment of Lakshadweep Islands*

Lakshadweep is an archipelago consisting of 12 atolls, three reefs and five submerged banks scattered in the Arabian Sea, about 200 to 500 km off the west coast of Kerala. It lies between 8^0 and 12^0 north latitudes and 71^0 and 74^0 east longitudes. It comprises 10 inhabited islands, 17 uninhabited islands, attached islets, 4 newly formed islets and 5 submerged reefs. Androtт is the largest with an area of 4.84 km^2 and Bitra is the smallest of the inhabited island, just 0.1 km^2 in area. Out of the total land area of 32 km^2, usable land area is only 26.32 km^2.

Island-wise area, elevation and population of Lakshadweep are given below (Table-3.3.6.1). According to 2001 Census, the inhabited Islands had a total population of 60595 covering 31,118 males and 29,477 females with a ratio of 947 females per 1000 males. The density of population is 2253 per km^2.

S.No	Island	Land use area km^2	Elevation (m)	Male	Female	Population	Population density
1.	Agatti	2.71	3.0-6.0	3632	3375	7007	2586
2.	Amini	2.59	0.5-2.5	3727	3613	7340	2834
3.	Androtт	4.84	1.0-7.0	5356	5364	10720	2215
4.	Bangaram	0.58	-0.1-0.4	56	9	65	112
5.	Bitra	0.1	0.8-4.0	158	106	264	2640
6.	Chetlat	1.04	1.5-5.5	1183	1106	2289	2201
7.	Kadmat	3.12	2.5-6.5	2685	2634	5319	1705
8.	Kalpeni	2.28	1.5-5.5	2279	2040	4319	1894
9.	Kavaratti	3.63	2.0-6.0	5579	4534	10113	2786
10.	Kltan	1.63	0.6-4.0	1847	1817	3664	2248
11.	Minicoy	4.37	1.5-7.0	4616	4879	9495	2173
Total		26.89	--	31118	29477	60595	2253

Table 3.3.6.1. Island-wise area, elevation and population of Lakshadweep Islands (2001 Census)

Sample No.	Location	SPM µg/m^3	RPM µg/m^3	SO_2 µg/m^3	NO_x µg/m^3	CO µg/m^3
1	North end of the island (chicken neck)	61	43	-	-	-
2	Centre of the proposed site	73	33	BDL	5.4	100
3	Helipad	24	26	BDL	8	-
4	Light hose	29	25	-	-	-
5	Burial ground (N)	41	32	-	-	-
6	Essa palli	50	44	®	4	100
7	Power house	51	40	19	24	500
8	Navodaya Vidyalaya (Old)	30	30	-	-	-
9	Canning factory	24	23	12	14	300
10	Boat Jetty	39	38	10	14	350

Table 3.3.6.2. Air sampling- locations and results-Minicoy

The marginal differences in pollution level at various sampling locations are mainly due to the difference in types of activities, human interferences, vehicular movements, etc. The air quality monitoring showed that the pollution level all over the island is low (Table 3.3.6.2).

The major land use categories indicate agricultural area, semi agricultural area and settlements. About 50% of the total island areas are occupied by settlements, 25% by agriculture, mainly coconut, and 25% by semi-agriculture. Coconut plantations cover

Fig. 3.3.6.1 Minicoy has thick coconut groves and extensive beach vegetation-Scenes from the island interior and beach

about major portion of the total sown area. The island canopy is thick with coconut palms, which yield the finest copra available in the territory. In low lying areas rice was grown in olden days. The project work is in progress covering different aspects and themes of SoE reporting.

Fig. 3.3.6..2.Sand dune & Beach vegetation in Thinnakkara island

Dr. C.N. Mohanan

3.3.7 Exploring interrelationship between environmental degradation and poverty: selected micro level case studies across Kerala

This plan project was initiated during December, 2007. The project aims to investigate linkage between environmental degradation and poverty through micro level mapping and case studies covering selected panchayats in Kannur and Wayanad districts. Work began with preparation of a brief review note on poverty situation in Kerala. Four panchayats in Wayanad district, namely Thirunelli, Thondanad, Noolpuzha and Meppadi were taken up for detailed analysis. BPL data have been collected for all four panchayats. To understand nature of land degradation maps on geomorphology, soil erosion, land use and drainage have been worked out for three panchayats. Questionnaires are being finalized for poverty survey in the field. Sample panchayats in Kannur district are being identified.

Dr. Srikumar Chattopadhyay

3.4 Coastal Zone Mangement

3.4.1 Shoreline management plan for selected locations along Kerala coast

This project funded by Ministry of Earth Sciences, Govt of India through the ICMAM Project Directorate at Chennai, aims to develop appropriate and environmentally acceptable coastal protection measures through Shoreline Management Plans derived through numerical model studies. Coastal areas identified for this study are Thumba - Muthalapozhi- Anchuthengu (Thiruvananthapuram), Munambam - Vadanapally - Chettuwa (Thrissur) and Beypore - Puthiyapa (Kozhikode). The study consists of collection of offshore wave, tide and current data, generation of shoreline change maps, beach profile observations, beach and nearshore sediment characteristics and numerical model studies along each of the above sectors. Numerical models developed will be calibrated and validated for these sectors to make the models efficient to predict shoreline changes under different conditions.

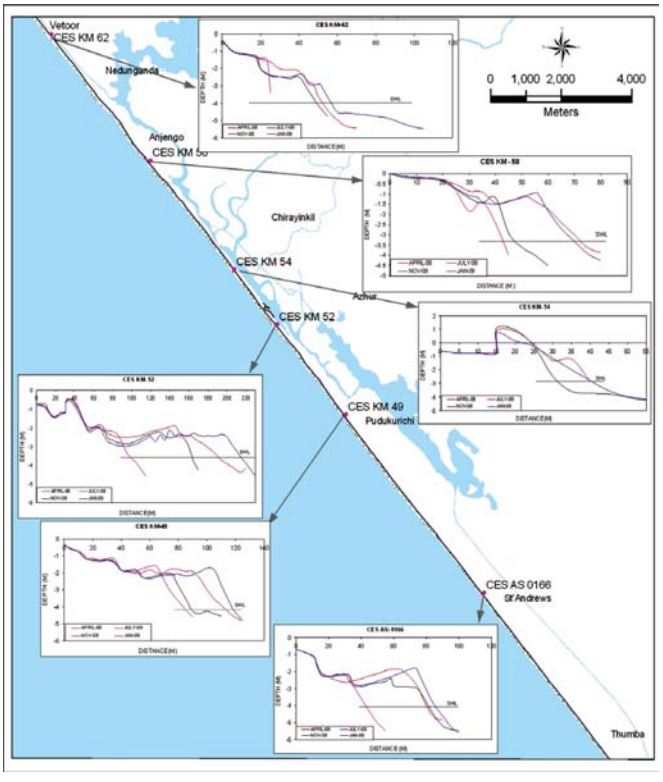

Fig. 3.4.1.1 Beach profile variations for selected locations of Thiruvananthapuram coast

Thumba-Anchuthengu-Muthalapozhi sector in Thiruvananthapuram has been identified for the first phase of the study. The sediment cell extending from Thumba to Nedunganda (Vettoor) has been identified for detailed studies and observations. The recent construction of breakwaters at Muthalapozhi has subdivided this sediment cell further into 2 cells consisting of Thumba-Muthalapozhi cell and Muthalapozhi-Nedunganda cell (south of Vettoor-Varkala cliffs).

Primary data collection through field measurements has been undertaken for hydrodynamic and sedimentological data. Shoreline mapping, beach profile measurements and beach and nearshore sediment sampling were carried out for the study area during different seasons. In addition to this, nearshore bathymetric survey off Thumba-Nedunganda coast was undertaken. Wave, tide and currents were measured during pre-monsoon, monsoon and post-monsoon seasons by deploying equipments in the offshore at different depths at 3 locations in the study area.

South of the inlet wide beach is noticed throughout the year. Embayment erosion is a dominant mode of erosion during monsoon. Immediate south of the south breakwater, the beach shows net accretion. North of the breakwater the beach is highly eroding. The beach further north along the Mampally-Nedunganda stretch (south of the cliff at Vettoor) is stable. Beach profile variations for selected locations are given in Fig.3.4.1.1

Dr. K. V. Thomas

Funding: Ministry of Earth Sciences, Govt. of India

3.4.2 Coastal zone studies- Kerala and Lakshadweep islands

The work plan contains five major study components i) mapping and monitoring of the coastal zone ii) preparing local level map on 1:5000 scale for CRZ using remote sensing satellite data iii) mapping and monitoring the marine protected areas iv) vital/critical coral reefs habitat. IRS P6 LISS IV/LISS III+PAN and CARTOSAT data have been used for the study.

Mapping and monitoring of the coastal zone of Kerala and Lakshadweep group of islands:

Main objective is to prepare coastal wetland maps between HTL and LTL and coastal landuse above HTL on 1:25,000 scale using IRS P6 data. Landuse classification of 81 topo grids as per the national data framework completed and rechecking is in progress.

Eco-morphological zonation of Vital/Critical Coral Reefs Habitat of Lakshadweep Islands:

Satellite data used for classifying the coral reefs was subjected to

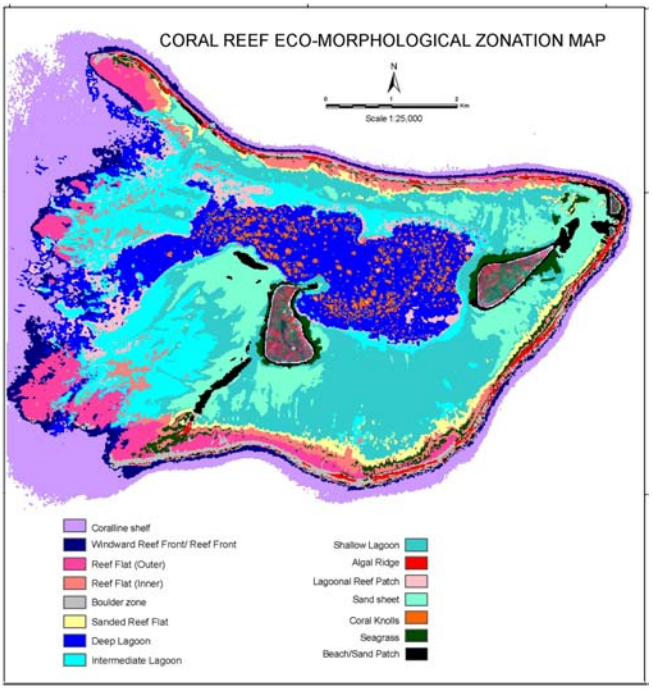

Fig. 3.4.2.1 Lay out of the coral reef hazard zonation map of the Bangaram Islands

image corrections for both geometric and radiometric including image enhancement techniques. Unsupervised classification was carried out followed by supervised classification. Methodology and classification system as developed by SAC has been adopted in this study. Ecomorphological zonation of coral reefs of Lakshadweep Islands (Fig. 3.4.2.1) have been carried out and recoding of unsupervised classified image done. 1:25,000 toposheet-based lay out of the coral reef ecomorphological zones prepared. QA/QC of the digital database of Kerala and Lakshadweep coastal landuse data, and ecomorphological zones (EMZ) of Lakshadweep Islands were carried out at SAC, Ahmedabad. The modification suggested is being incorporated.

Dr.M.Samsuddin

Funding: Space Application Centre, Ahmedabad

3.5 Biophotonic applications

3.5.1.Sunlight-induced multi-spectral fluorescence imaging for vegetation assessment

Plant growth and development depend on photosynthetic efficiency, which in turn is related to the availability of sufficient water, mineral nutrients, carbon dioxide and light. Insufficient availability of these vital inputs due to natural or anthropogenic stress can affect the photosynthetic performance directly or indi-

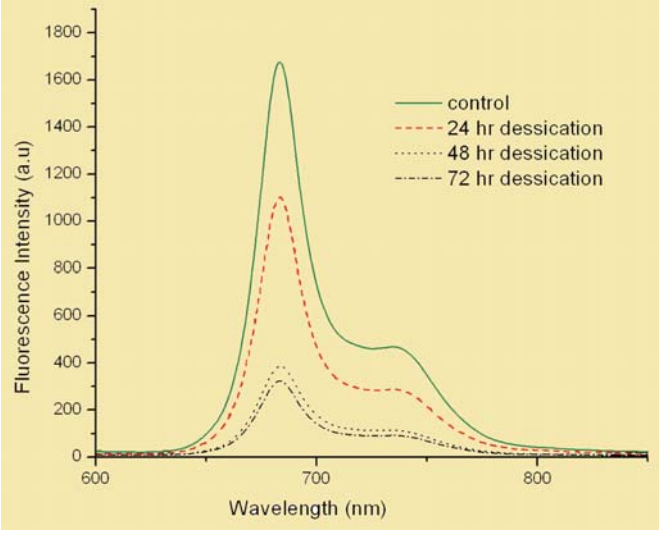

Fig. 3.5.1.1 Chlorophyll fluorescence spectra of Pallavicinia at different hours of desiccation

rectly, thereby altering the optical fluorescence properties. Photosynthesis is particularly sensitive to stresses, such as drought, nutrient deficiencies, acid rain, suspended particulates and air pollutants.

The project proposes to develop a fluorescence imaging system to detect solar induced plant fluorescence from different types of vegetation, to characterize them and to correlate the results with photosynthetic parameters of vegetation. This developed instrument could aid in passive remote sensing of vegetation through the measurement of fluorescence at selected Fraunhofer lines and digital processing of fluorescence images. The study would cover vegetation health monitoring along with the measurement of actual photosynthetic function in different plant types with respect to their altitude and climatic variability.

Preliminary laser induced fluorescence studies were carried out on the bryophyte Pallavicinia subjected to 24, 48, and 72 hours of desiccation followed by 10 minutes of rehydration after each desiccation. The portable fiber optic fluorosensor used for measurements is shown in Fig.3.5.1.1. The system consists of a 404 nm diode laser for excitation and a miniature fiber optic spectrometer (Ocean Optics Inc, USA, Model: USB2000FL) for recording of plant fluorescence. Chlorophyll fluorescence peaks at 690 and 740 nm were observed in ex situ plant samples (Fig. 3.5.2.1).

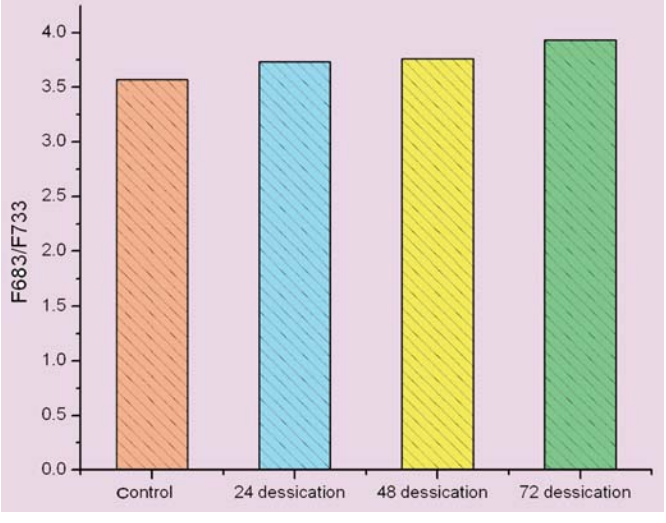

Fig. 3.5.1.2 F683/F733 ratio of Pallavicinia at different hours of dessication

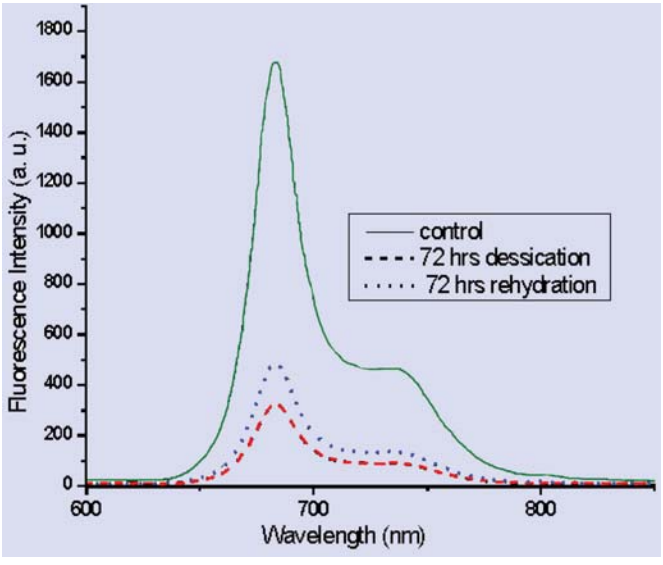

Fig. 3.5.1.3 Changes in chlorophyll fluorescence spectra with 72 hours desiccation and followed by rehydration

The fluorescence intensity ratio of red/ far-red band (F683/F733) was computed during different stages of desiccation. The ratio was found to increase from 3.57 in the control group to 3.94 in the 72 hrs desiccated samples (Fig. 3.5.1.2) with a corresponding reduction in total chlorophyll content from 36-23 mg/gFW.

When the sample was rehydrated after subjecting it to 24 and 48 hours of desiccation it did not show the tendency to recover but when the sample was rehydrated after 72 hours of desiccation the fluorescence intensity was found to increase from the desiccated levels (Fig. 3.5.1.3). The study has shown an inverse relationship of chlorophyll fluorescence ratio (F683/F734) with chlorophyll content and demonstrates the effectiveness of LIF in detecting water stress.

Dr. N. Subhash

3.5.2 Oral cancer diagnosis with LIFRS

The laser-induced fluorescence and diffuse reflectance spectroscopy (LIFRS) system developed in the Biophotonics laboratory of CESS was used for detection of oral cancer and in discrimination of its different grades in collaboration with Regional Cancer Centre (RCC), Trivandrum. The approval of the RCC Ethical Committee (Sanction No. HEC/02-2005/14 dated February 4, 2005) was obtained before initiation of clinical trials.

40 patients with cancers affecting different oral cavity sites such as buccal mucosa, tongue, alveolus, floor of the mouth, and inner lip were studied at the OP clinic of RCC. Study included clinical examination by physicians, recording of detailed case reports of each patient and spectral measurements with the LIFRS system as per the approved clinical protocol, after obtaining informed consent from the patient. Biopsy specimens were taken from the measurement sites and histopathological examination was carried out. The pathological reports obtained (SCC-18, Dysplasia- 12, and Hyperplasia-10) were correlated with spectral measurements (Fig. 3.5.2.1 A & B) The spectral data from 21 patients were used to develop a spectral ratio reference standard (SRRS) for discrimination of oral cancer, the effectiveness of which was tested in 17patients in a blind test. The diffuse reflectance (DR) spectral intensity ratio R545/R575 related to oxygenated hemoglobin absorption peaks at 545 and 575 nm was found to be a useful parameter in lesion classification.

Clinical trials based on the autofluorescence spectral intensity ratios (F500/F635, F500/F705, and F635/F705) and the diffuse reflectance ratio (R545/R575) was able to discriminate normal oral lesions from hyperplasia, dysplasia and SCC. Using linear discriminant analysis (LDA) alongside principal component analysis (PCA) premalignant dysplastic lesions could be classified from malignant SCC with 100% accuracy. The results obtained are in agreement with the gold standard and gave improved sensitivity and specificity as compared to previous reports, and confirmed the advantages of using multivariate statistical analysis for non-invasive diagnosis and grading of oral mucosa.

It was further noticed that for discrimination of different grades of malignancy in sites such as vermillion border of lip, and dorsal and lateral sides of tongue, the DR spectroscopy is more powerful than tissue autofluorescence.

The time required for 5-ALA , which is used to enhance tissue fluorescence and in photodynamic therapy, to get transformed to PpIX, was studied to determine the optimum time of accumulation at different anatomical locations. It was found that maximum accumulation takes place within 90-150 minutes of administration at most of the sites.

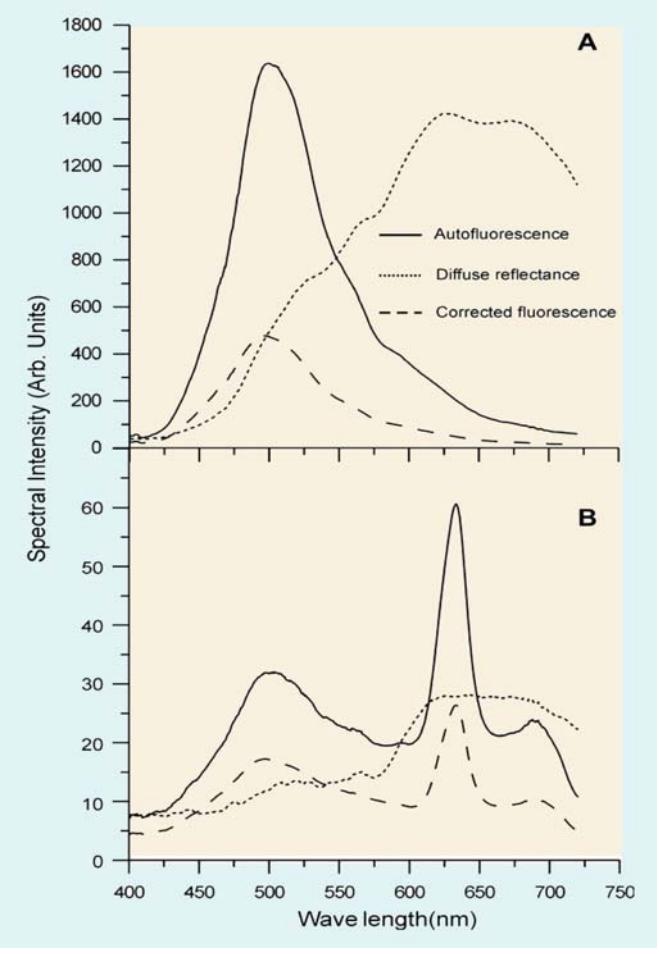

Fig. 3.5.2.1 Average in vivo autofluorescence and DR spectra from healthy buccal mucosa (A) and well-differentiated SCC buccal lesion of a patient (B), and the corresponding corrected fluorescence spectra.

Curve-fitting of the LIAF spectra using Gaussian spectral functions was used to locate the exact peak positions, areas under each peak, and amplitude of LIAF peaks recorded from different types of oral mucosa under in vivo environments. The curve-fitted Gaussian area and amplitude ratios, F500/F635 and F500/F685, were found to be most sensitive to tissue alterations. The variation in the fluorescence intensity ratios was much more robust and distinct than of raw spectral intensity ratios. Among the two spectral ratios, the Gaussian curve area ratio F500/F635 gave higher diagnostic accuracy.

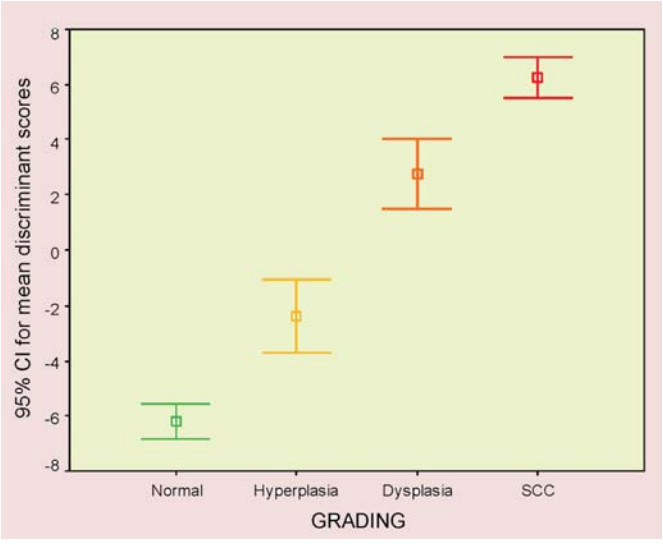

Fig. 3.5.2.2 Error bar plot of discriminant function scores for different lesions at 95% confidence interval for mean

With the help of diagnostic algorithms, the LIFRS has given very good sensitivities and specificities, as compared to other analytical methods (Fig. 3.5.2.2). However, LIFRS does not have the capability to identify the extent of disease or to precisely locate superficial margins in a fast and dependable manner. To overcome this, the EMCCD camera based multi-wavelength fluorescence imaging system will be used with excitation at 405 nm for demarcating and identifying oral lesions in real-time. The proposed system based on fluorescence image intensity ratios and DR ratios of oxygenated hemoglobin peaks will offer the advantage of instantaneous probing of entire lesion and its surroundings as compared to LIFRS point monitoring system that use fiber-optic probes.

Dr. N. Subhash and J. L. Jayanthi
SC & ST Dept. GoK

3.6. GIS and Remote Sensing Applications in Natural Resources Management

3.6.1 Geo-spatial survey and assessment of Munnar and adjoining panchayats

Sustainable economic development of any region depends largely upon the availability and the optimal utilization of natural resources without endangering the environment and ecosystem of that region. A dependable database of the resource availability and an excellent long term resource management plan, thus become imperative for the steady progress of the economy.

This is a major ongoing programme to create spatial/non-spatial digital database for implementing various developmental activities for eco-friendly and sustainable development of the region and is an inter-institutional programme involving Kerala State Council for Science Technology & Environment, Centre for Earth Science Studies, National Transportation Planning and Research Centre and Kerala Forest Research Institute. The project focuses on deriving spatial information on various themes of local importance in cadastral scale (1:4000). The satellite image QuickBird (0.60 m for the panchromatic band and 2.5m for MSS) and Cartosat I Stereo data that provide a clear synoptic view of the area is used for the study. The Original individual estate maps (in different pieces) in cadastre scale (1908) of the KDH village, Mankulam, Chinnakkanal, and Pallivasal were collected from Survey and Land Records Department, scanned at 300dpi, cleaned and the KDH village estate maps generated.

Four Principal Reference Points (PRP) Viz., Forest High range Nursery, Kallar UPS, Chenduvarai HSS and Top Vaghuvarai were identified and locations monumented. More than 72 hours continuous static measurements were carried out at each PRP using dual frequency GPS receiver. Post processing of the GPS data was carried out with respect to the IGS Station at Bangalore and precise coordinates established. State boundary stones, village boundary stones, rock marks, and survey boundary stones were identified in the field from the cadastre, QuickBird Imagery and block map and plotted them on the base map for GPS Survey.

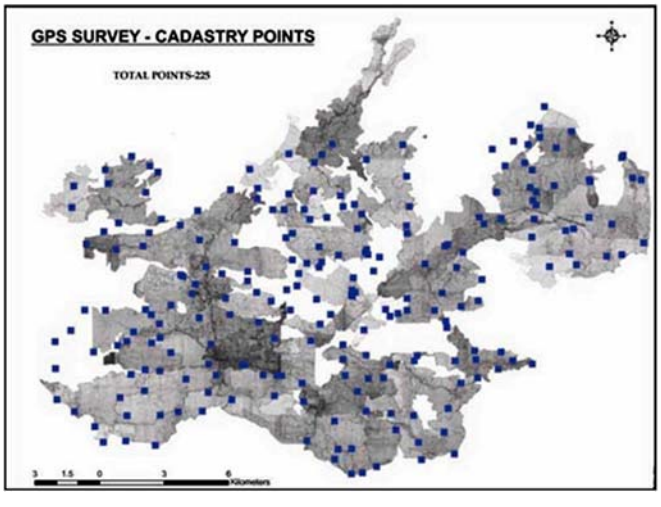

Fig. 3.6.1.1 GPS survey points – Cadastry of KDH Village (1908)

Dr. M. Samsuddin

3.6.2 Creation of a digital data bank at CESS

Objective of the project is to create state-of-the-art facilities for efficient management and retrieval of desired data and to develop a digital data bank of spatial and non-spatial data in conformity with NSDI framework. Collection, verification, standardization and organizing spatial/non spatial digital data already available in CESS for future use is also envisaged in this programme. As part of efforts to make the data bank contents web enabled, the metadata browser developed earlier has been modified, The modified version makes use of ASP.NET, HTML, UMN Mapserver and CSharp software. The Mapserver is open source software. It consists of the Webserver, database server and other scripting languages that are used to request the data to the server. The NSDI metadata utility software is used for generating metadata information. The prototype web application developed is being tested in the CESS intranet. It has facilities to zoom in and out, pan, identify, measure distance, view metadata etc.

Improvements in user-interface for the web application developed using UMN MapServer, HTML and ASP.NET were being implemented in CSharp. As part of data incorporation, NREDB map themes of 14 districts of Kerala were incorporated into the data bank, in addition to the Kerala Coastal Zone Management Plan maps and Geology maps. There are about 37 digital map layers per district with themes such as, Administrative Divisions (Local Bodies), Revenue Divisions, Transport Network, Watershed and Drainage System, Relief and Relative Relief, Landform, Slope, Geology, Soils, Land use/land cover, Landslide hazard zonation, Groundwater prospects and Demography.

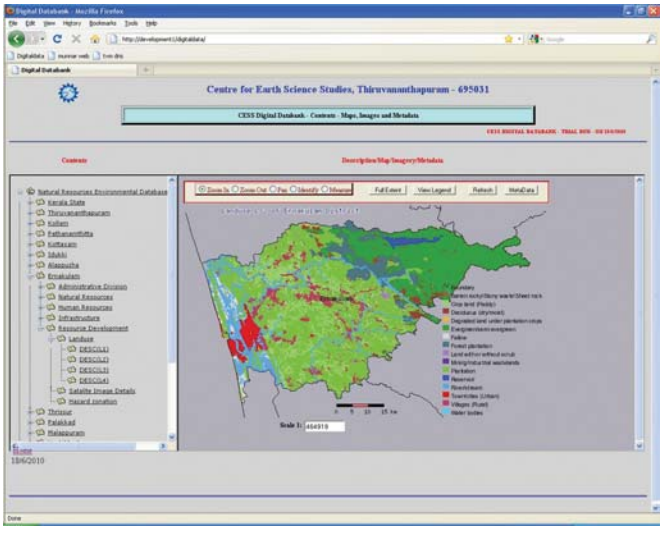

Fig. 3.6.2.1 Screen shot of CESS digital databank showing contents, maps, images and metadata

With a view to enhance the databank infrastructure a proposal was prepared and submitted for establishing an advanced data centre at CESS. Fig. 3.6.2.1 screen shot depicts Ernakulam landuse. In addition to ArcGIS format, enhancements for browsing spatial data in Mapinfo and Geomedia formats, were incorporated in the Mapserver, using CSharp and ASP.NET based web application. Its performance and features are being enhanced. Metadata structure on spatial data of different database is under progress.

V. N. Neelakandan

3.6.3 Cadastral Level Decision Support System for management of natural resource in Thiruvananthapuram district

This project envisages district-level integration of land and water resource information in a cadastral base, through integration of Geoinformatics with particular focus on local-level development in the urban/rural areas of Thiruvananthapuram District. It aims to develop attribute as well as spatial information base for various levels of urban/rural planning, develop standards with regard to database data exchange format and provide decision support system for planning activities in the Thiruvananthapuram District and to establish resource information Centre with support of Panchayat functionaries/peoples' representatives.

Training imparted to project staff for collecting ward level socio-economic, disaster and infrastructure data from all the Panchayats. Available of development documents and completed questionnaire have been collected from the local bodies of Trivandrum District. A customized application software for asset data entry has been developed using VB for entering 145 field attributes. The software was debugged and tested and data entry has been initiated. Plan documents, sketches, ward delineation details, asset register and available PRM Maps were collected from local bodies.

Cartosat image has been georeferenced with respect to SOI

Toposheets in WGS 84 datum and GCS coordinates using the conversion software downloaded from SOI website. Digital layers based on IRS-P6 satellite data and topographic sheets are being generated. Slope and drainage density maps are being vectorised. Land use vector thematic layer has been generated based on SOI toposheets.

Evaluation of technical bids for DGPS survey has been completed. A scheme for DGPS data collection has been prepared based on 1:50,000 toposheet and Cartosat image.

B. K. Jayaprasad

3.6.4 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. In order to display digital map layers and retrieve information based on user-specific queries, District Resources Information System (DRIS) has been developed by CESS using MapObjects and Visual Basic software for Wayanad, Ernakulam, Kollam, Malappuram, Idukki and Thrissur Districts in the current year.

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.

A Personal Computer with Windows Operating System, 1GB Random Access Memory and a minimum of 2 GB Hard Disk space is required to install the DRIS. The application can be started either by clicking the desktop shortcut or navigating the program menu and clicking on the item DRIS. Spatial data is organized separately by district, block and local bodies (panchayats/municipalities) wise with option for displaying attributes in Malayalam font. The startup screen of Wayanad District Resources Information System is shown below.

Prepared detailed report on natural resources of Wayanad district. A prototype District Resources Information System has been developed and tested. Preparation of a separate training manual for use in the village resource centers is nearing completion.

V. N. Neelakandan

Funding: Kerala State Planning Board

3.6.5 NREDB Data updation for service facilities in the Ernakulam District

As part of the UNDP and the Planning Commission project "on *strengthening state plans for human development*", a programme in the Ernakulum district was initiated with focus on locating and collecting primary attribute data of the service facilities with respect to the health and education sector. The spatial location of the institutions thus collected is to be integrated with NREDB database for integrating with the district level information system. The objective of the programme is:

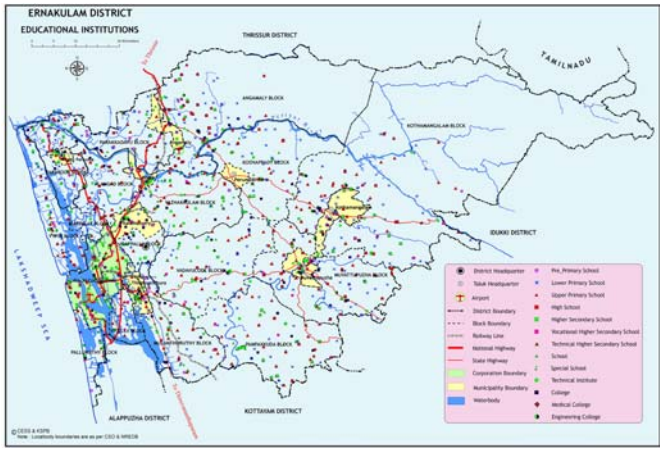

Fig. 3.6.5.1 Spatial distribution educational institutions in the Ernakulam District

1) To locate and collect primary attribute data of education and health institutions in Ernakulam District using Handheld GPS

2) Integration of facilities information collected through GPS with the digital district level information system.

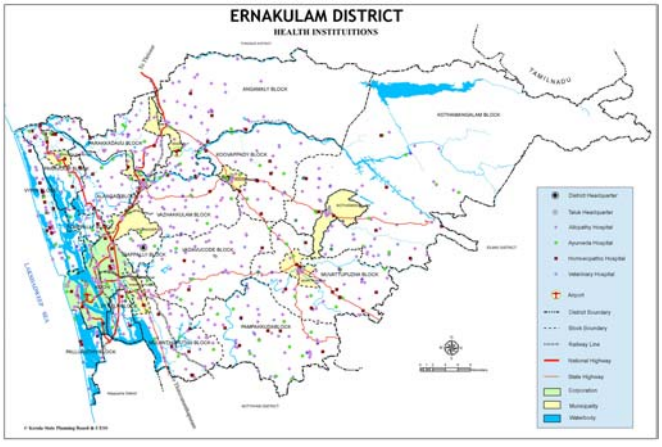

Fig. 3.6.5.2 Spatial distribution heath institutions in the Ernakulam District

3) Spatial analysis based on the collected spatial data (like proximity, location allocation etc.)

The educational and health institutions in the constituent local bodies were located and their coordinates were collected through an intensive fieldwork using hand held GPS (with an accuracy level of +/- 7meter) The coordinate values collected from each local body with attribute codes and addresses of the facilities were integrated with the NREDB digital database in 1:25,000 scale. Local body-wise spatial distribution of all the institutions in the health and education sector is plotted in the maps along with the relevant geographical features for further spatial analysis. The spatial locations of the institutions were generated in WGS 84-GCS coordinate system. The spatial location of the institutions is integrated with other thematic layers for integration and data dissemination (Fig. 3.6.5.1 & 3.6.5.2).

Final report has been submitted to the Kerala State Planning Board. The report has 51 thematic plates showing the spatial location of all educational and health institutions in the Ernakulam District.

B.K. Jayaprasad

Funding: Kerala State Planning Board

3.6.6 Kerala State Spatial Data Infrastructure (KSDI)

Kerala State Spatial Data Infrastructure (KSDI) is a collaborative programme involving contributions from CESS, KSREC, KSITM, NIC, Karnataka SDI and IITM-K. CESS has taken a lead role in establishing the KSDI, which is designed to create, maintain and deliver geospatial data and metadata in real time. Spatial data acquired/developed by different agencies are not in an interoperable format as they differ in projection system, datum, coordinate system, file formats etc. Inconsistency in layers creates significant issues in large scale projects in which data from different sources have to be used together. To avoid these issues, a single standard has to be specified and all available data has to be converted in to the globally acceptable interoperable standard, so that the user agencies can access the data without any hassles.

To tide over these difficulties, Government of India have established a National Infrastructure known as the National Spatial Data Infrastructure (NSDI) for the purposes of acquiring, processing, storing, distributing and improving utilization of spatial data being generated by various agencies of the Government of India. In line with the NSDI, Kerala Government has geared up its activities to set up a State Spatial Data Infrastructure (SSDI) to coordinate the activities of the State. Main objective of the geoportal is to develop a web based services to acquire, process, store, distribute and improve the utilization of geo-spatial data for planners, decision makers and public. The portal based on OGC/ ISO standards is used as a starting point and frequent gateway to access web resources and Geospatial data content. Once all the data is published to the server by the data providers, then various clients would be able to view the data availability and allowed to download the required data or be able to perform various spatial and non spatial functions. All that a user need is an internet explorer and a network connection. Only the authorized/

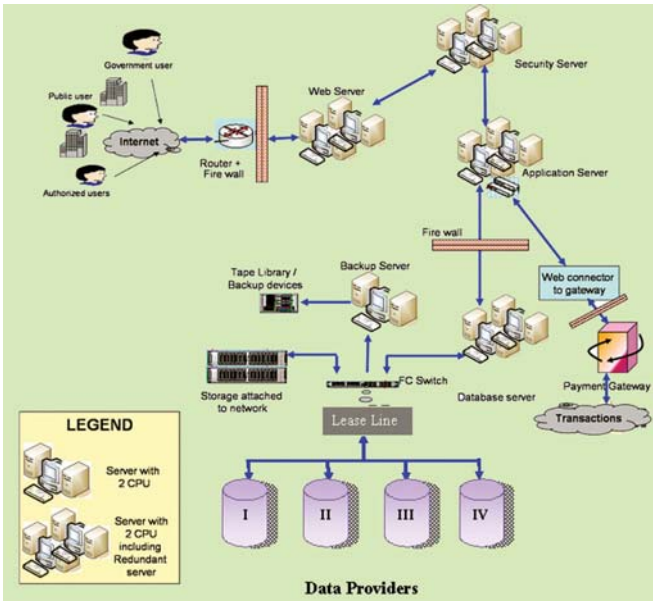

Fig. 3.6.6.1 Schematic diagram of the spatial data infrastructure

registered staff will have access to the server application/ database.

With the availability of the geoportal, availability of spatial data in different domains such as infrastructure, traffic planning, resource availability, demographic status, socio-economic status, health and culture-related information etc., are within a click of a mouse even up to the cadastral scale.

Based on the proposal submitted by the Technical group, the Kerala Government has given the approval for setting up of the Kerala State Spatial Data Infrastructure.

V.N. Neelakandan

3.6.7 Digital Resource Atlas of Kerala

Centre for Earth Science Studies has prepared and published Resource Atlas of Kerala in 1984. Most of the thematic maps prepared on secondary data have become obsolete. Now there is demand for revision of this atlas from various corners. In order to revise the old atlas, this plan project was initiated in June 2008. Since the size of the old atlas was odd and difficult to handle the proposed atlas maps are designed in A4 format with more themes in digital and hard copy formats. The following work has been completed: (a) prepared base showing taluks and districts to prepare thematic maps. Corrections in the administrative boundaries were carried out as on date, (b) collected data from the Census of India and processed them like percentage to the total population, (c) collected area and production data for 20 years from the Bureau of Economics and Statistics and calculated 10 years average. Calculated percentages of area under each crop to the total cropped area district wise. Calculated percentage of production to the total production of crops district wise, (d) collected data from Electricity Department on production of power from hydel power, thermal power and wind power and other aspects of power, (e) collected data from Health and educational services. Digitization of the following maps has also been completed viz. (a) Variability of Annual rainfall, (b) Rainfall Variability (Dry Season), (c) Rainfall Variability (South West Monsoon), (d) Rainfall Variability (North East Monsoon), (e) Climate: Rainfall (Mean monthly and annual rainfall), (f) Climate: Rainfall (South West Monsoon), (g) Climate: Rainfall (North East Monsoon), (h) Climate: Rainfall (Other than Monsoon).

B. Sukumar

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

Aim of this project proposal is to assess and monitor the land quality for sustainable agriculture in Kannur District with GIS based approach coupled with technology implementation. In order to achieve the objectives, following studies are envisaged: (a) assess and monitor land quality in terms of water and soil for sustainable agriculture in Kannur district, (b) create a data bank on hydrometeorological parameters with the available data and update with primary data being collected, (c) install meteorological instruments at 3 sites to collect rainfall intensity and duration, temperature, humidity and evaporation, (d) install hydrology instruments such as digital flow meters, permeameters and tensiometers to collect infiltration rate, discharge rate and soil moisture content, (e) create data bank on terrain parameters with the available data, (f) derive thematic maps for the terrain parameters like landform, geomorphic processes, slope, aspect, relative relief, drainage network, and drainage density, (g) prepare soil classification, soil charaterisation, land irrigability and land capability maps, (h) prepare a landuse/ land cover map using satellite imagery, (i) prepare a map showing distribution of duricrust and its depth, (j) prepare a geochemical atlas, (k) prepare a digital data bank of all these parameters in a GIS environment by digitizing all the inputs, (l) prepare zonation maps for water harvesting, recharging, flood prone areas, erosion prone areas, landslide prone areas, (m) discuss the results of analysis with experts and users, (n) identify sites and implement appropriate technologies with user participation, (o) study the extent of application of technology in agricultural practices and its impacts, (p) prepare plan document suggesting integrated actions for sustainable agriculture for the whole district.

The thematic maps prepared in 1:50,000 scale during the period are (1) relief, (2) drainage, (3) slope, (4) aspect, (5) landform, (6) geology, (7) Soil, (8) landslide prone areas, (9) flood prone areas, (10) agriculturally drought prone areas, (11) Panchayats, (12) watershed and (13) density of population.

Delineation of priority area for sustainable agriculture was done through a GIS modeling for Pervumba basin in Kannur district .

Fifty nine soil samples were collected from the field and prepared for analysis in NGRI. Sample sites were recorded using GPS. These samples were processed and analysed at different laboratries. The parameters analysed so far are 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 are under progress. The remaining two third area of the district will be covered in the next year. After completion of collection of samples and analysis, distribution maps will be prepared and used for integration with other parameters in GIS environment.

Statistical data on rainfall were collected with respect to Kannur and Irikkur pertaining to the years 1987 to 2004, and the rainfall data for Tellicherry and Taliparamba were collected for the years 1987 to 2005.

B. Sukumar

3.6.9. Urbanisation between Kochi and Thrissur

During the period under report prepared (a) digitized base map using survey of India topographic maps on 1:25,000 scale covering drainage, contour and roads themes, (b) maps showing administrative boundaries of Panchayat and towns using Central Survey Office maps and Census of India publication maps, (c) map showing spatio-temporal growth of Thrissur and Kochi Corporations, (d) density of drainage, (e) map showing paddy fields and water bodies for the year 1970, (f) Relief and drainage maps for the study area, (g) density of population maps for Ernakulam and Thrissur districts using Census 2001 data and (h) map showing Census towns for 1971, 1981, 1991 and 2001. Reconnaissance field work was carried out in and around Thrissur Corporation. Change in occupational structure for Ernakulam district is under preparation.

Change in occupational structure was analysed for 1981, 1991 and 2001 for Thrissur district using Census data.

Ahalya Sukumar

3.6.10. Kerala Resources Information System & Services (KRISS)

CESS has spatial/non-spatial data on a variety of themes related to land, water and air pertaining to the State prepared under various R&D projects. For dissemination of resources information through secured web access, the CESS Research Council has approved a proposal for establishing 'Kerala Resources Information System & Services (KRISS)'. 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). The project is proposed to be implemented through a competent Total Solution Provider (TSP) identified through public tender.

V. N. Neelakandan

3.6.11 Glimpses of Kerala through maps

It is proposed to prepare a set of 30 maps depicting various aspects of Kerala. Explanatory notes will accompany all maps. So far twenty one maps have been finalized. Another nine maps are being worked out. This atlas will be brought out shortly.

Dr. Srikumar Chattopadhyay

3.6.12 Application of Artificial Neural Network in pattern classification of remotely sensed images

This project was initiated during 2008-09. Its aim was to carry out supervised classification of satellite image using Artificial Neural Network [ANN]. Satellite image used is IRS-P6 Advanced Wide-Field Sensor [AWiFS] of the study area (Idukki district, Kerala) collected during the period March 2007 from NRSA. A

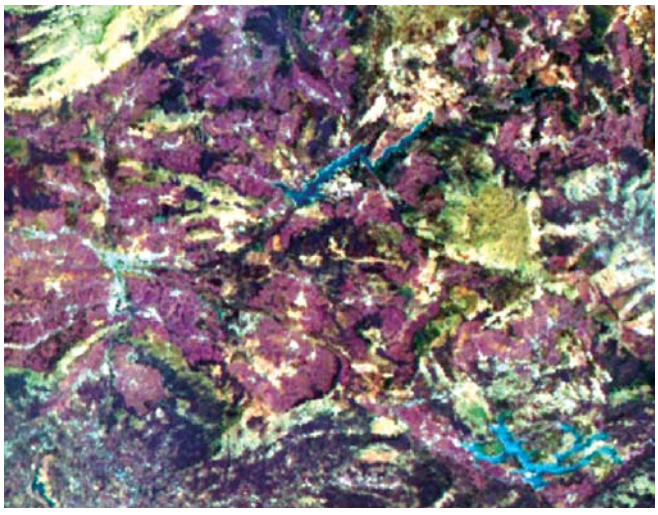

Fig.3.6.12.1 Unclassified Satellite imagery of covering Devikulam Taluk

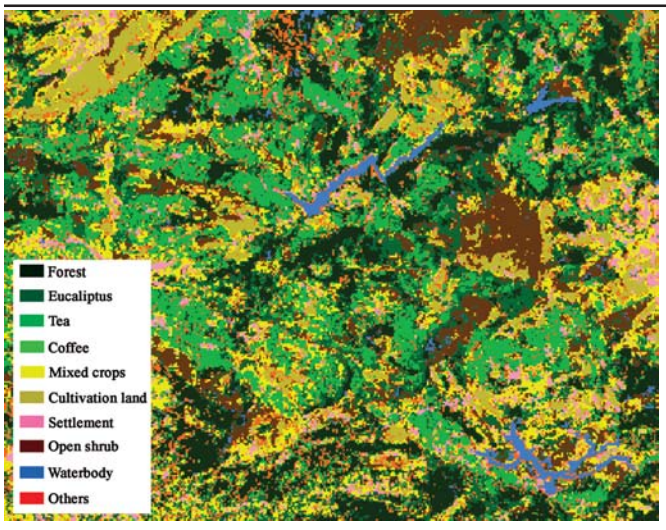

Fig. 3.6.12.2 Classified thematic map of the Devikulam Taluk

small part of the study area (Devikulam taluk), (Fig.3.6.12.1) was selected for initial study and ground truth survey. Nine major classes were identified (Tea, Eucalyptus, Water, Settlement, Forest, Cultivation land, Open Scrub, Coffee and Mixed crops) in the unclassified satellite imagery of Devikulam shown in (Fig. 3.6.12.2). A data set was prepared from the data collected in a survey of the study area and was used to train the ANN.

A Multi-layer Perceptron [MLP] ANN having an input layer, one hidden layer and an output layer was designed. The number of neurons in each layer of the above layers was 4, 12 and 10, respectively. The ANN was successfully trained with back propagation algorithm to classify the image of Devikulam and classified with an accuracy of 82%.

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.

The optimum management of the energy resources forms an integral component of any natural resources management system. Technology can be defined as skills, knowledge and the process of making, using and doing things. Any technology when implemented has its own impacts. This is true of energy technology also. Energy makes possible all physical and biological endeavours. What necessities the adoption of energy technologies and nature of their impacts on society has been taken up for study in this project. This 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 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. This study involves the collection of household level information which was carried out employing a suitably designed questionnaire. This method thus yields primary data. The questionnaire is rather exhaustive and attempt was made to make it comprehensive so that required primary data can be collected from respondents.

A pilot survey was carried out on the basis of the formulated questionnaire. This led to the refinement of the questionnaire for the later surveys. This year the survey was carried out in hundred households of Kilimanoor panchayat. The households surveyed were selected randomly using a random number table. It is seen that 74% of the houses of Kilimanoor panchayat have their own land; of this 50% of the households have agricultural business and remaining houses have agricultural produce to meet their own needs. In spite of the shortage of labour, only 5% of households use tractors for agricultural purposes. These tractors are hired. Regarding energy use for transportation of agricultural items, mostly manual methods are employed for bringing agricultural produce from field to houses, whereas mechanical methods are employed to take it to the market. It is seen that there is enough scope for further mechanization in agricultural sector for a region like Kilimanoor panchayat. Though agriculture practice is traditional, only 6% of the households surveyed are using inherited agricultural implements. This study indicates that 81% of the households use implements operated manually for their agricultural energy purpose. Further surveys in urban areas are being initiated.

K.Vijayakumar

3.8. Climate Change Studies

3.8.1 Monitoring Climate Change impacts in Sahyadri

Climate change is a multi-faceted issue, incorporating direct and indirect effects on human activity. Direct effects include land use conversion and intensification, and emissions of pollutants (eg. NOx, O3, heavy metals, acids). Indirect effects include atmospheric change associated with increase in trace gas emissions and stratospheric ozone degradation and subsequent impact on climate and UV-B radiation. Mountains are home and hotspots to a substantial portion of the planet's diversity of species and ecosystems. Globally, mountain regions provide water to about

50% of the world's population both in the mountains themselves and also to the downstream lowlands. Some of the direct effects of global change can only or best be studied in high mountains since these systems are among the few where direct human impacts are not so pronounced. Therefore, mountain regions present unique challenges and opportunities for Global Change research.

The steep slopes found in these regions give rise to some of the sharpest environmental gradients found on land surface. The characteristics of these gradients include: Rapid and systematic changes in climatic parameters, especially temperature and precipitation, over very short distances. Sharp climatic changes independent of photo-period (length of daylight) and often of soil type (thus, they complement high latitude gradients where photoperiod and soil type often change). Mountains also harbor systematic often-monotonous variations in slope angle, aspect and exposure. This would greatly enhance direct runoff and erosion, strongly influencing the overall hydrology. Systematic variation of other environmental parameters includes soil depth, structure, CO_2, UV-B radiation with elevations. The listed characteristics make mountain regions with their sharp topographical gradients, particularly valuable in providing basic understanding of hydrological and ecological responses to global change, particularly susceptible to the impacts of a rapidly changing climate, likely to be the areas where signals of climate change impacts can be expected and studied on a long term basis.

Natural processes and socio-economic responses along altitudinal gradients in mountain areas change very rapidly over short distances. Along altitudinal gradients, ecosystems often show differential, highly non-linear responses to changes in environmental parameters. Hence the extrapolation of information gathered from site-oriented studies often is not appropriate. On the other hand, vegetation stabilizes soils and has a profound influence on hydrology and, specifically, on downslope safety. Thus, comprehensive, gradient-oriented basic research is a fundamental requirement to advance a predictive understanding of hydrology and ecology in mountain regions.

The project is in its initial stage of implementation. Formalities for setting up permanent Climate and Green house gas observatory at Munnar, Chinnar and Mankulam are progressing.

Dr. C.N. Mohanan

3.8.2 Urban Heat Island in Kochi

Urbanisation is known to modify the microclimate of a region. The most prominent among such modifications is the elevation of night time air temperature within the urban area compared to adjacent rural areas. This is known as Urban Heat Island (UHI), and its intensity could be as high as 10°C under favourable conditions. UHI affects the physical efficiency, aggravates certain indispositions, mental agility and work efficiency, energy consumption for space cooling and refrigeration, etc. UHI is caused by

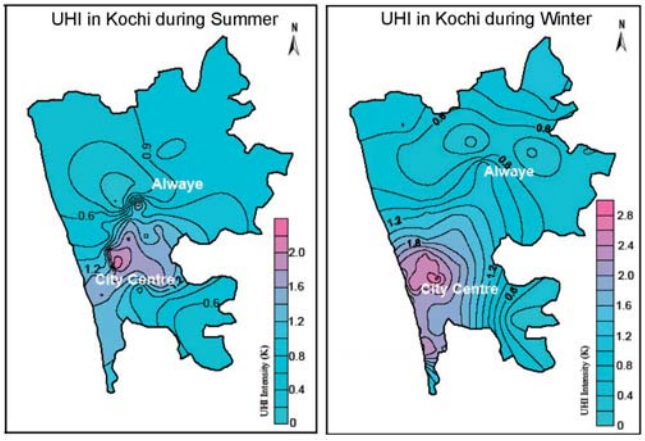

Fig. 3.8.2.1 Urban Heat Island in Kochi

the storage of heat by buildings, roads, etc., during daytime and its slow release during night time. Other factors include reduction in surface winds due to obstruction by buildings, reduction in vegetation and cooling by evapotranspiration, low permeability of built up surfaces resulting in lower soil moisture content, etc. Nonetheless, it is possible to reduce the intensity of UHI by controlling geometry of the streets, building materials used, vegetation cover, coverage area, etc.

As part of a preliminary study of the heat island in Kochi, air temperature distribution was recorded using mobile traverse method employing temperature recorders installed in automobiles. Winter and summer UHI recorded in Kochi are shown in Fig.3.4.2.1. The intensity of the winter UHI was 2.8°C and that in summer was 2.2°C, which is moderate compared to that in other major cities in South India.

Dr. E. J. Zachariah

4 Consultancy Programmes

4.1 Costal Regulation Zone Status Reports

In recognization to our expertise in the field of Coastal Zone Management, CESS has been authorised by the Govt of India as one among the institutes selcted to demarcate the High Tide Line and Low Tide Line for the purpose of Coastal Regulation Zone (CRZ). CRZ Reports are being prepared through identifying the coastal ecosystems and delineating the High Tide Line (HTL) and Low Tide Line (LTL). It also includes identification of different categories of Coastal Regulation Zones based on landuse, landform and status of development. The CRZ maps are prepared in cadastral scale for easy interpretation by implementing agencies. DGPS control points are relied upon for rectification and data input.

The extent of influence of tidal action in the water bodies is determined based on salinity. The HTL and LTL are determined from geomorphologic signatures such as berms crests, tidal flats and cliffs. The sensitive coastal ecosystems such as mangroves, sand dunes, tidal flats, fish breeding grounds, etc are identified and their spatial extent demarcated. 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 Department, Kerala Police, Calicut Development Authority, Kozhikode Corporation, Tourism Department, Goshree Island Development Authority and Bakel Resort Development Corporation. The Cochin Port Trust, National Highway Authority, Indian Rare Earths Ltd, Coast Guard and Maharashtra State Road Development Authority are some other organisations for which CRZ mapping has been undertaken. In addition to this a major CRZ mapping programme is being carried out for the Govt of Maharashtra. Work was also done for private concerns such as Reliance, Essar Oils, Tata Power, Indian Petrochemicals, Pioneer Jellice, Ganesh Benzo Plast, Adithya Environmental Services, Somatheeram Resorts and Escapade Resorts.

Technical support was provided to KSCSTE and Kerala Coastal Zone Management Authority on numerous issues connected with Coastal Regulation Zone, such as court cases, expert opinion on violations and CRZ clearances.

Dr. K. V. Thomas

Funding: Various Agencies

4.2 Enviornmental Impact Assessment (EIA)

4.2.1 Rapid EIA study for the proposed air strips at Andrott and Minicoy Islands in Lakshadweep.

Considering the limited infrastructure, the administration of Lakshadweep islands proposes to promote low volume high value tourism to these islands due to the fragile eco-system, consisting of maritime vegetation and corals. One major stumbling block in island tourism is poor connectivity. Tourism cannot be promoted unless the air and sea links across the various places of tourist interest in the islands are improved.

The thrust area in the transportation sector of the Union Territory of Lakshadweep (UTL) has been the establishment of air transport facility in various islands with reference to the inhabited as well as the uninhabited islands. In order to achieve this, the Department of Science and Technology, UTL has been pursuing proposals to construct mini airstrips at certain islands of which Andrott is found to have potential importance.

Agatti is the only island in Lakshadweep having an airport now. Even though, Andrott is excluded from tourism activities, it is assessed that this island can be used as a perfect ground for safe landing of airplanes. As per the carrying capacity study, Andrott is found to be highly fragile and hence, these areas have to be protected from tourism impacts, and simultaneously, the available resources should be properly utilized for sustainable tourism activities. Compared to other islands, the area available for infrastructure developments is high in Andrott. An airstrip at Andrott, therefore, increases the accessibility and hence further development.

Considering the volume of air traffic to be handled, basic pattern of single runway is found suitable in present state of affairs. This is the simplest pattern of runway. It must usually be adopted when the air traffic requirement does not exceed the capacity of such pattern. In Visual Flight Rules (VFR) conditions, single runway can provide maximum of 45 to 60 operations per hour. In Instrument Flight Rules (IFR) conditions, its capacity reduces to 20 to 40 operations per hour. The lay out of the air strip designated is given as 4.2.1.1

The airstrip is aligned east-west. The dimension proposed is 1732m x190m with a run way length of 1372 m and width of 30 m. The best direction of runway is usually along the direction of the longest line on the wind rose diagram. The best orientation of runway is along the NS direction.

An EIA is envisaged to analyze and assess the present status of the major component of the environment such as Land, Water and

Air, Biologic and Socio economic aspects. The scope of the study can be summarized as follows:

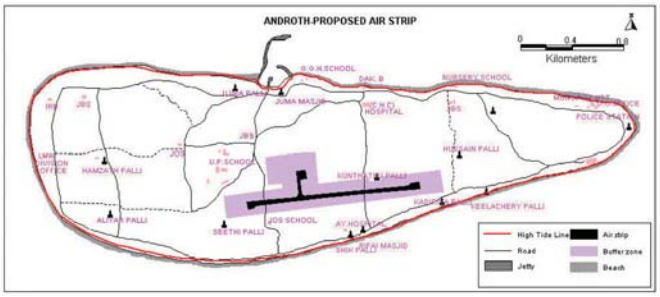

Fig. 4.2.1.1 Layout of the proposed Air strip

- Identify and quantify the impacts due to the proposed project on the environmental components.
- Suggest Environmental Management Plan (EMP), signifying additional control technologies to be adopted for mitigation of adverse impacts.
- Delineate post-project environmental quality monitoring to be taken up by the proponent.

Dr .R. Ajaykumar Varma and Dr. C. N. Mohanan
Funding: Lakshadweep Administrtion, U.T. Lakshadweep

4.2.2. Rapid EIA study for the proposed Vallarpadam Container Terminal Moolampilly to Chathanad road

The Goshree Islands Development Authority (GIDA) is a Special Purpose Vehicle created by Government of Kerala for the integrated development of Vypeen, Vallarpadam, Mulavukad, Thanthonnithuruthu and Kadamakkudy islands, lying in and around the Kochi urban area. GIDA, after completing the road linkage of three islands, namely Vypeen, Vallarpadom and Bogatty to the Kochi city proper, is now implementing a road project linking the islands of Vallarpadom, Mulavukad and Moolampally to NH 17 at Cheranelloor. This is to support the road traffic anticipated due to the development of Vallarpadam Container Terminal (VCT). In order to divert part of the traffic to the northern side from VCT and also to link fully or partially isolated islands of Moolampilly, Pizhala and Valiyakadamakkudi, the GIDA now proposes a link road between Moolampilly and Chathanad for establishing a direct road linkage from Ernakulam and North Parur. An overview of the GIDA territory and completed and proposed road linkages are given in Figure 4.2.2.1.1. The proposed road will reduce the distance between Ernakulam and North Parur by 13 km and improve the road connectivity of Kadamakkudi Panchayat. The proposed road will have a length of 4.345 km and width of 22m and will have 4 bridges and 19 culverts. Since the road alignment is through an environmentally fragile landscape, GIDA desired to have an Enviromental Impact Assessment study and entrusted the Centre for Earth Science Studies (CESS) to carry out the same.

The proposed link road mainly traverses the Kadamakkudy Grama Panchayat that has an area of 12.92 km^2 and population of around 15500. The Panchayat lies between latitudes 10°02'0" N and 10°04'0"N and longitudes 76°014'0" E and 76°17'0" E. It comprises of islands namely, Moolampilly, Pizhala, Kothad, Cheriyakadamakkudy, Chennur, Cherianthuruth, Valiyakadamkkudi etc. The proposed road will directly link Moolampally, Pizhala, Valiyakadamakkudy to Chathanad and then to NH 17 at North Parur Municipality. The road corridor cut across different branches of River Periyar, associated canals, filtration ponds, river banks, mangrove patches, paddy fields, habitation areas and agricultural land with coconut, banana and vegetables. The proposed road alignment is given in Fig. 4.2.2.2

The proposed road corridor is an environmentally fragile region at

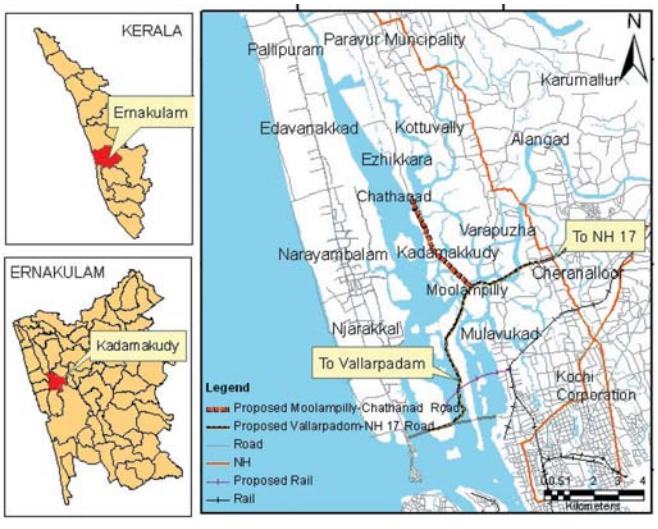

Fig. 4.2.2.1 Project area of GIDA with proposed roads and rail

the interface zone of River Periyar and Kochi backwaters. The construction of road is likely to influence the quality of environment in and around the proposed site during the construction and operation phases. The nature and magnitude of these impacts on different aspects of environment such as land, water, air, ecology, socio-economy etc. may vary. If such variation is not within the

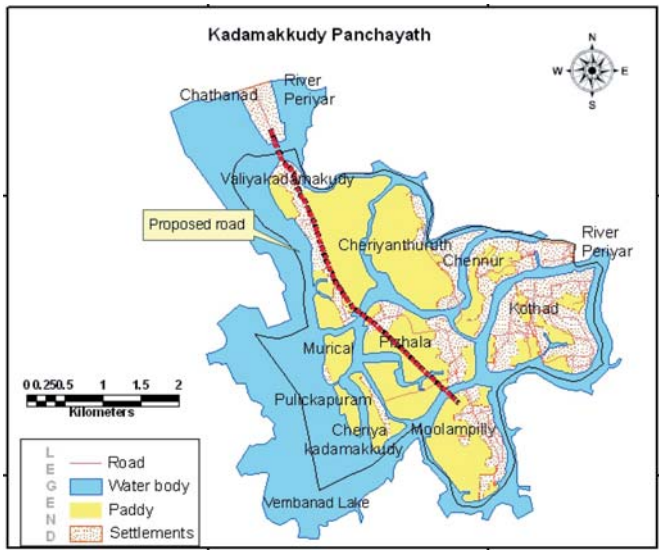

Fig. 4.2.2.2 Proposed Moolampally-Chathanad road alignments

assimilative capacity of the environment of the locality, it will be detrimental and may be irreversible and sometimes catastrophic. Therefore, it is necessary to study the nature and magnitude of such variation and find out whether such variation can be regulated within the permissible level and if so, what are the measures appropriate for such management. This can be assessed through an Environmental Impact Assessment (EIA) study. The study has lead to the identification of various impacts on different environmental components due to the activities of the proposed intervention and also facilitate delineation of measures for mitigation of the impacts. The mitigation measures are prioritized and compiled in sequential manner to formulate an Environmental Management Plan (EMP). The EMP can be incorporated into the Detailed Project Report (DPR) of the proposed development intervention, so that most of the anticipated environmental impacts are taken care of in the implementation stage itself.

Dr. R. Ajaykumar Varma and Dr. C. N. Mohanan
Funding: Goshree Island Development Authority

5 List of Projects

5.1 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.	Subsurface Flux of coastal water and management of coastal aquifier	Dept. of Science & Technology, Govt. of India	Dr. D.S Suresh Babu	Marine Sciences	Dr.A.L.Ramanathan, Dr. Chudaeva Valentina Anatolyevna, Dr. S. Chidambaram	2006-2009	10.12	01.95
2.	Tracking the past disasters and tsunami along the parts of Tamil Nadu coast	Dept. of Science & Technology, Govt. of India	Dr. Terry Machado	Marine Sciences	Sri. P. Aravahi	2006-2009	16.33	02.00
3	Metasedimentary rocks of the Kerala khondalite belt, Southern India: petrology and geodynamics of their formation	Dept. of Science & Technology, Govt. of India	Dr. G.R. Ravindra Kumar	Geosciences	-----	2006-2009	17.85	03.70
4.	Inactivation of pathogenic bacteria in periodontal disease: Fluorescence diagnostics and photodynamic therapy	Dept. of Science & Technology, Govt. of India	Dr.N.Subhash	Atmospheric Sciences	Dr.Ajaykumar, Dr.E.Sreekumar, Dr.N. Nandakumar,	2008-2011	05.27	01.76
5	Monitoring the impact of environmental changes in Corals of Lakshadweep archipelago by fluroescence imaging	Dept. of Science & Technology, Govt. of India	Dr.N.Subhash	Atmospheric Sciences	Dr..T. N. Prakash, Dr..M. S. Syed Ismail Koya	2008-2009	34.40	27.00
6	Interstitial water chemistry of aquatic environments and its significance in nutrient dynamics: a case study	Dept. of Science & Technology, Govt. of India	Dr.K.Narendra Babu	Chemical Sciences	-----	2008-2011	15.23	07.48
7	Spatio temporal shore changes during Holocene and tracing the evolutionary history of the Ashtamudi estuary Southern Kerala.	Dept. of Science & Technology, Govt. of India	Dr. T N Prakash	Marine Sciences	Dr..M.Samsuddin	2009-2012	27.49	18.44

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay Rs. in lakhs	Fund Received during the year Rs. in lakhs
8	Coastal ocean monitoring & prediction system	Dept. of Ocean Development, GOI	Dr. P. P. Ouseph	Chemical Sciences		2008-2013	----	19.96
9	Evaluation for appropriate technology based utilisation of laterite horizons in Neyyar watershed in western ghat region as water harvesting structure	Western Ghat Cell, Kerala State Planning Board	Dr. Narayanaswamy	Geosciences	Dr. Terry Machado	2007-2010	06.95	03.76
10	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		2008-2009		03.30
11.	Landslide stabilisation schemes Vellara-Poolakutty of Kannur District	Soil Conservation Unit, Dept of Agriculture	Sankar G	Geosciences		2008-2009	00.08	00.08
12.	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		2008-2010	03.47	02.08
13.	River sand auditing: A case of Manimala River	Revenue Dept., GoK	Dr.D.Padmalal	Environmental Sciences		2008-2009	34.53	34.53
14.	Rainfall validation & characterization and cloud physics studies using megha tropiques data	Department of Space, GoI	Dr. G. Mohan Kumar	Atmospheric Sciences	Dr. S. Sampath	2007-2010	22.50	15.27
15.	Optical characterization of coral reef diversity for understanding the impact of changing environmental conditions	Space Applications Centre	Dr..M.Samsuddin	Geomatics Lab		2009-2013	15.00	03.80
16	Impact of tsunami on the Kerala coast and an initiative for development of a management plan for the region	Department of Science & Technology, GOI	Dr. M .Baba		Dr. T.N. Prakash, Dr. N.P. Kurian, Dr. Srikumar Chattopadhyay, Dr. A.S.K. Nair, Sri.C.K.Sasidharan	2005-2008	11.50	NIL
17	Numerical simulation - aquifers.	Department of Science & Technology, GOI	Dr. D.S. Suresh Babu	Marine Sciences		2005-2006	06.50	00.51
18	Chemical loading into reservoirs: Investigations from selected watersheds of Periyar basin in Western Ghats, Kerala	Ministry of Environment and Forests, GOI	Dr. M.N.M Nair	Chemical Sciences	Dr. D. S. Suresh Babu, Dr. R. Ajaykumar Varma, Dr. C.N. Mohanan	2005-2009	10.30	01.03

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay Rs. in lakhs	Fund Received during the year Rs. in lakhs
19	Demarcation of vulnerability line (on pilot scale) along the coastal stretches of India based on the recommendation of Prof. M.S. Swaminathan committee report 2005	Ministry of Environment & Forests, GOI	T.S. Shahul Hameed	Marine Sciences		2007-2009		NIL
20	A model system for management and disposal of sewage in the Lakshadweep Island, India	Union Territory of Lakshadweep	Dr. M.N.M. Nair	Chemical Sciences		2005-2009	42.65	NIL
21	Environmental monitoring of water & sediment quality parameters in Cochin harbour	Cochin Port Trust	Dr. P.P. Ouseph	Chemical Sciences		2006-2007	03.99	01.77
22	Palaeointensity and Reunion/Marion plume activity in India	Project 32072 , IFPR	Dr. T. Radhakrishna	Geosciences	Sri. G. Balusubramonian	2006-2009	22.45	02.44
23	Environmental management plan for Alappuzha-Shethalai canal and Kanjikuzhy Gramapanchayat-a participatory action research programme	Kerala State Council for Science, Technology and Environment	Dr. Srikumar Chattopadhyay	Resources Analysis		2008-2010	07.50	04.24
24	Cadastral scale CRZ maps for urban areas in Kerala; phase 1 - Kochikode, Kollam & Trivandrum corporation and Varkala Municipality	Kerala State Council for Science, Technology & Environment	Dr. K.V. Thomas	Marine Sciences	Dr. N.P. Kurian, Dr. D. Raju, Sri. S. Mohanan, Sri. M. Rameshkumar	2006-2007	06.98	NIL
25	Tectonic and hydrologic control on late Pleistocene Holocene landforms, paleoforest and non-forest vegetation: Southern Kerala	Kerala State Council for Science, Technology & Environment	Dr. D. Padmalal	Environmental Sciences		2006-2008	00.20	00.08
26	SoE Lakshadweep	Kerala State Council for Science, Technology & Environment	Dr.C.N.Mohanan	Environmental Sciences	Dr. K.V. Thomas, Dr.T.N Prakash, Shri.S.Sidharthan	2008-2009	01.00	01.00
27	Workshop LSGI-CRZ Notification	Kerala State Council for Science, Technology & Environment	K.V.Thomas	Marine Sciences		2009-2010	02.00	01.50
28	Rejuvenation and utilisation of Alappuzha-Sherthalai canal for participatory development and poverty alleviation: a watershed based development approach	Rural Development	Dr. Srikumar Chattopadhyay	Resources Analysis		2007-2008	02.44	02.44

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay Rs. in lakhs	Fund Received during the year Rs. in lakhs
29	Hariyali project - Technical assistance for identification of watersheds in Chadayamangalam block Panchayat and preparation of detailed project report	Rural Development	John Mathai	Geosciences	-----	2007-2010	01.49	01.49
30	Late quarternery environmental changes in the Coastal Plains of southern Kerala, Southwest India	Council of Scientific & Industrial Research	Dr. D. Padmalal	Environmental Sciences	-----	2005-2007	00.09	00.10
31	Tsunami and storm surge inundation modelling and mapping for the coasts of Kerala, Karnataka and Lakshadweep	Ministry of Earth Sciences, Govt of India	Dr. N.P. Kurian	Marine Sciences	Dr. T.N.Prakash, Dr. K.V.Thomas, Sri. B.K.Jayaprasad, Dr T.S. Shahul Hameed	2006-2008	27.80	----
32	Nitrous Oxide and methane in coastal ocean and estuaries	Ministry of Earth Sciences	Dr. E.J. Zachariah	Atmospheric Sciences	Dr. P.P. Ouseph, Dr. C.S.P. Iyer	2007-2010	18.48	NIL
33	Shoreline management for Kerala coast	Ministry of Earth Sciences	Dr. K.V. Thomas	Marine Sciences	Dr. N.P.Kurian, Dr. T.S.Shahul Hameed, Mrs. Sheela Nair	2008-2013	176.63	20.73
34	Impact of landscape alterations on watersheds and ecosystem implications-a case study from the western ghats provenance of Idukki District, Kerala	Western Ghat Cell, Kerala State Planning Board	Dr. K. Soman	Resources Analysis	-----	2006-2009	07.20	NIL
35	Application of Space Technology for the development of Kerala	Western Ghat Cell, Kerala State Planning Board	V.N. Neelakandan	------	Sri. B.K.Jayaprasad, Dr. M.Samsuddin	2008-2010	12.62	07.00
36	Environmental monitoring and management plan with regard to dredging operations of the Travancore Cements Ltd, Kottayam	Travancore Cements Ltd.	Dr. P.P. Ouseph	Chemical Sciences	------	2008-2009	00.31	00.25
37	Physical, chemical & biological monitoring study at dredging site in vembanad lake	Travancore Chemical Ltd.	Dr.P.K.Omana	Chemical Sciences		2008-2010	01.15	00.58
38	Studies on shore protection measures for Lakshadweep Islands	Union Territory of Lakshadweep	Dr. T.N. Prakash	Marine Sciences	Mrs. Sheela Nair, Dr.T.S. Shahul Hameed, Dr. K.V. Thomas	2007-2009	25.48	25.48
39	NREDB Atlas and Digital database for Kerala State	Indian Space Research Organisation	Dr. M Samsuddin	Geomatics Laboratory		2008-2009	02.10	02.10

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 Report-Globlink Hotels, Kochi	M/s Globlink Hotels	Thomas K V	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008	01.80	01.80
2.	CRZ Report-Vasu Coco and Resorts, Cherthala	M/s Vasu Coco and Resorts, New Delhi.	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2008	01.35	01.35
3	CRZ Report-Indian Rare Earths Ltd., Chavara	M/s Indian Rare Earths Ltd.	Thomas K V	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008	03.90	03.90
4.	CRZ Report-Dr.Sarathchandran Beach Resort, Naduvattom, Kozhikode	Dr.Sarathchandran	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2008-09	00.99	00.99
5.	CRZ Report for Essar Steel Ltd., Surat	CRZ Report for Essar Steel Ltd.	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008-09	08.10	08.10
6.	CRZ for EVM Enterprise for Thirumullavaram., Kollam	M/s EVM Enterprise for Thirumullavaram	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008-09	00.99	00.99
7.	CRZ Report-Muralya Properties	M/s Muralya Properties	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008-09	00.68	00.68
8	CRZ Study for NHAI for Edapally- Kuttippuram sector	M/s National Highway Authority of India	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2008-09	07.50	07.50
9	CRZ-Aqua plast, Kochi	Anil Kumar Varma	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008-09	01.65	01.65

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay Rs. in lakhs	Fund Received during the year Rs. in lakhs
10	CRZ study for Munniyur Panchayat	M/s Munniyur Panchayat	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2008-09	00.10	00.10
11	HTl/LTL, CRZ -Azhimala Resort, Azhimala,Trivandrum.	M/s Azhimala Resort, Azhimala, Trivandrum.	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2008-09	00.24	00.24
12	CRZ study for BPCL LPG pipeline from JNPT Liquid Cargo Jetty to BPCL Urban LPG Plant, Mumbai	M/s Bharat Petroleum Corporation Ltd.	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008-09	09.00	09.00
13.	CRZ Report forRing road, Kochi for Greater Cochin Development Authority.	M/s Greater Cochin Development Authority, Cochin	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2009	04.05	04.05
14.	CRZ Report for Matha Amrithanandamayi, Alappad	M/s Matha Amrithanandamayi	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008-2009	00.57	00.57
15.	CRZ Report for NHAI (Package-1)-Kazhakkuttom-Poovar	National Highway Authority of India	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2009	01.50	01.50
16.	CRZ Report for Koodankulam Nuclear Power Project, Thirunelveli	M/s Koodankulam Nuclear Power Project, Thirunelveli	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2008-2009	04.05	04.05
17.	CRZ-EQMS for land fall point, Mumbai	M/s EQMS India Pvt., Ltd.,	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2008-2009	03.75	03.75
18	CRZ study for NHAI for Kazhakuttom Cherthala.	National Highway Authority of India	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2009-2010	07.35	07.35
19	CRZ study for Adelie Builders & Developers, Marine Drive, Kochi	M/s Adelie Builders & Developers, Kochi	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2008-2009	01.50	01.50
20	CRZ Report for Apartment Development for DLF, Chilavannur, Kochi	M/s DLF, Chilavannur, Kochi	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2009	01.50	01.50

Sl. No.	Project Title	Funding Agency	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay Rs. in lakhs	Fund Received during the year Rs. in lakhs
21	CRZ Report for Purvankara Grand Bay, Marine Drive, Kochi	M/s. Purvankara Projects Ltd., Kochi	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2009	01.50	01.50
22	CRZ Report for Purvankara Marina, Kochi	M/s.'Purvankara Projects', Kochi	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2009	01.50	01.50
23	CRZ Report for LPG-Indian Oil Corporation Ltd, Vypeen, Kochi	M/s Indian Oil Corporation Ltd.	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju	2009	04.50	04.50
24	CRZ Report for M/s. Centurions Housing & Constructions Pvt.Ltd., Purva Oceana, Ernakulam	M/s. Centurions Housing & Constructions Pvt. Ltd.	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, `Sri. D. Raju	2009	01.50	01.50
25	CRZ/HTL/LTL - study for resort development at Mullur, Vizhinjam, Trivandrum.	Architecture Incorporate Ltd, Trivandrum	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2009	00.98	00.98
26.	CRZ study for Muthoot Trivandrum	M/s Muthoot, Trivandrum	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. S. Mohanan	2009-2010	01.50	01.50
27.	CRZ Report for Asset Homes, Kochi.	M/s Asset Homes, Kochi	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2009	01.50	01.50
28	CRZ Report for Carnousite Resorts, Mararikulam, Cherthala	M/s Carnousite Resorts, Cherthala	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2009	01.50	01.50
29	CRZ Report for CISO Institute of Oceanic Studies	M/s CISO Institute of Oceanic Studies, Thrissur.	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2009	00.63	00.63
30	CRZ Report for Rizvi Builders	M/s Rizvi Builders, Mumbai	Dr. K. V. Thomas	Marine Sciences	Dr. N. P. Kurian, Sri. D. Raju, Sri. S. Mohanan	2009	07.50	07.50

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 205	Landuse-landcover change, its impact on biophysical system and environmental consequences: case studies in two sensitive zones of Northern Kerala (Kakkiar - Agastymalai hill tract)	Dr. Srikumar Chatttopadhyay	Resource Analysis		2004-2006	04.80	00.81
PLAN 206	Heavy metal and REE abundances in edible plants of heavy mineral areas of Kollam and Alappuzha districts, Kerala	Shri. G. Balasubramonian	Training & Extension	Shri. V. Vasudevan, Dr. C. N. Mohanan	2003-2006	12.64	00.02
PLAN 211	Creation of digital data bank at CESS	Shri V. N. Neelakantan	Geomatics Lab	Dr. C. M. Harish, Dr. M. Samsuddin, Dr. K. K. Ramachandran, Sri. B. K. Jayaprasad	2003-2006	12.10	00.66
PLAN 219	Studies on agro-ecological regions of Palakkad District, Kerala	Dr. E. Saravanan	Training & Extension	Shri V. Shravankumar	2004-2006	08.70	01.19
PLAN 231	Cadastral level decision support system for managment of natural resources in Thiruvananthapuram district	Sri. B. K. Jayaprasad	Geomatics Lab	Sri. John Mathai, Sri.V.N.Neelakantan, Dr.K.K.Ramachandran, Dr.C.M. Harish	2005-2009	59.64	06.86
PLAN 232	State of the environment and action plan for Kochi urban area	Dr. Ajayakumar Varma	Environmental Sciences	Dr. C. N. Mohanan, Dr. M. N. M. Nair, Sri. B. K. Jayaprasad, Sri. C.K. Sasidharan	2005-2009	52.12	09.55
PLAN 233	Development of integrated coastal zone management plans	Dr. K. V. Thomas	Marine Sciences	Dr. K. V. Thomas, Dr.Srikumar, Chattopadhyay	2005-2009	21.95	02.22
PLAN 234	Measurement of Cloud parameters and cloud modelling	Dr. V. Sasikumar	Atmospheric Sciences	Dr. V. Sasikumar, Dr. S. Murali Das	2005-2010	187.37	07.14
PLAN 239	Preparation of district level natural hazard zonation maps for Kerala	Shri. John Mathai	Geosciences	Shri. John Mathai, Dr. Srikumar Chatopaydhyay	2005-2009	19.65	03.47

List of 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 240	Study of coastal processes and hazard along Kerala coast with particular reference to disaster preparedness	Dr. N. P. Kurian	Mairne Sciences	Dr. N. P. Kurian, Dr. K. V. Thomas	2005-2009	13.04	03.58
PLAN 241	Geospatial survey & assessment of Munnar and adjoining panchayats by modern tools of geoinformatics	Dr. M. Samsuddin	Geomatics Lab	Shri. John Mathai, Shri. V.N.Neelakantan, Shri. B.K. Jayaprasad, Shri. K.R. Unnikrishnan	2008-2009	51.80	14.20
PLAN 250	Exploring interrelationshiip between enviornmental degradation and poverty: selected micro level case studies across Kerala	Dr. Srikumar Chattopadhyay	Resources Analysis	Sri. C. K. Sasidharan, Smt. C. Sakunthala	2007-2010	24.28	01.13
PLAN 251	Geomorphic setting, landscape alterations and fluvial regime change in the Western Ghats provenance of southern Sahyadri - Achankovil Ar	Dr. Mahamaya Chattopadhyay	Resources Analysis	Smt. C. Sakunthala	2007-2010	25.06	00.40
PLAN 252	Mapping of coastal cliffs and their vulnerability between Kanyakumari and Mangalore, south west coast of India	Dr. A. S. K. Nair	Marine Sciences	Shri. G. Sankar, Shri. John Paul	2007-2010	25.06	00.26
PLAN 253	Impacts of Urbanization on soil and water resources of some selected cities of Kerala	Dr. K. Narendra Babu	Chemical Sciences	Dr. D. Padmalal, Dr. K. Maya, Dr. K. Raju	2007-2009	06.60	00.76
PLAN 254	Quaternary geology and geomorphic evolution of the coastal lands of Kollam district, SW india	Dr. D. Padmalal	Enviornmental Sciences	Dr. K. Narendrababu , Sri. B. Sukumar, Dr. K. Maya	2007-2010	19.00	01.79
PLAN 255	Tropical freshwater myristica swamps of Kerala and its ecological and evolutionary significance	Dr. C. N. Mohanan	Environmental Sciences	Dr. D. S. Suresh Babu	2007-2009	15.00	00.60
PLAN 256	Hydrochemical charcterization and drinking water potential of the coastal springs of southern Kerala	Dr. K. Narendra Babu	Chemical Sciences	Dr. D. Padmalal	2007-2009	10.00	00.72
PLAN 257	Study of urbanization between Kochi and Thrissur	Smt. Ahalya Sukumar	Resource Anaysis	Sri. B. Sukumar	2008-2010	11.68	08.22
PLAN 258	Data bank on estuarine and river systems of Kerala	Dr. M. N. M. Nair	Chemical Sciences		2007-2009	10.55	00.61
PLAN 259	Application of Neutral Network in pattern calssification of remotely sensed images	Sri. K. J. Mathew	Atmospheric Sciences		2008-2010	07.58	00.13
PLAN 260	Sunlight - induced Multi-spectral fluorescence Imaging System for vegetation assessment	Dr. N. Subhash	Atmospheric Sciences	Dr. C. N. Mohanan	2007-2010	26.5	01.33
PLAN 261	Human - Induced land modifications and its impacts: A study in Thodupuzha taluk - Idukki district Kerala	Dr. K. Raju	Training & Extension	Shri. G. Sankar, Dr. V. Nandakumar	2007-2010	05.98	00.98

Project Code	Project Title	Principal Investigator	Division	Co-Investigators	Project Period	Total Outlay Rs. in lakh	Expenditure during the year Rs. in lakh
PLAN 240	Study of coastal processes and hazard along Kerala coast with particular reference to disaster preparedness	Dr. N. P. Kurian	Mairne Sciences	Dr. N. P. Kurian, Dr. K. V. Thomas	2005-2009	13.04	03.58
PLAN 241	Geospatial survey & assessment of Munnar and adjoining panchayats by modern tools of geoinformatics	Dr. M. Samsuddin	Geomatics Lab	Shri. John Mathai, Shri. V.N.Neelakantan, Shri. B.K. Jayaprasad, Shri. K.R. Unnikrishnan	2008-2009	51.80	14.20
PLAN 250	Exploring interrelationshiip between enviornmental degradation and poverty: selected micro level case studies across Kerala	Dr. Srikumar Chattopadhyay	Resources Analysis	Sri. C. K. Sasidharan, Smt. C. Sakunthala	2007-2010	24.28	01.13
PLAN 251	Geomorphic setting, landscape alterations and fluvial regime change in the Western Ghats provenance of southern Sahyadri - Achankovil Ar	Dr. Mahamaya Chattopadhyay	Resources Analysis	Smt. C. Sakunthala	2007-2010	25.06	00.40
PLAN 252	Mapping of coastal cliffs and their vulnerability between Kanyakumari and Mangalore, south west coast of India	Dr. A. S. K. Nair	Marine Sciences	Shri. G. Sankar, Shri. John Paul	2007-2010	25.06	00.26
PLAN 253	Impacts of Urbanization on soil and water resources of some selected cities of Kerala	Dr. K. Narendra Babu	Chemical Sciences	Dr. D. Padmalal, Dr. K. Maya, Dr. K. Raju	2007-2009	06.60	00.76
PLAN 254	Quaternary geology and geomorphic evolution of the coastal lands of Kollam district, SW india	Dr. D. Padmalal	Enviornmental Sciences	Dr. K. Narendrababu , Sri. B. Sukumar, Dr. K. Maya	2007-2010	19.00	01.79
PLAN 255	Tropical freshwater myristica swamps of Kerala and its ecological and evolutionary significance	Dr. C. N. Mohanan	Environmental Sciences	Dr. D. S. Suresh Babu	2007-2009	15.00	00.60
PLAN 256	Hydrochemical charcterization and drinking water potential of the coastal springs of southern Kerala	Dr. K. Narendra Babu	Chemical Sciences	Dr. D. Padmalal	2007-2009	10.00	00.72
PLAN 257	Study of urbanization between Kochi and Thrissur	Smt. Ahalya Sukumar	Resource Anaysis	Sri. B. Sukumar	2008-2010	11.68	08.22
PLAN 258	Data bank on estuarine and river systems of Kerala	Dr. M. N. M. Nair	Chemical Sciences		2007-2009	10.55	00.61
PLAN 259	Application of Neutral Network in pattern calssification of remotely sensed images	Sri. K. J. Mathew	Atmospheric Sciences		2008-2010	07.58	00.13
PLAN 260	Sunlight - induced Multi-spectral fluorescence Imaging System for vegetation assessment	Dr. N. Subhash	Atmospheric Sciences	Dr. C. N. Mohanan	2007-2010	26.5	01.33
PLAN 261	Human - Induced land modifications and its impacts: A study in Thodupuzha taluk - Idukki district Kerala	Dr. K. Raju	Training & Extension	Shri. G. Sankar, Dr. V. Nandakumar	2007-2010	05.98	00.98

5.4 R & D Infrastructural Projects

Project Code	Project Title	Co-ordinator	Division	Allotment for the year (Rs. lakh)	Expenditure during the Year (Rs. lakh)
PLAN 101	XRF facility	Director		27.60	07.99
PLAN 102	Upgradation of Geosciences laboratories	Head, GSD	Geosciences	06.55	01.62
PLAN 103	Strengthening of Ecological labortory	Head, ESD	Environmental Sciences	02.05	00.86
PLAN 104	Upgradation of Electronic and Instrumentation laboratory	Head, ASD	Atmospheric Sciences	11.75	04.03
PLAN 105	Upgradation of Chemical laboratory	Head, CSD	Chemical Sciences	19.95	08.12
PLAN 106	Upgradation of Library facilities	Head, TED/ Librarian	Library	23.60	34.92
PLAN 107	Publication of monographs/memoirs/annual reports/newsletters	Director		05.70	01.20
PLAN 108	Upgradation of training/extension/exhibition/LAN and other technical facilities	Head, TED	Training & Extension	06.55	02.16
PLAN 110	Seminar/workshops/meetings	Director		03.25	02.54
PLAN 111	Marine Laboratory infrastructure development	Head, MSD	Marine Sciences	44.40	03.04
PLAN 112	Geomatics Laboratory infrastructure development	SIC, GML	Geomatics Lab	24.09	09.75
PLAN 114	Placer Mineral Testing Laboratory	Head, MSD	Marine Sciences	36.40	06.51

5.5 R & D Building Infrastructure Projects

Project Code	Project Title	Co-ordinator	Division	Allotment for the year (Rs. lakh)	Expenditure during the Year (Rs. lakh)
PLAN 109	Construction of Sophisticated Analytical Facility Building	Registrar		21.00	32.85
PLAN 109 (1)	Construction of compound wall and road	Registrar		15.00	----
PLAN 119	Recreation facilities at CESS	Secretary, Recreation Club		01.00	NIL
PLAN 120	Upgradation of centralised Air Conditioning and facilities of CESS buildings	Dy. Registrar, Stores		02.80	NIL
PLAN 122	Construction of parking shelter	Registrar		10.00	NIL
PLAN 123	Upgradation/ repair and maintenance of toilets	Dy. Registrar, Stores		00.50	NIL
PLAN 124	Upgradation of EPABX system	Registrar		02.50	NIL
PLAN 126	Garden development and landscaping	Registrar		02.00	NIL
PLAN 128	Upgradation of elctrical installations and facilities and upgradation/purchase of a new DG set	Registrar		01.00	00.91
PLAN 150	Construction of water tank and modification to the existing water supply scheme	Registrar		15.00	15.00
PLAN 151	Replacement of damaged cast iron stair case in the administrative building	Registrar		01.50	NIL
PLAN 152	Upgradation of computer facility in administration block	Registrar		05.00	NIL
PLAN 153	Upgradation of security area and rooms	Registrar		01.00	NIL
PLAN 156	Construction of compound wall in the land at Ernakulam	Registrar		30.82	30.82

6 HONOURS & AWARDS

6.1 Awards

Dr. Harsh K. Gupta, President, Geological Society of India honoring Dr. M. Baba, Director CESS, for his valuable contributions to Earth Sciences, during the Golden Jubilee function on 12 October, 2008 at Bangalore

Mr. S. Arjun, 2009-10 has been awarded the second best student paper award for his paper entitled ' Numerical modeling of flooding due to remote forcing along south central Kerala coast' at OSICON' 09 on Recent Development in Ocean Science, Engineering and Technology during 19-21 March 2009 held at the Centre for Studies on Bay of Bengal, Andhra University, Visakhapatanam. The paper was coauthored by Ms. L. Sheela Nair and Dr. N. P. Kurian

Dr. M. N. Muraleedharan Nair, Scientist E2, Chemical Sciences Division has won the award for the best poster presentation for the paper 'Assessment of Heavy Metals and Pesticides in the Reservoir Sediments of the Periyar River Basin' at the XXI Kerala Science Congress held at Kollam during 28-31 January 2009. The paper was co-authored by Prasanth M. Sinosh P. K. and Jiji Kumar S.

6.2 Ramanujam Fellowship

Dr. C. P. Rajendran, Senior Scientsit has been awarded Ramanujam Fellowship by the Ministry of Science and Technology, Government of India. This fellowship extending for five years is for the studies on palaeoseismology / seismology in the Indian Institute of Science, Bangalore

6.3 Ph.D Awarded

Sri. Anil Earnest was awarded Ph. D by the CUSAT for his work 'Constraining the active tectonic deformation of the Andaman-Nicobar Arc in the background of December 26, 2004 the great Sumatra-Andaman earthquake' carried out under the supervision of Dr. C. P. Rajendran, Scientist, CESS.

6.4 Participation in Training Programmes

Leica Geosystems conducted training on Mobile Matrix Survey for the Scientists and Research Fellows of CESS during 3-7 November, 2008.

Shri. K. R. Unnikrishnan attend training in 'Earthquake Hazard Mitigation and Management' at the National Institute of Disaster Management', New Delhi during 14-20 June 2009.

6.5 Ph. D Students

Student	Topic	Research Guide	University
Shamji V. R.	Coastal morpho dynamics	Dr. N. P. Kurian	CUSAT
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
Tiju I Varghese	Beach and estuarine evolution of Kollam coast during holocene	Dr. T. N. Prakash	CUSAT
Arun J John	Tracking the anthropocene in the sedimentary basin of Kerala, SW coast of India	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
Abilash P. P.	Charcterization of marine pollution along the southern coast of Kerala using the macrobenthic assemblages	Dr. P. P. Ouseph	CUSAT
Praveen S. S.	Numerical modelling of tsunami inundation along Kerala Coast	Dr. N. P. Kurian	CUSAT
Arjun S.	Numerical modelling of tides and coastal flooding	Dr. N. P. Kurian	CUSAT
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
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
Anjali R.	Study of ambient atmospheric carbon monoxide in the tropics	Dr. G. Mohan Kumar	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
George Thomas	The development of urban heat island in a tropical coastal city	Dr. E. Zachariah	Kerala
Vishnu R.	Electricial charcteristics of thunderstorms and lightning	Dr. S. Muralidas	Kerala
Dhanya V.	Environmental resource management in achancovil river basin- a watershed based approach	Dr. Srikumar Chattopadhyay	Kerala
Divya G Mohan	Studies on variation of elemental concentration in different soil types of Kannur district	Dr. Ansom Sebastian	Kerala
Sreekanth T. S.	Charcterization of tropical rain fall in terms of drop size distribution at surface, its varaition with altitude and comparison of rain rates with satellite measurements	Dr. G. Mohan Kumar	Kerala
Vandana M.	Land system analysis of kabani river basin	Dr. Srikumar Chattopadhyay	Kerala
Ranikrishna L.	Tropical freshwater myristica swamps of Kerala and its ecological and evolutionery significance	Dr. C. N. Mohanan	Kerala
Praveen. M. N.	Geological aspects of the eastern part of betal belt, Central Indian tectonic zone	Ravindra Kumar. G. R	CUSAT

6.6 P.G Studentship Programme

As recommended by the Research Council, CESS supports Post Graduate students by extending studentships since 2005-06, to improve research aptitude among students in different areas of Earth Science. During the academic year 2008-09, 57 applications were received from meritorious students from different parts of Kerala and thirteen 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
Lekshmi Raj N	Sree Narayana College, Kollam	Kerala	A Comparative evaluation of phosphorus species in surface and bottom sediment of paravur lake, Kerala	Dr. K. Narendra Babu
Veena I	Sree Narayana College, Kollam	Kerala	Impacts of urbanization in groundwater sources of Thiruvananthapuram urban and its adjacent areas	Dr. K. Narendra Babu
Linu Xavier	Sree Narayana College, Kollam	Kerala	Evaluation of phosphorus in the core sediment of paravur lake: its relation between iron, organic carbon and texture	Dr. K. Narendra Babu
Vishnu S	Christian College, Kattakada	Kerala	Assessing the pollution status of the parvathiputhanar at Vallakadavu using hydrochemical and bacterial indicators	Dr. P. K. Omana
Asha R	Sree Narayana College, Kollam	Kerala	Packaged drinking waters of Kerala market- A consumer level study for quality monitoring in its "Ready to drink attention"	Dr. P. K. Omana
Athulya A T	Sree Narayana College, Kollam	Kerala	Analysis of total mercury in sediments of Muvattupuzha river by Cold Vapour Atomic Absorption Spectroscopy (CVAAS)	Dr. P. K. Omana
Noujas V	CUSAT, Kochi	CUSAT	Numerical wave height distribution of a medium energy coast of southern Kerala	Dr. T. S. Shahul Hameed
Shiny L	All Saint's College, Thiruvananthapuram	Kerala	Hydrogeochemistry of manimala river, Kerala, south west India	Dr. K. Maya
Abdulla Nasheeth	CUSAT, Kochi	CUSAT	Petrology of Kasaragod jalsoor belt and its comparison with Sargur & Wayanad schist belt	Dr. G. R. Ravindra Kumar
Shaji J	University College, Palayam	Kerala	The spatial distribution and the socio-economic analysis of slum dwellers using GIS: A study in Neyyattinkara town	Sri. B. K. Jayaprasad
Sharaniya L	University College, Palayam	Kerala	Land use change sin the IT corridor using GIS and remote sensing	Sri. B. K. Jayaprasad
Divya Das S. S	University College, Palayam	Kerala	Crime mapping and analysis using GIS and GPS; A case study of Thiruvananthapuram city	Sri. B. K. Jayaprasad
Hima K. Reghunath	Government College, Kottayam	MG	Different sedimentological analysis and their interpretation	Dr. T. N. Prakash

6.7 M.Sc/B.Tech/M.Tech dissertations

Name of student	Affiliation	University	Topics of Dessertation	Supervisor
Manjima. K.S.	Kerala University	Sree Narayana College, Chengannur	Regional variation of ground water quality in Thiruvananthapuram city and surrounding areas	Dr. K. Narendra Babu
Praveena. V.P.	Kerala University	Sree Narayana College, Chengannur	Soil chemistry of some selected farm lands of Thiruvananthapuram district	Dr. K. Narendra Babu
Reshma. B	Kerala University	Sree Narayana College, Chengannur	Water chemistry of selected temple pond waters in Thiruvananthapuram city region	Dr. K. Narendra Babu
Reshmy. O	Kerala University	Sree Narayana College, Chengannur	Hydrochemistry of selected spring water resources of Varkala	Dr. K. Narendra Babu
Dhanya Vishwanath	Kerala University	Sree Narayana College, Chengannur	Impact of urbanization on the surface water quality of Thiruvananthapuram city	Dr. K. Narendra Babu
Savitha Mathew	Madurai Kamaraj University	Lady Dock College, Madurai	Ambient Carbon monoxide and surface ozone at a coastal site	Dr. G. Mohankumar
Kavitha. K	Madurai Kamaraj University	Lady Dock College, Madurai	Ambient Carbon monoxide and surface ozone at a coastal site	Dr. G. Mohankumar
Shiekha E. John	Pune University	University of Pune	Impact of tourism development in Sankumukham	Dr. C.N. Mohanan
Soumya. S.S	Kerala University	Christian College Kattakada	An automatic detection system for negative electric filed	Dr.Murali Das
Priya Lekshmi S G	Bharathidasan University	Dhanalakshmi Srinivasan College of Arts & Science for Women	Automatic signal control	Dr. S. Muralidas
Kavitha. U	University of Kerala	University College, Kariavattom	Impact of smoking and drinking on oral mucosa: A pilot study using laser induced autofluorscence	Dr. N. Subhash
Vaisakhan Thampi. D.S	University of Kerala	University of Kerala, Kariavattom	Solar Ultraviolet-B radiation ozone and water vapour measurement at a tropical site	Dr. G. Mohan Kumar
Santhosh Kumar. S	University of Kerala	University of Kerala, Kariavattom	Solar Ultraviolet-B radiation ozone and water vapour measurement at a tropical site	Dr. G. Mohan Kumar
Saranya Krishnan.J.B	Kerala University	St. Xavier's College, Thiruvananthapuram	Design of Virtual instrument for Data acquisition from an electric field will using embedded controller	Dr. S. Muralidas
M. Rajesh Karthik		Government Dental College	Immediate distribution of root canal using photodynamic therapy	Dr. N. Subhash
Ammukutty. A	Kerala University	College of Engineering Thiruvananthapuram	Land use land cover changes in selected wards surronding Padmanabha Swami temple of Trivandrum city corporation using remote sensing in GIS	Sri. B. K. Jayaprasad
Deepthi. N	Kerala University	College of Engineering Thiruvananthapuram	Land use land cover changes in selected wards surronding Padmanabha Swami temple of Trivandrum city corporation using remote sensing in GIS	Sri. B. K. Jayaprasad
Sheena P	Periyar University	AVS College of Arts & Science, Ramalingapuram	Spatial variation of water quality in Bharathapuzha river: a comparative study of river water quality with nearby well water	Dr. K Narendra Babu

Name of student	Affiliation	University	Topics of Dessertation	Supervisor
Shiny.L	Kerala University	All Saints' College	Hydrogeochemistry of Manimala river, Kerala, South West India	Dr. K. Maya
Drishya Das	Kerala University	All Saints' College	Geoenvironmental Appraisal of Manimala river (Kerala State) with special reference to sandmining, Ripuram vegetation and fish biodiversity	Dr. K. Maya
Remya.K	Kerala University	All Saints' College	Environmental Impact Assesment of Sand mining - A case from Manimala river	Dr. K. Maya
Renoy		P.S.N.A College of Engg. & Technology	Landuse classification in Neyyar River Basin with special reference to Special Analysis of Rubber Plantation	Dr. K. K. Ramachandran
Sumy Jagath	Kerala University	S.N. College, Kollam	Environmental factors that affect the hydrochemistry of Chalaiyar river	Dr. Narendra Babu
Rekha. S	Kerala University	S.N. College, Kollam	Chemistry of interstitial water with respect to overlaying water in Kadinamkulam lake	Dr. Narendra Babu
Aruna. P.S	Kerala University	Govt. All Saints' College	A Preliminary study on Noise Pollution and its Imapct on Human Hearing Impairment	Dr. V. Muraleedharan
Rahi. Nair	Kerala University	Govt. All Saints' College	Hydrochemistry of Vellyani Fresh Water Lake: with special reference to the Drinking Water Quality	Dr. V. Muraleedharan
Deera. A	Kerala University	University of Kerala, Kariavattom	Pattern classification of Remotely Sensed Images using Artificial Neural Network	Shri. K.J.Mathew
Remyamol. S	Kerala University	University of Kerala, Kariavattom	Pattern classification of Remotely Sensed Images using Artificial Neural Network	Shri. K.J.Mathew
Saba Gaffoor	Kerala University	S.N. College, Varkala	Anthropogenic impacts on Vellayani Lake water Thiruvananthapuram	Dr. K. Narendra Babu
Nikil Chandra	Kerala University	S.N. College, Varkala	Hydrochemistry of spring water resources of Hariharapuram	Dr. K. Narendra Babu
Sandhya. I.B	Kerala University	S.N. College, Varkala	Impacts of urbanization of the water quality of Karamana river	Dr. K. Narendra Babu
Lekshmi. M	Kerala University	University of Kerala, Kariavattom	Human Interventions on inland fisheries- a case study of Manimala River, Kerala, India	Dr. K. Maya
Saritha G Nair	Karpagam Arts and Science College, Coimbatore		Impact of human activities on the water qualityof lake and river water systems in Thiruvananthapuram	Dr. K. Narendra Babu
Divya B G	S. N. College, Varkala	Kerala	Effect of pH on the release of iron from the sediment of a fresh water lake: A case study in Vellayani lake, Thiruvananthapuram	Dr. K. Narendra Babu
Sarimol S	S. N. College, Varkala	Kerala	Release of phosphorus from sediment under differnt PH conditions: A study in Akkulam lake, Thiruvananthapuram	Dr. K. Narendra Babu
Lekshmi S Pillai	D. B. College, Sasthamcotta	Kerala	Hydrochemistry of Sasthamcottah lake - The impact of human interventions	Dr. K. Narendra Babu
Nith S	S. N. College, Kollam	Kerala	Water chemistry of the spring resources in Chirakkara - Nedungolam areas, Kollam district	Dr. K. Narendra Babu

6.8 CESS Review Committee

The Review Committee constituted by the Kerala State Council for Science Technology and Environment to review the functioning of CESS and to suggest recommendations for the future, had its final sitting during 22-23 September 2008 at CESS. The members of the Committee were Dr. Victor Rajamanickam, Prof & Head, Disaster Management, SASTRA University; Dr. R. Sadasivan Nair, Director, Geological Survey, Kerala Circle and Prof. M. Ravindran, Advisor, Rural Technology Action Group, Chennai (Chairman).

6.9 Visits abroad

Sri. R. Harikumar, Research Fellow, Atmospheric Sciences Division participated and presented four papers in the 37th Committee on Space Research (COSPAR) Scientific Assembly held at Montreal, Canada during 13-20 July, 2008.

Dr. N. Subhash visited the Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria during 9-28 March 2009 as part of a collaborative project on 'Inactivation of pathogenic bacteria in periodontal diseases-Fluorescence diagnostics and photodynamic therapy', funded by DST, Government of India.

6.10 Membership in Committees

Dr. M. Baba

Member of National Coastal Zone Management Authority

Member of Kerala Disaster Management Authority

Member of the COMAPS Review Committeee, Ministry of Earth Sciences, Government of India

Member of the State Level Agency of XI Plan National Watershed Development Project for Rainfed Areas.

Chairman of the Technical Committee by the Industries Department, Government of Kerala, to study the environmental aspects of Clay and Bauxite mining in Kasaragod District.

Member of Kerala Coastal Zone Management Authority

Member of Dam Safety Authority

Dr. K. V. Thomas

Member of the GIDA Committee on Vypeen Munambam coastal road.

Dr. C. N. Mohanan

Member of the State Wetland Technical Unit (WTU), KSCSTE

Member, State Committee on Ecologically Fragile Land,Forest Department, GoK

Dr. A. S. K. Nair

Member of the State Wetland Technical Unit (WTU), KSCSTE

Dr. M.Samsuddin

Group Leader and Convenor for formulating a technical proposal and preparation of Request For Proposal for establishing the Kerala State Spatial Data Infrastructure, GoK

6.11 Training Imparted

Sri. B.K.Jayaprasad has imparted training for the surveyors in Palakkad and Alappuzha Municipalities for tax mapping under MOUD-UNDP programme for KILA.

Sri. B.K.Jayaprasad has imparted training on advanced survey techniques (GIS, GPS and Remote sensing) for PWD engineers at Kozhikode on 30.10.08.

7 Library

7.1 Library

CESS Library supports the academic and research activities of CESS by serving as an excellent information centre in the field of Earth Sciences. It is a major resource for Earth Science and related disciplines and has an excellent collection of both printed and electronic literature. The collection of the Library consists of books, journals, backvolumes, CDs, VCDs, CD ROM database, Maps and Atlases, Theses, Project Reports, Reference Books, Annual Reports etc. In addition to the scientific community of the CESS, the library is used by other R&D Centres and Universities.

During the year, the Library has facilitated in creating new knowledge through acquisition, organisation and dessimination of documents. A total of 46 books were added to the collection. Library subscribed to 17 international and 27 Indian journals. In addition to this, many books and journals were being received as gratis. Library was actively engaged in creation of digital contents. The digital contents of the Library include electronic journal articles, VCD/CD films, CD ROM database, conference proceedings etc. The CD ROM database – GEOBASE published by Elsevier contains abstracts of articles spanning from 1994-2005. Besides, library has started

subscription to online database – 'keralastat.com'. As part of enriching its digital collection, subject based digital collection has been started and digitisation of in-house technical reports are progressing. The CESS library continued to offer different types of services such as Selective Dissemination of Information (SDI), Literature Search, Reference Service, Library Membership, Reprint Service, Press Clipping Service and Document Delivery Service to users. Besides this, Library also provide facility for internet browsing. Three terminals were dedicated for this purpose. Library has taken institution membership in various reputed libraries for the staff. In addition, Library offered Current Awareness Services such as list of new additions, display of CESS publications, display of details of various scholarship, fellowship, forthcoming conferences, seminars etc.

The Library is using the software SOUL, which is an integrated multi-user Library management system that supports all in-house operations of the Library. The software has different modules like Acquisition, Catalogue, Circulation, Serial Control, Online Public Access Catalogue (OPAC) and Administration. Bibliographic records of books available in the Library can be accessed through this OPAC module. One personal computer has been provided for users to search the OPAC. Search can be done by using different access points like title, author, accession number, subject, ISBN, publisher, class number etc. The search can be refined by using other parameters also. The database of books is being updated on day-to-day basis with details of recently acquired books. WEBOPAC module has been developed and incorporated with the software so as to enable users to search Library database from their desktop inside the campus. During this year a seperate module has been developed for backvolume database and integrated with the software. In addition to the Library collection, details of all in-house project reports in the Library were also included in the database. As part of infrasturcture development few furniture were added. A proposal for new library building has been submitted to the authorities as well.

8 Publications

8.1 Publication in Journals, Proceedings and Books

8.1.1 In Journals

Kurian, N. P., Rajith, K., Shahul Hameed, T. S., Sheela Nair, L., Ramana Muruthy, M. V., Arjun, S., Shamji, V. R. (2009) 'Wind waves and sediment transport regime off the south central Kerala coast, India', Natural Hazards, 48: 259-273.

Kurian, N. P., Nirupama, N., Baba, M., Thomas, K. V. (2009) 'Coastal flooding due to synoptic scale, meso-scale and remote forcing', Natural Hazards, 49: 325-345

Santhosh Kumar, E. S., Radhakrishnan, C., Kunhikannan, J. F., Veldkamp, and Mohan, C. N. (2008) Rediscovery of Maesa velutina Mez (Maesaceae/Myrsinaceae): An Endemic and Endangered species of the Western Ghats, India. Rheedea, 18 (1): 39-42.

Rajith, K., Kurian, N. P., Thomas, K. V., Prakash, T. N. and Hameed, T. S. S. (2008) 'Erosion and Accretion of a Placer Mining Beach of SW Indian Coast, Marine Geodesy, 31: 128-142.

Rupananda Mallia, Shiny Sara Thomas, Anitha Mathews, Rejinish Kumar, Paul Sebastian, Jayaprakash Madhavan, Narayanana Subhash (2008) 'Oxygenated hemoglobin diffuse reflectance ration for in vivo detection of oral pre-cancer, Journal of Biomedical Optics 13(4), 1-10.

Shiny, S., Thomas, Rupananda J Mallia, Mini Jose, Narayanan Subhash (2008) 'Investigation of in vitro dental erosion by optical techniques, Journal of Lasers Med Sci (2008) 23:319-329 DOI 10-1007/s 10103-007-0489-z, 1-9.

Tim Jennerjahn, and Soman, K. (2008) 'Effects of landuse on the biochemistry of dissolved nutrients, suspended and sedimentary organic matter in the tropical Kallada river and Ashtamudi Estuary, Kerala, India, Journal of Biogeochemistry, 90, 29-47.

Santhosh Kumar, E. S., Radhakrishnan, K., Kunhiraman, C., Veldkamp, J. F. and Mohanan, C. N. (2008) 'Rediscovery of Maesa velutina Mez (Maesaceae/Myrsinaceae): An Endemic and Endangered species of the Western Ghats, India, Rheedea, 18(1), 39-42.

Jayanthi, J. L., Mallia, R., Shiny, S. T., Baiju, K. V., Mathews, A., Kumar, R., Sebastian, P., Madhavan, J., Aparna, G. N. and Subhash, N (2009) 'Discriminant analysis of autoflourescence spectra for classification of oral lesions in vivo, Lasers in Surgery and Medicine, 41:345-352 (DOI:10.1002/ism.20771)

Zachariah, E. J. and Johny, C. J. (2009) 'Methane in estuarine discharges to coastal ocean – A study at Ashtamudi Estuary, Kerala, India'. Asian Journal of Water, Environment and Pollution (AJWEP), 6(2): 15-22

Hamsa Varikodan, Harikumar, R., Sasikumar, V., Muralidas, S., Sampath, S. and Mohankumar, G.(2009) 'Properties of cloud base height during southwest monsoon period over a tropical station, Thiruvananthapuram, Current Science, 96(4), 562-568

Harikumar, R., Sampath, S. and Sasikumar, V. (2009) 'An empirical model for the variation of raindrop size, distribution with rain rate at a few locations in southern India, Advances in Space Research, 43, 837-844

Omana, P., K., and Mahesh Mohan (2008) 'The new mercury pollution threat to acquatic ecosystems of India- an example from Kerala' Ecol. Env. & Cons. 14(2-3) pp.341-346

Harikumar, R., Sampath, S. and Sasi Kumar, V. (2008) 'An Empirical Model for the Variation of Rain Drop Size Distribution with Rain Rate at a few Locations in Southern India', *Adv. in Space Research,* 43, 837-844, DOI: 10.1016/j.asr.2008.11.001.

Harikumar, R., Sasi Kumar, V. and Sampath, S. (2009) 'Variation of Rain Drop Size Distribution with Rain Rate at a few Coastal and High altitude Stations in Southern Peninsular India', *Adv. in Space Research* DOI: 10.1016/j.asr.2009.09.018

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Aneesh, V. R., Mohankumar, G. and Sampath, S. (2008) ' Spatial distribution of atmospheric carbon monoxide over Bay of Bengal and Arabian Sea: Measurements during pre-monsoon period of 2006', *J. Earth Syst. Sci.* 117, No. 4, pp. 449–455

Anjali, R., Mohan Kumar, G. and Sampath, S. (2009) 'Observed local enhancements in atmospheric carbon monoxide during biomass burning events', *J. Ind Geophys. Union* 13,149-158.

Sreejith, C. and Ravindra Kumar, G.R., (2009) 'Petrological and geochemical characteristics of Marunthurkota syenites from the Kerala Khondalite Belt, southern India'. *Journal of the Geological Society of India,* v.73, pp.386–392

Maya. K., Padmalal, D., Narendra Babu, K. and Sreeja, R. (2009) 'Limeshell mining from the Vembanad lake basin (Kerala State), SW Coast of India: Problems and prospects'. The University Journal of Earth Sciences, Icfa, Vol. 3, No. 2, pp 41-54.

8.1..2 In Proceedings

Sukumar, B., Ahalya Sukumar and Savitha, N. (2008) 'Delineation of Agriculturally drought prone areas in Wayanad district, Kerala using satellite imagery and GIS' INCA Journal, Vol. 28 pp. 335-38.

Ahalya Sukumar, Savitha, N. and Sukumar, B. (2008) 'Spatio-temporal growth of Thrissur Corporation, Kerala: A study using satellite imagery and GIS' INCA Journal, Vol. 28 pp. 535-44.

Savitha, N., Ahalya Sukumar and Sukumar, B. (2008) 'Changing Occupational Structure of Thrissur District, Kerela State: A Cartographic Appraisal' INCA Journal, Vol. 28 pp. 339-44

Deepthi, P., Ahalya Sukumar and Sukumar, B. (2008) 'Regional variation in development: A cartographic appraisal using GIS in Kottyam District, Kerala' INCA Journal, Vol. 28 pp. 367-372.

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Divya,U, M., Ahalya Sukumar and Sukumar, B. (2008) 'Regional variation in development: A cartographic appraisal using GIS in Malappuram District, Kerala' INCA Journal, Vol. 28 pp. 361-366

Anuja, S. and Sukumar, B. (2008) 'Application of GIS in Fluvial geomorphic studies in Kollam district, Kerala' INCA Journal, Vol. 28 pp.545-48

Panda Sampad Kumar, and Sukumar, B. (2009) 'Delineation of area for water conservation of Pervumba basin, Kannur disitrict using remote sensing and GIS, Proc. National Conference of on Innovations and Recent advances in Geospatial technology: PSNA college of Engineering, Dindigul, pp. 1-7

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Harikumar, R., Sampath, S., Mohan Kumar, G., Sasi Kumar, V. & Gairola, R. M., (2009) 'Preliminary Comparison of TRMM precipitation data with Micro Rain Radar, Disdrometer and Manual Rain Gauge data during different monsoon seasons at Coastal and High altitude Stations in Peninsular India', International Conference on Megha-Tropiques Science and Applications, Bangalore', March 23 – 25, 2009, PP 104-108.

Harikumar, R., Sampath, S., Mohan Kumar, G. & Sasi Kumar, V. (2009) 'Simultaneous Evidence for the origin of rain from Stratiform or Convective Clouds From the Micro Rain Radar Bright Band Signature and the Vertical profiles of Z-R Empirical relation, International Conference on Megha-Tropiques Science and Applications', Bangalore, March 23 – 25, 2009, PP 109-113.

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8.1.3 In Books

Chattopadhyay, S (2009) Geoenvironmental appraisal for sustainable development in Kerala. Earth System Science, Vol. II (Eds. A. Kumar, R. S. Kushwaha & B. Thakur) Concept Publication, New Delhi, pp. 494-509.

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8.2 Project Reports

R. Ajayakumar Varma, C. N. Mohanan, M. N. M. Nair, K. V. Thomas, S. Muralidas, K. R. Unnikrishnan and P. V. S. S. K. Vinayak (2008) 'Rapid EIA study for the proposed Vallarpadam Container Terminal Road at Moolapilly to Chathanad and the final report submitted to GIDA, Kochi, ,150p

K. Soman (2009) 'Land use change and water quality: A case study in the Western Ghats provenance of central-south Kerala rivers,. Report submitted to the Western Ghats Cell, Planning Board.

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for Globlink Hotels, Kochi.

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Report for Beach Resort at Naduvattom, Kozhikode.

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for EVM Enterprise for Thirumullavaram, Kollam.

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for Muralya Propertied, Thiruvananthapuram

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Study for NHAI for Edapally-Kuttippuram.

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for Aqua Plast, Kochi

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Study for Munniyur Panchayat.

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Status Report and Delineation of HTL, LTL Azhimala Resort, Azhimala, Thiruvananthapuram.

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for BPCL LPG pipeline from JNPT Liquid Cargo Jetty to BPCL Urban LPG Plant, Mumbai.

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for Ring road, Kochi for Greater Cochin Development Authority

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for Matha Amrithanandamayi, Alappad

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Report for NHAI (Package-I) Kazhakkuttom, Poovar

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ –EQMS for landfall point, Versova, Mumbai, India Pvt. Ltd., Delhi

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Study for NHAI for Kazhakuttom, Cherthala

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for Adelie Builders & Developers, Marine Drive, Kochi

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for Apartment Development for DLF, Chilavannur, Kochi

Thomas, K.V., Kurian, N. P., Raju, D.,CRZ Report for Purvankara Grand Bay, Marine Drive, Kochi

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for Purvankara Marina, Kochi

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for LPG-Indian Oil Corporation Ltd, Vypeen, Kochi

Thomas, K.V., Kurian, N. P., Raju, D., CRZ Report for M/s. Centurions Housing & Constructions Pvt.Ltd., Purva Oceana, Ernakulam

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ/HTL/LTL - study for resort development at Mullur, Vizhinjam, Thiruvananthapuram.

Thomas, K.V., Kurian, N. P., Mohanan, S., CRZ Report for Muthoot, Thriuvananthapuram

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Report for Asset Homes, Kochi.

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Report-CISO Institute of Oceanic Studies

Thomas, K.V., Kurian, N. P., Raju, D., Mohanan, S., CRZ Report for Rizvi Builders, Dev Silk, Bandra Mumbai

9 Conference, Seminar, Workshop

9.1 Bala Sastra Congress

CESS hosted the 'Bala Sastra Congress 2008', organized by the Kerala Sastra Sahitya Parishad during 3-4 May 2008. Nearly 150 School children learning in upper primary, high school and higher secondary classes selected from among 25000 students participated. The theme of the Congress was 'Landuse and its impact on the environment'. The projects presented by the children were evaluated by experts from CESS, which was followed by group discussion and comments for improvement. The students were also given a chance to visit the laboratories of CESS. The second day of the Congress was dedicated for field study by students to identify the landuse changes in CESS campus. There was an open forum moderated by Prof. M. K. Prasad, Executive Director, Information Kerala Mission, Prof. Subramanian Iyer, Kerala Agricultural University, Dr. M. Baba, Director, CESS, Dr. M. Samsuddin, Dr. C. N. Mohanan, Sri. V. N. Neelakandan, Sri. G. Sankar and Sri. B. K. Jayaprasad, Scientists from CESS. The functionaries of KSSP and the ward councilor of Thiruvananthapuram Corporation participated actively for the success of the event. Dr. K. Raju, Scientist, CESS was the convener of the congress.

Student delegates of the 'Bala Sastra Congress'during a presentation and group discussion.

9.2 The Chandrayaan team felicitated

The Kerala State Council for Science, Technology & Environment (KSCSTE) and the Centre for Earth Science Studies (CESS) organized a felicitation for the Chandrayaan team for their unparalleled achievement in the launch of Chandrayaan I. The felicitation was held at a glittering function graced by the Hon'ble Chief Minister of Kerala, Sri. V. S. Achuthanandan, Ministers and several other dignitaries, at Co-bank Towers, Thirvananthapuram on 11 December 2008. Almost all the architects of the Chandrayaan mission led by Dr. G. Madhavan Nair, Secretary, Department of Space & Chairman, ISRO were present. The large audience comprised of a galaxy of scientists from ISRO and other institutions, academicians, professionals, students and dignitaries from various walks of life. The Hon'ble Chief Minister of Kerala, Sri. V. S. Achuthanandan, was the first to offer felicitations by presenting 'ponnada' and memento to each one of the team members. The ISRO team consisted of Dr. G. Madhavan Nair, Chairman, ISRO: Dr. K. Radhakrishnan, Director, VSSC; Sri. P. S. Veeraraghavan, Director, IISU; Dr. T. K. Alex, Director, ISAC; Sri. M. C. Dathan, Director, SHAR; Sri. M. K. G. Nair, Director, LPSC; Sri. George Koshy, Project Director, PSLV; Dr. S. Ramakrishnan, Director-projects, VSSC; Sri. A. Bhaskaranarayana, Scientific Secretary; Dr. V. Adimuruthy, Associate Director, VSSC; Sri. H. N. MMadhusudhana, Director, BEA; Dr. C. Venugopal, Vehicle Director, PSLV C-11 and Sri. M. Annadurai, Mission Director, Chandrayaan.

Hon'ble Chief Minister Sri. V. S. Achuthanandan presenting 'Ponnada'and a memento to Dr. G. Madhavan Nair, Chairman, ISRO and the leader of the 'Chandrayaan team' during the function

A view of the audience

9.3 Prof. C. Karunakaran Endowment Lecture: Space for development of Kerala

Prof. C. Karunakaran Endowment Lecture 2008, the eighth lecture in the series was delivered by Dr. G. Madhavan Nair, Chairman, ISRO and Secretary, Department of Space, Government of India after the felicitation of the 'Chandrayaan I' team at the Co-bank Towers, Thiruvananthapuram on 11 December 2008. Dr. M. Baba, Director, CESS gave the background of the Endowment Lecture and remembered the significant contributions made in the area of earth sciences by Prof. C. Karunakaran, the founder Director of CESS. In his lecture, Dr. Nair focused mainly on the applications

Hon'ble Minister Sri. Binoy Viswam offering felicitations

Earlier Dr. E. P. Yesodharan, Executive Vice President, KSCSTE welcomed the dignitaries. After the presentation ceremony felicitation were offered by Sri. C. Divakaran, Hon'ble Minister for Food, Civil Supplies and Animal Husbandry: Sri. Binoy Viswam, Hon'ble Minister for Forest and Housing: Sri. P. J. Thomas, Chief Secretary and Dr. C. G. Krishnadas Nair, former Chairman & Managing Director, Hindustan Aeronautics Ltd. Dr. N. P. Kurian, Head, Marine Sciences Division, CESS proposed the vote of thanks.

Dr. G. Madhavan Nair, Chairman, ISRO, and Secretary, Department of Space, Government of India, delivering the Prof. C. Karunakaran Endowment Lecture

Hon'ble Minister Sri.C. Divakaran during his presidential address

of earth observations for the development of Kerala. He asserted that Kerala, the land of rivers, backwaters, plantations, beaches and forest, is endowed with rich natural resources. The State's major task, according to him, is to manage its land resources, namely soil, water, plant and animal systems within the agro-ecological zones to meet the human aspirations and challenges of the future taking care of conservation of the environment. Dr. Nair also mentioned about the important studies, applying remote sensing techniques, carried out for natural resource inventory to suggest suitable measures for the sustainable development of the region. The major ISRO initiatives in this direction are Integrated Mission for Sustainable Development to generate a database on natural resources, landuse and landcover mapping on 1: 250,000 scale to provide information on net sown area for different cropping seasons, scientific surveying (inventory) of coffee plantations at the

behest of Coffee Board, survey of potential and actual area under sericulture for mulberry cultivation in different parts of Kerala, wasteland inventory and groundwater prospects mapping for the entire State on 1:50,000 scale, for wasteland reclamation and locating bore wells and the generation of comprehensive database by CESS and KSREC for management of natural resources in the State. He also highlighted the cadastral level mapping of Tirurangadi Development Block of Malappuram district using high resolution satellite imageries as a pioneering effort carried out by CESS. The Chairman, ISRO also hailed the CESS works on the mapping and monitoring of the coastal zone and the marine protected areas, vital/ critical coral reefs habitat and study of impact of sea lelvel rise for the coastal areas of Kerala and Lakshadweep. The development of a methodology to locate schools of fish using ocean colour and sea surface temperature and operational forecasting of potential fishing zones was another applauded work done with ISRO assistance.

Dr. Madhavan Nair also elaborated on the space-based societal development efforts in Kerala. He specifically mentioned the applications of societal relevance such as the tele-education programme (100 interactive classrooms with two channels setup in Kerala), School network for distance education (1,500 ROTs in Malappuram District under EDUSAT Utilization Programme), training to the parents and teachers of the mentally retarded children (6 centres each of the Central Institute of Mental Retardation (CIMR) and C-DAC have been connected through EDUSAT), the Tele Health and Medical Education Network (6 Government Medical Colleges and 2 super speciality hospitals are connected with 9 District Hospitals and 1 Community Health Centre at Attapady), the space technology based disaster management support system (The State Disaster Control Room is linked with National Disaster Control Room at New Delhi, National Remote Sensing Centre at Hyderabad, and other institutions engaged in disaster management related activities) and Village Resource Centers (18 Village Resource Centers have been set up, in association with Amrita Vishwa Vidya Peetam, Kerala State Planning Board and M. S. Swaminathan Research Foundation. Another 30 VRCs are soon going to be added)

At the beginning of his lecture, Dr. Madhavan Nair expressed his gratitude to CESS for having given him the opportunity to deliver the Prof. C, Karunakaran Endowment Lecture. He started his lecture by paying tributes to Prof. C, Karunnakaran: "Prof. Karunkaran, a visionary, an outstanding Geologist, an arduous explorer, is remembered for his many contributions in the field of Earth Sciences."

Dr. Nair also gave an overview of the Indian Space Programme which had a humble beginning in early 1960s at Thiruvananthapuram. He stated that the Indian Space Programme was implemented through a well orchestrated planned strategy of first demonstrating the efficacy of the space systems using the available international missions followed by developing experimental satellites such as BHASKARA and APPLE missions, and later transgressing to operational IRS and INSAT systems. The development of operational launch vehicles also followed through a planned sequence of development efforts through SLV and ASLV to reach the current operational PSLV and GSLV systems. He added that today India has an enviable constellation of both IRS and INSAT satellites in operation. The Chandrayaan-1 launched using the indigenous work-house launcher, the PSLV, on October 22, 2008, marks yet another great achievement by India.

In the concluding part of his lecture, Dr. Nair affirmed that, in the coming years, ISRO is augmenting the space observation capabilities, to observe the Earth System with increased repetitively, in all weather conditions, providing capability of deriving critical parameters for atmospheric and climate studies as well. The ultimate objective, he stated, is to energize a social process to enhance the quality of life and empower the community through seamless integration of space technology products and services into the societal fabric. He expressed confidence that the Centre for Earth Science Studies with multidisciplinary faculties and expertise would continue to contribute to the development of the State, which would be the greatest tribute to Prof. Karunakaran.

9.4 Invited Lectures

Dr. M. Baba

Delivered the Key Note Address on 'Climate Change-Issues and Challenges' in OISCA Global Meet 2008 on the theme 'Human Activities and Climate Change' organized by OISCA on 28 September, 2008 at Thiruvananthapuram.

Delivered the forty first Engineers Day Address organised by the Institution of Engineers (India), Kerala Centre on 17 September, 2008 at Thiruvananthapuram.

Delivered an invited talk on 'Oceanographic inputs in CRZ and CMZ in the National Conference of Ocean Society of India – 'OSICON-09' organised by Andhra University on 20 March 2009 at Visakhapatanam.

Dr. N. P. Kurian

Delivered a talk 'Coastal Engineering Problems of the West Coast and need for Shoreline Management Plan' in the training programme organized by ICMAM PD at Chennai on June 2, 2008.

Delivered an invited talk at Institute of Land and Disaster Management on 'Coastal Hazard and Management: Kerala contest' in the training programme on Coastal Hazard Management.

Sri. B. Sukumar

Delivered a talk on 'Panchayat level Resource Mapping with People's participation in Kerala and Spatial analysis modeling through GIS' in the workshop on Emerging trends in Geo-spatial analysis and modeling at the University of Madras, Chennai on March 1, 2008.

Delivered a talk on 'Information for Environment Management' to the college teachers, Academic Staff College, Madurai on 25.11.2008

Delivered a lecture on 'status of some aspects related to health in India in the National seminar on climate change and emerging diseases' at Maduari Kamaraj University, Madurai during 12-13 December 2008

Dr. N. Subhash

Delivered an invited talk on 'Autofluorescence and diffuse reflectance spectroscopic techniques for in vivo discrimination of oral premalignancies' at the First World Congress on Cancer (WCC, 2009) held at Kottayam during January 12-14, 2009.

Delivered an invited talk on 'Early detection of oral cavity cancer by optical spectroscopy' at the National Oncological Centre, Sofia, Bulgaria on March 11, 2009

Delivered a talk on 'Overview of CESS and general research interests' at the Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria on March 11, 2009.

Dr. K. Soman

Delivered a lecture on 'Coastal Zone Management perspective alternatives' at the Institute of Land and Disaster Management on February 27, 2009

Dr. Srikumar Chattopadhyay

Delivered a talk on 'Tools and Techniques in PRA' for the participants of the training programme on 'Horticulture Extension' organized by MANAGE, Hyderabad and SAMETI, Department of Agriculture, Government of Kerala on 27 August 2008 at Thriuvananthapuram.

Delivered a lecture on 'Micro planning, Panchayat Raj and Participatory Natural Resource Management' on 9 August 2008 at Thiruvananthapuram.

Delivered a lecture on 'Sustainable Development' in the Refresher course on Environment Sciences in the UGC Academic Staff College, University of Kerala on March 5, 2009

9.5 Conference / Workshop / Symposium / Seminar

Name	Conference/Symposium/Seminar	Title of the Paper
Smt. Ahalya Sukumar	National Seminar on Climatic change and emerging diseases organized by the School of Earth and Atmospheric Sciences at Madurai Kamaraj University, Madurai during December 12-13, 2008	Sources of drinking water and sanitation in Tamil Nadu
	National Seminar on Career in Science for Women challenges and opportunities at Planning Board, Trivandrum, in the first week of March, 2009	NIL
Dr. Ansom Sebastian	National Seminar on Aquatic Chemistry (Aquasem' 09), held at School of Marine Sciences (CUSAT) during March 26-28, 2009	Geological and geochemical aspects, with special emphasis on rock soil hydrogeochemistry of Krishnapuram
Dr. M. Baba & Dr. Srikumar Chattopadhyay	Seminar on Coastal sediment cells organized by the Institute of Wetland on behalf of Ministry of Environment and Forests and World Bank at Kolkata and Digha (W.B) during May 26-27, 2008	NIL
Smt. J. L. Jayanthi	Kerala Science Congress 2009 held at Kollam during January 28-31, 2009	In vivio discrimination of oral premaligancy using laserinduced autofluorescence spectroscopy
Dr. N. P. Kurian, Smt. L. Sheela Nair, Sri. S. S. Praveen, Sri. V. R. Shamji, Sri. S. Arjun and Sri. Liju I Varghese	National Conference on Recent Developments in Ocean Sciences, Engineering & Technology (OSICON 09) held during 19-21 March 2009 at Vishakhapatanam	Numerical Modelling of Tsunami Inundation for the southern Kerala coast by Praveen et al Numerical Modelling of shoreline change in a coastal inlet area protected by breakwaters by Shamji et al Numerical Modelling of changes in coastal sedimentation due to breakwater construction at Kayamkulam inlet, southe west coast of India by L. Sheela Nair et al Long-term coastal erosion at Kavaratti Island, Lakshadweep by T. I. Varghese et al Numerical Modelling of flooding due to remote forcing along South Central Kerala Coast by S. Arjun et al
Dr. K. Maya	National seminar on "Career in science for womanCllenges and opportunities". Organized by KSCSTE, Sasthra Bhavan, Pattom & Dept. of Science and Technology, Govt. of India. Held at Sasthra Bhavan, Pattom during 17-18th March, 2009.	NIL
Dr. C. N. Mohanan	21st Kerala Science Congress held at Kollam and served as a member of the judges panel for the Environment, Forestry and Wildlife theme.	NIL
	Participated in the National Seminar on Global Warming and Climate Change implications to Kerala at Technopark, organized by the State Forest Dept., during 19-21 January, 2009.	NIL
	Participated in the National Seminar on Global Warming and Climate Change implications to Kerala at Technopark, organized by the State Forest Dept., during 19-21 January, 2009.	NIL
	Attended the meeting in KFRI in connection with the Consultative group for Forestry Research and Management.	NIL

Name	Conference/Symposium/Seminar	Title of the Paper
Dr. G. Mohan Kumar	Kerala Science Congress 2009 held at Kollam during January 28-31, 2009	Atmospheric carbn monoxide pattern and its local enhancement during biomass burning events
Dr. M. N. M. Nair	World Aqua Congress at Delhi	Heavy metals in the reservoir sediments of the Periyar river basin, Kerala, India
Sri. V. Muralidharan	National Global Warming Workshop organised by Department of Forest, Government of Kerala , KFRI at Kanakkakkunnu Palace, Trivandrum, in Feb 2009	NIL
Smt. N. Saniya	XXVIII INCA International Conference held at Gandhinagar, Gujarat during 4-6 November 2008	Assessment of Crop Combination Regions and Agro-ecological Regions of Palakkad District: A study in GIS environment
Dr. Srikumar Chattopadhyay	International Conference on Role of new technology in sustainabledevelopment: The case of Kerala on 27 January 2009	Technology use landuse studies: Application of GIS
	International training programme on Universaling socio economic security organized by ISS, The Hague, SEWA, Ahemedabad and CDS Trivandrum at Trivandrum on 9 March 2009	Delivered a lecture on Ecological Security as a base for Social Security
	National consultative workshop for the development of Higher Secondary syllabus based on Kerala Curriculum frame work, 2007 on 13 March 2009 at Trivandrum	Delivered a lecture on Approch to Geography syllabus for Higher Secondary School
	State Technical Group Trainers training at Trivandrum on 16th and 18th July, 2008	NIL
	Total Energy Security Mission meeting on Biomass assessment on 26th July and 8th August, 2008	NIL
	State Technical Group meeting on 18th August, 2008	NIL
	Pathiramanal Biodiversity Bioparak Project execution meetin at Alappuzha on 25th August, 2008	NIL
	Indian Environment Society on 9th August 2008 at Trivandrum	Micro planning Panchayat Raj and participatory natural resource management
Sri. B. Sukumar	National Seminar on Geoinformatics for Natural Resources Managment during 28-29 February, 2008 organized by the Department of Geography, University of Madars, Chennai	Identification of areas vulnerable for natural hazards through geomatic studies in Kasaragod district, using Satellite Remote Sensing and GIS Integration of data at Panchayat level for spatial analysis using GIS: A case study of Vadakarapathy Panchayat in Palakkad district.
	XXVIII INCA International Conference held at Gandhinagar, Gujarat during 4-6 November, 2008	Delineation of Agriculturally drought prone areas in Wayanad district, Kerala using satellite imaginery and GIS
	National Seminar on Climatic change and emerging diseases organized by the School of Earth and Atmospheric Science, Madurai Kamaraj University, Madurai during 12-13 December, 2008	NIL

10.1 Training Programme on Coastal Zone Regulations

CESS and Local Administration Department jointly conducted a one day training programme on the various aspects of rules related to Coastal Regulation Zone for more than 500 functionaries form the coastal panchayats of Kerala. The training programme was inaugurated at the head quarters of Thiruvananthapuram district panchayat by the Hon'able Minister for Local Administration, Sri. Paloli Muhammed Kutty, on April 9, 2008. Dr. M. Baba, Director, CESS and Dr. K. V. Thomas, senior scientists of CESS, handled the classes and clarified the doubts of participants on the rules related to the implementation of Regulations in the Coastal Zone. The Director of Panchayats, Government Secretaries and other senior officials attended the function. A special issue of 'Vasudha',

Local Administration Minister Sri. Paloli Muhammed Kutty inaugurating the CRZ training programme. Sri. T.K. Jose, Secretary, LSGD and Dr. M. Baba were present.

the Malayalam newsletter of CESS, on CRZ was distributed to the participants.

10.2 National Technology Day 2008

CESS and NATPAC jointly organised the National Technology Day Celebrations on June 4, 2008. The Hon'able Minister for Public Works Sri. Mons Jospeh inaugurated the function, presided over by Dr. E. P. Yesodharan, Executive vice President, KSCSTE. The theme of the Day was 'Technologies for Sustainable Development'. Dr. M. Baba, Director, CESS, delivered the key-note address. Dr. R. V. G. Menon, a noted populist of Science, was the Chief Guest of the function and he delivered an invited talk on the theme topic.

Quiz and painting competitions were organised for school children invited from different schools in Thiruvananthapuram district. Sri. Mons Joseph gave away the prizes to the winners.

Sri. Mons Joseph, Minister for Public Works inaugurated the Technology Day observation. Dr. R.V.G. Menon, Dr. E. P. Yesodharan, Dr.M.Baba and Dr. Ajith Prabhu are also on the dias.

10.3 Utilisation and Revalidation of Panchayat Resource Maps

Panchayat Resource Mapping (PRM) programme, implemented by CESS earlier, has generated plot level land and water resource data in cadastral scale. However, due to lack of adequate training in map reading and in extracting data from maps these maps could not be fully utilized. Utilisation of resource maps are also beset with the problem of time lag between the survey and the time of data use. Imparting adequate training to the volunteers selected

Dr. T. M. Thomas Isaac, Hon'ble Finance Minister, Government of Kerala, inaugurating the training programme at CESS. Dr. M. Baba, Director CESS and Sri. U.B. Soman, President, Thanneermukkom panchayat are also seen on the dias.

Dr. Thomas Isaac interacting with the participants of the training programme

from the Grama Panchayats to improve their skill in the utilization and revalidation of resource maps and to prepare development plans for the panchayat incorporating this spatial data was taken up by CESS on a request from the Thanneermukkom Grama Panchayat in Alappuzha district.The panchayat felt the need for such a training while attempting to implement a set of developmental activities, especially in the fisheries sector. Accordingly, CESS, organized a one day training programme on Utilisation and Revalidation of Panchayat Resource Maps' on 14 January 2009. Dr. T. M. Thomas Isaac, Hon'ble Minister of Finance, Government of Kerala inaugurated the programme. The training module consisted of two components viz. theoretical lectures and group discussion. Theoretical lectures covered three main topics viz. panchayat resource mapping, surface water management for fisheries and action plan preparation. The use of data format for water related information and fisheries development was also explained to the participants.

Dr. Srikumar Chattopadhyaya, Dr. Thomas Isaac and Dr. M. Baba anchored the interactive session.

Group discussion was conducted and hands-on training was given to volunteers to improve their skill in map reading and data extraction from cadastral maps.

There was a session in the evening to deliberate on the future activities in detail. Dr. Isaac, along with Dr. Manoj, Member of Parliament of the Alappuzha constituency attended and guided this session. Prof. M. K. Prasad, Chairman Information Kerala Mission took part in the deliberations. Dr. M Baba, Director, CESS chaired both the inaugural session in the morning and planning session in the evening. Sri P Sudeep, Registrar, CESS proposed the vote of thanks. Dr. Srikumar Chattopadhyay coordinated the training programme. Resource persons for the training were drawn from the Resource Analysis Division of CESS. At the end, a detailed plan was drawn up for data collection. Resource persons from CESS subsequently visited the Thanneermukkom panchayat for providing field training to volunteers and to liaison with the students of Kerala Fisheries College, who were collecting data on fisheries. A concrete proposal for fisheries development in Thanneermukkom Grama Panchayat was developed and a project document was prepared by the team. Seventy two volunteers including Thanneermukkom Grama Panchayat President participated in the programme.

10.4 Earth Hour 2009

CESS coordinated the activities connected with the observations of the 'Earth Hour 2009' in Kerala on 28 March 2009. The main activity was to spread the message to voluntary switching off the lights at 8.30 pm on that day and thereby firmly resolving to fight global warming. The World Wide Fund for Nature, Kerala Chapter: Kerala State Electricity Board, The Energy Management Centre, Dooradarsan and many environmental activitists joined the campaign spearheaded by CESS. A public meeting and a candle light vigil was also organised at Gandhi Park Maidan, Trivandrum. Mr. Suresh Gopi, Cine Artist participated as the Chief Guest of the function along with environmental enthusiasts. CESS broadcasted messages for the public through an FM radio service and prizes for radio quiz on climate change were given to the participants. According to an estimate of Kerala State Electricity Board nearly 20% of the families in Kerala participated in the campaign and saved 540 MW of power

10.5 Radio talks

Dr. N. P. Kurian gave a talk in the All India Radio on 'Coastal erosion and tsunami' on 29 July, 2008.

Shri. G. Sankar gave a talk in the All India Radio in March 2008 on 'influence of landuse on the occurrence of landslide'

10.6 National Science Day

CESS observed National Science Day on 28 February 2009 with the focal theme 'Expanding Horizon of Science' jointly with the Kendirya Vidyalaya, Air Force Station, Trivandrum. The programme conducted at the Activity Hall of the school, was attended by more than 120 students form class IX and class XI. Smt. P. S. Geothi Nair, Principal of the school welcomed the gathering. Dr. M. Baba, Director, CESS delivered the inaugural address highlighting the importance of the National Science Day and the expanding horizons of various branches of science and their impact on human life. He called upon the student to emulate Dr. A. P. J. Abdul Kalam who was the first Indian scientist to become the President of our country. Dr. Srikumar Chattopadhyay, Scientist, CESS gave a lecture on 'Advances in technology for landuse study: Application of Remote Sensing and Geographical Inofrmation'. Dr. Chattopadhyay traced the history of landuse mapping and explained to students the usefulness of Remote Sensing and GIS tools in landuse mapping. He also cited examples of student's participation in landuse mapping in UK, India and Kerala. Dr. G. Mohan Kumar scientist from CESS talked on 'Trace Gases in the Earth's Atmosphere'. The emerging concern in the scenario of the present climate change was also presented. The students also discussed the techniques of measurement, present levels and the mutual interaction of Green House Gases with Dr. Mohan Kumar.

Dr. M. Baba, Director, CESS inagurating the Science Day programmes at the Kendriya Vidyalaya, Southern Air Command, Akkulam

10.7 Exhibition

CESS participated in the Technical Fest and exhibition called 'Vastheya' organized by the Rajiv Gandhi Institute of Technology Kottayam during 25-26 September, 2008.

CESS participated in the KSCSTE's stall which was part of the Kerala Government pavilion in the India International Trade Fare at the Pragathy Maidan, New Delhi held during 14-27 November 2008. The Kerala pavilion was adjudged the second best and

CESS stall in the exhibition organised as part of the XXI Kerala Science Congress during 28-31 January 2009 at Kollam.

Council's stall the best in the fare.

CESS participated in the exhibition organized by the Sree Narayana College, Cherthala as part of birth centenary celebrations of late Sri. R. Sankar during 19-26 October 2008.

10.8 Other activities

Sri. P. Sudeep, Registrar, CESS has been elected as the Southern Regional Vice President of the National Institute of Personnel Management (NIPM), the professional body of practicing HR Professionals in the country. Sri. Sudeep was the Chairman of the Trivandrum Chapter of the NIPM during 2006-08.

Sri. S. Chandrasekharan Nair, a farmer turned blogger delivered an interesting lecture on blogging in CESS. The programme was organized by CESS Recreation Club.

Dr. Justine Padamadan renowned clinical psychologist, delivered a talk on 'Family Enrichment' for the benefit of all members of the CESS family on 17 April 2008. This inspiring talk aimed at bettering inter-personal relationship in the family and at work place was organised by the CESS Recreation Club.

Onam was celeberated at CESS under the auspices of the CESS Recreation Club . *'Athappokkalam'* competition, *'Maveli', 'Onasadya'* and *'payasam'* were the main highlights of the celebrations. Staging of cultural programmes by the family members of CESS enriched the fervor and gaiety. Gifts and mementos were distributed to children and winners of competitions

Glimpses from the Onam celeberations by the CESS Recreation Club

CESS Recreation club organised Christmas celeberations and cultural evening to welcome the New Year 2009. The talented children of staff members staged a host of cultural programmes in an atmosphere of happiness and joy. Cake cutting, distribution of sweets and gifts by Christmas papa made the children excited.

Scences from the Christmas and New year celeberations of CESS Recreation Club

11 Visitors to CESS

11.1 Distiguished visitors

Scientists from the Royal Institute of Technology, Sweden

A team of Swedish scientists led by Prof. Ramon Alexander Wyss of the Royal Institute of Technology, Sweden visited CESS as part

Swedish team interacting with Director and senior scientists of CESS

of its mission to conduct mobile workshops on 'Sustainable Urban Development' organized by the Centre for Indian-Swedish Cooperation on Technical Research and Education (INSTEC), KTH, Valhallavägen 79, Stockholm, Sweden. The other members of the team included Prof. Baboo M. Nair, Professor Emeritus at the

Swedish team going round the laboratories of CESS

Dept of Food Engineering, Technology & Applied Nutrition, Lund University, Dr. Göran Baurne of KTH, Prof. Lars-Christer Lundin of Uppsala University, Lars Öberg of Umeå University and Björn Karlsson of LTH, Lund University. The members also held discussions with KSCSTE and Government of Kerala to assess the feasibility for initiation of collaborative projects. Dr.M.Baba, Director, CESS briefed the visiting delegation on the activities of the centre. All senior scientists of CESS participated in the discussions with the Swedish team.

Dr.Chapman, University of Utah, USA

Dr. David S. Chapman

Dr. David S. Chapman, Professor of Geology and Geophysics in the University of Utah, USA delivered a talk on Climate Change in CESS on 22 December 2008. Dr. Chapman's thermal studies group has several active research projects centered on the theme of temperatures in the Earth's crust, heat flow, and geologic and hydrologic processes that affect temperatures. His long term study on the 'geothermics of climate change' evaluates how borehole temperature profiles can best be used to reconstruct past changes of temperature on the Earth's surface and therefore, is an important component of global warming studies.

Dr. Renganath Ramarao Navalgund

Dr. Renganath Ramarao Navalgund, Director, Space Application Centre, Ahmedabad visited Centre for Earth Science Studies on 19 February 2009.

Dr. Ravi P. Gupta, Professor and Head, Department of Earth Science Indian Institute of Technology, Roorkee visited this Centre on 4th December 2008.

12 Committees

12.1 Statutory Committees

12.1.1 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	Member & Ex-Officio Convener

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

12.2 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	

12.2.2 Editorial

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

12.2.3 Purchase

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

12.2.4 Library Management

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

12.2.5 Library Stock Verification

Sri. V. N. Neelakantan	Chairman
Dr. Narayanaswamy	Member
Ms. Ahalya Sukumar	Member

12.2.6 Canteen

Dr. N. Subhash	Chairman
Sri. V. Muralidharan	Member
Sri. S. Devadas	Member
Ms. Ahalya Sukumar	Member
Sri. A. Gopinathan	Convenor
Sri. V. Vasudevan	Member

12.2.7 Physical Toposheet Verification

Dr. E. J. Zachariah	Chairman
Dr. K. Raju	Member
Sri. K. J. Mathew	Member

12.2.8 Plan Project Evaluation & Monitoring

Dr. S. Sampath	Chairman
Dr. S. Chattopadhyay	Member
Dr. R. Ajay Kumar Varma	Member
Sri. John Mathai	Member
Dr. K. V. Thomas	Member
Dr. K. Narendra Babu	Member
Dr. M. Samsuddin	Member
Sri. G. Balasubramonian	Member
Sri. C. K.Sasidharan	Convenor

12.2.9 Stock Verification

Dr. E. J. Zachariah	Chairman
Dr. Narayanaswamy	Member
Sri. B. Sukumar	Member
Dr. P. K. Omana	Member
Sri. John Paul	Member
Sri. Ramesh Kumar	Member
Sri. K. J. Mathew	Member
Sri. M. Ismail	Member
Sri. K. Surendran	Member
Ms. P. Prabhavathy	Member
Ms. S. Lyla Beevi	Member
Sri. K. Ravikumar	Convenor

13 Staff Details

13.1 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)

13.2 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)
Sri. T.K.Krishnachandran Nair	Technical Officer,G2 Gr.3)
Ms. P. Prabhavathy	Stenographer (Gr 1)

13.3 Chemical Sciences Division

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

13.4 Environmental Sciences Division

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

13.5 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

13.6 Geosciences Division

Dr. T. Radhakrishna	Scientist-F & Head
Sri. John Mathai	Scientist-F
Dr. C. P. Rajendran	Scientist-E2
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)

13.7 Marine Sciences Division

Dr. N. P. Kurian	Scientist-F & Head
Dr. K. V. Thomas	Scientist-F
Dr. A. S. K. Nair	Scientist-E2
Dr. T. N. Prakash	Scientist-F
Dr. T. S. Shahul Hameed	Scientist-F
Dr. X. Terry Machado	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
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)
Ms. K. G. Omana Amma	Typist (Gr. II)
Sri. Louis Williams	Helper (Gr. II) (VCL)

13.8 Resource 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	Technical Officer (G2,Gr.4)
Ms. A. Balkeez	Typist (Gr. I)
Sri. P. C. Sasikumar	Helper (Gr. I)

13.9 Training & Extension Division

Sri. G. K. Suchindan	Scientist-F & Head
Sri. G. Balasubramonian	Scientist-F
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)

13.10 Library

Sri. A. Abdunnasar	Scientist-B (Librarian)
Ms. P. Girija	Office Assistant (Gr. I)
Sri. P. M. Gopakumar	Helper (Gr. II)

13.11 Camp Office, Kochi

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

13.12 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. P. Gopakumar	Asst. Controller, Finance
Sri. A. Gopinathan	Section Officer
Sri. M. A. K. Haroon Rasheed	Section Officer
Ms. K. V. Padmaja Kumari	Section Officer
Sri. P. Ramachandran Nair	Driver (Gr. I)
Sri. S. Krishnakumar	Office Asst. (Gr. II)
Sri. R. Haridas	Section Officer
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. 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. K. Gopi	Skilled Assistant
Sri. R. Karthikeyan Nair	Helper (Gr. I)
Ms. S. Vimala Kumari	Helper (Gr. I)

Sri. P. S. Anoop	Helper (Gr. I)
Sri. B. Rajendran Nair	Helper (Gr. II)
Sri. P. Saseendran Nair	Helper (Gr. II)
Sri P. Rajendra Babu	Helper (Last Grade)

13.13 Retirements

The following staff members of the Centre retired during 2008-09

Sri. G. K. Suchindan
Head, Training and Extension Division & Public Information Officer

Sri. P. Gopakumar
Asst. Controller of Finance & Administrative Officer at the KSCSTE on deputation

Sri. T K. Krishnachandran Nair, Technical Officer, Atmospheric Sciences Division

Smt. P. Girija, Office Assistant Grade I, Library

Smt. K. G. Omana Amma, Typist

Smt. A. Balkeez
Typist

Sri. P. Ramachandran Nair, Driver

Sri. K. Gopi
Skilled Assistant

13.14 Recruitments

During the period of this report Ms. P. S. Divya was appointed as helper Grade I.

CENTRE FOR EARTH SCIENCE STUDIES

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

Balance Sheet as at 31st March 2008 (without excluding inter-unit balances of CESS and External Projects)

Liabilities	SCH	31.03.2009	31.03.2008	Assets	SCH	31.03.2008	31.03.2007
		Rs. Ps.	Rs. Ps.			Rs. Ps.	Rs. Ps.
General Fund	I	54724763.00	40781328.07	Fixed Assets	VI	54724763.00	53715647.00
Current Liabilities and Provisions	II	11468466.00	24727862.00	Current Assets	VII	7447621.85	5764582.85
				Loans & Advances	VIII	20082535.00	12194377.00
Unspent balance of Grant from GOK		16061690.85	6165416.78	Grant-in-Aid Research & Service Component Projects			
Unspent Balance of Grant-in-Aid Research & Service Component Projects	III	22784439.71	15874547.71	Current Assets	IX	22718398.71	15889273.71
				Loans & Advances	X	66041.00	(14726.00)
Unspent balances of Consultancy Projects	IV	30952655.00	53691045.00	Consultancy Projects:			
				Current Assets	XI	19547531.00	28840276.00
				Loans & Advances	XII	11405124.00	24850769.00
Corpus Fund	V	34560906.50	17787698.50				
				Corpus Fund			
				Balnce with SBT		1460906.50	187698.50
				Term Deposits		33100000.00	17600000.00
Total		**170552921.06**	**159027898.06**	**Total**		**170552921.06**	**159027898.06**

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: 30.09.2009

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