



THE WORLD ENVIRONMENT DAY

Chief Minister Sri. Oommen Chandy stressed the need for public participation in policies and programmes aimed at protecting the environment. He was inaugurating the valedictory function of the World Environment Day celebration organised by the Kerala State Council for Science, Technology and Environment (KSCSTE) along with Centre for Earth Science Studies, held at the KSST Museum Auditorium on 5th June, 2005. He said development was not possible without giving due consideration to the protection of the environment. Pointing out that mobilisation of public opinion had become a deterrent to plundering of forests, he said the same approach could

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Sri. Oommen Chandy, Hon'ble Chief Minister of Kerala delivering the Valedictory address at the World Environment Day Celebrations in the presence of Er. T. Elangovan, Director, NATPAC, Dr. K.R.S. Krishnan, Member Secretary, KSCSTE, Dr. A.E. Muthunayagam, Executive Vice President, KSCSTE, Dr. M. Baba, Director, CESS, and Dr. Radhakrishna pillai, Director, RGCB.

ATMOSPHERIC METHANE

E.J. Zachariah

Earth's atmosphere keeps away harmful radiation from outer space and redistributes the energy it receives from the Sun. It transports water from the oceans to the dry upper lands and continental interiors. It also sustains majority of life forms on earth, and keeps it warm during the night time when sun 'goes down'. The atmosphere is the most important as well as variable component in Earth's climate system, which is forced or influenced by various mechanisms including the solar radiation and human activities. The dry atmosphere is composed of 78.1% nitrogen (N₂), 20.9% oxygen (O₂), and 0.93% argon (Ar). These gases have only limited interaction with the incoming solar radiation and they do not interact significantly with the infrared radiation emitted by the Earth. However, there are a number of trace gases such as carbon dioxide (CO₂), methane (CH₄),

nitrous oxide (N₂O), and ozone (O₃), which absorb and emit infrared radiation. These so called greenhouse gases, with a total volume mixing ratio less than 0.1% in dry air, play an important role in Earth's energy budget. These gases allow short wavelength solar radiation to reach the Earth's surface, but does not allow the longer wavelength heat waves (infrared waves) from its surface to leave the Earth, acting like a blanket. This reduces radiative cooling of the Earth's surface resulting in warmer surface temperature.

Greenhouse gases & global warming

The relative capacity for global warming of different greenhouse gases are conveniently expressed in terms of their Global warming potential (GWP), which is a relative measure of the radiative effect of the gas in comparison with that

of carbon dioxide. The GWPs are computed over different time horizons taking into account short-term and long-term effects, including their relative residence times in the atmosphere. Table 1 gives some of the important parameters associated with the major greenhouse gases in Earth's atmosphere.

The greenhouse gases had maintained a stable atmospheric concentration over the past many centuries prior to the industrial revolution. However, their concentrations in the atmosphere have increased spectacularly after the onset of the industrial revolution, and are threatening to modify the climate on Earth. The period starting by 1800 AD, the time of the first slow increase of atmospheric CO₂ and CH₄ concentrations above previous longer-term values, has been termed the

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From the Director's Desk

The Earth experiences long-term changes in climate, with average temperatures often rising or falling by a few degrees over a period of centuries. This has led to recurring warm periods and ice ages, the last ice age ending about 10,000 years ago. The last warm period was experienced approximately 1000 years ago, while a "mini ice age" was noticed about 300 years ago.

However, the Earth is now experiencing a warming up over and above the long-term temperature fluctuations, which has become the single largest common concern of humanity today. Most researchers have associated this change in the climate to increasing levels of greenhouse gases, which is one of the gravest concerns associated with development. Accumulation of industrial effluents in the atmosphere has been known to be modifying earth's climate. It is generally considered that the 'anthropocene' started around 1800 AD, when the carbon dioxide (CO₂) and methane values showed a definite increasing trend over the background variations. There are also other views, which date the onset of the anthropocene to thousands of years back when organized farming and deforestation started around mid Holocene. In either case the human influence over climate is now accepted.

The anthropogenic agents capable of causing climate modification include greenhouse gases (GHG), suspended particulate matter (SPM) in the air, albedo changes due to urbanization and landuse changes, etc. These result in modified rainfall pattern, global warming, sea level rise, vulnerability to harmful radiation, urban heat islands, inundation of arable land, epidemics due to new and modified strains of pathogens, and the like. The Intergovernmental Panel for Climate Change (IPCC) business-as-usual scenario projection predicts CO₂ concentration to increase to about 460 ppm by the middle of the century. There are also views that increased CO₂ levels in the atmosphere would lead to increased carbon sequestration and thereby compensate the changes atleast partly.

CESS had initiated some programmes for monitoring the greenhouse gases. Some glimpses of measurement of methane are presented in this newsletter. Though the climate change per se is global in nature the regional contributions sometimes become very significant. Moreover the impact of climate change becomes more evident regionally. Along with the few international programmes, the ISRO under its Geosphere Biosphere Programme is addressing the problem through various research projects being carried out by a few laboratories, institutes and universities. In consonance with this, it is high time to embark on programmes to monitor all the factors contributing to the climate change. It is also necessary to closely examine the impacts of climate change in this region.

Dr. M. BABA

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yield rich dividends in other areas of environment protection. Chief Minister said the government was formulating a strategy to check reclamation of wetlands and conservation of water bodies.

The Focal Theme for this year's celebration was "GREEN CITIES". Earlier in the day Dr. A.E. Muthunayagam, Executive Vice President of KSCSTE inaugurated the celebrations and said that there is an urgent need to ensure sustainability in the utilization of natural resources to conserve the environment. As part of the program a Photo Exhibition was organized on the theme of the Day. A large number of school students participated in the painting, elocution and quiz competitions conducted in this connection. A panel discussion entitled "City and its environment with particular reference to Thiruvananthapuram", was organized in which representatives of State /Central Government Departments, Autonomous Institutions, NGO's and

the members of public participated. Dr.C.S.P.Iyer moderated the discussion.

In the valedictory function, Dr. A.E.Muthunayagam, delivered the Presidential address. Convenor of the program Dr. A.S.K. Nair presented the World Environment Day - 2005 report and recommendations of the panel discussion. Sri. Oommen Chandy, the Hon'ble Chief Minister of Kerala released the "State of Environment Report - Kerala 2005" and also distributed prizes to the winners of different competitions held under the auspices of the World Environment Day-2005.

Dr. K.R.S. Krishnan, Member Secretary, KSCSTE welcomed the gathering. Dr. M. Baba, Director, CESS, Er. T. Elangovan, Director, NATPAC, Dr. M. Radhakrishna Pillai, Director, RGCBC offered felicitations and Dr.K.Kokkal, PSO, KSCSTE extended the vote of thanks.

Continued from p. 1 ATMOSPHERIC METHANE

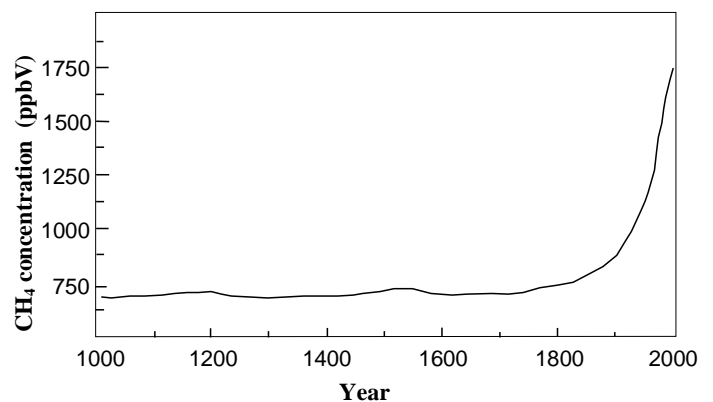


Fig.1 Variation in the atmospheric concentration of methane during the period 1000 – 2000 AD. It is seen that the value remained constant before the industrial revolution, and increased spectacularly after that (As per Climate Change 2001 Report of the IPCC)



Coconut husk retting in the backwaters - a scene from Trivandrum district.

'Anthropocene'. There is also another class of greenhouse gases, the synthetic ones like HFCs, PFCs, CFCs, SF₆, which never existed in the atmosphere before the industrial revolution.

Characteristics of Methane

Methane is a colorless, odorless, gaseous, saturated and most abundant hydrocarbon in the Earth's atmosphere. It is lighter than air, melts at -184°C, and boils at -161.4°C. It is combustible and can form explosive mixtures with air. Methane occurs naturally as the principal component of natural gas; it is formed by the decomposition of plant and animal matter under anaerobic conditions.

Sources of Methane

Methane is produced when any biological material decomposes under anoxic conditions. Methane is also produced during combustion of biomass and fossil fuels. Other sources of methane are enteric fermentation in the

guts of ruminant animals, natural wetlands, agriculture, landfills, termites, coal and petroleum mining, etc. There are also large reserves of methane in the form of methane hydrates on ocean floors, which could be released if they are disturbed. More than 60% of the methane in the atmosphere is emitted from human activities like agriculture and industries. Fig.1 shows the trend in the atmospheric concentration of methane since 1000 AD till 2000. The atmospheric concentration of methane has more than doubled during the past 200 years and it still continues to increase. Other major greenhouse gases like carbon dioxide and nitrous oxide also show similar trends.

Methane and radiation

Methane is a greenhouse gas with strong absorption bands in the infrared region of the electromagnetic spectrum. Its peak absorption wavelengths are 3.31 μm, 3.43 μm, 6.55 μm and 7.65 μm. The radiative forcing from increase

Gas	Atmospheric concentration in 1998 (ppm)	Atmospheric Lifetime (years)	Radiative Efficiency Wm ⁻² ppb ⁻¹	Global Warming Potential		
				20 year horizon	100 year horizon	500 year horizon
Carbon dioxide	365	50-200	1.5 x 10 ⁻⁵	1	1	1
Methane	1.745	12	3.7 x 10 ⁻⁴	56	21	6.5
Nitrous oxide	0.314	120	3.1 x 10 ⁻³	280	310	170

Major greenhouse gases in Earth's atmosphere.

in methane concentration in the atmosphere during 1750 to 2000 is estimated to be 0.46 Wm⁻², out of the total 2.43 Wm⁻² due to all greenhouse gases.

Sinks of Methane

Methane is removed from the atmosphere by a variety of processes. The dominant sink is oxidation by chemical reaction with hydroxyl radicals (OH). Methane reacts with OH to produce CH₃ and water in the tropospheric layer of the atmosphere. Stratospheric oxidation also plays a minor role in removing methane from the atmosphere. Similar to tropospheric oxidation, minor amounts of methane are destroyed by reacting with OH in the stratosphere. These two OH reactions account for almost 90% of methane removals. In addition to methane reaction with OH, there are two other known sinks: microbial uptake of methane in soils and methane's reaction with chlorine (Cl) atoms in the marine boundary layer. It is estimated that these sinks contribute 7% and less than 2% of total methane removal,

	Estimates by various Scientists	Estimate by IPCC*
Natural Sources		
Wetlands	115-225	
Termites	~20	
Ocean	10-15	
Hydrates	5-10	
Anthropogenic Sources		
Energy	75-110	
Landfills	35-73	
Ruminants	80-115	
Waste treatment	~25	
Rice cultivation	88-100	
Biomass burning	40-55	
Other	~20	
Total Emission	495-600	598
Sinks		
Soils	10-30	30
Tropospheric OH	450-510	506
Stratospheric losses	40-46	40
Total sinks	460-580	576
Net atmospheric loading		+22

Estimated methane budget (tg/year) as per the IPCC Report.

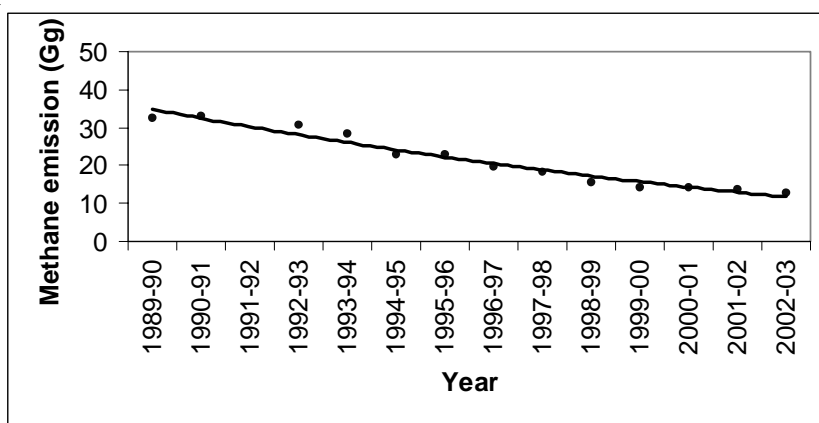
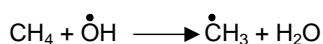


Fig.2 Estimated methane emission from rice cultivation in Kerala during the period 1989-'90 to 2002-'03.

respectively. Reaction of methane with OH radical produces methyl radical in accordance with:



The methyl radical further reacts with oxygen to produce methylperoxy radical, which undergoes further reactions to produce formaldehyde, and beyond. The tropospheric life-time of methane is of the order of 10 years. This long life-time enables the gas to mix uniformly in the troposphere.

Coconut husk retting

Though emissions of greenhouse gases due to industries are relatively low in Kerala, other sectors like natural wetlands, agriculture, rural industries, firewood burning, etc., are contributing

to it. Studies carried out by CESS have shown that coconut husk retting for the extraction of coir fibre is a significant source of methane emission. On an average 9 kg of methane is produced per ton of husk retted. Nearly 1.36 million tons husk was processed during 2003-'04 in Kerala, resulting in the emission of 0.012 tg (million tons) methane during the corresponding year. However, there has been a significant reduction in coconut husk retting in Kerala.

Paddy fields

Rice cultivation in flooded rice fields is another major source of methane. Though rice is cultivated extensively in Kerala, a significant part of the rice fields are not inundated. Hence, the methane



Decay of aquatic weeds leads to methane emission from wetlands. Water hyacinth in the Akkulam lake, Trivandrum.

fluxes from these rice fields are less than the global default values. The methane emission from the rice fields in Kerala during 2002-'03 was estimated to be 0.013 tg. There has been a significant reduction in the area under rice cultivation during the past few decades, due to various reasons. This has resulted in a significant downward trend in the production of methane from this source as seen in Fig.2.

Coastal wetlands

Wetlands are generally considered to be strong sources of methane emission. Though Kerala has a large network of natural wetlands and backwaters, CESS study has shown that methane emission have been modest, probably due to the salinity present in the coastal lakes. The current methane emission from Kerala wetlands has been estimated at 0.022 tg / year.

Methane from animals

Enteric fermentation in the guts of ruminant animals like cattle, buffalo, etc., are major known sources of atmospheric methane. The generation of methane depends on quality of feed, daily feed intake, milk production, work done in the case of animals used for draft, weight gain by animal, etc. It has been estimated that the methane emission from ruminant animals in Kerala during 2003 is 0.097 tg. The population of ruminants in Kerala has been decreasing significantly during the past decades, due to various reasons. This has led to a significant reduction in the methane emission from this sector. Fig.3 shows the trend in methane emission from enteric fermentation in the guts of ruminant animals in Kerala, as well as the emission from the manure produced by them during the period 1961 to 2000.

Waste disposal

Solid wastes and waste disposal are another major source of methane emission, which is increasing rapidly in Kerala. As mentioned earlier, methane

EARTH DAY - 2005

The Earth day 2005 was celebrated on 22nd April with various programmes in CESS. On the occasion the Research Laboratories were opened for the public and students. Nearly 400 school children and public attended the open house

programme. These children were drawn from the Summer School organized by the Thiruvananthapuram Public Library, thus representing a cross section of the student community of the city and its suburbs. On the day they got a rare chance to see the laboratories of CESS

and interact with the scientists. The highlight of the event was a quiz competition held for high school students on the Earth Day theme “Protect our children’s health and our future”, in which 5 school teams contested. A video film show on the 26th December 2004 Tsunami was an added attraction. Dr. M. Baba, Director gave away the prizes to the winners of the quiz competition.



The Open House program organised as part of the Earth Day celebration in CESS attracted large number of students.



Dr. M. Baba, Director, CESS giving away the prizes during the Earth Day function.

is produced when biological matter decomposes under anaerobic conditions. Accordingly, landfills are potential source of methane. The relatively high moisture content in the waste material also increases methane emission potential. The current annual methane emission from this source has been estimated to

be 0.049 tg.

Global warming trends

There is concern over increase of greenhouse gas concentrations in the atmosphere and resultant global warming of Earth. The Earth’s global average surface temperature has

increased by 0.6°C over the course of the twentieth century, and most of the observed warming is likely to have been due to increase in greenhouse gas concentrations. Nighttime minimum temperature over land increased by ~ 0.2°C per decade between 1950 to 1993. The corresponding daily maximum temperature rise was 0.1°C. The increase in sea surface temperature was about half the corresponding value for land.

The Intergovernmental Panel for Climate Change (IPCC) has estimated an increase between 1.4°C to 5.8°C in the globally averaged surface temperature over the period from 1990 to 2100. About half of the uncertainty in this projection arises from uncertainty about future greenhouse gas emissions and about half from uncertainties in global climate models. Changes in rainfall, sea level and extreme climatic

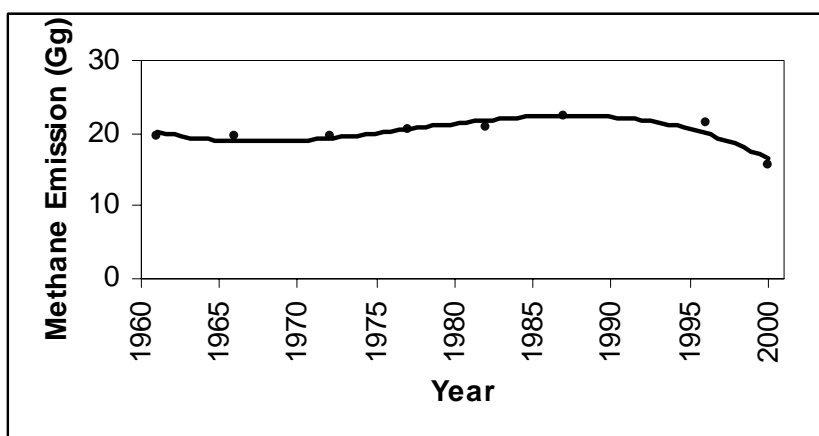


Fig.3 Estimated methane emission from ruminant animals in Kerala during the period 1961 to 2002.

MoEF Meeting on Coastal Vulnerability mapping in CESS

A four-day meeting of Ministry of Environment and Forests-Space Application Centre-Centre for Earth Science Studies was held at CESS from 1st to 4th June to formulate approaches for vulnerability mapping along the Indian Coast. This mapping is in accordance with the recommendations of the Dr. M.S. Swaminathan Committee, constituted by Ministry of Environment and Forests, Govt. of India. This Committee while examining the CRZ norms found that a 'management system' will be more appropriate than the present 'regulatory system'. The meeting was attended by the



Meeting on Coastal Vulnerability mapping in progress.

international advisor to MoEF, Prof. John Pethick of UK, Dr. Shailesh Nayak (SAC), Dr. N. Hosa Bettu and Mr. Senthil Vel (MoEF). Dr. M. Baba, Dr. N.P. Kurian, Dr. K.V. Thomas and Dr. Sreekumar Chattopadhyay (all from CESS) participated in the deliberations.

Dr. G.R. Ravindra Kumar delivered the T.N. Muthuswami endowment lecture 'Lithology and metamorphic evolution of granulite facies segments of Kerala, South India' at Geological Society of India on 18 May 2005.

Dr. Srikumar Chattopadhyay delivered Prof. Sibaram Bhattacharya memorial lecture at the Dept. of Geography, University of Calcutta, Kolkata on 2 May 2005.

Sri. G. Sankar delivered a lecture on 'Landslides: possibilities and preventions' at the Regional Agricultural Research Centre, Wayanad on May 1, 2005.

Dr. M. Baba delivered an invited lecture on 'Tsunami Disaster in India' in the Plenary Session at the 'World Mayors Conference on Millennium Development Goals and the Role of Cities' organized by the Ministry of Urban Development & Poverty Alleviation, Govt. of India at Cochin on 4 April 2005.

Dr. M. Baba delivered the Earth Day Special Lecture in the valedictory function of the Earth Day Celebrations of GREENS, Thiruvananthapuram on 24 April 2005.

events (storms, cyclones, droughts, etc.) are also expected as the climate changes.

Steps required

The studies carried out at CESS show that methane emission from a number of significant sources like rice cultivation, cattle rearing, coconut husk retting, etc., are reducing in Kerala. This reduction is mainly due to the reduction in the scale of these activities itself. However, other sources like automobiles, solid waste disposal sites, etc., are on the increase leading to higher emissions. The net emissions from the state might remain steady for a while due to these opposing trends. However, increase in the consumption of fossil fuels as well as generation of larger quantities of solid wastes as the standard of living increases, could lead to a net rise in future emissions. Measures like improved solid waste disposal methodologies that can reduce methane production, improved public transport systems to reduce fossil fuel consumption, etc., need to be developed.



PUBLICATIONS

Baba, M. (2005) 'Coastal Zone Regulation - New Dimensions' (Invited lecture) Proc. Kerala Environment Congress 2005, pp. 113 - 121.

Nair, A.S.K. (2005) 'Evolutionary Model of the Holocene Coastlines of the South West Coast', Proc. Kerala Environment Congress 2005, pp. 113 - 121.

Biju John and Rajendran, C.P. (2005) 'Constraining the Pattern of Deformation Associated with Low-displacement Faults in the Cratonic Regions: an example from the Precambrian Province of Kerala, South India', Journal of Geological Society of India, Vol.66, pp.29-41.

INVITED TALKS

Dr. Srikumar Chattopadhyay delivered a lecture on 'social and ecological security in Kerala's perspective' on 14 April 2005 at the IRMA Doctoral Committee colloquium.

EXHIBITION

As part of the World Environment Day celebrations, CESS conducted an All India Nature Photographic competition jointly with the Kerala State Council for Science, Technology and Environment, on 5 June 2005.

VISITS ABROAD

Dr. D.S. Suresh Babu participated in the international conference (IGCP 464) on "Mineral deposits of continental shelves" in St. Petersburg, Russia during 30th May to 5th June,

ADVISORY COMMITTEE MEETING OF THE KERALA COASTAL PROTECTION PROGRAMME

CESS organised the Advisory Committee meeting of the Kerala Coastal Protection Project of the KSCSTE on 30 May 2005. Dr. A.E. Muthunayagam, Executive Vice President, KSCSTE chaired the meeting. Prof. S. Narasimhan (formerly IIT, Mumbai), Dr. N. Ravindran (formerly NIOT, Chennai), Dr. P.P. Vaidyaraman (former Director CWPRS, Pune), Sri. I.Z. Poonawala (CWPRS), Dr. Jayakumar (Advisor, Vizhinjam Project), Smt. Lathika (C.E, IDRIB, Irrigation Dept), Dr. K.R.S. Krishnan (Member Secretary, KSCSTE) and Dr. M. Baba (Director, CESS) were the members who attended. Representatives from KSCSTE, NIOT Chennai, Ports Department, KFRI, Harbour Engineering Dept, Irrigation Dept. and CESS participated.

2005 and presented a paper “An information system for Manavalakurichi Placer Deposit”.

Anil Earnest participated in the Annual meeting of Asia Oceania Geosciences Society during June 20 - 24, 2005 held at Singapore and presented a paper “The deformation characteristics along the Andaman-Nicobar arc associated with the December 26, 2004 megathrust earthquake: Insights from GPS data”.

CONFERENCE/SEMINAR/WORKSHOP

Dr. A.S.K. Nair chaired the Panel sessions in the workshop on “Forging Strategic Linkages Between Local Governments and Non-Governmental Organizations” organized by the State Planning Board and Local Self Government Department of the Government of Kerala during May 16 - 17, 2005 at Thiruvananthapuram.

Dr. N. P. Kurian attended the International Workshop on Tsunami Modelling held at IIT, Madras during April 1 - 2, 2005.

Dr. T. Radhakrishna participated in the DST sponsored National Group Discussion Workshop held at the Department of Geology, Bangalore

University, during April 28 - 29, 2005 to discuss themes and possible coordinated programs of integrated research along E-W transect corridors in the Dharwar craton, Southern India.

Dr. T. Radhakrishna participated in the DST sponsored discussion meet on “Magnetostratigraphy and Palaeomagnetism in India” under Deep Continental Studies programme during April 12 - 13, 2005 at the Department of Geology, Mizoram University, Aizawl for identifying knowledge gaps and study regions relevant to palaeomagnetism and magnetostratigraphy, in understanding deep geodynamic processes.

GUEST LECTURE

Dr. R. Ajayakumar Varma delivered a talk ‘Environmental significance of the high ranges of Kerala’ in the Regional level Training of Trainers Programme organised by KSSP at CWRDM Sub-Centre, Neyyattinkara.

Sri. John Mathai delivered two talks on microlevel surveys for locating water sources to KRWSA officials on 8 April 2005, at Palakkad and on 16 April 2005, at Malappuram.

Dr. A.S.K. Nair delivered a talk “Coastal Disasters - Issues and Preparedness” at the Training of

Trainers Programme organized by KSSP at Cherthala on 24 April 2005.

Dr. A.S.K. Nair delivered a talk “Wetland Conservation - Policy and Action Plan for Kerala” on 23 April 2005 at the Earth Day Celebrations organized by GREENS at VJT Hall Thiruvananthapuram.

Dr. K.V. Thomas gave a lecture on Coastal Zone Management in the Workshop organized by KSSP on 23 April 2005 at Pattanakkad.

Dr. A.S.K. Nair delivered a lecture on ‘Disaster Scenario in Kerala’ at the Short-term Training Programme organized by the Extension Training Centre, Kottarakara on 8 June 2005.

NOMINATIONS

Dr. R. Ajayakumar Varma was nominated to the Core Committee of Mahatma Gandhi University, Kottayam to deal with all academic matters pertaining to UGC sponsored B.Sc Geology- Water Management Course.

OTHERS

Sri. S. Devadas, Photographer was a member of the panel of judges for the All Kerala Photography Competition “ECO Vision 2005” organized by the Energy Conservation Society, Trivandrum on May 29, 2005.

REPORTS SUBMITTED

P.P. Ouseph et al. “Coastal Ocean Monitoring and Prediction System (COMAPS) – Results of CRV Sagar Purvi 17th Cruise programme from Karwar to Kochi”, CESS-PR-06-2005.

Ansom Sebastian et al. “Graphite Mineralization in the Chirakkadavu

Paika Belts, Kottayam District, Kerala: Genesis, Texture, Morphology and Geochemistry”, CESS-PR-07-2005.

V. Nandakumar et al. “Watershed based agricultural development plans for the tribal settlements of Idukki district”, CESS-PR-08-2005.

Ajaykumar Varma et al. “Rapid

EIA of Mill Development Plan of HNL”, CESS-PR-09-2005.

D. Padmalal et al. “River Sand Mining and Management: Thrissur district, Kerala”, CESS-PR-10-2005.

S. Sidharthan et al. “GIS based Information System for Amachal Watershed Development Programme”, CESS-PR-11-2005.

CONSULTANCIES COMPLETED

River Sand Mining -for two grama panchayats (Vijayapuram and Vadakarapathy)

CRZ Status Report for Development of commercial complex at Goregaun, Mumbai for Atul Enterprises.

ANNOUNCEMENTS

ASSISTANTSHIP TO PG STUDENTS

The Centre for Earth Science Studies, as part of its efforts to improve research aptitude among students in different areas of earth sciences, proposes to support post graduate students by extending assistantships. The program is proposed to be introduced during the academic year 2005-06 onwards. The assistantship will be extended to selected students nominated by the Departments of Universities and Government/ aided colleges in the disciplines of **Geology/ Geography/ Chemistry/ Physics/ Environmental Sciences/ Computer Applications/ Geophysics/ Oceanography/ Atmospheric Sciences/ Mathematics** for supporting M.Sc/ M.Tech students for their dissertation/internship programme in CESS.

Applications are invited from the University Departments/Colleges for consideration of the internship with a monthly assistantship of Rs.2000/- for a period of 3 to 6 months. The Heads of the Department of Universities and Principals of Colleges may nominate their meritorious students who are interested in carrying out the dissertation/ internship program in CESS to the Director, Centre for Earth Science Studies, P.B. No. 7250, Akkulam, Thiruvananthapuram 695 031.

Sixth Prof. C. Karunakaran Endowment Lecture

‘Ground Water Management - A Key for Sustainability’

in CESS on 1st August 2005

by

Dr. Saleem Romani

Chairman, Central Ground Water Board

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