

analytical approach to various related issues, notably estimating the quality of estimates and numerical experiments to progressively improve these as well as selection of future measurement sites that would have the potential of adding meaningfully to the information content of the data acquired.

To address these issues requiring a high level of understanding involved in inverse modelling and the desirability of sharing these with a wider group in the country, scientists at C-MMACS and IIA, proposed a discussion meeting on inverse problems with special reference to atmospheric transport. It was attended by 15 scientists from different institutions in the country as well as three scientists from LSCE/CNRS France. Peter Rayner, Philippe Bousquet and Michel Ramonet, who have worked on the estimation of CO₂ fluxes over the globe under the transcom set-up, were the main speakers.

This discussion meeting commenced with an introduction by V. K. Gaur outlining some of the outstanding scientific issues of carbon cycle research, especially the estimation of reliable global carbon fluxes and determination of the source of uncertainties. He stressed the need to develop a good network of monitoring sites and a robust modelling framework to achieve this goal. Thereafter, P. K. Gupta (Raja Ramanna Centre for Advanced Technology, Indore) delivered a talk on inverse problems and initiated discussion on critical issues involved in inverse problems and model reduction. This was followed by Bousquet's presen-

tation on the comparative estimates of CO₂ for land and oceans from different models.

Ramonet gave a description of the CO₂ network around the world. He also suggested a few stations in India and emphasized the necessity of setting up an analysis laboratory in India equipped with gas chromatograph or mass spectrometer to determine greenhouse gas (GHG) concentrations of flask samples collected at a dozen sites over India and the adjoining regions.

In the succeeding sessions Rayner led a wide-ranging discussion on the specifics of different atmospheric transport inverse models and issues of numerical modelling and advection schemes in the Transcom reference frame. This was followed by further discussion on source/sink attribution through inverse modelling at climate scales, by Bousquet and on the design of observing networks by Rayner.

The final session was devoted to presentations by scientists from various institutions: Attri talked about the work on CO₂ measurements and related area with other organizations that India Meteorological Department (IMD) has initiated. Yogesh Tiwari (Indian Institute of Tropical Meteorology (IITM)), Pune expressed interest in installing a few additional stations in India to augment the geographical spread of CO₂ monitoring sites in India among the network stations proposed by Ramonet based on his analysis of back trajectories computed for a dozen sites over India. Vikram Reddy explained his recent project jointly designed with

C-MMACS to analyse the GHG concentrations from flask samples collected at the shore site of Pondicherry University, Puducherry to highlight the winter fluxes (northeast monsoon) over the Bay of Bengal and P. S. Swathi discussed the work done in C-MMACS on estimation of carbon fluxes. The meeting concluded with presentations made by Bousquet on methane emissions and their estimates in Europe, and by Rayner on carbon cycle data assimilation.

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MEETING REPORT

Third Kerala Environment Congress*

A healthy environment is the most critical component essential for the well-being of a society and the foundation for a sustainable and strong economy. A spirit of partnership among the stakeholders in the environmental spectrum should be fostered so as to ensure the sustainable use of natural resources. It is in this con-

text that the relevance of the Kerala Environment Congress (KEC), initiated by the Centre for Environment and Development (CED) in 2005, with the main objective of providing an annual platform for interaction among various experts, scientists, institutions and groups, discussing the major environmental issues that Kerala is facing, comes into focus.

The focal theme of this year's Congress (KEC 2007) was 'Wetland Resources of Kerala'. The wetlands in Kerala are currently being subjected to acute pressure

owing to rapid developmental activities and indiscriminate utilization of land and water. A deeper appreciation of ecosystem complexities and biological resources and sustainable multiple-use management which rests on ecosystem approaches should be the strategy for wetland conservation. Lack of understanding of the values of wetlands and the functions they render are considered as the major factors responsible for the callous attitude towards this natural resource. Many efforts have been initiated in this direction at the gov-

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environmental, institutional and individual levels. A participatory, multi-disciplinary and collaborative effort is required to preserve these wetlands against the onslaught of development fallouts.

The Government's commitment to protect the environment in general and the wetlands in particular, was reflected in the inaugural address by the Minister for Finance, Government of Kerala, T. M. Thomas Isaac, himself an environmental activist, who unveiled the Government's plans for introducing a Capital Gains Tax to check the reclamation and diversion of wetlands and to use this revenue to protect the threatened wetlands. He was unequivocal in stressing the need to revive traditional ecofriendly farming practices in the wetlands and developing sustainable and responsible tourism as a major input for the State's growth. The Minister for Water Resources, Government of Kerala, N. K. Premachandran, in his presidential remarks underscored the need for a strict legislation to check the depletion of wetland resources of Kerala.

The technical sessions of the Congress were split into four categories, viz. invited presentations, general presentations, award presentations and an open forum. There were fifteen invited presentations by senior scientists, which covered the whole gamut of wetland concerns, the physical, ecological, socio-economic, management and policy-related aspects.

The keynote paper entitled 'Hydrologic considerations in the management of wetlands in Kerala', by E. J. James (Centre for Water Resources Development and Management – CWRDM), reiterated the need for an integrated and river basin-based approach for the management of wetlands in Kerala. Monitoring of three sets of catchments in the Western Ghats draining into the wetlands, to understand the impact of deforestation on hydrologic parameters, revealed that the wetlands get filled up just by one type of human intervention – deforestation. The total annual sediment yield from all the river basins draining into the Vembanad lagoon and the Kol lands is estimated to be 32 and 4 million tonnes respectively. Sedimentation survey in one of the reservoirs in the Western Ghats has shown that almost 20% of the total capacity (121 million cubic metres) of this reservoir has been lost mainly because of deforestation in the catchment and change in the cropping pattern. The presentation gave a detailed analysis of

the hydrologic parameters of three Ramsar sites and two national sites in Kerala. An integrated water management plan for a high-altitude wetland, the Pookot Lake, and various aspects of circulation mixing and pollution dispersion in the coastal wetlands of Kerala were also discussed.

The origin and evolution of coastal wetlands of Kerala were highlighted in the presentation by K. P. Thriuvikramji. Based on morphology and lithology, two types of coastal lands (CL), i.e. permeable or strand plain shorelines associated with low CL and impermeable or cliffed shoreline linked with high CL have been recognized. Low CL is home to 'kayals' (lake) of shore-parallel (type I, e.g. Kavvai kayal and Kayamkulam kayal), shore-oblique (type II, e.g. Vembanad kayal), and shore-transverse types (type III, e.g. Ashtamudi kayal). Freshwater kayals of low midlands (ML; type IV, e.g. Sasthamkotta kayal and Vellayani kayal) are geologically older in comparison with types I–III. Geologically, rock-bound and rock-floored basins of highlands (HL) are the oldest among all. All basins changed into proto-kayals with the onset of monsoon climate in the peninsula, i.e. by late Cretaceous or ~66.40 ma BP. Finally, the coastal tertiary sedimentary basin was perhaps a mega kayal in the geological history of Kerala. Geologically, all basins and consequently kayals and associated wetlands are landforms with a short life-span.

A. S. K. Nair (Centre for Earth Sciences Studies – CESS) gave a comparison of the classification schemes adopted for wetlands by Ramsar and the Ministry of Environment and Forests, Government of India. The Wetland Classification and Inventory Maps evolved thereby are important tools for different applications, as they serve the baseline data for monitoring the status of areas of vital/critical concern and prioritizing their preservation, conservation and management. He concluded that the Ramsar classification is preferable for wetland inventory and also that there is an urgent need for a 'nation-wide' effort for mapping the wetlands of India based on Ramsar Classification.

S. Sudhakar (National Remote Sensing Agency – NRSA, Hyderabad) discussed about monitoring of wetlands with inputs from space-based Indian Remote Sensing Satellite systems. Based on a case study on the mapping of mangroves in the Sunderbans, he established that remote sensing coupled with GIS/GPS technologies pro-

vides essential information on mangrove communities, canopy density and their degradational status and accretion studies to identify temporary and permanent accretion status and their monitoring. With the increasing capability of new satellites such as Cartosat 1 stereo data and very high resolution of 1 m Cartosat 2 data, mapping to the extent of species level would be possible to delineate with expected accuracy and monitoring of changes over a period of time precisely.

The procedures involved in digital mapping of major wetlands of Kerala were the theme of the paper presented by K. V. Ravindran (CED). His presentation not only demonstrated the potentials of satellite remote sensing data for wetland mapping, but also brought into focus the need for utilizing satellite data of varying spectral, spatial and temporal resolutions to monitor the fast rate of changes.

P. O. Nameer (College of Forestry, Thrissur) in his presentation revealed that, out of the 475 species of birds in Kerala, 128 species belonging to 27 families are wetland-dependent, of which 52 (40.63%) are winter migrants, while 59 (46.09%) species have been reported to be breeding in Kerala. Wetland birds, especially the migratory birds are facing extreme threat from indiscriminate use of pesticides and poaching. The paper suggested implementation of conservation/community reserve concept of the Wildlife (Protection) Amendment Act, 2002 for the conservation and wise use of wetland habitats – a human-dominated ecosystem.

Based on an investigation in 15 major wetlands of Kerala, T. Sabu (CED) analysed the characteristics of wetland flora of Kerala and its significance. A total of 725 vascular plants belonging to 106 families were identified. The dominant families are Cyperaceae (113 species), Poaceae (83 species), Scrophulariaceae (46 species) and Fabaceae (29 species). Out of the 725 plants listed, 503 species are specific to wetlands and adjacent areas, while 222 species occur in other areas also. He suggested an intensive floristic study covering all wetlands of Kerala and also to explore the traditional knowledge associated with wetland flora.

An account of the wetland soils of Kerala, its characteristics, occurrence, taxonomy, etc. was presented by Sudishkumar (Directorate of Agriculture). Wetland soils have distinct advantages and disadvantages for food production. They

are usually level and often occur in large land units, making large-scale farming feasible. They have low erosion hazard and moderate to high inherent fertility. Major disadvantages include cost of development and difficulty of management. Some wetland soils have special problems such as salinity, high Na content, low pH, or poor physical properties following drainage. Better management strategies are required for best use of the wetland soils of Kerala.

Kuruvilla Varghese (Kerala Agricultural University, Vellanikkara) in his presentation described paddy fields of Kerala as a typical wetland ecosystem with numerous significant ecological and economic functions that benefit the people. Despite existing laws, conversion of paddy fields for non-agricultural purposes is rampant. Scientific crop diversification, specifically suited to each wetland rice ecosystem, is a practical means of enhancing the total production and profit without adversely affecting the ecosystem. This will effectively curb the unbridled paddy land conversion to a great extent. Homesteads with adjacent wetland paddy fields in the lowland coastal ecosystem of Kerala can be developed into systems with remarkable ecological and social stability.

A detailed account on the status of wetland pollution in Kerala, its sources, impact and management was given by Ajaykumar Varma (CESS). Impaired flushing is found to be the main causative factor for enhancing pollution. The Kerala wetlands are also characterized by eutrophication, near freshwater conditions, lack of natural flushing, prolific growth of aquatic weeds and poor waste quality. As a result, there is significant reduction in the assimilative capacity of the aquatic environment and considerable stress on carrying capacity of wetland systems, limiting their functional utility. An integrated approach in terms of planning, implementation and monitoring, requiring specific information on a range of subjects like ecology, hydrology, economics, watershed management, appropriate technology, traditional knowledge and local expertise and participation of local people, planners and decision makers, was suggested.

'The sustainability factors of the freshwater lakes' of Kerala was the theme of

the presentation by M. P. Nair (Botanical Survey of India, Kolkata). Based on a case study on Sasthamkotta freshwater lake, a Ramsar site of Kerala, he presented management strategies and actions for different components like landuse, water sources, boundaries, plankton diversity, aquatic vegetation, fish diversity and pollution from various sources.

Management interventions in wetlands through a participatory approach make the stakeholders well aware about the necessity of conserving the ecosystem, and they should be made partakers in the management plans. Various aspects involved in stakeholder analysis of wetlands were discussed in the presentation by C. Bhaskaran (Kerala Agriculture University). The ecosystem benefits currently being derived by the stakeholders should be allowed in future with necessary regulations and thus conflicts in conservation should be avoided at all levels. In order to address the various stakeholder conflict situations and their possible mitigation, he suggested the methodology of mixed quantitative/qualitative approach in stakeholder analysis.

V. S. Vijayan (Chairman, Kerala State Biodiversity Board) presented a detailed account on the results of economic valuation studies on wetlands and established the immediate need for implementation of National Wetland Conservation and Sustainable Use Strategy and Action Plan. His presentation critically analysed various strategies and action plans proposed in the draft outline.

The conservation aspect of wetland ecotourism was the theme of the presentation by K. G. Mohanlal (Kerala Tourism Development Corporation). The prime objective of wetland ecotourism should be conservation and the strategies for identification of wetland sites should include inventory of the resources available, stakeholder analysis and consultation, carrying-capacity studies, local economic and social benefits, etc. The ecotourism management strategies should attempt to move ecotourism experiences beyond mere enjoyment to a more active role, which incorporates learning, attitude and behavioural change.

Twelve papers were presented in the general paper session, the content and coverage of which included specific case studies like bio- and phyto-remediation

studies, wetland protection and conservation, success stories and utility of various biodiversity assessment methodologies. Presentations in the 'Young scientist award' session also covered almost all aspects of wetland studies, including mapping, inventory, faunal, avifaunal and floral biodiversity and agro-biodiversity.

An Open Forum on Whither Vellayani Lake? was a special attraction of KEC 2007. The forum was chaired by the noted environmentalist M. K. Prasad. E. J. James (CWRDM), sensitized the audience about the subject, through a colourful audio-visual presentation. A cross-section of stakeholders comprising peoples' representatives, the general public, scientists and activists attended the Forum.

The valedictory address of Prabhat Patnaik (Kerala State Planning Board) mainly focused on the environment and development, and the equitable sharing of resources. He stressed on developing a pragmatic programme with people-public-private-local body partnership and participation for the wise use of wetlands. He distributed the young scientist awards for best oral and poster presentations.

The Congress brought about new thoughts and attitudes towards an integrated approach in wetland management, ensuring the participation of various Government departments and other stakeholders. It had successfully chalked out a detailed procedure for undertaking a comprehensive study and preparing a management plan for the Vellayani Lake, one of the most threatened freshwater lakes in Kerala and ways in which to bring it to the status of a national/international site. There was also a good interaction between senior scientists and young researchers, which provided much support to the latter in structuring their studies in a more productive manner.

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