



Submarine Groundwater Discharge in Kerala coast

Coastal areas are natural sites for groundwater release from shallow aquifers because of their down gradient position. Submarine Groundwater Discharge (SGD) can occur whenever hydraulic head is above sea level and the aquifer extends beyond the shoreline to crop out at the sea floor, or is hydraulically coupled with marine waters through permeable bottom sediments. By definition, SGD is fresh and/or saline groundwater that escapes or recirculates from coastal margins into the marine environment; it commonly occurs as seepage, submarine springs, tidally controlled groundwater discharge from unconfined and artesian aquifers, etc. Number of investigations conducted on the Mediterranean and Atlantic coasts have indicated positive correlation between the submarine groundwater discharge and the beach accretion. Although long overlooked, in recent years SGD has received increasing attention due largely to its potential

importance in the transport of chemical constituents to the sea. Indeed, SGD occurrence and control mechanisms are still poorly understood. Submarine discharge often represents only a minor component of regional total water budgets. Since the estimated fluxes are highly variable and quantification remains challenging, the process deserves to be carefully evaluated while investigating marine ecosystems and/or the safety of geological repositories in coastal areas, notably for the underground storage of CO₂. Particularly in view of globally increasing urbanization and climate change, this contribution should prove useful also to local governments and scientists involved in coastal groundwater and ecosystem management.

CESS has carried out a study to identify probable SGD zones in Kerala, to



The Estimates Committee of the Kerala Legislative Assembly during their sitting at CESS (Report in page 3)

quantify the SGD from a unit area and to establish its relationship with beach accretion. Satellite images of entire Kerala coastal zone has been subjected to slicing on the basis of wetness factor. Possible sites of SGD pertaining to the unconfined aquifer layer, comprising the Warkalli sediments (Tertiary) and the Coastal sands (Recent) were delineated. One such typical unit falling within the Thiruvananthapuram district (Pulluvila

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International Workshop on Fluvial and Marine Processes of Cenozoic and Formation of Placers



Hon'ble Minister for Water Resources, Sri. N. K. Premachandran inaugurating the workshop at CESS on 1 November 2007

The international workshop on 'Fluvial and Marine Processes of Cenozoic and Formation of Placers' was organized by Centre for Earth Science Studies, Thiruvananthapuram with a two-day conference in CESS, four days of field work between Kanyakumari and Goa and a concluding session at Goa University.

Delegates from India, Sri Lanka, China, Russia and Australia took part in the workshop. The workshop was organized as part of the International Geoscience Correlation Program (IGCP), a joint endeavour of the UNESCO and International Union of Geological Sciences (IUGS). The Hon'ble Minister for Irrigation and Water Resources, Govt. of

Kerala, N. K. Premachandran inaugurated the workshop on November 1, 2007. The inaugural session was presided over by Dr. E. P. Yesodharan, the Executive Vice President of the KSCSTE. An overview of IGCP was presented by Dr. N. G. Patyk-Kara (Russia), Project Coordinator, IGCP-514. Dr. M.

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Prithviraj, Director, Department of Science and Technology, Govt. of India, Dr. M. Baba, Director, CESS, Dr. N. P. Kurian, Head, Marine Sciences Division, CESS and Dr. D. S. Suresh Babu, Scientist CESS and the Organising Secretary of the Workshop spoke on the occasion.

The inaugural session was followed by the technical session on 'Neotectonism, Glaciation and River Metamorphosis' consisting of four papers. The second technical session on

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From the Director's Desk



The growth India has achieved in the last sixty years, though commendable by any yardstick, could not provide succor to all. A planning strategy for the development of the entire population can be achieved only if we have a near-total understanding of the diverse features of the earth. Moreover, the new challenges posed by climate change also need to be attended to, to realize the goals of total development. India offers unique settings to study many earth system processes. A protracted history of deposition, deformation and metamorphism covering the entire geological period, from Archaean to the Recent, is well preserved in its diverse provinces. Although there have been some intense field and significant laboratory studies/research to understand the evolution of the Indian continent, several grey areas still remain. The evolution and processes of the earth system involves close interaction between geosphere, hydrosphere, atmosphere and our position in the planetary system. Changes at any point in the system may have long term effects elsewhere. For example, the earth's alternate warm and cold climate changes are linked to the changes in the earth's orbit around the sun. Earth's atmosphere might have been created instantaneously and is related to the process of core-mantle differentiation in the deep interior of the earth or impact melting or to the process of continuous degassing throughout the geologic time. The atmosphere, which envelops the planet, serving as a medium for transporting matter between oceans and land, constantly interacts with the geosphere and hydrosphere. This global process is singularly important in understanding the biogeochemistry of the earth and its evolution. On another front the palaeoclimate gives clues on the crustal evolution and geomorphological processes. Climate change, on the other hand, is a phenomenon that affects all regions of the globe through its effects in changing the atmospheric temperature, altering atmospheric regulators and sea level in the long term. But, it has been realized that human activity can bring global changes in climate even in short term and also affect regional climates. Climate change can play a major role in producing catastrophic effects that would change the face of the earth. To take any remedial or corrective action on this, it is necessary to understand the causative factors for the climate change, their sources and sinks. Co-operation and co-ordinated research between national agencies, such as IMD, IITM and ISRO and regional agencies such as CESS is the need of the hour.

Dr. M. Baba

Submarine Groundwater.....

region) was studied in detail during 2003-07 period using different techniques namely (a) field work (beach profiling, piezometer observations, location and performance of springs, water table fluctuations in monitoring wells, recognizing recharge-discharge areas etc), (b) data collection using CTD meter (c) resistivity surveys (longitudinal, transverse and seasonal) (d) water quality analysis (spatial, vertical and temporal), (e) isotope analyses and (f) computation of SGD through modeling.

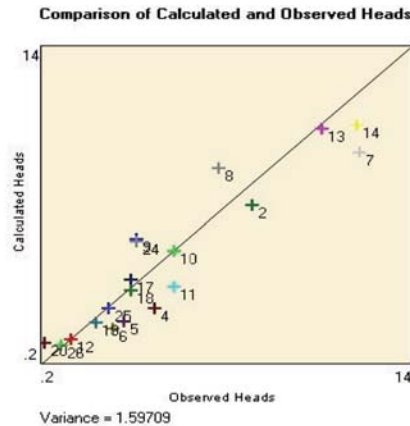


Fig.1 Comparison between observed and calculated values of water head

Primarily, the beach at Pulluvila, which appears to be accreting during last decade and the neighboring beaches around Vizhinjam have been severely eroded. The accretion is more than 80m, considering either the summer or the monsoon shoreline positions.

All the information collected from the field and laboratory were used for building a steady state groundwater model for the area. The modeling study included steps like, conceptualization of groundwater system, developing the model to derive optimal parameters, calibration studies and simulating the groundwater flow to determine the hydrologic budget. The program PMWIN was used to simulate groundwater flow. For the calculation of the initial hydraulic heads, two-year data from 26 continuous monitoring wells along four transects as well as 10 spatially different observation wells of the study area were used. Before drawing the water table heads, groundwater flow velocity, flow direction and water budget, the generated model was calibrated. The calibration target of <2 m was set as the accepted margin of difference between calibrated and observed heads for each well (Fig.1). Simulation of a general head boundary along the northern and southern model boundary of the study region suggests that there are two additional sources of recharge to the aquifer viz., Kottukal Thodu and Neyyar river, apart from the rainfall.

Groundwater outflow terms of the model included river leakage (3.44×10^4 m³/day) and submarine discharge from the coastal boundary to the sea (2.6×10^4 m³/day). The total calibrated groundwater budget was of the order of 7.44×10^4 m³/day. The particle velocity, duration of travel of different particles (residence time) and direction of movement of ground water in the study area are shown in Fig.2. Based on the sensitivity analyses performed for this investigation, it is apparent that the model is sensitive to changes in horizontal hydraulic conductivity and recharge, but least sensitive to river bed vertical hydraulic conductivity.

The synchronised beach profiling with water table monitoring, hydrochemical data from observation wells and inferences from the resistivity surveys strongly support the possibility of truncated extension of coastal unconfined aquifers towards sea, providing SGD from land. Geologically, the Pulluvila region comprises of Tertiary sedimentary layers conformably overlying the Precambrian basement. It is postulated that the configuration of surface topography of crystalline basement coupled with the intense neotectonic disturbances that took place in the area have led to the development of potential submarine groundwater discharge zone, lying between rock abutments at Adimalathura and Poovar. Vertical displacement occurred in Tertiary sediments, reportedly of Neogene, is typically visible at Adimalathura region, where the sandstone layers are seen at about 30m above the ground level in the cliff. Hence, the block containing sandstones that have sunk

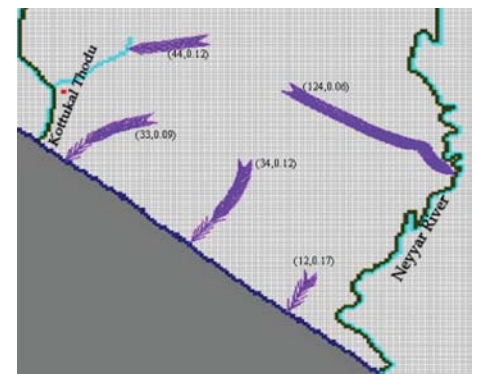


Fig.2 Model calculated residence time (years), velocity of particles (m/s) and direction of particle movement from selected locations of model area. The first figure in parantheses represents time required for travel and the second one, velocity of particle.

down on the southern side of Adimalathura is perhaps conducting the groundwater in appreciable quantities at the seafloor. The accreting shore in Pulluvila indirectly supports the probable seaward extension of aquifer sand layers, which are also getting reworked and offers better beach stability.

-Dr. D.S.Suresh Babu and Dr.Terry Machado

Exhibition

CESS participated in the Earth Science Expo-2007 held during November 21-24, 2007 at the University Student's Center, Thiruvananthapuram. The exhibition was organized by the Geology Old Students Association (GOSAN), University of Kerala.



Students at the CESS stall at the GOSAN exhibition

Estimates Committee visits CESS

A special sitting of the Estimates Committee of the Kerala Legislative Assembly was held at CESS on November 28, 2007 to conduct a hearing on the follow up action taken on the Committee's recommendations on various activities of the Centre. Members of the Legislative Assembly Sri.Anathalavattom Anandan (Chairman), Sri.Kadannappally Ramachandran, Sri.Therambil Ramakrishnan, Sri.A.C.Moideen and Sri K. V. Kunhiraman interacted with the scientists of CESS in the presence of Dr. E.P.Yesodharan, Executive Vice President, KSCSTE and Dr.M.Baba, Director, CESS. All members expressed their satisfaction on various activities of CESS that help the common people of the State. The Committee recommended to undertake more research activities to give early warnings to people about natural hazards and to suggest alternative building materials in the wake of scarce natural resources. Members also visited the laboratory facilities of CESS and expressed their appreciation.

P.G. Studentship programme

CESS selects ten meritorious post-graduate students from various colleges / university departments within Kerala State to work for their final year dissertation work under the studentship programme. The selected P. G. Students shall use the laboratory and library facilities of CESS under this programme.

CESS to study old tsunamis

Tracking the past disasters and tsunami along the parts of Tamil Nadu coast is another initiative of CESS to carry out paleotsunami studies for the southeast coast of India and

document sedimentologic and geomorphic imprints of tsunami along this coastline. Tsunami events with extreme effects on sediment transport and coastal geomorphology are rather rare with regard to human history. However, considering geological time scales, they occur frequently. At least 100 mega tsunamis in different parts of the world have been recorded in the past 2000 years, but presumably far more have failed to be noticed during historical times and are not mentioned either in written or oral ancient records. Field research concerning paleotsunami is astonishingly rare within the scientific realm and only 5% of the existing tsunami literature is related to this subject. This percentage is miniscule for the southeast coast of India. This endeavor is to identify spatial and temporal incidences of extreme sea surge events mentioned in the Tamil literature, archaeological reports and to suggest locations where future paleotsunami studies need to be initiated and correlated with sedimentological signatures. The outcome of the project would have tangential importance to tsunami modeling work.

The project is funded by the DST, Government of India.

Rs. 2.22 crores for CESS under COMAPS

The Ministry of Earth Sciences, Government of India has sanctioned Rs.2.22 crores to CESS to continue the ongoing project of Coastal Ocean Monitoring And Prediction System (COMAPS) for another five years from 2007. Under this programme CESS has been continuously monitoring 25 water quality parameters in the 0-10 km sector of the coastal ocean between Thiruvananthapuram and Mangalore. The Centre is one of the ten institutions in the country participating in the water quality monitoring programme along the east and west coasts, including the islands of India.

Publications

Mahesh Mohan and P. K. Omana (2007) Statistical analysis of water quality data from a Ramsar site - the Vembanad backwaters, SW coast of India, Asian Journal of Microbial Biotech, Ev.Sc.Vol.9 (2), pp 313-320

T. N. Prakash, K. P. Black, J. Mathew, N. P. Kurian, K. V. Thomas, T. S. Shahul Hameed, M. V. Vinod, and K. Rajith (2007) Nearshore and Beach Sedimentary Dynamics in a Placer-Dominated Coast, Southwest India, Journal of Coastal Research, V. 23 No.6, pp.1391-1398.

Rupananda J. Mallia, Shiny Sara Thomas, Rejnish Kumar R, Anitha Mathews, Paul Sebastian, Jayaprakash Madhavan and N. Subhash (2007) Oral premalignancy detection using autofluorescence spectral ratios, Oral Oncology Suppl. 2(1), pp 259-260.

Subhash N. (2007) Optical Spectroscopy – An emerging technology for dentistry, Contemporary Optics and Optoelectronics (eds. P. P. Sahu and P. Deb), Tata McGraw Hill, New Delhi), p.79-81.

Nominations

Dr. K. V. Thomas is nominated as member of the expert committee to study coastal erosion of Poonthura by the Water Resources Department, Government of Kerala.

Dr.R.Ajayakumar Varma is nominated to the committee to study the environmental issues due to iron and steel industries at Kanjikode, Palakkad district by Government of Kerala.

Dr. Ajayakumar Varma is nominated as Chairman of the Subject Committee on drinking water, sanitation and solid waste management, by the Government of Kerala

Sri G. Sankar is nominated as a member of the expert committee constituted by the Government of Kerala to inquire into the pipe burst of the Panniar Hydro-electric Project

Seminar / Meetings/ Workshops

Dr. M. Baba inaugurated the national seminar on 'National Self Reliance - Frontier Areas in Science and Technology' of 'Swasraya Bharath 2007' and delivered the inaugural address at Kochi on October 15, 2007.

Dr. N. P. Kurian delivered an invited talk on 'Beach sediment budgeting for sustainable heavy mineral exploitation in the International Workshop on Fluvial and Marine Processes of Cenozoic and formation of placers at Thiruvananthapuram on November 2, 2007.

Sri. B. K. Jayaprasad presented a paper in the ISRS annual convention held at Kolkata during December 18-20, 2007.

Dr. Ajayakumar Varma delivered the keynote address at the Groundwater Awareness Seminar organised by Department of Groundwater, Government of Kerala on December 11, 2007

Retirements

Sri. G. Chandukutty (Clerical Assistant) and Sri. C. N. Gopalakrishnan (Stenographer) retired from the services of the Centre.

International Workshop.....



Delegates of the IGCP 514 international workshop held at CESS

'Submergence of River channels in Coastal zone' consisted of three paper presentations. The third session was on Paleochannels and formation of Mineral



Delegates of the IGCP workshop at Goa

Resources completed with four presentations.

The penultimate session was on 'Role of rivers in offshore placer genesis' with three papers and the last technical session was on 'Modern Fluvio-marine processes and exploration of Placer deposits' with five presentations. The technical sessions were followed by four days of field tour in the Kerala, Tamil Nadu and Goa region. Visit to the layers of bauxite, clays, sandstone and laterite at the Karichal cliff section, laterites on the Khondalite basement at Aruvippuram, placer deposits at Manavalakurichi, Teri Formation or ancient sand dunes at Muttom, Warkallai formation

at Varkala cliff region, the clay deposits at Kundara and visits to Ashtamudi Kayal, Sasthamkotta kayal and Indian Rare Earth factory at Chavara were the highlights of the first two days of tour. The third day was dedicated to a cruise in the Vembanad Lake, the largest estuary in Kerala, in a house boat. The final field excursion was at Aguada headland, Bardez, Goa. The parent rocks of meta sediments and basic dykes were found exposed in this wave cut platform area. Primary depositional features of Precambrian age and recent erosional features were visible. Boxwork and honeycomb structures were seen among other interesting features.

New Year Celebrated

CESS staff and their family members celebrated new year eve with dance, music and sweets. Dance performance by children and skits by staff members were the highlights of the variety entertainments. Dr.T. S. Murty, the visiting scientist from the University of Ottawa was the chief guest of the function.



CESS & BARC collaborates

Radon concentration in water is widely being used as a useful tool to discriminate the phenomenon of Submarine Groundwater Discharge (SGD). A team led by Mr.Noble Jacob, Scientist, Isotope Hydrology Division, BARC, Mumbai and scientists from CESS jointly conducted *in situ* measurements of radon in surface water, coastal groundwater and in sea water, pertaining to a potential groundwater discharge zone in Thiruvananthapuram district during October 26-28, 2007. Measurements were carried out using portable in-situ radon monitoring system. Preliminary results with higher values of radon above the normal range in sea water are encouraging and indicate SGD.



Radon meter

Dr. Terry Healy in CESS

Dr.Terry Healy, Research Professor of Coastal Environmental Science, Coastal Marine Group, University of Waikato, New Zealand visited CESS during December 10-11, 2007.



Dr.Healy is a leading expert in the field of coastal erosion, inlet and inner shelf sedimentation processes, dredging issues for port and marina development planning, etc. Dr.Healy delivered a talk in the Earth Science Forum of CESS on December 10, 2007. His talk focussed on performance evaluation of numerical modelling and enhancing coastal function by sensible set back for open duned coasts. Dr.Healy also joined a discussion on set back line demarcation with Dr.T.S.Murty and scientists of the Marine Sciences Division. Dr.Healy visited a few of the laboratories of CESS and had wide ranging discussions with the Scientists.