

D. A. Bradley, University of Exter, UK, spoke on 'Near-edge photon interactions and synchrotron-based research at Exter'. Synchrotron sources provide high brightness, highly monochromatic tunable sources of X-ray photons, allowing panoply of investigative techniques. His lecture reviewed observation of elastic photon scattering from dilute aqueous ions, use of XANES and EXAFS in examining the charge state of dopants in glassy thermoluminescence media and application of X-ray fluorescence (XRF) in detection of trace elements involved in the process of breast carcinoma. Bradley also indicated that recent synchrotron-based XRF analysis of trace elements in cancerous human tissue has demonstrated higher concentration of elements such as zinc in regions that are identified as tumours.

Shivaramu, IGCAR, Kalapakkam spoke on 'Irradiation effects on nuclear power plant concrete structures'. The calculated neutron fluence and cumulative gamma dose received by the concrete surrounding the PFBR and the results of irradiation effect on moisture level and its detection by gamma scattering method were presented. The approximate threshold radiation levels to create measurable damage in concrete, the type of damage and deg-

radation due to irradiation and the results of studies conducted and reported in the literature to investigate the effects of irradiation on aggregates, cement pastes and mortars were also reviewed.

Amar Sinha, BARC, spoke on 'Phase contrast imaging-A simulation study'. X-ray radiography is a powerful non-destructive method used in materials and medical science. However, X-ray phase contrast radiography produced contrasts not only on differences in absorption but also on differences in the real part of the refractive index. Sinha presented a method of simulation for the development of such a system using simple 2D and 3D objects like circular, spherical, and cylindrical fibre. The results were encouraging and illustrated the various aspects of such imaging techniques like coherent requirement, source-to-object distance, object-to-detector distance and so on.

P. Sethulakshmi, BARC, spoke on 'Radiological safety aspects of cyclotron and PET facilities'. She stated that 'Positron emission tomography' (PET) is the latest diagnostic modality in nuclear medicine and has wide applications in the field of oncology, neurology and cardiology. PET uses isotopes which are cyclotron-produced. Both medical cyclotron

and PET facilities involve the use of radiation and hence it is necessary to provide adequate structural shielding for these facilities in order to keep the radiation doses to occupational workers and the public within permissible levels. She presented an evaluation of the doses in a 16.5 MeV medical cyclotron facility and PET facility using computational and experimental measurements.

Maitreyee Nandy, SINP, Kolkata spoke on 'Neutron emission from spallation sources: Estimation using quantum molecular dynamics'. She cited some examples of new frontline research initiatives on accelerator-based neutron sources that are being taken up worldwide to get slow, high intensity neutron beams for use in neutron science projects, transmutation of long-lived radioactive wastes from nuclear fuel cycle and so on. Theoretical estimation done in the framework of quantum molecular dynamics approach in conjunction with a statistical decay model was also presented.

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MEETING REPORT

Six months after the tsunami*

A meeting was held recently to discuss the unexpected tsunami that struck the shores of South India and other neighbouring countries on 26 December 2004. An under-sea earthquake that occurred at 07:58:53 local time in Sumatra caused the tsunami. The tsunami was among the deadliest disasters in modern history, and killed more than 240,000 people. The epicentre of the earthquake was in the Indian Ocean, north of Simeulue island, off the western coast of northern Sumatra, Indonesia. The resulting tsunami devastated the shores of Indonesia, Sri Lanka, South India, Thailand and other countries, with waves of

tens of metres height. It caused serious damage and loss of life as far as the east coast of Africa, with the farthest recorded death due to the tsunami occurring at Port Elizabeth in South Africa, 8000 km away from the epicentre.

The objective of the meeting was to discuss different aspects of the tsunami, including our scientific knowledge of the phenomenon, its environmental, historical, sociological, psychological and behavioural dimensions, and the most appropriate action that the country might take so that the large losses in human life and property that accompanied the December 2004 tsunami will not be repeated. The meeting brought together scientists, representatives from the government, historians and social groups that have been involved in tackling the consequences of the disaster. There

were about fifty participants: twenty of them speakers (including six from outside Bangalore) and the rest invitees.

The meeting began with a welcome speech by K. Kasturirangan, Director, National Institute of Advanced Studies (NIAS), Bangalore, who stressed the need for attention to the problem from a variety of different viewpoints. This was followed by an introduction by R. Narasimha, who highlighted the need for better understanding and monitoring of tsunamis; they do not give long warnings like cyclones, but on the other hand, once it is known that a tsunami has been triggered, the rest of its course can be predicted sufficiently accurately to take action to prevent loss of life, provided an efficient method of issuing warnings along the coastlines can be institutionalized.

*A report on the one-day discussion meeting entitled 'Six months after the tsunami' held on 16 June 2005 at the National Institute of Advanced Sciences, Bangalore.

C. N. R. Rao was one among the few Indian scientists who were actually witnesses of the event; he and his family were in Sri Lanka, right on a beach where the tsunami struck. Fortunately, he was not a victim of its fury, as a last minute decision to go away from the beach saved him and his family. He shared his first-hand experience of encountering this unexpected natural disaster, and stressed that what struck him most was how helpless he and others felt because of the difficulty in communication. The usual systems had all failed. (One mobile, which could reach Colombo, turned out to be a boon.) However, the entire ground floor of the hotel where they were staying was washed away along with furniture and many unfortunate people were taken unaware. As he was in a canal close by at the time of the disaster, the first thing that he noticed was that the water level in the canal rose abruptly, and all of a sudden many crocodiles appeared. He mentioned several questions that were raised by the devastation caused by the tsunami, including proper regulation of construction near the shoreline, measures that might be taken to have well-understood warning systems (frequently checked), and the setting up of an effective disaster management system which could respond immediately. He noted that this disaster was among the deadliest in modern history.

V. S. Ramamurthy (Department of Science and Technology, Government of India) delivered the keynote address, which began with details of the earthquake. He said that earthquakes are a major source of tsunamis, especially if the magnitude of the quake is more than 8 on the Richter scale. There is limited time to prepare for it. He proposed an earthquake monitoring system that works non-stop; ocean-based earthquake and tsunami detection systems; an on-line tide gauge network which will run round the clock, and a tsunami alert system where appropriate software will issue warnings to all cell-phone users. Ramamurthy pointed out that communicating in times of emergency is not easy (even if the system is working): one may not know what and how to communicate and how to respond. Referring to the false alarm on 31 December, a few days after the 26 December tsunami, he said there is nothing unprofessional in raising an alarm and withdrawing it; people should be trained to respond to such warnings. A tsunami in the South-east Asian area is uniquely characterized

by low probability, long recurrence intervals and high-consequence hazard. Despite large aftershocks in the Andaman region since 26 December 2004, there have not been any tsunamigenic events till date. Therefore, he pointed out that a tsunami early warning system tailored to the specific characteristics of the Indian Ocean region has to be designed. Ramamurthy also suggested a National Emergency Response System, where a bulletin is issued if an earthquake is detected. The magnitude of the earthquake, sea-level data and ocean bottom sensors would give inputs for issuing tsunami warnings. It could be decided on the basis of such data whether the earthquake or the observed tidal wave activity would be enough to cause a tsunami. If the results are positive, a confirmatory warning could be given. He stressed that future efforts should be directed towards enhancing public awareness, improving disaster communication and modernization of existing technical systems.

The science of the tsunami was discussed by Vinod Gaur (Indian Institute of Astrophysics, Bangalore). He stressed the importance of creating quantitative hazard maps. He explained at length how a tsunami results from a rupture in the sea crust only if the earthquake results in an upward displacement of the sea-floor, and how we could use existing data on tsunamis and earthquakes to determine if conditions are changing. Based on the chronology of tsunamis and the topography, Gaur said that there would probably not be another tsunami from the same Sumatra source for another 100 years or so. He said that programmed science involving preparation of hazard maps, collection of relevant data, advanced warning systems, education and awareness, communication with appropriate software and construction of tsunami barriers may help in future tsunami disaster management. A tsunami may only be a metre or so high over the deep oceans, but can increase to tens of metres in height in shallow coastal waters. Close to land it begins to feel the ground, the wavelength decreases and the wave overturns. Considering that Indonesia is along plate boundaries, the earthquake itself was not unexpected, but what was astonishing was that it would travel thousands of kilometres. It is a lesson that rupture zones can link up, considering the quakes of 1881 and 1941 in the Andaman Islands.

In the session on 'Modelling and observational approaches', S. R. Shetye (National Institute of Oceanography, Goa) presented an analysis of the events of 26 December 2004, using the wealth of information provided by tide gauges in the Indian Ocean and elsewhere. As we plan for the future, sea-level data need to be carefully analysed to understand better the physics associated with such events. He said historical data that exist in the country concerning extreme events along the coastline should be carefully analysed, as it would help in taking a holistic view of many coastal hazards when we develop warning systems for some.

K. Radhakrishnan (Indian National Centre for Ocean Information Services, Hyderabad) said that his institute was a member of the government initiative to have operational tsunami and storm-surge warning system models by September 2007, the estimated total cost of which was Rs 125 crore.

S. Hegde (ISRO Headquarters, Bangalore) discussed the steps recently taken by ISRO, like the development and installation of automatic weather stations, which would be continuously operational and provide key parameters for atmospheric studies. He stressed the urgent need to expand India's radar network to cover all the coastal areas, and ISRO's proposal to develop optical or photonic sensors that can be placed at the ocean bottom to sense changes in tidal activity. Hegde also outlined the work undertaken using space-based platforms in inundation mapping, detailed scale damage assessment, identification of safer places for rehabilitation, integrated coastal management for reducing the impact of tsunamis using remote sensing data, providing communication links for relief, telemedicine and counselling via satellite.

The present status in India, of earthquake monitoring systems and plans for the future was explained by R. S. Dattatrayam (India Meteorological Department). He said the idea is to install a system called DART (Deep Ocean Assessment and Report) that would provide early warning of tsunami arrival on Indian coasts. It is expected to be fully functional in two-and-a-half years.

S. Settar (NIAS) and Sukumar (Indian Institute of Science, Bangalore) provided two unusual dimensions to the discussions at the meeting. Settar took us back to the 7th century Tamil poet, Nilakanthan, whose work records that out of three Sangams, two were lost due to what pre-

sumably were tsunamis. During the first Sangam, the south of Sri Lanka was 'grabbed' by the ocean (*kadalkol*); and literature surviving today refers to the rivers Pehruli and Kumari and the land lost by them. Settar also discussed the legend of a sunken continent around South India called Lemuria.

Sukumar spoke on animal behaviour before and after the tsunami. Strangely, very few animals perished in it. Could it be because animals have a hidden sixth sense that tells them of such threats beforehand? Or could it be because animals like elephants, which communicate by sound waves around 10 Hz, can sense seismic signals, and can hear the approaching waves of the ocean? He cited an instance of eight tame elephants in Thailand that bolted away from the coast. There were reports of flocks of birds that left the Tamil Nadu coast, and wild animals which moved inland before the tsunami. One may ask if animal behaviour can be used to warn about quakes. In 1985, Chinese scientists predicted an earthquake based on their observations of rats coming out of their burrows everywhere, although the method was later discontinued.

The session on the 26 December tsunami event brought in reports of some firsthand experiences of people who were either in the affected areas at the time or reached there soon after the disaster. From the Andaman Islands there was a vivid account by V. V. Bhat, who was in charge at Port Blair. There were many practical problems during relief operations, e.g. the huge number of bodies of victims along the coastlines, difficulties in extracting and disposing of dead bod-

ies, and delays in arrival of relief and help at Port Blair because of damaged runways, and bodies lying on the airstrip.

Sanjay Lewin (St. John's Medical College, Bangalore) spoke of how his disaster relief teams participated in tsunami relief in the Andaman Islands. He shared the challenges faced by the teams and highlighted the need for being prepared to face a large-scale emergency situation, training people to provide relief in a productive way, prioritizing medical needs for providing essential drugs, and the need for disease surveillance, preventive measures, vaccinations, curative care, psychological counselling and local field assessments.

The kind of investments being made in sensor systems and other technologies seemed in direct contrast to the lack of funding support for the rehabilitated tsunami victims at Chennai. A film clipping projected by Thelma Narayan, an epidemiologist with Community Health Cell, Bangalore showed how miserable living conditions were in the relief camps. The material used for the dwellings became so hot that the residents were forced to go out, where squalor, trash and disease co-exist. Women and children were not safe, and men did not earn enough to eat. The day before the meeting, she said, these dwellings had caught fire and many had died. These tsunami victims only prove the fact that to be poor in India is a sin.

Rama Govindarajan (JNCASR, Bangalore) presented an observer's viewpoint on the relief operations. She said that there were many volunteers but manpower was not properly used. There was desperate need for equipment like earth-

movers, trained volunteers, and proper allotment and distribution of work. There was shortage of skin ointments, bandage kits, scissors, and local anaesthetics that are basic needs in a situation like this. Abundance of unwanted old clothes was the biggest hindrance in relief operations.

The last session was a panel discussion chaired by Arcot Ramachandran. Baldev Raj (IGCAR, Kalpakkam) dwelt on measures taken in the township and surrounding areas; S. S. Meenakshisundaram (NIAS) on rehabilitation and reconstruction strategies in general; D. Sengupta (IISc) on the need for research on disaster management and appointing right people for it; and Thelma Narayan on post-tsunami public health response to meet community needs. The meeting came to an end with Kasturirangan summarizing the proceedings of the day and with closing remarks by R. Narasimha.

It was clear from the workshop that we have tsunami relief teams all over the country, numerous NGOs girding their loins to outdo each other in helping the victims, a 'tsunami response watch' etc., but the question remains when we will be in a position we are better equipped to deal with another such multi-dimensional disaster, if one were to occur in the near future.

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MEETING REPORT

Bird and environment*

There were nine plenary lectures, 25 invited talks, 60 oral and 51 poster presentations in the International Conference on Bird and Environment. Over 160 ornithologists, conservation biologists, gov-

ernment representatives and naturalists including 31 from 17 countries participated in the conference.

In the first and second sessions, namely 'The biology of avian vocal behaviour' and 'Advances in avian bioacoustics', speakers covered a substantial range of topics, examining numerous aspects of biology of singing behaviour such as diversity of acoustic communication, sex-

ual selection and neurobiology of bird song, discrimination of temporal fine structures of songs by birds, etc.

In the first session, Peter Marler (Univ. of California, Davis, USA), father of the 'Avian communication system', in his plenary talk entitled 'The science of bird songs: nature's music' said, 'Environmental factors influence the communicative efficiency of acoustic signals

*A report on the International Conference on Bird and Environment held in Gurukula Kangri University, Haridwar from 21 to 24 November 2004.