



# VIDYA

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## Science & Technology Management Information System (STMIS) Data base



*Inauguration ceremony of publishing STMIS Webpage online*

The official website ([www.mis.nsf.ac.lk](http://www.mis.nsf.ac.lk)) of the Science and Technology Management Information System (STMIS), which comes under the Science and Technology Policy Research Division (STPRD) of the National Science Foundation (NSF), was launched online by Hon. Prof Tissa Vitarana, Minister of Science and Technology at a ceremony held in the NSF on the 08th November 2004. This Project was supported by the ADB funded Science and Technology personnel Development Project (STPDP) of the Ministry of Science and Technology.

Prof. Sirimali Fernando, Chairperson of the National Science Foundation welcomed the invitees and highlighted the role of the NSF to provide S&T indicators and other useful information to the stakeholders. Delivering the Keynote address, the Chief Guest Prof. Vitarana mentioned a brief history of the ADB/STPD Project and expressed his views on the S&T policies

of the current government. Speaking on behalf of the ADB/STPD project, Mr. D.B.Sumitrarachchi appreciated the role played by the STPRD in meeting this target. Dr. M.C.N.Jayasuriya, Director/ National Science and Technology Commission (NASTEC) spoke on the usefulness of the STMIS database to the policy makers and other stakeholders in the country. Dr Seetha I.Wickremasinghe, Project Manager of the MIS Unit and Coordinator of the STPRD made a presentation introducing the STMIS database to the audience, its objectives, future plans and limitations etc. She appealed to the scientific community in the country, to provide their information by submitting the duly completed questionnaire available at the NSF. At the end, a short demonstration on the STMIS database was conducted by Mr. A.P.Hettiarachchi (Computer Programmer) and Dr P.R.M.P.Dilrukshi (Researcher) of the Science and Technology Policy Research Division.

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### VIDYA

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## *Gaining a scientific research culture.....*

The scientific research enterprise, like other human activities, is built on a foundation of trust. Scientists trust that the results reported by others are valid. Society trusts that the results of research reflect an honest attempt by scientists to describe the world accurately and without bias. The level of trust that has characterized science and its relationship with society attributes very much to a good research culture. A good research culture in a particular country will be established only if the scientific community devotes itself to exemplifying and transmitting the values associated with ethical scientific conduct.

Who are the main actors contributing to this research culture? The two leading actors are the universities and the R&D institutions while S&T institutions (e.g. NASTEC, NSF, CARP, Dept. of Census and Statistics, Dept. of Meteorology) play a supportive role. In the universities, teaching is the main role and the responsibility. The research comes next along with services such as consultancies. In the R&D institutions, research is the main role while consultancies and teaching are additional activities. The supportive S&T institutions such as NSF, CARP etc., play a key role in funding for R&D and many other scientific activities, organizing seminars, workshops etc., training of scientific personnel, publishing scientific material such as research work and other scientific information, maintaining science and technology databases and so on. All three actors also publish their scientific and/or research work. Therefore, it is important to establish a close network among all three actors to maintain a good research culture. But who is the main or the key source to create this close network? The answer is simple. The key source is none other than the scientific community in the country.

However, there is a growing concern over the issue that the research culture among academics and scientists in the scientific community is diminishing. The reason for this situation, as majority of scientists and academics point out, is the lack of funds for R&D. But is it the main reason for diminishing scientific research culture in the country? Perhaps, the view of the S&T supportive institutions such as funding institutes would be different. The most prevalent issue for them is the lack of good and sound proposals with promising outcome that has a direct impact on the socio-economic development in the country. Also, there are reasons related to globalization and the shift of research from a "resource based" concept to a "knowledge based" concept (not discussed here) that have direct and indirect impact.

The research, on the other hand, is an activity which is complicated because, it could be private and personal, difficult to evaluate and challenging to promote and maintain. Research could also be at individual level, team level within an institute and team level among various institutions such as universities, government departments, R&D institutions, S&T institutions and private sector including industries, which attributes to difficulty in justification and funding.

Therefore, the responsibility of the scientific community is to take initiatives to attract financial support for their research, use their creative ideas, generate and maintain active research programmes in their institutions including frequent scientific discussions, seminars, workshops etc., organizing field visits, camps and tours but not limiting their research only to laboratories. Because, the future science depends on attracting outstanding young people to research, not only to attract, but to retain as well.

The responsibility of the leading actors, which are universities and R&D institutions, is that they should promote the attitude of working together among scientists, assign a reasonable amount of workload to academics and scientists allowing them to spare time on research, not make them too busy with administrative commitments and carefully monitor their service commitments.

The responsibility of supportive S&T institutes is to create a friendly and welcoming atmosphere to scientific community, to attract them for submission of good research proposals, to help them publish their good research results, to organize frequent discussions, seminars, workshops on topics that are of interest and relevance to scientific issues, provide data on S&T indicators through maintaining S&T databases, and closely monitor their research work.

But all the issues raised above depend greatly on the proper leadership of the leading and supportive actors identified here. The leadership must show support for research and scholarly activities and encourage publishing and dissemination of research findings while convincing them that publishing of research work is important in recognition as a scientific community. The leadership should not be reluctant to deal firmly with "difficult" colleagues. It should not have a "one size fits all" policy about research. The leadership must convince the scientists that research should be done for the benefit of the user community and the socio-economic development of the country but not merely for their own benefits such as financial gains and promotions in their career.

Therefore, it is incumbent on all scientists, universities, R&D institutes and all administrators of science to help provide a research environment that, through its adherence to high ethical standards and creative productivity, will attract and retain individuals of outstanding intellect and character to one of society's most important professions. This will easily pave the way to gain a good scientific research culture in the country.

Dr Seetha I. Wickremasinghe  
Head  
Science and Technology Policy Research Division  
National Science Foundation

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## Research Forum

### Insecticide resistance of vector mosquitoes of malaria and insect pests of rice

Grant No. RG/99/B/01

Chief Scientific Investigator - Dr S.H.P.P. Karunaratne, Dept. of Zoology, University of Peradeniya

Insect pests of rice are a major constraint in paddy cultivation in Sri Lanka. Control of insect pests heavily depends on the use of insecticides, for which the major threat has been the development of resistance.

Insecticide resistance and the underlying resistance mechanisms were studied in five rice insect pests (brown planthopper *Nilaparvata lugens*; green leafhopper *Nephotettix virescens*; paddy bug *Leptocorisa oratorius*; white planthopper *Cofana spectra* and white-backed planthopper *Sogatella furcifera*), and four of their predators (lady-bird beetle *Micraspis discolor*; ground beetle *Ophionea indica*; mired bug *Cytorhinus lividipennis* and spider *Tetragnatha* sp.). Insects were collected from the rice fields at Batalagoda and Angunakolapalassa. Insects were subjected to insecticide bioassays and Log-probit mortality lines and LD<sub>50</sub>/LD<sub>90</sub> values were obtained.

*N. lugens* collected from both sites showed high resistance to permethrin. *L. oratorius* population at Angunakolapalassa was resistant to carbosulfan compared to Batalagoda population. *L. oratorius*, *M. discolor* and *Tetragnatha* sp. populations at Angunakolapalassa were susceptible to permethrin compared to Batalagoda populations and *Tetragnatha* sp. population was susceptible to chlorpyrifos resistance at Angunakolapalassa. Others showed similar resistance levels at both study areas. In general, most of the species tested from Batalagoda and Angunakolapalassa had lower tolerance for malathion although some species showed higher tolerance for DDT.

The major mechanism of insecticide resistance of rice insect pests and predators was elevated carboxylesterases. Highest carboxylesterase activity was present in *S. furcifera*. Lowest activity was found in *L. oratorius*. Malathion metabolism studies showed

the absence of malathion carboxylesterases in all the species. *S. furcifera*, *Tetragnatha* sp. and *C. lividipennis* populations were not sensitive to these insecticides.

Status of insecticide resistance and the underlying resistance mechanisms were also determined in the populations of *An. culicifacies* (major vector of malaria) and *An. subpictus* (secondary vector) in five malarious districts of Sri Lanka i.e. Auradhapura, Kurunegala, Monaragala, Puttalam and Trincomalee. Adult mosquitoes were tested against World Health Organization (WHO) discriminating dosages of DDT, malathion, fenitrothion, propoxur, cyfluthrin, cypermethrin, deltamethrin, etofenprox, I-cyhalothrin and permethrin.

Activities of insect enzymes, which provide metabolic resistance, were estimated by biochemical assays and gel electrophoresis. Sensitivity of the insecticide target site, acetylcholinesterase, was tested by insecticide inhibition experiments. Results showed that DDT resistance is still very high in all the anopheline populations tested, due to high activities of mosquito GSTs. Kurunegala *An. culicifacies* population is susceptible to organophosphates due to low activities of metabolic enzymes and high sensitivity of the insecticide target site whereas Trincomalee *An. subpictus* population maintains a high organophosphate resistance via target site insensitivity. *An. nigerimus* and *An. Peditaeniatus* populations have developed resistance to all the insecticides tested. Malathion resistance of *An. culicifacies* and *An. subpictus* was mainly due to malathion carboxylesterase mechanism. 'kdr' type resistance (i.e. pyrethroid resistance due to mutated Na<sup>+</sup> channel regulatory genes) is present at a lower frequency in the tested populations of *An. culicifacies* and *An. subpictus* except for *An. subpictus* from Trincomalee.

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## Recent Events

### Exploitation of Sri Lankan Industrial Mineral Resources

Most of the mineral resources available in Sri Lanka have not been exploited to the full extent and the mineral developers have faced various problems which has become a barrier for the development of mineral industry in Sri Lanka.

With the objectives of creating awareness about the mineral resources available for exploitation and value addition and to address the problems faced by mineral developers, the Research Committee on Geology & Mineral Resources of the National Science Foundation organized a seminar on 'Exploitation of Sri Lankan industrial mineral resources.' This seminar was held on 17<sup>th</sup> November 2004 at the NSF auditorium.

Delivering the address of welcome, Prof. Sirimali Fernando, Chairperson of the National Science Foundation emphasized that attention has not been paid for this industry in the past and therefore there had not been a significant impact on national development. Mr Priyalal Dias, Chairman of the Research Committee on Geology & Mineral Resources of the National Science Foundation introduced the objectives of the seminar and Mr Dulip Jayawardena, former Director of the Geological Survey Department made an overview of Sri Lankan industrial mineral resources.

Mr Athula Mudunkotuwa, Deputy Director Geology of the Geological Survey & Mines Bureau in his

presentation on export of mineral based products stated that a growth has been observed in minerals and mineral based products over the past six years.

Sand resources available in Sri Lanka were explained by Mr C.H.E.R. Siriwardhana, Senior Geologist of the Geological Survey & Mines Bureau and the offshore mineral resources were explained by Mr S.U.P. Jinadasa, Research officer of NARA. Gem mineral resources in Sri Lanka were discussed by Mr Sarath Weerawarnakula, Director of the Geological Survey & Mines Bureau.

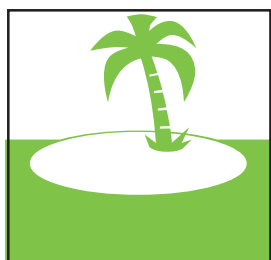
The main thrust of the Petroleum Resources Development Secretariat is to explore with external expertise the geophysical prospects of identifying potential sources and locations of oil and gas in Sri Lanka as stated by Mr Titus Jayawardena, the Director General.

Existing problems faced by the mineral developing industries were discussed by Dr Bandula Perera, Managing Director of Samson Rajarata Tiles Ltd. and the environmental impact on mineral exploitation was discussed by Mr U.R.B. Navaratne, Deputy Director of the Central Environmental Authority.

The presentations were followed by a general discussion and formulation of recommendations to be forwarded to the relevant authorities.

### Tsunami Preparedness

#### Workshop Proceedings



A massive earthquake registering 9 on the Richter scale occurred off the Island of Sumatra in Indonesia on 26<sup>th</sup> December 2004. Prior to the Tsunami disaster, there was global recognition that the Indian Ocean was free

of Tsunami. It was pointed out in Thailand although there was an effective Early Warning System installed on the Pacific Ocean side, there was no such device for the Indian Ocean side, because it was not considered a disaster-prone area. The Earthquake was the result of the interactions between the Indian, Burmese, Australian and the Sunda tectonic plates. It was postulated that a 1000-kilometer of seabed was affected through the effects of the earthquake. The

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earthquake resulted in the upward movement of the sea floor, which affected the sea surface, and waves similar to those observed when a pebble is dropped into a pond were generated. These waves then propagated across the Indian Ocean causing severe damage to many countries including Sri Lanka. The travel time of the Tsunami to Sri Lanka ranged from 2-3 hours. There is evidence that the effects of the Tsunami have been recorded as far away as the Antarctica, west coast of the United States of America and Mexico. In Sri Lanka a maximum height of 2.64 meters was reached in Colombo (Mutwal harbour) where the only tide gauge in Sri Lanka is located. There are reports of water levels rising more than 12 meters (~ 40 feet) in certain parts of the Island with the maximum incursion of water inland being more than 5 kilometers. This undersea earthquake generated a Tsunami that devastated about two thirds of the coastline in the north, northeast, south and the southwest of Sri Lanka. The waves that were over 40 feet in height when reaching the land resulted in the loss of nearly 40,000 lives, a calamity unprecedented in the recent history of Sri Lanka. This natural disaster also destroyed the entire existing infrastructure such as roads, railways, ports, fisheries harbours, public buildings, homes and tourist hotels.

As a consequence of the above natural disaster, which had a severe impact on the entire country, the Government of Sri Lanka with the close collaboration of all political parties, the private and the public sectors together with the civil society including the NGOs, has launched a massive reconstruction programme to bring normalcy to the affected areas. The influx of foreign assistance in the form of multi-lateral and bi-lateral assistance by way of financial resources, medical aid and manpower are flowing into Sri Lanka.

In the aftermath of this major natural disaster, and as a part of the nation building process, the National Science Foundation, the apex body promoting scientific research in the country organized a Workshop on Tsunami Preparedness on 11<sup>th</sup> January 2005.

The objectives of the Workshop were to analyze the causes that led to the Tsunami, review the scientific and technological capability needed to prevent or mitigate occurrences of this nature, create public awareness for such natural disasters and to identify relevant R & D needs related to the Tsunami.

Scientists, professionals and heads of institutions that have a responsibility to formulate strategies and act

accordingly, to safeguard the country and its citizens from facing similar consequences in the future attended the Workshop. The Workshop was structured around two main technical presentations. The first presentation dealt with the scientific and technical facets of Tsunami and other waves, and the resultant consequences, and the second presentation unfolded the sequences of events that preceded and followed the December 26<sup>th</sup> 2004 Tsunami.

The key objective of the Workshop was to bring in the stakeholders to a common platform to make an audit of the recent events and in particular the events that led to and the impact of the Tsunami wave disaster. The current need was to see how best Sri Lanka could use science and technology to mitigate or prevent a future event of this nature and to see what steps should be taken as regards to science and technology to minimize the consequences of similar occurrences.

The Honorable Minister of Science and Technology Professor Tissa Vitarana said that the recent catastrophic Tsunami has caused untold physical suffering and trauma to fellow citizens in addition to the large number of lives lost. The response of Sri Lankans to this disaster was overwhelming, and all the people rallied around as one nation irrespective of various differences, to bring solace to the suffering masses. This tragedy has brought about a new identity to Sri Lankans that would greatly facilitate solving the country's national problem in the North and East.

The scientists and other professionals should be conscious of the issues emerging after the Tsunami and provide answers to misconceptions that have emerged. For example the people are now refusing to eat fish, and also fear to live near the sea. It is the responsibility of the scientific community to win the confidence of the civil society by disseminating the correct information. The Government has also taken some major decisions on the recommendation of the Urban Development Authority to keep 100 meters of the coastline free of any building construction activities. Between 100 and 300 meters, constructions would be permitted if the sites were three meters above sea level. In this zone therefore construction will be on hillocks or on pillars. Beyond 300 meters there will be planned construction. In any event no buildings including houses within a distance of one kilometer could be constructed without planning permission from UDA. However the consequences of such decisions on the fishing industry, tourism and prawn culture have to be studied and remedial action taken.

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Sri Lanka has a claim for a vast ocean economic zone, which is about ninety times its land area. In order to effectively coordinate all scientific research within this large ocean space, it is imperative to have a very effective and integrated institution. To this end it is proposed that a well equipped and well funded National Institute of Oceanography should be established. It is proposed that under the Indo-Sri Lanka Agreement on Scientific and Technical Co-operation, collaborative scientific investigations could be initiated. This in turn will bring maximum benefits to the country. It is the wish that this Workshop will provide wide-ranging recommendations to the Government, to ensure that the country would have the necessary scientific and technical capability to meet situations of the type experienced on the 26<sup>th</sup> of December 2004.

It was concluded that Sri Lanka may also be influenced by other oceanic features such as tropical cyclones, and continental shelf waves which though not as severe as a Tsunami, their occurrence may be more frequent. Therefore, a **coordinated effort is required to mitigate the effects of natural disasters** due to oceanic phenomena.

The system that is in place at present at Pallekelle, has to communicate through California University, via Santiago to USGS, and from there it gets on to the internet. Since Pallekelle is an automatic data collecting center, it is not manned by anyone, but information recorded is transmitted to USGS automatically. In fact if anything goes wrong with this system, it is the USGS that informs Sri Lankan authorities about it.

There is no doubt that Sri Lanka needs to understand what is happening beyond the southern borders of Sri Lanka. Since plate boundaries are also getting developed, the country is becoming vulnerable to earthquakes. Hence there is a justification to acquire an Early Warning System for Tsunami, and an Advanced Seismic Monitoring System for Earthquakes.

### Recommendations of the Workshop

#### Public Awareness and Preparedness

1. Create an effective **public awareness and preparedness programme** for the general public on water related disasters such as Tsunami and other ocean phenomena, as well as cyclones,

floods and earth tremors. In particular a system to provide factual information is necessary to prevent spread of rumours.

2. Students at primary, secondary and tertiary levels should be educated **on natural disaster preparedness, and the subject be included in the school curriculum.**
3. Educational material such as books, **charts and flyers** describing natural disasters, and procedures to be followed for evacuation should be prepared and distributed to schools and the general public. Popularization of Science Programme of NSF and other similar bodies should take an active role in this.
4. The creation of a Civil Defence Force with appropriate training programmes, including periodic drills for evacuation during natural disasters, should be established in Sri Lanka in coordination with all stakeholders, including civil society and the NGOs.

#### Tsunami Warning System

5. A Tsunami Early Warning System that includes public preparedness and an effective communication network should be established.
6. The warning system should also encompass all activities related to disasters. Apart from Tsunami and other ocean phenomena, cyclones, storms, landslides, flash floods and seismic activity **over 5 on the Richter scale** should be included in the warning system. With the occurrence of Tsunami being most unlikely for a very long period, emphasis should be on the more frequent storm water related disasters.
7. The facilities for detection of seismic activity at the **GSMB and the Geology Department at University of Peradeniya** should be upgraded and effectively linked, so that real time data could be exchanged and retrieved for dissemination. Such a system should be integrated with the **Global Seismic Network**, and there is no need to set up a broadband data retrieval system in this regard.
8. A long term contingency plan should be drawn up for natural disasters and disaster management,

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focusing on three areas namely, (a) effectively restoring the livelihoods of the people such as fishing, farming etc. within a minimum period of time, (b) resettlement of people in areas affected by natural disasters, and (c) improving the life saving skills during natural disasters.

9. The establishment of a **National Information Center** related to disaster preparedness and mitigation under the Urban Development Authority (UDA) should be given priority. UDA must be effectively linked with all relevant agencies to facilitate the process.
10. Establish strong linkages with the relevant institutions dealing with natural disasters such as the GSMB, Meteorology Department, Coast Conservation Department, Marine Pollution Prevention Authority, NARA, Sri Lanka Navy, Sri Lanka Air Force, Universities and other relevant specialized agencies, and upgrade the facilities for early warning systems for natural disasters with emphasis on R&D capabilities.
11. Establish linkages and a unifying mechanism (e.g. A National Authority with an operation room unit/facility), among the above institutions so that a **multidisciplinary team could be mobilized for mitigation** of natural disasters in the **shortest period of time**.
12. The **contingency plan** formulated by the Marine Pollution Prevention Authority for detection of oil spills and its mitigation, could be used for guidance in formulating a National Disaster Preparedness Plan.
13. The National Oceanographic Data Center at NARA should be upgraded for collection, storage and dissemination of relevant oceanographic data to relevant local research institutions and international bodies, for study of near and deep ocean phenomena that give rise to natural disasters such as Tsunami and storm surges.

### Reconstruction and Restoration

14. Architects, structural engineers and foundation engineers should develop building codes to withstand earthquakes and other disasters such as cyclones and Tsunami as well as other ocean phenomena such as storm surges. It is recognized that an earthquake prone area exists 400 km to 500 km South West of Sri Lanka (Prof. C.B.

Dissanayake, *et al*). In this context high rise structures, especially those located in the coastal belt will need careful review.

15. Appropriate legislation should be drafted to enforce effective planning guidelines of the UDA, as well as the relevant codes for building construction and in the use of building materials. ICTAD can facilitate this process. Inputs of sand for reconstruction are significant. This should be evaluated immediately by way of all available alternatives to river sand.
16. Strictly enforce the existing laws in the country, especially those related to coast conservation, environment conservation and building construction.
17. Carry out an in depth study on the damage to the coastline due to the Tsunami, and formulate plans for integrated coastal zone management by establishing a mechanism for conflict resolution.
18. Effectively identify the coastal areas by zoning for vulnerability and conservation, while at the same time giving high consideration for fishing, tourism and other forms of recreation, including water sports as well as industry, and designate specific areas for such activities after resolution of conflicts.
19. Introduce an appropriate road reservation on the proposed southern highway from Colombo to Hambantota so that relief efforts during a natural disaster could be carried out without any hindrance.
20. Taking into account the damage caused by the present Tsunami, action should be taken to provide a broad safety zone along the coastline in the East without any human habitation.
21. The recommendations should be prioritized so as to identify the immediate relief measures that will promote relief, reconstruction and rehabilitation. To this end the vulnerability of the eastern seaboard at places such as Kalmunai should be studied, and alternate sites for settlements should be identified. The villagers living within the coastal zone should be relocated within a safe distance from the coastline. In such flat terrain such as Oluvil, Saindamarathu, Akkaraipattu, Pothuwil, Yala and other areas, the safe reconstruction distance should be established. The Survey Department has the necessary topographical maps, aerial photographs, and satellite imagery to assist in this work.

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22. Government should take immediate action to stop the disposal of rubble and other debris generated from the Tsunami back into the sea, and find alternate disposal sites.
  23. With the massive reconstruction programme to be launched by the Government commencing 15<sup>th</sup> January 2005, there will be a dearth of construction materials such as sand stone for aggregate bricks as well as cement. Immediate assessment of such requirements should be initiated and alternate sources such as sea sand as well as innovative construction methods should be identified by civil and material engineers. A Government Policy is needed in this regard.

### **Research and Development**

24. The Government should allocate a minimum of one per cent of its GNP for scientific research, focusing on priority areas that include prevention and mitigation of natural disasters.
25. The National Science Foundation (NSF) has instituted a mission orientated research programme commencing in 2005. NSF should give high priority for funding research projects on disaster preparedness and management.
26. Immediate action should be taken to obtain aerial photographs of affected areas before and immediately after the Tsunami, to assess damage to buildings, public utilities and infrastructure such as roads, railway and bridges.
27. Universities should actively pursue research on early warning systems and disasters, and effectively educate the civil society on the need to be vigilant. Scientific investigations in the use of traditional wisdom in disaster mitigation and preparedness should also be undertaken. (It is significant that even in the current calamity, there is evidence of how some traditional communities have escaped the wrath of the Tsunami through traditional wisdom). The civil society requires a mechanism for emergency contacts with relevant authorities.

### **Coordination and International Linkages**

28. Sri Lanka should effectively participate in activities of United Nations agencies and Regional Inter Governmental Organizations that deal with ocean affairs and environment, as well as those

associated with natural resources such as UNESCO/IOC, UNEP, UNESCAP, International Maritime Organization (IMO), FAO, SACEP, IUCN, United Nations Office of the Law of the Sea and Ocean Affairs (UNCLOS), International Hydrographic Office (IHO), IOC Indian Ocean, International Meteorological Organization, and IOMAC, and foster research related to ocean, land and atmospheric interface that trigger natural disasters.

29. A National Authority with legislative and executive powers linking existing institutions, should be created to coordinate all phases related to natural disasters and mitigation.
30. Research activities on global phenomena that could trigger natural disasters such as sea level rise, global warming and climate change should be strengthened by establishing strong linkages with the relevant international scientific communities.
31. A National Ocean Commission established for coordination and preparation of implementation plans, should ensure integration and achievement of national research goals.
31. A National Ocean Commission established for 30. Research activities on global phenomena that could trigger natural disasters such as sea level rise, coordination and preparation of implementation plans, should ensure integration and achievement of national research goals.
32. Coordination within the relevant ministries and state institutions involved in scientific studies, data analysis and dissemination of information should be strengthened. The Ministry of Science and Technology should act as the apex body for such activities.
33. In view of the limited financial resources available to the Government, it is imperative that the relevant state organizations and universities should be equipped keeping in mind the priorities to deal with natural disasters. To this end maximum utilization of resources including human resources should be harnessed to achieve the required objectives.
34. A National Ocean Commission with high level representation from all institutions associated with coastal and marine activities should be established to coordinate the preparation of implementation plans, and monitor the progress.

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## NSF CELEBRATES WORLD SCIENCE DAY FOR PEACE AND DEVELOPMENT

10 November 2004



*Inaugural Ceremony of the  
World Science Day*



*A Section of the Audience*

The General Conference of UNESCO at its 31<sup>st</sup> Session has proclaimed 10 November each year as the World Science Day for Peace and Development (WSDPD). The purpose of the WSDPD is to strengthen public awareness on the role of science and to renew the commitment to science for peace and development and for the benefit of the society.

In accordance with this proclamation the National Science Foundation which functions under the aegis of the Ministry of Science & Technology organized a programme with the guidance of the NSF Special Committee on Science Popularization on 10 November 2004 from 9.00 a.m. – 2.00 p.m. at the Navarangahala, Royal College, Colombo.

The Chief Guest at this event was Prof. Tissa Vitarana, Minister of Science and Technology.

In his address to the audience he highlighted the importance of raising public awareness in science and of bridging the gap between science and the society.

The Chairperson of the NSF Prof. Sirimali Fernando read the message by her Excellency the President of Sri Lanka.

This event was mainly targeted to the school children of GCE O/Level and A/Level grades.

Teachers, University students, representatives from various scientific organizations and relevant ministries also participated.

Prof. Carlo Fonseka, Director, Institute of Indigenous Medicine delivered a lecture on “Scientific Thinking and Use of Innovation for Development”.

There were two dramas produced by Mr Mangala Senanayake, Lecturer, Department of Aesthetic Studies, University of Kelaniya as a mode to convey scientific messages to the general public. These were produced under the themes (1) Scientific thinking and use of Innovation for Development, (2) Application of appropriate technology for improving of the agriculture sector.

Encouraging young innovators was another event that has been focused on this day. The Young Innovators were selected from school children based on a competition conducted by the Institute of Engineers of Sri Lanka for the year 2004. They were presented with a plaque, a certificate and a cash award. The following were the winners of the Young Innovators Competition.

1. A.A. Ranjeewa Jayasuriya ( Humbuluwa Maha Vidyalaya, Humbuluwa.



A young innovator receiving his award

2. W.A. Asanga Silva, St Joeseph College, Colombo 10.
3. D. Palinda Hettiarachchi, Sri Siddhartha Central College, Eppawala

An introduction to the formation of school science societies at NSF was addressed by Dr Hiran Amarasekera, Department of Forestry and Environment, University of Sri Jayewardenepura. The school science societies that have already been established in schools were requested to register with

the NSF by completing an application form and sending it to the NSF. The idea of forming these societies was to popularize science among school children by organizing various activities related to science through these societies.



A scene from a Drama

The proceedings of the day were brought to a close by a Science Quiz Competition organized by the National Science and Technology Commission to the school children and a chemistry magic show conducted by the Department of Chemistry, University of Colombo.

## Journal of the National Science Foundation

September & December 2004 Issue

- Some factors influencing infectivity of the human malaria parasite *Plasmodium vivax* (Haemosporidia: Plasmodiidae) to the mosquito vector *Anopheles tessellatus* (Diptera: Culicidae) - M.S. Ramasamy, K.A. Srikrishnaraj, S.A.V. Moorthy, S. Jayaweera and R. Ramasamy
- DNA fingerprints of the Asian elephant in Sri Lanka, *Elephas maximus maximus*, using multilocus probe 33.15 (Jeffreys) - Himesha Vandebona, Maya B. Gunasekera, W.D. Ratnasooriya, Nalin C.W. Goonesekere, D.S. Kodikara and J. Alahakoon
- Germination characters and seed reserve mobilization during germination of different wheat genotypes under variable temperature regimes - M. A. Hasan, J. U. Ahmed, T. Hossain, M. M. Hossain and M. A. Ullah
- Oviposition rates, larval and pupal survival rates of *Culex quinquefasciatus* in different plant leaf infusions - K.Manoranjani and M. Dharmaretnam
- Amperometric method for the determination of propanil in a simulated rice field environment - N. Priyantha, A. Navaratne, D.A. Jayawickrama and U.S.K. Welivegamage
- Repellency and toxicity of four essential oils to *Sitophilus oryzae* L. (Coleoptera: Curculionidae) - P.A. Paranagama, K.H.T. Abeysekera, L. Nugaliyadde and K.P. Abeywickrama
- Ferrofluid lubrication of a slider bearing with a circular convex pad - Rajesh C.Shah and M.V.Bhat
- Influence of *El Niño/La Niña* episodes on the rainfall regime of the DL<sub>1</sub> region of the North Central Province of Sri Lanka - B.V.R. Punyawardena, R. P. de Silva and S. Nijananthy

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## NSF Research Grant Awards

October - December 2004

### Engineering & Built Environment

#### RG/2004/E/10

Sri Lankan Water Resources: Their Dynamics and Future Through System Dynamics Simulation.

**Dr. K.D.W. Nandalal** Dept. of Civil Engineering University of Peradeniya **Mr R de S. Ariyabandu** Water Resources Secretariat 2-125, BMICH Colombo 07.

### Medicine

#### RG/2004/M/14

Study on the influence of zinc concentration in serum and seminal plasma on semen parameters and sexual behaviour.

**Prof. P.S. Wijesinghe**, Dept. of Obstetrics & Gynaecology, Fac. of Medicine, University of Kelaniya  
**Prof. W. D. Rathnasooriya**, Fac. of Science, University of Colombo.

**Prof. (Ms) S. Wimalasena**, Fac. of Science, University of Kelaniya.

#### RG/2004/M/15

Pilot study on the role of fine needle aspiration in the diagnosis of Tuberculosis lymphadenitis.

**Dr. L.K.B. Mudduwa**, Dept. of Pathology, Fac. of medicine, University of Ruhuna.

**Dr. A. de S. Nagahawatte**, Dept. of Microbiology, Fac. of Medicine, University of Ruhuna.

#### RG/2004/M/16

Prevalence of neuro-pathological changes of Alzheimer disease in Sri Lankan postmortem brains and its correlation to arteriosclerosis and ApoE genotype.

**Dr. K. R. D. de Silva**, Dept. of Anatomy, Fac. of Medicine, University of Sri Jayewardenepura.

#### RG/2004/M/17

Histological, immunohistochemical and gene expression study of vascular channels in the matrix of costal cartilage.

**Dr. (Ms) N. P. A. D. Gunasinghe**, Dept. of Anatomy, Fac. of Medicine, University of Peradeniya.

### Physics

#### RG/2004/P/05

Computer aided designing of new types of conducting polymers and other materials which can be used as good photosensitizers in solar device development.

**Dr. Asiri Nanayakkara**

Institute of Fundamental Studies Hantana Road, Kandy.

### Veterinary Medicine & Animal Science

#### RG/2004/V/05

Post harvest control of Campylobacter in broiler meat through determination of critical control points (CCP) in broiler processing line and design of intervention measures.

**Dr. Ramani H. Priyankarage**, **Dr. Ruwani S. Kalupahana**, **Prof. Preeni Abeynayake**

Dept. of vet. Pathobiology, Fac. of Vet. Medicine & Animal Science, University of Peradeniya.

#### RG/2004/V/06

Study on the mechanisms of thermoregulation in domestic Asian elephants.

**Dr. A. J. Rajaratne**, Dept. of Physiology, Fac. of Medicine, University of Peradeniya.

**Dr. Asoka Dangolla**, Dept. of Veterinary Clinical Studies, Fac. of Vet. Medicine & Animal sc., University of Peradeniya.

### Biotechnology

#### SIDA/2004/BT/05

Production of transgenic rice plants from Sri Lankan rice varieties mediated by *Agrobacterium tumefaciens* gene transfer.

**Dr. G. A. U. Jayasekera**

Dept. of Plant Sciences, University of Colombo.

#### SIDA/2004/BT/06

Cloning of the rice glutelin-B-1 promoter towards the development of a rice endosperm specific expression vector.

**Dr Sarath R. Sirimanne**

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**Dr Sharmila Jayasena**

Dept. of Biochemistry & Molecular Biology, University of Colombo.

**Traditional Medicine****RG/2004/TM/03**

Studies on the Chemistry and Standardization of Ayurvedic Medicinal Oils.

**Prof. A. M. Abeysekera**

Dept. of Chemistry, University of Sri Jayewardenepura.

**RG/2004/TM/04**

Determination of a National Strategy for Sri Lanka for systematic cultivation of medicinal and aromatic plants.

**Prof. (Mrs.) Kshanika Hirimburegama**, Dept. of Plant sciences, Univ. of Colombo.

**Prof. Tuley De Silva**, 451/75, Thimbirigasyaya, Colombo 05.

**Dr. R.O.B. Wijesekera**, 16, Kirimandala Mawatha, Nawala.

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**Completed NSF Research Projects****October-December 2004****Medicine****RG/2001/M/10**

Antioxidative and hepatoprotective effects of some Sri Lankan medicinal plants in chemically induced hepatotoxicity in mice.

**Prof. Cithra Pathirana, Dr. K.A.P.O.W. Jayatilake**

Dept. of Biochemistry, Faculty of Medicine, Univ. of Ruhuna.

**RG/2001/M/11**

**Prof. Rohan Jayasekera**, Dept. of Anatomy, Faculty of Medicine, Univ. of Colombo.

**Dr. P. H. Dissanayake**, Faculty of Medical Sciences, Univ. of Sri Jayewardenepura.

**Engineering & Built Environment****RG/99/Ep/02**

Estimation of day light availability in Colombo and energy saving potential through the use of natural day light in building design.

**Dr Priyantha Wijetunga** Dept. of Electrical Engineering **Dr Rahula Atalage** Dept. of Mechanical Engineering Univ. of Moratuwa.

**RG/2001/Ep/03**

Solar Energy in tea drying process.

**Dr Priyantha Wijetunga** Dept. of Electrical Engineering Univ. of Moratuwa.

**RG/2004/E/05**

Error analysis of the digital photogrammetric technique.

**Mr. K.R.M.U. Bandara, Mr S.T. Heart, Mr. G.S.N.**

**Perera** Dept. of Surveying Sciences Sabaragamuwa University Belihuloya.

**Physics****RG/2000/P/03**

Interpretation of gravity anomalies over the Indian Ocean regions around Sri Lanka.

**Prof. D.A. Tantrigoda** Dept. of Physics Univ. of Sri Jayewardenepura Nugegoda.

**RG/2001/P/03**

Development of a Coastal Zone Geographic Information System (CZGIS).

**Dr. P.Wickramagamage Dr. S.N. Wickramaratne** Department of Geography **Dr. S.W. Nawarathne** Dept. of Geology University of Peradeniya Peradeniya.

**Chemistry****RG/99/C/07**

Protective measures for the current latex protein allergy problem – A serious threat to natural rubber industry.

**Dr. L.M.K. Tillekeratne, Dr G. Seneviratne** Rubber Research Institute **Dr L. Karunanayake** Dept. of Chemistry Univ. of Sri Jayewardenepura.

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## NSF Travel Grants

**October-December 2004**

Ms. R. P. Hewawasam, University of Ruhuna  
Second Global Summit on Medicinal and Aromatic Plants, India

Dr. A. G. Johnpillai, Eastern University  
10<sup>th</sup> International Conference in Modern Group Analysis, Cyprus

Prof. R. T. Serasinghe, University of Ruhuna  
7<sup>th</sup> World Buffalo Congress, Philippines

Dr. K. Mendis, University of Kelaniya  
17<sup>th</sup> World Conference of Family Doctors, USA

Dr. S. Karunaratne, University of Peradeniya  
12<sup>th</sup> World Congress on Comparative Education, Cuba

Mr. P. A. K. Karunanda, University of Peradeniya  
International Conference on Computational Methods (ICCM 2004), Singapore

Ms. T. N. Pathiraja, University of Colombo  
VIIth ISTERH Conference, Thailand

Ms. R. M. R. Nilanthi, Plant Genetic Resources Centre  
Theoretical and Practical Course "Analysis of Stress Responsive Plant Genes, India

Mr. A. S. P. Manamperi, Water Resources Secretariat  
Inaugural Australasian Hydrogeology Research Conference, Australia

Mr. G. M. Bandaranayake, University of Sri Jayewardenapura  
Annual Conference of Watershed Management, USA

Dr. V. A. Sumanasinghe, University of Peradeniya  
World Rice Research Conference 2004, Japan

Dr. U. S. Perera, Ministry of Health  
14<sup>th</sup> World Congress of the International Society for the Study of Hypertension in Pregnancy, Austria

Dr. P. P. M. Jayaweera, University of Ruhuna  
International Conference on Computational Modelling, China

Dr. S. J. De Silva Hewavisenthi, University of Kelaniya  
14<sup>th</sup> Biennial Conference on the Asian-Pacific Association for the Study of the Liver, India

Dr. A. Anandacoomaraswamy, TRI  
American Society of Agronomy Annual Sessions 2004, USA

Dr. T. S. V. De Zoysa, Open University of Sri Lanka  
18<sup>th</sup> Asian Association of Open Universities Annual Conference (AAOU), China

Dr. J.D.S. Dela, Visiting Academic, Open University of Sri Lanka  
XX Congress of the International Primatological Society, Italy

Mrs. W. Seneviratne, University of Colombo  
World Library and Information Congress : 70<sup>th</sup> IFLA General Conference, Argentina

Dr. (Mrs.) S.K. Gunathilaka, University of Peradeniya  
Sixth International summer Symposium, Japan

Dr. (Miss) S. Sri Ranganathan, University of Colombo  
8<sup>th</sup> world Congress on Clinical Pharmacology & Therapeutics, Australia

Dr. G.R.W. Godakumbura, National Hospital of Sri Lanka  
The 12<sup>th</sup> Congress of the International Society for Burn Injuries, Japan

Dr J. J. Wijetunga, University of Peradeniya  
29th International Conference on Coastal Engineering, Portugal

Ms. M. H. S. Ariyaratne, NARA  
6<sup>th</sup> International symposium on Tilapia in Aquaculture, Philippines

Dr. S. D. Wanniarachchi, University of Ruhuna  
Eurosoil 2004, Germany

Dr N. S. Dolage, University of Sri Jayewardenepura  
15<sup>th</sup> International Congress on Child Abuse and Neglect, Australia

Dr A. J. Thisairajah, Eastern University  
Coastal Zone Asia Pacific Conference, Australia

Dr L. M. Hettihewa, University of Ruhuna  
World Conference on dosing of anti-infectives, Germany

Dr W. M. W. Weerakoon, Rice Research & Development Institute  
International Symposium on Food Production & Environmental Conservation, Japan

Dr Indrika Rajapaksha, University of Moratuwa  
21<sup>st</sup> Conference on Passive & Low energy Architecture, The Netherlands

Dr C. Gomes, University of Colombo  
International Conference on Lightning Protection, France

Dr M. D. Amarasinghe, University of Kelaniya  
World Conference on Environmental Management, Malaysia

Dr L. M. K. Tillekeratne, Rubber Research Institute  
International Rubber Research & Development Annual Meeting & Conference, China

Dr Neluka Fernando, University of Sri Jayewardenepura  
European Helicobacter study Group XVII International Workshop, Austria

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## Ceramics – far beyond traditional approach

With the dawn of technological era, scientists and researchers shed their untiring efforts to nurture the world with timely needed scientific advances. In this sense the role played by the material scientists are praiseworthy. Without restricting the word ceramic to pottery and chinaware, it now finds many more applications in wide spectrum of industrial uses thanks to them.

As such the time is up for all of us to think little beyond on this hidden but advanced area of ceramic. Partaking with the advanced countries in this context would no doubt enable us to touch the areas where we could actively engaged.

Deriving from the Greek term “*keramos*” meaning “a potter” or “pottery”, ceramics can be defined scientifically as inorganic, non-metallic materials in crystalline nature. Ceramic materials are inorganic and non-metallic. Usually they are shaped from the “green body” at room temperature and acquire their typical properties during a sintering process at high temperatures. New processes and advances in forming and manufacturing techniques introduced in recent years have led to the development of advanced ceramics possessing unique and amazingly powerful physical, thermal and electrical properties. These excellent properties make them highly resistant to melting, bending, stretching, corrosion. Further the hardness, physical stability, extreme heat resistance, chemical inertness, biocompatibility etc have opened up the whole new world of development opportunities for manufacturers in a wide range of industries. It is reported that around 90% of ceramics are hidden in hidden industrial applications inclusive of automotives, information technology, electronics, biomaterials, refractories, whitewares and structural materials.

Electronics ceramics is the most advanced and emerging field where the materials used are characterized by the oxides of many more inorganic materials having extraordinary physical and chemical properties. Insulating, semi conducting, metallic, super conducting, sensing, electro optics etc, are kind of such properties that could find many potential applications in the electronics industry. Variety of products including computer chips, CD players, Ultrasonic cleaners, Digital cameras, sensors etc, have been derived from electro ceramic materials such as  $\text{BaTiO}_3$ ,  $\text{ZrO}_2$ ,  $\text{PbTiO}_3$ ,  $\text{Mn}_3\text{O}_4$  etc.

Another outstanding application in ceramics is its use as biomaterials in the field of medical applications like artificial bone, dental implants, joint prostheses, drug

delivery, cancer treatments and bioresistant coatings. Zirconia ceramics obtain from naturally occurring ores though contain trace amounts of radioactive elements of the actinide series is a valuable implant material.

Further the scientists started clinical trials to assess the viability of ceramic on metal artificial hips, which will be available for patients with in five years.

Many thousands of engineering components have benefited from advanced ceramic solutions for wear, corrosion and thermal resistance, providing considerable lifetime increases over conventional metal components. Typical components include wear plates



and thermal barriers, bearings for high speed and high stiffness spindles, bushes, gears and many others. Dynamic-Ceramic can now provide hundreds of case histories on the successful and cost effective application of advanced ceramic solutions in mechanical engineering applications.

*Fig.1 Alumina and Zirconia for implantable medical device manufacturing*

Advanced ceramic composite materials still need to develop to the point at which industry will assume the full risk of final commercialization. There are many challenges for getting these materials into commercial use: long-term stability of the advanced ceramics in the applications' environments, component cost, consistent material properties/reproducibility, development of codes and standards, and collection of long-term data and material properties.

In order to keep our industrialists, academia and scientists abreast with these new developments in the electronics industry Technology Watch Center of the National Science Foundation (NSF) has conducted a seminar on Electronics ceramics on 06<sup>th</sup> January 2005 at the NSF auditorium with more than fifty participants. Dr.Vasantha Amarakoon, Director NYS center for advanced Ceramic Technology (CACT) addressed the gathering sharing his enormous experience in this field for more than twenty years.

Formulating an informal forum with all interested groups to discuss industry problems is a major outcome of that workshop.

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## SCIENCE AND TECHNOLOGY MANAGEMENT INFORMATION SYSTEM

(STMIS)



Science and Technology Management Information System (STMIS) is a computerized information system developed by the National Science Foundation (NSF) of Sri Lanka with a view to provide information on the S&T sector of the country to the stakeholders of the NSF.

### Objectives

- ★ Bring Planners, Policy makers, Industry sectors, S&T Institutions and R&D centers as much closer as a working network and creates new partnership to facilitate problem solving and decision making for industrial competitiveness.
- ★ Share and exchange information among stakeholders with respect to capabilities of institutions and individuals.
- ★ Collect data and monitor the demand and supply of S & T personnel on a regular basis and provide such information to relevant policy makers.
- ★ Develop indicators for evaluation of the S&T sector.
- ★ Analyze and highlight the strengths, weaknesses and trends of S&T sector (with

special reference to manpower) to facilitate decision-making process of policy makers and planners.

[www.mis.nsf.ac.lk](http://www.mis.nsf.ac.lk)

STMIS is a computerized information system on S&T which aims at collecting, storing and disseminating information pertaining to the S&T sector with particular reference to S&T manpower. Further, it collects stores and disseminates information relating to R&D expenditure, S&T organizations, S&T graduates, S&T resources, etc.

### Potential users

Policy makers, Planners, Researchers, Academics, Scientists & Technologists, S & T Institutions, S&T funding organizations, University students as well as international organizations in the field of S&T.

### About STMIS

This page gives the genesis, activities and the role of STMIS in facilitating S&T policy planning in the Country.

### STMIS Database

Provides online facilities to enter and update the information on individuals, organizations, etc., related to S& T sector. It also provides user friendly search facilities for easy and quick access to the following search parameters.

- ★ Scientists in Sri Lanka including their disciplines, area of expertise, qualifications, consultancies, research conducted, etc.
- ★ S&T institutions in Sri Lanka including the research conducted, special technologies developed, special and rare equipment available, training programmes available, services offered, etc.

(To facilitate online data entry, user may have to obtain a 'user name' and 'password' to register)

## Research

Provides summarized information on research carried out in the area of S&T policy by the NSF.

- ★ Tracer study of S&T graduate
- ★ National survey of Research & Development
- ★ Tracer study of S&T postgraduates
- ★ Case studies

## Benefits to the Scientist

- ★ Make it easy to find the “Experts, Services, and Technologies” exist in the country.
- ★ Introduce you and your work to interested parties and widens your field of research.
- ★ It will link you to industrial and other organizations that need your service.
- ★ In future, NSF will use this system to select scientists as resource persons for various research programmes, conferences, workshops, committees, training programmes ...etc.

## Benefits to the institutions

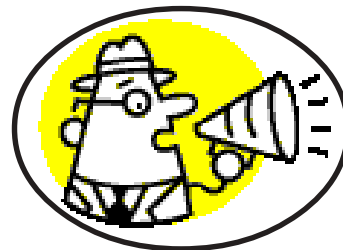
- ★ Make it possible for institutions to publish their S&T capabilities and facilities through a central system.
- ★ Make it quick and easy for you to find the specific services, technologies, and experts that you require in your organization (e.g. workshops, seminars ...etc).
- ★ Help stakeholders to choose and make appropriate contacts with your institution or individuals for utilization of institutional capabilities for their requirements.



Users may log on to [www.mis.nsf.ac.lk](http://www.mis.nsf.ac.lk) for the latest information on S&T resources in the country or write to :

Head/Science & Technology Policy Research Division,  
National Science Foundation,  
47/5, Maitland Place,  
Colombo 7,  
E-mail: [stmis@nsf.ac.lk](mailto:stmis@nsf.ac.lk)  
Tele/Fax: 011- 2675841

### Attention !



Please get yourself registered in this database. In the future, the

NSF would require your registration number, to proceed with the processing of your Research/Travel grant applications. Therefore, it is to your advantage that you register yourself in this database, to avoid any unnecessary delays.

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## Visit of Foreign Experts



Prof. Adam Holbrook, Associate Director and Adjunct Professor, Centre for Policy Research on Science and Technology, Simon Fraser University, Vancouver, Canada visited the NSF as a Consultant to the Science and Technology Management Information System (STMIS) database established at the S&T Policy Research Division (STPRD). His visit was funded by the Science and Technology Personnel Development Project of the Asian Development Bank.

During his stay from 20 December 2004 to 15 January 2005, Prof. Holbrook evaluated the STMIS database and had several discussions with the staff of the STPRD to improve and maintain the same. He also met with the Minister of Science and Technology, Hon (Prof.) Tissa Vitarana and several other stakeholders. Prof. Holbrook was the key resource person of the workshop on "Measurement of innovation and human capital using science and technology indicators" organized by the STPRD, which was held on the 12<sup>th</sup> January 2005 at the NSF. Dr. Seetha Wickremasinghe, Head/STPRD also made a presentation on the STMIS database at this workshop.

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## Staff Update

Dr R.M.W. Amaradasa has completed his PhD from Faculty of Commerce, University of Wollongong , Australia in Nov 2004. Title of the Thesis is **Role of public policy in linking universities and research institutes with industries in Sri Lanka**

### Resignation

Mr Rohan Pathirage, Scientific Officer / Statistical Analyst of the Science and Technology Policy Research Division (STPRD), resigned from the NSF with effect from 31 December 2004. He had served the NSF for a period of five years and during this period, he obtained a MSc (Statistics) degree with financial support from the NSF. We appreciate his service to the NSF and wish him good luck!

### Journal of the National Science Foundation

#### Call for Papers

Manuscripts are accepted on the understanding that they will be reviewed prior to acceptance and that they have not been submitted for publication elsewhere. Papers may be subjected to editorial revision in order to improve presentation. The authors should consult a recent issue of the journal in order to familiarize themselves with the conventions and layout of articles. The decision of the Editorial Board on publication is final.

Twenty reprints will be supplied free of charge to the authors.

**Contact:** The Editorial Office, Journal of the National Science Foundation of Sri Lanka  
National Science Foundation, 47/5, Maitland Place, Colombo - 7  
Phone - 011 2696771-3, Fax - 011 2694754,  
E-mail - [jnsf@nsf.ac.lk](mailto:jnsf@nsf.ac.lk), Web - [www.nsf.ac.lk](http://www.nsf.ac.lk)

## WAYS: future generations of scientists build global community

The World Academy of Young Scientists (WAYS), the permanent global network of young researchers, aims at empowering young excelling scientists both in the North and the South. It is dedicated to provide opportunities for the young generation of researchers to actively participate in today's' and tomorrow's knowledge – based societies.

WAYS, supported by UNESCO, ISESCO, and the TWAS held its 1<sup>st</sup> General Conference in Marrakech, Morocco from 11 – 13 December 2004. The event was organized - under the high patronage of His Majesty Mohammed VI, King of Morocco and was attended by more than 120 talented and motivated young scientists from all over the world, representing about 70 countries and national/international organizations, and by leading scientists, policy makers, and representatives of major international institutions and non-governmental organizations. Ms. Asha Pitadeniya, Scientific Officer, National Science Foundation attended the conference in Marrakech.

The event provided an excellent opportunity to discuss major S&T issues, in particular the situation and role of young researchers with regard to the profound changes in the scientific environment. Themes such as; New knowledge-based professions and training requirements, Science education worldwide, Employment and funding opportunities, Career development of young scientists, Communicating and sharing scientific knowledge drew much attention.

Some of the points made were :

- ♣ Science and Technology are the two of the most potent forces for individual, societal and global change in the contemporary era. Thus, understanding the natures, causes and social consequences of scientific and technological developments, how S & T function in different societies , and how social forces attempt to shape and control decisions that serve diverse, often conflicting interests is crucial.
- ♣ There is a need for a lively discovery of the concrete world and of the scientific method in the classrooms. The scientific community should participate in renovation of science education in schools helping teachers to renovate their way of teaching science *via* observation, inquiry and experimentation.
- ♣ Although science as a subject has been developed immersively in the recent past there is no real improvement with regard to formal status of scientists and there are only limited changes in the way young scientists are trained and educated. We still lack clear career development strategies for students striving for a research career. Now it is high time we revise our perception of science and accept 'science as a true profession'.
- ♣ The challenge to the universities is to ensure; that education and research are tightly linked, curricular are based on problem based learning, faculties do not hinder the development of multidisciplinary approaches, provide opportunities for young researchers to get international experience and ensure that young researchers get training in writing scientific papers and grant application.
- ♣ The young scientists must be innovative and challenge conventional wisdom while being brave enough to move into new areas and address new challenges.
- ♣ Science communication plays a critical role for any country to participate in the global knowledge economy. It is important that the results of research as well as its likely impacts are adequately communicated. This will enable the communities to use science based products for their own social and economic development.
- ♣ While the business sector is responsible for turning scientific knowledge to a new product the scientists have a responsibility, through their knowledge and insight to facilitate the process, and also ensure that practice of science becomes more transparent and accessible.
- ♣ During the last decade interdisciplinary approaches to basic science had been placed at the centre of S & T policy decisions, thus making a transition from discipline based to problem – driven research possible. Solving global problems such as fuel crises requires the association of various scientific disciplines and their close interaction. The centre of gravities of the separate disciplines are found in the interdisciplinary composites, which do not lay any more in the combination of object and methodology of the separate components, but in their general complex subject, a problem which the given scientific composite is required to solve.
- ♣ The commitment of all the social actors involved in scientific-technological derived problems is a major step to start a real public dialogue in the very controversial issues of our time. The resolution of dilemmas such as the use of GMOs versus the search for food safety, or the unlimited human activities versus the need to preserve the environment is a challenge for the ongoing century.
- ♣ From research to policy: the scientists have a major role in improving the quality of political decision making too.

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## **Sri Lanka's Participation at the 18<sup>th</sup> Session of the International Coordinating Council of the Man and Biosphere (MAB) Programme of UNESCO**

Sri Lanka, as a newly elected council member, participated at the 18<sup>th</sup> Session of the MAB-ICC held in Paris from 24 to 28 October, 2004. Mr L.C.A.de S. Wijesinghe, Chairman of the National Man and the Biosphere Committee and Ms Anusha Amarasinghe, Director Scientific Affairs of the National Science Foundation who acts as the Secretary to the National Committee formed the Sri Lankan delegation. Ms. Saroja Perera, First Secretary, Sri Lanka's Permanent Delegation to UNESCO, occasionally participated in the meeting, and the Sri Lanka Ambassador, Mr Ananda Gunasekera, spent a short time during the session on day four.

Mr Gonzalo Halfter of Morocco was elected Chairman of the Council, and from that point on he continued to preside over the meeting. The Republic of Korea was elected to one of the five posts of Vice Chairman, to represent the Asian region. Dr N. Ishwaran, as appointed to the post of Director, Division of Ecological Sciences, in which capacity he also serves as Secretary of MAB, reported to the Council on the programme and activities of MAB since the 17<sup>th</sup> Session and continued to take an active part in the proceedings of the present Session. Sri Lanka was among 15 of the council member countries that presented reports on major activities carried out since the 17<sup>th</sup> Session held in 2002. Besides submitting a written report, Sri Lankan Delegation made an oral presentation. Nine countries with Observer status also made presentations, and India was among them. India was reported to have three Biosphere Reserves (a fourth was added during the current Session), and, interestingly, the Gulf of Mannar is one of these.

### **A concise text of the presentation made by the Sri Lankan delegation at the ICC is as follows:**

The National Committee continues to function under the aegis of the National Science Foundation, which houses the secretariat and provides the financial resources for the programme. During the biennium 2002-2004, the Committee was able to carry through a satisfactory programme of work despite the limitations of financial and human resources for MAB activities.

Sri Lanka has two biosphere reserves within the World Network of Biosphere Reserves (WNBR); these are the Sinharaja Biosphere Reserve in the wet zone and the Hurulu Biosphere Reserve in the seasonally dry area. In accordance with the requirement of periodic independent reviews to be carried out on biosphere reserves, a comprehensive review of the Sinharaja reserve was carried out in 2003. The study revealed that the reserve continued to be managed in line with the WNBR objectives. Several recommendations were made for further strengthening the participatory management activities. Among the recommendations that have been made, the following may be highlighted.

- Extending the participatory management model to new areas in the southern buffer zone;
- The regular evaluation of the participatory management process with the possible creation of an award scheme for community based organizations which contribute significantly to forest management and increase their entrepreneurial development;
- Disseminating the results of pilot studies;
- Focusing on ecotourism;
- Developing a better understanding between researchers and the Biosphere Reserve staff.

34 areas have been identified, representing also, for the first time, wildlife reserves and coastal and marine ecosystems, for designation as **National MAB Reserves**. The departments concerned will be taking action to accord these reserves the appropriate status and to prepare and implement management plans in accordance with biosphere reserve objectives.

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The MAB National Committee took steps to put up three areas for inclusion under the world network of biosphere reserves. These are the **Kanneliya Dediyaagala Nakiadeniya (KDN)** forest complex, the **Bundala National Park** and the **Knuckles Forest Reserve**. Each of these areas is unique in its own way and was considered suitable for nomination.

The KDN complex is a biodiversity rich lowland rainforest with a record of over 50 percent of the tree species being endemic. It is ringed by villages, and there is considerable scope for community participation in conservation and sustainable use (of non timber products) activities. The Knuckles forest contains a wide range of ecosystems, including montane ecosystems. It also is the refuge of a large number of endemic fauna and flora. The Bundala National Park is notable for the vast number of bird species, resident and migrant, found in the area, and its coastal sections are the breeding ground for five species of turtles. It is a wetland site declared under the Ramsar Convention.

The field studies and the preparation of documentation needed for the three nominations were carried out and nominations submitted for consideration by the Advisory Committee of UNESCO. One of these proposals (the KDN forest complex) has been recommended for inclusion in the WNBR at the 18<sup>th</sup> session of the ICC. As for the Knuckles Forest Reserve, the nomination papers may have to be revised with the inclusion of more data. The nomination of the Bundala National Park as a Biosphere Reserve will be examined by the Advisory Committee when it next meets.

The MAB National Committee has been requested to nominate the Adam's Peak Sanctuary and the adjoining contiguous natural forest areas as a World Heritage Site with both natural and cultural heritage values. The necessary studies and field activities needed to support the nomination will be started shortly.

The National Science Foundation, in collaboration with the MAB National Committee, organized a South and Central Asian MAB Meeting on Environmental Conservation, Management and Research, in October 2002. The aim of the 2002 meeting was to promote exchange of information and experience among National MAB Committees and Biosphere Reserves Managers/Experts in order to enhance environmental conservation, management and research in the context of Biosphere Reserves and similarly managed areas. This meeting also marked the startup of the South and Central Asian MAB Network (**SACAM**). The first volume of the SACAM Newsletter was published by the National Science Foundation in collaboration with the National MAB Committee in 2003.

Sri Lanka participated in the SACAM network meeting of experts held in the Republic of Iran in September 2004. The subject of the meeting was Sustainable Ecotourism in Biosphere Reserves and similarly managed areas. The subject is most appropriate for Sri Lanka as well as for the rest of the region where ecotourism is gaining momentum and there is a pressing need to address the issue of sustainable management of this activity.

The year 2002 was declared as the International Year of Ecotourism by the UN. Appropriately, in the SACAM meeting that followed, Ecotourism was taken as the theme. Ecotourism is a growing industry in that part of the world and it has considerable scope for contributing towards achieving the objectives set for the management of biosphere reserves. At the same time, there are potential dangers in unbridled expansion and inexpert handling of this activity. These considerations were at the centre of the deliberations at the meeting and are reflected in the outcome.

Recognizing the complex nature of ecotourism and the need for further studies, Iran has offered to set up a Regional Centre for Ecotourism Studies. The meeting endorsed this suggestion in principle and has requested Iran to send a draft proposal to the member states for their consideration.

Focusing further on ecotourism, each member state was requested to nominate at least one biosphere reserve or similarly managed area for implementation of sustainable ecotourism and to share experiences with other member states.

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The meeting proposed that the SACAM takes Rehabilitation and Restoration of Degraded Habitats and other related topics as the theme for the next meeting. It has been recommended that Bangladesh explores the possibility of holding the next SACAM meeting, in 2006.

Research projects carried out under the MAB programme, with financial support from the National Science Foundation, focused mainly on matters related to the subject of biodiversity. This is understandable since (a) Sri Lanka is noted for its very high level of biodiversity and of endemism among the fauna and flora, (b) the fragmentation of the forests and other ecosystems pose a threat to the survival of the native fauna and flora, and (c) there are significant gaps in our knowledge of the ecology and survival of the indigenous biota. These research activities were carried out by scientists from the universities.

The following research projects were in operation or were concluded during the period under review:

- Diversity, abundance, and richness of canopy arthropods in the Knuckles range and their spatial and temporal distribution related to canopy structure
- Performance of selected forest species providing non- timber forest products in the Sinharaja World Heritage Site
- Exploitation levels of indigenous aquatic plants and fish in Sri Lanka.

On the recommendation of the MAB National Committee, the National Science Foundation has called for expressions of interest from scientists who would like to work on projects related to promoting the broad objective of MAB, which is "Developing the basis, within the natural and social sciences, for the sustainable use and conservation of biodiversity and for the improvement of the relationship between people and their environment, globally".

In developing the programme, the National Committee will take into account the need for putting into practice activities directed towards the proper management of the biosphere reserves and the national MAB reserves for promoting the biosphere reserve objectives. Matters related to the nomination of sites as biosphere reserves and World Heritage Sites will be given due consideration.

There is a great deal of similarity in the MAB related activities between Sri Lanka and the other countries of the region. For example, many of these activities are centered round tropical rain forest ecosystems. Sharing information on research activities as well as on sustainable use initiatives, community based management practices, and educational and awareness activities would mutually benefit the national programmes within the region. Also, since Sri Lanka is now widely recognized as a biodiversity hotspot, the information on the conservation and sustainable use of the country's biodiversity that could be provided through a MAB Website would be of interest globally.

With these objectives in view, and to give greater visibility to Sri Lanka's MAB programme both within and outside the country, the MAB National Committee, in collaboration with the National Science Foundation, the Forest Department, the Department of Wildlife Conservation, and other partner organizations is taking steps to set up a Website for MAB Sri Lanka.

Medicinal plants form an important component of Sri Lanka's biodiversity and they are the basis of the ayurvedic system of medicine practised in the country. The five volumes of Medicinal Plants of Sri Lanka by D M A Jayaweera published by the predecessor to the National Science Foundation in the 1980s is much in demand but copies are no longer available for sale. The MAB National Committee is taking action to revise the nomenclature and taxonomic position of the plants wherever necessary and reprint the five volumes.

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National MAB Committee envisages holding a Golden Jubilee International Conference in Sri Lanka in 2006 on selected topics to mark the event.

On the subject of **Capacity Building and Training**, the Sri Lanka delegation stressed the importance of developing new initiatives particularly focusing on the scientific, educational and training aspects of the biological sciences in relation to biodiversity conservation and protected area management. Sri Lanka considers capacity building and training to be areas of utmost importance in pursuing the objectives of conservation and sustainable development. This applies particularly to the less developed countries wherein the bulk of the world's biological diversity lies. There is a need to produce training materials and course contents for training activities. Training manuals for teachers, along with power point presentations in the local languages, are useful tools. The delegation mentioned the possibilities of establishing partnerships with international organizations such as IUCN's Commission on Education and Communication.

The Sri Lankan delegation congratulated the MAB secretariat on the implementation of the **Young Scientists Awards** scheme. There was an interesting discussion on the **Awards Scheme for Young Scientists**. In the Sri Lankan statement, two points were highlighted (1) the need to raise the age of "young scientists" who are eligible to apply; and (2) to delete the obligation that the research should be done in biosphere reserves or "similarly managed areas". The first is the 35-year age limit. 35 year age limit seems alright in terms of the developed countries. Here a student graduates in the very early 20s, and within a few years takes his postgraduate degree. In the less developed countries, university education is often interrupted, sometimes for years. Then, after graduation they have to seek employment and remain in the job for some years before managing to secure a scholarship or other financial support to enable him to enlist for a postgraduate degree. At the time they acquire their postgraduate degree or soon afterwards they would be disqualified from applying for an award because of the prescribed age limit. If good quality research is required from the less developed countries the delegation urged the UNESCO to raise the age limit for applicants. The delegation also requested UNESCO to reconsider the proposal to limit the number of applications to one per country, and keep it to at least two. Second is the condition when calling for applications that the proposed research project should be located. The researchers are forced to gravitate towards the single biosphere in our wet zone, an area of the country where research interest in biodiversity is greatest. Many of the habitats rich in biodiversity, which would form ideal field laboratories for research on conservation and sustainable use of biodiversity, do not fall into the category of "similarly managed areas". What is important is, whether the research is consonant with the MAB objectives.

The Sri Lankan Delegation supported the proposal to establish a scheme to give non-financial awards, such as MAB medals, certificates, etc. to scientists who, through their work, have contributed significantly to the achievement of the MAB mission.

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Coordinator

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Colombo 7,

Sri Lanka. Sri Lanka.

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Tele/Fax : +94112675841 :

**Benefits to the institutions** **Benefits to the Scientist\*** Case studies **Research** (To facilitate online data entry, user may have to obtain a 'user name' and 'password' to register) This page gives the genesis, activities and the role of STMIS in facilitating S&T policy planning in the Country.

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## Staff Update

Dr R.M.W. Amaradasa has completed his PhD from Faculty of Commerce, University of Wollongong , Australia in Nov 2004. Title of the Thesis is **Role of public policy in linking universities and research institutes with industries in Sri Lanka**

### Resignation

Mr Rohan Pathirage, Scientific Officer / Statistical Analyst of the Science and Technology Policy Research Division (STPRD), resigned from the NSF with effect from 31 December 2004. He had served the NSF for a period of five years and during this period, he obtained a MSc (Statistics) degree with financial support from the NSF. We appreciate his service to the NSF and wish him good luck!



## Journal of the National Science Foundation

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Some factors influencing infectivity of the human malaria parasite *Plasmodium vivax* (Haemosporidia: Plasmodidae) to the mosquito vector *Anopheles tessellatus* (Diptera: Culicidae)

M.S. Ramasamy, K.A. Srikrishnaraj, S.A.V. Moorthy, S. Jayaweera and R. Ramasamy

DNA fingerprints of the Asian elephant in Sri Lanka, *Elephas maximus maximus*, using multilocus probe 33.15 (Jeffreys)

Himesha Vandebona, Maya B. Gunasekera, W.D. Ratnasooriya, Nalin C.W. Goonesekere, D.S. Kodikara and J. Alahakoon

Germination characters and seed reserve mobilization during germination of different wheat genotypes under variable temperature regimes

M. A. Hasan, J. U. Ahmed, T. Hossain, M. M. Hossain and M. A. Ullah

#### *Short Communication*

Oviposition rates, larval and pupal survival rates of *Culex quinquefasciatus* in different plant leaf infusions

K. Manoranjani and M. Dharmaretnam

Amperometric method for the determination of propanil in a simulated rice field environment

N. Priyantha, A. Navaratne, D.A. Jayawickrama and U.S.K. Welivegamage

Repellency and toxicity of four essential oils to *Sitophilus oryzae* L. (Coleoptera: Curculionidae) P.A.

Paranagama, K.H.T. Abeysekera, L. Nugaliyadde and K.P. Abeywickrama

Ferrofluid lubrication of a slider bearing with a circular convex pad

Rajesh C. Shah and M. V. Bhat

Influence of *El Niño/La Niña* episodes on the rainfall regime of the DL<sub>1</sub> region of the North Central Province of Sri Lanka

B.V. R. Punyawardena, R. P. de Silva and S. Nijananthy

Author Index

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WAYS, supported by UNESCO, ISESCO, and the TWAS held its 1<sup>st</sup> General Conference in Marrakech, Morocco from 11 – 13 December 2004. The event was organized - under the high patronage of His Majesty Mohammed VI, King of Morocco and was attended by more than 120 talented and motivated young scientists from all over the world, representing about 70 countries and national/international organizations, and by leading scientists, policy makers, and representatives of major international institutions and non-governmental organizations. Ms. Asha Pitadeniya, Scientific Officer, National Science Foundation attended the conference in Marrakech.

The event provided an excellent opportunity to discuss major S&T issues, in particular the situation and role of young researchers with regard to the profound changes in the scientific environment. Themes such as; New knowledge-based professions and training requirements, Science education worldwide, Employment and funding opportunities, Career development of young scientists, Communicating and sharing scientific knowledge drew much attention.

Some of the points made were :

Science and Technology are the two of the most potent forces for individual, societal and global change in the contemporary era. Thus, understanding the natures, causes and social consequences of scientific and technological developments, how S & T function in different societies , and how social forces attempt to shape and control decisions that serve diverse, often conflicting interests is crucial.

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- Although science as a subject has been developed immersively in the recent past there is no real improvement with regard to formal status of scientists and there are only limited changes in the way young scientists are trained and educated. We still lack clear career development strategies for students striving for a research career. Now it is high time we revise our perception of science and accept 'science as a true profession'.
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- While the business sector is responsible for turning scientific knowledge to a new product the scientists have a responsibility, through their knowledge and insight to facilitate the process, and also ensure that practice of science becomes more transparent and accessible.
- During the last decade interdisciplinary approaches to basic science had been placed at the centre of S & T policy decisions, thus making a transition from discipline based to problem – driven research possible. Solving global problems such as fuel crises requires the association of various scientific disciplines and their close interaction. The centre of gravities of the separate disciplines are found in the interdisciplinary composites, which do not lay any more in the combination of object and methodology of the separate components, but in their general complex subject, a problem which the given scientific composite is required to solve.
- The commitment of all the social actors involved in scientific-technological derived problems is a major step to start a real public dialogue in the very controversial issues of our time. The resolution of dilemmas such as the use of GMOs versus the search for food safety, or the unlimited human activities versus the need to preserve the environment is a challenge for the ongoing century.
- From research to policy: the scientists have a major role in improving the quality of political decision making too.

## Staff Update

### Postgraduate studies

Mrs. Seetha I Wickremasinghe, Senior Scientific Officer completed her Ph.D degree in Science Policy in September 2004. Her split Ph.D programme was carried out at the Centre for Studies in Science Policy, Jawaharlal Nehru University, New Delhi, India. The title of the Ph.D. Thesis : National agricultural research systems in India and Sri Lanka: a study of organization, scientific communities and their contribution to rice research”

Dr. (Ms) Wickremasinghe is the Coordinator of the Science Policy Research Division of the NSF.

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### **Research grants awarded**

Biotechnology

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## **NSF Travel Grants**

Ms. R. P. Hewawasam, University of Ruhuna

Second Global Summit on Medicinal and Aromatic Plants, India

Dr. A. G. Johnpillai, Eastern University

10<sup>th</sup> International Conference in Modern Group Analysis, Cyprus

Prof. R. T. Serasinghe, University of Ruhuna

7<sup>th</sup> World Buffalo Congress, Philippines

Dr. K. Mendis, University of Kelaniya

## **Tsunami Preparedness**

### **WORKSHOP PROCEEDINGS**

A massive earthquake registering 9 on the Richter scale occurred off the Island of Sumatra in Indonesia on 26<sup>th</sup> December 2004. Prior to the Tsunami disaster, there was global recognition that the Indian Ocean was free of Tsunami. It was pointed out in Thailand although there was an effective Early Warning System installed on the Pacific Ocean side, there was no such device for the Indian Ocean side, because it was not considered a disaster-prone area. The Earthquake was the result of the interactions between the Indian, Burmese, Australian and the Sunda tectonic plates. It was postulated that a 1000-kilometer of seabed was affected through the effects of the earthquake. The earthquake resulted in the upward movement of the sea floor, which affected the sea surface, and waves similar to those observed when a pebble is dropped into a pond were generated. These waves then propagated across the Indian Ocean causing severe damage to many countries including Sri Lanka. The travel time of the Tsunami to Sri Lanka ranged from 2-3 hours. There is evidence that the effects of the Tsunami have been recorded as far away as the Antarctica, west coast of the United States of America and Mexico. In Sri Lanka a maximum height of 2.64 meters was reached in Colombo (Mutwal harbour) where the only tide gauge in Sri Lanka is located. There are reports of water levels rising more than 12 meters (~ 40 feet) in certain parts of the Island with the maximum incursion of water inland being more than 5 kilometers. This undersea earthquake generated a Tsunami that devastated about two thirds of the coastline in the north, northeast, south and the southwest of Sri Lanka. The waves that were over 40 feet in height when reaching the land resulted in the loss of nearly 40,000 lives, a calamity unprecedented in the recent history of Sri Lanka. This natural disaster also destroyed the entire existing infrastructure such as roads, railways, ports, fisheries harbours, public buildings, homes and tourist hotels.

As a consequence of the above natural disaster, which had a severe impact on the entire country, the Government of Sri Lanka with the close collaboration of all political parties, the private and the public sectors together with the civil society including the NGOs, has launched a massive reconstruction programme to bring normalcy to the affected areas. The influx of foreign assistance in the form of multi-lateral and bi-lateral assistance by way of financial resources, medical aid and manpower are flowing into Sri Lanka.

In the aftermath of this major natural disaster, and as a part of the nation building process, the National Science Foundation, the apex body promoting scientific research in the country organized a Workshop on Tsunami Preparedness on 11<sup>th</sup> January 2005.

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The objectives of the Workshop were to analyze the causes that led to the Tsunami, review the scientific and technological capability needed to prevent or mitigate occurrences of this nature, create public awareness for such natural disasters and to identify relevant R & D needs related to the Tsunami.

Scientists, professionals and heads of institutions that have a responsibility to formulate strategies and act accordingly, to safeguard the country and its citizens from facing similar consequences in the future attended the Workshop. The Workshop was structured around two main technical presentations. The first presentation dealt with the scientific and technical facets of Tsunami and other waves, and the resultant consequences, and the second presentation unfolded the sequences of events that preceded and followed the December 26<sup>th</sup> 2004 Tsunami.

The key objective of the Workshop was to bring in the stakeholders to a common platform to make an audit of the recent events and in particular the events that led to and the impact of the Tsunami wave disaster. The current need was to see how best Sri Lanka could use science and technology to mitigate or prevent a future event of this nature and to see what steps should be taken as regards to science and technology to minimize the consequences of similar occurrences.

The Honorable Minister of Science and Technology Professor Tissa Vitarana said that the recent catastrophic Tsunami has caused untold physical suffering and trauma to fellow citizens in addition to the large number of lives lost. The response of Sri Lankans to this disaster was overwhelming, and all the people rallied around as one nation irrespective of various differences, to bring solace to the suffering masses. This tragedy has brought about a new identity to Sri Lankans that would greatly facilitate solving the country's national problem in the North and East.

The scientists and other professionals should be conscious of the issues emerging after the Tsunami and provide answers to misconceptions that have emerged. For example the people are now refusing to eat fish, and also fear to live near the sea. It is the responsibility of the scientific community to win the confidence of the civil society by disseminating the correct information. The Government has also taken some major decisions on the recommendation of the Urban Development Authority to keep 100 meters of the coastline free of any building construction activities. Between 100 and 300 meters, constructions would be permitted if the sites were three meters above sea level. In this zone therefore construction will be on hillocks or on pillars. Beyond 300 meters there will be planned construction. In any event no buildings including houses within a distance of one kilometer could be constructed without planning permission from UDA. However the consequences of such decisions on the fishing industry, tourism and prawn culture have to be studied and remedial action taken.

Sri Lanka has a claim for a vast ocean economic zone, which is about ninety times its land area. In order to effectively coordinate all scientific research within this large ocean space, it is imperative to have a very effective and integrated institution. To this end it is proposed that a well equipped and well funded National Institute of Oceanography should be established. It is proposed that under the Indo-Sri Lanka Agreement on Scientific and Technical Co-operation, collaborative scientific investigations could be initiated. This in turn will bring maximum benefits to the country. It is the wish that this Workshop will provide wide-ranging

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recommendations to the Government, to ensure that the country would have the necessary scientific and technical capability to meet situations of the type experienced on the 26<sup>th</sup> of December 2004.

It was concluded that Sri Lanka may also be influenced by other oceanic features such as tropical cyclones, and continental shelf waves which though not as severe as a Tsunami, their occurrence may be more frequent. Therefore, a **coordinated effort is required to mitigate the effects of natural disasters** due to oceanic phenomena.

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There is no doubt that Sri Lanka needs to understand what is happening beyond the southern borders of Sri Lanka. **Since plate boundaries are also getting developed, the country is becoming vulnerable to earthquakes. Hence there is a justification to acquire an Early Warning System for Tsunami, and an Advanced Seismic Monitoring System for Earthquakes.**

## **Recommendations of the Workshop**

### **Public Awareness and Preparedness**

1. Create an effective **public awareness and preparedness programme** for the general public on water related disasters such as Tsunami and other ocean phenomena, as well as cyclones, floods and earth tremors. In particular a system to provide factual information is necessary to prevent spread of rumours.
2. Students at primary, secondary and tertiary levels should be educated **on natural disaster preparedness, and the subject be included in the school curriculum.**
3. Educational material such as books, **charts and flyers** describing natural disasters, and procedures to be followed for evacuation should be prepared and distributed to schools and the general public. Popularization of Science Programme of NSF and other similar bodies should take an active role in this.

4. The creation of a Civil Defence Force with appropriate training programmes, including periodic drills for evacuation during natural disasters, should be established in Sri Lanka in coordination with all stakeholders, including civil society and the NGOs.

## **Tsunami Warning System**

5. A Tsunami Early Warning System that includes public preparedness and an effective communication network should be established.
6. The warning system should also encompass all activities related to disasters. Apart from Tsunami and other ocean phenomena, cyclones, storms, landslides, flash floods and seismic activity **over 5 on the Richter scale** should be included in the warning system. With the occurrence of Tsunami being most unlikely for a very long period, emphasis should be on the more frequent storm water related disasters.
7. The facilities for detection of seismic activity at the **GSMB and the Geology Department at University of Peradeniya** should be upgraded and effectively linked, so that real time data could be exchanged and retrieved for dissemination. Such a system should be integrated with the **Global Seismic Network**, and there is no need to set up a broadband data retrieval system in this regard.
8. A long term contingency plan should be drawn up for natural disasters and disaster management, focusing on three areas namely, (a) effectively restoring the livelihoods of the people such as fishing, farming etc. within a minimum period of time, (b) resettlement of people in areas effected by natural disasters, and (c) improving the life saving skills during natural disasters.
9. The establishment of a **National Information Center** related to disaster preparedness and mitigation under the Urban Development Authority (UDA) should be given priority. UDA must be effectively linked with all relevant agencies to facilitate the process.
10. Establish strong linkages with the relevant institutions dealing with natural disasters such as the GSMB, Meteorology Department, Coast Conservation Department, Marine Pollution Prevention Authority, NARA, Sri Lanka Navy, Sri Lanka Air Force, Universities and other relevant specialized agencies, and upgrade the facilities for early warning systems for natural disasters with emphasis on R&D capabilities.

11. Establish linkages and a unifying mechanism (e.g. A National Authority with an operation room unit/facility), among the above institutions so that a **multidisciplinary team could be mobilized for mitigation** of natural disasters in the **shortest period of time**.
12. The **contingency plan** formulated by the Marine Pollution Prevention Authority for detection of oil spills and its mitigation, could be used for guidance in formulating a National Disaster Preparedness Plan.
13. The National Oceanographic Data Center at NARA should be upgraded for collection, storage and dissemination of relevant oceanographic data to relevant local research institutions and international bodies, for study of near and deep ocean phenomena that give rise to natural disasters such as Tsunami and storm surges.

### **Reconstruction and Restoration**

14. Architects, structural engineers and foundation engineers should develop building codes to withstand earthquakes and other disasters such as cyclones and Tsunami as well as other ocean phenomena such as storm surges. It is recognized that an earthquake prone area exists 400 km to 500 km South West of Sri Lanka (Prof. C.B. Dissanayake, *et al*). In this context high rise structures, especially those located in the coastal belt will need careful review.
15. Appropriate legislation should be drafted to enforce effective planning guidelines of the UDA, as well as the relevant codes for building construction and in the use of building materials. ICTAD can facilitate this process. Inputs of sand for reconstruction are significant. This should be evaluated immediately by way of all available alternatives to river sand.
16. Strictly enforce the existing laws in the country, especially those related to coast conservation, environment conservation and building construction.
17. Carry out an in depth study on the damage to the coastline due the Tsunami, and formulate plans for integrated coastal zone management by establishing a mechanism for conflict resolution.
18. Effectively identify the coastal areas by zoning for vulnerability and conservation, while at the same time giving high consideration for fishing, tourism and other forms of recreation, including water sports as well as industry, and designate specific areas for such activities after resolution of conflicts.

19. Introduce an appropriate road reservation on the proposed southern highway from Colombo to Hambantota so that relief efforts during a natural disaster could be carried out without any hindrance.
20. Taking into account the damage caused by the present Tsunami, action should be taken to provide a broad safety zone along the coastline in the East without any human habitation.
21. The recommendations should be **prioritized so as to identify the immediate relief measures** that will promote relief, reconstruction and rehabilitation. To this end the vulnerability of the eastern seaboard at places such as Kalmunai should be studied, and alternate sites for settlements should be identified. The villagers living within the coastal zone should be relocated within a safe distance from the coastline. In such flat terrain such as Oluvil, Saindamarathu, Akkaraipattu, Pothuwil, Yala and other areas, the safe reconstruction distance should be established. The Survey Department has the necessary topographical maps, aerial photographs, and satellite imagery to assist in this work.
22. Government should take immediate action to stop the disposal of rubble and other debris generated from the Tsunami back into the sea, and find alternate disposal sites.
23. With the massive reconstruction programme to be launched by the Government commencing 15<sup>th</sup> January 2005, there will be a dearth of construction materials such as sand stone for aggregate bricks as well as cement. Immediate assessment of such requirements should be initiated and alternate sources such as sea sand as well as innovative construction methods should be identified by civil and materials engineers. A Government Policy is needed in this regard.

## Research and Development

24. The Government should allocate a minimum of one per cent of its GNP for scientific research, focusing on priority areas that include prevention and mitigation of natural disasters.
25. The National Science Foundation (NSF) has instituted a mission orientated research programme commencing in 2005. NSF should give high priority for funding research projects on disaster preparedness and management.
26. Immediate action should be taken to obtain aerial photographs of affected areas before and immediately after the Tsunami, to assess damage to buildings, public utilities and infrastructure such as roads, railway and bridges.

27. Universities should actively pursue research on early warning systems and disasters, and effectively educate the civil society on the need to be vigilant. Scientific investigations in the use of traditional wisdom in disaster mitigation and preparedness should also be undertaken. (It is significant that even in the current calamity, there is evidence of how some traditional communities have escaped the wrath of the Tsunami through traditional wisdom). The civil society requires a mechanism for emergency contacts with relevant authorities.

## **Coordination and International Linkages**

28. Sri Lanka should effectively participate in activities of United Nations agencies and Regional Inter Governmental Organizations that deal with ocean affairs and environment, as well as those associated with natural resources such as UNESCO/IOC, UNEP, UNESCAP, International Maritime Organization (IMO), FAO, SACEP, IUCN, United Nations Office of the Law of the Sea and Ocean Affairs (UNCLOS), International Hydrographic Office (IHO), IOC Indian Ocean, International Meteorological Organization, and IOMAC, and foster research related to ocean, land and atmospheric interface that trigger natural disasters.

29. A National Authority with legislative and executive powers linking existing institutions, should be created to coordinate all phases related to natural disasters and mitigation.

30. Research activities on global phenomena that could trigger natural disasters such as sea level rise, global warming and climate change should be strengthened by establishing strong linkages with the relevant international scientific communities.

31. A National Ocean Commission established for coordination and preparation of implementation plans, should ensure integration and achievement of national research goals.

32. Coordination within the relevant ministries and state institutions involved in scientific studies, data analysis and dissemination of information should be strengthened. The Ministry of Science and Technology should act as the apex body for such activities.

33. In view of the limited financial resources available to the Government, it is imperative that the relevant state organizations and universities should be equipped keeping in mind the priorities to deal with natural disasters. To this end maximum utilization of resources including human resources should be harnessed to achieve the required objectives.

34. A National Ocean Commission with high level representation from all institutions associated with coastal and marine activities should be established to coordinate the preparation of implementation plans, and monitor the progress.

D:\Tsunami\Submission to Vidya-Tsunami Preparedness

## Research grants awarded

Biotechnology

SIDA/2004/BT/05

Production of transgenic rice plants from Sri Lankan rice varieties mediated by *Agrobacterium tumefaciens* gene transfer

Dr. G. A. U. Jayasekera

Dept. of Plant Sciences, University of Colombo

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Traditional Medicine

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VIDYA Vol.7, No. 1, January 2005

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Determination of a National Strategy for Sri Lanka for systematic cultivation of medicinal and aromatic plants

Prof. (Mrs.) Kshanika Hirimburegama, Dept. of Plant sciences, Univ. of Colombo

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Dr. R.O.B. Wijesekera, 16, Kirimandala Mawatha, Nawala

the R&D institutions while S&T institutions (e.g. NASTEC, NSF, CARP, Dept. of Census and Statistics, Dept. of Meteorology) play a supportive role. In the universities, teaching is the main role and the responsibility. The research comes next along with services such as consultancies. In the R&D institutions, research is the main role while consultancies and teaching are additional activities. The supportive S&T institutions such as NSF, CARP etc., play a key role in funding for R&D and many other scientific activities, organizing seminars, workshops etc., training of scientific personnel, publishing scientific material such as research work and other scientific information, maintaining science and technology databases

and so on. All three actors also publish their scientific and/or research work. Therefore, it is important to establish a close network among all three actors to maintain a good research culture. But who is the main or the key source to create this close network? The answer is simple. The key source is none other than the scientific community in the country.

However, there is a growing concern over the issue that the research culture among academics and scientists in the scientific community is diminishing. The reason for this situation, as majority of scientists and academics point out, is the lack of funds for R&D. But is it the main reason for diminishing scientific research culture in the country? Perhaps, the view of the S&T supportive institutions such as funding institutes would be different. The most prevalent issue for them is the lack of good and sound proposals with promising out come that has a direct impact on the socio-economic development in the country. Also, there are reasons related to globalization and the shift of research from a “resource based’ concept to a “knowledge based” concept (not discussed here) that have direct and indirect impact.

The research, on the other hand, is an activity which is complicated because, it could be private and personal, difficult to evaluate and challenging to promote and maintain. Research could also be at individual level, team level within an institute and team level among various institutions such as universities, government departments, R&D institutions, S&T institutions and private sector including industries, which attributes to difficulty in justification and funding.

Therefore, the responsibility of the scientific community is to take initiatives to attract financial support for their research, use their creative ideas, generate and maintain active research programmes in their institutions including frequent scientific discussions, seminars, workshops etc., organizing field visits, camps and tours but not limiting their research only to laboratories. Because the future science depends on attracting outstanding young people to research, not only to attract, but to retain as well.

The responsibility of the leading actors, which are universities and R& D institutions, is that they should promote the attitude of working together among scientists, assign a reasonable amount of workload to academics and scientists allowing them to spare time on research, not make them too busy with administrative commitments and carefully monitor their service commitments.

The responsibility of supportive S&T institutes is to create a friendly and welcoming atmosphere to scientific community, to attract them for submission of good research proposals, to help them publish their good research results, to organize frequent discussions, seminars, workshops on topics that are of interest and relevance to scientific issues, provide data on S&T indicators through maintaining S&T databases, and closely monitor their research work.

But all the issues raised above depend greatly on the proper leadership of the leading and supportive actors identified here. The leadership must show support for research and scholarly activities and encourage publishing and dissemination of research findings while convincing them that publishing of research work is important in recognition as a scientific community. The leadership should not be reluctant to deal firmly with “difficult” colleagues. It should not have a “one size fits all” policy about research. The leadership must convince the scientists that research should be done for the benefit of the user community and the socio-economic development of the country but not merely for their own benefits such as financial gains and promotions in their career.

Therefore, it is incumbent on all scientists, universities, R&D institutes and all administrators of science to help provide a research environment that, through its adherence to high ethical standards and creative productivity, will attract and retain individuals of outstanding intellect and character to one of society’s most important professions. This will easily pave the way to gain a good scientific research culture in the country.

Dr Seetha I. Wickremasinghe

Coordinator

Science and Technology Policy Research Division

National Science Foundation

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3) For inner pages as an advertisement

## SCIENCE AND TECHNOLOGY MANAGEMENT INFORMATION SYSTEM (STMIS)



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Science and Technology Management Information System (STMIS) is a computerized information system developed by the National Science Foundation (NSF) of Sri Lanka with a view to provide information on the S&T sector of the country to the stakeholders of the NSF.

#### Objectives

- Bring Planners, Policy makers, Industry sectors, S&T Institutions and R&D centers as much closer as a working network and creates new partnership to facilitate problem solving and decision making for industrial competitiveness.
- Share and exchange information among stakeholders with respect to capabilities of institutions and individuals.
- Collect data and monitor the demand and supply of S & T personnel on a regular basis and provide such information to relevant policy makers.
- Develop indicators for evaluation of the S&T sector.
- Analyze and highlight the strengths, weaknesses and trends of S&T sector (with special reference to manpower) to facilitate decision-making process of policy makers and planners.

**[www.mis.nsf.ac.lk](http://www.mis.nsf.ac.lk)**

STMIS is a computerized information system on S&T which aims at collecting, storing and disseminating of information pertaining to the S&T sector with particular reference to S&T manpower. Further, it collects

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stores and disseminates information relating to R&D expenditure, S&T organization, S&T graduates, S&T resources, etc.

### **Potential users**

Policy makers, Planners, Researchers, Academics, Scientists & Technologists, S & T Institutions, S&T funding organizations, University students as well as international organizations in the field of S&T.

### **About STMIS**

This page gives the genesis, activities and the role of STMIS in facilitating S&T policy planning in the Country.

### **STMIS Database**

Provides online facilities to enter and update the information on individuals, organizations, etc., related to S&T sector. It also provides user friendly search facilities for easy and quick access to the following search parameters.

- Scientists in Sri Lanka including their disciplines, area of expertise, qualifications, consultancies, research conducted, etc.
- S&T institutions in Sri Lanka including the research conducted, special technologies developed, special and rare equipment available, training programme available, services offered, etc.

(To facilitate online data entry, user may have to obtain a 'user name' and 'password' to register)

### **Research**

Provides summarized information on research carried out in the area of S&T policy by the NSF.

- Tracer study of S&T graduate
- Tracer study of S&T graduates      National survey of Research & Development
- \* National survey of Research & Development Tracer study of S&T postgraduates
- \* Tracer study of S&T postgraduates      Case studies

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## Benefits to the Scientist

- Make it easy to find the “Experts, Services, and Technologies” exist in the country.
- Introduce you and your work to interested parties and widens your field of research.
- It will link you to industrial and other organizations that need your service.
- In future, NSF will use this system to select scientists as resource persons for various research programmes, conferences, workshops, committees, training programmes ...etc.

## Benefits to the institutions

- Make it possible for institutions to publish their S&T capabilities and facilities through a central system.
- Make it quick and easy for you to find the specific services, technologies, and experts that you require in your organization (e.g. workshops, seminars ...etc).
- Help stakeholders to choose and make appropriate contacts with your institution or individuals for utilization of institutional capabilities for their requirements.

Users may log on to [www.mis.nsf.ac.lk](http://www.mis.nsf.ac.lk) for Users may log on to [www.mis.nsf.ac.lk](http://www.mis.nsf.ac.lk) for the latest information on S&T resources in the country or write to:

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**Benefits to the institutions****Benefits to the Scientist\*** Case studies**Research**(To facilitate online data entry, user may have to obtain a ‘user name’ and ‘password’ to register)This page gives the genesis, activities and the role of STMIS in facilitating S&T policy planning in the Country.

## 4)Staff Update

Resignation

Mr Rohan Pathirage, Scientific Officer / Statistical Analyst of the Science and Technology Policy Research Division (STPRD), resigned from the NSF with effect from 31 December 2004. He had served the NSF for a period of five years and during this period, he obtained a MSc (Statistics) degree with financial support from the NSF. We appreciate his service to the NSF and wish him good luck!

Information Technology Unit -

Mr Madhawa Perera

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## Tsunami Preparedness

### WORKSHOP PROCEEDINGS

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The objectives of the Workshop were to analyze the causes that led to the Tsunami, review the scientific and technological capability needed to prevent or mitigate occurrences of this nature, create public awareness for such natural disasters and to identify relevant R & D needs related to the Tsunami.

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The scientists and other professionals should be conscious of the issues emerging after the Tsunami and provide answers to misconceptions that have emerged. For example the people are now refusing to eat fish, and also fear to live near the sea. It is the responsibility of the scientific community to win the confidence of the civil society by disseminating the correct information. The Government has also taken some major decisions on the recommendation of the Urban Development Authority to keep 100 meters of the coastline free of any building construction activities. Between 100 and 300 meters, constructions would be permitted if the sites were three meters above sea level. In this zone therefore construction will be on hillocks or on pillars. Beyond 300 meters there will be planned construction. In any event no buildings including houses within a distance of one kilometer could be constructed without planning permission from UDA. However the consequences of such decisions on the fishing industry, tourism and prawn culture have to be studied and remedial action taken.

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4. The creation of a Civil Defence Force with appropriate training programmes, including periodic drills for evacuation during natural disasters, should be established in Sri Lanka in coordination with all stakeholders, including civil society and the NGOs.

## **Tsunami Warning System**

5. A Tsunami Early Warning System that includes public preparedness and an effective communication network should be established.
6. The warning system should also encompass all activities related to disasters. Apart from Tsunami and other ocean phenomena, cyclones, storms, landslides, flash floods and seismic activity **over 5 on the Richter scale** should be included in the warning system. With the occurrence of Tsunami being most unlikely for a very long period, emphasis should be on the more frequent storm water related disasters.
7. The facilities for detection of seismic activity at the **GSMB and the Geology Department at University of Peradeniya** should be upgraded and effectively linked, so that real time data could be exchanged and retrieved for dissemination. Such a system should be integrated with the **Global Seismic Network**, and there is no need to set up a broadband data retrieval system in this regard.
8. A long term contingency plan should be drawn up for natural disasters and disaster management, focusing on three areas namely, (a) effectively restoring the livelihoods of the people such as fishing, farming etc. within a minimum period of time, (b) resettlement of people in areas effected by natural disasters, and (c) improving the life saving skills during natural disasters.
9. The establishment of a **National Information Center** related to disaster preparedness and mitigation under the Urban Development Authority (UDA) should be given priority. UDA must be effectively linked with all relevant agencies to facilitate the process.
10. Establish strong linkages with the relevant institutions dealing with natural disasters such as the GSMB, Meteorology Department, Coast Conservation Department, Marine Pollution Prevention Authority, NARA, Sri Lanka Navy, Sri Lanka Air Force, Universities and other relevant specialized agencies, and upgrade the facilities for early warning systems for natural disasters with emphasis on R&D capabilities.

11. Establish linkages and a unifying mechanism (e.g. A National Authority with an operation room unit/facility), among the above institutions so that a **multidisciplinary team could be mobilized for mitigation** of natural disasters in the **shortest period of time**.
12. The **contingency plan** formulated by the Marine Pollution Prevention Authority for detection of oil spills and its mitigation, could be used for guidance in formulating a National Disaster Preparedness Plan.
13. The National Oceanographic Data Center at NARA should be upgraded for collection, storage and dissemination of relevant oceanographic data to relevant local research institutions and international bodies, for study of near and deep ocean phenomena that give rise to natural disasters such as Tsunami and storm surges.

### **Reconstruction and Restoration**

14. Architects, structural engineers and foundation engineers should develop building codes to withstand earthquakes and other disasters such as cyclones and Tsunami as well as other ocean phenomena such as storm surges. It is recognized that an earthquake prone area exists 400 km to 500 km South West of Sri Lanka (Prof. C.B. Dissanayake, *et al*). In this context high rise structures, especially those located in the coastal belt will need careful review.
15. Appropriate legislation should be drafted to enforce effective planning guidelines of the UDA, as well as the relevant codes for building construction and in the use of building materials. ICTAD can facilitate this process. Inputs of sand for reconstruction are significant. This should be evaluated immediately by way of all available alternatives to river sand.
16. Strictly enforce the existing laws in the country, especially those related to coast conservation, environment conservation and building construction.
17. Carry out an in depth study on the damage to the coastline due the Tsunami, and formulate plans for integrated coastal zone management by establishing a mechanism for conflict resolution.
18. Effectively identify the coastal areas by zoning for vulnerability and conservation, while at the same time giving high consideration for fishing, tourism and other forms of recreation, including water sports as well as industry, and designate specific areas for such activities after resolution of conflicts.

19. Introduce an appropriate road reservation on the proposed southern highway from Colombo to Hambantota so that relief efforts during a natural disaster could be carried out without any hindrance.
20. Taking into account the damage caused by the present Tsunami, action should be taken to provide a broad safety zone along the coastline in the East without any human habitation.
21. The recommendations should be **prioritized so as to identify the immediate relief measures** that will promote relief, reconstruction and rehabilitation. To this end the vulnerability of the eastern seaboard at places such as Kalmunai should be studied, and alternate sites for settlements should be identified. The villagers living within the coastal zone should be relocated within a safe distance from the coastline. In such flat terrain such as Oluvil, Saindamarathu, Akkaraipattu, Pothuwil, Yala and other areas, the safe reconstruction distance should be established. The Survey Department has the necessary topographical maps, aerial photographs, and satellite imagery to assist in this work.
22. Government should take immediate action to stop the disposal of rubble and other debris generated from the Tsunami back into the sea, and find alternate disposal sites.
23. With the massive reconstruction programme to be launched by the Government commencing 15<sup>th</sup> January 2005, there will be a dearth of construction materials such as sand stone for aggregate bricks as well as cement. Immediate assessment of such requirements should be initiated and alternate sources such as sea sand as well as innovative construction methods should be identified by civil and materials engineers. A Government Policy is needed in this regard.

## Research and Development

24. The Government should allocate a minimum of one per cent of its GNP for scientific research, focusing on priority areas that include prevention and mitigation of natural disasters.
25. The National Science Foundation (NSF) has instituted a mission orientated research programme commencing in 2005. NSF should give high priority for funding research projects on disaster preparedness and management.
26. Immediate action should be taken to obtain aerial photographs of affected areas before and immediately after the Tsunami, to assess damage to buildings, public utilities and infrastructure such as roads, railway and bridges.

27. Universities should actively pursue research on early warning systems and disasters, and effectively educate the civil society on the need to be vigilant. Scientific investigations in the use of traditional wisdom in disaster mitigation and preparedness should also be undertaken. (It is significant that even in the current calamity, there is evidence of how some traditional communities have escaped the wrath of the Tsunami through traditional wisdom). The civil society requires a mechanism for emergency contacts with relevant authorities.

## **Coordination and International Linkages**

28. Sri Lanka should effectively participate in activities of United Nations agencies and Regional Inter Governmental Organizations that deal with ocean affairs and environment, as well as those associated with natural resources such as UNESCO/IOC, UNEP, UNESCAP, International Maritime Organization (IMO), FAO, SACEP, IUCN, United Nations Office of the Law of the Sea and Ocean Affairs (UNCLOS), International Hydrographic Office (IHO), IOC Indian Ocean, International Meteorological Organization, and IOMAC, and foster research related to ocean, land and atmospheric interface that trigger natural disasters.

29. A National Authority with legislative and executive powers linking existing institutions, should be created to coordinate all phases related to natural disasters and mitigation.

30. Research activities on global phenomena that could trigger natural disasters such as sea level rise, global warming and climate change should be strengthened by establishing strong linkages with the relevant international scientific communities.

31. A National Ocean Commission established for coordination and preparation of implementation plans, should ensure integration and achievement of national research goals.

32. Coordination within the relevant ministries and state institutions involved in scientific studies, data analysis and dissemination of information should be strengthened. The Ministry of Science and Technology should act as the apex body for such activities.

33. In view of the limited financial resources available to the Government, it is imperative that the relevant state organizations and universities should be equipped keeping in mind the priorities to deal with natural disasters. To this end maximum utilization of resources including human resources should be harnessed to achieve the required objectives.

34. A National Ocean Commission with high level representation from all institutions associated with coastal and marine activities should be established to coordinate the preparation of implementation plans, and monitor the progress.

