



THE UNIVERSITY OF  
WESTERN AUSTRALIA



## *Training Program in Coastal physical oceanography of Indian Ocean Waters*

Under the auspices of

**The Nippon Foundation—Partnership for Observation of the Global Oceans (POGO)**

in association with

**National Aquatic Resources Research and Development Agency (NARA), Sri Lanka, and  
School of Environmental Systems Engineering, The University of Western Australia**

**Venue: Holiday Inn, Colombo, Sri Lanka**

**Part I – 26 January to 15 February 2006**

**Part II – 5 to 23 June 2006**

**Visiting Professor – Dr. Charitha Pattiaratchi**

### **Final Report**

#### **Overview**

The Nippon Foundation-POGO training program on ‘*Coastal physical oceanography of Indian Ocean waters*’ was held in Colombo, Sri Lanka (at the Holiday Inn, Colombo) from 26<sup>th</sup> January to 15<sup>th</sup> February 2006 (Part I) and from 5 to 23 June 2006 (Part II). A total of 31 and 29 students participated in each part of the course respectively. There was a reduction in the number of local students in Part II due to re-allocation of duties, whilst another student who participated in Part I of the course was selected to undertake training in tsunami modelling (in Belgium) at the same time as Part II of the program. In total, there were 6 international students, 5 from institutions in Sri Lanka outside Colombo, 6 from institutions within Colombo, and 14 from the host institution – the National Aquatic Resources Research and Development Agency (NARA). A list of students is provided as Appendix A.

The Part I of the training consisted of a series of formal lectures in the morning (and some afternoons), hands-on training in the use of MATLAB in the analysis of physical oceanographic data sets and the development of group projects. During Part II of the training the group projects were continued whilst a field training of scientist was undertaken during a residential field camp in Weligama, located ~150 km to the south of Colombo. Here, students were exposed to collection and analysis of data from four different environments: (1) estuary; (2) beach; (3) coastal (Weligama Bay); and, (4) the continental shelf.

## Theory and Practical Sessions

The formal lectures included an Introduction to physical oceanography with an emphasis on continental shelf processes and the Indian Ocean region. The lecture schedule is presented on Appendix B. All students received copies of lectures (which were all presented in MS PowerPoint) on a CD as well as all resource material (Matlab tutorials, Text book on Physical Oceanography by R.W. Stewart in PDF format). A graphical user interface (GUI) was developed as part of the present project to analyse sea level data. Data sets from the Indian Ocean region were used to examine storm surges, tidal characteristics and tidal harmonic analysis, and were also included in the CD. At the conclusion of the training all students were given a package containing two CD's which included all the data, programs (Matlab routines) and models used by all students during the training. This ensured that all students had equal access to programs and data for the future.

The Matlab tutorial included the use of the SEAWATER package developed by CSIRO Australia to calculate physical properties of sea water, including a tutorial for oceanographers which used Matlab to display temperature, salinity contours as well as the calculation of geostrophic currents from CTD transect.

## Group Projects

A series of small group projects were developed in conjunction with the students, taking their interests into account and the availability of data sets. The students worked as a group in an integrated project based on various aspects of physical oceanography of the region. These included the analysis of remotely-sensed data (altimeter, ocean colour and SST), ARGO buoy data from the northern Bay of Bengal, Arabian Sea and around Sri Lanka, and meteorological data. A complete list of projects (total of 9) is listed in Appendix C. The students worked through the inter-session period (between February and June) with guidance from the visiting Professor via email. A formal presentation of the group project outcomes were presented to the student body in June and are attached. I plan to publish the results of all the group projects, as well as the data collected during the field component (see below) in a special issue of the NARA Journal in 2007.

## Field Program

Part-II of the program was held from 5- 23 June and included completion of the group projects and a field component. The field component collected physical oceanographic data from the south coast of Sri Lanka, where strong upwelling region is indicated in ocean-colour imagery. A residential camp, in which all students participated, was held at Weligama Bay, a small (~5 km wide) semi-enclosed Bay

located along the south-south-west coast of Sri Lanka (Figure 1). The Bay is relatively shallow with max depth of 10m.

A summary of the data collected in each of the environments are presented below:

- (1) Estuary: CTD transects were undertaken along the estuary to determine the dynamics of the salt wedge under different tidal states on 4 different days (see Figure 2)
- (2) Beach: beach profiles and tidal levels were measured to determine beach behavior on 4 different dates (Figure 3).
- (3) Weligama Bay: A current meter was moored for 3 days and a CTD transect was undertaken across the Bay (Figures 4 and 5).
- (4) Cross-Shelf Transect: A CTD cross-shelf transect was conducted on 11 June. Unfortunately, at the final station the CTD was snagged on the bottom and could not be retrieved.

The results of field studies and well as the group projects will be written up as journal papers and it is intended to publish them as a special issue of the NARA journal in June 2007.

### **Value of the Nippon Foundation-POGO Visiting Professorship Program**

The students who participated in the course had varied backgrounds in physical oceanography ranging from those who had no formal training to those who had some training but were limited in the range of subjects covered during the training. For all of the students this was the first time that they had participated in a training program which covered theoretical aspects, field data collection and data analysis and presentation. The feedback from the students was that the training was immensely beneficial to them since:

- (1) The theory explained quite a few phenomena which they had observed but lacked the knowledge to explain;
- (2) Data analysis techniques using Matlab provided skills in data processing and presentation as well as exposure to a range of data sources, especially ARGO buoys and remotely-sensed imagery, available through the internet; and,
- (3) Exposure to a range of field techniques including dealing with problems encountered during the field measurements, which are usually not anticipated, as well as identification of phenomena covered in the theoretical part of the course.

In summary, the students were exposed a range of skills and experiences which will help with their own work, from physical oceanography, to fisheries and coast conservation.

## Continuation of Training in Sri Lanka

The contact with the students who participated in the program and with National Aquatic Resources Research and Development Agency (NARA) will continue into the future. It is anticipated that annual visits will be undertaken to Sri Lanka (funded through various sources, including the University of Western Australia) to work with NARA scientists and some of the students who participated in the course. Initially, these contacts will be concentrated on the publication of the papers in the NARA journal as well as providing research advice and further specialised training. Examples, of these include:

- (1) Provision of additional training over a 12 month period beginning in April 2007 to A.V.P.Vijitha of Moratuwa University on exploration and transport of heavy mineral sands at the University of Western Australia and funded through a World Bank project awarded to Moratuwa University;
- (2) External supervision to Rezah Badal (Mauritius) for the completion of his Ph.D. thesis in physical oceanographic processes in the south-western Indian Ocean; and,
- (3) Additional training on tsunami inundation modelling provided as my role as a Chair of the Working Group on Modelling, Forecasting and Scenario Development of the Indian Ocean Tsunami Warning System (IOTWS). Five students who participated in the NF-POGO training program (Ratnayake, Sujeewa, Uddin, Badal, Garu) have also participated in tsunami modelling training courses with additional training to be provided within the next 12 months.

## Acknowledgements

I would like to acknowledge the support provided by the Nippon Foundation to allow this comprehensive training program to take place in Sri Lanka. I also acknowledge the support of POGO through Drs Shubha Sathyendranath and Venetia Stuart.

C Pattiaratchi  
POGO Visiting Professor to Sri Lanka 2006.



Figure 1- Location of Weligama Bay, including the field sites within the Estuary, Beach and the Current meter deployment.



Figure 2- Sampling in Weligama Estuary.

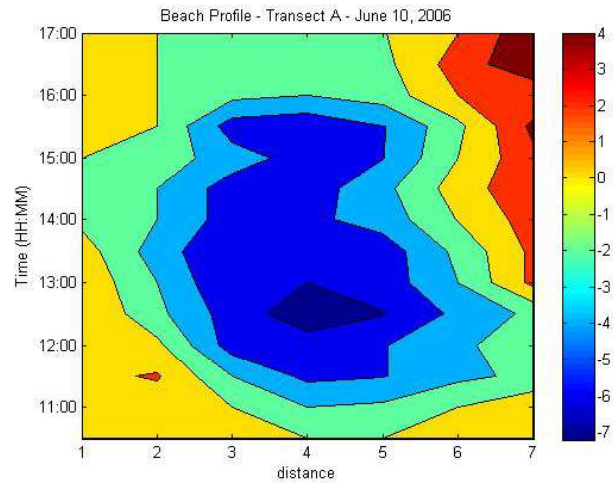


Figure 3- Measuring beach profiles (left) and time series of beach elevations indicates erosion of the beach during the day coinciding with the high tide.



Figure 4- Deployment of CTD within Weligama Bay.

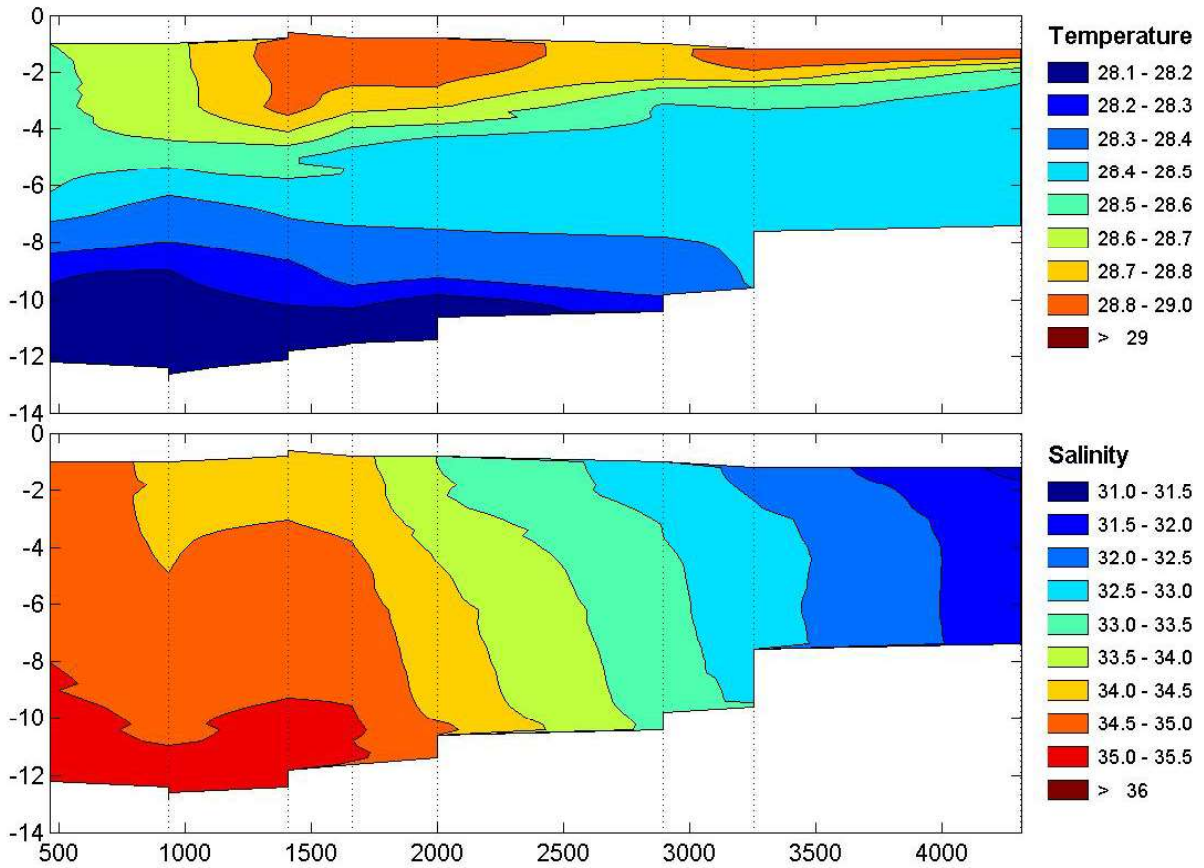


Figure 5- CTD transect across Weligama Bay showing lower salinity water along the eastern end of Bay due to freshwater input from the Estuary.

## APPENDIX B: TIMETABLE – Lectures

Date	0900-1030	1100-1230	1330-1500	1530-1700
26 January	Introduction	Instrumentation	Instrumentation (cont)	Ocean Basins Equations of Motion
27 January	Atmospheric circulation	Physical properties of SW	Marine Acoustics	
30 January	<b>Water level variability:</b> tides, storm surges, tsunamis, seiches, continental shelf waves, mean sea level rise			
31 January	Tides: shallow water	Currents – no friction	Introduction to Matlab: tutorials	
1 February	Currents with friction	Surface circulation	Matlab: physical properties	
2 February	T/S diagrams	Water masses	Matlab: physical properties	
3 February	T/S diagrams	Water masses	Matlab: sea level data analysis	
6 February	Indian Ocean oceanography	Indian Ocean oceanography	Visit to NARA (Seminar: Tsunami Warning systems)	
7 February	Continental shelf processes	Continental shelf mixing	Group projects	
8 February	Continental shelf circulation: Island Wakes	Continental shelf circulation: Australian region	Group projects	
9 February	Estuarine hydrodynamics	Surface gravity Waves	Group projects	
10 February	Nearshore hydrodynamics	Coastal Dynamics	Group projects	
13 February	Numerical modelling	Numerical modelling	Group projects	
14 February	Group projects	Group projects	Group projects	



## APPENDIX C: List of Group Projects

		1	2	3
1	Argo data analysis from Sri Lankan regional waters	Priyantha Upul	Niroshan	Gihan
2	Sea Level variability around Sri Lanka (and the region) and Gulf of Aden	Mohammed	Ananda	Thusara
3	Analysis of meteorological data from Katunayake, Sri Lanka	Sujeewa	Nalin	Priyadharshana
4	Study of distribution patterns of ocean circulation, SST and Chlorophyll around Sri Lanka	Kanthi	Jayasiri	Nishantha
5	Argo data and water mass characteristics of the northern Arabian Sea and Bay of Bengal	Naeem	Uddin	
6	Wave pressure distribution around harbours	Mustapha		
7	Tsunami modelling	Nalin Jagath	Vijitha	Suranga
8	Nutrient distribution in Palk Strait and ocean circulation around Sri Lanka	Dharana Sindhu	Sashi Priyadharshani	Samanthi
9	Oceanic processes around Mauritius	Reza		



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## APPENDIX D: TIMETABLE – Field Training

Date	Activity
Thurs 9 June	In transit: Colombo to Weligama
Fri 9 June	Introduction, field preparation. CTD transect along estuary, beach profiles. Attempt to deploy current meter
Sat 10 June	Deploy current meter, CTD transects across Bay, CTD transects along estuary, beach profiles
Sun 11 June	CTD transect across continental shelf; CTD transects along estuary along estuary, beach profiles
Mon 12 June	Recover current meter, CTD transects along estuary, beach profiles
Tue 13 June	In transit: Weligama to Colombo