Maldives Training Course in
Seismology and Tsunami Warnings

Figure 1 Training course participants, lecturers and hosts.

A five-day international training course in Seismology and Tsunami Warnings was held in Male', Maldives from August 21-25, 2006. The course involved 15 participants from the Maldives Meteorology Department (MMD). In addition, 6 observers from the MMD were present for all or a significant portion of the training. The observers sat in for the lectures and generally had an active role in the exercises and discussions. The UNESCO Intergovernmental Oceanographic Commission (IOC), the US Geological Survey (USGS), the US Agency for International Development (USAID), and the MMD sponsored the training course.

The training was directly relevant to the daily duties of one third of the participants, MMD employees currently training as geological observers. The remaining participants were mainly oceanographic observers, who will be working alongside those for whom the training was directly relevant. The observers were more senior employees of the MMD. A full list of participants is provided in Appendix 1. The level of previous knowledge of earthquake seismology and tsunami warning was very low. No participant had any training in seismology and the majority had only a high-school education. A small number of participants and observers had undergraduate degrees in meteorology or oceanography.

The training course was structured to give an introduction to tsunami warning center procedures and operations in the first 2 days, then introduce the earthquake seismology needed for these operations in the remaining 3 days. The first day gave an overview of global seismicity, the generation and propagation of tsunami waves and an overview of warning centers, their objectives and activities. These lectures were supported by a hands-on computer session using TsunamiTeacher program and an open discussion about

Figure 4 Laura Kong and Masahiro Yamamoto introducing a hands-on session using TsunamiTeacher.

sea level data. The second day further reviewed tsunami generation and propagation through a Japanese television documentary, and then covered tsunami mitigation, warning dissemination and emergency response in greater detail. The second day was supported by computer exercises on tsunami travel time modeling and historical databases using winITDB software (Tsunami Laboratory, ICMMG SD RAS, Novosibirsk, Russia).

The third to fifth days introduced a range of topics in earthquake seismology. On day 3 the basic theories of earthquake source mechanisms and seismic waves were introduced and the damaging effects of earthquakes reviewed. These lectures were supported by hands-on computer exercises looking at earthquake location and wave propagation and a television documentary on earthquakes. Day 4 focused on practical methods of data interpretation in seismology. This involved a lecture and computer exercise on locating earthquakes, a lecture on focal mechanism solutions, and several hours of practical exercise on reading seismograms and identifying seismic phases. The day concluded with a guest presentation by Mr. Zahid of the MMD reviewing run-ups in the Maldives from the 2004 tsunami. The final day of training covered seismic instrumentation and networks, and discussed earthquake forecasting. The day also involved a hands-on exercise on earthquake focal mechanisms, and ended with a review on the topics covered in the training using the Sumatra 2004 earthquake as an example. The full agenda for the course is provided in Appendix 2.

At the end of the training course questionnaires were given to the participants. Fourteen of the participants provided feedback. The responses were very positive, with the all participants reporting that they gained knowledge in the training and 50% stating that the gained a great deal of knowledge. Twelve of the fourteen participants stated that the training fulfilled their expectations (the other two gave a neutral answer). For the first

Figure 2 Walter Mooney helping participants during a computer exercise.

Figure 3 Annabel Kelly and participants discussing the interpretation of seismic data.

time in this series of training programs, a significant number of participants commented that the course ran for too many hours each day. The training was predominantly 9am-5pm (ending at 5:30pm on day 1); however, the working day in the Maldives is often 7:30am-2:30pm, and this should be taken into account in any future training efforts. The starting level and speed of the training was also positively reviewed, with just two participants stating that the starting level was slightly too advanced and two responding that the speed of the lectures was slightly too slow. The only criticism of the course in general, was that the training should be extended over more than 5 days, with three participants commenting on the desire for more time to absorb the information and develop topics further.

Examples of the comments provided by the participants:
"This course was a great help for us to learn a lot about seismology and tsunamis."
"The information we learnt is new and very important."
"The duration of the training was too short to learn more and to fully understand its concepts."
"Even though we get breaks, the number of hours of training is too high."
"It was excellent, and so simple to understand."
"The course fulfilled my expectations and it increased my interest in seismology."

Conclusions
Fifteen employees of the Maldives Meteorological Department were introduced to earthquake seismology and tsunami warnings during a 5-day training course hosted by the MMD. The material covered in the training provided the background in science and the practices of warning centers required to allow the participants to confidently participate in the development of their national tsunami warning center. The course was extremely successful, with all participants gaining knowledge and several commenting in increased interest and enthusiasm for seismology.

Appendix 1 Participants

Name	Designation
Aishath Shimana	Assistant Data Processing Officer
Ibrahim Humaid	Geological Observer (Trainee)
Fathmath Fairooza	Geological Observer (Trainee)
Aishath Faznee Hassim	Oceanographic Observer (Trainee)
Aminath Nasra Naseer	Oceanographic Observer (Trainee)
Khadhiyya Simaany	Oceanographic Observer (Trainee)
Hawwa Shiruhaana	Geological Observer (Trainee)
Nabeel Yoosuf	Oceanographic Observer (Trainee)
Azeema Ahmed	Meteorological Forecaster
Thameem Abdul Razzaq	Geological Observer (Trainee)
Mohamed Sujuan Ibrahim	Oceanographic Observer (Trainee)
Hashim Nabeel	Oceanographic Observer (Trainee)
Hussan Waheed	Assistant Meteorological Forecaster
Hassan Naseer	Geological Observer (Trainee)
Nadha Zahir	Oceanographic Observer (Trainee)

Observers:
    Zahid, Senior Meteorological Forecaster
    Yazeed Ahmed, Meteorological Forecaster
    Ahmed Muslim, Meteorological Forecaster
    Ali Shareef, Assistant Oceanographer
    Ahmed Inaan, Assistant Engineer
    Ahmed Muaz, Technician

Lecturers:
    Laura S Kong, Director, ITIC
    Masahiro Yamamoto, Senior Tsunami Advisor, UNESCO-IOC
    Walter D Mooney, Senior Seismologist, USGS-IOTWS Program leader, USGS.
    Annabel Kelly, Seismologist, USGS

Appendix 2 Training Course Agenda

Time	Topic	Lecturer
Day 1	*Tsunamis and Tsunami Warning and Mitigation Systems*	
9:00-9:30	**Introductions**	Maldives, IOC, USGS
9:30-10:00	Coffee	
10:30-11:30	**Seismicity and Plate Tectonics**	Kelly
11:30-12:30	**Tsunami Warning and Mitigation Systems - Overview**	Kong
12:30-1:30	Lunch	
1:30-2:30	**Tsunami generation and physics**	Yamamoto
2:30-3:30	**Computer learning: TsunamiTeacher**	Kong, Kelly, Yamamoto
3:30-4:00	Coffee	
4:00-4:30	**Tsunami Observations** Discussion of variation in leading wave polarity and review of Japanese sea level data following the 2003 Tokachi-Oki earthquake.	Kong, Kelly, Yamamoto
4:30-5:30	**Tsunami warning center operations - objectives and activities** **Tsunami Warning Center Operations (PTWC and JMA) - IO Scenario** Procedures for the IOTWS Interim Advisory Information Service	Yamamoto Kong
Day 2	*Tsunami Warning and Mitigation Systems*	
9:00-10:00	**DVD documentary on tsunamis - NHK video**	
10:00-11:00	**Tsunami Warning Center Operations (PTWC and JMA) - IO Scenario** Case Study: Indonesia Source Region Case Study: Makran Source Region	Kong
11:00-11:30	Coffee	
11:30-12:30	**Tsunami Hazard Risk Assessment and Preparedness**	Kong
12:30-1:30	Lunch	
1:30-2:00	**Warning Dissemination and Public Alerts - Communications Technologies**	Yamamoto, Kong
2:00-2:45	**Tsunami Emergency Response after warning issuance**	Kong
2:45-4:00	**Computer tsunami exercises (winITDB)**	Kong, Kelly, Yamamoto
	Coffee	
4:00-5:00	**Tsunami Mitigation - Preparedness (Evacuation + Hard Countermeasures**	Yamamoto
Day 3	*Seismology*	
9:00-10:30	**Earthquake theory - sources**	Mooney
10:30-11:00	**Computer exercises (winITDB)**	Kelly
11:00-11:30	Coffee	
11:30-12:30	**Earthquake theory - waves**	Mooney
12:30-1:30	Lunch	
1:30-2:45	**Computer exercises (SeismicWaves + SeismicEruption)**	Kelly
2:45-3:15	coffee	
3:15-4:00	**Damaging effects of earthquakes**	Mooney

4:00-5:00	**DVD documentary on earthquakes**	
Day 4	*Seismology*	
9:00-10:00	**Seismic data interpretation - Location**	Mooney
10:00-11:00	**Seismic data interpretation - focal mechanisms**	Kelly
11:00-11:30	Coffee	
11:30-12:30	**Computer exercises (seismic data interpretation)**	Kelly
12:30-1:30	Lunch	
1:30-3:00	**Computer exercises (seismic data interpretation)**	Kelly
3:00-4:00	**Computer exercises (earthquake location)**	Kelly
4:00-4:30	Coffee	
4:30-5:00	**Review of run-ups in the Maldives from the 2004 tsunami**	Zahid
Day 5	*Seismology*	
9:00-10:00	**Seismic instrumentation**	Kelly
10:00-11:00	**Earthquake forecasting**	Mooney
11:00-11:30	Coffee	
11:30-12:30	**Seismic arrays and networks**	Mooney
12:30-1:30	Lunch	
1:30-3:30	**Hands-on exercise (focal mechanisms)**	Kelly
3:30-4:00	Coffee	
4:00-4:45	**Review of seismology training and the Dec 26, 2004, Sumatra Earthquake**	Kelly
4:45-5:00	**Concluding remarks**	Maldives, USGS, IOC