

**INTERGOVERNMENTAL COORDINATION GROUP / INDIAN OCEAN
TSUNAMI WARNING SYSTEM (ICG/IOTWS)**

**UNESCO-IOC INTERNATIONAL TRAINING COURSE ON
TSUNAMI NUMERICAL MODELLING
COURSE II: TSUNAMI INUNDATION MODELLING**

Bangkok Thailand, 28th June- 7th July
(*R. Badal, D. Greenslade, V. Titov, C. Moore and U. Kanogli*)

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1. Summary

Following the success of the first session of the UNESCO-IOC International Training Course on Tsunami Numerical Modelling, in Melbourne, a second session of the training has been organized in Bangkok, Thailand. The training course was hosted at the Chulalongkorn University, Bangkok with the support of the US-IOTWS. Funding for the training course was provided by UNESCO-IOC and USAID through the US-IOTWS. In-kind support for the workshop was provided by the Chulalongkorn University of Bangkok.

2. Attendees



Back Row: Prof. Utku Kanoglu, Mr. Boonthum Tanglumlead, Mr. Ameer Hyder, Mr. Rezah Badal, Dr. Pramot Sojisuporn, Mr. Haris Sunendar, Mr. Hipolito da Costa Cardoso, Mr. Somsak Wathanaprida, Mr. Hashim Nabeel, Dr. E.M.S. Wijeratne, Mr. Seelam Jaya Kumar, Mr. Zin Aung

Front Row: Mr. Chodavarapu Patanjali Jumar, Dr. Diana Greenslade, Mr. Peter Collier, Dr. Vasily Titov, Mr. Orestes Anastasia, Dr. Piamsak Menasveta, Dr. Absornsuda Sirapong, Mr Sujit Kumar Debsarma, Mr Ali Shareef, Mr Sultan Salim

Humaid Al-Yahyai, Rear Admiral Thavorn Charoender, Ms. Chatchie Chongpaibul,
Ms Tamonwun Wunpun

Instructors

Dr Diana Greenslade
Bureau of Meteorology Research Centre, Melbourne, Australia

Professor Utku Kanoglu
Middle-East Technical University, Ankara, Turkey

Mr Christopher Moore
NOAA Center for Tsunami Research, Seattle, USA

Dr Vasily Titov
NOAA Center for Tsunami Research, Seattle, USA

IOC Observer

Mr M. Rezah Badal
ICG/IOTWS Secretariat, Perth, Australia

Participants

The course announcement was distributed via the ICG/IOTWS Secretariat on the 14th of May 2007. The closing date for applications was 24th May 2007. In total, 40 applications were received. The participants were initially assessed by a technical selection committee consisting of Charitha Pattiaratchi, Diana Greenslade and Vasily Titov, consistent with the Melbourne session of the course. The final participant selection, using the technical rankings as guidance was made by representatives of the funding agencies (US-IOTWS and ICG/IOTWS Secretariat). 15 applicants were offered positions at the training course. One participant withdrew before the start of the course (Somalia) apparently due to his unwillingness to be refunded part of his travel at a later stage. This place in the course was taken by the participant from Pakistan. The number of participants was 16 in all, including Mr M. Rezah Badal who also participated in the training as a Mauritian representative.

LDC's			
1	Mr Hipolito da Costa Cardoso	National Institute of Meteorology	Mozambique
2	Mr Sujit Kumar Debsarma	Bangladesh Meteorology Department	Bangladesh
3	Mr Zin Aung	Department of Meteorology	Myanmar
4	Mr Ameer Hyder	Pakistan Meteorological Dept/National Tsunami Warning Centre	Pakistan

US_IOTWS			
5	Dr E.M.S Wijeratne	NARA	Sri Lanka
6	Mr Ali Shareef	Department of Meteorology	Maldives
7	Mr Chodavarapu Patanjali Kumar	INCOIS	India
8	Mr Seelam Jaya Kumar	National Institute of Oceanography	India
9	Mr Hashim Nabeel	Department of Meteorology	Maldives
10	Mr Haris Sunendar	Institut Technology of Bandung	Indonesia
Self-funded			
11	Mr Sultan Salim Humaid Al-Yahyai	Department of Meteorology	Oman
Thailand			
12	Dr Pramot Sojisuporn	Chulalongkorn University	Thailand
13	Dr Anat Ruangrassamee	Chulalongkorn University	Thailand
14	Mr Prasong Thammapala	Department of Disaster Prevention & Mitigation	Thailand
15	Mr Narumitr Sawangphol	Geo-Informatics Center	Thailand
IOC/Mauritius			
16	Mr M. Rezah Badal	IOC	Mauritius

3. Agenda

The agenda is listed at Appendix A.

4. Participant reports

All participants gave a 10 to 15 minute oral presentation on the final day and produced a summary written document describing their case studies and results. The written reports are included at Appendix B.

5. Participant feedback

- a) A questionnaire was given to the participants on the final day for them to fill in. This questionnaire is included at Appendix C. All of the responses provided by the participants were collated and are included at Appendix D. Some highlights are:
- The overall view of the course was very positive
 - All the participants agreed that they had increased their knowledge of tsunami inundation and modelling. In some cases they have been able to compare their results with different models, thus strengthening their confidence.
 - Most of the participants feel confident to pass on their knowledge to others

- Nearly all the participants agreed that they had enough time to prepare for the course
- Many of the participants suggested that the training course should cover more on handling bathymetry data.

6. Issues

There were several observers on the course, who stayed throughout the hands-on training. This meant that there were often more than 20 people in a computer room that was meant for 20 students and the back of the room was sometimes over-crowded. The number of participants in the course had been limited to 16 predominantly due to the limited amount of space available in the computer room. While the observers did not hinder the involvement of the official participants in any way, it was a little unfair to the unsuccessful applicants to the course who were not local.

This was a relatively minor issue, in terms of the success of the course and everything else ran very smoothly. The main issues encountered during the Melbourne session of the course were not encountered during this course.

Specifically:

- All participants were able to obtain visas, due to the existence of “visa-on-arrival” at Bangkok airport.
- Fewer issues with computer viruses and insufficient computing power with the participants’ laptops were encountered.
- All participants brought their own laptops, so there was no requirement to provide extra PCs.
- IT support at Chulalongkorn University was very good, despite initial problems with data projection facilities.
- The facility provided by NOAA for developing bathymetry grid files proved to be a very useful tool and enabled the participants to spend more time running test cases and experiments.

7. Budget

The total cost of the training course (not including in-kind support and USAID contribution) was \$8,029.

Budget	Amount (US\$)
Per diem etc	1784
Printing	35
Tickets	3571
Hotel	2639
Total	8029

This was within the originally budgeted expenses. There were no extra charges. However, please note that these expenses represent only those incurred by UNESCO. USAID supported the participations of 6 participants from US_IOTWS countries and bear some of the local charges.

8. Conclusion

- This second session of the inundation modelling training course has proven to be very successful, as was the first session.
- There are now a total of X people from Y countries of the Indian Ocean who have been trained in inundation modelling and the use of the ComMIT modelling interface.
- The remaining countries of the Indian Ocean for whom no-one has been trained are Comoros, Kenya, East Timor, South Africa, Somalia, Iran and Malaysia. These countries should be strongly targeted for the 3rd session of the course, planned for late August 2007.

APPENDIX A – Survey summary

(1=Strongly Agree, 2=Agree, 3=Neither agree not disagree, 4=Disagree, 5=Strongly Disagree)

Overall view of the Training Programme:	1	2	3	4	5
The content of the course was relevant to my needs	7	8			
The trainers were supportive and encouraging	12	3			
There was appropriate balance between theory and practical	4	9	2		
The course material was easy to follow	5	9	1		
The course material was a useful resource	9	6			
The duration of the training programme was adequate	3	7	4	1	
The location and facilities were appropriate for the training programme	7	6	2		
I had sufficient time to prepare for the training course	4	6	5		
Benefits of the Training Programme:					
Tsunami inundation modelling					
I have improved my knowledge on tsunami inundation modelling	10	5			
I feel confident that I am able to undertake tsunami inundation modelling	5	9	1		
I am confident in my ability to pass knowledge to others	6	8	1		
The training subject matter will be useful in my job	9	6			
Tsunami inundation modelling concepts were clearly explained	4	8	2	1	
ComMIT software					
I found ComMIT easy to use and understand	10	5			
The different components of ComMIT was adequately explained	5	8	2		
I feel confident in using ComMIT to undertake inundation modelling in my country	7	7	1		
I feel able to help other users in my country in the use of ComMIT	8	7			

Can you identify any skills or knowledge you gained on the course that you will be able to apply in your country?

- The theory of tsunami modelling and skill in using ComMIT.
- Yes it is very important that for the Makran regime Tsunami model, I got many answer for Question Tsunami current issue and panic in my city Karachi.

- Application of ComMIT to simulate inundation model for SIFT database, and understand method for developing the inundation database and mapping
- The course will help us identify which islands will be most affected by a tsunami and estimated arrival time of a tsunami. So we can be better prepared next time. If we could find good enough bathymetry we can do an inundation map for Maldives.
- Yes, I can identify and apply it at my country.
- Application of unit sources to generate Tsunami propagation scenarios is one skill that will be used for studying the vulnerability of different coastal regions.
- After training I can apply ComMIT model for mapping inundation area from various source of earthquake and we can setting up the evacuation plan with export output from ComMIT to GIS and overlaid with various sources of data for setting up the implementation plan for local community.
- The concept of Unit sources and Inundation modelling using the propagation database, the separate codes for propagation as well as inundation is the approach to represent the realistic situation of tsunami triggering. The bathymetry data preparation and different data format conversion tools those helpful for users.
- I am able to run inundation model for any coastal locations in Thailand. We already have some good bathymetry and elevation data for some interested coasts of Thailand. I can make the inundation map if any Thai governmental offices or local people want them.
- Yes, I can create scenarios and inundation map in my country for evacuation plan and evacuation routes in risk areas.
- I have known what sort of effect it could have on the propagation and inundation of a tsunami by having small islands like the Maldivian islands. And specially got an idea about the resolution of the bathymetry and topography that we have to have if we are to prepare inundation maps for the islands.
- Transformation techniques of topographic, bathymetric datasets (x,y,z) format to MOST format and animation tools.
- I will be able to run different cases
- I will be able to pass the knowledge
- Inundation mapping of coastal areas with respect to tsunamis, however, in our case, coastal bathymetry and elevation data needs to be improved.
- Yes, I can. I will be able to apply in my country

Is there any content from the course you have found particularly useful?

- Time scale of tsunami wave propagation
- The fundamental theory of the MOST model.
- Yes, knowledge about inundation parameter using NetCDF, its very interesting
- It help me understand more about how a model works and the way tsunami waves move in the shallow water of a country like Maldives, and more about the Indian ocean tsunami warning system.
- All the content of the course was useful for me, because it is new area of application for me.
- Unit sources database and the ability to generate Tsunami propagation for different combinations of the source parameters has been found very useful.
- The useful content of this course are theory background of tsunami propagation modelling and ComMIT model

- The basic concepts involving from propagation to inundation by the non linear modelling of shallow water theory. And the practical approach of ComMIT software.
- The theory of tsunami wave is very useful because I didn't have good knowledge background on tsunami study. With plenty of material that this course provided, I can better understand the progression of tsunami model study in the US. And I can explain to governmental and lay people what the scientist can do to study the tsunami in a proper way.
- Yes, I have gotten more experience and new knowledge about Tsunami.
- The use of ComMIT would be of great help in the future in my work. Another useful feature was to learn how the waves are behaving in the shallow waters inside the atolls and the effect played by the islands in focusing the energy in different parts of the atoll.
- All contents are useful.
- Theory of Inundation modelling
- Using the CoMMIT Model
- Most of the content from the course is very useful
- Yes. NcBrowse is useful for my project.

Is there any content from the course you have found particularly difficult?

- No
- Grid bathymetry
- None
- No, I understood all the contents well.
- Not difficult enough
- The course content has been explained very well by the resource persons and they also cleared the doubts in an understandable way.
- Tsunami propagation modelling because It's far from my background but this topic was a must to learn when we want to modelling tsunami model
- The data format conversion to most, identifying the various reasons for blow-up of the model runs. And particularly we to download unit source greens function for each model run, which is time consuming process.
- We don't know the right source to use for the tsunami run.
- Yes, sometimes I confused some procedurals and condition.
- Some of the theoretical aspects of certain topics.
- None
- Theory of Inundation modelling
- No
- No.

Was enough time spent on each topic?

- May be no
- Yes.
- Yes
- Yes, I believe that enough time was spent on all the topics
- Yes was enough.
- Yes! The resource personnel spent good amount of time explaining their topics.

- No, there have many topics to learn. Participants are come from different background, some are geologist or seismologist, and some are planner have little background on seismology
- Yes, it is enough but some more time on inundation mapping it is needed.
- The lecture might be too short and the participants should have read some recommended material before coming to the seminar. It is difficult to find good theoretical studied materials to read in Thailand also I don't know the history of tsunami study.
- Yes, it is.
- More than enough.
- Not enough time was spent.
- yes
- It could be much better if spent more time on model formulation, model grids and numerical techniques, particularly for MOST model code etc. Interesting to see how the moving boundary condition was handled by MOST code formulation with positive and negative slopes. Particularly, how the moving boundary condition is handled after initial inundation of valleys along the coast.
- Yes. That is enough time.

Are there topics which were not covered? If so, which ones?

- Grid bathymetry
- Yes. The source modelling was not clearly explained.
- Since I have used TUNAMI-N2 for inundation modelling. Using both ComMIT and TUNAMI in estimating tsunami inundation will give me more confidence in the result.
- None for inundation model using ComMIT
- No, all the topics needed were covered
- All topics were covered.
- Topic on different bathymetries and topography and such details which are very important in the modeling.
- Application of ComMIT output in practical, e.g. export output to made inundation or evacuation planning, animation of simulation results
- Some topics like the ComMIT server installation in software module
- I want to know thoroughly on tsunami source and propagation.
- No,
- Hands on converting various types of bathymetry types to MOST could have been included even though it's kind of out of theme.
- Feel more confident in using the inundation model after several simulations by changing different parameters. Also have been able to understand several theoretical aspects about tsunami propagation and inundation, which I wasn't aware of before.
- Source codes not shown nor given.
- Not really
- Please see above, however during a short period of time it may difficult to cover all topics in great detail. Notes, list of relevant literature, manuals and CD with presentations could be helped to go in more detail.
- No. All topics are covered.

How have you benefited from participating in this training programme, eg. greater knowledge, increased confidence in tsunami modelling, access to software?

- Yes of course it is great experience.
- I would like to listen to the theory behind tsunami inundation.
- Yes, all of them
- I gained more knowledge about tsunami inundation and modelling, and it is easier to download the program and all the needed components from the internet.
- Increase confidence in tsunami modelling and accessing to software.
- Greater knowledge on the methodology of Tsunami propagation and inundation, access to software, increased exposure to the Tsunami propagation and inundation modeling has definitely me.
- Yes, I used to work with MOST in Unix version, but ComMIT are very easy to use and we can selected the sources of earthquake by access the propagation database
- Definitely YES, I have more benefited from the participation in this training programme
- I am greatly benefited from this workshop for that I have a mean to run the inundation model for Thailand. Now I can help drawing the inundation map for Andaman Sea coast of Thailand. I think the MOST inundation model works very well. I am very sure that we can draw good inundation map if we have accurate coastal terrain map.
- I have gained more knowledge about tsunami and I can use tsunami modeling for my job. Additionally, I can share knowledge and exchange experiences with other participants
- Knowledge enhanced and use of some new software known.
- All
- Increased confidence on tsunami modelling and access to ComMIT, however it could be much better if we can access to MOST model code.
- This course give some knowledge and increased confidence in modelling

Do you have any suggested improvements to the training programme?

- Increase seismic records or data which already occurred
- the course material, i.e.: presentation and manual should be give to participant before class, so everybody can prepare question and discussion better
- No.
- Yes, to increase the time of the training.
- As the participants of this training course had different backgrounds viz., meteorology, geophysics, oceanography, etc., I personally felt that there was a gap in the understanding of the topics and methodologies by some of the participants. It is suggested that this can be overcome in due course of time.
- Bathymetry is an important input for the modeling - hence it is utmost important for it to be appropriate - a day or two can be spent on that during the training.
- Increase more time for theoretical lesson, it new for us
- I think we have enough time to train 3 steps of MOST tsunami model in 7 days. Now that the MOST inundation model plus the bathymetry files and the internet interfaces work smoothly, we have extra 2 days to try the source and inundation models.
- You should continue this course for advance the program and give opportunity as me.
- Some time should be spent on programming of solving NS-Equations.

- On course1, we have used Avi-Nami for propagation and know ComMIT which is based on MOST for inundation. Next time try to be consistent. So if we were using MOST on both, we could have mastered it.
- Needs more time to think?

Do you have any other comments?

- I am really grateful to the team teachers and all organisations and teams
- In present version of comMIT, we just can simulate inundation forecasting base on SIFT source database, but I think for the future, the inundation modelling and forecasting must be can do with source from historical data
- No, and thank you for providing this course.
- Updates on further courses may please be intimated in advance so as to enable us get prepared better. Software updates / intimation of the updates may be sent by mail to the participants.
- It will be useful, if you include the propagation executable and unit source definition including the programs to create deformations defined by user and uploading to specified location like OpenDAP servers.
- I will be happier to help you set up future training if you decide to hold it at Chulalongkorn University.
- The instructors did a great job. Thank you.
- Participants may be given chance to show their modeling works if any.
- Further courses will be appreciated
- Since MOST model code is not available, ComMIT interface must be improved to add the different tsunami sources.