Enhancing Coastal Hazard Early Warning and Response:
Tools and Institutional Strengthening

WORKSHOP ON SURVEY DATA PROCESSING
17 June – 20 July 2013, RIMES Program Unit, Thailand

TRAINING REPORT

1. Background

For countries with inadequate resources for disaster preparedness, as is the case for most countries in the Indian Ocean and Southeast Asian region, identification of areas at high risk to tsunamis is crucial for prioritizing resource allocation. Tsunami risk assessment, which provides an estimate of potential losses in lives and cost of building damage, would reveal communities that would be highly vulnerable to the hazard and, hence, need to be prioritized for enhancing readiness. The assessment, however, entails detailed inundation modeling for a range of scenarios from most important source zones, and requires computational capability and good-quality near-shore bathymetric, topographic, and exposure datasets, which most countries in the region lack.

The project entitled *"Enhancing coastal hazard early warning and response: tools and institutional strengthening"*, supported by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) through the Trust Fund for Tsunami, Disaster and Climate Preparedness, aims to build tsunami risk assessment capacities in Myanmar, Philippines, Sri Lanka, and Thailand, building on UNESCO/IOC efforts in the Indian Ocean region and taking advantage of low-cost methodologies developed at RIMES. RIMES shall build tsunami risk assessment capacity through training, demonstration of tool application, and transfer of equipment, software, systems, and training manuals to the countries to facilitate replication/upscaling. These tools are: a) low-cost near-shore bathymetric, topographic, and exposure survey methodologies; b) data processing tool to generate high-resolution data required for tsunami risk assessment; c) internet-based tool for tsunami risk assessment (named INSPIRE); and d) computer-based evacuation mapping tool (named ESCAPE).

A key project activity is capacity building on generation of near-shore bathymetric, topographic, and exposure data. Field surveys were undertaken in January 2013 in the project's pilot site in Barrio Barretto, Olongapo City, the Philippines. Processing of field data to generate near-shore Digital Elevation Model (DEM) for tsunami inundation simulation and exposure data inventory for tsunami loss estimation and evacuation modeling was demonstrated in a workshop from 17 June to 20 July 2013 at RIMES Program Unit in Thailand.

2. Training Objective

The Workshop on Survey Data Processing aimed to demonstrate the generation of:

a) near-shore DEM for use in tsunami inundation simulation; and
b) exposure data inventory for use in tsunami loss estimation and evacuation modeling.

3. Participants

The workshop was designed for technical officers who have responsibilities in the generation of near-shore bathymetric, topographic, and exposure data, and tsunami hazard and risk mapping for tsunami early warning and/or disaster mitigation, preparedness, response and management. For Philippines, the

training targeted two (2) officers from the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and four (4) officers from the National Mapping and Resource Information Authority (NAMRIA), as listed in Table 1.

Table 1. List of workshop participants

Participant Name	Organization
1. Mr. Ericson B. Bariso	PHIVOLCS
2. Mr. Danikko John V. Rivera	PHIVOLCS
3. Lt. Jg. Danilo A. Arguelles. Jr.	NAMRIA- Hydrography Department
4. Ens. Jaya A. Roperez	NAMRIA- Hydrography Department
5. Mr. Renato P. Esperanza	NAMRIA- RSRDAD
6. Mr. Saldivar B. Asprit	NAMRIA- RSRDAD

3.1 Participant Background

Near-shore bathymetric DEM generation. Two participants from NAMRIA- Hydrography Department were involved in near-shore bathymetric DEM generation. The participants have experience in surveying and mapping. At NAMRIA, the participants are responsible for conducting sounding surveys using Odom single beam transducer in shallow water depths and the Hypack software for processing sounding data, as well as leveling survey when transferring MSL elevations from one benchmark to another. However, while proficient in using high-end survey equipment and software necessary in abiding with IHO standards, they have little experience in using low-cost equipment and methodologies, but are proficient in GIS, particularly the ArcGIS software.

Near-shore topographic DEM generation. Two participants from NAMRIA-RSRDAD were involved in near-shore topographic DEM generation. The participants are currently working on a project to survey and map coastal and low-lying areas vulnerable to sea level rise at NAMRIA. They are proficient in GPS, leveling and traverse surveys, as well as processing field data. Although there is basic background in photogrammetry, none of the participants have been assigned by their agency to conduct photogrammetry work. As they are working as technical officers in the national mapping agency, they are proficient in cartography, and GIS, particularly in ArcGIS software.

Exposure data inventory generation. Two participants from PHIVOLCS were involved in exposure data inventory generation. The participants are currently working as science research specialists in Geology and Geophysics Research and Development Division. Both participants have background in geology, and GIS and remote sensing applications. They have been previously involved in exposure data survey activities with PHIVOLCS for collecting building information for seismic hazard and risk assessment. However, they have little experience in tsunami risk assessment and processing data to support evacuation planning. During the training, participants were introduced in using free software, in particular QGIS, which was main tool used in the workshop.

4. Resource Persons

Near-shore bathymetric DEM generation. The resource person for near-shore bathymetric DEM generation has strong background and experience in surveying, mapping, remote sensing, and GIS. Currently, she is working at the RIMES Earthquake Monitoring and Tsunami Watch division as Technical Specialist for topographic survey, remote sensing, and GIS. As part of the tsunami risk assessment and mapping project team, her work includes data collection, field surveys, data preparation and quality checks, development of DEMs and gridded datasets, and development of database for GIS and research applications. She conducted research on the evaluation of different interpolation methods as well as survey intervals, and development of tools and methodologies using low cost equipment and optimization of survey work to generate bathymetric DEM, which were adopted for this workshop.

Near-shore topographic DEM generation. The resource person for near-shore topographic DEM generation has strong background and experience in surveying, mapping, remote sensing,

photogrammetry, and GIS. He is currently working as a pilot in the Aerial Survey Division of the Royal Thai Survey Department. As expert associated with RIMES, his work includes data collection, field surveys, data preparation and quality checks, photogrammetry, development of DEMs and gridded datasets, and development of database for GIS and research applications. He conducted research on the evaluation of different topographic sources, such as maps, field survey, photogrammetry using aerial photographs and satellite images, and freely available DEMs, and the development of methodologies to generate topographic DEM, which were adopted for this workshop.

Exposure data inventory generation. The resource person for exposure data inventory generation has a strong background and experience in tsunami hazard and risk assessment and evacuation modeling. Currently, she is working at the RIMES Earthquake Monitoring and Tsunami Watch division as coastal hydrodynamics scientist. She leads RIMES research and development activities in tsunami early warning, tsunami risk assessment, and tsunami forecast model and tsunami database development. Under the current project, she has developed INSPIRE and ESCAPE software analysis tools and designed the field survey methodology to collect exposure data for tsunami loss estimation and evacuation planning.

5. Workshop Highlights

Participants were divided into three (3) groups to work on near-shore bathymetric, topographic, and exposure field data, according to the work schedule presented in Table 2. The workshop started with an overall lecture on the project's rationale and objectives, followed by group-specific lectures on data processing methodologies and expected outputs. The workshop adopted a hands-on training approach, with close instructions by the resource persons. Discussion and feedback were exchanged during the course, which fostered a good learning relationship between participants and resource persons. The training ended with the presentation of outputs and identification of lessons learned by participants, including evaluation of the training activity.

5.1 Near-Shore Bathymetric DEM Generation

Sessions aimed at building participants' capability to process bathymetric survey data to generate DEM, for use in tsunami inundation simulation. Data processed included sounding data, tidal data, and leveling survey data (for transferring MSL elevation from a known benchmark to the pilot site), as well as maps and ancillary data, such as nautical charts, topographic maps, etc. A script to automatically correct sounding data, using tidal and draft data, was developed in RIMES to assist the participants. Most of the data processing was done using the ArcGIS platform. The processed bathymetric data was combined with the processed topographic data for interpolation, to generate the digital elevation models needed for tsunami inundation modeling.

5.2 Near-Shore Topographic DEM Generation

Sessions aimed at building participants' capability to process GPS field survey data and photogrammetry, using stereo pair images for the pilot site. Aside from the RTK-DGPS survey conducted along the road network, fast static DGPS surveys were conducted to collect ground control and checkpoints necessary for photogrammetry.

One of the issues concerning the session on topography is the poor quality of aerial photographs. Some fiducial marks necessary for interior orientation are missing. Therefore photogrammetry cannot be performed. The coarser resolution (2.5 m) ALOS PRISM stereo pair images were used instead of aerial photographs with sub-meter resolution. Due to ALOS' coarser resolution, it was difficult to define the right shape of the mountain areas. Therefore, ASTER GDEM was used complementary to ALOS for the area with elevation higher than 50 m. The main software used to perform photogrammetry is the Leica Photogrammetry Suite in ERDAS. Likewise, for combining topography with bathymetry data for interpolation to generate the DEMs, ArcGIS software was used.

5.3 Exposure Data Inventory Generation

Sessions aimed at building participants' capability to process field survey data and related information for generating exposure and town information, to support tsunami risk assessment and evacuation planning. Building images along the road, collected from the pilot site, were interpreted for the building properties (construction type and occupancy type) and linked to the building footprint map. Reference zones for risk assessment were managed in a format that can be further used in the analysis by INSPIRE. Information for evacuation modeling was adjusted to a format that can be inputted to ESCAPE. These data include topographic slope, land cover, transportation network, population density, population ratio for different age and gender, shelter locations and shelter capacities. Most of the data processing was carried out using free software, QGIS.

6. Workshop Outputs

Near-shore Bathymetric & Topographic DEM Generation:

Final outputs from the near-shore bathymetric and topographic DEM generation sessions are digital elevations for four (4) regions, having varying resolutions and extents: 1) Region 1, having the coarsest resolution at approximately 3.5 km; 2) Region 2, with resolution of approximately 450 m; 3) Region 3, with resolution of approximately 150 m; and 4) Region 4, with resolution of approximately 50 m. Data for Region 4 was acquired from bathymetric and topographic surveys, while data for Region 3 is combination of survey data, map data, satellite DEMs, and other existing data. Data used for Regions 1 and 2 are from GEBCO data only. Final DEMs were validated by inputting to INSPIRE, for tsunami inundation simulation. Outputs are presented in the accompanying report entitled *Generation of Low-Cost Digital Elevation Models for Tsunami Inundation Modeling in Barrio Barreto, Olongapo, Philippines.*

In addition, accuracy of the fish finder used to generate the bathymetric data was compared with data collected using IHO-standard sonar from NAMRIA. The performance of the fish finder was tested against the NAMRIA sonar across varying depths (shallow, deep) and different terrain conditions (smooth, rough). Results show that fish finder data is within the required vertical accuracy of 1m, with only one out of 45 samples significantly exceeding this requirement. This sampling point is located in an area with a lot of sudden/steep terrain variations. In addition, difference between both sources are very small at less than 20m depths, while around 1m difference was seen starting at depths greater than 20m. In conclusion, the low-cost equipment is comparable to the survey-grade equipment used by NAMRIA and satisfies the vertical accuracy required for tsunami inundation modeling.

Exposure Data Inventory Generation:

Final outputs from exposure data inventory generation session are: 1) building inventory map, with building construction type, building occupancy type, and number of residents as attributes; 2) land cover integrated with road network in grid format; 3) topographic slope in grid format; 4) *purok* (village) map used as the reference zoning map in grid format; 5) database of critical facilities and potential evacuation shelters; and 6) population data required for evacuation modeling. Final exposure data was validated as inputs to INSPIRE for tsunami loss estimation and ESCAPE for evacuation planning.

Table 2. Day-to-day workshop schedule

Activity	Week1							Week 2							Week 3							Week 4							Week 5					
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6
Topographic Survey Data Processing (NAMRIA- RSRDAD)																																		
1 Oreintation for bathymetric data processing and ERDAS LPS module installation																																		
2 Photogrammetry block (interior and exterior orientation)																																		
3 Elevation point extraction from photogrammetry																																		
4 Combine elevation data from photogrammetry with bathymetric data and RTK GPS survey																																		
5 Result review and data correction																																		
Bathymetric Survey Data Processing (NAMRIA-Hydrography Dept.)																																		
1 Oreintation for bathymetric data processing and ArcGIS and analysis software installation																																		
2 Survey data preparation (image and vector map)																																		
3 Survey route preparation																																		
4 Tidal and sonar data conversion (Excel)																																		
5 Tidal data filtering (Excel)																																		
6 Sonar data correction for tide and draft (Excel)																																		
7 Determination of local variation areas (locvar.exe)																																		
8 Sonar data editing (3D GIS software e.g. ArcScene)																																		
9 GEBCO data processing (GEBCO software & ArcMap)																																		
10 Interpolation by Natural Neighbor method (ArcMap)																																		
Exposure Survey Data Processing (PHIVOLCS)																																		
1 Extract building construction type and building usage from VDO+ link to footprint																																		
2 Generate reference zone grid for loss estimation																																		
3 Generate Land cover grid for evacuation modelling																																		
4 Estimate other inputs for evacuation modelling e.g. density of populaiton and critical facility																																		
5 Generate Topographic slope grid for evacuation modelling																																		
Test run INSPIRE and ESCAPE (All)																																		
1 Test all inputs for INSPIRE																																		
2 Test all inputs for ESCAPE																																		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Jun-13														Jul-13																			

Working day
Spare day
Holiday

7. Participant Feedback

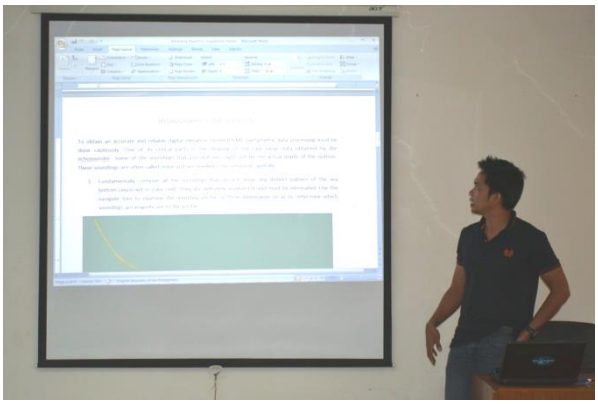
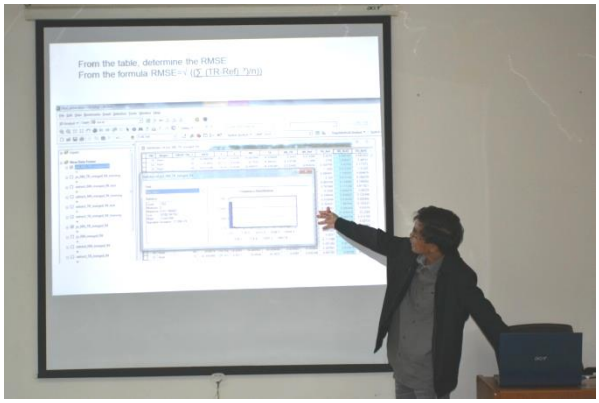
Participants found the course content and materials useful and relevant. Time allocated for discussing theoretical concepts and group discussions were adequate. Participants in the topographic data processing group found the training duration short; these participants joined two weeks late due to conflict in their work schedule with the training schedule.

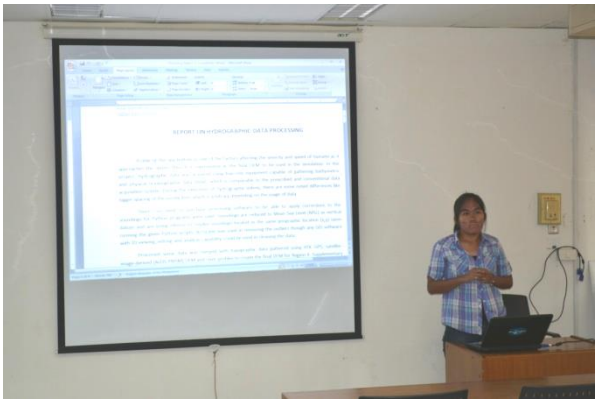
Participants appreciated the new knowledge and experience gained on data processing techniques from the workshop. Participants felt that the sessions on tsunami inundation modeling and risk assessment and evacuation modeling using INSPIRE and ESCAPE were limited. These sessions, however, were included to test the data products from the workshop; a separate training on INSPIRE and ESCAPE is planned separately.

8. Workshop Photos

Hands-on session for data processing


Lecture and interactive discussion



Presenting results and lessons learnt

9. Updated Project Schedule (as of September 2013)

Project Schedule	2012						2013												2014					
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
1. Project initiation																								
1.1 Project initiation meeting																								
2. Capacity building in tsunami risk assessment																								
2.1 Training on near-shore field surveys																								
2.2 Training on survey data processing and DEM generation																								
2.3 Training on tsunami risk assessment and evacuation mapping																								
3. Improvement of response capabilities																								
3.1 Evacuation map testing and exercise, manual adaptation																								
4. Regional resource sharing policy and mechanism development																								
4.1 Resource sharing policy and mechanism development																								

ANNEX 1
Workshop on Survey Data Processing
17 June – 20 July 2013, RIMES Program Unit, Thailand

COURSE FEEDBACK

1. Presentations (in %)

	Good	*Satisfactory*	*Needs Improvement*	*Comments*
1) Content	100	-	-	
2) Method of delivery	100	-	-	
3) Question and Answer	83	17	-	

2. Course materials (readings, course booklet, supplementary materials) (in %)

	Good	*Satisfactory*	*Needs Improvement*	*Comments*
Quality	100	-	-	
Relevance	100	-	-	

3. Time allocated to theoretical part (in %)

Too Much	*Enough*	*Not Enough*	*Comments*
-	100	-	Enough time for theoretical part, but needs much longer time for the processing of aerial photographs and DEM acquired from ALOS. It takes longer time in editing elevation data.

4. Time allocated to group discussions (in %)

Too Much	*Enough*	*Not Enough*	*Comments*
-	83	17	There is a need to discuss more between the groups (3 groups) on the data, for improvements e.g. data gathering, processing and evaluation Discussions were made throughout the training.

5. Time allocated to exercises (in %)

Exercise	*Too Much*	*Enough*	*Not Enough*	*Comments*
Bathymetric data processing	33	67	-	I think it is too much but it is a good thing because we had time to learn from the other group
Topographic data processing	-	50	50	Because the group from NAMRIA-RSRDA joined 2 weeks later due to work assignment

				More time is required to evaluate effectively the points from the RTK survey
Exposure data processing	-	100	-	
Application in ESCAPE for evacuation modeling	-	100	-	Some of the input data were completed later in the training, so they were not tested.
Application on tsunami inundation modeling by INSPIRE	-	75	25	Needs more discussion on the parameters to be used for the scenarios
Application on Tsunami risk assessment by INSPIRE	-	100	-	

6. Usefulness of the session covered (in %)

Sessions and Exercises	*Very Useful*	*Useful*	*Not Useful*	*Comments (use additional sheets if necessary)*
Topographic data processing				
Orientation on bathymetric data processing; ERDAS LPS module installation	100	-	-	Some software issues (ERDAS and ArcGIS sometimes did not work properly) Processing technique learned from this workshop contributed to the activities undertaken in Philippines. Idea and developed process are useful in the ongoing project
Photogrammetry block (interior and exterior orientation)	100	-	-	
Elevation point extraction from photogrammetry	100	-	-	
Combination of elevation data from photogrammetry with bathymetric data and RTK GPS survey	100	-	-	
Bathymetric data processing				
Orientation on bathymetric data processing, and ArcGIS and analysis software installation	100	-	-	
Survey data preparation (image and vector map)	100	-	-	
Survey route preparation	50	50	-	
Tidal and sonar data conversion	50	50	-	
Sonar data correction for tide and draft	50	50	-	
Determination of local variation areas (locvar.exe)	100	-	-	
Sonar data editing (3D GIS software e.g. ArcScene)	100	-	-	
GEBCO data processing (GEBCO software & ArcMap)	100	-	-	
Interpolation by Natural Neighbor method (ArcMap)	100	-	-	
Exposure data processing				
Extract building construction type and building usage from VDO+ link to footprint	100	-	-	This is very useful because it is not time consuming, thus limiting the amount of time for survey
Generate reference zone grid for loss estimation	100	-	-	
Generate Land cover grid for evacuation modelling	75	25	-	
Estimate other inputs for evacuation modelling e.g.				This is very useful especially

density of population and critical facility	75	25	-	for densely populated and urbanized cities situated near the coast for evaluation and planning of evacuation process
Generate Topographic slope grid for evacuation modeling	100	-	-	
Test INSPIRE and ESCAPE				
Test all inputs for INSPIRE	100	-	-	
Test all inputs for ESCAPE	100	-	-	

7. How much have you learned from this course? (%)

[83] more than expected **[17]** same as expected **[0]** less than expected

8. Subjects that could be deleted from the course:

- There is no need to delete any of all subjects in the exercises/training because all of them are necessary in the course of tsunami evaluation and how the participants will understand the concept and entire process.
- None. All subjects are very useful.

9. Subjects that could be added to the course:

-

10. Do you have any general comments about the workshop?

- This workshop is very informative and helpful. It is such a great privilege to be part of it.
- In general, this workshop is pretty informative and beneficial. I learned a lot. We will probably use some of the methodologies that we learned here to our surveying advantage.
- The workshop is good. All of participants are happy enjoying what we do during the workshop.
- The time is more than enough for exposure data processing but other inputs such as topographic DEM, due to time limitation, were only made available later in the training. This limited the use/exploration of all available data as input to test INSPIRE and ESCAPE. Synchronization of data completion was challenging, with three groups with different schedules working together. Either adjust/ increase INSPIRE/ ESCAPE input testing, or adjust scheduling of the data processing.