REPORT OF IN-HOUSE WORKSHOP ON BENTHIC HABITAT MAPPING ON BOARD M.V. SEAFDEC 2

17 - 19 September 2012

TD/RP/163
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Referring to the recommendations made at the "Expert Meeting on Deep-Sea Fishing and Its Impact on Ecosystem" that SEAFDEC is requested to find best practice of the sampling gears for deep-sea fisheries resources. Over the years, SEAFDEC/TD has explored ways to utilize the deep-sea fisheries resources in Southeast Asian Region through improvement of so-called "environmental friendly sampling gears", including mid-water trawl, gillnet, and bottom vertical longline. It was also suggested through the series of activities related to deep-sea fisheries resources exploration in the Southeast Asian Region that technical information/knowledge and experience on bathygraphic mapping (fisheries resources mapping) should be transferred to the Member Countries in order to provide an alternative source of fisheries resources from the deep-sea waters of the Member Countries with science-based information, particularly on the vulnerable marine ecosystem of their respective waters. In respond to this, SEAFDEC TD has developed a set of equipment ready to be put into the trial before transferring such knowledge and technology to the Member Countries. Subsequently, SEAFDEC/TD plans to organize "Regional training workshop on benthic habitat mapping" scheduled in the third quarter of 2012, of which the tools² for resources mapping are needed to be trailed.

With this regard, SEAFDEC/TD proposes to carry out the in-house workshop on the benthic habitat mapping on board M.V. SEAFDEC 2.

Objectives:
System testing preparing benthic habitat mapping including:
- Underwater VDO camera
- ROV
- Side Scanning Sonar
- Echo Sounder and
- Bottom trawl

Participants

1. Ms Penchan Laongmanee Coordinator
2. Asst.Prof. Pachoenchoke Jintasaeranee(Ph.D.) Resource person (Lecturer from Burapa University)
3. Dr. Natinee Sukramongkol Participant
4. Mr. Sukchai Arnupapboon ,,  
5. Mr. Narong Ruangsivakul ,,  
6. Mr. Sayan Promjinda ,,  
7. Mr. Nakaret Yasook ,,  
8. Mr. Suchart Kitsamut ,,  
9. Mr. Komson Pofa ,,  
10. Dr. Taweekiet Amornpiyakrit ,,  
11. Dr. Nopporn Manajit ,,  
12. Mr. Weerasak Yingyuad ,,  

¹ organized under project deep-sea fisheries resources exploration in the Southeast Asia during 31 August - 2 September 2010
Activities summary

Lecture
Two topics related to basic knowledge echo-sounder including bottom topography survey and mapping the sea floor basic knowledge were lectured by Asst.Prof. Pachoenchoke Jintasaeranee (Ph.D.) from Department of Aquatic Science, Faculty of Science, Burapha University. He also shared his experience on sea floor mapping project in collaboration with German University in Andaman Sea. His lecture notes were attached in Annex I and II.

Performance testing result

1. Underwater VDO camera (SEA Viewer underwater VDO camera), fig. 2
   The sledge attached with Underwater VDO camera were operated five cast to depth about 20 meter near Ko Phai island (fig.1) to test the most suitable angle of VDO camera and light to capture bottom seafloor. It was found that the survey area is high turbidity; the light source from the SEA Viewer is too low to focus sea floor. Following is recommendation for the future SEA Viewer cast in the turbid water.
   - SEA Viewer light should be turn off (the camera lens focus to colloid / suspended solid when turn on the SEA Viewer light)
   - Use outside light source which should be alternately switches on and off every 5 minutes to save battery.
   - Trawling speech 0.7-1 knot
   - Attached angle of SEA viewer to frame is 67°
   - Operating time should be in day time
   - Should overlay position from GPS to VDO
   - Should mark length of sea cable to correct position

2. Remotely Operated underwater Vehicle (ROV), fig. 3
   The ROV system is working well when testing on desk. With unknown reason it malfunctions when lowering to depth about 20 meters after 5 minutes testing period. Both underwater and on desk unit were check by Port engineer. There were no part of the ROV is leak. He suggested to send main board of underwater unit to repair.

3. Side Scanning Sonar (Furuno HF 600)
   The system was not able to retrieve before the workshop period. The performance testing of HF600 was abolished from the schedule. We are contracting to Furuno co. Ltd. to repair the system.

4. Echo Sounder (Furuno GP-1650 WF) fig. 4
   The Furuno GP-1650 WF is working well when testing. However some improvement is need for better operation in term of quality of data and convenience for practical operation including:
   - Portable rack for installing transducer (fig. 5)
   - Purchase electric power inverter (220 V to 12 V)
   - Operate at ship speech 2 knot
   - Data should be plot to overlay with underwater VDO seafloor

5. High opening trawl, fig. 6
   Refer to MV SEAFDEC 2 survey in Vietnam cruise no. 39-1-2012 that more than 50% of survey area are in the water deeper than 100 meter depth. The bottom trawl of M.V SEAFDEC 2 opening mouth is too small for sampling mid water fishery resource. In order to solve the problem, SEAFDEC/TD construct new High opening trawl which more appropriate for the mid water fishery resource survey.
This new high opening trawl were operated four haul to adjust trawling technique. Trawling area are near to Phai island where depth about 30-40 meter. This trial suggested that it able to catch pelagic fish. Highest catch rate was 94 kg/hour. Majority of catch are pelagic fish. Following is note for future operation and improvement of high opening trawl.

- The trawl body of high opening trawl is lighter than bottom trawl, therefore M.V. SEAFDEC 2 able to trawl at faster speed to maximum at 5 knots.
- Trawl trial by M.V.SEAFDEC 2 found that maximum trawl height is 22 meter with ship speed at 3.5 knots while the faster speed (4.5 knots) reduced trawl height to 8-12 meter.
- Head rope should be improved to avoided entangle with trawl wing. Number of float should be added as well in order to increase the trawl height.

Figure 1 Map of working area (pink square)
Figure 2 Underwater VDO camera performance testing
Figure 3 ROV performance testing
Figure 4 Portable Echo Sounder performance testing

Figure 5 Suggested Echo sounder transducer mouthing unit
Figure 6 High Opening Trawl performance testing
### Activities time table

<table>
<thead>
<tr>
<th>Date/time</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>17 September 2012</strong></td>
<td></td>
</tr>
<tr>
<td>09:00-10:00</td>
<td>Lecture on Bottom topography survey by Dr. Pachoenchoke</td>
</tr>
<tr>
<td>10:00-11:00</td>
<td>Lecture on Mapping the sea floor by Dr. Pachoenchoke</td>
</tr>
<tr>
<td>11:00-14:00</td>
<td>Equipment preparation</td>
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<td>14:00-16:00</td>
<td>M.V.SEAFDEC 2 leave for Phai island</td>
</tr>
<tr>
<td>17:00-19:00</td>
<td>Underwater VDO camera performance testing</td>
</tr>
<tr>
<td><strong>18 September 2012</strong></td>
<td></td>
</tr>
<tr>
<td>05:00-08:30</td>
<td>High opening trawl performance testing</td>
</tr>
<tr>
<td>08:30-10:00</td>
<td>Portable echo sounder no.1 performance testing</td>
</tr>
<tr>
<td>10:00-11:00</td>
<td>High opening trawl #1</td>
</tr>
<tr>
<td>11:00-13:00</td>
<td>ROV performance testing</td>
</tr>
<tr>
<td>13:00-15:00</td>
<td>Underwater VDO camera performance testing</td>
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<tr>
<td>15:00-17:00</td>
<td>High opening trawl #2</td>
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<tr>
<td>19:00-19:30</td>
<td>Discussion for testing result</td>
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<tr>
<td><strong>19 September 2012</strong></td>
<td></td>
</tr>
<tr>
<td>06:00-07:30</td>
<td>High opening trawl #3</td>
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<tr>
<td>07:30-10:00</td>
<td>High opening trawl #4</td>
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<tr>
<td>10:00-11:00</td>
<td>Packing all equipments</td>
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<tr>
<td>11:00-15:00</td>
<td>Leave for SEAFDEC/ TD</td>
</tr>
<tr>
<td>16:00</td>
<td>Arrived SEAFDEC/ TD</td>
</tr>
</tbody>
</table>
Bottom topography survey

Asst. Prof. Pachonchoke Jintasawat

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Faculty of Science
Birapha University
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ANNEX I

1997 Smith and Sandwell. Global sea floor topography from satellite altimetry and ship depth soundings. The data on shallow water need to be corrected before using (Smith & Sandwell, 2000).

Why do we need bottom topography surveys?

1. Risk
   - submarine landslide generated tsunami
   - tsunami propagation run-up model
   - applications as diverse as tsunami hazard assessment

2. Resources
   - communications cable and pipeline route planning
   - resource exploration
   - habitat management
   - territorial claims under the Law of the Sea

3. Climate changes
   - methane hydrate

Characteristics of known submarine landslides (Hampton et al., 1996):

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth (m)</th>
<th>Volume (million m³)</th>
<th>Speed (m/s)</th>
<th>Run-up (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Southeast Asia</td>
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<td></td>
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<tr>
<td>Hawaii</td>
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</tbody>
</table>

Recorded past submarine landslide:

The Kilauea landslide (Booij et al., 1993):
- caused by the collapse of Kilauea Volcano on Oahu in Hawaii ~1.5 myr. ago
- the slide volume was 1,500 km³
- extends more than 230 km from the island.
- no tsunami records

Recorded submarine landslides generated megatsunami (the Sumatra slide):
- caused by the rush of sand and mud off Sumatra coast ~950-9,000 yr. ago
- slide length ~12,000 km down a slightly sloped seafloor, with an initial burst of speed ~70 km/h.
- the estimated maximum volume of slide displacement was 2.4 km³ and the maximum was 3.2 km³
- mass slid around 800 km into the deep sea.
The storegga landslides generated mega tsunami
- tsunami reached a height of 25 m in Scotland and along the coasts of Iceland, Norway, the Faroe Islands and Shetland (Brooks et al., 2003)

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2004 Sumatra-Andaman Earthquake (M=9.2)
- The initial tsunami generated from 2004 & 2005 (USGS, 2005)

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2005 Northern Sumatra Earthquake (M=8.8)

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Tsunami wavetrain for the 2004 Sumatra-Andaman earthquake 1 hour after generation

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Tsunami bearing pattern associated with the 2004 Sumatra-Andaman earthquake.
Lighter colors represent higher open-ocean tsunami amplitudes

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What mapping techniques are available?
- Bathymetry mapping (Single beam/Multibeam echosounding)
- Reflection-seismics (3D/4D)
- Side-scan sonar
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2. Resources - Natural gas & petroleum
- Natural oil & gas complex
- Communications cable and pipeline route planning
- Resource exploration

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3. Climate changes
- Methane hydrate
- Global warming

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Methane Explosion Warned Predictions Earth

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Areas affected by the 2014 Indian Ocean tsunami

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The 2014 Indian Ocean tsunami hazard map for Khun Lak Bay assessed from field surveys and reconstructed tsunami run-up from tsunami deposit characteristics (Glaubem & Wanea, 2010)
A new detailed bathymetry

- The depth accuracy tests revealed that 95% of the processed grids obtained values equal or better than 1% of water depth.
- The map is acceptable for the generation of a final grid [Bayer et al., 2000; de Almeida et al., 2003; Bayer et al., 2005] when grid resolution has been set to 50 m.

Previously unknown plateaus

- The plateau A has an elliptical shape and covers an area ~26 km². The plateau B-D is ~246 km², and the plateau E-J covers ~466 km².
- The plateaus have an almost flat top, but are slightly inclined seaward.
- The edges of the plateaus are bounded by rather steep vertical slopes with relief heights of about 50 m towards the shelf and exceed more than 200 m towards the slope.
- All plateaus show the presence of cracks around their edges and deep moats surrounding them.

Fluid flow features

At least 24 locations show evidence of possible gas or fluid accumulation below the seafloor in the southwestern part of the study area in water depths of about 550 m

Previously unknown mud dome

- The size of the dome is ~20 m height and 60 m length.
- Strong subbottom echoes and echoes in the water column suggest that sediments are gas-charged in the vicinity of the mound and that gas may even escape into the water column.

- One landslide (a) is studied at a water depth ~670 m.
- The displaced mass is ~100x10⁶ m³.
- Sub-bottom profiling recorded shows deposit of the failed mass.

- Another slide is studied at a water depth ~860 m.
- The failure is ~150x10⁶ m³.
- A subbottom profile indicates different phases of failure processes.
Mapping the seafloor

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18th century First bathymetric measurements with plumbs
(ship-depth sounding)

Maury (1855)

Ship-depth sounding map
(Navigation charts NC)
- Measure a wire angular to
calculate actual depth
- Tide compensates to MSL
- Map projection
- Datum Indian1975/WG584

Bathymetry from space

Specific netCDF data format

How can we read the GDA data?

netCDF (network Common Data Form) is a set of software
libraries and self-describing, machine-independent data
formats that support the creation, access, and sharing of
array-oriented scientific data.

C++, Fortran, Perl, MATLAB, Octave, Python, GMT

Concept of single beam echo-sounding

2*water depth = Vw*Ft
Vwater=1.5km/s
depth (km)=1.5/2*Ft
What opening angle should we use?

Concept of multibeam beam echo-sounding (Sea beam)

Multi-beam echosounder are using a swath of beams giving off-track-depth

How do they work?

Figure 2.8 Principle of bathymetric mapping system, manufactured by General Instrument Inc., USA. (a) Total area of a survey is divided by transmission points. (b) Areas of the survey covered by omitting hydrophones. (c) Signals are sampled from 90 rectangular areas. (d) Combination of (a) and (c), showing the sampled acoustic energy, covering from 0 to 8000 m. From Boyd and Andros, 1979. Reproduced by permission of the International Hydrographic Bureau.

Bottom Coverage by Survey Method

Leadline  Single Beam  Multibeam

- Study area is the western part of Meggi ridge in the EEC
- To determine the morphology of the area for future investigations
- To identify prominent features
- To determine the extent of the area

Field survey:
- 1st cruise: 10 November - 6 December 2008
- 2nd cruise: 6 - 15 November 2008

Research vessel:
- RV Chaotian, Tianjin, PR of China
SEABEAM 1050
- 3000 m depth performance
- frequency 50 kHz
- number of Beams max. 126
- beam Width 15°
- power Supply 115/230V AC, user selectable
- integrated side scan view
- real-time motion compensation
- Windows 2000/XP or UNIX-LINUX
- portable and easy to install
- survey speed up to 16 kn for continuous seabed coverage

How to process bathymetric data
- Position/Time/Ship motion
- Edit file system
- Simulate GMT script
- Mapping GMT scripts
- Global mapping/redemission

MultiBeam Processing
1) Professional (proprietary) software:
   - System independent software, i.e., Carl, Grassi,
   - Software delivered with system, i.e., Raveskarp, Seabean, Pisam, Atlas

2) Free software:
   - MultiBeam System

The MB-System™ Cookbook
Val Schmidt, Columbia University
Dale Cayes, Columbia University
Dave Caress, Monterey Bay Aquarium Research Institute

Processing strategy
• Organize your data in useful surveys (revised area, data size)
• Check the raw data to get an overview about area coverage and quality of depth data, navigation data, metadata (roll, pitch, heave)
• Plot data, look at statistics
• Process Navigation data (smoothing)
• If necessary (and possible), replace depth data with better VSP
• Automatic data processing (Etak)
• Interactive depth data processing
• Grid and display data

The Generic Mapping Tools
- Generic
  - Project, Translate, Rotate, Resample, GridMap
- Tools
  - Ca. 30 programs and transformations

Operating system: Unix, Linux, Windows
License: Public Domain, GNU General Public License
Homepage: gmt.soest.hawaii.edu
Fledermaus Professional is a powerful 3D data visualization system that uses the same core technologies as Fledermaus Standard, plus adds a sophisticated Area Based editing module, cable and route planning, and real-time tracking of objects. Fledermaus Professional is used in a variety of applications such as earth bathymetry, dockside and quality control, marine construction, military applications, and coastal zone mapping.

Featuring the same intuitive data display as Fledermaus Standard, Fledermaus Professional is capable of visualizing large volumes of data of numerous types in a single 3D scene with the powerful SHRScape™ rendering engine. Data display can be controlled with the Sea, an intuitive 6 degree of freedom input device.

A wide variety of industry standard formats are supported for direct import of data to the 3D scene, and Fledermaus also allows data from remotely operated vehicles, ships or other entities, to be visualized in real-time. Due to its flexible object oriented software design, Fledermaus can be easily tailored to support many additional visualization modules.

If you would like more information on Fledermaus, the full documentation is available online. A free viewer for Fledermaus files named View3D is also available.

Features
- Contains all of the functionality of the Fledermaus Standard visualization package.
- Adds a powerful Area Based editing module for processing data from a wide variety of multibeam, single beam, LiDAR, or other data formats.
- Support for OFUE based statistical based processing with support for uncertainty surfaces, error modeling, and multiple hypothesis editing, QC, and analysis.
- Track the position of remotely operated vehicles, AUVs, or other vehicles and visualize the object in real-time in a 3D scene.
- Plan routes for pipelines or cables with the Routplaner application.
- Perform sophisticated statistically analysis of multibeam surveys to ensure data quality control.