THE SEAFLOOR MORPHOLOGHY OF SUNDA STRAIT FOR LAYING THE UNDERWATER CABLES

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ABSTRACT

The coastal and offshore areas around the Sunda Strait will be developed to be a submarine cable corridor connecting between Java and Sumatra Islands. There are some requirements that should be considered before laying the underwater cables.

One of these considerations is to understand the seafloor morphology of the Sunda Strait. The study was conducted based on six of track lines with 1 km line spacing and 4 Cross lines. The water depth obtained then was corrected to the depth of water from the Lowest Water Level (LWL).

The seabed condition in the near shore area of Sumatra side is very flat and is influenced by 2 km offshore tide activity. The coast line is characterized by mangrove and fine fraction of sediments (mud and clay). At the Java side, the coastal morphology is characterized by the very steep slope and most of the area is occupied by the industrial activities.

Keywords: seafloor morphology, under water cables, Sunda Strait

SARI

Area pantai dan perairan Selat Sunda akan dikembangkan sebagai bagian dalam penempatan kabel bawah laut yang menghubungkan Pulau Jawa dan Pulau Sumatera. Rencana penempatan kabel bawah laut ini membutuhkan beberapa persyaratan teknis yang harus dipertimbangkan.

Salah satu pertimbangan untuk peletakan kabel bawah laut adalah memahami morfologi dasar laut selat Sunda. Penelitian dilakukan berdasarkan 6 lintasan pemeruman dengan jarak antar lintasan 1 km, dan 4 lintasan memotong lintasan utama. Kedalaman laut yang diperoleh kemudian dikoreksi dengan muka laut terendah.

Kondisi permukaan dasar laut di sisi pantai Sumatra sangat datar serta sejauh 2 km ke arah laut lepas masih dipengaruhi oleh aktifitas pasang surut. Garis pantainya dicirikan oleh tanaman bakau dan fraksi sedimen halus (lumpur dan lempung). Pada sisi Jawa, morfologi pantai dicirikan oleh kemiringan lereng yang curam dan kebanyakan area ditempati oleh aktivitas industri.

Kata kunci: *morfologi dasar laut, kabel bawah laut, Selat Sunda*

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INTROUDUCTION

The study area is located in northwest part of Sunda Starait between Java and Sumatera Islands. Administratively, it belongs to the Kalianda District, Lampung Province and the Cilegon District, Banten Province. Geographically, the area is located approximately between latitude 5^{o} 55' 39.5" and 5^{o} 40` 22" South; and between longitude 105^{o} 46' 7" and 106^{o} 6'42'' East (Figure 1).

The Sunda Strait will be developed to be a submarine cable corridor connecting between Java and Sumatera Islands. Inrelation to this planning, there are some requirements that should be consired and one of these is to understand the seafloor morphology of the Sunda Strait.

The purpose of this study is to conduct coastal and marine geological/geophysical investigations to have a location for laying the underwater cable. Some of data such as geological and geophysical both *horizontally and vertically* are required as a place for cable laying corridor. The natural conditions of bathymetry, tide observation and physical submarine sediments of the study area are required for making viability assessment for the cable installation based on the map of seabed profiles along the survey routes.

A previous study shows that the seabed morphology was influenced by the current, the tidal condition and the sediment covered the study area (Kuntoro et al,1990). It is expected that the survey results could provide in making an assessment on the potentiality of cable installation within the selected area.

Data and map of bathymetry were derived from the Naval Hydrographic and Oceanographic Service (Dishidros-TNI AL,..........). The bathymetry map was made from data point of depth and was transferred to

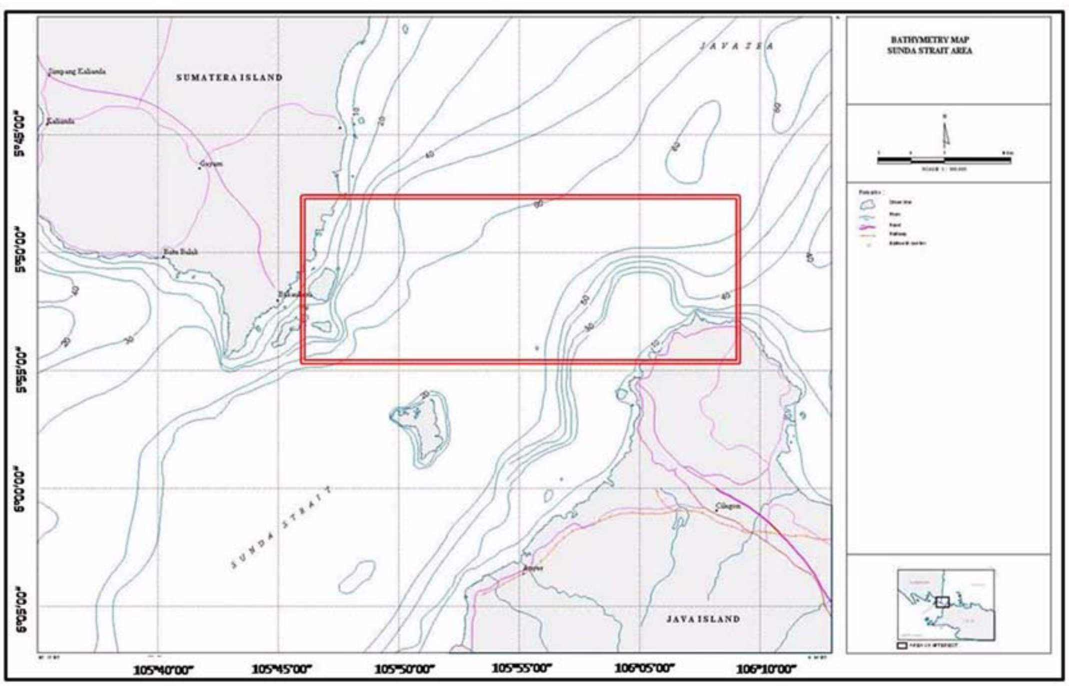

Figure 1. Study area

generate a contour map. Furthermore, this contour was used to create the Digital Elevation Model (DEM) in order to illustrate the seafloor in 3D form. Based on the bathymetrical map, the deepest part of study area is about 79 m. Figure 2 shows bathymetry map of study area and seabed morphology in 3 Dimension.

The oldest rock of Sunda Strait basin has the same stratigraphic condition with South Sumatra Basin. The Miocene rock has the same condition with the west Java Basin. Generally the Sunda Strait basin consists of Talang Akar, Baturaja, Gumai, Air Benakat, Parigi and Cisubuh Formation (Mangga et al., 1994)

Sub Bottom Profile

Base on subbottom profile data, the development of geological structure around the Sunda Strait water is being concentrated at the narrow strait. These faults have a very high density and the distribution can be divided into 2 zones. The first zone has a pattern and direction parallel with the fault at the Lampung bay. The second zone shows as a minor structure and was resulted from the development of fracture zone. The surficial sediment based on the megascopic and microscopic analyses, consisted of muddy sand with small amount of gravel, Sandy mud with gravel and Gravelly mud with small amount of sand (Kuntoro et al 1994).

Coastal Topography

The coastal tophography has been classified based on Dolan, 1975.

Generally, the coastal topography of Java and Lampung is different. The coastal topography of Java is steep and hilly (Mustapa et al., 2004). The flat area is found around the coast and the maximum elevation is about 80 m. The topography of Sumatra side is less undulated with the maximum elevation of about 35 m above sea level.

Conditions of eastern coast of Sumatra constitute swamp region with low relief / flat. Based on the geological map it is being covered by alluvial. Beach inclination/slope is generally less than 1°, but then local area encounters undulating and hilly areas, which form a part of young volcanic features. Shoreline on this region generally constitutes mangrove with muddy sediments.

Conditions of west coast of Java constitute a system that is influenced by Sunda Strait conditions. On the north of the area is a cape region originated from the member of Gunung Gede volcanic rock. This region is located in the north of Merak. Conditions of beach in this region are relatively stable and have beach morphology of adequately steep feature. Beach inclination/slope varies from 3° to 5°. In the local area contains of pocket beach, that consisting of alluvial with medium sand.

METHODS

The study activities consist of Echo sounding with very high accuracy of positioning system (Differential Global Positioning System) and sampling of Sea Bottom sediments by using gravity corer.

To identify the vertical datum, the measurement of tide for 15 days was done. The tide data measured during the study period was used for correction of echo sounding measurement. The calculations of vertical datum have used the admiralty method, and as a result Mean Sea Level was obtained. The vertical datum was derived from the calculation deducting Zo from the MSL The water depth obtained then was corrected to the depth of water from the Lowest Water Level, LWL.

The study area was determined taking into account the recognized result and the six of track lines with 1 km line spacing and 4 cross lines was designed.

The positioning system was linked to a laptop computer/notebook, which processed

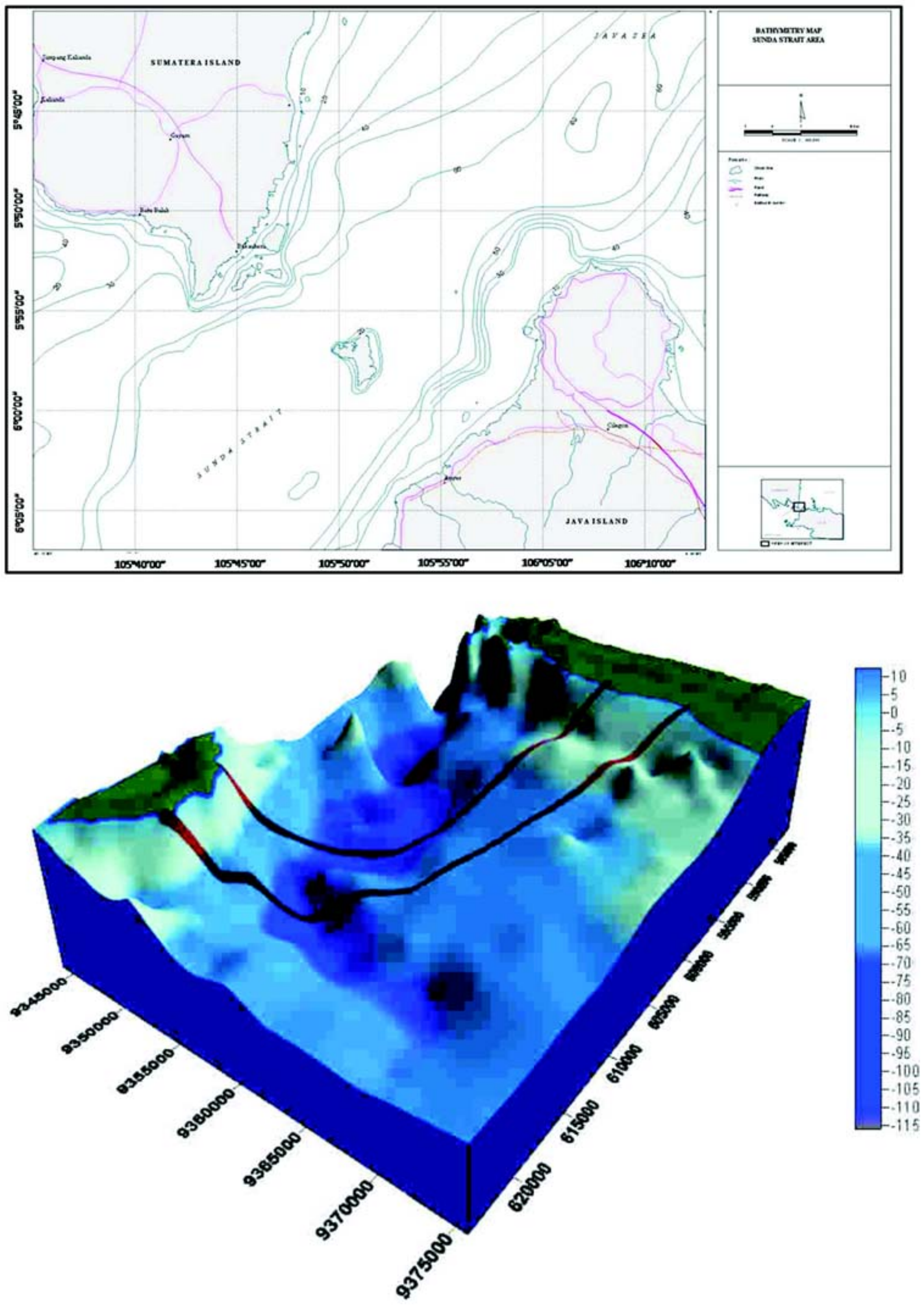

Figure 2. Bathymetry map regional and the seafloor in 3D form was used to create the Digital Elevation Model (DEM)

Table 1. Harmonic constants of tide at Ketapang area

Component	So	M2	S2	N2	K2	K1	O1	P1	M4	MS4
A (cm)	87.2	10.7	13.04	2.65	1.09	12.59	9.92	6	0.71	0.91
G		73	306	69	37	90	103	334	151	14

the data for boat navigation by the software "HydroNAV". Then all the positioning data acquired were processed by Excel programs. The output data of this method above are based on the ellipsoid WGS-84, where the coordinates of study results were drawn in the map based on the UTM projection.

RESULT AND DISCUSSIONS

Acquired results of study activities are the data of tidal observation, bathymetry and sediment sampling. The measurement of tide was carried out for consecutive 15 days at Mr. Seli's Port, Ketapang. Method that utilized on tidal data analysis is British Admiralty Harmonious method, which accounts for tidal harmonic constants consisting of: mean sea level, amplitude and phases of 9 tidal components (M2, S2, N2, K1, O1, M4, MS4, K2, and P1). The results of the tide harmonic analysis are shown in Table 1 above.

The results of tide harmonic calculation of data in table 1 are as follows :

- Position of high water spring (HWS) above mean sea level (MSL):
- The results of high water is 37.25 cm above mean sea level.
- Position of high water tide is 50.29 cm above mean sea level.
- High water is 56.29 cm above mean sea level.
- Position of lowest high water is 60.56 cm above mean sea level.

Route Description

The sounding survey was acquired along the 6 main lines (S1; LP; N1; N2; N3; N4) with the line spacing of 1 km in addition to the 4 cross lines (Figure 3). Prior to the survey, the level of water relative to station level was measured at the time noted. The water height determines the water level relative to the LWS, hence the level of the survey station.

The line N-1 is located in the northernmost of the prospected area. At the Sumatra side location, the coast condition is very flat and is influenced by 2 km offshore tide activity. The coast line is characterized by mangrove and fine fraction of sediments (mud and clay). At the Java side, coast morphology is characterized by the very steep slope and most of the area is occupied by the petrochemical industry activity.

The line N-2 is located in the south of N-1. The condition of sea bottom morphology shows the same features as the line N-1, but the area close to the Sumatra side is characterized by the undulation surface of coral reef.

The condition of Line N-3, at the Sumatra side is characterized by transition area between mangrove and sandy coast. The slope around the coast is steeper than N-1 and N-2, which translates that the area is not likely to be affected by tide than other areas.

The line N-4 at the Sumatra side, the landing point is characterized by the steeper slope than the other at southern and northern coastal area. At some locations near the coast

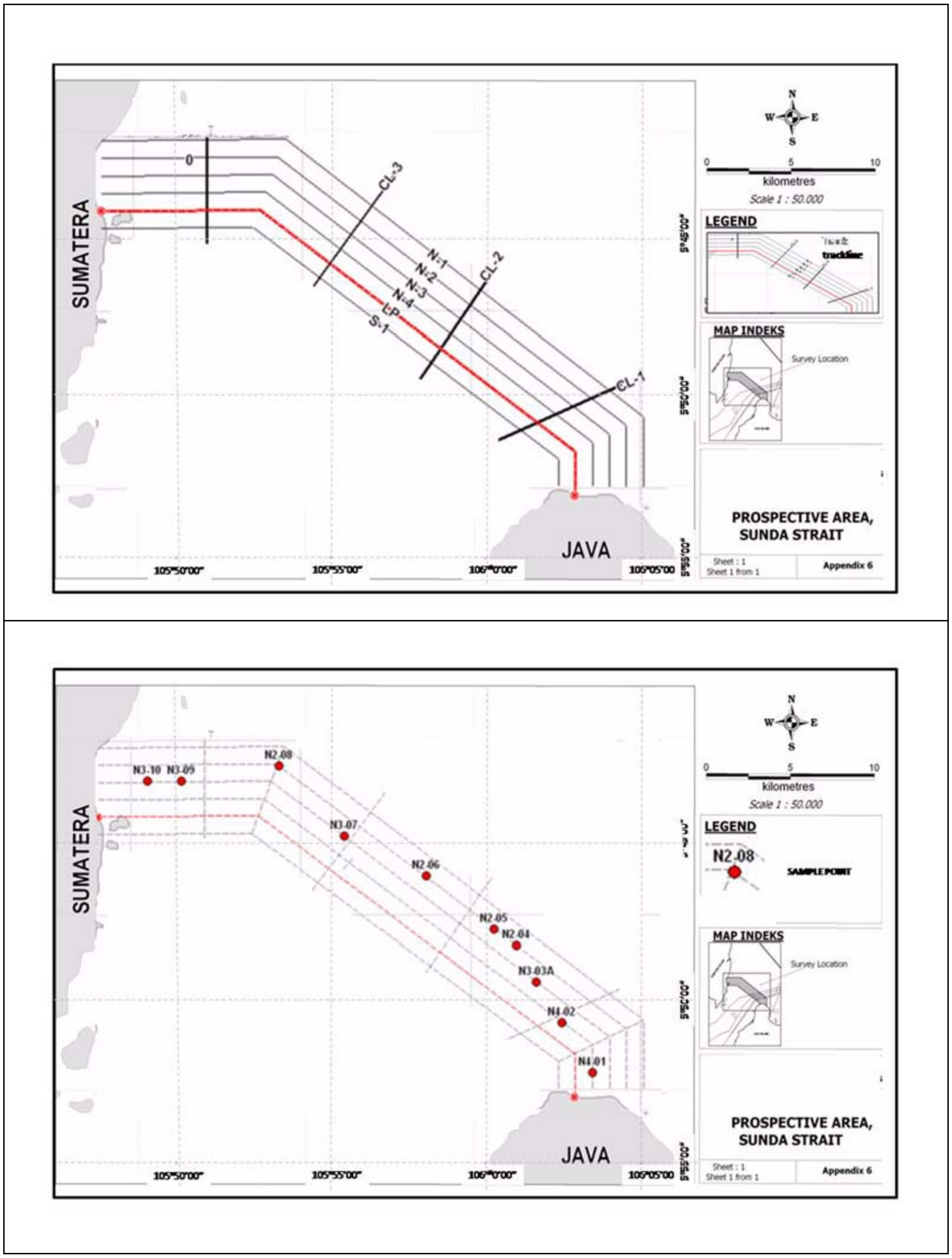

Figure 3. Survey track lines and sampling sediment locations

cliffs are found a relatively height of about 2m However, the ground stability looked better than the other coast for cable landing point and switch yard. Furthermore the area is located on a hilly ground being protected from the wave action.

The LP (Landing Point) is the tentatively designed cable landing point where the respective survey lines intersect with the shoreline. Some lines were considered to be appropriate to alter its course to the N-2 line due to the offshore morphology at Java side, which is being characterized by steep slopes. At the Java side, the prospective submarine cable Landing Point and switching yard are located around Salira Coast.

The line S-1 is the southernmost survey line. The coast condition is the same as LP line. At the Sumatra side the near-shore area is covered by sea grass plantation and at Java side the area is occupied by PLTU Suralaya.

The 4 numbers of cross line was selected, which crossing the 6 main lines almost perpendicularly. The sea bottom morphology of CL-2 and CL-3 is characterized by the slope of less than 1^o, but CL-1 and CL-4 is characterized by the slope between 1^o and 10^o.

The bottom samples were collected at 10 locations in the Sunda Strait. From the megascopic description analysis that in general the soil/sediment in the survey area is featured by sand to sandy materials at the top and clay minerals at the bottom. The surface distribution of sand (top) is very thin, between 3 and 9 cm in thickness. Since the catchers of corer were damaged at locations 4 and 5, the seabed there was assumed to be constituted with very hard materials (rock?).

The study area can be divided into six apparently different topographic conditions. Followings are the descriptions about those specific features lying across the survey area from the Sumatra to Java Island (figure 4 and 5).

a. The seabed in the near shore area of Sumatra LP is characterized by the widely spreading shallow water. The seabed beyond the 5m contour line gradually changes its slope. The sediments in this area are assumed to be the pro-delta sediments. Mostly sediment in this area up to a certain depth of water, the underlying bedding layer protrudes on the surface based on the echo sounding records obtained. The water depth at the end of these pro-delta sediments is less than 15 m at the survey line N3. From the result of bottom sampling at No.10, a terrace-like seabed feature is recognized at 15 m of water depth. It is assumed that the sediments extending from the shore portion would be trapped by the seabed features mentioned above and the bedding layer underneath is assumed to be the consolidated clayey sediments.

b. The trough accompanied by undulations exists in the seabed in the offing of the near-shore slope. A pinnacle-like feature is identified along the N2 survey line. This feature is also recognized in the trough feature mentioned at N3 and N4 survey lines. However, the sequentialities of these projections cannot be identified based on the cross line survey results and the sub-bottom profiling records provided by MGI. Therefore, it would be concluded that these projections were being formed after the formations of trough and undulations not by the dyke intrusion. Although we could not identify the bottom materials of this feature by this survey, it is inferred to be the reef-building limestone or similar materials. If it’s in such a case, an event of mass movement of turbid water flowing into the Java Sea might have occurred at a certain period in the past. It is recommended that the

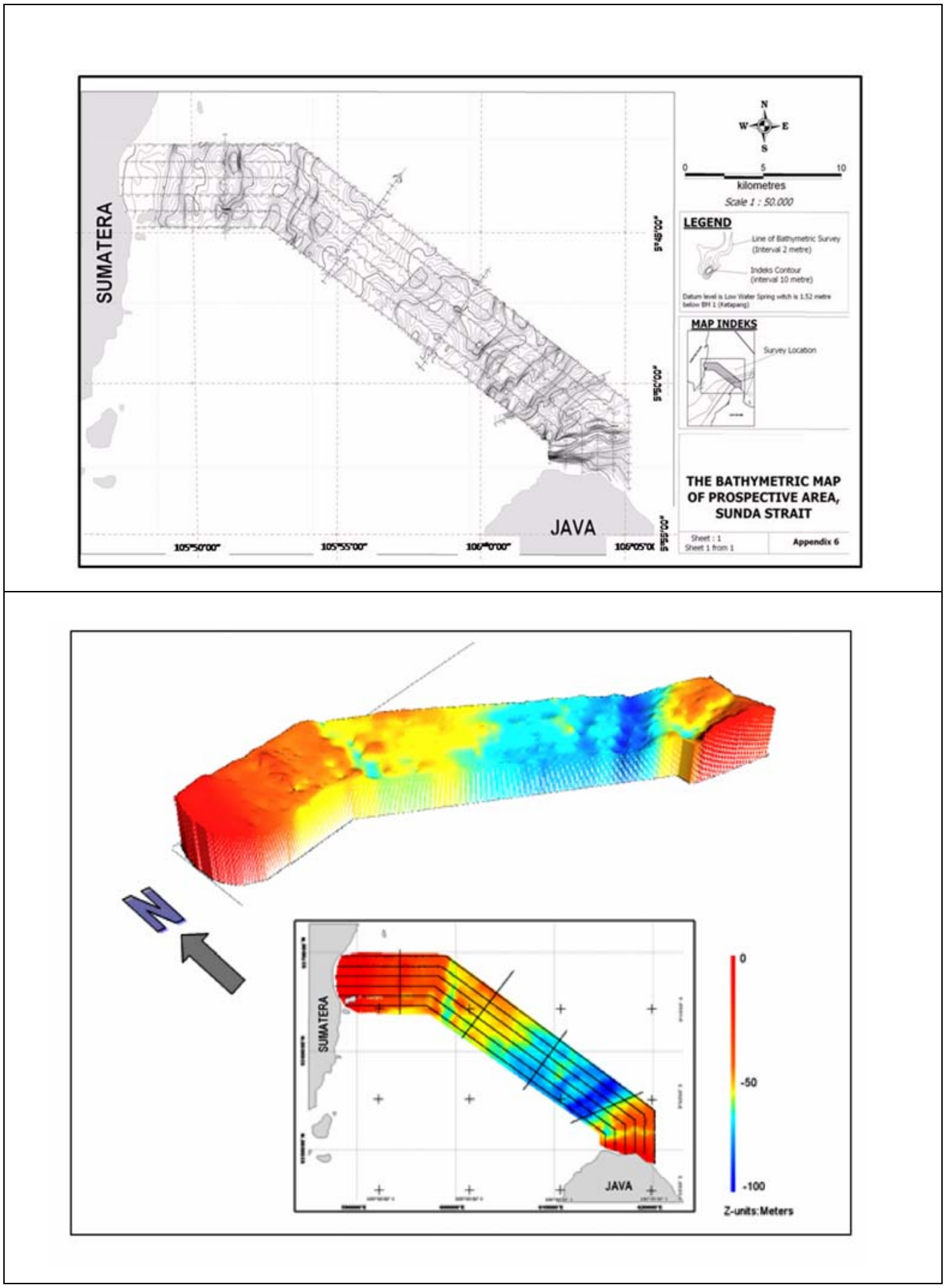

Figure 4. Bathymetri map result

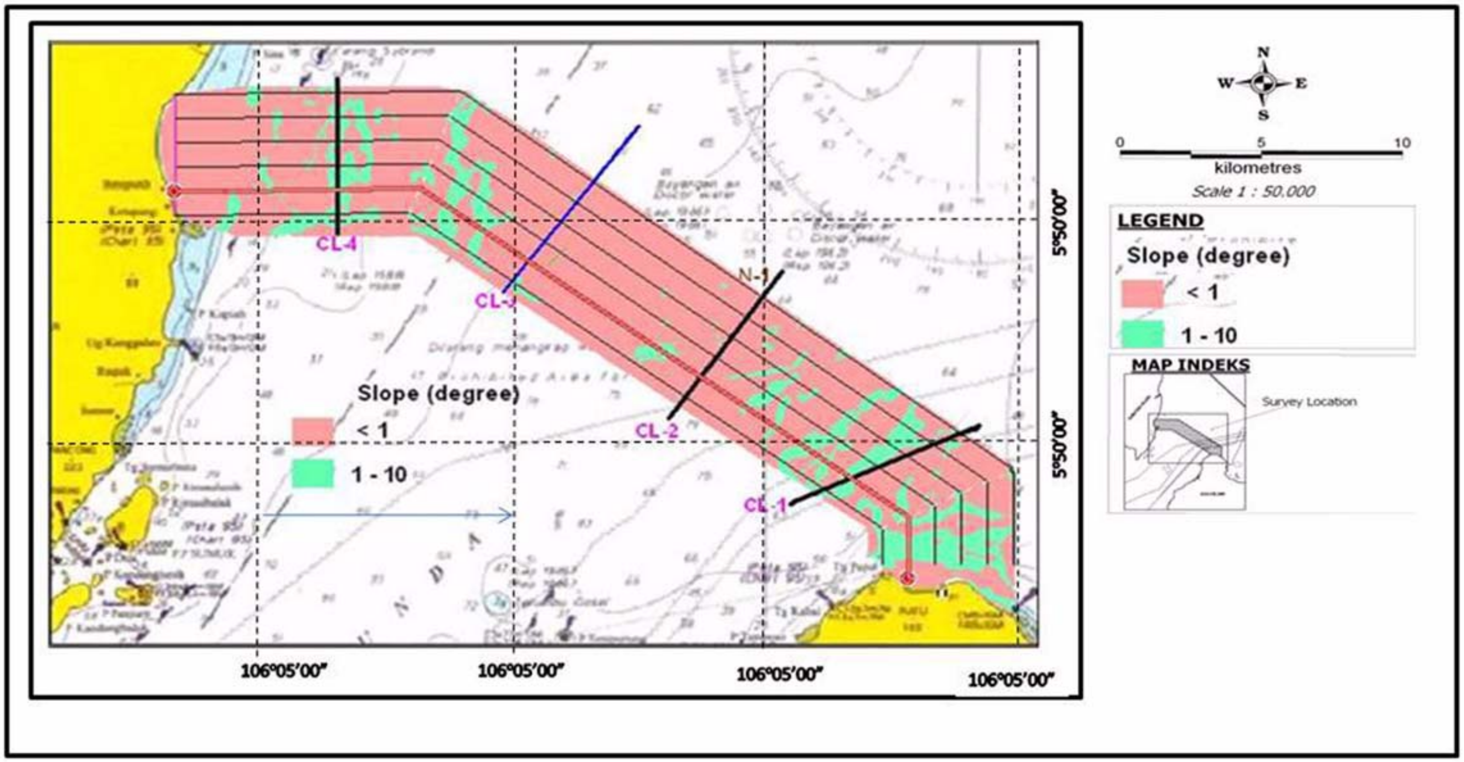

Figure 5. Crossline of N3, N2, N1 lines, black color slope $<5^{o}$ red color slope 1^{o}-10^{o}

detailed information as to this protruding topography should be obtained by the MBES and SSS surveys in the next phase of detailed design.

c. The erosional valley is identified in the east of topographic high along the survey lines of N3 and N4, however it is changed to depression contour with gentle slope at the survey line N2. This would either signify that the thalweg might have been altered at the northern part of survey line N3 or the potentiality of dividing ridge in the old period near the survey line N2. Since there seems to be some possibility of hollow bottom elongating from east to west, it is recommended to carry out the detailed survey by means of MBES for its confirmation in the next phase.

d. The depression contour prevails accompanied by the gentle slopes at the western portion of the central part of the strait. The thin layer of very coarse sand over semi-consolidated sediments formed by the assumed action of drainage for consolidation was confirmed from the sample obtained. If, in such a case that the prevailing undulations in and around the area were to be attributed by the differential erosion due to the interbedded sand, the application of sub-bottom profiler with higher resolution should be needed to reveal the different natures of bedding layers.

e. The undulated topography in deep water exists at the eastern portion of the central part of the strait, which would be difficult to avoid for the cable systems from this deep area between the Sumatra and the Java. Another topographic feature in this area is the steep slope with 25 m relative height in the southern part of N4. Further, a pinnacle-like topography is identified in the northern part of N3. A notable topographic feature is the water depth of 100 m, which cannot be recognized by the currently available nautical chart. If this topographic feature were attributed to be the caldron, it should be recommended to carry out the coring along with sub-bottom profiling for the confirmation of whether the sedimentation has already been occurred.

f. There exists factory equipment and mooring berth in the coastal area from N1 to N3 of the Java Island. The seabed along the survey line LP is characterized by the sequential steep slopes up to 70 m of water depth, though there exists small scale terrace-like feature with gentle slope at water depth of 44 m. On the other hand, the seabed along the survey line N4 is featured by the terrace like bottom with gentle slopes at water depths of 32 m and 42 m. The undulated seabed prevails beyond the water depth greater than 42 m. but its slope is not steeper than that of the survey line LP. Also the water depth in the deepest portion is 60 m along the survey line N4.

CONCLUSION

As a result, it confirms there exists some potentialities about the cable installation in the northern part of the survey area between N2 and N4.

The area between line N2 and N4, fulfill a createria for sub marine cable laying as follows relatively flat, weak current, and no human activities.

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