Marine Geological and Hydro Oceanographic Data for Site Seaport Location Selection at Sampit Bay and its Surrounding, East Kotawaringin, Central Kalimantan

Data Geologi Kelautan Dan Hidro Eseanografi Untuk Pemilihan Lokasi Pelabuhan Laut Di Teluk Sampit Dan Sekitarnya, Kabupaten Kota Waringin Timur, Kalimantan Tengah

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ABSTRACT: Sampit Bay is one of many main gates to enter the Central Kalimantan Province, because there is Mentaya River Mouth as an access to the Sampit Harbour as a main port at its province.Until now, the Sampit Bay only used as anchored for big ships waiting turn to enter Sampit Port. The methods used are coastal characteristic mapping, seafloor surficial sediment sampling, grain size analyses, echosounding, and current measurement. Sampit bay has sandy coast, sand of sea floor surficial sediment, and gradation of sea floor morphology which is suitable for sea port location. On the other hand, the velocity of the surface and midle current in the bay ranging between 0.1 – 0.3 m/second which is dominated by south east direction. The mentioned velocity is under threshold for safety ship anchoraged. Beside that, most of the bay open to the wind from west and south west facing Java Sea, where the velocity ranging from 5 – 13 m/second which is included into weak catagories. Location is recommended to be sea port candidate in the south of Ujung Pandaran.

Key words : Sampit Bay, port location, coastal characteritistic, sea floor surficial sediment, current velocity.

ABSTRAK: *Teluk Sampit adalah salah satu gerbang utama memasuki Propinsi Kalimantan Tengah, karena tempat bermuaranya Sungai Mentaya yang merupakan akses menuju ke pelabuhan Sampit sebagai pelabuhan utama di provinsi tersebut. Selama ini teluk Sampit hanya digunakan sebagai tempat lego jangkar kapal-kapal besar yang menunggu giliran untuk berlabuh di Pelabuhan Sampit. Metode yang digunakan adalah pemetaan karakteristik pantai, pengambilan contoh sedimen permukaan dasar laut, analisis besar butir, pemeruman, dan pengukuran arus. Teluk Sampit memiliki jenis pantai berpasir dan sedimen permukaan dasar laut pasir serta morfologi dasar laut yang bergradasi cukup layak untuk lokasi pelabuhan. Disamping itu kecepatan arus permukaan dan menengah di teluk tersebut berkisar antara 0,1 – 0,3 meter/detik dengan arah dominan ke arah tenggara, dimana kecepatan arus tersebut masih dibawah ambang batas untuk keamanan kapal berlabuh. Disamping itu, sebagian besar teluk tersebut terbuka terhadap hembusan angin arah barat dan tenggara yang berhadapan dengan laut Jawa dimana kecepatan angin yang bertiup antara 5 – 13 meter/detik dan termasuk dalam katagori lemah. Lokasi yang paling layak untuk lokasi pelabuhan adalah sebelah selatan Ujung Banaran.*

Kata Kunci : *Teluk Sampit, lokasi pelabuhan, karakteristik pantai, sedimen permukaan dasar laut, kecepatan arus.*

INTRODUCTION

Mentaya River is one of many largest rivers in Central Kalimantan, which empties into the Sampit Bay, and also one entrance gate to Central Kalimantan from the sea; thus, making the Sampit Bay has strategic significance value and potential for development. (Lugra et al., 1997).

Sampit Bay is located about 80 km from Sampit as the capital city of East Kota Waringin District, which could be assessed by road about 2 hours, and also could be reached through Mentaya River about 5 hours. The usage of Sampit Port from year to year tends to increase, accordingly, in the future Port Sampit facing problems to be able to provide the best service for the users. As one alternative to solve the problem is considering the Sampit Bay be developed as a port. Recenly, Port of Sampit is Container Port Category II, where the drift volume of goods export commodities, from year to year increase about 3.3% /year. While the rate annual growth volume of domestic goods inter-

island is 9.18% and the ship people traffic is increasing very rapidly, namely 27.13% /year.

Geographically, the area is located at coordinates of 112^{O} 54'-113^{O} 21 'E longitude and 03^{O} 00' - 03^{O} 15'S within Kecamatan Samuda, East Kota Waringin District, Central Kalimantan. Coastal features of the Sampit Bay is spit at Ujung Pandaran, with the direction of the spit is seasonally changed. On the other hand, the Sampit Bay also used as a place of anchorage ships that will enter to Sampit Port, waiting for the right moment to get into Mentaya River to the port.

The aim of the study is to determine the areas that suffered erosion, sedimentation and potential locations for the port. While the target is to support regional development for regional autonomy framework in marine resources and contribute to the development Sampit Bay as an alternative seaport viewed from marine geological aspects.

General Criteria For Determining The Location of Sea Ports

In general, the sediment transport systems in coastal is the interaction of waves, currents and sediment material. The characteristics of waves and currents indicate that energy dimention for sediment transportation. While, the waves and currents behavior influenced by wind velocity, wave generating position, and coastal topography. (CERC, 1984).

Frankel (1987) states that there are some factors should be considered in determining the location of the port, those are :

For the location of the port the first step is to arrange the potential locations of port sites, then choose a location with no natural condition problems, local conditions which include availability of labor, socio-economic and infrastructure. The natural conditions include climate, oceanographic parameters, surface and subsurface geology, and the depth of the sea.

Besides, the chosen location should be protected (Coastal Protection of US, 1989) from the effects of coastal processes disturbances that occur, for example as a result of environmental damages induced by coastal constructions around the port.

Nur Yuwono (1998) states that for protection of the coast, there are two approaches, namely the natural protection and artificial protection. Natural coastal protection is a protection provided by nature such as coast sand, mud coast and coral coast

While, artificial protection is the protection based on its usability whether a building against waves and so on, depended on its oceanographic character approaching the coastal area.

Construction of an artificial protection is done with technical approaches which include: changing of the longshore sediment transport rate, reduction of the wave energy that reaches the coast, strengthen of coastal cliffs to resist wave action, increase the supply of sediment to coast and planting trees undergo a coastal protection (Silvester, 1974).

Considering the Sampit Bay as disposal place for Mentaya River and several other small rivers. Accordingly, there is one thing to note stabilitation of river mouth with the Jetty construction. If the selected port location has not been protected naturally, there is a need to think about an artificial protector such as breakwater adapted to the layout of the harbor, ocean depths, high tides (Triatmodjo, 1996).

The general criteria for determining of port location that already discussed above, which need to be considered are : the sea water depth, the coastal characteristics / coastal processes, and geological conditions / lithology.

Geology

The study area is included within the geology map of Kuala Pembuang Sheets (Soetrisno, et al., 1995) as shown in Figure 1, with details of the units on the terrestrial lithology as follows :

- *Coastal Deposit* consist of sand, silty clay, loose quartz sand, white to yellowish colored, medium-fine-grained, not layered, locally was found marin organic. These sediments form sand dune morphology extends along the coast with 2 meters thickness.
- *River Deposit* consist of gravel - boulder, sand, silt, clay, which contains land organic remains.
- *Swamp Deposit* consist of peat, clay, silt and mud.
- *Unclassified clastic sediment* composed of sand, silt, clay and peat.
- *Pembuang Formation* composed of calcareous sandstone, conglomerates, silt, clay and peat. Calcareous sandstone is medium-coarse sizes, F-feldspar composition, carbon and biotite. Conglomerates have various material, quartz fragment particulary, calcite and sand stone. Not compact sandstone, fine- medium grained. This formation was deposited by traction currents mechanism in fluvial environment, namely rivers woven and river meandering, covering 3 cycles sedimentation and the estimated age of sedimentation is Late Pleistocene.

METHODS

The coastal characteristics mapping was done along the coast of study area. The elements mapped refers to the Dolan Classification, et al. (1975), which includes geology (lithology), morphology (relief) the shoreline character as well as the dominant processes that occur.

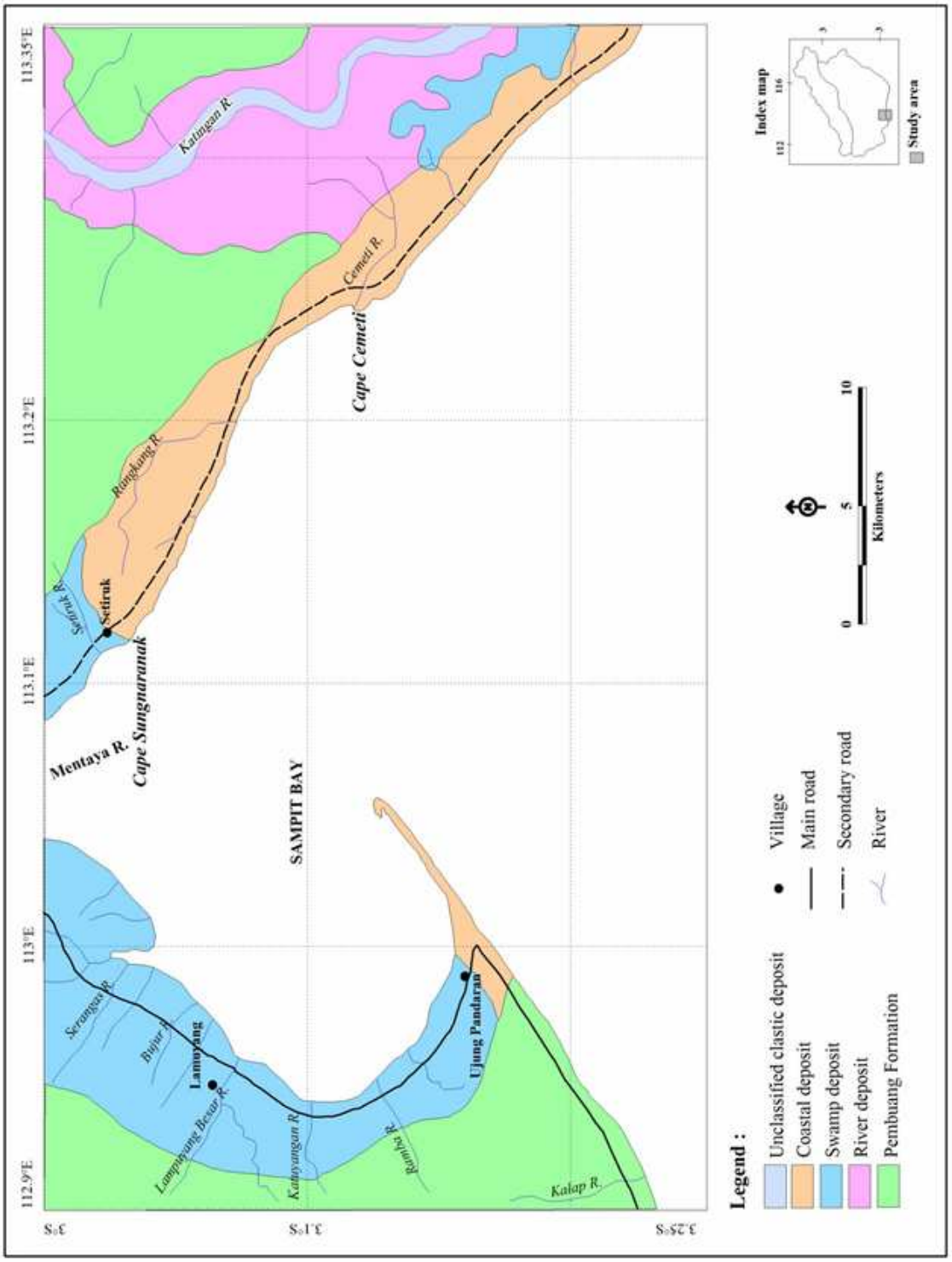

Figure 1. Geological map of sampit bay (Sutrisno,B., et.al., 1995).

Coastal and sea floor sediment sampling by grab sampler, with a predetermined lattice in order to obtain results for the entire region representative of the study area, followed with grain size analysis to determine the sediment texture and its statistical parameters refer to Folk, (1980). Mapping the seabed morphology was used echosounder Raytheon 200KHz with trajectory track line that covers the study area. The whole positioning is done with Magellan GPS M500Pro. Tidal observation was also carried out for 15 days to determine the type of tidal and bathymetric map correction. Trajectory observations to determine the current pattern at 3 depth levels (surface, middle and deep current).

RESULS

Coastal Characteristic

Based on the main parameters mentioned above, the coast of study area can be classified into 2 coast types as shown at figure 2. (Lugra et al, 1997 & Astawa etal, 1999), namely:

Sandy coast (Type I)

This coast type is spreading at some places namely Ujung Pandaran (southwestern of study area), Setiruk, Tanjung Cemeti (eastern part of study area) and west off Ujung Pandaran. Relatively the sandy coast at ujung Pandaran is accretion, where the coast relief is moderate and occupied about 25 % of the coast length in study area. The coast sediment is dominated by sand

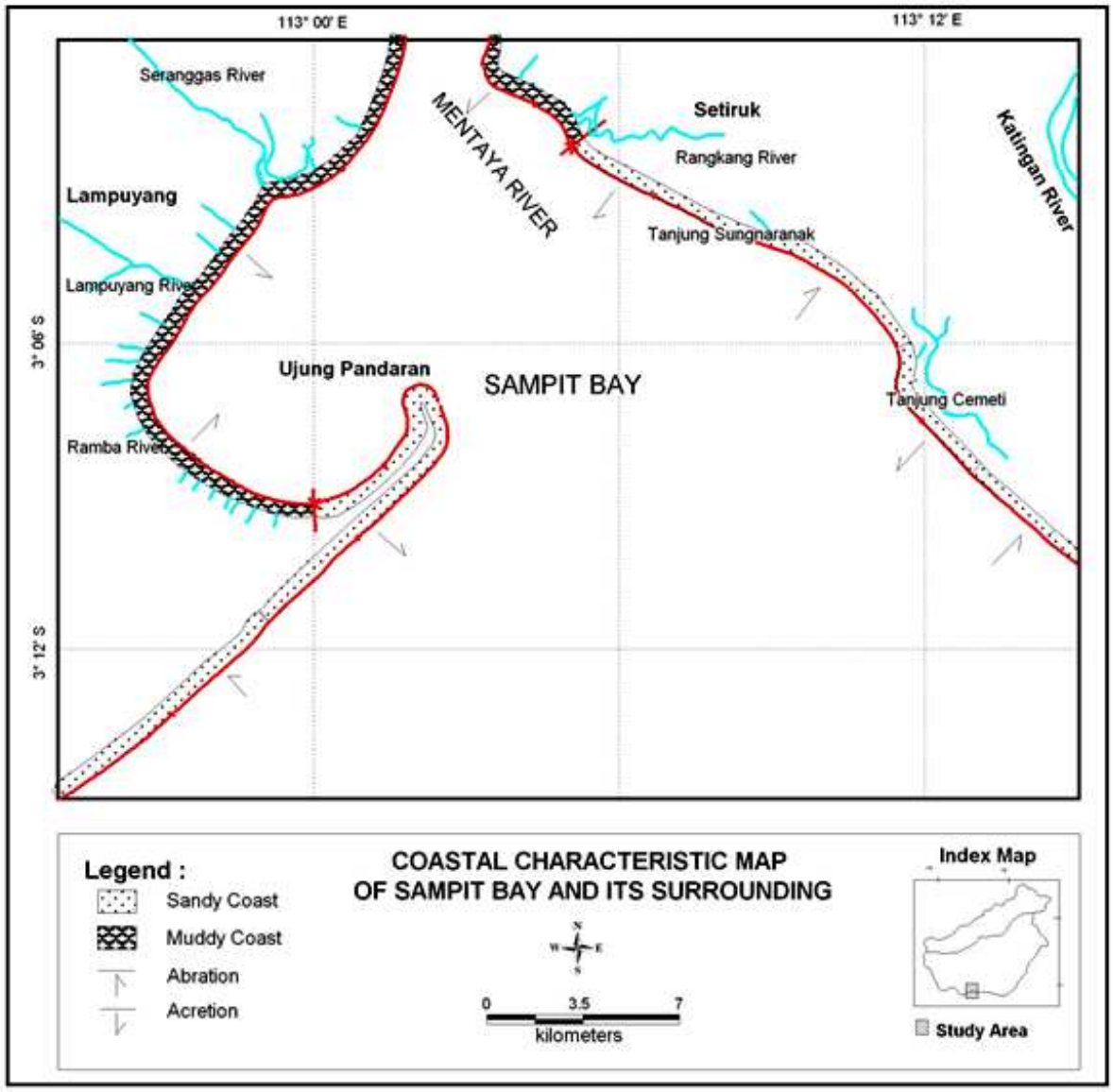

Figure 2. Coastal characteristic map

deposits (white sand), a few of silt and clay, with slope of 6^o - 9^o (Figure 3 & 4). The coast width ranging between 11 to 25 meters. The vegetation is dominated by pine trees, coconut and coast grass. Generally this type of coast is sedimentation and the dominant process of coast formation is marine process, suggested the sediment source from alluvium unit and Pembuang Formation detrital.

The sandy coast at Setiruk and Tanjung Cemeti have moderate relief and occupied about 20% of the total coast length in study area (Figure 5). Coast sediment consists of sand, gravel and clay and had been eroded. The erosion evidence is shown by many mangrove trees uprooted as a result of waves action that hit the coast.

The sandy coast at the west off Ujung Pandaran (west end of study area), arround 15% of coast length of the study area. The coast are dominated by sandstone of Formation Kuala Pembuang which well exposed along the coast (Figure 6).The coast relief is medium to high cliff, with rugged coastline character, consist of white sand (quartz). The coast slope ranging from 6^o - 13^o, and the width approximately 19 meters with pine trees, pandanus and coast grass vegetation. Generally, this coast have abrasion which is characterized by the pine trees were uprooted by waves action that hit the coast (Figure 7). The eroded of Pambuang Formation sediments resulted in cliff coast with 1 - 4 meters height. The dominant process of the coast formation is marine process because sand coast comes from abrasion of Pambuang Formation , which is deposited along the coast.

Muddy Coast (Type II)

Muddy Coast located at western part of Sampit Bay and at the either side of River Mentaya estuary with low reliefs, covering 40% of the coast length in study area (Figurte 8). Coastal sediment consists of swamp deposit (peat), clay, silt and mud with gentle slope. Generally this coast is

Figure 3. Sandy coast at west off Ujung Pandaran, width ranging from 11 to 25 meters and slope of 6^o - 9^o

Figure 4. Sandy coast at Ujung Pandaran, width ranging from 15 to 30 meters and slope of 1^o - 5^o, laying along the cape.

Photo 5. Sandy Coast at Seteruk and Tanjung Cemeti had been eroded

prograded, characterized by mangrove vegetation. The dominant process of coast formation is land process, which is marked by numerous of fine to medium-sized material transported by rivers that empty into the area and then deposited along the coast.

Seafloor Surfacial Sediment Distribution

The seafloor sediment samples was taken at 51 locations (Figure 9). Grain size analysis results of 51 sediment samples show that the study area covered by 4 types of sediment texture (Figure 10) as follows:

Mud

Lateraly, the spreading of this unit is the most extensive and covers study area from near shoreline at 1 meter water depths to the offshore until more then 20 meters depths. This mud is light brown to black coloured, very soft, low plasticity and generally it contains brown fine sized plant remnants. Its assumed that this mud sediment probably derived from teresterial fluviatil sediment that was transported by fluvial process.

Muddy sand

Distribution of this units occupy the southeast region of study area, at water depths of 5 to 18 meters. This sediment units characterized by light brown colored, medium dense, fine to medium grain, and contain small amount of mafic minerals and some fragments of mollusc shells, with size less than 3mm.

Sandy mud

This sediment is the least distributed and can be found at the northern part of the study area. This sediment is characterized by fine-grained sand, light brown muddy, very soft and low plasticity, containing small amount fine to coarse of mollusc shells.

Figure 6. Sandy coast at west off Ujung Pandaran caharacteriszed by low cliff caused by wave energy erotin

Figure 7. Sandy coast at southwest of Ujung Pandaran (the pine trees were uprooted by waves action)

Figure 8. Muddy Coast located at either side of Mentaya Estuary

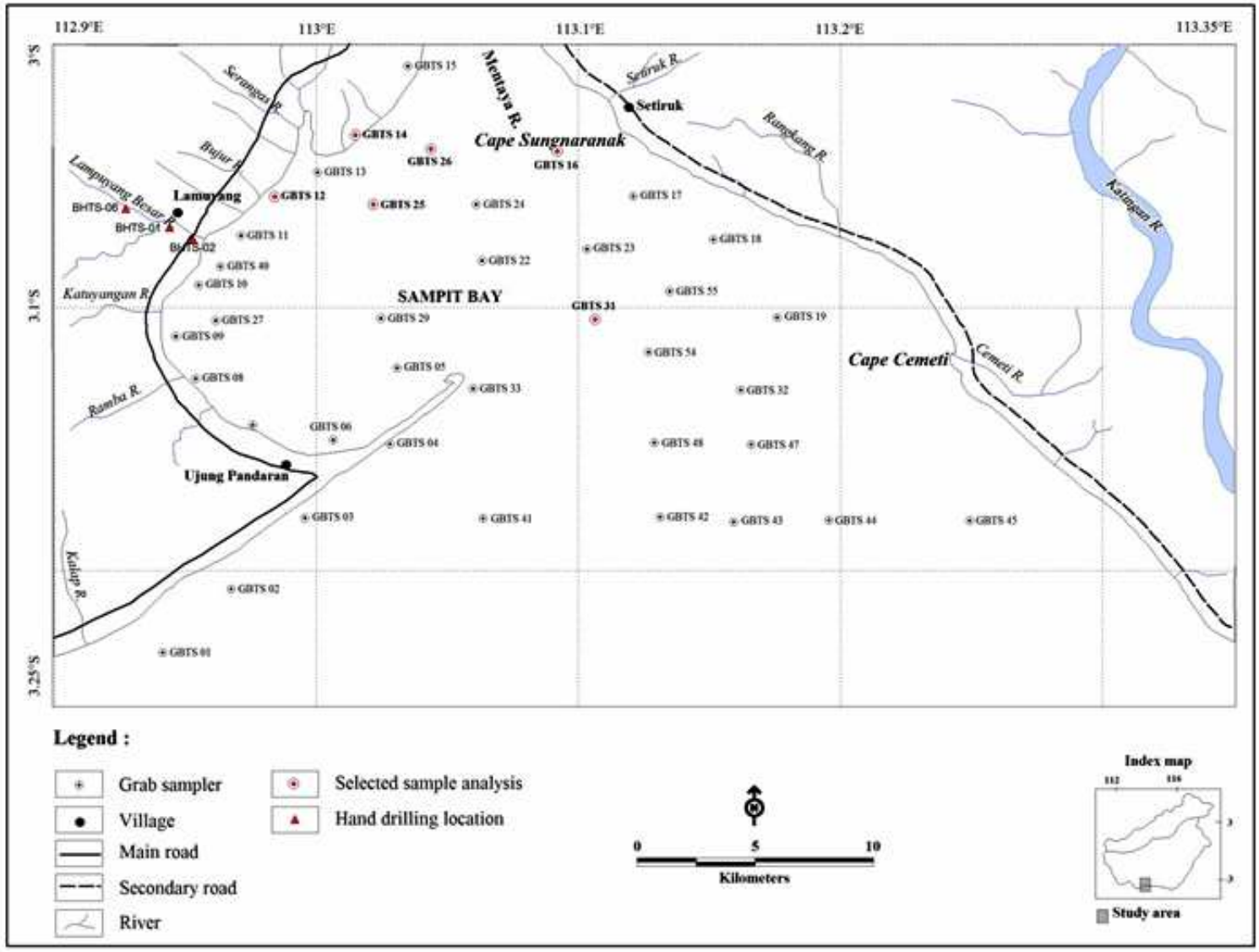

Figure 9. Seafloor Surficial Sediment Sampling Map of Sampit Bay

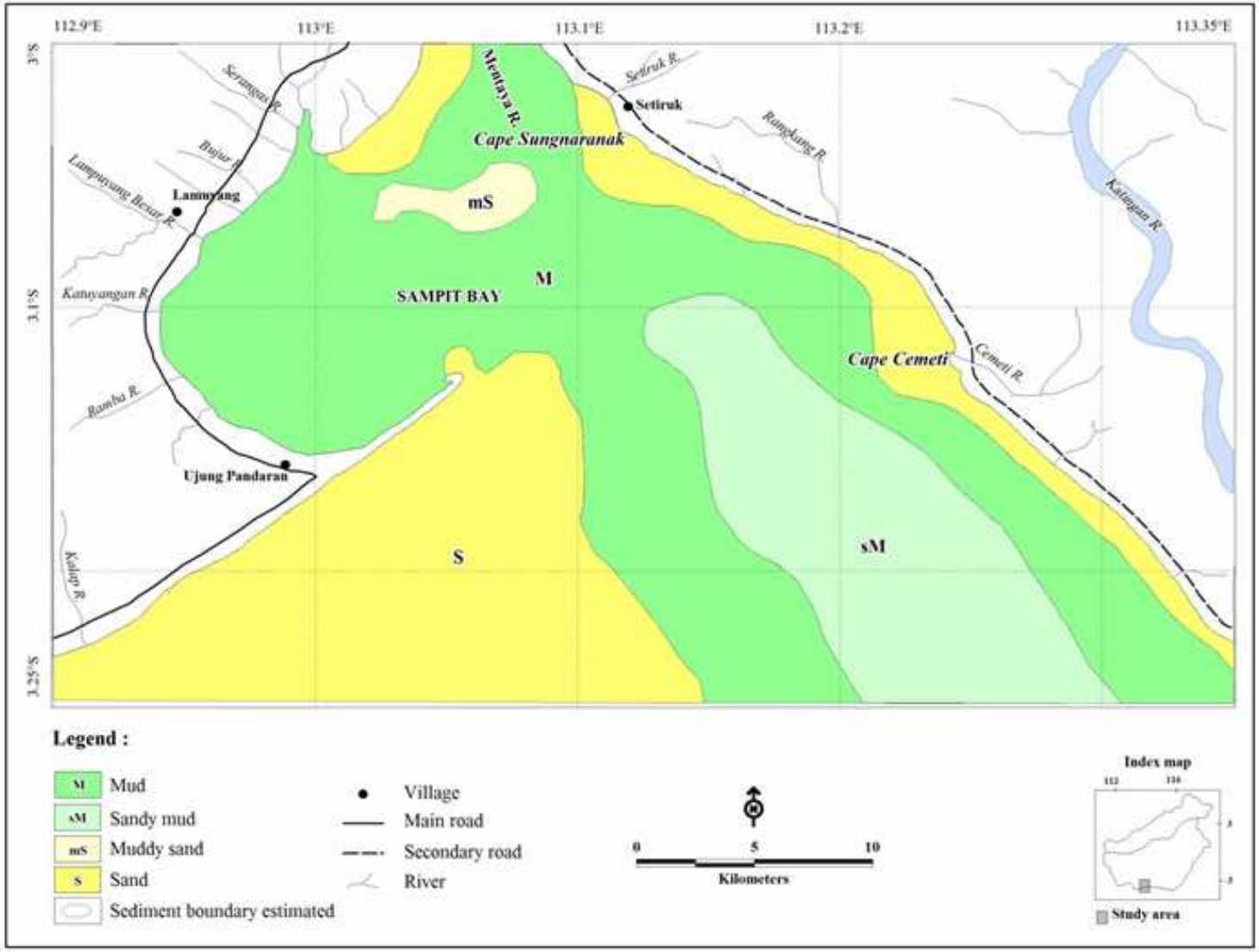

Figure 10. Seafloor sediment distribution map of Sampit Bay

Sand

Sand unit is found at the west side of Mentaya River estuary, along the east coast and the southeast of the study area. Physical and engineering properties of sand deposits are difference with the other locations of study area. Megascopically, the sand that occupies western part of the river and estuary on the east coast of study area are fine to medium grained, light brown to grayish brown, loose to medium dense, moderate sorted, rounded to sub rounded, contains of quartz and mafic minerals. Meanwhile, the type of sand which occupies the southwest of study area, consist of medium-coarse sand, medium sorted, angular to sub angular, yellowish brown, dominantly of quartz, also founded mollusc shell fragments with good condition.

Sand in this area is probably derived from sandstone layers of Pambuang Formation which exposed in the cliffs of the coast.

Seafloor morphology (Bathymetric Map)

Generally, the bathymetric contour pattern of the study area, is accordance with the pattern of coastline. The lowest depth is 1 meter and the deepest 34 meters with 1 meter interval contour as shown in figure 11.

The deepest area is located in the middle of study area that is resemble the lense channel with southeast – northwest direction. This condition was expected as old river channel, where the north and south have been covered by sediment.

In the north area are covered by sediment that supplied by rivers in Sampit Bay such as Sranggas River, Lempuyang River and Cemeti River. Meanwhile, the south area are covered by sediment that supplied by longshore current system.

In the east and southeast of the study area, contour density is relatively tighter than in the west. This is caused by geographical conditions in western study area that are protected by Tanjung Ujung Pandaran. This conditions caused the environment around bay is more calm, that enable the intensive sedimentation by river sediment around the bay.

While in the east and southwest is strongly influenced by the season. This dynamic season can affect the sedimentation that as not as intensive as in the western part.

Current

The current measurement result in study area indicates that surface current velocity ranged between 0.1 to 0.3 meter/sec with the dominant direction to the southeast. The largest surface current velocity, occurred at 08:00 until 10:00 p.m to the southwest direction with velocity 0.3 meter/sec. The most high velocity of middle current occurred at 08:00 p.m. to 9:00 p.m. with southwest direction. The highest velocity of surface and middle current reached at 7:00 to 9:00 p.m. during the high tides.

Wave

Most of Sampit Bay is open to the west and southeast wind blows, that are facing Java Sea. The wind velocity between 5 and 13 meters / sec, whithin the weak category, which is produced wave height ranges less then 1.5 meter, as shown in table 1.

The existence of sandrift in Sampit Bay reducing the waves from the open sea to the Sampit Bay that caused settling of mud in the bay and reducing the current velocity.

Tabel 1. High Range Regional Wave at Sampit Area

Month	High Range Wave
December - February	0,3 – 1,0 meter
March - May	0,3 – 0,7 meter
June - August	0,5 – 1,2 meter
September - November	0,5 – 1,5 meter

Source : Pelabuhan Indonesia 1985 in Sofremer-Airstan (1985)

Longshore current direction on the east sandrift is directly related to the coming wave direction and angle of the waves to shore. Longshore current direction caused sandrift growing eastward as what is happening in Ujung Pandaran. This fact showed that eastward longshore current is influenced by the frequency of dominant waves from the west or south.

DISCUSSION

Seafloor Morphology

To simplify the sea depth discussion that fulfill the requirements for the port, it is necessary to know the relation between the types of port and its relations to the vessel dimensions and draft that needed by the vessel while docked, as shown in following table 2.

From the sea depths aspect, Sampit Bay and its surrounding has no obstacle to be considered and developed to become one location seaport in Central Kalimantan because it has a gradation changes depth from the coast towards the sea.

Gradually depth changes in east and west side of bay starting from 2 to 32 meters, this is a grace to be thankful for and should be utilized as good as possible. To obtain the depth of the draft ship within 5-6 meters from the shore is only about 0.5 - 2 km from the coast line.

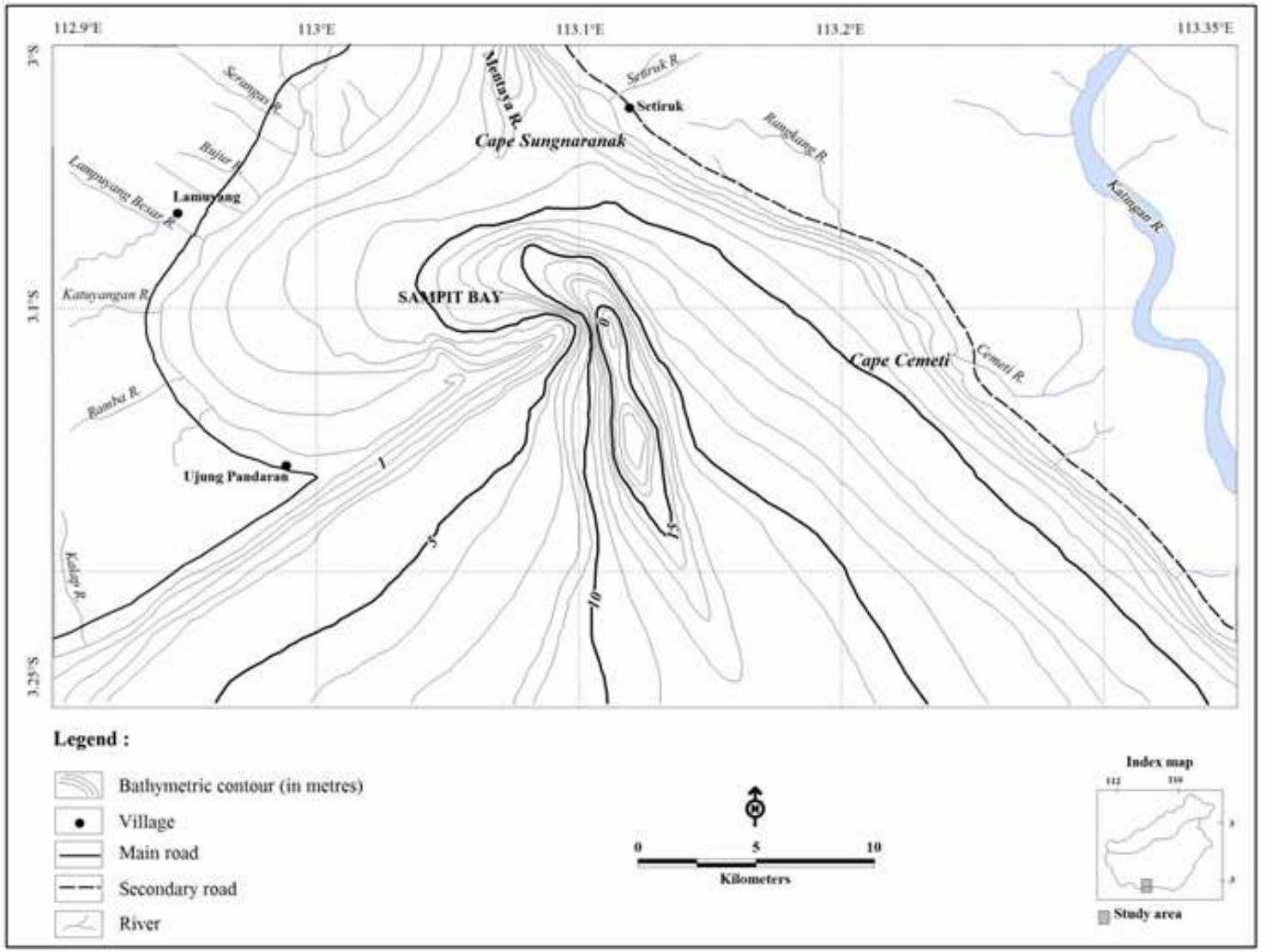

Figure 11. Bathymetric map of Sampit Bay.

Table 2. Relationship between Port-type and vessel dimensions

NO	PORT TYPE	VESSEL DIMENTION			JETTY LENGTH (meter)
		WEIGHT (DWT) THOUSANDS	DRAFT (meter)	LENGTH (meter)	
1.	Container Vessel	15-25	9-12	175-285	300
2.	General Cargo Ship	8-20	8-10	135-185	200
3.	BDPP Vessel	5-7	7,5	100-130	150
4.	Passenger Ship	3-5	5-6	100-135	165

However, to determine the exact location for the most suitable port site, it requires consideration of another aspect. The depth of the sea water is determined by elevation of sea level which can change at any time. Accordingly, would require an elevation that is determined based on the tides data, that can be used as a guide in the planning of a port

There are two terms that very decisive in determining the port. First, the highest water level (Mean High Water Level / MHWL) is the average of the highest water level with 19 years periode. It is used to determine the elevation of the peak of the breakwater, pier, buoy mooring chain length etc. The second, Low lowest water (LLWL/low lowest water level) is required to determine the depth of the port shipping lanes and ponds. (Triatmodjo, 1996).

Coastal Characteristic

Coastal Characteristic that become consideration for the port location are referring to natural coastal protection, (Nur Yuwono, 1995). Natural protection consist of sandy coast, muddy coast and rocky coast.

Natural protection consist of sand coast that is considered in determining the port location. Because the sandy coast fuctionate for reducing wave energy, that usually shaped sand dune.

Taking into consideration mentioned above, that the sandy coast has highly priority considered as a potential port location. Sandy coast spreading at southwest of the study area namely Ujung Bandaran and in eastern part of study area such as Setiruk and Tanjung Cemeti. The coast has moderate relief and occupies nearly 25% of the study area.

This coast are dominated by sediment sand deposit, a few of silt and clay, the shore line character is white sandy coast. The coast slope ranging from 6^{O} to 9^{O} within the gentle catagory coast (Van Zuidam, 1979), and width coast ranging from 11 to 25 meters. The vegetation behind the coastline is dominated by pine trees, coconut and coast grass.

In general this type of coast undergo accretion and stable as well as the dominant process in the coast formation is marine process.

Seafloor Sediment Distribution.

The distribution of seafloor sediments contained in the Sampit Bay are mud, muddy sand and sand. Mud is the dominating sediment in study area, followed by sand, muddy sand and the last was sandy mud.

From the seafloor sediment aspect, that should be considered for determining potential port locations is sand type seafloor sediment (Nur Yuwono 1995). For these criteria, the potential locations for the port is in the southern tip of Ujung Pandaran and the eastern part of the bay.

The sand type seafloor sediment is very helpful when mobilizing construction equipment LST Ship type that can be directly docked to the coast.

From discussions some factors above, the potential sites for the port location in the Sampit Bay is the south tip of Ujung Pandaran with the following considerations

1. The sandy coast is naturally acts as a coast protector
2. The coastline is relatively straight, thus simplifying the dock construction with a long ranges from 165 meters to 300 meters
3. Carrying capacity of sandy material is about 2.75 to 4.5 kg / cm2 and considered as a good category (Sunarto et al., 1998)
4. The rate of coastal abrasion in potential locations come under the medium category due to the abrasion occurred less than 500 meters coastline length (Sunarto et al., 1998)
5. Seafloor sediment is sand that is technically easier for building the construction of supporting facilities as well as a very safe harbor for vessels under certain conditions occured shipwreck. Sand is also indispensable as a main materials construction, and thus helps in the provision of excavated C group materials. Besides, sand also facilitate landing construction equipment (heavy equipment) using a vessel type LST.
6. Sea depth changes is relatively graded, in order to reach a sea depth of 5-7 meter as a requirement

ships weighing 3-7 thousands DWT, it is still relatively close to the coastline. Besides that, it simplify and reduce the cost of dredging to create a shipping channel and port basin.

7. Surface and middle current velocity ranges from 0.1 to 0.3 meters / sec with a dominant direction to the southeast. The largest current velocity occurs at 8-10 p.m with velocity 0.3 meters/second towards the south-west. Highest middle current velocity occur at 08-09 p.m in the southwest direction. Surface and middle current velocity reached highest in 7 to 9 pm during the high tides. The current velocity rate is still far below the threshold for the security of the ship anchored.
8. Sampit Bay largely open to the west and southeast wind blows, that is facing Java sea. The wind velocity is 5 up to 13 meters / sec and are considered as weak category that produce low wave. The highest wave range is September-November with a height of up to 1.5 meters and 0.3 meters in June-August. Wave height range will give not significant influence when the ship docked in the port basin, because wave height range tolerance for ship docked in the port basin is maximum 1.5 meters.

CONCLUSIONS

Coast type for port location is sandy coast that can turn into naturally coast protector. Type of seafloor sediment that eligible to build a port is sand because it is safe for vessels under certain conditions the vessel shrink in the harbor. Beside that sand sediment is very helpful for the building materials supply in the construction of facilities and its also make dredging become easier. Sea depths changes in the Sampit Bay is gradually, its caused construction of port at selected area not found of sea depths obstacles. The surface and middle current velocity ranges from 0.1 to 0.3 meters / sec with a dominant direction to the southeast. The velocity current is below the threshold for the security of the ship docked. Wind velocity at Sampit Bay is weak category with velocity ranging from 5 to13 meters/second, that is not significant influence when the ship docked in the port basin. The most eligible place for potential port location is south of Ujung Pandaran.

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