New Land Accretion From 2000-2003 at Segara Anakan Lagoon, South Coast of West and Central Java

Pertambahan Daratan Baru Dari 2000-2003 di Laguna Segara Anakan, Pantai Selatan Jawa Barat dan Jawa Tengah

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ABSTRACT: Segara Anakan Lagoon is an unique lagoon , where a lot of rivers enter into the lagoon such as Citanduy, Cibeureum, Cijolang, Cikawung and Ciseel Rivers. These rivers bring the sediment materials from upstream to the lagoon areas and resisted by Nusa Kambangan Island. The rate of sediment transportation every year occurred continuously and significantly. Its caused the creation of new land at eastern part of Segara Anakan Lagoon was about 376.69 hectares which is located at Cilacap District, while in the western part is about 15,78 hectares which is located at Ciamis District.
Since 1999 to 2003 land accretion at Segara Anakan Lagoon was about 392.47 hectares with the rate of accretion around 78.50 hectares/year. In 1999 the area of the Segara Anakan Lagoon approximately 1,595 hectares. Based on the averages of rate land accretion, its predicted that in the middle of the 2019 whole of Segara Anakan will be land. The study had been done in 2003 by using hand drilling up to 2 meters depth, grab sampler and GPS Garmin 250 Map. The hand drilling result at accretion area, show that at eastern part of study area is composed of silt and cly, while at Nusawere Bay and Solok Jero is characterized by fine to coarse sand.

Keywords : sediment materials, accretion area, and Segara Anakan

ABSTRAK: *Segara Anakan merupakan sebuah laguna yang unik dimana banyak sungai yang bermuara di perairan tersebut seperti Citanduy, Cibeureum Cimuntur, Cijolang, Cikawung, dan Ciseel. Sungai-sungi tersebut membawa material sedimen dari daerah aliran hulu ke kawasan laguna yang tertahan oleh Pulau Nusa Kambangan. Transportasi sedimen berlangsung terus menerus dengan laju pertambahan dari tahun ke tahun cenderung meningkat secara signifikan. Akibatnya terjadi pertambahan daratan di perairan Segara Anakan bagian timur sekitar 376,69 hektar yang termasuk wilayah Kabupaten Cilacap dan di bagian barat sekitar 15,78 hektar yang terletak di wilayah Kabupaten Ciamis.*
Sejak 1999 – 2003, total luas pertambahan daratan di perairan Segara Anakan sekitar 392,47 hektar dengan perkiraan laju pertambahan daratan sekitar 78,50 hektar/tahun. Tahun 1999 luas Perairan Segara Anakan kurang lebih 1.595 hektar. Berdasarkan laju pertambahan daratan rata-rata tersebut, maka diperkirakan pada pertengahan tahun 2019 Perairan Segara Anakan seluruhnya menjadi daratan. Pada tahun 2003, telah dilakukan penelitian dengan menggunakan bor tangan sampai kedalaman 2 meter, pemercontoh comot dan GPS Garmin 250 Map. Hasil pemboran di lokasi pertambahan daratan tersebut menunjukkan di bagian timur tersusun dari lanau dan lempung, sedangkan di Teluk Nusawere dan Solok Jero disusun oleh pasir berbutir halus sampai sangat kasar.

Kata kunci : *material sedimen, pertambahan daratan, dan Segara Anakan*

INTRODUCTION

Sagara Anakan Lagoon which separated the Nusakambangan and Java island has a typical ecosystem especially in the southern district of Ciamis and Cilacap. These waters are the estuary of Citanduy tributaries in Ciamis District, West Java and Cibeureum River and several other rivers such as Cimuntur, Cijolang, Cikawung, Ciseel Rivers in Central Java. Rivers that carrying suspended material of the watershed toward the coast, held back by the island of Nusa Kambangan and nearly stalled in the Segara Anakan Lagoon. This suspended material flow continues over time with the rate increase from year to year significantly. This condition is caused by uncontrol upstream area of the rivers that empties into the Segara Anakan Lagoon. This phenomenon caused the

narrowing of Segara Anakan Lagoon. Due to this facts, the substrate that entirely up to the lagoon can not flows out to sea, and its caused new land rise in these waters.

In 2003 Marine Geological Institute conducting marine geology and geophysics study in Segara Anakan Lagoon. The main purpose of this study was to determine in more detail the wide changes of Segara Anakan Lagoon from 2000 to 2003 and the dominant type of sedimentation and estimates of the closed waters by sediment from year to year.

Administratively, the study area is located in two regions, namely the western part belong to Ciamis District, West Java Province, while the eastern part belongs to Cilacap District, Central Java Province. Geographically, the study area is boundaried by coordinates of $108^{O}45$ '- $108^{O}52'$ 30" E and $7^{O}39'20"$-$7^{O}42'$ 10"S.

Segara Anakan Water conditions based on previous research (Usman, 2003) can be described as follows:

The AMS (American Map Service, 1944) is the first map, which was supperimpossed with the aerial photographs. The result show that the total area of Segara Anakan Lagoon was 5,535 hactares, consists of vast waters 5,350.50 hectares and 184.50 hectares of the land. During this previous time, there was only one island in Segara Anakan Lagoon, form of scorched sands and has been integrated with the mainland of Java, whithin to Cilacap District.

During 1944 to 1963 had been occurred sedimentary process from the river, where the material were supplied from the abration at surrounding area. This phenomenon shows as a natural balancing of coastal environment by envolving of abrasion and accretion processes at the same time. Due to this condition, the addition of Segara Anakan area approximately 281.65 hectares. In 1963, or about 19 years later, there were more then 10 small islands found immediately in Segara Anakan Lagoon. Generally, those islands are located in the eastern part of the lagoon. On the other hand, significant abrasion also occurred in the western part closed to Majingklak Harbour, Ciamis District and Nusa Kambangan Island. Therefore, the total of lagoon area was approximately 5,632.15 hectares and total of new islands reached about 363.85 hectares.

In 1989, or 26 years later, the vast of Segara Anakan Lagoon decreased to 2,957 hectares, while the new small islands were connected each other into four major islands with a total area about 702.72 hectares. Land accretion occurs either in the form of islands, south of Java and Nusa Kambangan Island that reached 2,674. 85 hectares.

In 1992 Segara Anakan Lagoon is about 1,973.18 hectares consequently the number of islands increased to be seven islands with a total area approximately 829.82 hectares. During three years the lagoon area decreased was about 984.12 hectares (average about 328.04 hectares/year). Generally, the islands are formed parallel to the pattern of tidal flow direction and longshore current direction, respectively.

In 1994, the vast of Segara Anakan Lagoon was about 1,925.6 hectares and consequently there were 10 islands exposed with a total area about 1,152.94 hectares. During 1992 to 1994 the waters area was decreased was about 48.12 hectares or an average is 24.6 hectares / year

In 1999 the area of Segara Anakan Lagoon was about 1,595.11 hectares and 11 islands around the coast were exposed with a total area was about 1,062.89 hectares. During five years (1994-1999) the loss of waters area was about 329.5 hectares, so that, average of land accretion approximately 65.9 hectares/ year.

Details of area changes the of Segara Anakan Lagoon from 1944 - 1999 as shown in table 1.

Based on the results of previous investigators from 1944-1999 or less than 55 years, the intensive decreasing of Segara Anakan Lagoon was about 3,755.39 hectares (5,350.50 to be 1,595.11 hectares) or 68.28 hectares per year.

In order to know more about Segara Anakan Lagoon, the changes and developing of land accretion surrounding this lagoon can be seen in Table 2.

Based on the Geological Map Sheet Map of Pangandaran, Java, compiled by Siamanjuntak and Surono (1992), the stratigraphy of surounding study area can be divided into five stratigraphic units from the youngest to the oldest as follow (Figure 1) :

- Alluvial deposits (Qa) consisting of mud, sand and gravel, almost covered 40% of study area, that occupies along the coast and the Parigi Gulf, Pangandaran Gulf and tributaries of Citanduy river, which empties into the Sagara Anakan.
- Coastal Deposit (Qal) consist of iron sand which is found in the South Coast of Nusa Kambangan Island in Solok Cibodas Region.

Table 1. The change of Area Segara Anakan Lagoon from the 1944-1999 (in Sarmili, et al., 2000)

No	Year	Area of Segara Anakan Waters
1	1944	5.350,50 hectare
2	1963	5.632,15 hectare
3	1989	2.957 hectare
4	1992	1.973,8 hectare
5	1994	1.925,60 hectare
6	1999	1.595,10 hectare

Table 2. Period and the average land accretion at Segara Anakan Laggon (in Sarmili et al., 2000)

NO.	PERIODE	LAND ACRETION	LAND ACRETION EVERAGES PER YEAR
1.	1944-1963 (19 years)	- 281.65 hectares	- 14.83 hectares
2.	1963-1989 (26 years)	2,674.85 hectares	102.879 hectares
3.	1989-1992 (3 years)	984.12 hectares	328.04 hectares
4.	1992-1994 (2 years)	48.12 hectares	24.60 hectares
5.	1994-1999 (5 years)	329.5 hectare	65.9 hectare

- Kalipucang Formation (Tmkl) is composed by limestone and deposited in Miocene.
- Pamutuan Formation (Tmpa) consist of sandstone, calcarenite, napal, tuff, claystone and limestone, its deposited in Miocene located at west off Nusawere
- Nusa Kambangan Formation (Tmnt) is composed of tuff, lapilli tuff, tuff sand and gravel which is inserted sandstones in the middle and alternating with mudstone and breccia. This formation is predominantly spread and cover the island of Nusa Kambangan.
- Jampang Formation (Tomj) consists of volcanic breccia, tuff with lava insertions, alternating with sandstone, marl and clay stone which is inserted by conglomerate, sandstone, gravel. This formation dominates the central and western of Citandui River, eastern part of Nusa Kambangan island and Cape Cimanggu (Pasir Panenjoan).

METHODS

The Global Positioning System device (GPS) Garmin Map 235 was used to map land accretion of Segara Anakan Lagoon. The measurement was applied from high tide toward slack tide a long the coastline. It is assumed that all the parameters affect the sedimentation process constantly (2000-2003).

The point location of measurement result is plotted into the base map and then overlain with previous map that is resulted in 2000. The result showed that the land accretion will be occurred over a period of 3 years.

The shoreline mapping was used to estimate tha land accretion of Segara Anakan Lagoon during three years (2000-2003)

The observation of morphology, sedimentation process, shoreline position at the lagoon area which is influenced by hydrodynamics pattern (Nichols, 1989) was used as reference for this study. Sampling of lagoon sediment was carried out by grab sampler systematically. The data was obtained in order to know the distribution and environments of lagoon surfacial sediment. The hand drilling method was used at new land accretion in order to know the sub surface of lithology until 2 meters depth. Grain size analysis was processed by software that was developed Classification by Folk (1980). This analysis was used to determine the sediments textures and sedimentary nomenclature.

RESULTS

The land acretion area

Based on the mapping results that was done in 2000 there were 12 islands exposed, while in 2003 appeared only 11 islands. Most of them are located in the eastern part of study area. Several small islands at the river mouth of Sabuk Tiram, has been merged become one island, and one island at the east of Karang Anyar has connected with the Java Island (mainland). Beside that, some of them are jointed each others. While the new island was also appeared at tip of Ujung Gagak river mouth and two other small islands was found at the north of Klaces.

Based on the comparison between the map of shoreline changes (2003) and the coastline in 2000 (Sarmili et al., 2000), suggests that the accretion of study area has occurred rapidly (figure 2). Dashed line is the new coastline, which was measured in 2003.

Hand drilling (until two meters depth) was done at two different locations. The results showed that there was found very fine to coarse grained sediment, and there is no forams or coral fragments found (Figure 3).

Lagoon surficial sediment distribution patterns.

Sea floor sediment at 44 locations taken using grab sampler at Segara Anakan and adjacent area, with sample code of "SA-01".

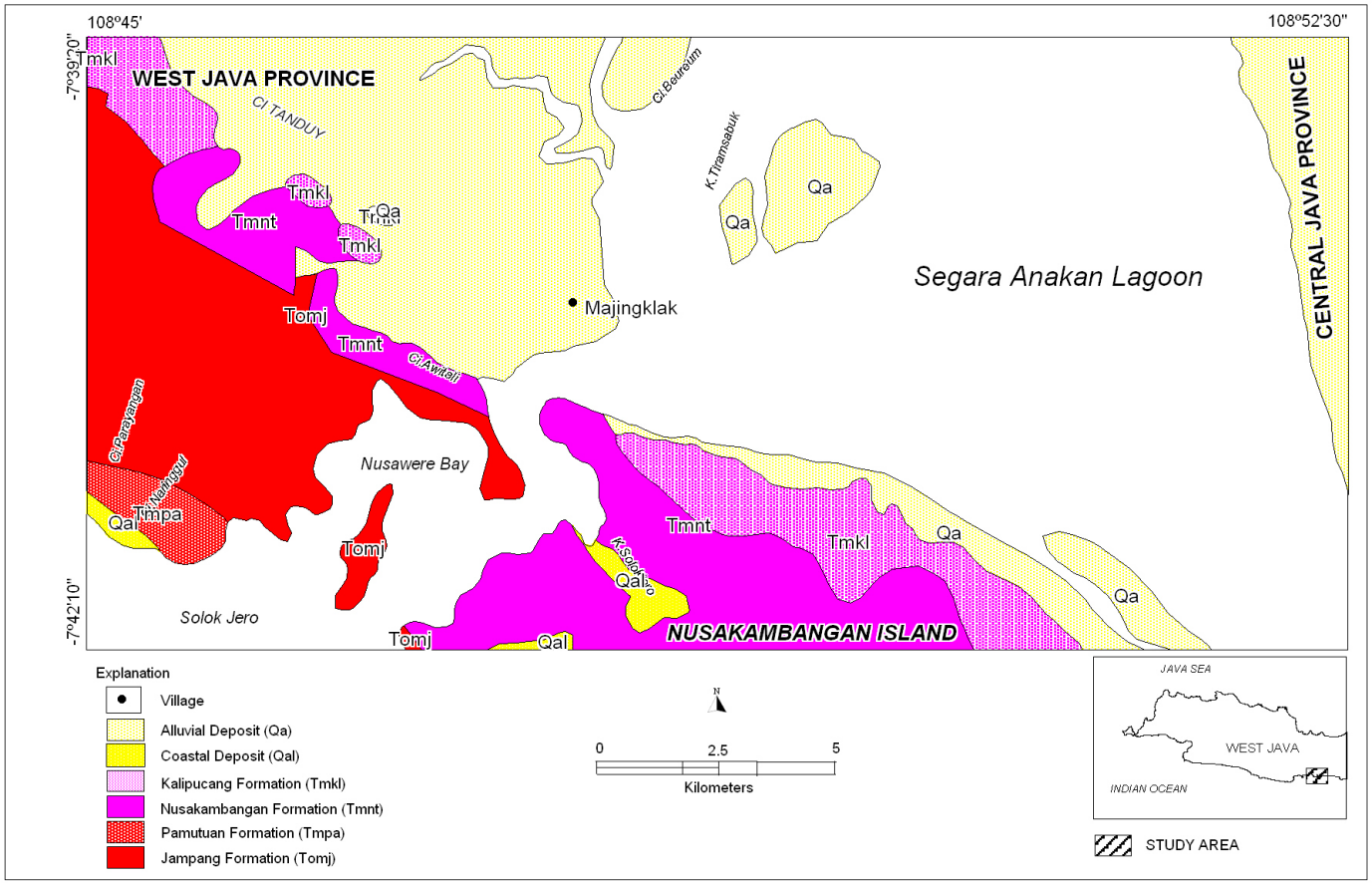

Figure 1. Geological map of Sagara Anakan and adjacent area

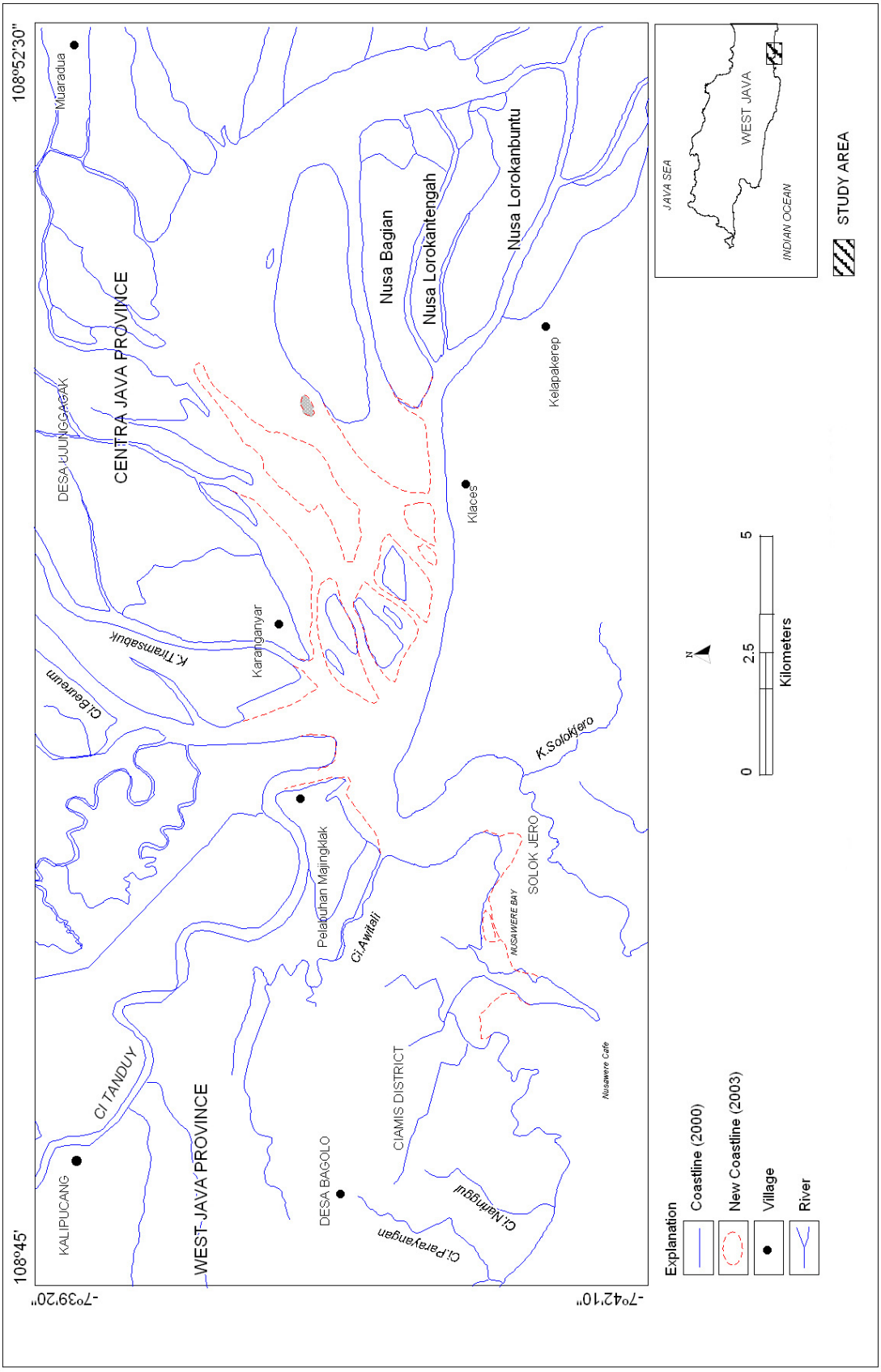

Figure 2. Coastline condition of Segara Anakan Lagoon 2000-2003

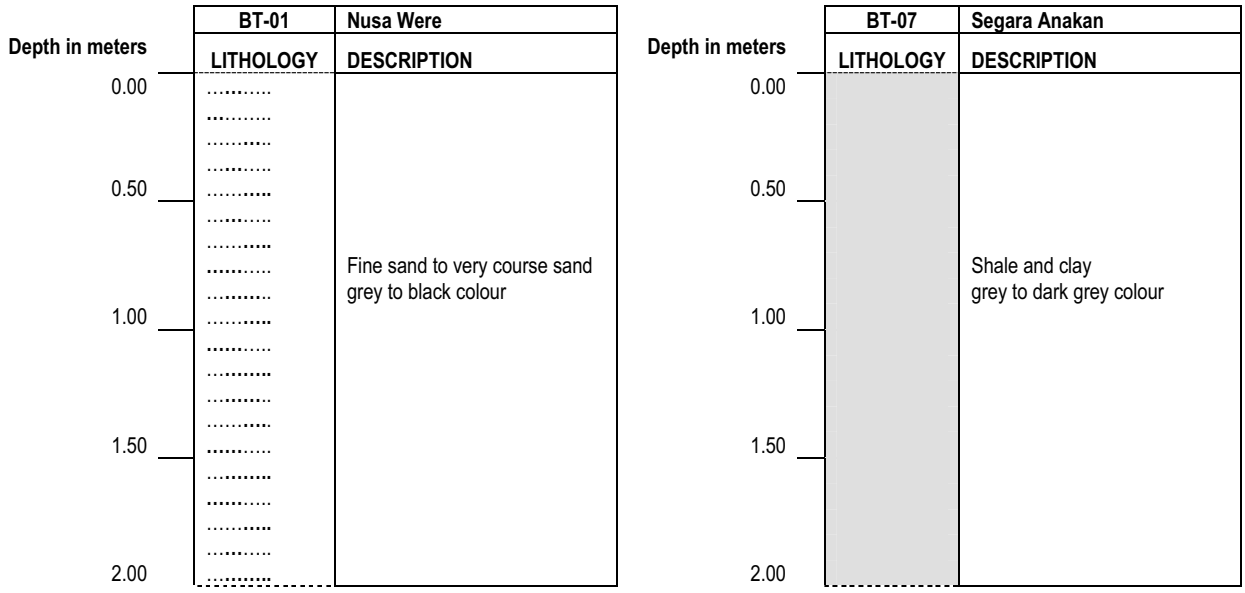

Figure 3. Profil of hand drilling at Segara Anakan Lagoon and Nusawere Bay

Based on grain size analysis, sediment type of the lagoon is composed of silt, sandy silt, sand, slightly gravelly sand as shown in Figure 4.

From the distribution of sediment types, it shows that silt spread most widely and cover extensively is about 43.18% of the lagoon. It distributes widely in the eastern part, followed by slightly distribution at the north of Citanduy river mouth.

Sandy silt fraction occupied approximately 36.36% of the study area and spreading at Citanduy river mouth. It distributes to the east and west Nusa Kambangan island that parallel to the pattern of coastline.

Sand fraction is about 15.9% of total study area, and scattered locally at west outlet of Segara Anakan (Solok Jero). While the slightly gravelly sand fraction occupies 4.5% of study area, accumulated at bend of west outlet of Segara Anakan.

The distribution map of sediment types were then overlaying with land accretion map 2003, it can be seen that the largest land accretion appeared at the eastern part. It is composed of 99% of silt, except in the east of Tiram river mouth and west of Majingklak Harbour covered by slightly sandy silt.

DISCUSSION

The increase land accretion at Segara Anakan Lagoon can be classified into three types: (1) increasing of small islands area; (2) the emergence of new land; (3) coastline accretion around river mouth of Citanduy (Central Java and West Java Provinces). Mostly, the new small islands at the lagoon are expanding to various directions, particularly to the west direction that reach approximately 81 hectares.These new small islands in the eastern part were caused by sedimentation processes.

Land accretion, most significantly occurred at the west off Majingklak Harbour, Solok Jero and the Nusawere Bay at Ciamis District (West Java Province). Majingklak coast developed to the east and south direction, where the land accretion is characterized by very dense mangrove (1.9 hectares). While, at Solok Jero land accretion is almost parallel with western part off Majingklak Harbour.

From the grain size analysis of sediment sample, it can be concluded that, land accretion at Segara Anakan Lagoon was caused by the supply of sediment from the rivers. This condition is also supported by the absence of foraminiferal shells and shell fragments up to 2 meters depth.

The development of the land accretion at Solok Jero, is very disrupting the channel cruise of fishermen boat from the lagoon to Indian Ocean. This channel tends to be narrow in the last 3 years, approximately 12 meters.

Recently, land accretion in Pelawangan is one of a beach tourism destination, consist of fine to very coarse sand, gray to black colour, chaharacterized by Ketapang trees.

Similarly, the condition is also appeared in the coast of Nusawere Bay. In 2000, the bay area has approximately 5 km^2 and average sea water depth is about 2-4 meters (Sarmili et al., 2000). At the present,

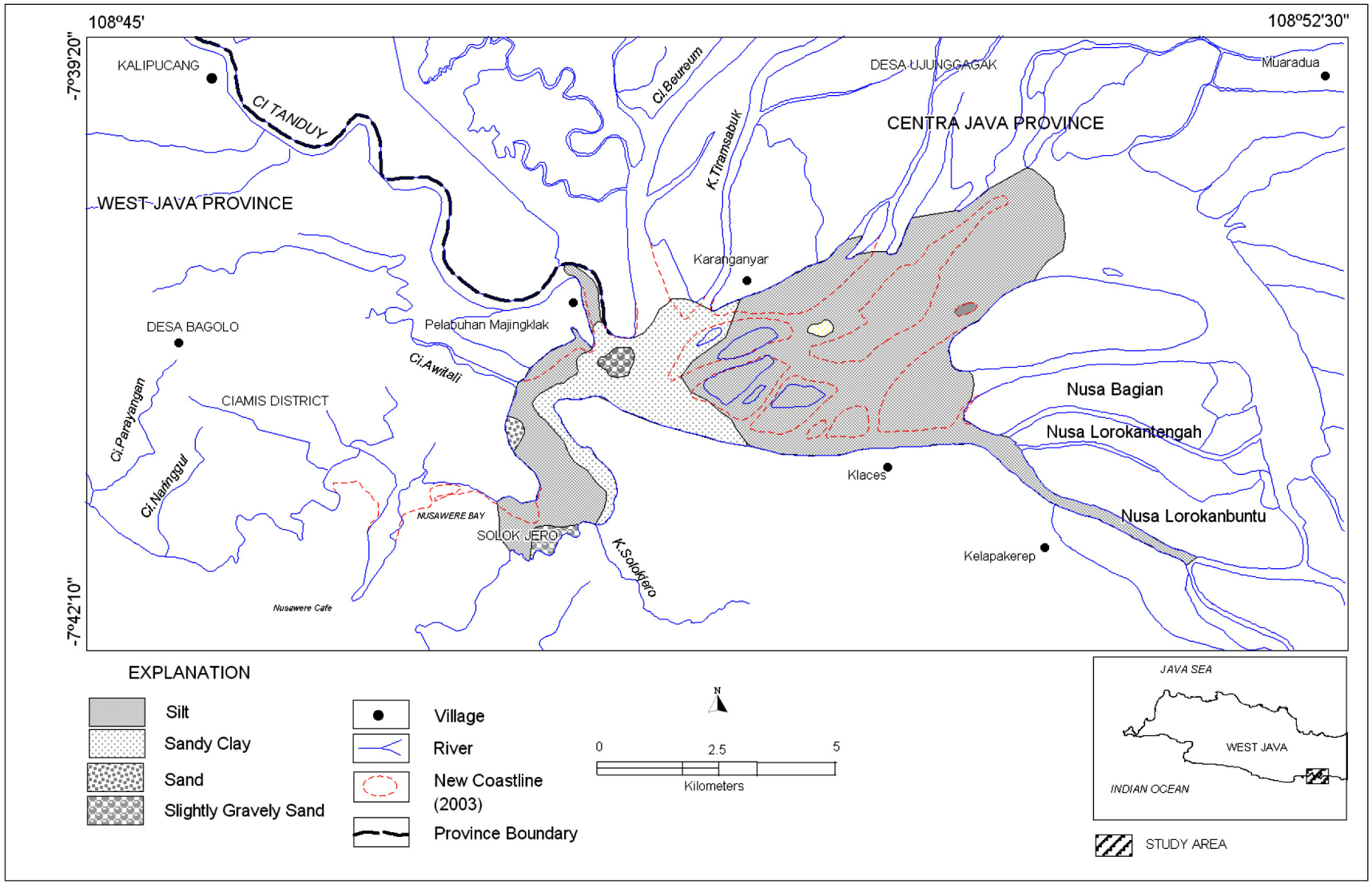

Figure 4. Surficial sediment map of Segara Anakan Lagoon

this area was rapidly filled by sand that distributed about 30-45 meters seaward.

From 2000 until 2003, land accretion occured at the eastern part of Segara Anakan Lagoon (east off Citanduy Estuary) that approximately 376.69 hectares.

In the western part off Citanduy River mouth, the land accretion reached 15.78 hectares. While at Nusawere bay and west off Solok Jero, the land accretion was about 43.36 hectares.

Quantitatively, the land accretion at Segara Anakan Lagoon during 5 years has reached an area about 392.47 hectares. This condition will occur if the average of land accretion was about 78.50 hectares/ year. In 1999, the rest area of Segara Anakan Lagoon was about 1,595.10 hectares. While in 2003, the vast water was about 1,202.63 hectares. It was due to occurrence of 392.47 hectares of land accretion over 5 years period. Concerning to the rate of land accretion annually (approximately 78.50 hectares), it might be predicted that within a period of 15.5 years or in the middle of 2019, the Segara Anakan Lagoon will disappear. Extensive changes of the Segara Anakan Lagoon in this discussion, it only refers to broad changes from the measurements results in 2000 and 2003 as well as references from previous researches. It was not based on the calculated of sediment supply carried by rivers that empty into the lagoon.

Based on the distribution of sea floor surficial sediment types of Segara Anakan, it can be seen a snapshot process of the current energy or the type of sediment transport as moderate to high energy.

In the eastern part of Segara Anakan Lagoon (north off Klaces village, south off Karang Anyar Ujung and Ujung Gagak Village), the sediment type of land accretion, mostly composed of silt. It can be interpreted that the most energy influence in the sedimentation system is low energy in the river (fluvial environment) and lake environments (Dam, 1994). The same condition, land accretion was also occurred in the west of Citandui River mouth, precisely around Majingklak Harbour. This condition was supported the result of hand drilling sediment samples at a new land accretion. It also showed that material from the surface to 2 meters depth consist of silt and clay (Lugra et al., 2003). Therefore, we can conclude that the land accretion composed of silt and it is distributed laterally and vertically until 2 meters depth.

Different conditions encountered in the Nusawere Bay and Pelawangan, where land accretion is composed of very fine to very coarse sand, gray to black, with poor sorting, angular to sub angular shaped. This suggests that the land accretion affected by high current energy system and deposited in alluvial fan environment. Sedimentation process of land accretion in the west compared with east of the Citanduy Estuary, it showed that the energy systems and environmental deposition of both areas is different.

The land accretion around the lagoon was different with the images interpretation resulted by Profil Balai Besar Wilayah Sungai Citanduy, Ditjen Sumber Daya Air, Departemen Pekerjaan Umum. The present study shows that the area of Segara Anakan was about 1,200 hectares in 2003. On the order hand, the images interpretation resulted by Profil Balai Besar Wilayah Sungai Citanduy, Ditjen Sumber Daya Air, Departemen Pekerjaan Umum in same year showed 600 hectares (Figure 5).

CONCLUSIONS

1. Land accretion at eastern part of Segara Anakan Lagoon which is included to Cilacap Distrrict

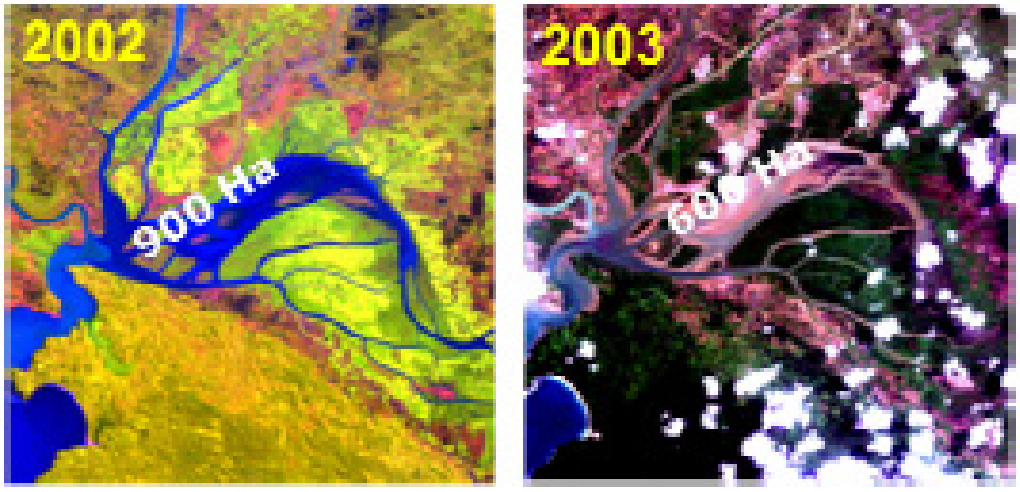

Figure 5. The images of land accretion of Segara Anakan Lagoon 2002 and 2003 (Source : Profil Balai Besar Wilayah Sungai Citanduy, Ditjen Sumber Daya Air, Departemen Pekerjaan Umum).

from 2000 to 2003 is about 376.69 hectares, while in Ciamis District is about 15.78 hectares, caused by sedimentation.

2. Total area of land accretion in Segara Anakan Lagoon from 2000-2003 covering 392.47 hectares or about 78.50 hectares annually.
3. The total area of Segara Anakan Lagoon in 1999, was approximately 1,595.10 hectares, where the rate of land accretion approximately 78.50 hectares/year, it is interpreted that by mid of 2019 whole of Segara Anakan Lagoon might be to be a land.
4. The core hand drilling results up to 2 meters depth at new land accretion of the eastern part Segara Anakan Lagoon, consist of silt and clay, while in the Nusawere Bay and Solok Jero, consist of fine to very coarse sand.
5. Accretion in the eastern part of Segara Anakan Lagoon more faster than in the western part.

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