COASTAL MORPHODYNAMIC STUDY USING MULTI TEMPORAL DATA IN BANTEN BAY, INDONESIA

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ABSTRACT

Banten Bay and its surrounding area has been indicated as the coastal areas that serious the environmental problems due to poor management of the natural marine resources that has been going for a long time. This study was carried out focusing on the coastal morphodynamic processes, using the multi temporal satellite images as the main sources of the information. The topographic data of year 1923 has been used for the baseline data for research carried out supported by others thematic data that can be collected for the area of study. The multi temporal images used were aerial photographs at 1:30.000 scale acquired in 1981/1982 and at 1:50.000 scale acquired in 1994; SPOT XS images dated 1990 and 1997 as well as LANDSAT MSS of 1976; LANDSAT TM of 1996 & 2000. Geomorphological map for the study area has been prepared on 1:50,000 scale and the coastal morphodynamic were studied in detail using remote sensing approach completed with the ground-truthing using stratified random sampling techniques. Physical aspect related to coastal changes can be treated throughout vector data gatherred from topographic and the thematic data. The results indicate that there were coastal changes has been found in some where Eastern part of the coast line segment close to Pulau Dua (Dua Islands) as tombolo formation. To the east, Ciujung Delta has been growing with typical bird foot delta. On the other hand, abrasion process took place in Tanjung Pontang (old Ciujung Delta) and also within the coast line segment at Lontar Village. The rate of abration processes within the study area has been 0,0436 mm/yr for the coral islands distributed within shallow coastal sea in the study area, 0,0316 mm/yr along the adesitic volcanic coast line at the western part of the study area, and 0,503mm/yr in soft sediment rock area. Deposition processes were also active in the coastal area between Bojonegoro up to Kamanjungan that is indicated by the bathymetry changes from 2.5 m in the year 1923 to < 1.25 m at present condition in the Karanghantu harbor at a distance of 100 m from the present coast line.

Keywords: morphology, dynamics, coastal zone, remote sensing, coastline change.

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INTRODUCTION

Coastal zones are physical appearance of area where marine and land influences meet. To the sea direction there is land influence and vice versa. The natural processes in the coastal zone are generally caused by the interaction of marine influences (such as wave, current, tides), climate, geological structures and biotic activities including human activities. The existing process in the coastal zone go on and on either in the day time or night time, and the each process is related to other (Duinker 1989, Kucera 1994, Pinet 2000, McKnight 2001). Coastal water are important ecological systems and vital assets for Indonesia as wide maritime nation distributed within the equatorial region. Estuaries, bays, and coastal margins are among the most productive natural systems on Earth. Coastal productivity supports multiple trophic levels as well as recreational and commercial fisheries. Coastal waters are active areas for processing of nutrients and carbon and there fore play a roll in flux, cycling, and fate of atmospheric CO_2. Coastal water link land and ocean system primarily through the discharge of river. River serve as major conduit for the delivery of significant amounts of dissolved and particulate materials from terrestrial environments to coastal ocean. There is considerable interest in studying coastal waters to gain a better understanding of earth system process for climate change research or environmental factor for management decisions. Unfortunately, the dynamic nature of coastal waters renders most traditional field measurements and sampling protocols ineffective in capturing the range and variability of many coastal processes.

The understanding of the coastal ecosystems and the governing natural processes and feedback mechanisms should be improved, also make impact assessment of development planning decisions to be of a higher standard. Knowledge and information should be made available to planner and decision makers in an appropriate and accessible way and they should be provided with tools that help them to evaluate their decisions. These tool are at present not available, there after monitoring of ongoing development, environmental values and ecosystem behavior and connecting the resulting information system to an analysis tool for impact assessment, strategy evaluation and future planning requires special attention more than coastal zone planning as such. Banten Bay is one of coastal area in Indonesia that has complex dynamical processes. Environmental problem is one important issue that must be faced today. One of the considerations that is used to select Banten Bay as the study area is the problems related to the environment degradation. The degradation is related to coastal erosion, sedimentation in Ciujung River Mouth, and acression in several places. It is believed that problems in Banten Bay can be found elsewhere in Indonesia, as a tropical region.

The topic research proposed will be able to prepare some information dealing with the physical aspect of the Banten Bay coastal area and it surrounding. The information produced within the research carried out basically used the multi temporal remote sensing images as the main sources and also morphodynamic processes will be treated on the point of few the coastal geomorphology aspects. In contrast, remote sensing from aircraft and space-base platforms offers unique large-scale synoptic data to address the complexes nature of coastal waters. The utility of remote sensing to a wide range of disciplines is well documented. However, to apply remote sensing to a particular application, especially within a dynamic coastal environment, new user are often challenged to find appropriate reference material to gain an adequate understanding of

remote sensing in quick and effective manner. Coast line changes has been active processes within the Banten Bay coastal area due to dropping of sediment materials coming from landward in correlated with active land erosion in the field of agricultural system at the upper area.

Coastal morphodynamic processes be able to be studied by using multi temporal remote sensing images, and others former topographic data was collected and used. Quantitative and qualitative of approach has been considered to support coastal morphodynamics study, completed by ground truth in some sample points selected. The information gathering base on coastal morphodynamic changes visualize on spatial thematic data produced. It's will able to indicate the ecosystem degradations occurred within the Banten bay and it's surrounding coastal area. There after the information produced on the research carried out will able to support development planning that will be propose by local government authority as well as to determined the best solution of the environmental problem faced.

Problems related to Banten Bay were gathered in the field and obtained from secondary data available. Several fishermen reported the sedimentation in the Karangatu Port where they embark adn disembark. This active sedimentation is also seen with the coastline change that move toward the sea. The connecting formely Dua Island to Java Island is evidence that shows how fast the coastline has changed. Coastal erosion is the opposite process that has also occured in the area with different quantities. The development of Ciujung Delta since the establishment of Ciujung Cannal in 1941 had greatly influenced the erosion and sedimentation processes. Other activities that also degraded the areas need to be consedered such as the sea grass and coral reefs destructions, mangroves deforestation adn industrial development. From the geomorphological point of view, problems in Banten Bay can be formulated as follows.

1. There have been varying geomorphological processes along the Banten Bay region and its surrounding that have negative impact on the environment.
2. There are needs for research on the factors that influences such processes.
3. Evaluation on the morphological dynamics needs to be conducted related to conflict of interests between conservation and development in the area.

Based on the problems defined above, the objectives of this research are:

1. to study the morphological dynamics of the research area based on the factors that influence the process,
2. to assess the capability of multi temporal satellite images to obtain parameters that characterise the coastal morpho-dynamics, and
3. to evaluate the coastal morphodynamics in relation to conservation efforts and development.

STUDY AREA

Geographically, the study area located 5^0 43′ 00″ - 6^0 5` 20″ LS dan 106^0 00′ 00″ - 106^0 25′ 03″ BT (Figure 1). Banten Bay is an open-type one facing the Java Sea. Tanjung Puyut is determined as the western point of the boundary reclaim for the study area, which is part of the volcanic foot slope composed of basaltic and andesitic rock. The Tenoayu village as the boundaries in eastern part for study area, closed with Ciujung delta, mostly consist of quartenary fluvial sediment deposit . The landward boundary of the study area was

considered base on the physical impact due to marine induces and it's characteristics, and sea ward limit boundaries was considered as maximum distance of the sediment distributed given by rivers influences in the field.

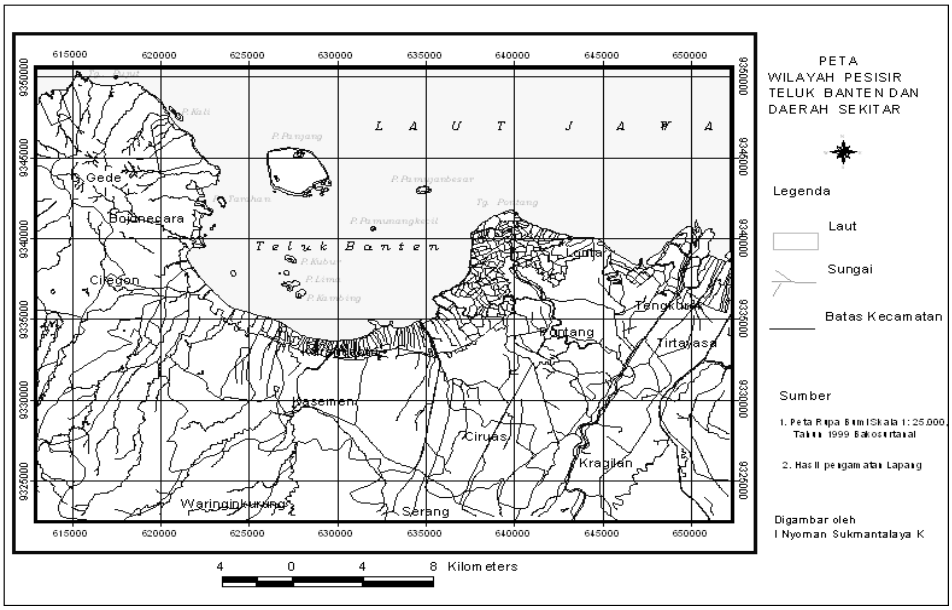

Figure 1: Study Area.

The Banten Bay consists of a semi-circular body of water where a number of small-scale rivers and canals from shrimp ponds debouch. More then ten islands can be found in the bay, some of which are submerged, accommodating coral and coral reefs. Due to higher of marine sediment volume reach the coastal water of the Banten Bay, there is new coastal landform was constructed known as tombolos, located at 2.5 km in eastern part of Karanghantu Harbour. These landform has been connecting the Pulau Dua with the main land of Java. The eastern flank of the bay is enclosed by the abandoned delta of Ciujung, namely Tanjung Pontang. Since 1920's, the Ciujung river flow was diverted by a short-cut canal with a north-eastern orientation crossing the Tengkurak villages towards the Java Sea. The abandoned delta has been subject to reworking due to active erosion processes while a new delta of elongate type (bird foot delta) was constructed at the new Ciujung River Mouth. The delta formation is still growing.

The Banten bay and its surrounding area is a small, relatively shallow coastal embayment in NW Java near the mergence of Sunda Strait and the shallow adjacent Java Sea. The coastal system of Banten bay and its surrounding area is determined by the seasonally strongly different sediment input by rivers, monsoon governed coastal accretion/erosion, possible seafloor erosion and by sediment input from the open sea. The seasonal variability of sediment input and distribution of the fine grained suspended matter within the water column may also have a pronounced effect on biological conditions, affecting development of flora (sea grass fields) and fauna (benthic fauna, fisheries and coral growth). In addition, the entire Javanese coastal area is prone to tsunami waves, the last important tsunami in the Banten Bay being related to Krakatau explosion in year 1883.

The coastal slope is gentle, most of it bottom consist of silt and clay materials, western tip indicated bay Mount Gede (595 m) as in active volcanic which has the steep slope of coastal line, where is the barrier coral reef was growth up some of them has serious bleaching condition.

RELATED STUDIES

There are several researches that can be used as comparasion on the methodology and knowledge of morphodynamic processes in coastal areas. Yun *et al* (1990) claims that multi sensor images (aerial photographs, Landsat Tm and MSS, can be used to estimate the sediment concentration to locate a port area after computing the sedimentation rate and coastline change. Saremi and Faroukar (1990) used the geomorphological approaches and muli temporal data to study morphological dynamics of coastal area. Climate and historical geological data were used for field considerations. The inundationa and coastline change were suspected to be caused by the techtonic activities and relates to the geological structure.

Hoekstra (1987) studied the development of two deltas: Bengawan Solo and Porong based on the morphology and sedimentary aspects. Several satellite images and aerial photographs were used for analysis, as well as the old topographical map of US Army 1942. The analysis was based on the coastline change and the inundation of the area. The delta formation was affected by the sediment debit contributed by the Bengawan Solo that has an area of 16,000 Km^2 and total sediment debit of 19 x 10^6 tonnes/year. Meanwhile the Porong Delta was affected by the Brantas River Basin that has an area of 12,000 Km^2, and total sediment debit of 19,7 x 10^6 tonnes/year. The finger form of delta characterises the influence of river with high sedimentation in Solo Delta, while the delta-lobe form in Porong Delta was influenced by river sedimentation dominated by Sembilangan River, Alo River and Porong River.

METHOD

The processes that initiate change in coastal zone are extremely difficult to study because they are driven by interrelated forces of high energy, each of which may produce a different response in the same coastal environment. These processes are sometimes monitored over short time periods with the installation of temporary arrays of sensors. Long-term observation, however are not possible without permanent installations designed to provide precise measurement over various time interval. Within the research carried out in the Banten bay and it's surrounding coastal area, a new approach was considered to prepare thematic data that ca be used for studying the morphodynamic processes. The methodology research has been arranged as follows (see also Figure 2). The first phase of the research includes secondary data collection, satellite and aerial photographic image acquisition and study literature. Then, a working map based on the data compiled and interpreted images were used the second phase i.e. field data collection. Standard operation in image processing such as enhancement and geometric and radiometric correction were conducted. Coastline data and geomorphology appearance of the area were extracted from the images. The historical data were also used for analysis. The field survey was conducted for data validation and checking. Here secondary data such as

oceanographic data and climatic data assisted in identifying such dynamics. Re-measurement of oceanographic data were also conducted. Table 1 describes the secondary data used for the analysis.

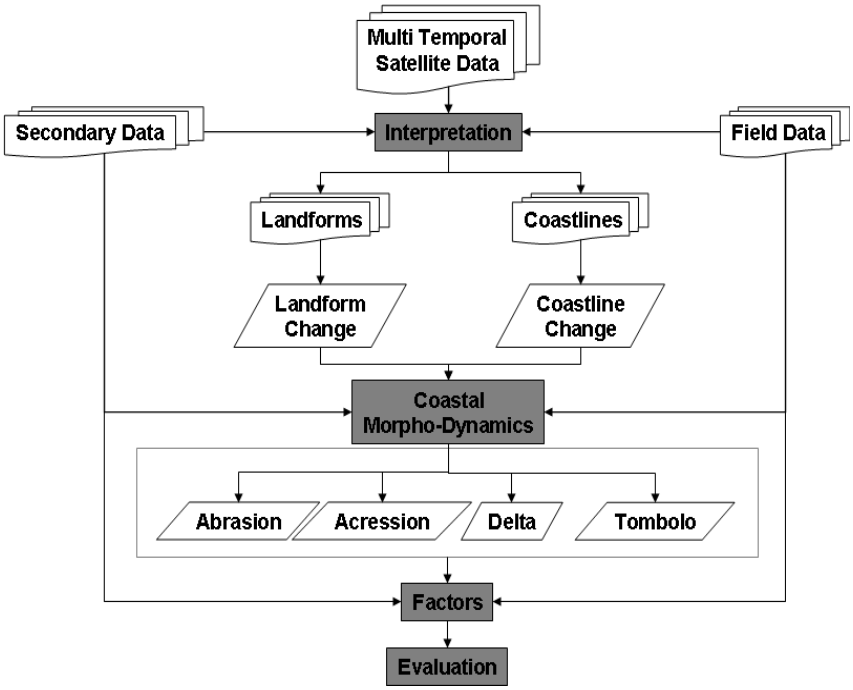

Figure 2: **Research Flow.**

Table 1: Source of Data

No	Source of Information	Year
1	Dutch Topographic map scale 1:50.000	1923
2	US Army Topographic map, scale 1: 50.000	1943
3	AMS Topography, scale 1:50.000	1960
4	Topographic Map of Bakosurtanal 1:25.000	1996
5	Geology map of Serang scale 1:100.000, Geological Institute Bandung	1985
6	Environmental Geology map of Serang scale 1:100.00, Geological Institute of Bandung	1992
7	Land used Map of Serang District, scale 1:50.000 BPN Serang	1990
8	Soil map type scale 1:100.000 Bapeda Serang	1989
9	Hydrography map of Banten scale 1:100.000 Dishidros Jakarta	1990
10	Areal photography scale 1:30.000 Bakosurtanal	1981/1982
11	Areal photography scale 1:50.000 Bakosurtanal	1994
12	SPOT XS & SPOT XS,	1990, 1997
13	LANDSAT TM & LANDSAT TM	1996, 2000

Landform assessment systematically gives interrelation level between the geomorphologic processes and has a role in the development of every landform. Verstappen 1977, Bush et al 1996 mention the typical abrasion, indicators such as horizontal displacement of coastline, overwash aprons with low elevation and no forest, widening river mouth, frontal dune formation, fallen trees from the bluff, shoreline change to inland direction and

temporary lagoon or swamp appears, eroded marine cliff, and the separation of some part of land to form new small land. Sedimentation as mentionen also by Verstappen (1977), Bush et al (1996) can be seen from the existing of marine sand bar formation, tombolo formation, delta front formations, shoreline changes to sea ward direction, shifted river mouthand and fluviomarine deposit.

RESULTS AND DISCUSSION

Geomorphology is one of the parameters for determining the type of coast and ecosystem, which are key factor for coastal zone development. In a tropical humid country with a high of weathering and upland erosion processes mainly due to high rate of rainfall, silt content of riverine water in coastal area is the very high. There after sedimentation is very pronounced and subsequently deltaic coastal plains are often formed, beside others coastal features such as tombolo, and coastal accretion almost faced within the shallow coastal water supported with less coastal current. Volcano in the past and present activity contributes much the amount of sediment brought by rivers system. Where the wave dominate the system of dynamic energy on the coast, the coastal plain will be able to growth in relatively regular form as we can see n for the southern coast of Central Java, which faced the open ocean. The others physiographic conversely for north coast of Java, where the input from rivers is the dominant factor, the bird foot or elongated type of delta will be formed. Geomorphology map on scale 1:50 000 was prepared for the study area, as the mapping units and map legends revered to BAKOSURTANAL landform unit map and classification system. There are 4 main group of landforms origin can be introduced or indicated for study area such as:

1. Forms of volcanic and denudational origin (Vd)
2. Forms of denudational origin (Dd)
3. Forms of fluvial origin (F)
4. Forms of marine origin (M)

The land ward information of the coastal zone can be learned from detail description of the geomorphology units which is considered some information dealing with (a) morpho-cronology, (b) morphography and morphometry, (c) morphogenesis, (d) morphological structures and (f) morphospatial arrangement. By considering details information given for each of the unit mapping of landforms classification mentioned on the geomorphology map of study area, some one can be easy to understand in order to have closed relationship amongst the coastal morphodynamic development within the study area. The Banten bay and its surrounding coastal area is a shallow bowl-shape embayment located the northern coast of Java, which has experienced severe land degradation over pas century. The bay represents a circa 10 to 15 Km wide Holocene sediment wedge containing predominantly silt and clay, only closed to the river mouth it was found fine sand mixed with mud dominant. The Ciujung (Ci means river) is the biggest river flows within the study area, which has the upper catchment located at Rangkasbitung and Sukabumi Regency. The main distributary of the Ciujung was diverted to the east in 1920's by means of a shortcut canal. An abandoned delta resulted, characterized by a reduction of sediment discharge after the inactivation of river branch flows to the Tanjung Pontang area. Consequently, the northward progradation of delta was halted and the canalization heralded a phase of retrogression of the inactivated delta, and the formation of delta at the newborn river mouth passing the Tengkurak village.

Coastline change detection

Based on the multi-temporal data interpretation, coastline change can be seen in Figure 3. It should be noted that there should be errors in extracting the coastlines from the satellite or photographic images due to geometric processing errors as well as the different resolutions of the images.

Three groups of coastal types were recognized within the study area. These were differentiated based on the physical aspects of the landforms. Each of coastal type has been indicated within the study area, and also differentiated into coastline segment having specific characteristics related with natural processes like abrasion and depositional or accretion dominated. These zones are:

1. **Zone A**: Moderate Steep slope coastal area composed of volcanic hard rocks structures
2. **Zone B**: Gently to Slightly sloping of the fluvial marine Coastal area, composed with fluvial sediment materials
3. **Zone C**: Gently to Slightly sloping of the fluvial marine Coastal area, Associated with delta formation composed with fluvial sediment materials

Zone A

These segments of the coastal area occupy in western part of Banten bay and its surrounding coastal area. The coastal area has topographic indication consist of lowest hilly with moderate steep slope and in some part of the coastline segment can be seen the marine terraces forms which is volcanic andesite and breccia has the geological structure composed. The upper part of topography of the coastal zone represents of the dormant lowest volcanic foot slope which is direct contact with the sea known as Sunda Strait. There were some coral reef barrier has been growing along in the front margin of the coastline in this coastline segments. The others some pocket beach was forms due to weakness of the rock structures composed and also as the direct impact of wave attack daily, with white sand materials covered on it. Western boundaries of this coastal type was Tanjung Piatu and the eastern point of the area was Badjonegara coastline section or segment. The main soil type of this area was redish-brown latosol and lithosol soil great group, and almost dry farms cultivation land used and scrub dominated. Within these coastal area, it's was decided to placed the industrial chemical and the international container harbour at Badjonegara sub district (Kecamatan). The rivers system was group as intermaten stream and genetic type was consequent river flows system. The sea wave characteristic can be classified as plunging sea breaker type, due to the coastline which has moderate steep sloping, made direct contact to the sea of Sunda strait with depth of coastal water > 10 m from lowest coastline distance to sea ward direction. Coastline changes was faced in this type of coastal area, due to reclamation processes as the interfere of human technology at Tanjung granyang coastal site. These area were build-up for international harbour site of container facilitate dealing with export and import of the industrial products and materials need to support industrial activity. Figure 4 shows the detailed evidence of the coastline change and Figure 5 shows its appearance on hystorical data and the satellite images. The total areas of abrasion and accretion occuring in this zone can be seen in Figure 6.

The condition of coastal area in zone A has been carefully examined, and it was analysis

using the multi temporal data by making the overlay of the coastline and others the tematic vector data. The main attention was given to have realized the geomorphic processes active and it was beleaved give the impact for modified or shaped the coastline since the past up to present condition. All of information derive from different multi temporal topographic maps and also combined with satellite coastline data raster after transformed to vector format data used for identification of the coastline changes. Multi stage remote sensing data analysis using synthetic holystic and pragmathic, approach were applied to make sure of the geomorphic coastal processes creating the changes of the coastal morphography and it surrounding environmental area.

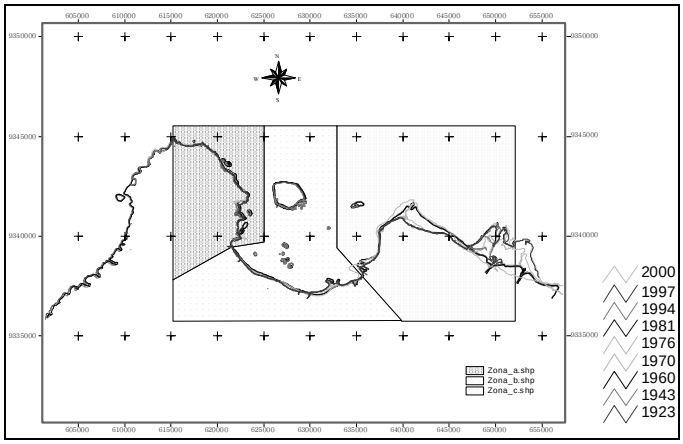

Figure 3: Coastline changes of the study area.

Table 2: Length of each coastline segment.

Year	Zone A (m)	Zone B (m)	Zone C (m)	Total Length (Analysed Zones)
2000	24,286.882	19,526.740	37,596.806	83,410.428
1997	24,907.149	22,685.594	32,655.729	82,245.472
1994	26,278.102	18,377.460	42,450.909	89,100.471
1981	23,049.889	18,222.273	28,497.959	71,751.120
1976	21,787.076	19,789.265	33,373.833	76,926.174
1970	20,418.825	20,234.991	34,013.443	76,637.259
1960	20,183.046	18,930.930	31,200.819	72,274.796
1943	20,215.974	17,613.866	31,600.838	71,373.678
1923	20,195.737	18,836.141	31,130.858	72,085.736

Coastline changes was faced in this type of coastal area, due to abrasion by wave and coastal current, also there were coastaline changes faced due to reclamation processes as the interfere of human technology at Tanjung granyang coastal site. These area were build-up for international harbour site of container facilitate dealing with export and import of the industrial products and materials need to support industrial activity. Abrasion process of the coastline partly active within this coastal area, but the rate of coastline erosion can be group be come very slow changes (< 0,045 mm/yr). Accretion proses temporally took place within the small pocket beach area distributed along the coastline in the zone A. The main material composed in the pocket beach was group as white sand partly consist of detritus of coral cay. These materials easy to be remove by wave and coastal current in very worse weathers conditions occurred within the study area, mainly in the wet monsoon season.

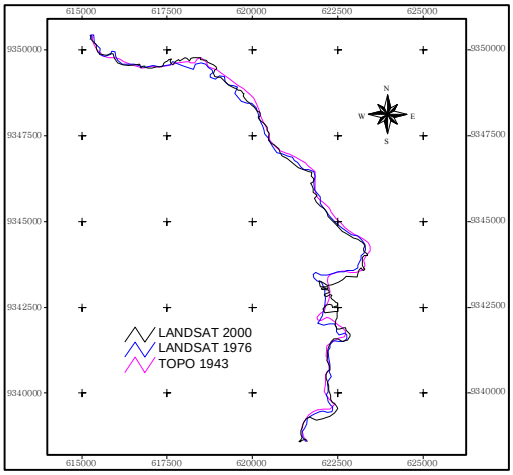

Figure 4: Coastline change in Zone A.

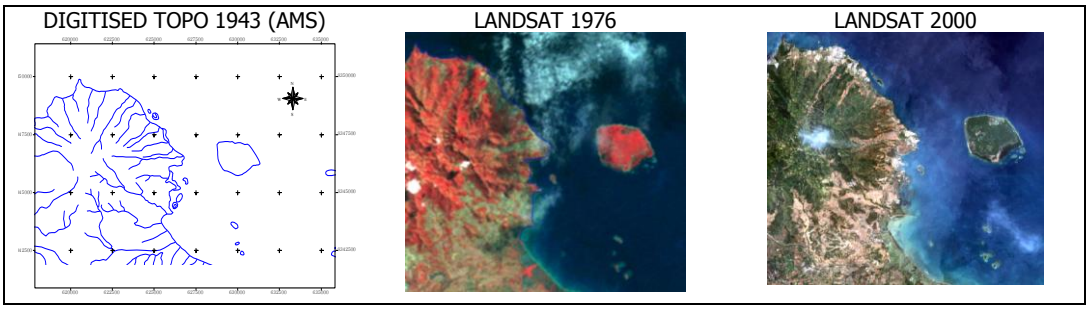

Figure 5: Multi-temporal image and data of Zone A.

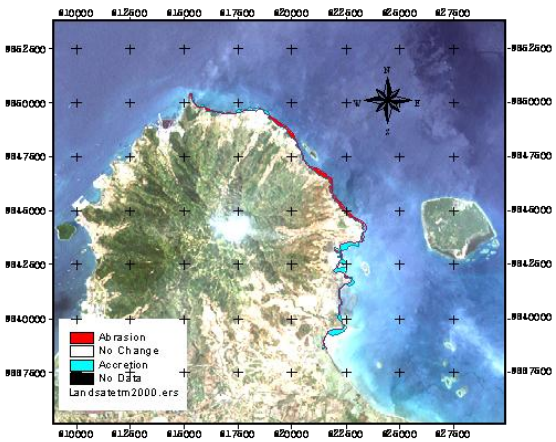

Figure 6: Abrasion and accretion in Zone A (Total Abrasion = 96 ha, accretion = 87 ha).

Zone B

These coastal area was very easy to be recognized by remote sensing images. Its topography expression mostly smooth and slightly sloping and it was occupied the eastern flank of study area in land ward direction. There was some point which has indication as the fluvial rivers terraces composed, due to river course in cession and sifted during the past period. Most of these coastal area were influenced by the marine environment impacts, such as tidal effect and sea water inundation during the full moon or spring tide, also the ground water intrusion during the dry season as especially in Jun up to august every years. The wester boundaries of the coastal segment is Bodjonegara coastal area and the eastern point of the coastal segment was Kamanjungan coastal area up to the mouth of Cianyar river tributaries.

Within the study area these parts of coastal area was occupied by fishpond, rice field and scatter fishermen villages and its can be groups under sub district of Karanghantu administratively. The only small part of the coastline segment has been used as the local fishermen harbour known as Karanghantu. Natural processes was active and it modified of the coastline changes within this segment of coastal area, due to active accretion or deposition processes took place since the year 1923. There after the depth of coastal water within this segment of the coastal area was changes and it be come shallow with the sea bottom materials consist of very fine fluvial marine sediment materials. The main soil type occurred in these coastal segment was group as alluvial soil group. Tombolo coastal features was formed in some where of the coastline segment close to Pengluhur village. Naturally the tombolo means the landform creating through the processes of active sedimentation and there after connecting the Pulau Dua with the main land of Java. These processes of deposition be come active, due to the impacts of the coral islands within the coastal water of Banten bay as the natural coastal barrier. It was given direct impact to reduce of wave and coastal current energy coming into the bay. The mean while the high sediment concentration was introduced by some rivers debouching within the Banten bay coastal water as especially during the raining season. At present condition the coastline has been changes due to accretion processes and it was believed this kind of natural process will be continued in the next time. Based on the WOTRO report the rate of deposition processes on going in the Banten bay coastal water > 0,50 g Cm^2 -/year, the calculation of the accumulation rate was done by considering the hydrodynamic regime crosscheck with result of carbon dating of sea core bottom materials samples(Pb^{210}). Figure 7 shows the detailed evidence of the coastline change and Figure 8 shows its appearance on hystorical data and the satellite images. The estimated areas of abrasion and accretion can be seen in Figure 9.

The condition of coastal area in zone B has been carefully examined, and it was analysis using the multi temporal data by making the overlay of the coastline and others the temathic vector data. The main attention was given to have realized the geomorphic processes active and it was noticed and believe can give the impact for modified or shaped the coastline since the past period up to present condition. All of information derive from different multi temporal topographic maps and also combined with satellite coastline data raster after transformed to vector format data used for identification of the coastline changes. Multi stage remote sensing data analysis using synthetic hallystic and pragmathic, approach were applied to make sure of the geomorphic coastal processes creating the changes of the coastal morphography and it surrounding environmental area.

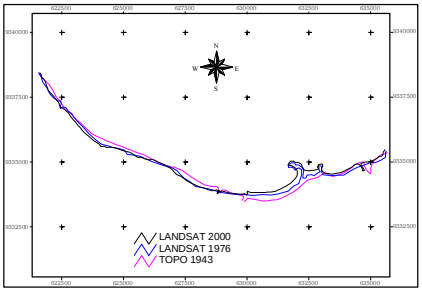

Figure 7: Coastline change in Zone B.

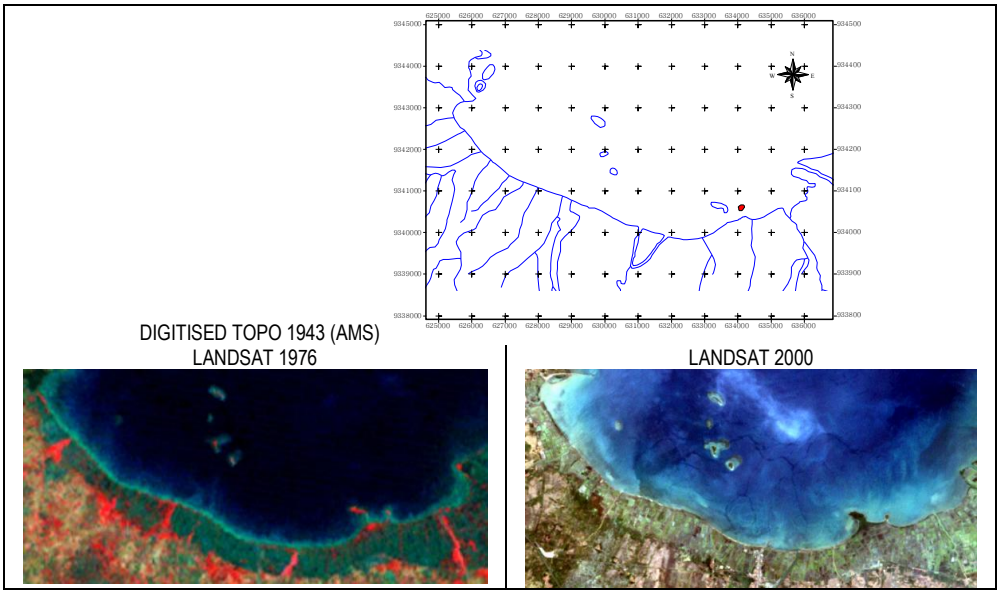

Figure 8: Multi-temporal image and data of Zone B.

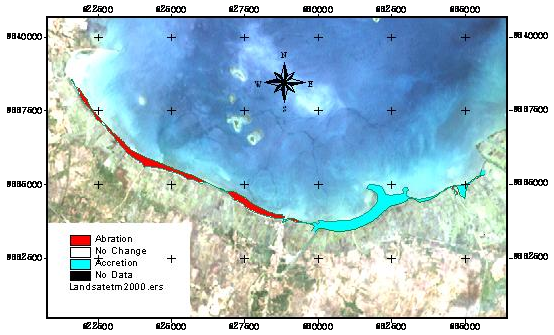

Figure 9: Abrasion and accretion in Zone B (Abrasion=121 ha, accretion=159 ha).

oastline changes was faced in this type of coastal area, due to temporary abrasion by

wave and coastal current in worse weathered condition indicate by loose of fishpond area becoming the sea. There were coastline changes faced due to deposition processes as the interfere of human technology (jetti construction) at Karanghantu harbour coastal site. These area were build-up for domestic lending ship and embarkation activity. Abrasion process of the coastline partly active within this coastal area, but the rate of coastline erosion can be group be come very small . Very famous of the accretion process took please in this type of coastal area was indicated by the formation of tombolo and it has morphography as half bow. Tombolo coastal features was formed in some where of the coastline segment close to Pengluhur village. Naturally the tombolo means the landform creating through the processes of active sedimentation and there after connecting the Pulau Dua with the main land of Java.

Dominant Accretion proses took place within this group B of the coastal area, distributed along the coastal water margin (< 150 m wide to the sea ward direction from present of the coastline)and indicated by decreasing of the coastal water depth 2.5 m at the year 1923, becoming < 1,5 m up to now. The main material composed and known as sea bottom sediment was determined as very fined sand, silty clay and mud. These materials easy to be rework by wave and coastal current creating high suspended sediment concentration in very worse weathers conditions occurred within the study area, mainly in the wet monsoon season (December up to February) every year.

Zone C

These coastal area was very easy to be recognized by remote sensing images. Its topography expression mostly smooth and slightly sloping and it was occupied the eastern flank of study area in land ward direction. The order also it's was marked of the Ciujung delta grows up to now still active and delta formation was reached the area about 4.2 Km wide from the base line coastline at Tengkurak village. There were some points which has indication as the fluvial rivers terraces and also dormant river channels composed, due to river course in cession and sifted during the past period. Most of these coastal area were influenced by the marine environment impacts since in past up to now, such as tidal effect and sea water inundation during the full moon or spring tide circulation, also the ground water intrusion during the dry season as specially in Jun up to august every years. The western boundaries of the coastal segment is Kamanjungan coastal area and the eastern point of the coastal segment was Tenyoayu coastal area, be long to Tirtayasa sub district.

Within the study area these part of coastal area was occupied by fishpond, rice field and scatter fishermen villages and its can be groups under sub district of Tirtayasa administratively. The only small part of the coastline segment has been used as the local fishermen station site known as Lontar landing fish area (Tempat Pelelangan Ikan/TPI). Natural processes was active and it modified of the coastline changes within this segment of coastal area, due to active abrasion processes took place since the year 1923. There after the depth of coastal water within this segment of the coastal area was changes and it be come slightly deeper and coastline retreated to land ward direction with the sea bottom materials consist of very fine fluvial marine sediment materials. These abrasion processes was faced closed to Lontar villages and also at Tanjung Pontang as the former of Ciujung delta formation. The total coastline sifted due to abrasion processes was reached > 3.5 Km at the Tanjung Pontang and coastline changes was 2.5 Km at Lontar village.

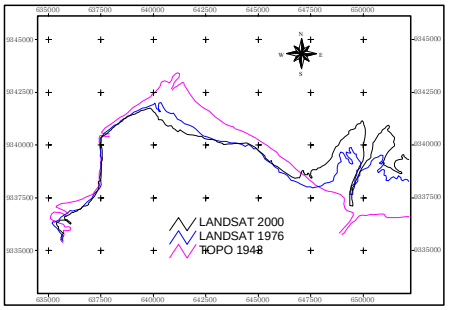

Figure 10: Coastline change in Zone C.

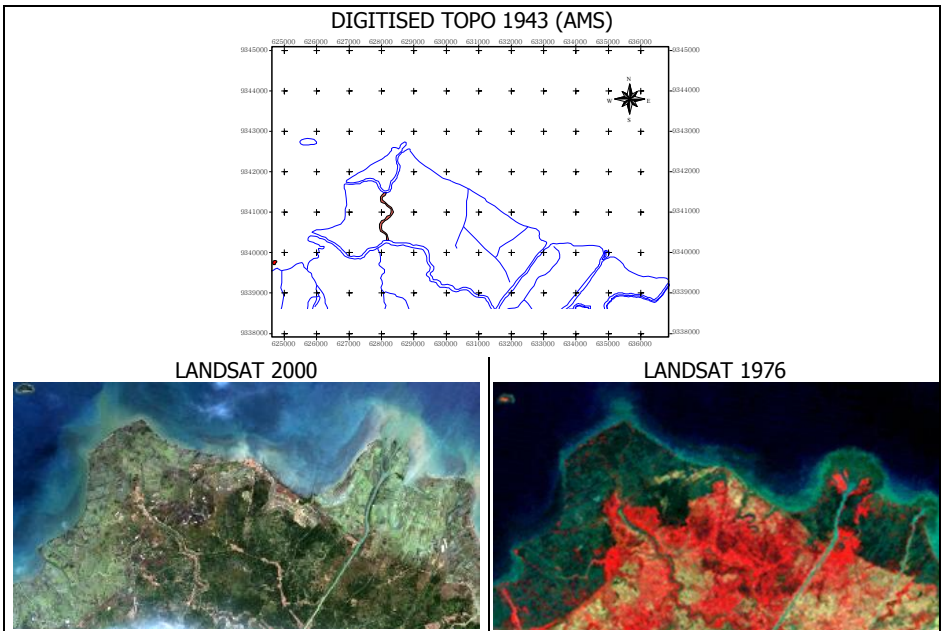

Figure 11: Multi-temporal image and data of Zone C.

Figure 12: Abrasion and accretion in Zone C (Abrasion=974ha, accretion=1302ha).

The main soil type occurred in these coastal segment was group as alluvial soil great group. Tombolo coastal features was formed in some where of the coastline segment close to Pengluhur village. Naturally the tombolo means the landform creating through the processes of active sedimentation and there after connecting the Pulau Dua with the main land of Java. These processes of deposition be come active, due to the impacts of the coral islands within the coastal water of Banten bay as the natural coastal barrier. It was given direct impact to reduce of wave and coastal current energy coming into the bay. The mean while the high sediment concentration was introduced by some rivers debouching within the Banten bay coastal water as especially during the raining season. At present condition the coastline has been changes due to accretion processes and it was believed this kind of natural process will be continued in the next time.

Based on the WOTRO report the rate of deposition processes on going in the Banten bay coastal water and its surrounding area > 0.50 g Cm^2 -/year, the calculation of the accumulation rate was done by considering the hydrodynamic regime crosscheck with result of carbon dating of sea core bottom materials samples (Pb^{210}). Figure 10 shows the detailed evidence of the coastline change and Figure 11 shows its appearance on hystorical data and the satellite images. The estimated areas of abrasion and accretion can be seen in Figure 12. Within this type of coastal segment known as zone C, the abrasion process has been indicated well and distributed since the western part of Tanjung Pontang coastal area where the coastline morphography is quite specific such as concave formed of the coastline The strait line of the coastline was faced at starting at Tanjung Pontang up to Lontar village in eastern point before reached the focal base line of the new Ciujung delta closed to Tengkurak village. The accretion of sediment were active due to delta formation at the geographical site of the Ciujung new delta Both coastal geomorphological process still active, and of course this active processe will much influence the coastal deformation in next periode within the study area.

CONCLUSION

Coastal morphodynamic can be studied well using the multi temporal data including remote sensing and hystorical data, and the final result of research can be used as input information for local government in order to prepared the best solution of the environmental problems occurred. The total area of coastal changes (accretion and abrasion) can be described and maps using multi temporal data available. There are varying amount of abrasion and/or accretion in the three zones. In Zone A the abrasion process is indicated with the irregular coastline morphography. Accretion also occurred in this zone, but it was only temporary in the form of pocket beach with its materials that has never settled due to its position between Sunda Strait and Java Sea. The abrasion process in Zone B was much influenced by temporary bad weather condition, while the abrasion in Zone C was much caused by on going process (current and wave energy). By preparing the geomorphological map of the study area, all of the physical aspects supported to abrasion, accretion processes can be learned or studied more accurately. Coastal changes are also applicable to be studied using GIS application, and are almost unanimous in their use of simple data model in which the coast is represented as a non-dimensional entities. This does not suffice for a volumetric assessment of coastal changes. Further details of conclusion and remark are:

1. the morphological dynamics of the research area can be studied based on the factors

that influence the process, and can be done and mapped accurately, either qualitatively or quantitatively,

2. the capability of multi temporal satellite images and hystorical data can be assessed to obtain parameters that characterise the coastal morpho-dynamics; and tombolo formation as well as Ciujung Delta growth is easily evaluated based on the coastal geomorphological approach, and
3. the coastal morphodynamics in relation to conservation efforts and development for study area based on synopthic and empirical calculation of environmental factors that create abrasion and/or accretion processes can be identified and documented accurately.

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