Problems, Causes and Handling Analysis of Tidal Flood, Erosion and Sedimentation in Northern Coast of Central Java: Review and Recommendation

S. Imam Wahyudi , Moh Faiqun Ni'am and Gilbert Le Bras

***Abstract*— Tidal flood, erosion and sedimentation are serious problem in Nord of Central Java-Indonesia. Many spots experience functional coastal land disturbance. This research, therefore, is aimed to identify coastal problems and analyze the causes and bring up some alternative engineering solution. The research method used is to hold a survey at the damaged location of the coast, to analyze the characteristics of hydrooceanography and spatial measurement and the alternative engineering solution. The total of coastal line of the studied coast based on Geographical Information System is 427,01 kilometers, covering 13 regencies and towns in Central Java Province. The dominant problem found at the studied location are tidal flood, erosion, estuary closing, sedimentation and sea water intrusion caused by the impact of coastal area development, mangrove plant cutting, and coral destruction. The most infrastructure built is port facilities without assisting building for anticipating impact. Mangrove plant cutting is due to extension of fish pool. Coral materials are exploited and traded. Generally the alternative engineering solution is protection with hard structure (groins, seawall), and with soft structure by replanting mangrove plants. Part of the alternative solution has been implemented and evaluated.**

***Index Term*— Coastal causes. Tidal flood. Erosion and sedimentation. Engineering solution. Central java. Indonesia**

I. INTRODUCTION

As a maritime country, Indonesian government concentrate onutilizing coastal and sea resources to anticipate decreases of productive land and land natural resources. National assets in form of coastal area and sea potentials are important for Central Java since some parts of the province are long coastal areas [1].

By time, the coastal areas requires attention to overcome damages caused by nature and people's activities. Natural disaster in the end of 2004 occurring in Nangroe Aceh Darussalam and Nias; Yogyakarta and Klaten on 2006; Kebumen, Cilacap and Pangandaran on 2007; for example, took hundred thousands of lives. The problems are serious because 75% of Indonesian people stay in coastal areas. To protect it, we need to plan of special structure.

In the last 30 years, northern coast of Central Java is an area with higher economic activities than other coasts in Indonesia. Activities such as sand mines, cultivation (shrimps and milkfish), buildings for navigation, industries and housing are held in the coast. Erosion since 1970s is an indication of economic resources exploitation without understanding the interaction of the coast and wave processes, tide, and current. Such exploitation was the trigger of abrasion (erosion) and sedimentation in the following days [2].

Exploration of coastal resources and sea will always invite arguments on the negative impacts. One group would attempt to utilize the resources maximally, and the other group would attempt to maintain the areas free from people activities. In reality, it is difficult to defend people activities in this region. Conflicts in which some short-term oriented sector is more dominant than other sectors can cause unbalanced utilization and environmental damages in between areas [3].

Coastal ecosystem can be endangered by unsustainable development patterns that can be pollution, erosion, aberration, accretion, costal habitats degradation, over exploitation, space utilization conflict and resources [4, 5, 6]. For sustainable development and preservation, detail study on the existing coastal problems are required.

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II. PHASES OF THE STUDY

Study area taken is northern coast of Central Java Province, Indonesian as shown in Figure 1. The aims of this study are to identify coastal area and infrastructure problems especially northern coasts of Central Java; analyze tidal flood, erosion and sedimentation in the causes; and to get description of solution alternatives. This paper is hoped to provide inputs on factors of tidal flood, erosion and sedimentation problems that should be given attention implementing development policies and coastal areas planning.

This study was conducted according to the framework as shown in Figure 2.

Fig. 1. Northern Coast of Central Java Province, Indonesia

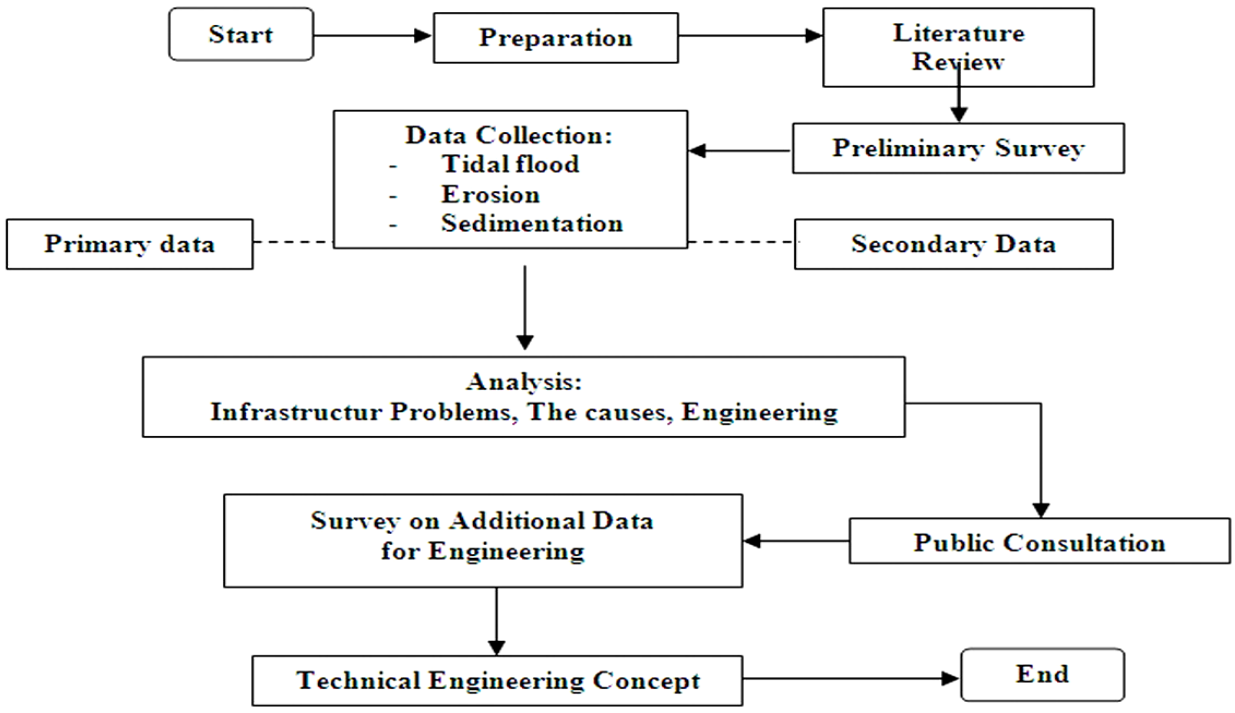

Fig. 2. Flow Chart of Study Phases

III. Result and Discussion

A. Characteristic of Northern Coast of Central Java

Administratively Coast of Northern Central Java includes 13 regencys/towns; Brebes Regency, Tegal Town, Tegal Regency, Pemalang Regency, Pekalongan Regency, Pekalongan Town, Batang Regency, Kendal Regency, Semarang City, Demak Town, Jepara Regency, Pati Regency, and Rembang Regency.

Northern coast of Central Java is connected to Java Sea which is relatively calmed. The highest wave is around 2 meters high and the tide is 1.20 meters [7]. Java Sea experiences muson climate, in which the wind changes direction every 6 months. Generally in dry season, the wind blows from east that causes what is so called *gelombang timuran* (eastern wave), and the wind blows from west in rain season and causes what is so called *gelombang baratan* (western wave) [8].

According to Wahyudi [7], the total coastal line length of Northern Central Java's coast, based on the map of GIS, is 427.01 kilometers covering Pemali Comal area (Brebes to Kendal town) 162.82 kilometers length, Jratun area (Kendal to Demak) which is 77. 59 kilometers length, and Seluna area (Demak to Rembang) 186. 60 kilometers length.

Coastal line is the line which borders sea water and land. Coastal line length can change anytime because of hydrodynamics of coast. Coast length is coastal line of a certain area 12 miles from land to the sea. Coast length is relatively more stable, or constant, than coastal line [9].

Generally the geomorphology of Northern Central Java's coast is sand base sediment beach, muddy sand. The declivity of the beaches is around 0.001 to 0.005. The beaches are categorized as slightly sloping beaches.

At some areas of muddy beaches are covered by populous mangrove, while other areas are covered by fish pools with damaged mangrove which require conservation. Sand areas at some locations experience coastal erosion which cause shoreline deterioration. Areas with coral reef, damages are caused by illegal mining the people around the beaches make.

B. Coastal Problem

Some data base of Northern Central Java's coastal problems can be identified as follows:

- ***Tidal flood*** occurs in some parts of towns along northern coast of Central Java. They are Semarang City [10], Pekalongan, Tegal. The development of exploiting the areas is relatively greater than other areas.
- ***Erosion*** occurs at Maribaya beach in Tegal, Muarareja Tegal, Mojo village, Pesantren in Pemalang, Suter and Semut in Pekalongan, Sari Beach and Slamuran in Pekalongan, Sendang Sikucing and Jomblom Kendal, Mangunharjo in Semarang, Sayung in Demak, Kedung – Semat, Bandungharjo in Jepara, Banyuwoto in Pati, Sarang in Rembang.
- Estuary Closing is problem that occurs in almost all estuaries in Northern Coast of Central Java, including the

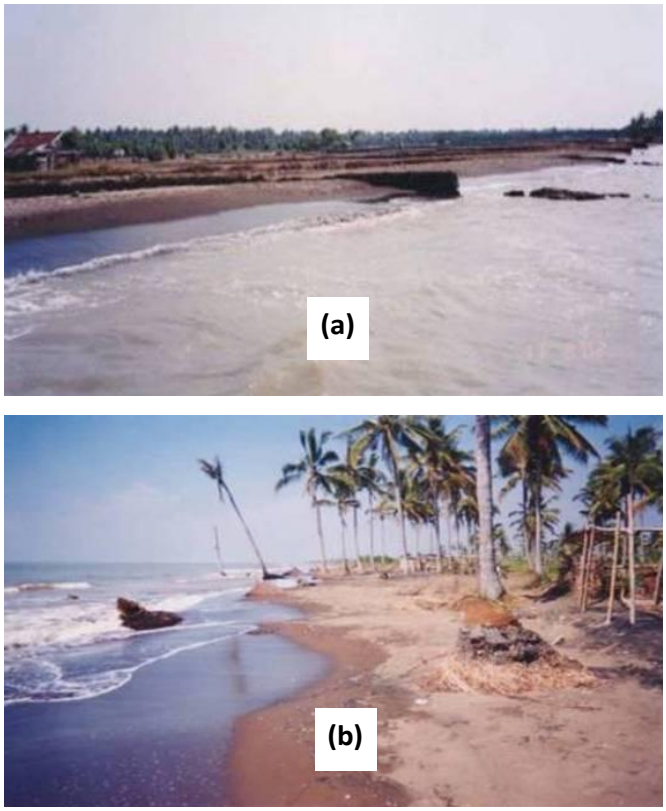

Fig. 3. Shoreline erosion at (a) Maribaya Beach, Tegal; and (b) Suter Beach, Pekalongan

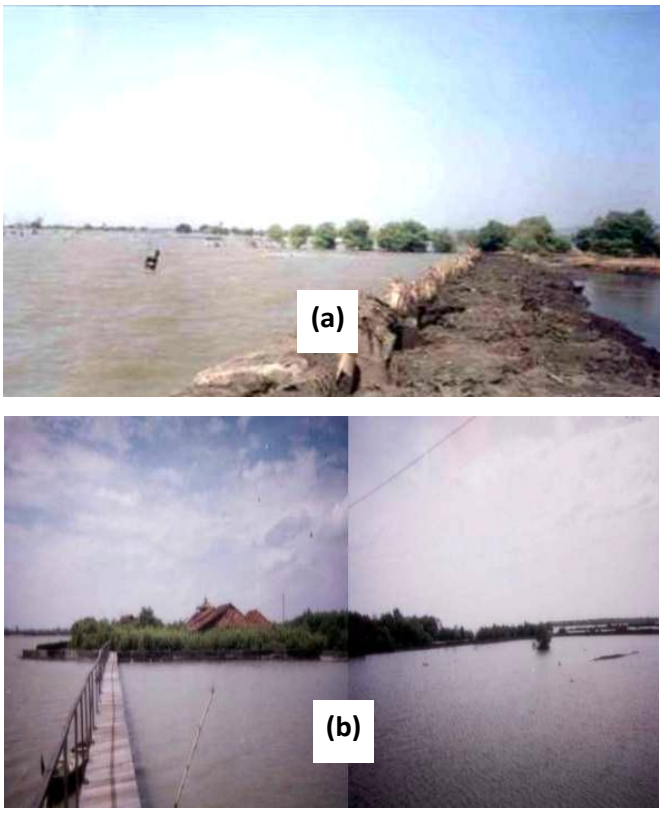

Fig. 4. Shoreline erosion causing loss of land and fishpond at (a) Mangunharjo, Semarang; and (b) Sayung, Demak

passages to fishery ports and harbor.

- Sedimentation at beaches is an advantage for people because of the emerging land. However, from space planning point of view, land ownership and land uses rules and procedure must be formulated. Sedimentation occurs in Pangaradan beach in Brebes, Bandengan beach in Kendal, Wulan river estuary in Demak.

C. The Causes of Coastal Problem

Fig. 5. Mangrove destruction caused by natural influences or tree felling for fishpond

Generally, the coastal problems at northern coast of Central Java such as tidal flood, caused by: land subsidence, sea water rise caused global warming, and water bazin decrease. While the coastal erosion problems, many caused by: coastal structures protruding into the sea, the destruction of mangrove trees caused felling or natural influences, and exploitation of coral reef. Meanwhile sedimentation problems caused by: coastal structures protruding into the sea, and transport sediment from the river.

From observation and research on the location of the study, the causes of coastal problems at northern coast of Central Java can be categorized in 3 group:

- Natural Causes, which includes land subsidence [11], erosion, sea water intrusion, river estuary movement, river estuary sedimentations, delta form change.
- Non-Natural Causes which are caused by human activities such as mangrove cutting, port and piers building, fish pools extension toward the sea, coral reefs exploitation, pollution.
- Combination of Natural and Non-Natural Causes such as aberration and accretion around wave blocker structures, aberration caused by exploitation of coral reefs, the stream pattern change caused by piers and port development, decrease of coastal line caused by mangrove cutting.

D. Handling Engineering Alternatives

Handlings that can be conducted is not only technical but also

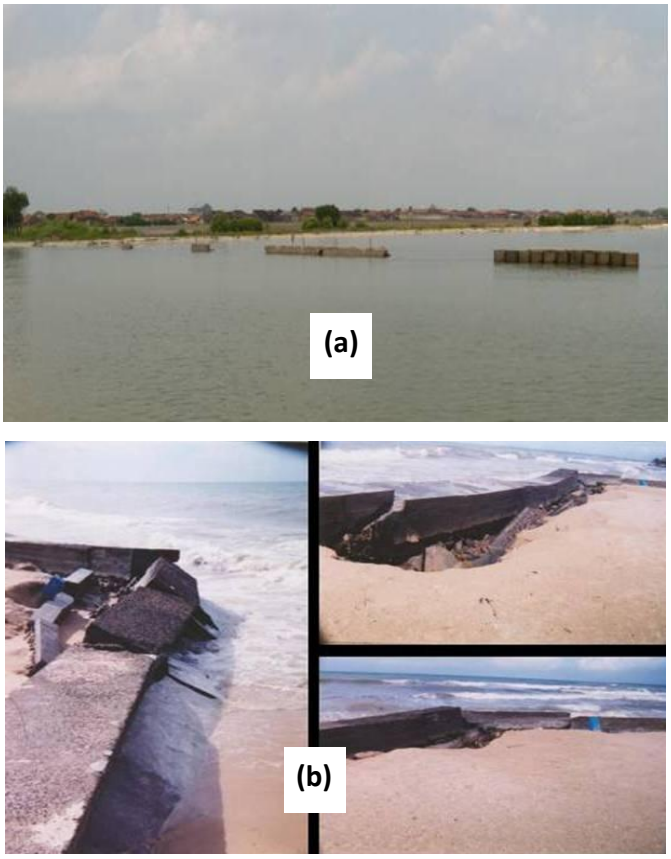

Fig. 6. Damage of coastal protection structures: (a) Jetty at Panggung River mouth in Jepara, and (b) Sea Wall at Sarang Beach in Rembang

non-technical as described below:

- Tidal flood handling. Repairing the drainage infrastructure system by using valve doors or polder system, decreasing land subsidence causes.
- Erosion handling. Building infrastructure with groin system or seawall combined with mangrove vegetation (Muarareja in Tegal, Pasir Kencana and Slamaran in Pekalongan town, Mangunharjo in Semarang, Sayung Demak, Kedung – Semat in Jepara, and Sarang in Rembang).

- Estuary Closing handling. Dredging periodically to open sailing channels which are covered by sediments, building Training Jetty at a number of sailing channels (Tanjungsari in Pemalang, Tawang in river of Kuto Kendal, Morodemak in Demak, Ujungbatu in Jepara, Juwono in Pati and Rembang).
- Sedimentation handling. Imposing regulation on Space Planning and land ownership to overcome emerging land effects and the uses like in river estuary of Menco (Wulan) Wedung in Demak, and Payuda in Brebes. Infrastructure development has to be well managed.

IV. Conclusions

Infrastructure problems that occur in northern coast of Central Java are erosion (abrasion), estuaries closing, emerging land caused by sedimentation, sea water intrusion like tidal flood.
The causes of the problems generally occurred because of natural process, uncontrolled people activities and the combination of the two such as building structure at the beach, and mangrove to fish pool switch.

The handlings of the problems can be done by soft structure (mangrove cultivation, for example), hard structure (building jetty, groin, seawall, and revetment) or the combination and also regulations as well as people empowerment and the infrastructures.

From this study, some our recommendations are follows:

- Institutional handling and coast infrastructure management needs to be coordinated by some government agencies at province, regency and towns level.
- Maintaining patterns should take mangrove conservation on top priority.
- Buildings on beaches must be anticipated by infrastructure concerned.

Further study or research work which can be done in the same area is the Detail Engineering Design (DED) according to the problems and potential of coastal areas, with priority is needed based on scale of priority

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