ANALYSIS OF SHORELINE CHANGES OF BENGKALIS ISLAND

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Abstract

The island of Bengkalis in Riau province is highly vulnerable against the impact of future sea level rise because of its low lying coastal area. Moreover, actions of waves, currents and human interferences may lead to even faster retreat of the coastlines. The objective of this study is to investigate the shoreline changes over the last decades and to determine coastalvulnerabilitydue to climate change in the future. GIS method has been implemented to assess shoreline changes based on satellite images and other supporting data. Based on LANDSAT images, we found the northern part of Bengkalisshoreline suffers 4 m/year of erosion while the southern part experiences 2m/year of erosion. Combined with the analysis of future climate changes that may lead to sea level rise, the island of Bengkalis is considered to have high index of coastal vulnerability due to dense occupation in the coastal area and constant retreat of shorelines.

Key words: GIS, shoreline changes, Bengkalis, climate change

1. BACKGROUND

As a dynamic area between land and marine environment, coastal areas are continuously adapted to the physical processes (e.g. wave, tides and current dynamics) as well as human interferences. (Solihuddin, 2009). One of important problems in coastal areas is high concentration of human population in which more than 70% of world big cities (megacities) are located in coastal areas. This is related to high potentials of coastal areas in many aspects such as: fisheries, agricultures, ports, tourisms, aquacultures and residential areas (Wahyudi, 2009). Meanwhile, coastal areas are also very vulnerable to extreme events such as storms surges or tsunamis that may cause damage to the environment and infrastructures. Furthermore, any disturbances to the coastal areas where human lives largely affect human daily lives (such as: transportation, industries, trades, and health) and environmental impacts. Shoreline changes either in the form of erosions or accretions are one of the problems in coastal areas that may be caused by many aspects such wind, waves, currents, high intensity of rains and human interferences to the environment (e.g. clearance of coastal forests or adding additional structures along the coastlines).

According to Dahuri (2011), shoreline changes are mainly caused by human activities in coastal areas such opening of new lands and exploitations of sands or other minerals which cause imbalances in sediment transport system along the coastlines. The main physical factors of coastline changes come from both sea and land sides. Land side factors are in the forms of sedimentation processes in rivers and the existence of coastal forest vegetations. Sea side factors could be from the waves, currents, tides and morphological characteristics of coastal beds. Furthermore, strong winds and sea level rise (or earth settlement) can also change significantly the coastlines (Pardjaman, 1977; Diposaptono, 2004; and Kalay, 2008).

Bowen and Inman (1966) in Komar (1976) concluded that erosions or accretions in the coastal areas are the results of coastal balances reflected from morphological stability of coastal areas. If accretion occurs, erosion in other neighbouring places should also happening and vice versa. These dynamics definitely will change the forms of coastlines in different time scales (months, years, decades or even centuries) and space scales (few hundred meters to hundreds of kilometres). The Island of Bengkalis in Riau Province (Fig. 1) has large marine potentials such as fisheries and trades. High concentration of human residences in coastal area and fast rates of coastal erosion in some areas of the island are some of main problems in Bengkalis Island. Thus, investigations on hydrodynamics sediment transport characteristics around Bengkalis Island are in great need. The knowledge on the characteristics of sediment transports are very important as the bases for coastal area management and development planning. Therefore, this study has an objective to describe coastline changes and evolution of Bengkalis Island as a first stage of coastal morphology studies in the region. Moreover, plan of further studies/research in the frame work of coastal vulnerability study carried out by the Research Institute for Coastal Resources and Vulnerability will also be discussed.

2. METHODOLOGY

Research location is in the Island of Bengkalis, Riau Province (2º30'-0º17' N, 100º52'-102°10'E). Other parts around the island such as the nearby rivers are also parts of the investigations. The island has an area of 7793.93 Km²consists of 8 districts and 102 villages. Most of the islanders are fishermen who catching fish along the coastal waters. The people also often used woods from mangroves in the island for chalk coals and building materials.

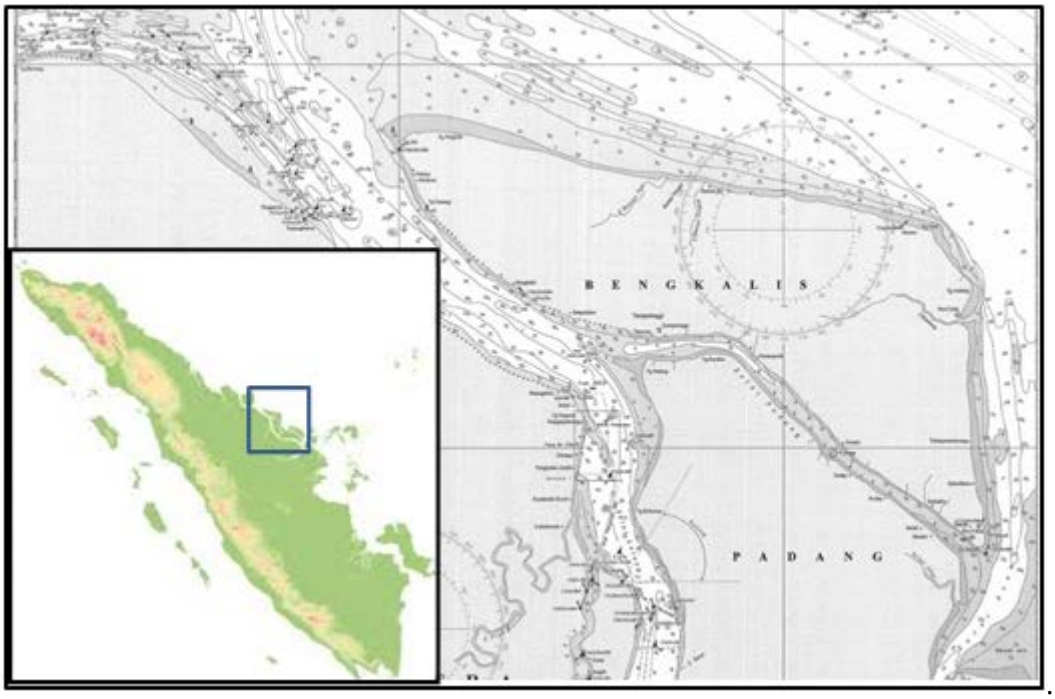

Fig. 1. Research location, the Island of Bengkalis (Dishidros, 2011)

The collected data from field are the width of the each (referring to the lowest water spring level to the highest water spring level) and information related to the erosion based on the interview with the locals and stake holders. Shoreline changes are determined based on GIS (Geographical Information System) by analysing LANDSAT images.

Softwares used in the analyses of shoreline changes are ER Mapper 7.1 and ArcGIS 9.3. Meanwhile, data used in the analyses are (Fig. 2):

1. Satellite image of LANDSAT 7 TM path/row 126/59 recorded on June, 30th 2010
2. Satellite image of LANDSAT 7 ETM+ path/row 126/59 recorded on June 18th, 2012.

The satellite images used are class one images consist of 7 bands where each band has its own functions. Those satellite images are composited into three colour filters: red, green and blue. Five bands of red colour, 4 bands of green colour and 2 bands of blue colour are used by the help of ERMapper 7.1. Afterwards, shoreline changes are further analysed from 2010 and 2012 LANDSAT images by using ArcGIS 9.3. This analysis is carried out by comparing and identifying the differences between the two images using overlaid techniques.

3. RESULTS AND ANALYSIS

GIS analysis shows significant shoreline change of Bengkalis Island compared to other neighbouring islands in Riau Province. Erosions are the most common type of shoreline change in Bengkalis Island, particularly in the North-West and South-East of the island. The North-West of the island suffers severe erosion with erosion rate reaches 4 m/year while the South-East coastline experiences 2 m/year of erosion (Fig. 3). High erosion rate in this area may have resulted from extreme wave actions frequently occur in the Malaka Strait. Severe erosion may also occur because the clearance of mangrove forest in most parts of Bengkalis coastlines. According to the latest interview with the locals, most of mangrove trees have been used by the locals for many purposes in daily lives such as fireworks and construction materials.

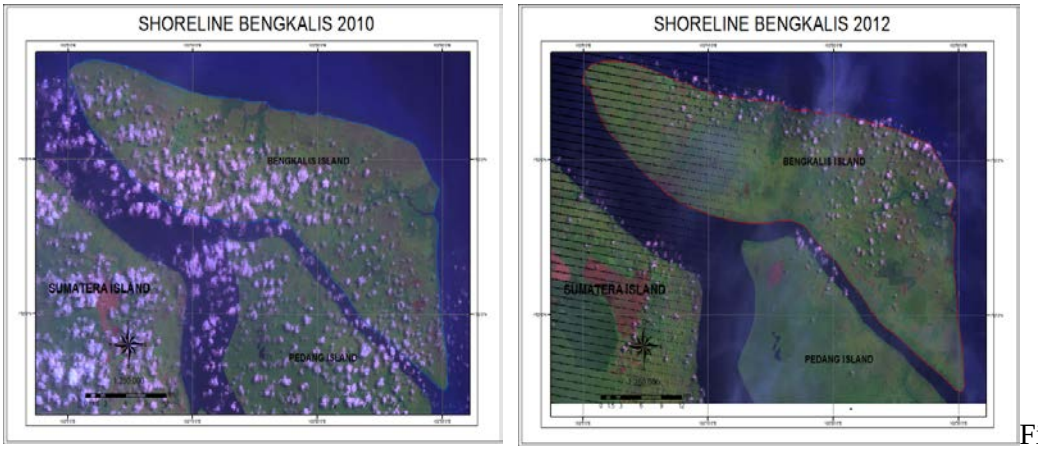

Fig. 2. Landsat satellite images of Bengkalis Island

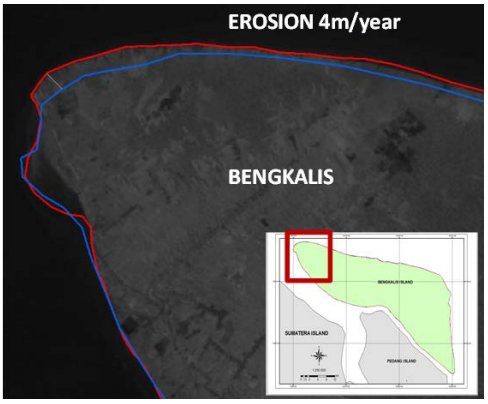

Fig. 3. High rate of erosion in the North-West of Bengkalis Island based on GIS analysis

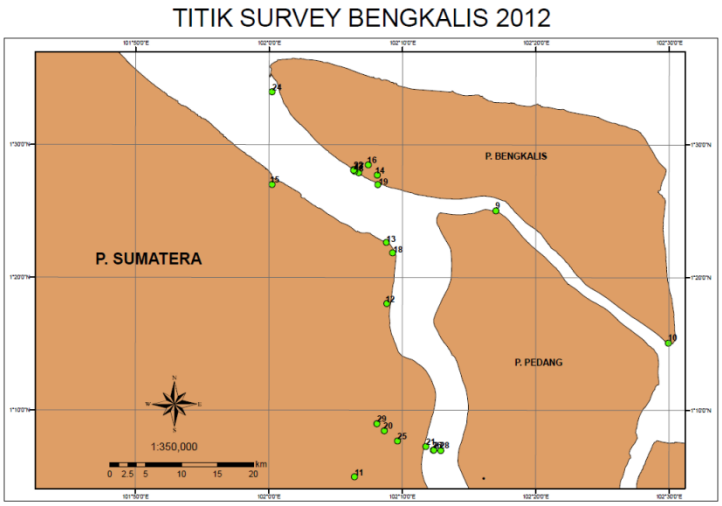

Fig. 4. Plan of measurement points around Bengkalis Island

Wave actions are not the only cause of severe erosion along the coastline of Bengkalis. Other aspects should definitely be investigated in more details such as sedimentation rate from the rivers and existing developments (e.g. coastal structures or land conversions) along the coastline may also have contributed to the erosions in some parts of the Island. Therefore, knowledge on the characteristics of hydrodynamics around the Island is absolutely needed in order to have estimation models of sediment transports along the coastline of Bengkalis. Once the behaviour of sediment transport has been explained, any other sediment transport diversion that may cause erosion or accretion due to coastal structures, land conversions, or sediment source dynamics can also be predicted for the future to come. This model estimation of sediment transport is very useful for the assessment and planning of coastal area management.

To understand the sediment transport behaviour along the coastline, LPSDKP is planning to deploy measurement devices such as ADCP, tide gauges, sediment trap and water quality meters in certain measurement points as shown in Fig. 4. The deployment will last for at least 15 days between October –November 2012. The data will be used as the input for numerical simulation using Mike21 for hydrodynamic model and GENESIS (USAC, 1984) for sediment transport model (Shoreline changes). The information from model simulation is very important for the analyses of coastal area vulnerability particularly by considering sea level rise due to climate change in the future.

4. CONCLUSION AND REMARKS

- Coastal erosion is a major threat in the Northern and Eastern parts of Bengkalis (4m/year), meanwhile in the Southern part, accretion turns to be a serious problems for many ports and navigations
- Long term evolution of Bengkalis coastline needs to be investigated, therefore on-going research carried out by LPSDKP will deploy measurement devices (e.g. ADCP and tide gauge) to measure hydrodynamics characteristics around Bengkalis.
- Numerical simulation employing hydrodynamics model coupled with sediment transport model will be implemented (Mike21 and Genesis) to predict coastline evolution in the future.

REFERENCES

Dahuri, R., J. Rais, S.P. Ginting dan M. J. Sitepu. 2001. *Pengelolaan Sumberdaya Wilayah Pesisir dan Lautan Secara Terpadu*. PT Pradnya Paramita Jakarta (In Indonesian).

Diposaptono S, 2004. Penambangan Pasir Dan Ekologi Laut. Kasubdit Mitigasi Lingkungan Pesisir Pada Direktorat Jenderal Pesisir Dan Pulau-Pulau Kecil, Departemen Kelautan Dan Perikanan (In Indonesian).

Kalay, Degen Erasmus. 2008. *Perubahan Garis Pantai di Sepanjang Pesisir Pantai Indramayu.* Sekolah pasca Sarjana IPB, Bogor (In Indonesian).

Komar P. D, 1976. Beach Proses And Sedimentation. School Of Oceanography Oregon Stste University Prentice – Hall, Inc Englewood Cliffs, New Jersey.

Pardjaman, D. 1977. *Akresi dan Abrasi Pantai Teluk Jakarta Disebabkan Kondisi Fisik dan Sosial*. LON – LIPI, Jakarta (In Indonesian).

Solihuddin Tb. 2009. *Karakteristik Pantai Dan Proses Abrasi Di Pesisir Padang Pariaman, Sumatera Barat*, Puslitbang Sumberdaya Laut dan Pesisir, Balitbang-KP, Jakarta (In Indonesian).

U.S.Army Corps of Engineers (USAC), (1984), Shore Protection Manual, Coastal Engineering Research Center, Vicksburg, Mississippi, US.

Wahyudi, Teguh Hariyanto, Suntoyo. 2009. *Analisa Kerentanan Pantai di Wilayah Pesisir Pantai Utara Jawa Timur*. Jurusan Teknik Kelautan. ITS Surabaya (In Indonesian).

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