Predicting Coastal Vulnerability Along Coast of Santubong

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Final Year Project Report ☑

Masters ☐

PhD ☐

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Predicting Coastal Vulnerability Along Coast of Santubong

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A report submitted in partial fulfilment of the Final Year Project (STF 3015) Course Aquatic Resource Science and Management

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The project entitled "Predicting Coastal Vulnerability along Coast of Santubong" was prepared by NorFaizah Binti Kaswadi and submitted to the Faculty of Resources Science and Technology in partial fulfilment of the requirement for the Degree of Bachelor of Science (Honour) in Aquatic Science and Resource Management.

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(NORFAIZAH BINTI KASWADI)

Date: _____

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Predicting coastal vulnerability along Coast of Santubong

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Abstract

The vulnerability of coastal systems to sea-level rise and to other drivers of change is determined by their sensitivity, exposure and adaptive capacity. The coastal environment is constantly changes due to natural and anthropogenic (human-made) factors. These changes were affecting the socio- economic activities of the local people of that area. Hence, the human induced tend to trigger more stress that come from wave action and monsoon season on coastal resources. Therefore the aim of this study is to monitor the coastal vulnerability along Tanjung Santubong's beaches by achieving these objectives: (1) to determine the geomorphological changes at beach along Tanjung Santubong, (2) to obtain trace of the present shoreline (to compare with the historical maps) and (3) to determine the awareness level of local community to general vulnerability. The data will be collected and analyse by using Coastal Integrity Vulnerability Assessment Toolkit (CIVAT) and CIVAT indicators respectively.
Keywords: Vulnerability, Coastal, Coastal Integrity Vulnerability Assessment Tool(CIVAT), Beach Profile, Shoreline Tracing, Climate Change

Abstrak

Kelemahan sistem pantai kepada kenaikan paras laut dan faktor lain perubahan ditentukan oleh sensitiviti, pendedahan dan keupayaan penyesuaian. Persekitaran pantai sentiasa berubah kerana faktor semula jadi dan antropogen (buatan manusia). Perubahan ini telah memberi kesan kepada aktiviti sosio-ekonomi penduduk tempatan dikawasan itu. Oleh itu, yang disebabkan cenderungan manusia untuk mencetuskan lebih banyak tekanan yang datang dari aktiviti ombak dan musim monsun pada sumber pantai. Oleh itu, tujuan kajian ini adalah untuk memantau kelemahan pantai sepanjang pantai Tanjung Santubong dengan mencapai objektif ini: (1) untuk menentukan perubahan geomorfologi di pantai sepanjang Tanjung Santubong , (2) untuk mendapatkan bentuk pantai ini (untuk membandingkan dengan peta sejarah) dan (3) untuk menentukan tahap kesedaran masyarakat tempatan kepada kelemahan umum. Data ini akan dikumpulkan dan dianalisis dengan menggunakan Coastal Integrity Vulnerability Assessment Toolkit (CIVAT) dan petunjuk CIVAT .
Kata Kunci: Kelemahan, Pantai, Coastal, Coastal Integrity Vulnerability Assessment Tool(CIVAT), Profil Pantai, Kesan Pantai , Perubahan Iklim

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CIVAT	Coastal Integrity Vulnerability Assessment Toolkit
POST-VA	POST-Vulnerability Assessment
PRE-VA	PRE-Vulnerability Assessment
PI	Potential Impact
CVI	Coastal Vulnerability Index
AC	Adaptive Capacity

1.0 Introduction

Vulnerability assessments are specific to a given location, sector or group and it depends on the local ecological and socio-economic characteristics (Hinkle and Klein, 2007). The vulnerability of coastal systems to sea-level rise and to other drivers of change is determined by their sensitivity, exposure and adaptive capacity (Nicholls and Klein, 2005). The dynamic and complex multi-functional coastal environment is constantly changing due to natural and anthropogenic driving factors. The human induced influences such as seawalls and revetments generally tend to reduce beach permeability and cause accelerated beach erosion and slower recovery (Fletcher, Mullane, & Richmond, 1997). Climate change, as a result of the shifts in the mean state of the climate or in its variability, has led to a rise in the earth's average surface temperature (Gomit, 2000).

Belanda Cape, Sipang Cape and Embang includes in Tanjung Santubong areas (Richmond, Bonetto, Brash, & Brown, 2013). This shows that Santubong is an important areas for recreational and tourisms besides for natural wildlife habitats. Due to the important roles of the Santubong area for recreational and tourisms, the monitoring of the Tanjung Santubong is needed to calculate the rate of erosion that occurs in that particular areas. This is because the coastal erosion occurs in that areas will affects human socio-economic either indirect or direct values. Therefore, it is very important to monitor and predicting coastal vulnerability particularly along the Tanjung Santubong area which is still rarely investigated, by applying these three proposed objectives:

(1) to determine the geomorphological changes along Tanjung Santubong's coasts.

(2) to obtain trace of present shoreline (to compare with historical maps).

(3) to determine the awareness level of local community to general vulnerability

2.0 Literature Review

2.1 Coastal of Tanjung Santubong

The Santubong peninsula or also known as Damai is a 10 km long finger of land jutting out into the South China Sea. Only 35 minute drive about 35 km away from Kuching, the capital of Sarawak to the Santubong area. The Santubong area is one of the best places in Sarawak to see rare Irrawaddy dolphin which inhabits rivers, estuaries and shallow coastal areas. The Santubong area has their own natural attractions such as mangrove forests, rivers, near shore waters and mudflats that supported variety of wildlife habitats. These Santubong areas are surrounded with few cape and bay such as Belanda Cape, Sipang Cape, Embang Cape, Belian Bay and Karang Bay. There are a few beaches located around Santubong area that are Damai Permai beach (0.31 km), Damai Central beach (0.60 km), Santubong beach (0.35 km) and Puteri beach (3.52 km).

2.2 Coastal Terminology

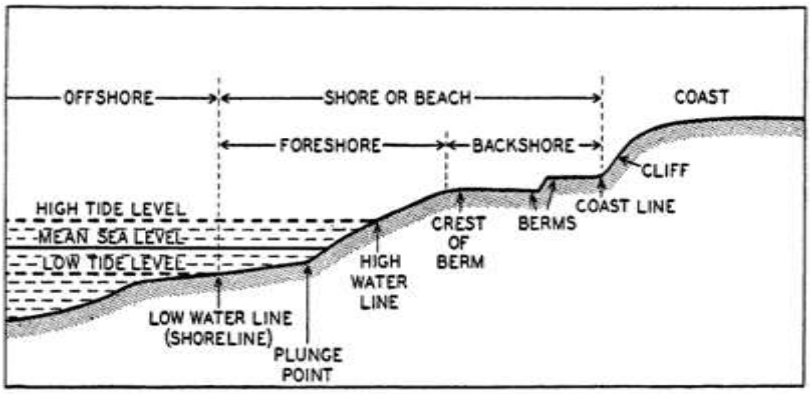


Figure 2.2: Terminology of coastal area. (Shepard and La Fond, 1940)

According to Post and Lundin (1996), coastal zone is defined when the land meets the ocean, as the interface where land meets the ocean, including the shoreline and adjacent coastal such as river, mangroves forest, beaches, and other coastal features. Coastal geomorphology deals with the evolution of coastal landform such as rocky shores, beaches and estuaries (Bird,

2000). The term coastline also known as shoreline indicates as far as the tides affect the beach. The shoreline can change moves to and back as the tides rise and fall. According to Sharifah Mastura, (1992), coastal zone is an area which land is narrow and the wetland immediately adjacent to the shoreline where the sea and the land meet. Coastal zone also known as an area which can extends seaward to the edge of the continental shelf, where man's activities may cause damage to natural system such as mangroves, fisheries and others (Hail J. , 1980).

2.2.1 Important of Coasts

Coastal areas they provide ecological services that have socioeconomic benefits to the human population, including or according to location, forage, building material, fisheries and protection of commercial, recreational (Williams, Coles, & Primavera, 2007). Based on the observation made at Santubong coast, coastal management is very important to the ecology culture of local people, preserving historical values and aesthetic values such tourism, recreational and fisheries.

2.3 Coastal Vulnerability

Vulnerability is considered as the extent of harm, which can be expected under certain conditions of exposure, susceptibility and resilience (Balica *et.al*, 2009; Hufschmidt, 2011; Scheuer *et.al*, 2010; Willroth *et.al*, 2010; Fuchs *et.al*, 2011). The potential for loss after receiving exposure from factors such as environmental risks and hazards are known as vulnerability (Cutter, 1996; Tunner et.al, 1996; Rosario, 2007). Vulnerability is a measure of the degree to which a human or natural system is unable to cope with adverse effects. Coastal vulnerability is cause due to uncontrolled process off erosion (Klein, 2002) mainly because of anthropogenic rather than natural causes.

2.3.1 Coastal Processes

2.3.1.1 Waves

Wave is undulations on a water surface produced by wind action. Winds blowing on the ocean surface create waves, however tides are also considered as waves caused by gravitational influence from the moon and sun (Brown *et.al*, 1999). The waves that larger than usual can cause beaches to become coarser and steeper (Husain *et.al*, 1995; Hill, 1966; Mastura, 1987; Husain *et.al*, 1988). As the waves strong, more changes of geomorphological occur along the coastal area which leads to the changes of present shoreline shapes of the coasts.

2.3.1.2 Storm Waves and Monsoon

The rise of water more than normal tide which is due to strong storm (strong winds) effect is known as storm surge (NOAA, 2013). The difference in temperature from the sun's radiation causes monsoon (Ministry of Science, Technology and Innovative, 2013). According to Malaysian Meteorological Department of Ministry of Sciences, Technology and Innovation (MOSTI) (2013), the weather in Malaysia is characterised by two monsoon regimes, namely, the Southwest Monsoon from late May to September, and the Northeast Monsoon from November to March. Where the Northeast Monsoon brings heavy rainfall throughout the east coast states of Peninsular Malaysia and western Sarawak, whereas the Southwest Monsoons is known as drier weather. The transition period in between the monsoons is known as the inter-monsoon period.

There are different types of waves between monsoon and storm wave phenomenon which brings up different types of energy level of the wave (Ministry of Science, Technology and Innovative, 2013). The level of coastal erosion will increase as the result of the increasing of wave energy that hit the coastal. Basically, the geomorphological of that coastal area will

experience massive change, and the changes can be determine by observing the steepness of the beach and compared the data before and after monsoon.

2.3.1.3 Tides

Tides are the result of the gravitational attraction and inertial forces from the Earth, the moon and to a lesser degree the Sun and are evident as a rhythmic rise and fall of sea once or twice a day (Davidson, 2010; Masselink, 2005; Schwartz, 2005; Woodroffe, 2003). As the tide rises and falls, the shaping of beach profiling, sorting of beach sediments and the modification by longshore drift are retarded by vertical dispersal wave energy (Bird, 2000). The tidal current play an important role in the shaping of the shoreline of the coasts as result of rises and falls of tide.

2.3.1.4 Sea Level Rise

The changes in sea-level rise is affecting the sediment accumulations and landforms, as the shoreline moves the coastal areas is either exposed or flooding and this will leads to the changes of coasts (Davis, 1994). According to Scheffers *et.al*, (2012), many of risks due to sea-level rise are associated with flooding event from storm waves and surges or higher tides. Consequently, populated coastal areas are becoming more and more vulnerable to sea level rise and other impacts of climate change. As the population growth, the public education about the awareness towards the vulnerability must be created among the local communities by giving a talk or campaign so that they know the current situation that happened around them.

2.3.2 Impact of Coastal Erosion

2.3.2.1 Habitat Loss

Most of coastal habitats have been altered to some degree due to diverse agents of change. Humanity has profoundly impacted, degraded or destroyed many coastal wetlands worldwide by direct physical degradation and pollution (Zong, et al., 2007). The beaches of the world are affected by the erosion and transport associated with sea level rise, locally by human activities (Valiela, 2006). The loss of habitats can be result in the changes of geomorphological along coastal region for examples, when the cut of mangroves is increased it will result in the loss of sediment which is important for nursery and feeding ground for many organisms.

2.3.2.2 Beach Erosion

According to Bird (2000), beach is an accumulation of loose sediment, such as sand, gravel or boulders and sometimes confined to the backshore but often extending across the foreshore as well. Beach erosion occurs when there are higher rate of losing sediment alongshore, offshore or to the hinterland than they received from various sources. Since beach is part of coastal zone, beach erosion is refers to the geomorphological changes that occur on coastal area. The changes of shoreline of the beach also refer to coastline pattern. The changes of coastline can be determined by using the beach profiling and shoreline tracing method.

2.3.2.3 Man-Made Coastline

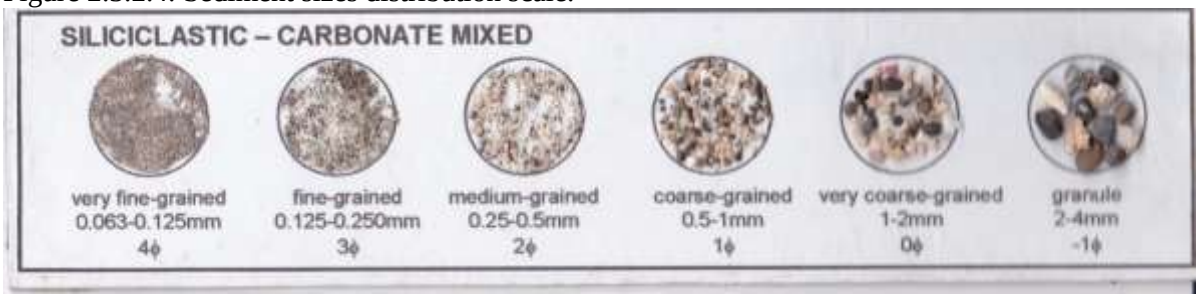
According to Scheffers *et.al*,(2012), coastal erosion may be introduced when beachfronts are developed for recreational, urban or industrial sectors. Artificial beach nourishment is often an alternative and more environment friendly method of choice to protect sandy beaches from erosion and to combat coastal retreat (Scheffers *et.al*, 2012). Hence, this nourishing method

basically will add sediments along shoreline which mean the geomorphological structure of the coasts will changed and the present shoreline's shape would be different than before.

2.3.2.4 Sand Distribution

The deposition and transport of sediments from erosion and accreation produces sandy beaches as its moves constantly along the shorelines and its affect the beach shape's change. The changes are mainly caused by waves and tides. Sand sizes can be classified into slightly muddy, very fine, fine, medium and coarse. Sand distribution can also be analysed by using grade scale. Figure 2.3.2.4 below shows the sediment distribution scale.

Figure 2.3.2.4: Sediment sizes distribution scale.



2.3.2.4 Mangroves

Mangrove ecosystems are highly productive areas and very important for economic and ecological point of view. Mangroves host a wide variety of organisms, including endangered species where these habitats needs a nursery and feeding ground to fish and invertebrate such as crustaceans and mollusks. They also help in preventing land erosion by stabilizing substrate and protecting the coast from storm surge and waves (Scheffers *et.al,* 2012).

2.4 Coastal Vulnerability Assessment Tools

There are many types of coastal vulnerability assessment tools such as Coastal Integrity Vulnerability Assessment Tool (CIVAT), Tools for Understanding Resiliency of Fisheries

(TURF), Integrated Coastal Sensitivity, Exposure and Adaptive Capacity to Climate Change Vulnerability Assessment Tool (ICSEA-C-Change), Dynamic and Interactive Vulnerability Assessment (DIVA), Community based Risk Screening Tool-Adaptation and Livelihoods (CRiSTAL) and Environmental Sensitivity Index (ESI). In this part, I will explain about the scope of difference tools and their disadvantages, and why I have choosing CIVAT. Please refer to the table below as a summary.

Table 2.4: Comparison between Coastal Vulnerability Assessment tools

Tools	Scope		Disadvantage
CIVAT *Coastal Integrity Vulnerability Assessment Tool*	• coastal integrity • Biophysical	Climate change impacts considered on : • sea-level rise waves	• focus on coastal integrity
TURF *Tools for Understanding Resiliency of Fisheries*	• Fisheries • Biophysical, with a socio-economic component	Climate change impacts considered on : • Waves • Storm surges • Sea-surface temperature	• Focus on fisheries
ICSEA-C-Change *Integrated Coastal Sensitivity, Exposure, and Adaptive Capacity to Climate Change Vulnerability Assessment Tool*	• Integrated, i.e. biodiversity, coastal integrity, fisheries • Biophysical	Climate change impacts considered on : • Sea-level rise waves • Storm surges • Sea-surface temperature • Rainfall	• Focus on data calculation in software system
DIVA *Dynamic and interactive vulnerability assessment*	• Biophysical • socio-economic consequences of sea-level rise • socio-economic development taking into account	• coastal erosion (both direct and indirect) • coastal flooding (including river) • storms • sea-level rise	• focus more on software calculation
CRISTAL *Community based Risk Screening Tool-Adaptation and Livelihoods*	• climate adaptation	• community based(local community level) • risk screening • adaptation and livelihood	• focus on local community only
ESI *Environmental sensitivity index*	• vulnerability value • ecological value • social value • economic value	• vulnerability index • ecological index • socio-economic index	• focus more on software calculation

The Coastal Integrity Vulnerability Assessment Tool or CIVAT, measures the vulnerability of the physical coast by analysing natural and anthropogenic factors driving beach processes. CIVAT are protocols in order to measure vulnerability to sea level rise and wave exposure. This assessment tools can identify specific adaptations options to improve coastal integrity. In doing the assessment for coastal vulnerability, CIVAT are more detailed which focusing specifically on coastal integrity respectively.

Tools for Understanding Resiliency of Fisheries or TURF, are protocols in order to measure vulnerability to waves, storms surges and sea-surface temperature. This assessment is concentrating more on fisheries which are not for coastal integrity. That's the reason why the TURF are not been choose for this project.

The Integrated Coastal Sensitivity, Exposure, and Adaptive Capacity to Climate Change Vulnerability Assessment Tool or ICSEA-C-Change, are protocols in order to measure vulnerability to sea-level rise, waves, storm surges, sea-temperature and rainfall. Even though this tool is focusing on integrated of coasts, but this assessment is focusing more on the use of software calculation which is will not use in this project.

The Dynamic Interactive Vulnerability Assessment model or DIVA is also a tool for coastal vulnerability assessment which includes biophysical and socio-economic consequences of sea-level rise also in the socio-economic development. Its protocols in order to measure vulnerability to coastal erosion (both direct and indirect), coastal flooding (including rivers), wetland change and salinity intrusion into estuaries. This tool focusing more on used of software calculation which is will not be use in this project.

CRiSTAL stands for Community-based Risk Screening Tool-Adaptation and Livelihoods which is a project-planning tool that helps in the designing the activities that support climate adaptation such as an adaptation to the climate variability and change at the community level. The disadvantage of this tool is they only focus on local community only.

ESI or Environmental Sensitivities Index was defined by multiplying vulnerability index (VI), ecological index (EI) and socio-economic index (SI). This tools very heavy on study of the software calculation values of vulnerability, ecological, social and economic which is not be use in this project.