Application of Coastal Protection Structure for Mangrove Rehabilitation & Rejuvenation of West Coast Johor. Case Study: Tanjong Labuh, Batu Pahat, Johor.

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Application of Coastal Protection Structure for Mangrove Rehabilitation & Rejuvenation of West Coast Johor. Case Study: Tanjong Labuh, Batu Pahat, Johor.

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Abstract: Tanjung Labuh beach was a muddy beach along the Malacca Strait and the shoreline was the land-sea border. The shoreline has an irregular existence and shifts because of human activities and nature, resulting in erosion and sediment eradication on the shore. The aim of this study focuses on identify the coastline changes from the image taken by using drone and to analyse the data from the image by using ArcGIS mapping software and also to determine soil properties, coastal properties and analyse the movement of sediment transport. DJI Phantom 4 Pro (UAV) is a method used to identify the shoreline changes in study area. Measuring large-scale land recovered by land survey methods such as the complete station and GPS however demands a great deal of time and job investment. Analysis such as specific gravity, hydrometer test and sieve analysis will be carried out to obtain results on the characteristic of sediment for identified coastal erosion. The result shows during the low tide between November 2020 and May 2021 the shoreline changes are visible. This research would allow organizations or some other group to shed light on problems and the construction of this coastal structure can give a significant impact on the ecosystem of mangrove area.

1. Introduction

Coastal erosion is also closely related to the latest issue of the phenomenon of high tides that often occur today. The occurrence of erosion in coastal areas is caused by a combination of factors nature and human action. The erosion problem becomes increasingly difficult to handle if the area is exposed to strong gusts and heavy waves [1]. In this environment, rising sea levels will exacerbate coastal erosion. This means that sea level changes affect coastline changes. The impact of rising sea levels on coastal area is worth noting in the coming decades. This is so that global observations for the long-term coastal position are relevant to support the development of more coastal impact models [2].

At both the national and community levels, significant efforts have been made to implement various adaptation methods in order to adjust to climate change. In coastal locations, one such effort is promoting the protection and repair of mangrove forests. However, it should be remembered that many coastal provinces have experienced fast industrialization and urbanisation in recent years, resulting in an imbalance between economic growth efforts and environmental conservation and social development, particularly in light of climate change [3]. The growth of urban and aquaculture development into low-lying coastal areas and lagoons has jeopardised mangrove restoration efforts and reduced the area covered by mangrove forests [4].

Construction of coastal structure is one of the methods for coastal nourishment and its function for produce more rehabilitation area at a side of the structure. Therefore, the aim of this study is focuses on mangrove rehabilitation and coastal erosion assessment using application of coastal protection structure [5]. The novel method of construction of coastal protection structure for mangrove rehabilitation and rejuvenation in this study will be useful for the government and private agencies to evaluate the coastal area especially for decision making purposes and coastal management.

2. Study area

The construction of coastal works to mitigate erosion and hard sea defence capable of altering the coast, such as breakwater, seawall and jetties. Other than hard structure, present beach erosion prevention methods include sand dunes, vegetation, sandbags, and sand fences. In this study, construction of jetties in CAGED are functioning as coastal protection structure for mangrove rehabilitation and rejuvenation. Jetties are structures that extend from the coast into the water. The ocean's currents and tides can gradually wipe away a beach or other features along the shoreline. Jetties safeguard a body of water's shoreline by acting as a barrier against erosion caused by currents, tides, and waves. Since erosion is inescapable, the challenge becomes figuring out how to prevent it. This coastal nourishment activity, in the same way, it can rehabilitation the area and produce more mangrove area. UAV and GIS are using for monitor the changes in the study area. The scope of study will outline the limitation of the study. The theories used to interpret the data and the specific data used for the research. The study conducted in Pusat Cerapan Data, CAGED, Tanjung Labuh, Batu Pahat, in Johor and the area was 60,000 m^2 located at south-west coast of Peninsular Malaysia. This study focused on mangrove changes by using Unmanned Aerial Vehicle (UAV) and image processing using software pix4Dmapper and analyse shoreline bathymetry using Global Mapper software.

The mangrove forest area on the Tanjung Labuh coastline is one of the main mangrove forest restoration study areas. The soil structure and risk to erosion are among the key factors in the success of the mangrove forest rehabilitation in that area. figure 1 shows the location of study area.

Figure 1. Tanjung Labuh, Batu Pahat, Johor

3. Unmanned Aerial Vehicle (UAV)

Unmanned Aerial Vehicle (UAV), sometimes known as a drone, is a human-pilotless aircraft that has been utilised in a variety of research, including moss beds in the Antarctic [6] and high-resolution topography building [7]. A UAV is a type of low-altitude aerial imaging. Over the last decade, the use of UAVs has expanded beyond military to civilian applications [8]. These characteristics have attracted the attention of a wide range of businesses, and UAVs have already begun to replace traditional survey methods in the mining, construction, and agricultural industries [9]. Topographical or 3D mapping is costly and time-consuming [10]. Because it can model in a three-dimensional (3D) system, UAVs have a significant advantage in determining coastal change and are one of the options that can be used in the next years. This is due to the fact that the existing approach is more expensive, more difficult, and takes longer to produce results than UAV. Furthermore, using a large-format aerial camera for small-area mapping is not cost-effective.

4. Materials and Methods

The study's flowchart is shown in figure 2. The coastal region has followed the conventional approach to control and inspection activities as a matter of principle. As a result, UAVs were used in this study to complete the work in a cost-effective and efficient manner.

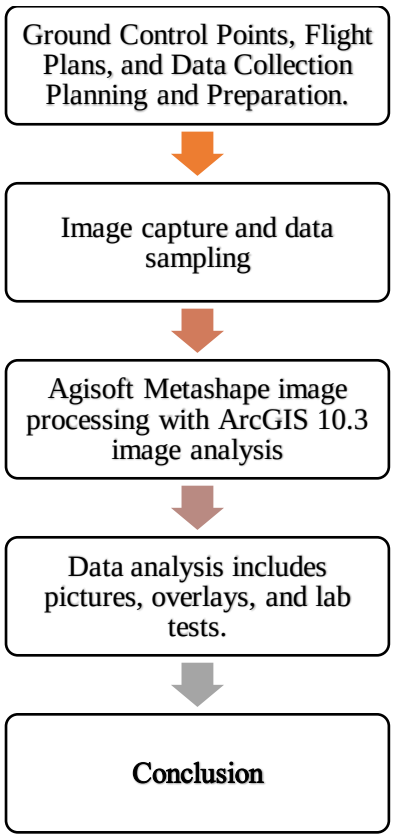


Figure 2. Flowchart of the study

Although UAVs do not normally record photographs in an intrusive manner, the consent of those involved in the research field is required to avoid privacy concerns. Weather has an impact on UAV data, so this factor should be taken into account. A package of DJI Phantom 4 Pro drones was employed in this research (UAV model).

4.1. Flight scheduling

UAV flights were probably carefully timed to avoid inclement weather and high seas. The tidal schedule received from the tide forecast was used in this research to determine the proper timing for the low tide UAV flying. The itinerary for flights between November 2020 and May 2021 is shown in table 1.

Table 1. The schedule for flight from November 2020 and May 2021

Title	Date	Tides	
Fly 1	17/11/2020	0.36 m (low tide) – 5:16 P.M.	3.14 m (high tide) – 11:21 A.M.
Fly 2	3/5/2021	0.45 m (low tide) – 5:07 P.M.	2.91m (high tide) – 11:13 A.M.

4.2. Fieldwork for sediment sample

Fieldwork for this study includes observing the height of coastal slope, measuring the depth of the beach, and collecting sediment samples in the study area. Observations of data for soil type or sediment will be taken to determine the size of the sediment found in the observation area. The method of using peat sampler is by immersing the body of peat sampler into the bottom of the beach and then turn the tool clockwise until a sediment sample is collected into the body of the tool. The sediment samples that have been taken next will be put in plastic bags that already have their respective labels and take it to geotechnical laboratory. Observational works such as sieve analysis test, specific gravity tests, and hydrometer tests have been carried out over a period. All observational data were recorded for the use of data analysis. The data observation process was done on 11 April 2021 during the low tide to facilitate the process of sediment sampling. Figure 3 shows the observation points on the actual map in Tanjung Laboh.

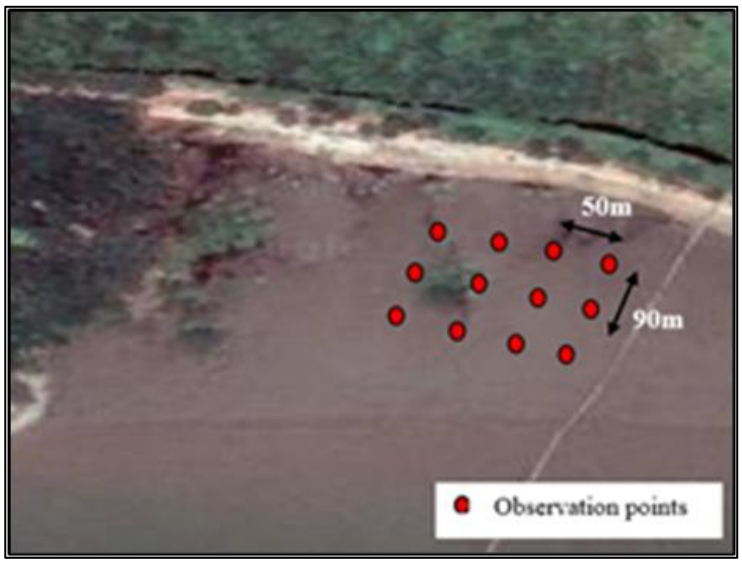


Figure 3. Observation points from the top view

5. Results

In this study, there were three types of analyses. To begin, Agisoft Metashape was used to process all the photos. This software will create a 3D model and integrate all the photos taken into one large image. Following the analysis of the pictures, ArcGIS was used to determine and depict the coastline alterations that occurred in Tanjung Labuh between November and May. These two programs are required to obtain the outcome of research. The UAV was flown at a height of 50 metres to gather photos suitable for processing in Agisoft Metashape. The image size is expressed as a proportion of necessary image processing operations such as dense cloud, mesh, texturing, tiled model, Digital Elevation Model (DEM), and orthomosaic. Between flying tracks, the pictures were overlapped 60% for frontal overlap

and 60% for side overlap. This is to ensure that high-resolution and accurate 3D images can be generated. Figure 4 illustrates the process of combining images to make an orthophoto in Agisoft Metashape.

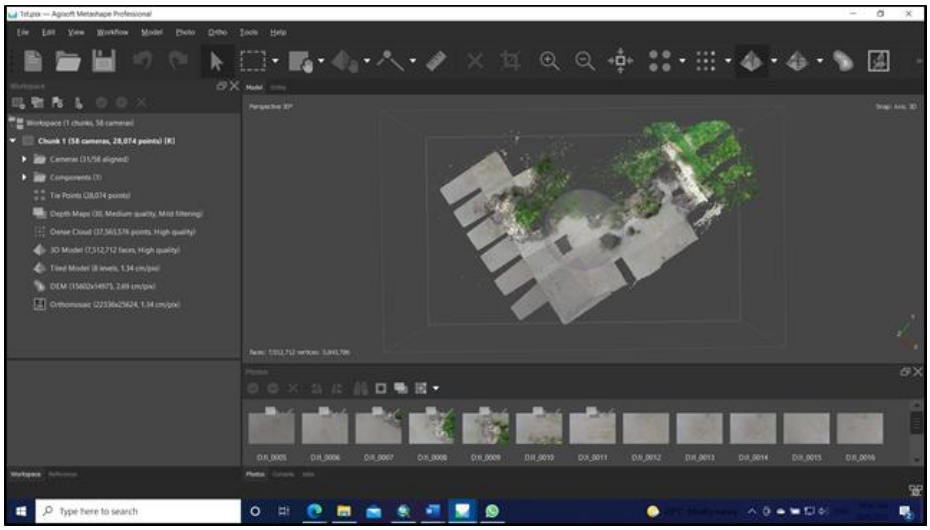


Figure 4. Image combined process to generated orthophoto in Agisoft Metashape

The UAV had acquired 145 photos in each flight plan and analysed them using ArcGIS software. All photos must be converted to a three-dimensional (3D) model as part of the program's workflow. The processing of the photographs took two days for each flight. After Agisoft Metashape has processed all of the photos, they will be sent to ArcGIS 10.3 in.tiff format. All pictures were overlay with ArcGIS so that modifications to the shoreline could be made manually and the real photographs could be seen clearly (Figure 5).

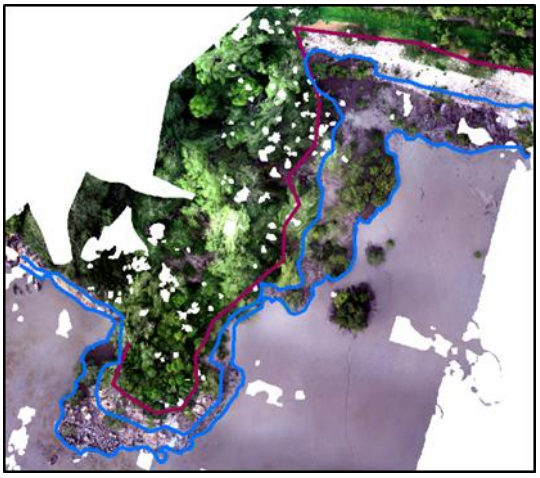
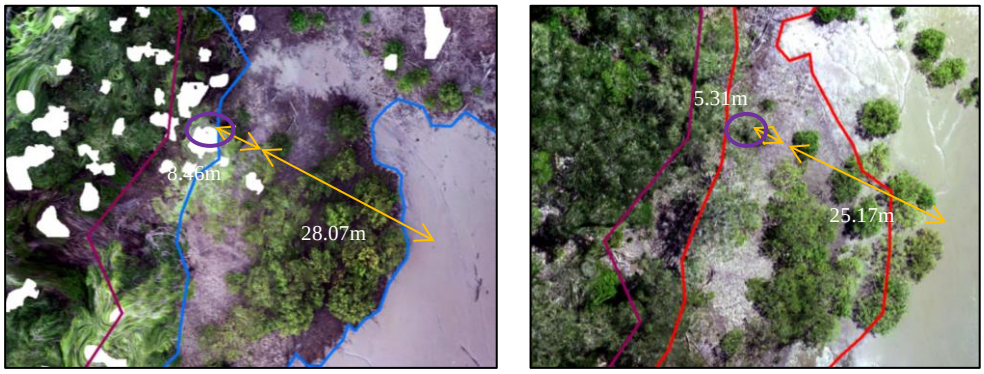


Figure 5. The lines that represent shoreline changes



(a) (b)

Figure 6. Shorelines change detection from (a) November 2020 (b) May 2021

Table 2. Shoreline changes from November 2020 to May 2021

Month	Shoreline Changes (m)
November 2020	28.07
May 2021	25.17

The first fly in November 2020 (Figure 6a), the seashore is represented by the blue line. The purple circle serves as a point of reference. The length of erosion point to the shoreline is represented by the yellow line. The distance between two coastlines is 28.07m (Table 2). While the second fly in May 2021 (Figure 6b), the seashore is represented by the red line. The erosion has intensified and the distance between two coastlines is 25.17m. In seven months from November 2020 to May 2021, the differentiate of distance for two shorelines for both months is 2.9m impact towards shore. Damaged mangroves are only placed on tidal clay soils close to the sea, which protects the hinterland from the impacts of sea waves and storms, whereas mangrove shorelines pull land inwards. This study effectively indicates the existence of erosion at Tanjung Labuh, with a total length of erosion. The erosion was detected using ArcGIS software for investigate.

Coastal depth observations were taken simultaneously with the sediment samples so that the data obtained could be correlated. The depth that has been obtained is around 2.41 m to 2.54 in the study area. Based on table 3, most of the specific gravity of the observation points is less than 2.5. Based on the previous study stated that the position of the specific gravity density for sand and mud is in the range of 2.00 to 2.60. It also stated that certain gravity values in the range have a very high mud content. This indicates that the sediments found on the coast of Tanjung Labuh consist of organic materials such as bark, leaves, shells, and barnacles.

Hydrometer tests and sieve analysis were conducted to identify the size distribution of sediments found in Tanjung Laboh. Figures 7 (a) – (c) shows a curve graph for each sediment sample that was taken. Based on figure 7(a), for curves that pass the sieve opening 10mm to 0.063 mm is based on the sieve analysis test while for curves that pass below 0.063 mm are based on the hydrometer test. Based on the curve graphs above show that the farther the distance of the observation point with the shoreline, the greater the size of sediment found in the area. This can be seen based on figure (b) and (c), sediment samples C1 to C4 have accumulated weights on sieves of size 5 mm and 2 mm compared to sediment samples from A, and B. Based on the figure above, it can also be seen that for sediment samples C1 to C4 have the least accumulated weight at the base of the sieve compared to sediments A and B. This shows that sediment at point C have least particle size of less than 0.063 mm.

Table 3. Specific gravity for each observation point

Observation point	Specific gravity, G_s
A1	2.39
A2	2.10
A3	2.08
A4	2.38
B1	2.25
B2	2.44
B3	2.49
B4	2.50
C1	2.58
C2	2.46
C3	2.28
C4	2.46

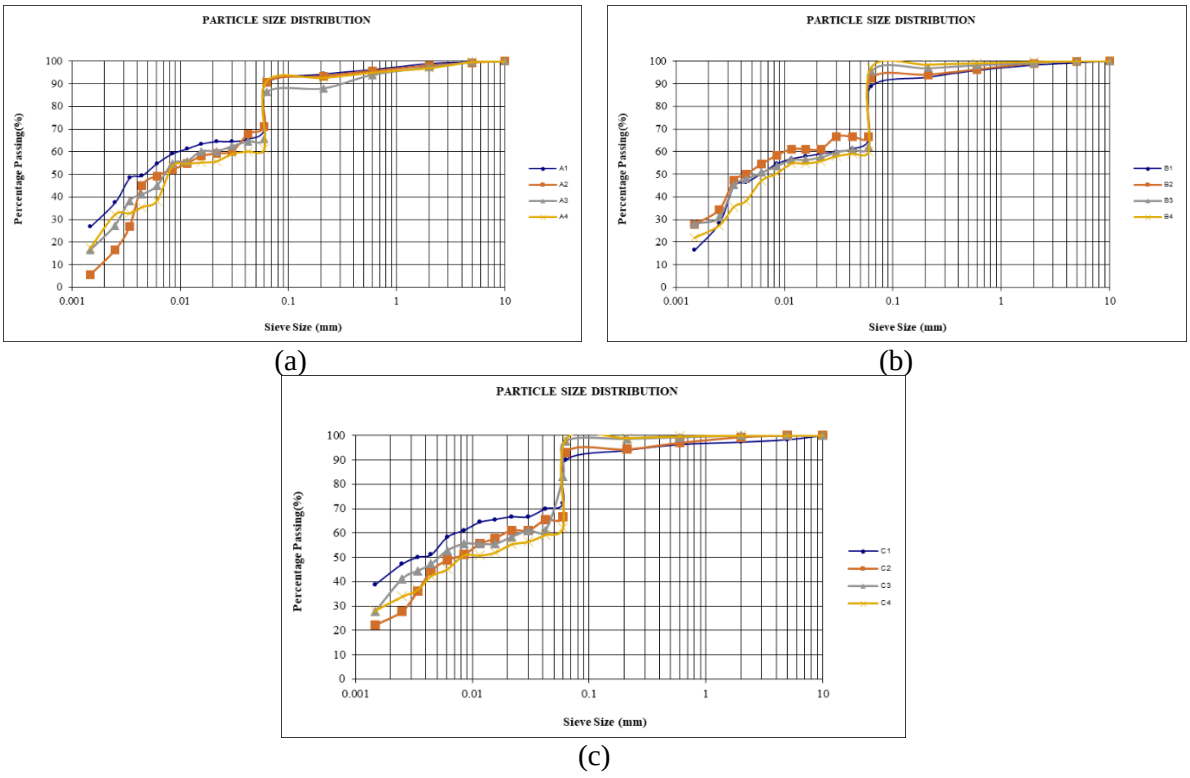


Figure 7. Curved graph for observation in (a) point A1 to A4 (b) point B1 to B4 (c) point C1 to C4

6. Conclusion

The degradation of our natural resources which is mangrove become the main concern, since this kind of ecosystem function is important to the coastal-nation like Malaysia. Therefore, the mangrove rehabilitation effort should be intensified, but not limited to the replanting program only. This study shows details mapping and information of the hotspot of the most risky and critical area to coastal erosion/coastal risk vs wide/size of the mangrove green belts of the particular area. A complete and detail database for physical and environment information of mangrove shoreline at study area of muddy shoreline is easily accessible and become source of reference for other field of study which related and take place at the mangrove shoreline. This study shows the construction of coastal protection structure is one of the solutions to stabilize the mangrove area and nourishment the coastline. The fact makes dependency to the mangrove green belt is one of the best benefits for the tropical country such as

Malaysia for managing the coastal risk. At the end, the abundance of mangrove green belts along the west coast of Peninsular Malaysia offers an economic alternative to reduce the cost and impact from the coastal risk such as extreme high tide event. Therefore, the rehabilitation and rejuvenation of the mangroves is important to help the authorities to control the excessive coastal erosion as well as benefit from the community.

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