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Shoreline Profile and Changes Monitoring Via Unmanned Aerial Vehicle (UAV) Photogrammetry

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Abstract: This research focuses on the identification of shoreline profile and its changes. As for this study, the shoreline of Pantai Punggur is selected as the study area. This study was driven by a climate change factors that resulted to a sea level rise and violent behavior of sea waves. This factor relates to coastal erosion and coastal changes along the west coast of Malaysia. Malaysia's coastline vulnerability on coastal changes is something that is important to be addressed as the location of this country is surrounded by water and the coastal area plays a big role in the socio-economic activity. In order to understand coastal erosion, it is important to understand about the physical properties of the sediment as well as the knowledge on how it is transported. There are three objectives of this study which are to analyze the condition of shoreline at Pantai Punggur using visual inspection method, identify the shoreline beach profile using Pix4D Mapper and Global Mapper software and to identify relationship between beach profile with shoreline changes. Based on the output of this study, all of the listed objectives are achieved successfully. In this study, the aerial image capture by the Unmanned Aerial Vehicle (UAV) is processed in the software thus determining the shoreline changes based on the processed aerial image. From this research, the shoreline average shoreline changes by Zone A, B, C, D and E is 2.406m, 1.978m, 1.698m, 0.956m and 0.812m.

Keywords: Shorelines Changes, Erosion, Pix4D Mapper, Global Mapper, UAV

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1. Introduction

Most of sandy beaches across the world have a tendency to recede their shorelines over years, if not decades, and this trend is a result of a number of reasons, both natural and man-made. Furthermore, beaches typically suffer from unique variations in a shorter time period, which is expressed by a representative sediment shortage or excess [1]. To forecast shoreline variability in such instances, numerical models of morphological development must include a rate of change of shoreline position for sediment gain or loss. Unmanned Aerial Vehicle (UAV) systems are becoming more appealing for many surveying applications in civil engineering, both as a data acquisition platform and as a measurement instrument [2].

Their UAV performance, however, is not well understood for these particular tasks. The scope of UAV presented the work it can build autonomously acquire mobile three-dimension (3D) mapping data [3]. Photogrammetric flight planning and execution for 3D point cloud generation from digital mobile images. The importance of unmanned aerial vehicle (UAV)-based automatic target recognition (ATR) is growing. This is due to the ease with which UAVs can be acquired in terms of price and accessibility. ATR systems are in charge of automatically detecting aerial vehicles via radar signals [4]. As the technologies tend to develop rapidly, the demand of technologies and approaches for research are relatively high. Therefore, in order to meet the demand, the process of identifying of shoreline changes area can be carried out by using Unmanned Aerial Vehicle with the aid of Pix4D Mapper and Global Mapper as a medium to analyze the beach volume changes

2. Coastal morphology

Coastal geomorphology is the study of the morphological formation and evolution of the coastal as it interacts with winds, waves, currents, and sea-level change. The terms coastline and shoreline are often used to define the location's border at the coastal morphology. Technically, these words refer to various sections of the coastal area. The coastline is the line that separates the ground from the ocean. It is continually changing because of the frequent activity of waves and tides.

2.2 Coastal erosion

Coastal erosion, by definition, processes erosion phenomena. In certain locations, accretion and erosion processes coexist, resulting in rapid and accelerated changes in coastal morphology. The increased rate of marine, erosion is one of the effects of Quaternary climate change, particularly since the last glacial period [5] The erosion is primarily caused by a lack of direct accumulation and by induced erosion processes that operate on tertiary age coastal outcrops. However, there is no explicit mention of increased erosion rates as a result of recent global warming. The factor of erosion (wind) can make the sea water move faster and the erosion from surface runoff, and mass movement geomorphic processes, all of which contribute to the continuing retreat of the tertiary coastal cliffs and Santa Cruz Rivers' middle and upper slopes.

Natural erosion processes have been aided by changes in the coastal substrate caused by urbanization and the proliferation of socioeconomic and industrial activities concentrated on the coast. In response to inadequate coastal management of the induced erosion phenomena caused by urbanization, various environmental risk responses have emerged [6].

2.3 Sediment transport

Coastal sediment transport also referred to the dynamic that erodes, transports and deposition sediments along shorelines, as “coastal sediment processes”. The coastal environment is constantly changing, due to the wind forces, waves, tides and currents. Stranded consist of sediments of different sizes, ranging from huge rocks to thin sand or mud. Sediment erosion occurs deposition is eliminated from a certain place when a spot of sediment is added [7]. Sediments from several sources can be obtained, and many sources are glacial deposits until (mixtures of clay, sand, gravel, and cobbles left behind by glaciers).

Sea cliffs are bluffs made from glaciers until the waves and higher tides are eroded. Inland glacial reservoirs can be eroded by water and stored by rivers and rivers in the ocean.

2.4 Unmanned aerial vehicle

An unmanned aerial vehicle (UAV) is an aircraft that does not have a human pilot on board. The unmanned aerial vehicle is controlled either autonomously by the system that uses a microprocessor or telemetrically by the operator who can control it on the ground. UAV can be programmed to carry out observation or detection missions automatically or remotely. They are mostly utilized in mapping applications, environmental change monitoring, disaster preventative response, resource exploration, and other similar applications. When acquiring aerial images, UAVs offer two benefits over other flying vehicles and satellite remote sensing technology: low cost and great mobility. However, they have many environmental restrictions on their use due to low flight stability. As a result, how to deploy UAVs in various settings so that geographic data for qualitative and quantitative analysis may be consistently processed and created is a critical problem influencing their implementation [8]. Figure 1 shows one of unmanned aerial vehicle (Drone).

Figure 1: Unmanned aerial vehicle (Drone)

3. Materials and Methods

Preliminary surveys at Pantai Punggur was conducted by observing coastal conditions. Apart from site visits by observing the location of the coast above ground, aerial photographs of the survey will help to get a complete picture of the changes in the coastline in the study area. An aerial photograph with a drone to record an image of the survey area at a determined location distance provides unlimited information on the details of the Earth's surface. Before starting the survey, a field visit to the survey area should be conducted to determine the condition of the survey area and the appropriate time to carry out the flight plan. Weather conditions also play a role in this study as to determine the suitable time to fly the drone. The ground check point (GCP) will used for making the temporary benchmark at the location that have been marking. The main function of GCP is to mark the GPS point when flying drone. GCP is used during the data retrieval process to facilitate aerial retrieval of data. Figure 2 shows the GCP. The implementation of Pix4D Mapper and Global Mapper software were used as a medium to quantify the shoreline changes. UAV (Unmanned Aerial Vehicle) is used a as tool to capture aerial image of Pantai Punggur with high resolution images to be processed by the software. This research implements physical and visual approach to correlate the shoreline changes and beach profile. Figure 3 shows the orthomosaic profile in Global Mapper software.

Figure 2: The ground check point

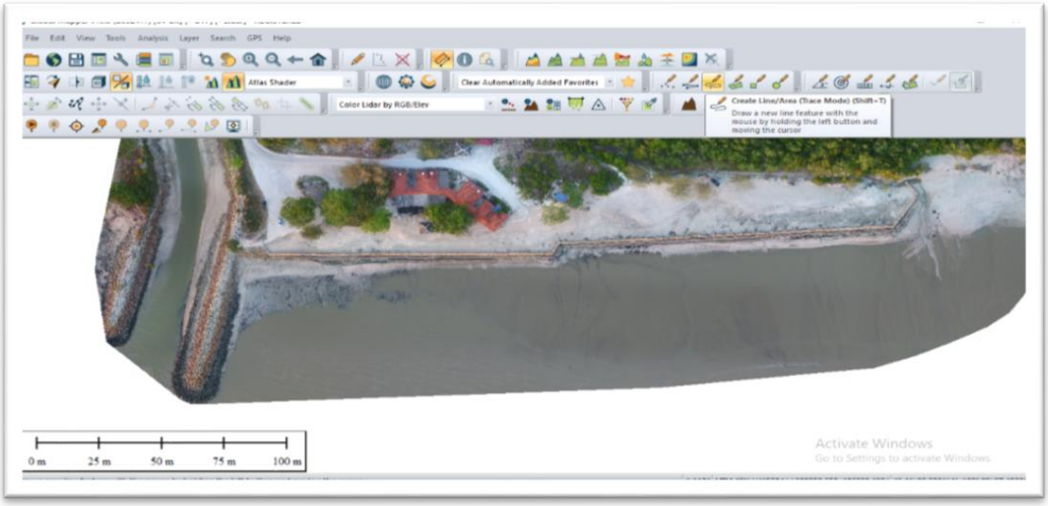

Figure 3: The process for sketching shoreline profile

4. Results and Discussion

Visual inspection and the study of shoreline changes were carried out based on visual inspection there are three elements accounted for consisting of mangrove forest, Labuan blocks and sand areas. Studies of shoreline profiles and beach profile on Pantai Punggur were conducted. Therefore, each location in the study area has different values that have been obtained for shoreline changes that result in a selected beach change decision at the selected location. Figure 4 shows the location of the selected A, B, C, D and E study along the Pantai Punggur. These five locations were selected as the primary stations because showed visible changes compared to other locations within two months for monitoring shoreline change and to identify the beach profile base on the shoreline changes values. Zone A is near the groin at the left side of the study area. For zone B, C and D that have been selected along the Labuan block. To the right of the study area, zone E beach the location around the mangrove and sandy.

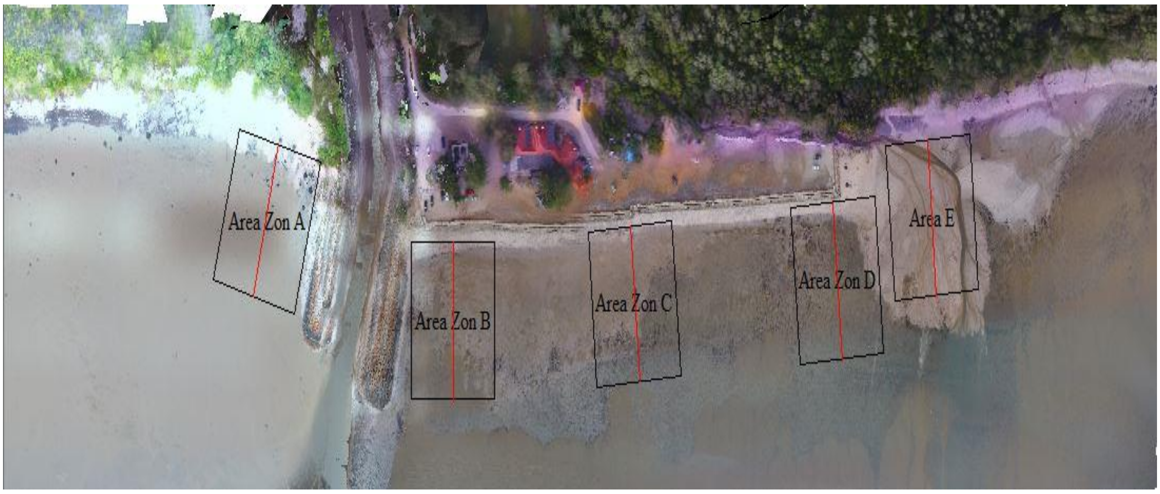

Figure 4: Location of zone A, B, C, D and E

Base on the data obtained, the shoreline changes are clearly measured between two selected dates within two months. Table 1 represents the line of the shoreline and Table 2 shows the changes of the shoreline at five different locations at Pantai Punggur.

Table 1: Represent line of shoreline changes

Date	Colour for shoreline
November 2021	(yellow line)
December 2021	(green line)

Table 2: Average of shoreline changes at five zones

Location by zone	Shoreline changes from November to December 2021 (m)
A	2.406
B	1.978
C	1.698
D	0.956
E	0.812

4.1 Detail of location showing shoreline changes

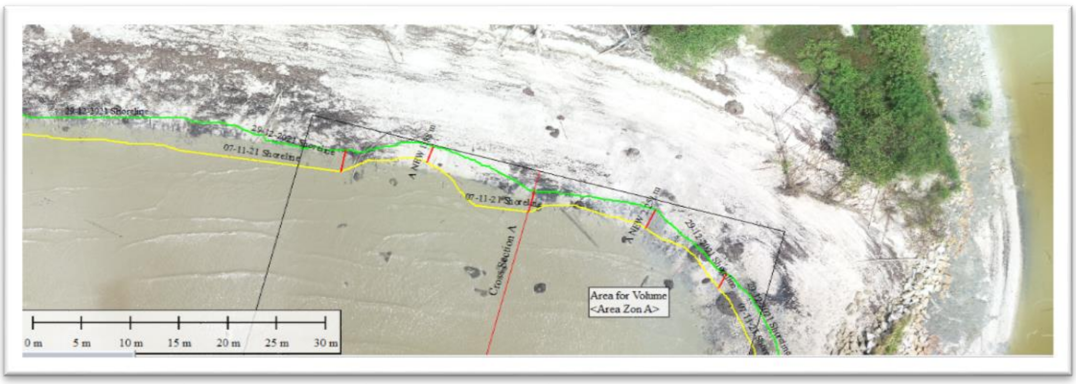

Figure 5: Shoreline changes at zone A

Zone A is located at the right side of the study area where mangroves area and groin structure is present. The location of the zone influence the data obtained for the shoreline changes starting from November to December 2021. Each image and data gathered is represented by the colour of the shoreline in the image above. From November to December 2021, Figure 5 above shows the total average of shoreline changes and significant changes, 2.406 m.

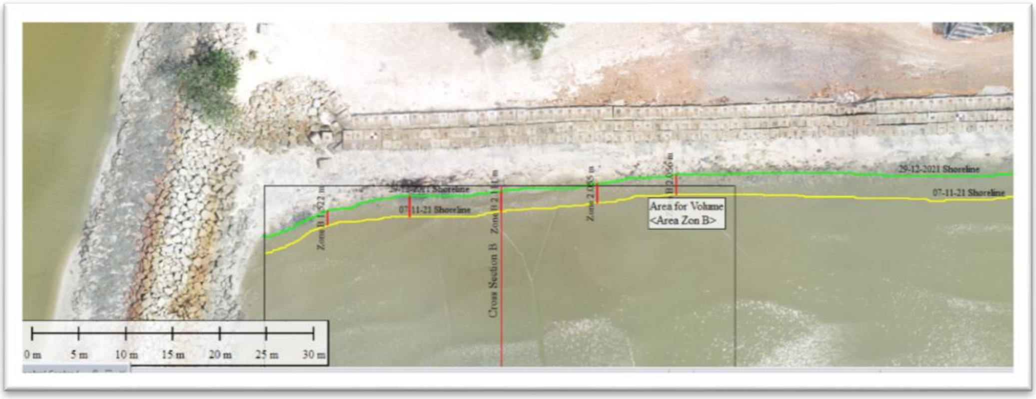

Figure 6: Shoreline changes at zone B

Location B as shown in Figure 6 also located at the stone cover and Labuan block at the right side of the study area. These are also slightly changed from November to December 2021 at this location. The total average of shoreline changes is 2.601 m.

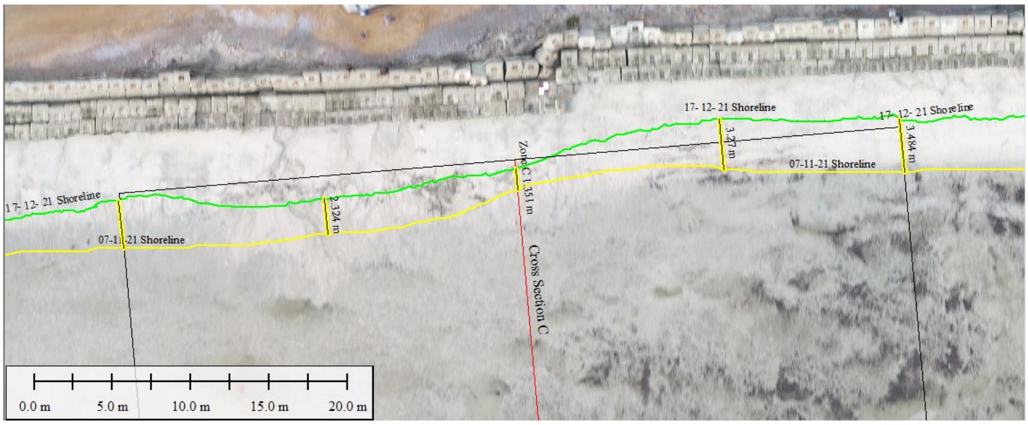

Figure 7: Shoreline changes at zone C

Zone C, as shown in Figure 7, is also located in the middle revetment. The revetment area, or in another definition, the Labuan block, covers all of the areas in the middle of this study scope area to prevent and control the shoreline changes from becoming worse in the future, threatening public economic activity in the coastal area. The shoreline changes at zone November to December 2021 is 1.698 m. The changes that occur between zone B and C are seen as intangible. Among the shoreline changes that occur between the two zones are 0.3 m.

Figure 8: Shoreline changes at zone D

Location D is selected near the left side of the study area which is not surrounded by the revetment thus that location is not protected against coastal erosion. There were abrupt changes that happened in that location from November to December 2021. The shoreline change is 0.956 m. In zone D from the observation, the occurrence of sand accretion is shown in this image. As a result, little movement in the shoreline occurs.

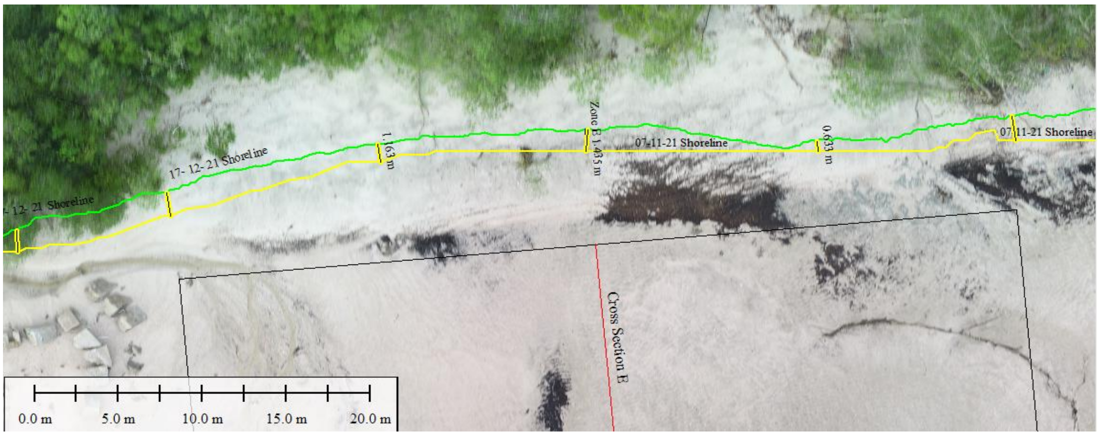

Figure 9: Shoreline changes at zone E

Location E is selected near the left side or the last location for the shoreline changes zone. Area zone E is surrounded by the mangrove forest and sand accretion is shown in this image. From the observation, the shoreline changes is 0.812 m. Zone E shows a little shoreline change compared to another zone.

According to the previous research, there are two factors that contribute to the coastline changes which are natural and anthropogonic factors [9]. The reclamation or development of building near the coastal area may affect the coastal changes that caused by anthropogenic factor. Meanwhile sea level rise, erosion which are assigned as littoral transport process is assigned as natural factors that triggers the shoreline changes. As the output for this research, it can be said that Pantai Punggur is one of the eroded areas in Batu Pahat that experience significant changes in shoreline [10].

4.2 Shoreline changes and beach profile analysis

The summary of shoreline changes and beach profile analysis was performed using the overlapping approach between November and December 2021. The average of shoreline changes at five zones along Pantai Punggur based on the data obtained by image processed by Global Mapper software have been determined.

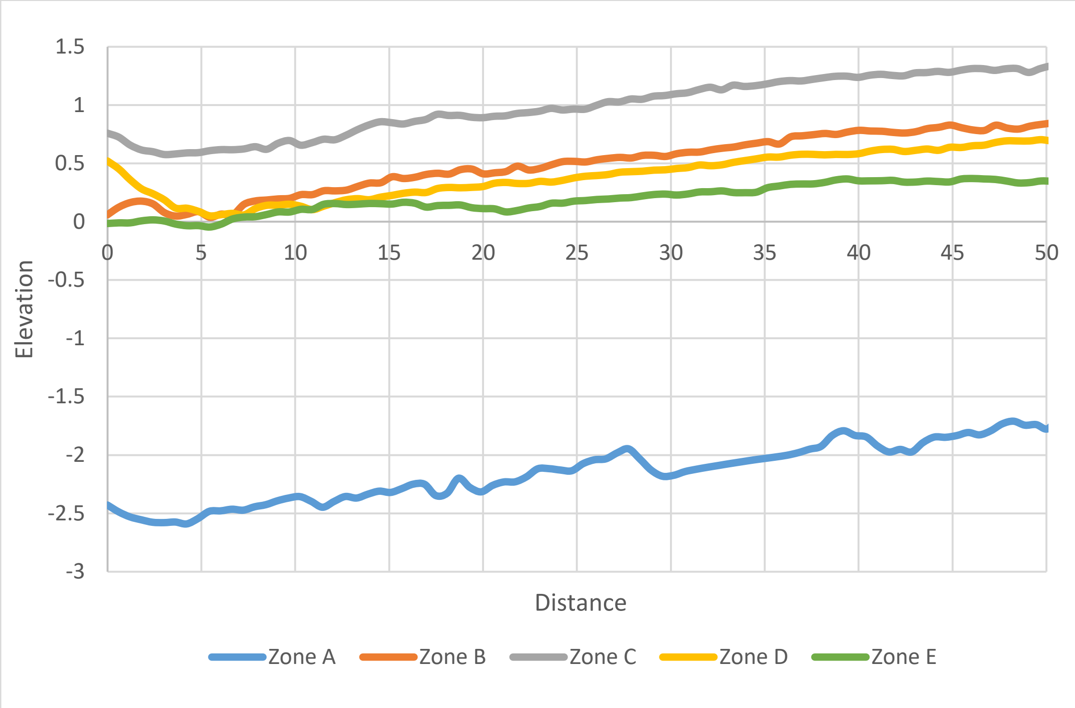

Figure 10: Beach profile for zone A, B, C, D and E

Figure 10 shows the plotted graph of beach profile for zone A, B, C, D and E. The profile for each zone were plotted based on the elevation and distance. Based on the graph shown pattern at zone A, it shows the lowest value and can be related to the shoreline changes. The shoreline changes at zone A is 2.406 m. and while zone B shows an increased pattern profile because location B is near the revetment and groin area. For zone A the shoreline changes are related to the graph as the value is 2.046 m. Despite the location of zone A, monsoon transition that has been occur on November are one of the factors that contribute the changes. Monsoon transition triggers the strong waves thus resulted in abrupt changes in this area. However, based on the graph shown for zone B, C, D and E, its shows quite a similar pattern. Zone E are lower compared to zone B, C, and D. The location of E where it is located at the right side of the study area which are one of the areas that is not covered by the revetment. In addition, this area is connected with the mangrove area where there is a water that keep flowing into this coastal zone. This two-factor area is crucial, which it is one of the reasons of erosion are critical at this area after zone A. From this observation the graph pattern and shoreline changes at zone A, B, C, D and E are reported as 2.046 m, 1.978 m, 1.698 m, 0.956m and 0.812m.

5. Conclusion

As for the conclusion, Unmanned Aerial Vehicle (UAV) is considered as one of the alternative to carry out visual inspection to observes and analyses the shoreline changes at the coastal area. The aerial image capture by the UAV can be processed and generated using Pix4D Mapper and Global Mapper software. The extraction of data from the software will help in the analyzation of beach profile and shoreline changes. Observation of shoreline changes is crucial in order to implement the steps to inhibit occurrence of erosion at the coastal area. The future of Pantai Punggur Beach will be very dangerous if there is no precautionary measure. Unmanned Aerial Vehicle (UAV) can be assigned as a one of the technologies that can be adapted inspect the shoreline changes from time to as it able to generate the data within a short period of time compared to other methods. Observation in this coastal area was conducted on two different dates in two months from November and December 2021, collection data have been done in two months and the result of shoreline changes was acceptable. Throughout the research, there was a change in the event of a few weeks of the study period. This proof is enough to conclude that the Batu Pahat area is one of the erosion categories around Malaysia. There are three main objectives to achieve in this study. Firstly is to analyze the condition of shoreline selected beaches using the visual inspection method, identify the shoreline beach profile using Pix4Dmapper and Global Mapper and identify relationship between beach profile with shoreline changes. All of these three main objectives of this study have been achieved successfully. The shoreline data are produced for each date capturing the images using DJI Phantom 4 by using Pix4D Mapper and Global Mapper. Both of this software are the most suitable software to be used in order to obtain the accurate and clear result of this study research.

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