Shoreline monitoring using Unmanned Aerial Vehicle (UAV) at Regency Beach, Port Dickson

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Abstract. For various coastal studies, coastal monitoring, mapping, and analysis include advancement of regression planning, geo-details, decomposition-enhancing research, and theoretical or predictive modelling and/or coastal characterization. The goals of this research were to identify shoreline changes at Regency Beach, Port Dickson using Pix4Dcapture, Pix4Dmapper and ArcGIS 10.3 software to use the images captured by unmanned aerial vehicle. Flight plans were scheduled from February 2020 to June 2020. In five months of study period, improvements to the shoreline have been noticeable and may impact the coastal region in the immediate future. As this study's objective was successfully achieved, drones can be recommended as an alternative technique for monitoring coastal changes.

1. Introduction

The coast of Peninsular Malaysia is 3,771.5 km long and the east coast of Malaysia is essentially 5,068.5 km longer [1]. The coasts of clay, mud and silt are distributed along the western coast of Malaysia and Sabah and the fertile soil is constantly eroded on all shores. Sandy shores are on the eastern Malaysian peninsula, Sarawak and western Peninsular Malaysia, including Penang, Port Dickson, and Malacca [1]. Erosion along the shoreline is widespread, and coastal erosion is not a local issue in Malaysia but a national problem. In coastal areas, many significant economic and social events take place and make coastal erosion more concerning. Under the aegis of the Economic Planning Unit (EPU), Minister's Department, the National Coastal Erosion Study (NCES) was carried out in 1985, funded by the Asian Development Bank in order to estimate coastal erosion, and the results showed that 30% of Malaysia's coastal areas were at risk of erosion. The phenomenon of erosion in coastal areas is attributed to a combination of natural and human factors. The issue of erosion is more difficult to deal with if the region is exposed to strong gusts and high waves. Sandy beaches are constantly evolving and often threaten assets like buildings or transportation infrastructure. In this environment, rising sea levels will exacerbate coastal erosion. This means that sea level changes affect coastline changes. This study aims to track and monitor shoreline changes using UAV.

2. Problem statement

There are basically several geo-information techniques for mapping or monitoring coastal erosion, for example manned aerial photogrammetry, remote sensing, light and ranging (LiDAR) and the global positioning system (GPS). Coastal growth ventures such as suburban areas, leisure theme parks and resorts are on the rise year after year. Aerial photogrammetry is also used today for research on highways, the environment, preliminary design, and geographic information system (GIS).
for aerial photogrammetry has been shown to have increased, especially following the development of UAV platform design, research and production [2-3]. It is time to respond to the urgent need for a comprehensive scientific study in Malaysia; research on the national coastal planning should be conducted. Integration between GIS and UAV allows for annual review of an exact and actual database.

3. Study area
Port Dickson is located at latitude 02 31 N and longitude 101 47 T where the chart datum standard for Port Dickson is 5.36m below the benchmark in the concrete mooring lights, or under 1.45m land survey datum. The coastal length of the study area is estimated at 850m and estimated erosion is about 450m long. The effects of erosion can be seen are the ruins of some banks built with rubble wall structure. Wave action on those structures has led to erosion in the study area. Coastal erosion occurring in this area has been around since the beginning of 2002 until now [1]. Several methods to overcome the erosion in the study area have been made since 2004, including Beach Management System (BMS), sand bag and geotextile, groin, erosion barrier structure and the latest is coastal reclamation. Although various methods have been carried out, but coastal erosion has occurred. The field of research occupies 174 m x 627 m and is situated at Regency Beach, Port Dickson. This area is one of the popular holiday destinations for accommodating 5-star hotels, The Grand Beach Resort and Tanjung Tuan Beach Resort Apartment. Regency Beach is situated at Batu 5 north of Avillion Admiral Cove along the coast of Negeri Sembilan, about 5 miles from Port Dickson Marina Bay. The beach is located between 2°29’7.63" N, 101°50’43.42" E and 2°22’42.67”N, 101°50’48.62”E with approximately 800m length [1]. The aerial view of Regency Beach is shown in Figure 1 below.

4. Unmanned Aerial Vehicle (UAV)
UAV (Unmanned Aerial Vehicle) commonly considered to be a drone, an unmanned aircraft device, or many other terms, is a human pilotless aircraft on board and has been used in many studies such as Antarctic moss beds [4] and topography construction with high resolution [5]. UAV is a low altitude aerial imagery. UAV has grown for military purposes over the past decade and has started to extend to public services [6]. These features have made UAVs particularly appealing to many industries and have already begun to replace traditional survey methods in the mining, building and agricultural industries [7]. The cost of topographical or 3D mapping is expensive and very long [8]. UAV is also a great advantage in determining coastal changes because it can model in a three-dimensional (3D) system and one of the alternatives which can be used in the next few years. This is because the current method is quite expensive, more complicated and took some time to get the result compared to UAV. In addition, it is not economical to use the large-format aerial camera for small area mapping.

4.1. Applications of UAV in civil engineering
There are wide ranges of UAV applications and it depends on who uses them. The UAV applications include coastal studies ([9] and [10]), land and military infrastructure mapping [11], military use [12], and agricultural mapping [13]. UAV also has been widely used in civil engineering field to monitoring and obtain data such as landslide monitoring [14], and building inspection [15]. According to [16], the
UAV can provide more reliable data than other approaches, as the lowest flown possible is 10 m. This shows that this approach will improve the mapping of coastal changes in Malaysia.

5. Methodology
Figure 2 shows the flow map, while Figure 3 shows one of the views on Regency Beach during the site visit. The traditional approach for control and inspection work has been used by the coastal region as a matter of principle. As a result, UAV was introduced in this study to carry out the work economically and efficiently.

![Flowchart of the study](image)

**Figure 2.** Flowchart of the study

![Regency Beach, Port Dickson](image)

**Figure 3.** Regency Beach, Port Dickson
Although UAV typically does not intrusively capture images, the consent of the parties involved in the field of research is necessary to avoid privacy concerns. UAV data is also influenced by the weather; the aspect should therefore be taken into account. The equipment used in this study included a package of DJI Mavic 2 Pro (UAV model), Pix4Dcapture and Pix4Dmapper applications.

5.1 Flight Planning
UAV flights were carefully arranged to probably prevent wet weather and high tides. In this analysis the tide schedule obtained from the tide forecast was used to prepare proper timing for low tide UAV flight. Table 1 displays the schedule for flights from February 2020 to June 2020.

| Flight | Date       | Tides Schedule (depth/time)   |
|--------|------------|-------------------------------|
| 1      | 25/02/2020 | High tide 2.58m/ 8.04am       |
|        |            | Low tide 0.23m/ 2.13am        |
| 2      | 25/05/2020 | High tide 2.52m/ 8.09am       |
|        |            | Low tide 0.53m/ 2.21am        |
| 3      | 25/06/2020 | High tide 2.57m/ 9.20am       |
|        |            | Low tide 0.61m/ 3.24am        |

6. Results and Discussion
The UAV was fly with a 50m high for images captured by drones is suitable to imported into pix4Dmapper for processed images. The amount of image is given as a percentage of vital image processing, such as orthomosaic, Digital Surface Model (DSM) and Digital Terrain Model (DTM). The image taken were overlapped 80% for frontal overlap and 72% for side overlap between flying tracks. This is to ensure that 3D image can be generated with high resolution and more accurate. Figure 4 below shows image combined process to generated orthophoto in pix4Dmapper.

In each flight plan the UAV had captured 149 images and processed them using Pix4Dmapper software. The program workflow requires all images to be transformed to a three-dimensional (3D) model. With each flight the time of processing the images was two days. Once all the images have been processed by Pix4Dmapper, it will be transferred in .tiff format to ArcGIS 10.3. By using ArcGIS 10.3, all images have been overlaid, so that adjustments in the shoreline can be drawn manually and clearly show the real images.
Figure 5. The lines that represent shoreline changes

Figure 6. Shoreline change detection from February to June 2020

Table 2. Erosion rate from February to June 2020

| Month          | Erosion |
|----------------|---------|
| February - May | 3.77m   |
| May - June     | 3.98m   |

Figure 5 shows the lines reflecting changes in the shoreline while Figure 6 shows identification of shoreline changes from February to June 2020. The first line describing the first shoreline began in February 2020, based on the study. As time passed, the line turned inward, as seen in Figure 6. After all the images were overlaid, the lines formed on that image using ArcGIS 10.3 software. Referring to Table 2, it is shown that, within five months, Regency Beach experienced significant erosion near the coast. The range from the shoreline increases from 3.77 m to 3.98 m between February 2020 and June 2020. In four months, the changes on the shoreline were noticeable and could affect the coastal region in the immediate future. Prevention must be done to ensure that the coastal environment is protected, especially along the coast.

7. Conclusion

This study introduced UAV as one of the new alternatives for knowledge collection and shoreline change recognition. This approach can however, also encourage changes in coastal and coastal degradation in various areas. The images created in this study illustrate the changes in the shoreline which occurred within five months. The shoreline changes have been increasingly noticeable and may in the near future impact the coastal region, and UAV may be proposed for potential research and development. Compared to other methods, UAV can provide more accurate data as the lowest height it can fly is 10 m, and particularly along the coastal area that is difficult to access and one of the best
tools to analyse shoreline changes as well as other coastal problems. This method is able to enhance inspection of shoreline changes in Malaysia and takes less time than regular inspection and is highly effective.

8. References

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