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Utilization of Unmanned Aerial Vehicle (UAV) for Shoreline Changes Mapping

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Abstract

In recent years, the use of unmanned aerial vehicles or drones as a mapping and measuring device has increased greatly, so that the need for coastal engineering applications has begun to be recognized. The coastal engineering applications described illustrate the huge potential of unmanned aerial vehicle system to enhance and potentially revolutionize the future monitoring of coastal zone. The goal of such a analysis is to decide the shoreline changes from the pictures taken by unmanned aerial vehicles and also to recognize shoreline changes by AgisoftPhotoscan and Global Mapper as well. In this analysis it is important to schedule commercial flight for an unmanned aerial vehicle. The shoreline changes in high tide is clearly visible depending on the outcome, because this destroys from August to November 2017. The shoreline changes are highly noticeable within four months of the duration of the study, and can impact the coastal site in the short term. Prevention needs to be taken to assure the security of those living in PantaiPunggur.Although the purpose of this analysis has been attained successfully, drone could be suggested as both an ideal modifications for monitoring the shoreline changes.

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1. Introduction

The shoreline or coastline is the land-water interface which is changed by the different coastal methods that control it, like wave characteristics, near-shore circulation, sediment characteristics and beach types [1]. A topographical change may be inferred through a shoreline change due to sediment transport, &the shoreline investigation was taken out using different techiques[2]. The High Water Line (HWL) are more commonly utilized measure of the shoreline as shown on several traditional charts and described in a region or through aerial photos [3]. HWL is described as the intersection of land at high tide with the water surface [4]. The HWL is often known in the field as the wet/dry sand boundary following high tide that is formed by the most far extend of the increasing water on a beach face[5][6].

Traditional ground-based studies to classify HWL will be highly time-consuming[7]. Concerning remote sensing, it is very costly and not really precise to carry out [8]. In addition, photogrammetry is often commonly utilized to decide shoreline changes, however the issues with that kind of approach requires highly specialized personnel, costly software and manned aircraft, perfectly calibrated and practically distortion-free metric cameras, restrictive image gatheringneeds and long scheduling times [9]. Although the new techniques are better for airborne sampling, they are fairly cost and more complex related to the use of Unmanned Aerial Vehicle (UAV) but are not preferred by so many organisations. It required a some period, not just that, to have the tests done. The expenses of the topographical or 3D mapping is expensive and highly long [10]. UAV is also a major benefit in deciding shoreline changes because it might carry out modeling in a 3D environment and some of the modification approaches which could be utilized in the years ahead. Usage of the wide format aerial camera for tiny area mapping is not economical. As a result, professional photogrammetrist has begun to usage tiny format camera to acquire aerial photographs and UAV provides quicker, cheaper methods for quick airborne sampling [11].

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Drones are Unmanned Aerial Vehicles (UAVs) which works remotely or autonomously through pilot on board. Most of these activity is based on individual participation [12]. In recent years, the need of UAV as a mapping and measuring device also increased greatly, and the ability for coastal engineering processes is begun to be known[13][11]. Recent techniques for gathering topographical data in the coastal zone usually include two-dimensional profiling use standard survey methods like Total Station, GNSS, EDM etc. or irregularly spaced, 3D sampling using RTK-GPS fitted on an both-terrain vehicle[2][14]. Most of UAV's clear benefits in generic photogrammetric mapping refer to coastal surveying. Those benefits include comparatively low hardware costs, strong photographic survey optimization and quite low operating costs. Considering the size of the image captured at the period of the report, small UAVs are ideally designed to moving the survey at low cost high repeatability in small areas like high resolution aerial photography.

Besides that, the potential of instant field analysis of photography by making repeat in case of failure diagnosis and quite minimum hazards in case of an accident related to the light weight of such devices is one of several important advantages to use UAV [15][16]. This study aims to map and examine shoreline changes via UAV.

The place of the study was section of the coastal area at Pantai Punggur, Senggarang, Batu Pahat, Johor as illustrated in Figure 1. The total shoreline of Batu Pahat is placed at latitude 1.62° to 1.87° N, longitude 102.78° to 103.19° E [17]. Batu Pahat are the more vulnerable area to coastal erosion danger which happens on a continuous basis beginning in 2007[18]. Earlier study concluded that in this 40-year period, the shoreline shifted to the land up to 300 m away or ranged around 5 m to 7.5 m a year[19]. In another analysis, the shoreline changes ranged from 50 m to 200 m through an maximum annual shift of 1.5 m to 7 m, since 1984 to 2013[20]. This has been related to the element of erosion and sedimentation generated by waves, currents and winds of these natural factors.

Figure 1: Aerial view of PantaiPunggur (The 1000m study area is marked with red line)

2. Methodology

Figure 2 shows one view during the visit to the site at PantaiPunggur. The coastal area has generally used the conventional technique for monitor and inspection works. Therefore, UAV was used in economically and efficiently doing the works in this study.

Figure 2: Pantai Punggur, Sengarang in Batu Pahat

Although UAV is generally a non-intrusive way to record images, the parties concerned in the work area need to give their consent to avoid questions about privacy issues. UAV data are often influenced by temperature, so the aspect must be considered. The equipment utilized in this study was a package of DJI Phantom 4 Pro (UAV model), Agisoft Photoscan, and software for Global Mapper. Figure 3 displays the model UAV which is to be utilized in the study.

Figure 3: DJI Phantom 4 Pro

A. Flight Planning

The UAV flights are carefully planned to prevent possible rainy weather and high tides. In this analysis, the tide schedule collected from the Department of Irrigation and Drainage (DID) is used to prepare accurate timing for UAV flight during low tide. Table 1 shows the flight plan from August to November 2017.

Table 1: The flight plans from August to November 2017

Flight	Date	Tides Schedule (depth/time)	
		High tide	Low tide
1	22/8/2017	2.38m/10.13 AM	0.24m/4.50 PM
2	20/9/2017	2.50m/9.55 AM	0.24m/4.36 PM
3	20/10/2017	2.75m/10.03 AM	0.23m/4.55 PM
4	22/11/2017	2.90m/11.50 PM	0.60m/6.49 PM

B. Image Capturing

The image capturing method was carried out in four months, beginning from August until November. In this analysis, photos are used as it can calculate not only in planimetry facilities as well as in topography. As shown in Figure 4, photogrammetry has been used to change the measurement devices like theodolite, measuring tape, and others.

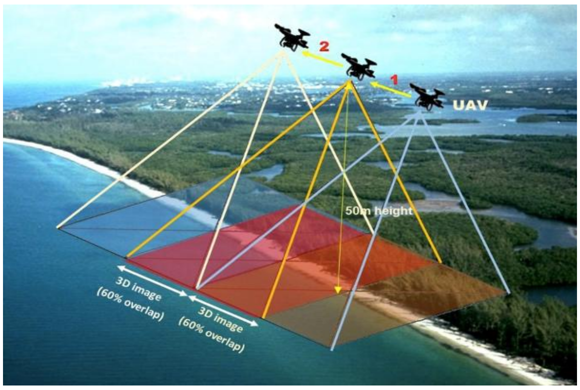

Figure 4: Capturing the aerial images from above

Referring to Figure 4, the UAV photos were taken throughout the flight at some intervals to assure a coverage of the entire study area. Photographs were taken such that 60% of overlapped photos could be used in pairs of each.Covered area in neighboring partner photos on a flight path is called stereoscopic fin area. Figure 5 shows the exact photo points collected during the flight, that are 1000m x 50m.

Figure 5: The drone captured images on each point in the map

C. Image Processing by AgisoftPhotoscan

The UAV had taken a total of 302 photos and handled them using AgisoftPhotoscan. The AgisoftPhotoscan workflow allows every images transformed into one huge 3D model. For each flight time with the processing photos was two days. Figure 6 displays the Agisoftphotoscan interface.

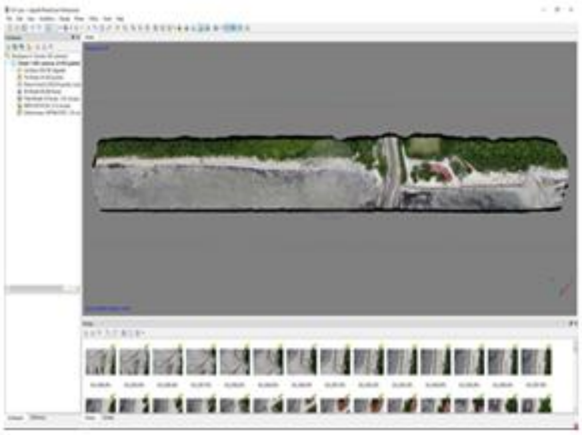

Figure 6: Processing images in AgisoftPhotoscan

D. Image Analysing by Global Mapper

It is moved to Global Mapper in.tiff format after AgisoftPhotoscan analyzes the entire images. When using Global Mapper, the entire images have been overlaid so that changes in the shoreline could be manually drawn and the actual images clearly produced. Figure 7 shows the Global Mapper interface.

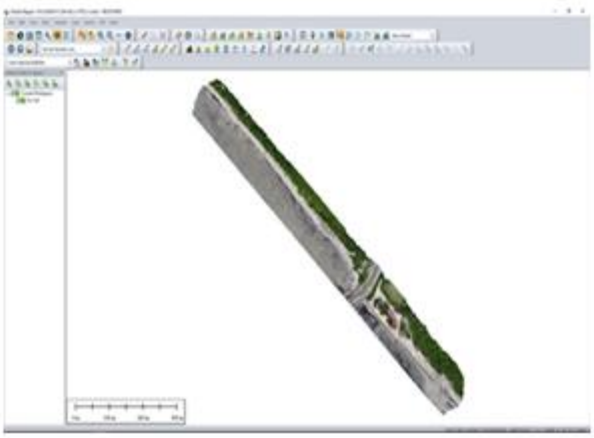

Figure 7: Analysing process by using Global Mapper

3. Results and Discussion

Figure 8 shows the aerial images which were obtained from August to November 2017. Figure 9 shows the lines representing changes in the shoreline over the consecutive four-month study duration. Although Figure 10 on the right hand side of PantaiPunggur shows the shoreline at high tide.

During high tide certain shoreline changes became clearly visible as they eroded from August to November 2017. The shoreline changes are clearly noticeable in four months and may in the immediate future impact the coastal site. To assure the people's safety who live in PantaiPunggur, prevention must be undertaken. While no modifications were observed after the overlaying process based on visual inspection at the right side of PantaiPunggur. The first line describing the first shoreline in August began off the beach based on the study. When time went by, the line was moving inwards towards the ground. Figure 11 shows the lines that formed after being overlaid on that image.

Figure 8: Aerial Images of study area from August, September, October and November 2017 (top to bottom), respectively

Figure 9: The lines that represent shoreline changes in the consecutive four months of study duration

Figure 10: Shoreline during high tide on the right side of PantaiPunggur

Referring to Figure 11, the shoreline distance variation from August through November 2017 was about 1.42 m. According to the monsoon season between August and November, the major shoreline changes may have occurred. This can be concluded which shoreline changes are unavoidable during high tide in PantaiPunggur, unless adequate prevention has been put into action. It can cause short-term deficiencies or erosion due to its rapid day-to-day changes. Coastal erosion, including changes to shoreline, can harm people. In fact, without warning, those changes are coming up quickly.

Figure 11: The shoreline during high tide represented by lines of the consecutive four months

E. Generating Digital Elevation Model

Digital Elevation Model (DEM) is commonly used to represent a terrain's surface. It is also used in determining which area should be monitored. This data was obtained from Global Mapper once it has finished overlaid. Figure 12 shows the exact image of DEM.

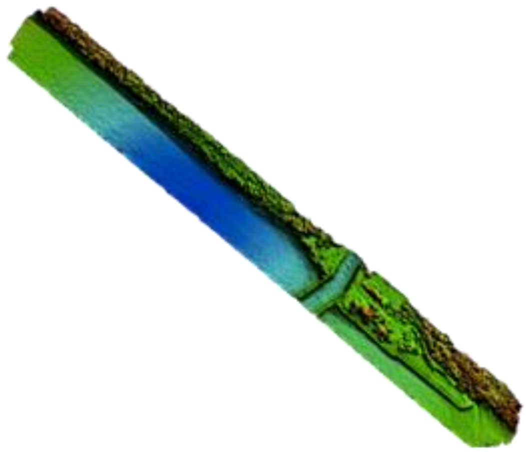

Figure 12: The exact DEM image of PantaiPunggur

Referring to Figure 12, by analyzing the color changes in DEM, the shoreline changes in PantaiPunggur were happening really fast. These color changes shows that PantaiPunggur is having a serious coastal erosion problem. It might be possible that one day the whole coastal area was eroded because of the shoreline changes and other coastal erosion.

F. Contouring the map

Each contour lines shows different height of PantaiPunggur. The contour line function is to show the terrain shape of the coastal site. In addition, the contour lines were the lines that connect the same points high above the sea level. From this contour line, it also shows the surface of the coastal site where the close contour lines were steep surfaces, while the big gap contours shows the sloping surface.

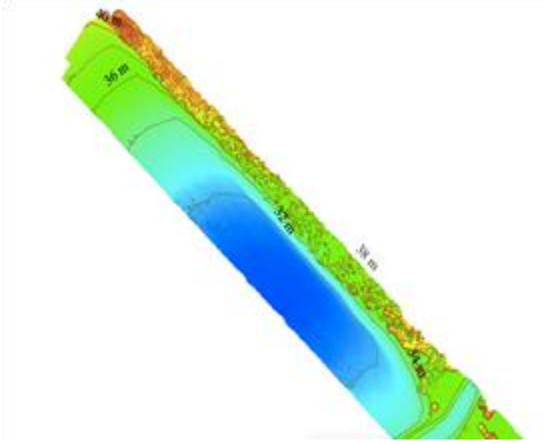

Figure 13: Contour lines on the left side of PantaiPunggur

Other than that, contour lines acted as an indicator to know the shoreline changes that happened in a certain period of time. The changes of contour lines means that the shoreline also has changed. Contour lines near the blue area have lower height compared to green and other colors. Once the map has been overlaid, the contour lines were very clear and slight changes can be seen from August to November 2017.

Figure 14 and 15show the actual contour images that were captured at the same point.

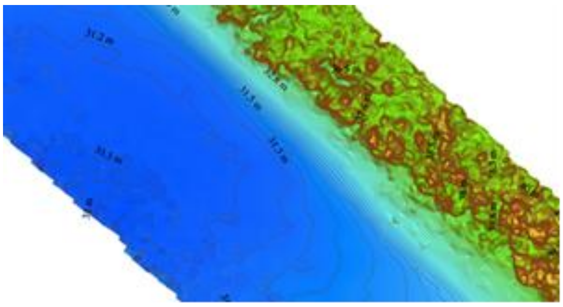

Figure 14: Contour of PantaiPunggur for August 2017

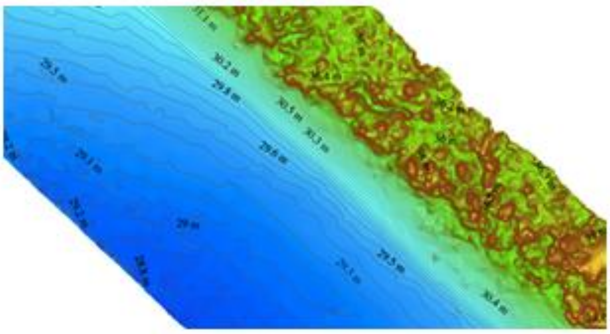

Figure 15: Contour of PantaiPunggur for November 2017

Based on these images, it can be concluded that there were major differences between the two contours. These changes are the cause of shoreline changes and coastal erosion that happened in PantaiPunggur. These lines cannot be seen by normal vision, it is only visible once the image has been zoomed. The lines were generated by Global Mapper and based on the analysis; the shoreline changes are hard to detect due to its miniscule size. Since the contour interval of orthophoto is 0.1m, it is expected to have the same spatial displacement on the shoreline changes. In additional, these two images proved that shoreline changes that were happening in PantaiPunggur are rapidly unsafe.

4. Conclusion

This research introduced the use of UAV as one of the new modifications for gathering data and detecting changes to shoreline. Moreover, this approach could also promote changes in the shoreline and coastal erosion in various areas. In this analysis, the images generated illustrate the changes in the shoreline that occurred in four months. In summary, the shoreline changes become clearly visible during high tide as it erodes from August to November 2017. The shoreline changes have been clearly noticeable and will in the near future impact the coastal site. Prevention needs to be undertaken to ensure the safety of those living in PantaiPunggur.

The method for future research and works that be suggested in this report. UAV is also an ideal devices for deciding shoreline changes and other coastal issues. UAV can give more precise data related to other methods because the lowest height it can fly is 10m, and particularly across the hard-to-reach coastal region. This approach will improve Malaysia's inspection of shoreline changes. It takes fewer time than usual inspection and is highly productivity efficient.

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