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Short communication

Application of Drone System for Land Cover Changes in Tembila Mangrove Forest and Pasir Akar Farm

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Abstract

The aim of this study is to determine the application of drone system for land cover changes in Tembila mangrove forest and Pasir Akar farm. This study was to compare land cover changes at Tembila mangrove forest and Pasir Akar farm within 10 years. This study also use another tool to determine land cover which is Google Earth Pro for providing data in 2007, 2012 and 2017. The data collected from the drone and was being analysed using Pix4d Mapper Pro and Drone Deploy in order to obtain the Normalized Difference Vegetation Index (NDVI), orthomosaic image and elevation. The results show that there are changes in land cover at Tembila mangrove forest and Pasir Akar farm. The total area of Pasir Akar farm is 0.27 km^2 meanwhile for Tembila mangrove forest is 0.86 km^2. For Pasir Akar farm, the changes from 2007 until 2017 is 98.84 % meanwhile for Tembila mangrove forest is 59.30 %. This land cover changes happened in Pasir Akar farm due to agricultural and livestock activity meanwhile in Tembila mangrove forest due to aquaculture and palm oil plantation.

Keywords: *Tembila mangrove forest, Pasir Akar farm, drone system, land cover changes, Normalized Difference Vegetation Index (NDVI).*

1. Introduction

Deforestation activities are process of cut down and clearing of forest cover for agricultural, industrial, land development or urban use. Those activities were impact to destruction of forest cover to make land available for industrial purpose, residential and commercial. This process leads to several imbalances in environment and ecology of the forest. One of the main causes of deforestation activities was agricultural activity. Due to the increment in human population and high demand for food production, large number of trees are cut down to grow crops and cattle grazing. Then, the logging also causes the deforestation activity. Wood has so many ways to become product such as paper, furniture and it also can become for fuel for both direct and indirect.

Due to deforestation activities, it causes soil erosion because there is no tree to uphold the soil. The cause of soil erosion was from rainfall intensity and runoff. The impact of heavy rain breaks the structure of the soil and runoff. It brings along the sediment into the river. Other than that, soil erosion also caused by wind. During drought season, the temperature is so high because the soil moisture is decreasing. This increase the rate of the soil carried away by wind. Another effect of deforestation activities were wildlife extinction. Due to large scale of tree that has been cut down, there are several of wildlife species was losing their habitat. This make they need to migrate to find new place to live [13].

Mangrove forest in Malaysia was a second largest in Asia [11]. The water type at mangrove forest normally brackish. There are a lot of biodiversity in mangrove that gives benefit to our ecosystem. The benefit of mangrove forest protects the coastline. It protects from strong tidal wave action that can cause erosion to the coastline. It also acts as wind protection. The mangrove tree blocks the strong wind from the sea [8].

Pasir Akar forest was a rain catchment area in Besut. It has a dam to collect the water then to transfer the water to irrigate the paddy field in Besut. Pasir Akar forest has so many benefits that are as earth protector. During heavy rain, the soil was not brought along to the river because the Pasir Akar forest has a lot of trees to hold the soil. This not cause the river become shallow because the rate of erosion is low [3]. Amid November and December, an extraordinary rainstorm can cause surge in the east shoreline of Peninsular Malaysia that makes all works are impossible and harm the house gear.

Drone system was a new technology in monitoring land cover. Previously, researcher was using remote control airplane to get aerial image. The benefit of drone system is it can provide higher image resolution. The latest camera resolution using by the drone was 12.7 megapixel that can produce sharper image [2]. Then, it is lower cost compare to Quickbird satellite image. The larger the scale, the higher the cost that it need to pay while using drone image analysis that it must pay once and can utilize much time to get the ethereal picture that needed. By using the drone system, it makes the research can be done faster than using other tools [4].

2. Materials and methods

2.1. Study Area

The study area was located along the Sungai Tembila and Pasir Akar farm that was been surveyed from Google Earth in the district of Besut. The length of Sungai Tembila was 5.99 km and the width range were 30 m [6]. Both areas were relatively developed for agricultural and aquaculture. The typical Besut climate was wet equatorial which all year was high temperature and seasonally heavy rainfall and it was normally happened during northeast monsoon from November to January [9].

2.2. Data Sources

2.2.1. Aerial photo

Open Pix4D Capture application on mobile device and planned a route for drone to take aerial photo. The camera of the drone should be in 90º position to produce correct ground sampling distance (GSD). GSD was used to process elevation data during processing image. Drone was planned 4 routes to cover all the study areas. After that, the image was transferred into the desktop for analysis using Pix4D Mapper Pro [12].

2.2.2. Google Earth Pro image

Google Earth image was used to identify the interested of the study area. By using the Google Earth image, it able to know the land changes that happened in our study area. The interested area was being surveyed by Google Earth Pro which covered Pasir Akar Farm and Sungai Kluang Besar mangrove forest. Google Earth Pro produced images from previous years from 2007 until 2012 [14]. From that images, it measured the areas of the study area to be used in land cover changes calculation. Then, the formula is shown below.

$$\frac{Land\ cover\ changes\ area}{Total\ area} \times 100\%.$$

2.2.3. Landsat series

The Landsat series data that used in this study covered the image of 2017, 2012 and 2007. The data downloaded from the Earth Explorer US Geological Survey website. The first step was to input the interested area coordinate. Then, set the date and tick the Landsat ETM box. After that, the data was processed. Select the image that wanted to analyse. The image was selected from aspect of cloud cover percentage. Then, downloaded the image and extract the image to obtain GeoTIFF file [16].

2.3. Data Analysis

The image captured by the drone, Google Earth application, and Landsat series were analyzed using different software which are Google Earth, Landsat image and Drone Image.

2.4. Database Creation

The database was created using Pix4D, Drone Deploy and Google Earth Pro software and the data set acquired spatial and non-spatial was used for creating the database.

3. Result and Discussions

3.1. Aerial Image

Fig. 1: Pasir Akar Farm.

Fig. 2: Tembila mangrove forest.

From Fig. 1, it showed the deforested part for agricultural used and life stock fodder. There are 2 types of fodders that have been planted at Pasir Akar farm which are Humidicola grass and Napier. There are 4 types of livestock at Pasir Akar farm consist of cow, chicken, meat goat and dairy.

There were changes in the land cover at Tembila mangrove forest as shown in Fig. 2. This land cover changed was due to aquaculture and palm oil plantation activities. Coconut tree also a plant acted as side crop along the fish pond. The pond is used for breeding the sea bass species. The water had been pumped from the nearest river. Brackish water was suitable for sea bass to growth. The fish had been given the pallet 2 times per day which were in the morning and evening. After the fish was being sold, the water was pumped back into the river due to the increment of the biochemical oxygen demand in the river and it can cause the algae bloom that can kill ecosystem in the river. Oil palm plantation also one of the cause that contaminate the river. The usage of fertilizer was absorbed by the soil and some of them will flow into the river.

3.2. Normalize Difference Vegetation Index (NDVI)

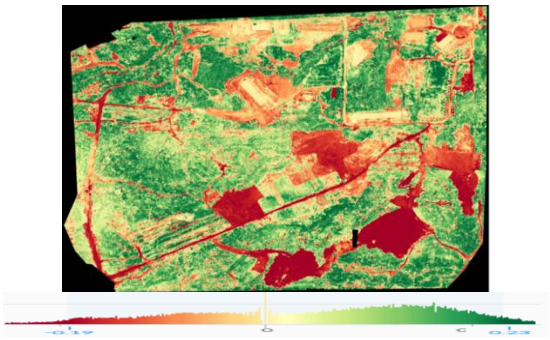


Fig. 3: Pasir Akar Farm.

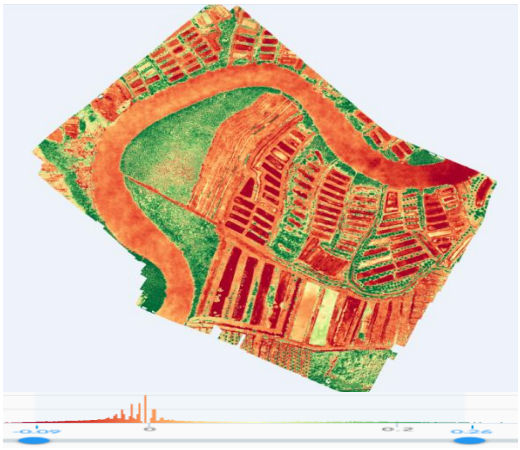


Fig. 4: Tembila mangrove forest.

From the Fig. 3, the intensity of the image indicated that the area with high vegetative and high non-vegetative at Pasir Akar farm. From the NDVI value, there was higher green area compared to the red area. The higher value of NDVI, the higher the green plant at the particular area {15}. During raining, the plant can uphold the water while the expose soil cannot uphold water and it might be caused an erosion. From the result, it can be indicated the health of the plant because the healthy plant reflects a high green of wavelength besides of unhealthy plant reflects a low green wavelength.

From the Fig. 4, it could be differentiated between the vegetative area and non-vegetative area. The chart shows that high non-vegetative area exposed at Tembila mangrove forest which reflects high red wavelength due to less green plant. From this chart, it can also be indicated with the high surrounding temperature due to the sun ray reflection during hitting the soil. If the sun ray hit the leaf, it can be absorbed in photosynthesis process.

3.3. Elevation Map

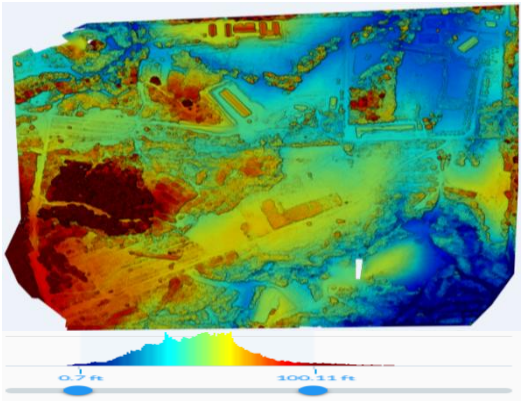


Fig. 5: Pasir Akar Farm.

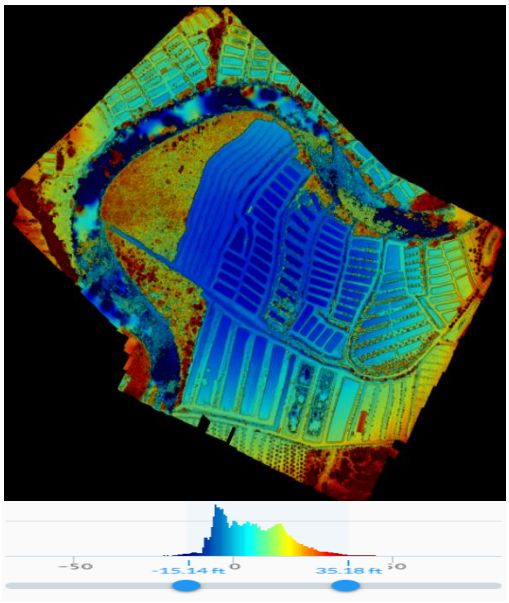
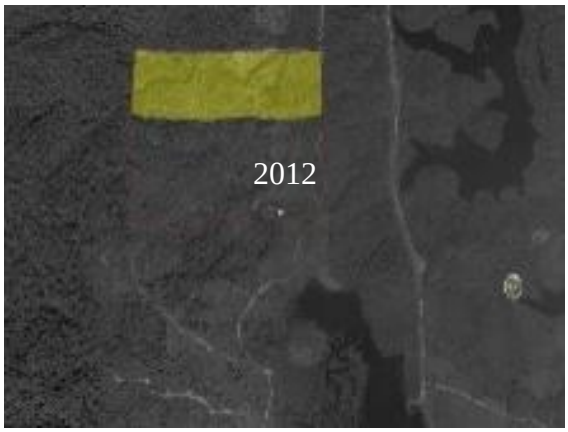


Fig. 6: Tembila mangrove forest.

From the Fig. 5, the highest average of elevation is 100.11 feet and the lowest average is 0.70 feet. Pasir Akar farm is hilly areas with an elevation at Pasir Akar farm showed in high altitude. There are a lot of canopy area layer covered in Pasir Akar farm. The depth of Sungai Chantek is shallow due to its morphological characteristic which is located at upper stream area. From the Fig. 6 above showed that the average highest and lowest elevation at Tembila mangrove forest. The highest average elevation is 35.18 feet meanwhile the lowest average elevation of Tembila mangrove forest is -15.14 feet (Fig. 6). The lowest area is Sungai Keluang Besar at Tembila mangrove forest. The type of water known as brackish water because it is a mangrove area.

3.3. Google Earth Pro

(a)



(b)

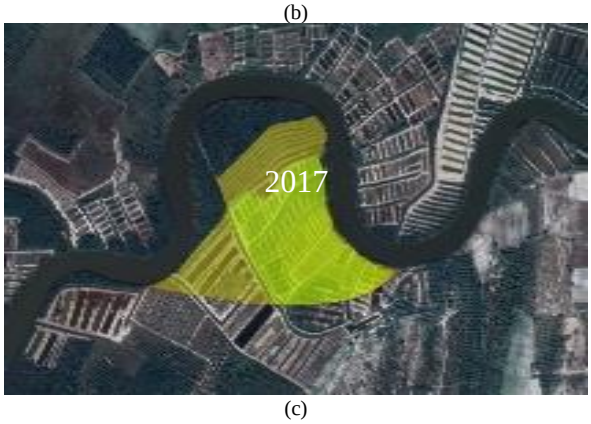
(c)

Fig. 7: Map of Pasir Akar Farm (a) 2007; (b) 2012 and (c) 2017.

In 2007, the total area of Pasir Akar farm is 0.86 km^2. During that time, there are no land cover changes. This can be classified as virgin forest. The virgin forest has a high number of biodiversity that important for human being to protect it. In 2012, the percentage of the land cover changes was 41.86 %. The yellow label shows the area of land cover that had been changes. This change happened due to the deforestation activities for creating an agricultural site. In 2017, the percentage of land cover changes was 98.84 %. The land cover changes were happened due to deforestation for creating agricultural site and livestock site. The alteration of the area is shown in Fig. 7.

(a)

(b)



(c)

Fig. 8: Map of Tembila mangrove forest (a) 2007; (b) 2012 and (c) 2017.

The percentage of land cover changes was 14.82 %. The red label was the area that has been changes. It shows that the changes were happened earlier from the year 2007. The percentage of land cover changes was 33.33 %. The green label showed the area that was changed from year 2007. The mangrove has been cut in order to build a sea bass pond. The yellow label was the area that has been changes from 2007. The percentage of land cover changes was 59.30%. Fig. 8 represents the changes occurred in particular year due to palm oil plantation and aquaculture activities at Tembila mangrove forest.

3.4. Effect of Land Cover Changes

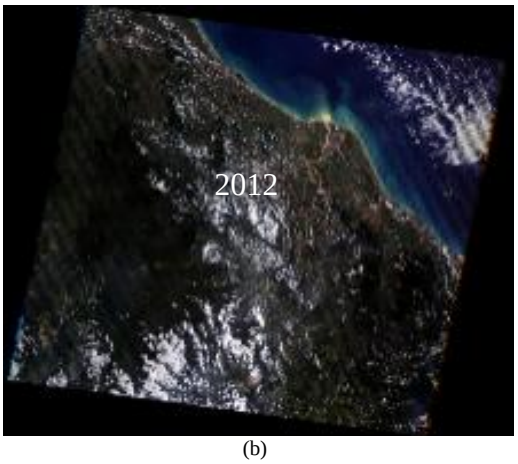
Fig. 9 shows that the effect of land cover changes at Pasir Akar farm was from soil erosion occurrence. During heavy rain, the soil particles are breakdown and it moves along with the rain known as surface runoff. This caused the river bed becomes shallow and it may cause flood at Pasir Akar farm as well.

Fig. 9: Effect of land cover changes such as erosion and run off sediment.

The activities of deforestation at Pasir Akar farm still occurred due to agricultural activities as viewed in the Fig. 10. This activity is not good for soil because the root from the tree hold the soil from erosion. To reduce the rate of soil erosion, the farmer needs to replant fast in order to recover the soil structure condition.

3.5. Landsat Image

(a)



(b)

(c)

Fig. 10: Landsat Image (a) 2007; (b) 2012 and (c) 2017.

4. Conclusions

In this study, drone system is a newly study in agriculture land cover changes as a support tool. From the result, it shows that there was a high trends of land cover changes at Tembila mangrove forest and Pasir Akar farm from 2007 until 2017. Besides that, it also can be obtained using Normalize Difference Vegetation Index (NDVI). Despite of it, the analysis of elevation map using drone image using Pix4D software as newly technique can be implemented. Drone image provides a very high resolution compare to Landsat satellite image and Google Earth image. A new approach for research study to provide high resolution image during mapping.

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