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Mapping Analysis of Mangrove Areas using Unmanned Aerial Vehicle (UAV) Method in Maros District South Sulawesi

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Abstract. Unmanned Aerial Vehicle (UAV) technology can be used for remote sensing applications. The use of UAVs increases the efficiency of collecting land use information in mangrove forest areas. The purpose of the study was to analyze the mangrove forest area using an Unmanned Aerial Vehicle around Sabang Tambua Pier and Ampekale Village. The data analysis technique is remote sensing analysis and geographic information system using Pix4D, Agisoft Metashape 1.7 and ArcGIS ArcMap 1.4 applications. The results of the analysis show that mangroves appear green in color, rough texture, elongated shape following the coastline. Residential settlements are white or brown in color, rectangular in shape, rough in texture and the site sometimes follows the highway and follows the coastline. The clear green pond resembles a body of water with a rectangular shape. The road segment is in the form of black lines on asphalt roads and grayish-white on concrete roads. The area of land use for mangroves, settlements, ponds, bodies of water (sea) around the Sabang Tambua Pier is 4.67 ha, 1.20 ha, 26.73 ha and 3.85 ha, while in Ampekale Village 4.06 h2, 1.95 ha, 12.61 ha and 2.10 ha.

Keywords : Analysis, mapping, mangroves, unmanned aerial vehicle (UAV)

1. Introduction

Mangrove forest is an important ecosystem and environmental support for areas located in coastal areas. Mangroves are woody plants that are tolerant of saline waters consisting of seedlings, trees, and shrubs and can grow and thrive in tropical intertidal areas and subtropical beaches with low wave strength [1]. Mangrove ecosystems play a role for developing countries in Asia-Pacific who are at the forefront of the impacts of climate change. This is due to the ability of mangroves to mitigate storm surges and floods as well as their high carbon sequestration and storage capacity [2]. The decomposition rate is the fastest, with an average of 0.27 g/day, and the slowest, with an average of 0, 14 g/day [3]. Wetlands of mangrove ecosystems are located between terrestrial land and oceans which are ecosystems that are sensitive not only to changes in the physical environment but also to anthropogenic processes of urbanization and economic development [4]. In mangrove protection work related to climate change, improving community knowledge and understanding may be a viable option[5]. In order For the mangrove ecosystem to remain sustainable, development and development activities around the mangrove forest area need to be accompanied by conservation, rehabilitation, and even restoration efforts for damaged areas.

In recent years, the emerging remote Unmanned Aerial Vehicle (UAV) sensing technology provides a cost-effective solution for measurement [6]. The application of remote sensing for coastal areas is very much needed in monitoring and evaluating the sustainability of the barrier ecosystem between land and sea. Spatiotemporal information on mangrove area, age, structure and biomass makes an important contribution for communities to examine the role of these ecosystems in terms of the services they provide (for example, in relation to carbon storage, biodiversity conservation), especially given the variability due to human activities and environmental impacts. nature of events and processes in them [7]. The use of the medium to low- resolution satellite imagery has not been able to provide further information in monitoring coastal areas. The type of high-level and detailed data for shallow and inaccessible coastal marine habitats is often challenging, time-consuming, and spatial and temporal coverage often has to be compromised to make routine monitoring more cost-effective [8]. The use of high-resolution satellite imagery also costs a lot for small or narrow areas. The use of drones/ UAV (Unmanned Aerial Vehicle) devices can be a major breakthrough in the study and monitoring of morphological changes caused by coastal dynamics because of the ease of use of these devices and the possibility of obtaining high resolution aerial photographs and georeferenced images, with high temporal resolution as well, can allows expansion of existing coastal mapping methods and databases of change and migration [9]. This approach will be very useful in other areas where mangroves grow, especially in remote, inaccessible, and difficult to observe environments [10]. Therefore, the use of remote sensing technology will be very helpful in assessing the ecosystem and even the potential that exists in land and water areas, especially in coastal areas.

The introduction and identification of mangrove forest areas can be done by various methods and one of them is using remote sensing. Remote sensing technology with the help of drones and satellites has shown strong potential in accurately capturing mangroves [11]. Accurate and timely monitoring of mangrove information is essential for proper and practical conservation management [12]. The ability of UAVs to provide detailed mangrove images (canopy density, environmental characteristics and profiles) that can be used to support activity management, especially mangrove replanting programs and low-cost and time-effective solutions for mangrove monitoring compared to previous high-resolution satellite imagery approaches [13]. Mapping and introduction of mangrove forest areas can be one of the first steps in the effort to manage mangrove forest resources in the need for sustainable management in integrated and sustainable cross-sectoral energy synergies [14]. Aerial imaging provides a fast way to collect a large number of drone images in the field [15]. Thus the approach by using UAV in mapping mangrove areas will be more helpful in terms of time, effort and cost.

Maros Regency is one of the regencies in South Sulawesi which has mangrove forests in its coastal areas. The mangrove forest in Maros Regency has a mangrove area of 201.93 ha consisting of 4 sub-districts, namely Bontoa, Lau, Marusu and Maros Baru [16]. The introduction and monitoring of mangrove forest areas in Maros Regency is a step and effort in providing information on the existence and current condition of the ecosystem so that further development potential can be identified that is suitable to be applied to the area. Based on the description above, the purpose of this study was to map the mangrove forest area around Maros Regency and the output obtained in the form of aerial photos and high resolution Elevation Model Data (DEM) in the mangrove forest area.

2. Methods

The research was conducted in Maros Regency, precisely around the mangrove forest area of Sabang Tambua Pier and Ampelkale Village. This study focuses on all mangrove areas and their surroundings that may be used as ecopreneurship areas. The sample was obtained using the purposive sampling method in the mangrove area and the surrounding community which is expected to provide information and responses regarding information about the mangrove forest area at the research location. The techniques used in data collection are interviews and observations by taking aerial photos of mangrove areas using Phantom 4 drones. Data analysis techniques in this study are remote sensing analysis and geographic information systems using the Pix4D, Agisoft Metashape, and ArcGIS ArcMap 1.4 applications.

3. Result and discussion

Aerial photography was taken at 2 location in Maros Regency, namely at Sabang Tambua Pier and Ampekale Village, Bontoa District. Orthophoto image at the research site. The location of the camera along with the level of photo overlap can be seen in Figure 1.

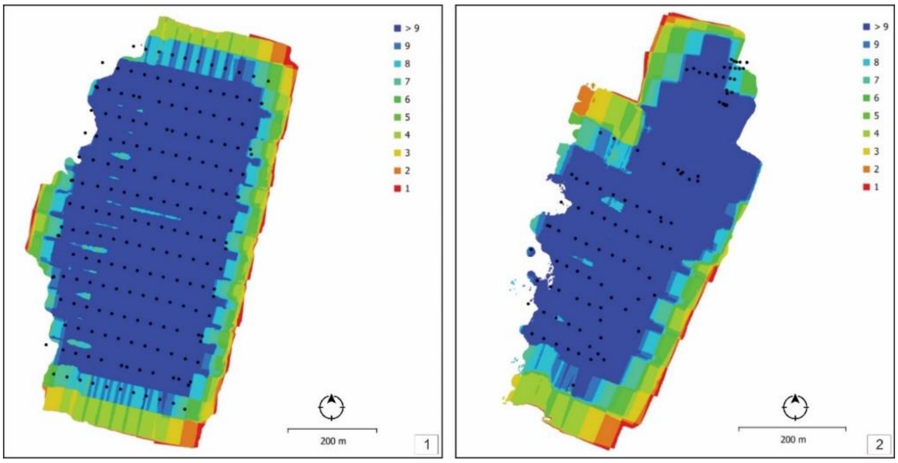

Figure 1. Camera location and image overlap

In Figure 1 it can be seen that the black dot is the location of the camera or the point of taking photos by the drone based on the path that has been made. The color gradation shows the level of overlap between one photo and another, which is indicated by the redder in the image, the lower the level of photo overlap. While the more blue, the higher the level of overlap. At the edges of each image the lower the level of overlap due to the limit of the coverage area. While the center of the image has a higher overlap because it is traversed by the drone's flight path, considering that the overlap level used is 80%. The specifications for aerial photography can be seen in Table 1.

Table 1. Specifications for aerial photography

Num.	Location	Num. of Img.	Flying Alt. (m)	Ground Res. cm/pix	Coverage Area km^2	Camera st.	Tie Point	Projection	Reprojection error (pix)
1	Sabang Tambua Pier	210	100	8.62	0.397	198	30068	85167	1.42
2	Ampekale Village	158	100	6.28	0.226	107	42382	119941	2.6

Source: Data processing, 2021

In Table 1 it can be seen that the number of images obtained at each location, namely Sabang Tambua Pier, is 210 images, while in Ampekale Village 158 images. This is also directly proportional to the area covered by the mapped area, because the area around location 1 mapped is wider than location 2. The estimated image taking position at the location can be seen in the following Figure 2:

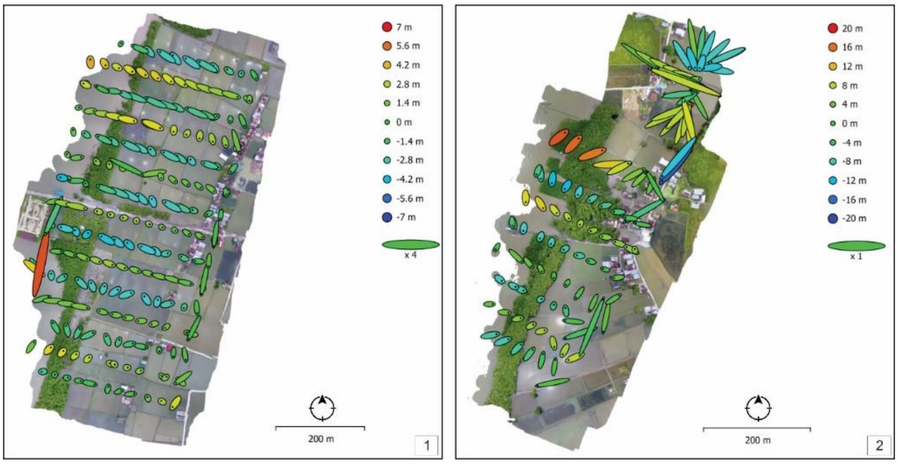

Figure 2. Camera location and error estimation

The Z-axis error or the mean error of the square root of the height is represented by color in the ellipse plane, while the X and Y axes or the average square root error of the location are represented by the size of the ellipse plane. The black dot is the approximate location of the camera. Based on the picture above, the average camera location error can be obtained as follows.

Table 2. The error rate of the image capture point

Num.	Location	X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
1	Sabang Tambua Pier	4.363	4.136	2.286	6.012	6.432
2	Ampekale Village	32.897	29.410	7.399	44.127	45.742

Source: Data processing, 2021

Table 2 above shows the error value of each axis in taking aerial photographs. At location 1 it can be seen that the total error rate when taking aerial photographs is 6.432 while at location 2 is 45.742. The error rate in imaging can be affected by weather such as strong winds or can also be affected by the area of the satellite signal level captured by the GPS drone while in the shooting path. The display of the obtained DEM data can be seen in the following Figure 3.

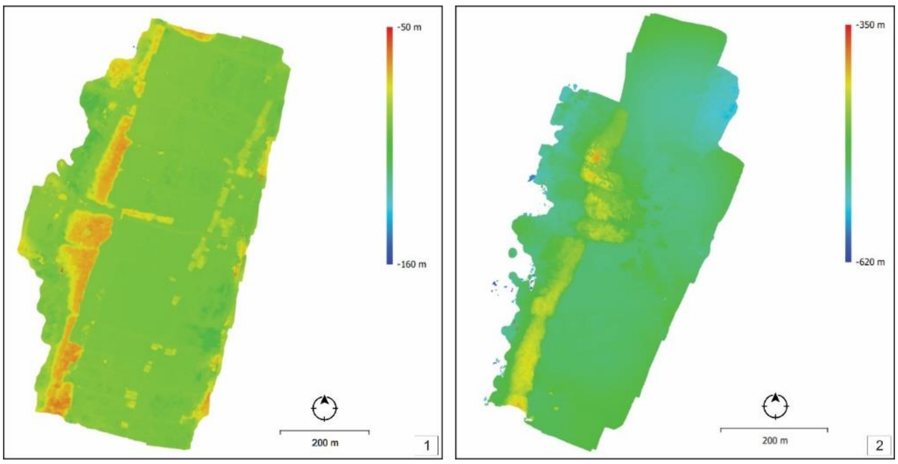

Figure 3. Display of the DEM of the research site

In Figure 3 it can be seen that the color gradation shows the level of elevation of the object captured by the drone. The more reddish-yellow the color is shown, the higher the elevation of the object being lifted. On the other hand, in a bluish-green color gradation, the elevation of the object will be lower. In the DEM appearance, both locations tend to be green because both locations are located near the coast or coastline. Meanwhile, in the two images, the yellow-orange color gradation is also seen as vegetation along the coast, in this case mangrove forests. The dem specifications obtained can be seen in Table 3.

Table 3. Research sites DEM specifications

Num.	Location	Resolution (m/pix)	Point Density (point/m^2)
1	Dermaga Sabang Tambua	34.5	8.24
2	Ampekale Village	25.1	15.8

Source: Data processing, 2021

In Table 3, it can be seen that the resolution of the resulting Digital Elevation Model is at location 2, namely Ampekale Village. This is indicated by a high resolution value of 34.5 m/pix while location 1 is only worth 25.1 m/pix. In addition, in high-resolution DEM, the point density level is also higher. as for the orthophoto results obtained at the observation point can be seen in the following picture. As for the orthophoto results obtained at the observation point can be seen in the following Figure 4.

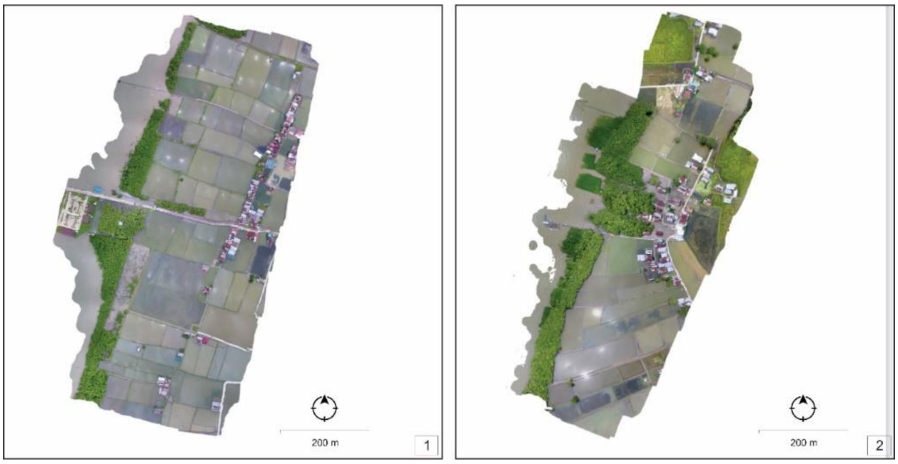

Figure 4. Orthophoto of Research location

In aerial photography result or commonly called orthophoto, objects that appear on the surface can be identified. Identification on the resulting aerial photo can use direct visual identification because of its high resolution and the appearance of objects that are very clear. Some examples of objects that can be recognized directly on aerial photographs of research locations include the following:

a. Mangrove vegetation

Mangrove vegetation is clearly visible in aerial drone photos with the characteristics at first glance of color or green hue, rough texture and elongated shape following the shoreline. Mangrove Ecosystem Resource Utilization Models and Ways Gear nets, traps, hooks [17]. To identify the mangrove species, further identification is needed on aerial photographs and even needs to be matched with actual field conditions. Mangrove area is 4.67 ha at Sabang Tambua pier and 4.06 ha in Ampekale Village

b. Settlement

Residential settlements in aerial photographs can be identified by white on new tin roofs or brown because they have rusted, square or rectangular shapes, with varying sizes depending on the area of land used, rough texture and the site sometimes follows the road or in coastal areas sometimes follows a line. Beach. The pier area is 0.85 ha, settlement area is 1.20 ha at the Sabang Tambua pier and 1.95 ha in Ampekale Village.

c. Pond

Community ponds can be recognized by their clear greenish color resembling a body of water with a shape that tends to be square or rectangular because of the embankment that limits one another and its wide size. The site is in the coastal area, precisely behind the mangrove forest because the mangrove itself acts as a barrier to waves that can abrade the embankment of the pond. The area of the pond is 26.73 ha at the Sabang Tambua pier and 12.61 ha in Ampekale Village.

d. Road

The road section is shown in the aerial photo in the form of black lines on asphalt roads and grayish white on concrete roads. Roads in coastal areas to connect residents' settlements as well as transportation access to the port/pier and to the community's pond area. Road length of 1688.32 m at Sabang Tambua pier and 1030.28 m in Ampekale Village

e. Water body

Water bodies that can be recognized in aerial photographs, especially coastal areas, are seas and rivers or streams. The color of the waters sometimes changes according to the reflection of the light received. The color or hue of the waters around the coast ranges from clear to dark blue. This is influenced by the light that is absorbed, reflected, or even scattered by the object caught on camera. The river is elongated and winding and its end empties into the sea. The area of the body of water is 2.85 ha at the Sabang Tambua pier and 2.10 in Ampekale Village

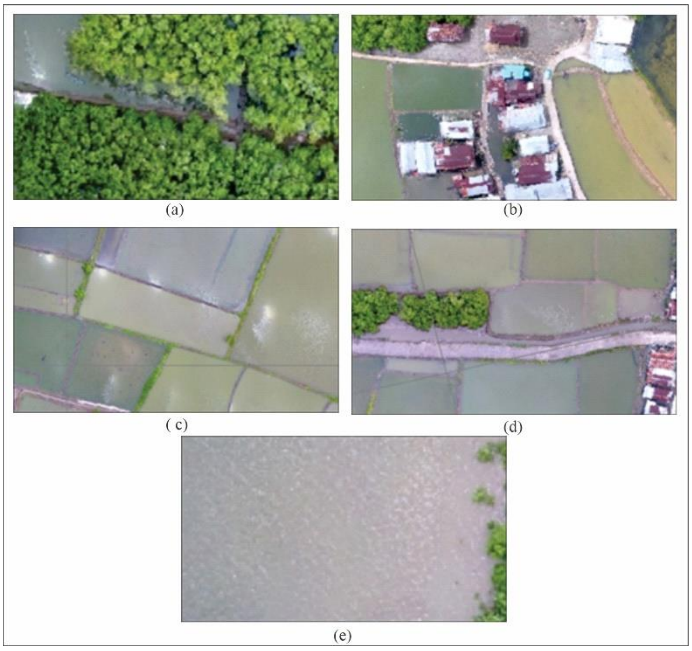

Figure 5. The appearance mangrove vegetation (a), settlement (b), pond (c), road (d) and water body (e)

The final stage of making a map or aerial photo image of the research location is the layout. The application used in the layout is Arcmap 1.4. The layout of the aerial photo is shown in Figures 6.

Figure 6. Aerial photo of the mangrove area of sabang tambua pier (a) and ampekale village (b)

4. Conclusion

Based on the results of the study, it can be concluded that mapping of mangrove areas using UAV can be seen that mangrove vegetation can be the recognized by the glance of color or green hue, rough texture and elongated shape following the shoreline and land cover that can be recognized through aerial photography is at the Sabang Tambua pier including mangrove vegetation covering an area of 4.67 ha, settlements covering an area of 1.20 ha, ponds covering an area of 26.73 ha, the water body is 3.85 ha and the pier area is 0.85 ha. Meanwhile, in Ampekale Village, there is 4.06 ha of mangrove vegetation, 1.95 ha of settlements, 12.61 ha of ponds, and 2.10 ha of water bodies. The output of this research consists of high-resolution aerial photos and elevation model data (DEM) for each location.

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