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A Study of The Density of Built-Up Land Based on Aerial Photographs in Pasaran Island, Bandar Lampung

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Abstract

Pasaran Island is a small island connected to the mainland island of Sumatra and located in Bandar Lampung. Pasaran Island is one of the supports for the economy in Bandar Lampung. This is in line with the 2011-2030 RTRW of Bandar Lampung as a strategic minapolitan area (Pasaran and Lempasing) in driving the regional economy and utilizing appropriate technology. Pasaran Island is dominated by fishing villages and seafood processing centers in Lampung. With a population of ± 1,233 people in an area of ± 12 Ha, Pasaran Island has the potential for continued development. A study of the density of Built-up Land on Pasaran Island needs to be carried out so that it can become important information and data in managing the development of Pasaran Island in the future. Remote sensing technology using UAV was carried out to retrieve accurate and precise large-scale mapping information that allows the level of detail of Built-up Land to be mapped according to the original conditions in the field. In this study, the data used to extract Built-up Land was orthophoto which was produced through visual interpretation methods, and to determine the level of density and efficiency of Built-up Land conditions the digitization method and spatial analysis was by calculating the area of Built-up Land and calculating the percentage of Built-up Land density in Pasaran Island. The results of this study consisted of two maps, which are a map of the classification of Built-up and Non-Built-up Land and a map of Built-up Land types. The percentage of Built-up Land density was obtained from the calculation of the area of Built-up Land classes divided by the area of Pasaran Island, which resulted in a built-up density of 87.15% consisting of building classes, open land, public facilities, and road networks. As for the results of the non-built density was 12.84%, which consisted of a vegetation class where the vegetation is in the tree-shaped form, the population density and building density of Pasaran Island are low density.

Keywords: Pasaran Island; Built-up Land; UAV; Orthophoto.

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Introduction

The addition of urban infrastructure is one indicator of the progress of an area. The phenomenon of growth and development of an area that is not planned is experienced by several cities. There are several factors that underlie the development of an area, such as the rapid growth of the population and the soaring economic growth, of course, both have an impact on the need for a space, land and infrastructure for various community activities and the need to have a place to live. A study conducted by Webster (2002) states that the factor that causes rapid growth in a city is the addition of residential areas as a place for various human activities such as the demand for housing development, industry, and other activities.

Along with the development of cities in Indonesia occurs based on the desire for the availability of land use that serves as a community facility. Mapping the distribution of land use is necessary for several studies such as global monitoring, planning activities, and resource management (Nabawi et al., 2020). The increase in population from time to time affects business activities that make demands on the survival of the population. So, it is necessary to carry out land management, so that there is no land conservation. According to Suyana & Muliawati (2014) defines as efforts made on land in general.

Bandar Lampung is a city with several tourism destinations, both culinary tourism, cultural tourism, marine tourism, and others. This certainly makes the development of various human activity traffic more advanced and better. Pasaran Island is one of the destinations in Bandar Lampung where Pasaran Island is the closest island to Bandar Lampung located in Teluk Betung with a panoramic view of its natural beauty. Pasaran Island is an artificial island, currently Pasaran Island is inhabited by many residents making Pasaran Island look like a slum island due to the increase in population growth living on the island.

Given that the need for space and land is needed to overcome the rate of population growth so that space and land can be properly distributed as a place for community activities, the study of the density of built-up land is important because it is a variable for urban management so that it can see the benefits of a city (Tiara et al., 2022). According to Wijaya (2013) that built-up land is a physical form that covers the face of the earth which is limited by built-up physical appearance. Many studies have been carried out on land and built-up land, including Nurrohmat (2021) Mapping deep built-up land the 250-meter Lembang fault corridor as a disaster mitigation effort. The combination of vegetation indexes uses world-view 2 satellite imagery (Hidayati et al., 2018). Other studies using NDBI and a combination of NDBI–NDVI transformations with overlay analysis were carried out by Salihin (2018). Alfarizi et al. (2015) research on built-up land using the GIS method. Land cover mapping using Landsat 8 OLI imagery using the MLC method (Sampurno and Thoriq, 2016), a combination of satellite imagery and aerial photographs for mapping the distribution of built-up land along riverbanks (Driptufany et al., 2022). Currently the existence of Unmanned Aerial Vehicle Technology is one of the efforts in accelerating the process of mapping, unmanned aerial vehicles are an alternative technology to replace remote sensing using satellite platforms (Gonçalves, 2016) especially in monitoring the increase in the number of buildings. Photogrammetry activities in general are a series of processes of photographing objects on the surface of the earth, measuring objects on aerial photographs, and processing aerial photographs into a resulting form called a map (Gularso et al., 2013). According to Syauqani et al. (2017), Photo maps can be used for planning on a large scale. Small-format aerial photographs are generally taken with a digital camera using a GPS (Gularso et al., 2015). Aerial photography using UAVs has been widely used in a variety of applications (Rahmad, 2019). The capability of the UAV-based photogrammetry system is that it has similarities with the production of using standard aerial photography images. What is different is the limited coverage area, which means it is adjusted to the ability of the system to reach locations (Andaru and Santosa, 2017). Identification of objects by interpreting aerial photographs (Chaerunnisa et al., 2017) Visual interpretation relies on image composites (Nugraha and Zuharnen, 2015). The on-screen digitization method produces line points and polygons so that they can form digital maps (Pidu et al., 2019). The on-screen digitization method can be easily repaired if there are errors (Fadilla et al., 2017). This research was conducted to determine and map the density of built-up land on Pasaran Island based on aerial Photoshoot with UAVs vehicles through visual interpretation of aerial photographs and on-screen digitization.

Materials and Methods

This study was conducted on Pasaran Island, Bandar Lampung (Figure 1). The time of this study began in May 2022 to October 2022. The material used in this study is Aerial Photoshoot data that has become orthophoto data. The equipment used includes Drone brand DJI Phantom 4 (Unmanned Aircraft), Geodetic GPS, Premark, Hardware, which is: Laptop Asus Core i7, Software which are: DJI Go Android application, Agisoft PhotoScan Professional Edition software.

Furthermore, the study implementation procedure consisted of preparation, data collection, measurement of control points and Aerial Photoshoot, processing of Aerial Photoshoot data, interpretation, classification and analysis. It is described as follows.

1. Preparation Stage

Conducting surveys to ensure field conditions, Flyway Plans, control point distribution plans, and tool preparation. Meanwhile, the preparation of literature studies is a series of activities related to library data collection methods including scientific journals, articles, books and others that are aligned with this study.

2. Data Collection

The data source used in this study was Aerial Photoshoot data obtained from Aerial Photoshoot using a Rotary Wing (Copter) type UAV (Unmanned Aerial Vehicle).

3. Control Point Measurement and Aerial Photoshoot

The control point measurement stage was to conduct a survey in advance to ensure that the site to be studied is safe for the distribution of the installed control points. The distribution for measuring control points on Pasaran Island is as follows in Figure 2.

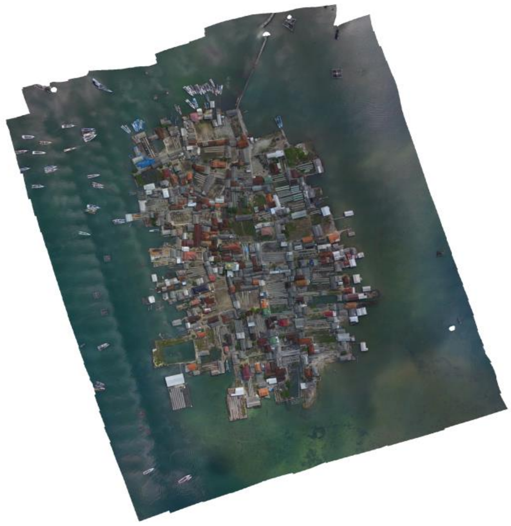

Figure 1. Pasaran Island.

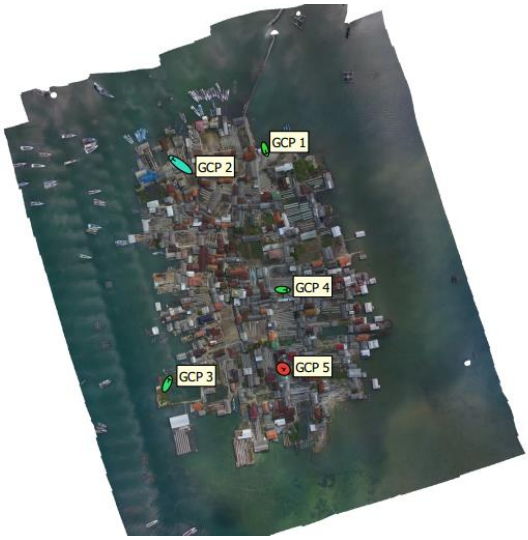

Figure 2. Ground Control Point Distribution.

The measurement of ground control points used Geodetic GPS (Figure 3) and performs GPS data processing of ground control points by calculating the results obtained from measurements and comparing with base maps that already have a coordinate system reference.

After determining the distribution of ground control points or GCPs, the Premark was installed (Figure 4), which was used as an identity for the existence of GCPs in the field. So that, when taking aerial photographs, it was seen from above and then measuring ground control points using Geodetic GPS.

Figure 3. Ground Control Point Measurement.

Figure 4. Installation of Premark.

Figure 5. Aerial Photoshoot using UAV.

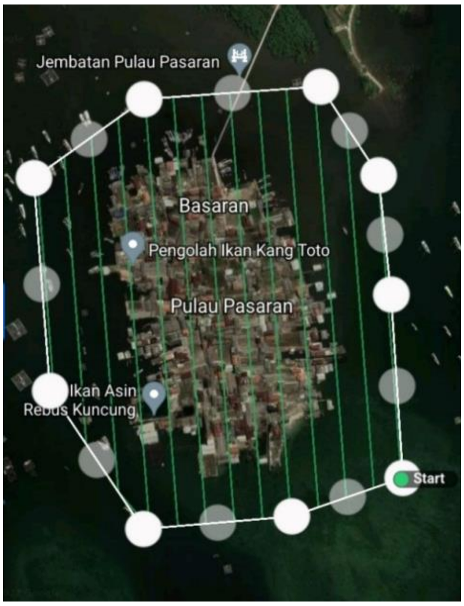

Figure 6. Flyway Plan.

The stages of Aerial Photoshoot were to carry out the tool calibration process first to eliminate existing distortions. Next, shooting with the UAV (Figure 5) was carried out in accordance with the Flyway Plan that has been designed. The following is an overview of the Flyway Plan as follows in Figure 6.

4. Data Analysis

a. Point matching process, inserting GCPs so that the coordinates in the photo match the coordinates on the ground, point cloud forming, orthophoto data forming and creating a DEM in this case an Aerial Photo DSM.
b. The process of visual interpretation and delineation of Built-up Land on orthophoto According to Sutanto (1994) using 9 elements of image interpretation, such as hue, size, shape, texture, pattern, height, shadow, position and association while Built-up Land Delineation by manually digitizing on screening of aerial photo data (orthophoto). This stage will produce Built-up Land parcels according to the situation in the field. Besides that, other land information can also be identified.
c. The process of Classification of Built-up Land is based on the recognition of

object characteristics spatially using elements of visual interpretation (Kohl et al., 2006). Classification is formed from the process of digitization or delineation. Khorram et al. (2013) that the image classification method involves some information spectral, temporal and spatial. Creating a training area is required before the manual classification process is carried out and divided into classes based on the criteria. the combination of the various selected channels can be the main point in the classification results because it relates to the visualization of the selected channel determine the classification results. Ensuring the extent of Built-up Land class and other classes. The criteria for built-up land are level II, which are: places of worship, settlements, and others. In addition to Built-up Land, other classes also need to be delineated as a complement in the depiction of the Built-up Land map. The classification of Built-up Land in this study is the class of buildings (Figure 7), open land (Figure 8), roads (Figure 9), and public facilities (Figure 10), while for Non-Built-up Land, it is the class of vegetation (Figure 11).


Figure 7. Building Class.

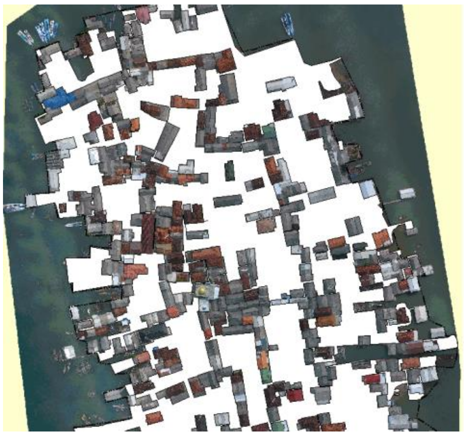
Figure 8. Open Land Class.

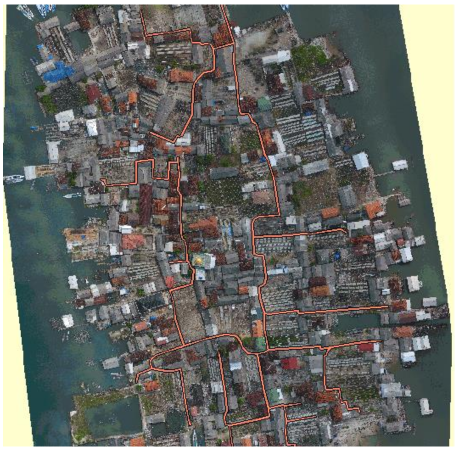
Figure 9. Road Class.


Figure 10. Public Facility Class.


Figure 11. Vegetation Class.

5. Density Analysis of Built-up Land

The analysis of the results was by calculating the area of Built-up and Non-Built-up land areas and then determining the class for the level of Built-up land density, in addition, the analysis was carried out to calculate the percentage of Built-up and Non-Built-up land in Pasaran Islandarea compared to the area so that the current state of Built-up Land and land cover of Pasaran Island was able to be known.

Results and Discussion

The results of the Aerial Photoshoot that has been carried out are as follows in Figure 12.

Number of images: 206

Flying altitude: 106 m

Ground resolution: 4.25 cm/pix

Coverage area: 0.387 km²

Camera stations: 206

Tie points: 117,043

Figure 12. Aerial Photoshoot Result.

From the photoshoot, the orthorectification process was carried out using five GCP points. If the RMSe value is large it will cause an error on the actual measurement results (Simbolon et al., 2017). The overall RMSe result is 0.067 with RMSe details as follows in Table 1.

DEM (Digital Elevation Model) results (Figure 13) on Pasaran Island show that elevations range from -60 m to 90 m.

Table 1. RMSe Orthorectification.

No	Point Name	RMS
1	GCP1	0.215093
2	GCP2	0.92053
3	GCP3	0.078985
4	GCP4	0.068125
5	GCP5	0.021074
	RMSe	**0.067997**

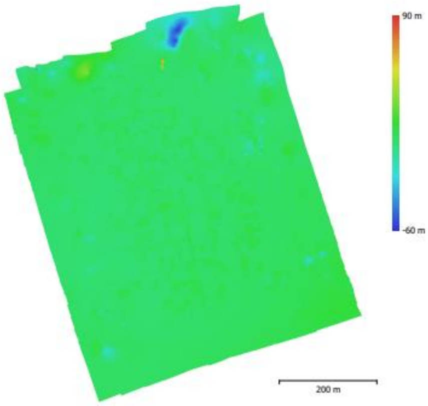

Figure 13. Digital Elevation Model Result.

The map of Built-up and Non-Built-up land was obtained from the process of digitizing on screening by means of aerial photo interpretation using image interpretation keys including hue or color where to distinguish land classes, using patterns. The patterns were seen that tend to be regular, shape and size adjust to the identified object. The analysis of Built-up Land Density is obtained by calculating the area of Built-up and Non-Built-up Land, determining the class for the level of built-up land density based on the classification of medium level Built-up Land such as road classes, public facilities, buildings, and open land. Calculating the percentage of Built-up and Non-Built-up Land in the area of Pasaran Island divided by the market island area, the results of the calculation of the area of each type of Built and Non-Built-up Land as follows in Table 2.

Based on the Table 2, the total area of Pasaran Island is 11.52 Ha, then the classification of Built-up and Non-Built-up Land. The Built-up Land class is divided into 4 classes, including 9 types of public facilities consisting of places of worship such as mosques, village halls, village health centers, to elementary schools with an area of 0.19 Ha, the road network class consists of 1 type of path of 0.38 Ha, the open land class consists of 1 type of salted fish drying place because Pasaran Island is the location of the largest salted fish center in Lampung of 5.05 Ha. Furthermore, the building class consists of 40 types consisting of settlements where the majority of physical buildings are permanent with an area of 4.42 Ha with a total Built-up Land area of 10.04 Ha. The percentage of built-up land density was calculated based on the number of each class divided by the total area as follows in Table 3.

Table 2. Built-up and Non-Built-up Land Class Area.

No	Classification	Area (Ha)
1	Total area of Pasaran Island	11.52
2	Built-up Land Area	
	Public Facility Area	0.19
	Road Network Area	0.38
	Open Land Area	5.05
	Building Area	4.42
	Total	10.04
3	Non-Built-up Land Area (Vegetation)	1.48

Table 3. Percentage of Built-up Land Density.

No	Density Type	Total (%)
1	Density of Built-up Land	87,15
2	Non-Built-up Density	12,84

Based on Table 3 above, the results of Built-up Land Density of 87.15% consist of building classes, open land, public facilities and road networks. While for the results of Non-Built-up density of 12.84% consist of a vegetation class where vegetation is in the form of shady trees. The area of Pasaran Island from the results of Aerial Photography is 11.52 Ha, with a total population of 1,233 people, the population density of Pasaran Island is 107 people / Ha, which is Low Density. As for calculating building density using building data. According to BSN (2004) SNI-03-1733-2004, the formula is as follows in Equation 1.

$$\frac{Number\ of\ Buildings}{Total\ Area} = Building\ Density \qquad (1)$$

Table 4. Classification of building density.

No	Building Density	Total (%)
1	> 100 unit/Ha	High
2	80 – 100 unit/Ha	Medium
3	< 80 unit/Ha	Low

Based on the Concept Guidelines for Identification of Slum Areas Buffering Metropolitan Municipality, the classification of density building is divided into three, which are high, medium and low (Kementerian Pekerjaan Umum dan Perumahan Rakyat Direktorat Jenderal Cipta Karya, 2006) as follows in Table 4.

Based on the calculation formula above and Table 4, the building density is obtained indicating a low building density in Pasaran Island. This study produced three maps, which are Built-up and Non-Built-up Land Map, Land cover map and Built-up Land Type Map in Pasaran Island. The results of this study are as follows in Figure 14 – 16.

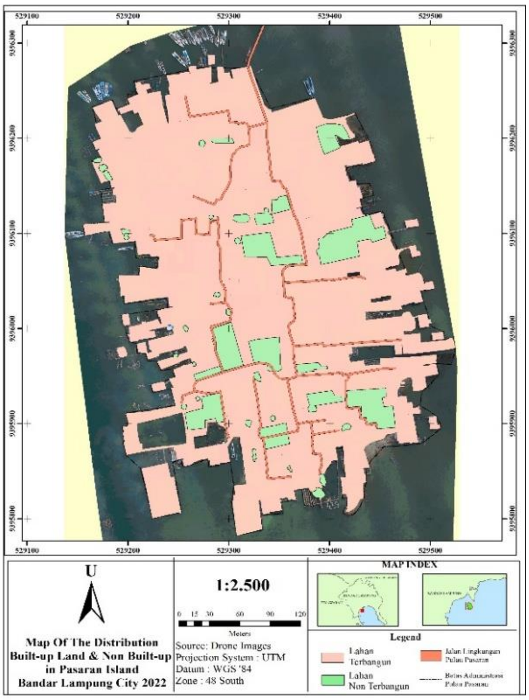

Figure 14. Map of Built-up and Non-Built-up Land of Pasaran Island.

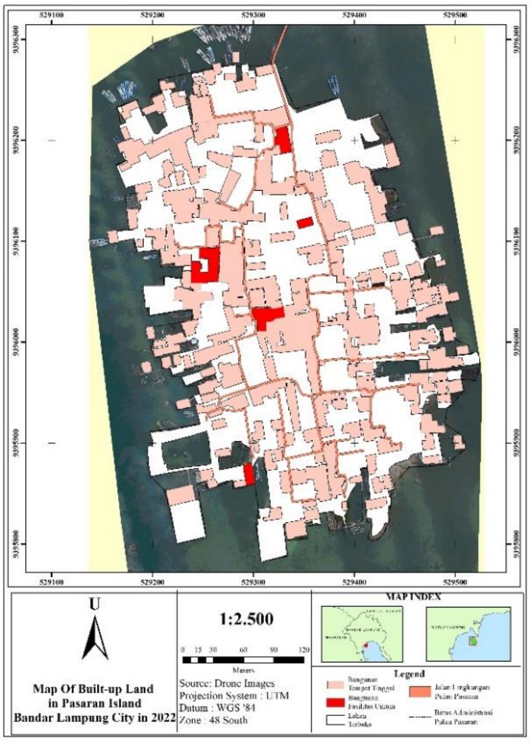

Figure 15. Built-up Land Map of Pasaran Island.

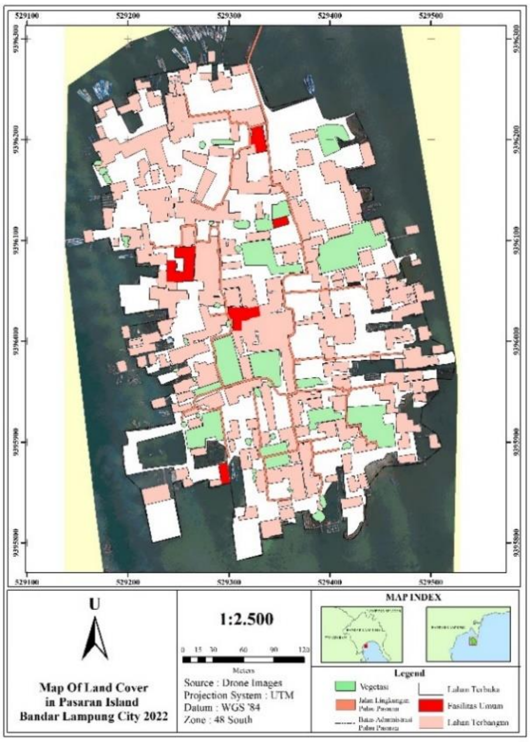

Figure 16. Land Cover Map of Pasaran Island.

Conclusion

The study of Built-up Land was obtained from visual interpretation using the satellite image interpretation keys of hue, shape, size, and pattern. Build-up Land Density Mapping using UAVs (drones) is a solution to get the results of Build-up Land Density Mapping quickly and easily. The percentage of Built-up Land Density of Pasaran Island obtains the results of Built-up Land Density of 87.15% consisting of building classes, open land, public facilities, and road networks. As for the results of non-built density of 12.84% consisting of vegetation classes where vegetation in the form of shady trees, the population density of Pasaran Island is low density and the building density of Pasaran Island is also low.

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Author Contribution

Division of tasks authors, the first author the processing of Aerial Photograph Data to Become Orthophoto (Results Analysis), Ground Control Points measurement. The second author did Built-up Land Classification (Introduction), planned Flyway, ground control points distribution (materials and method), Aerial Photography (conclusion and reference).

Conflict of Interest

In terms of financing there is already a financing agreement through research grants so it is not burdensome for researchers and fellow writers not to claim each other regarding research and article writing because there is already an agreement.

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