Analysis of Land Use Changes Based on Visual Interpretation Results of Satellite Images (Case Study: Canggu Village, North Kuta District, Badung Regency, Bali)

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Abstract. Research on land use changes is very important at this time because land use changes have an impact on the physical and social environment. This research aims to determine changes in land use in Canggu Village, North Kuta District, Badung Regency, Bali using satellite image data and Geographic Information Systems (GIS). The research method used is to compare two land use distribution data for 2005 and 2023 obtained from Landsat satellite image interpretation. Changes in land use from 2005 to 2023 are that village forests have decreased in area by 72,418,353 m^2, residential areas have increased in area by 2,225,172,192 m^2, rice fields have decreased in area by 2,071,195,788 m^2 and open land has decreased in area by 78,676,931 m^2. The spatial description shows that the Canggu Village area is the area that has experienced the most changes in North Kuta District. Changes in land use in Canggu Village are caused by the impact of the rapid arrival of foreign tourists and domestic tourists to the area, thereby spurring the rapid and rapid development of tourism supporting development and this has resulted in many land conversions.

Keywords: Land Use Change, Landsat Satellite Imagery, Canggu

1 Introduction

Land is part of the earth's surface that is useful for human life, and consists of physical and non-physical factors (Ritohardoyo, 2013). Very rapid population growth and increasing demands for land by society often result in discrepancies between land use and its designation. The increase in city population also means an increase in the need for land. Because land cannot be increased, land use changes occur which tend to reduce the proportion of previous land. Land is an area on the surface of the earth with certain characteristics which include the biosphere, atmosphere, soil, geological layers, hydrology, plant populations, animals, and the results of past and present human activities. These characteristics have a significant influence on human land use today and in the future (Kusrini, 2011).

In Indonesia, changes in land use also occur in several areas, one of which is Canggu Village, North Kuta District, Badung Regency, Bali. Changes in land use that occur can

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certainly result in changes in the economic value of land, and if management is not carried out properly, in the future it can result in degradation of the economic value of land (Panjaitan et al., 2019).

Changes in land use in Canggu Village are one of the phenomena of changes in an area due to human intervention. The phenomenon of land use change can be studied directly or indirectly. Through remote sensing, indirect studies of land use changes can be carried out more efficiently in terms of time and cost (Ramadhony et al., 2017). Identification of regional morphology can be done by utilizing remote sensing to find trends in the direction of regional development and development based on land use conditions at a certain time which can be presented on a map so that it can be compared (Sutanto, 1986). Multitemporal analysis with remote sensing data can help in the continuous monitoring of regional development so that it can be used for land development prediction purposes. Image interpretation is carried out by looking at the basic characteristics of the appearance of each land use/cover in the image which is assisted by interpretation elements. Research on land use changes is very important at this time because land use changes have an impact on the physical and social environment (As-Syakur, 2011). These inappropriate changes must be monitored to determine policies so that changes can remain under control and have a good impact on regional development (Arifin et al., 2018).

By using two satellite images, namely in 2005 and 2003, it can be analyzed the changes in land use in Canggu Village from 2005 to 2023 quickly, efficiently and cheaply. So that the results of the land change map obtained are useful for the government to take spatial planning policies, useful for academics to continue similar research and useful for the community to find out the level of population density.

2 Methodology

In general, the research was carried out in the form of information collection (secondary and primary data collection), field surveys, problem analysis, as well as formulating an inventory, and evaluating the performance of digital data processing. The research work steps are outlined in the form of a research diagram which describes the complete stages from beginning to end sequentially until the end with a research period duration of one year. The complete research flow diagram can be seen in Figure 1. Data collection in this research was through literature study, interpretation of satellite images both visually and digitally, related agencies, and field surveys. Literature studies are obtained through reading literature from books and journals. Interpretation is carried out after obtaining data on the USGS website for satellite imagery. Data from related agencies aims to strengthen analysis regarding the theme of land use change. The field aims to test the interpretation results after previous data processing in the laboratory.

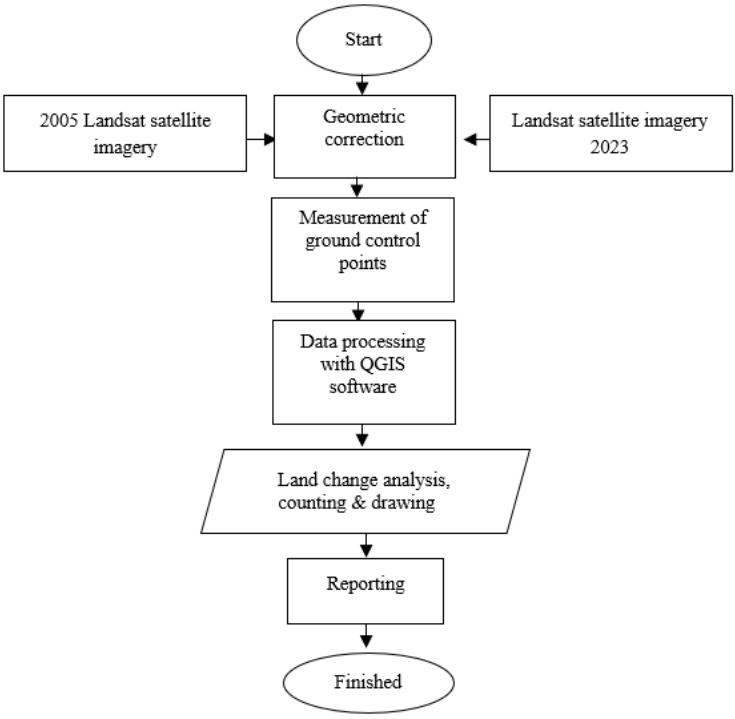

Figure 1. Research flow diagram

Data processing and analysis are divided into 3 main activities, namely pre-field, field, and post-field. Each of these activities is a main step in research activities. Pre-field activities consist of image correction and continue with interpretation. The correction carried out is image correction (including radiometric correction and geometric correction) and continued with visual classification for landform parameters and digital classification for land cover.

Radiometric correction aims to return the reflection value from the image recording to the actual reflection value of the object. Through radiometric correction, it is hoped that when carrying out digital classification of land cover it will be more objective. The change in the shape of the coverage frame from a square to a parallelogram is the result of this transformation. This stage is applied to raw digital images (directly recorded by satellites), and is a systematic geometric error correction (Lukiawan et al., 2019). Geometric correction is carried out to restore the image coordinate position so that it matches real conditions in the field. Corrections made to the research were in the form of an image to map, Landsat 5 TM regarding the Badung Regency Indonesian

Landform Map Sheet (RBI). Image-to-image correction was carried out using Landsat 5 TM images as a basis for correction for Landsat 7 ETM+ and 8 OLI images.

Geometric correction is carried out to transform the remote sensing image so that the image has the characteristics of a map in shape, scale, and projection. (Rahayu & Candra, 2014). Then the data is cropped to limit the research area, making it easier to analyze on a computer. Apart from that, cropping the image will reduce memory capacity, making it easier to process the image. Then proceed with sharpening the color contrast to obtain better image results.

After the process is complete, it is continued by creating a color composite image, and then NDVI analysis is carried out to determine the density level of the object using Equation 1.

$$NDVI = \frac{(NIR - red)}{(NIR + red)} \quad (1)$$

Information :
NIR = Spectral band near-infrared value
red = Spectral band red value

The above process was carried out in ER Mapper software, then the digitization process was carried out with QGIS software to mark the area and layout. Land use interpretation uses the maximum likelihood method. This algorithm uses the assumption that homogeneous objects always display a normally distributed histogram. The land cover classification then uses multispectral classification. This classification is designed to classify land cover information from remote sensing images so that it is more appropriate. Landforms in the research area are classified using a classification where the classification adapts to the conditions of the landscape so that it is suitable for use in research. Land use map classification is produced from a two-dimensional matrix between landform maps and land use maps. This research was conducted in Canggu Village, North Kuta District, Badung Regency, Bali can be seen in Figure 2.

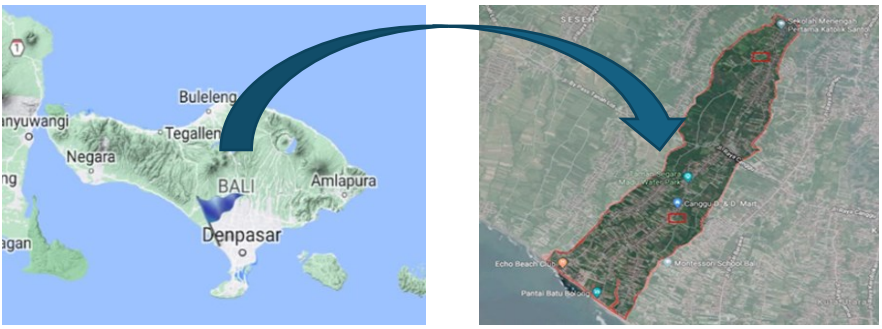

Figure 2. The research location is in Canggu Village, North Kuta District, Badung Regency, Bali

3 Result and Discussion

3.1 Result

From the results of this analysis, sample points were plotted and then ground checks were carried out (Dalilah et al., 2021). Ground control points (GCP) are measured using GPS/GNSS to obtain point coordinate values. GCP has an important role in correcting data and improving the overall image so that aerial photography results have high accuracy. In this research, GCP points with Premarks were obtained in the field as in Table 1.

Table 1. Ground control point

Point P	East E	North N	Description
1	297019.082	9044259.551	Road
2	296786.263	9044376.485	Road
3	296524.632	9044528.953	Ricefield
4	296243.258	9044718.467	Ricefield
5	295953.915	9044899.069	Settlement
6	295710.109	9044876.030	Settlement
7	295381.830	9044412.080	Village forest
8	294799.0233	9043818.595	Village forest
9	294304.369	9043396.763	Vacant land
10	293702.371	9042794.230	Vacant land

Before importing into QGIS, settings need to be made first so that the coordinate data from GPS as a Ground Control Point can be read by the QGIS software. Coordinate data stored in Excel is saved to a CSV (Comma delimited) file type. The following are the results of data input from the Ground Control Point.

At the map digitization stage, the aim is to create a layer/display in QGIS, in this case the land boundary lines. The following are the results of digitizing a map showing land boundaries.

The following are the results of inputting GCP coordinate data and digitizing regional boundaries in 2005 and 2023 satellite imagery, which can be seen in Figure 3.

Figure 3(a). Satelite imagery from 2005

Figure 3(b). Satelite imagery from 2023

3.2 Discussion

From the results of this analysis, sample points were plotted and then ground checks were carried out (Dalilah et al., 2021). Ground control points (GCP) are measured using GPS/GNSS to obtain point coordinate values. GCP has an important role in correcting data and improving the overall image so that aerial photography results have high accuracy. In this research, GCP points with Premarks were obtained in the field as in Table 1. The images from land mapping in 2005 and 2023 produce the following land change maps Canggu Village Land Cover Map in 2005, can be seen in Figure 4.

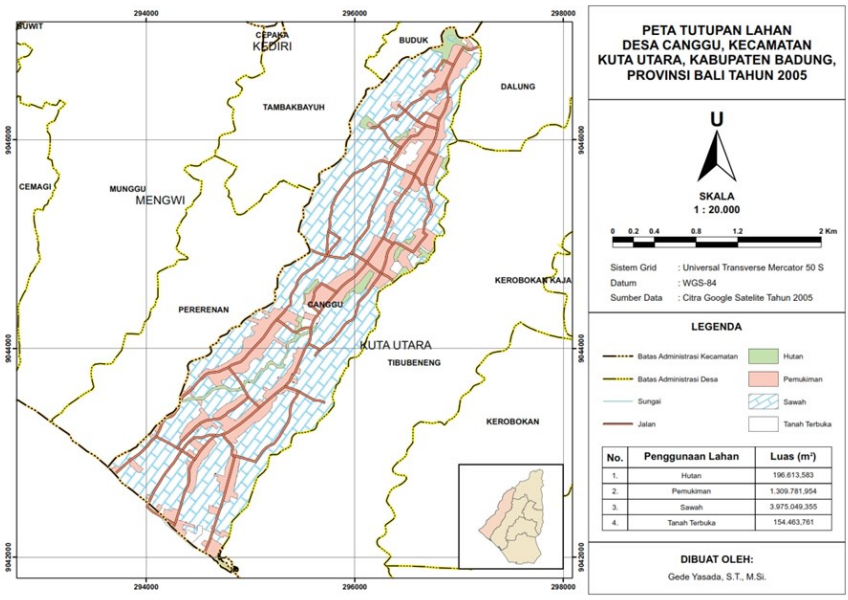

Figure 4. Canggu village land cover map in 2005

Canggu Village land cover map in 2023, can be seen in Figure 5.

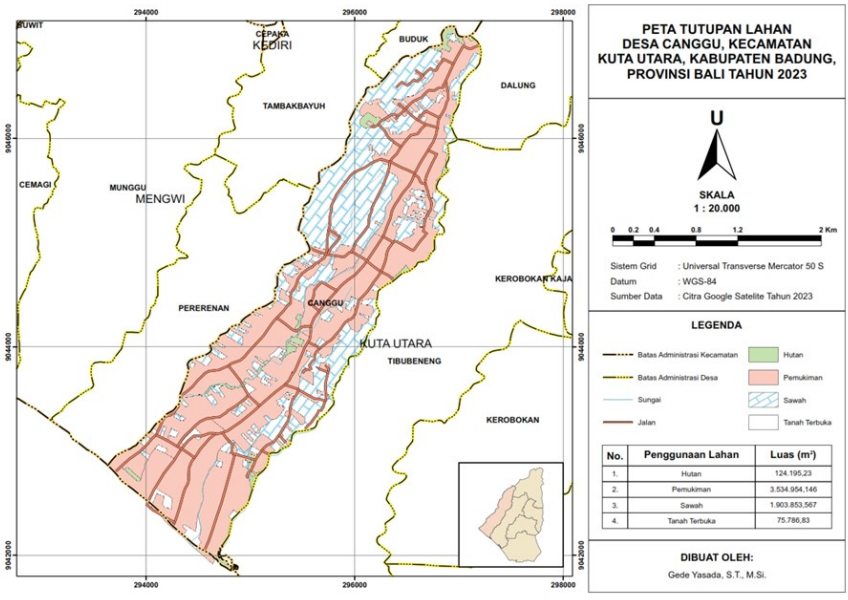

Figure 5. Canggu village land cover map in 2023

Canggu Village Land Cover Map in 2005 and 2023, can be seen in Figure 6.

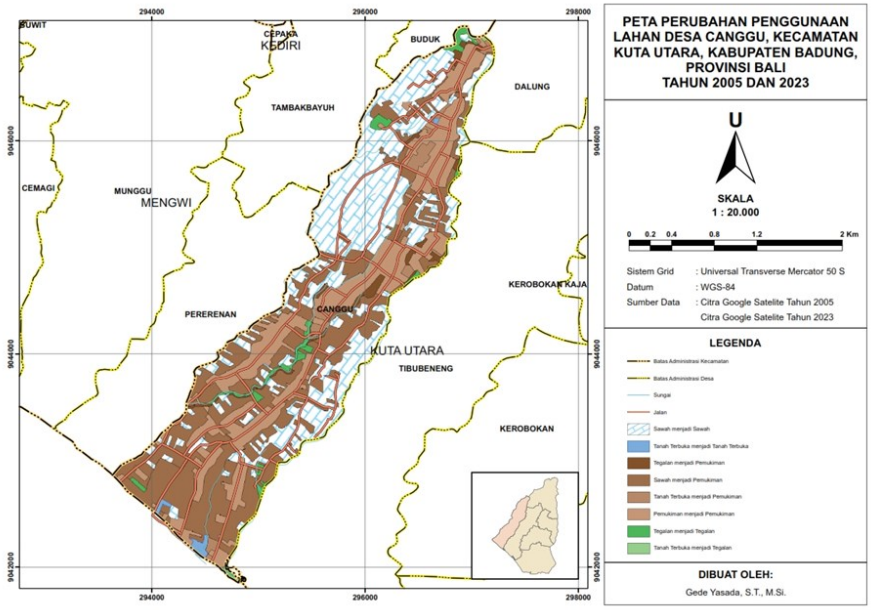

Figure 6. Canggu village land cover map in 2005 and 2023

Table 2. Land use changes from 2005 to 2023

No	Land type	2023 th (m^2)	2005 th (m^2)	Changes in land use (m^2)	Information
1	Village Forest	124,195.230	196,613.583	(72,418.35)	Reduce
2	Settlement	3,534,954.146	1,309,781.954	2,225,172.19	Increase
3	Ricefield	1,903,853.567	3,975,049.355	(2,071,195.79)	Reduce
4	Open Land	75,786.830	154,463.761	(78,676.93)	Reduce

Chart of Changes in land use from 2005 to 2023, can be seen in Figure 7 :

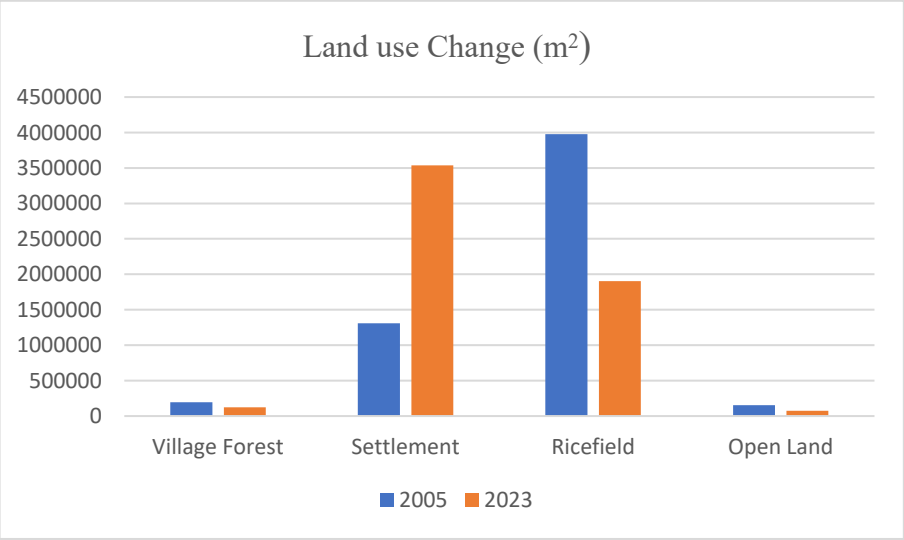

Figure 7. Changes in land use from 2005 to 2023

4 Conclusion

Analysis of Land Use Changes Based on the Results of Visual Interpretation of Satellite Images (Case Study: Canggu Village, North Kuta District, Badung Regency, Bali) is: a. Changes in village forest land use from 2005 to 2023 are a decrease in area of 72,418,353 m^2; b. Changes in residential land use from 2005 to 2023 are an increase in area of 2,225,172,192 m^2; c. Changes in the use of rice fields from 2005 to 2023 have decreased by 2,071,195,788 m^2; d. Changes in open land use from 2005 to 2023 have decreased by 78,676,931 m^2; e. Changes in land use in Canggu Village are caused by the impact of the rapid arrival of foreign tourists and domestic tourists to the area, thereby spurring the development of tourism supporting development very quickly and rapidly, and this has resulted in many land conversions.

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