Advances in Social Science, Education and Humanities Research, volume 671
International Webinar on Digital Architecture 2021 (IWEDA 2021)

Drone-Based Mapping for Visual Identification of Sembiran Village Settlement Characteristics

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ABSTRACT
Bali has different characteristics of settlements depending on the place or location where the settlement stands. Geographically, Balinese Traditional Settlement consists of 2 types. Bali Mountains Settlement (Bali Aga) and Bali Plains Settlement. Sembiran Village, which is located in Buleleng Regency, North Bali, is referred to as the Bali Mountains Settlement as well as a settlement Bali Aga. Based on this understanding, Sembiran Village certainly has characteristics like traditional Balinese mountain settlements or it can have distinctive characteristics considering that the settlements are located in mountainous-hill areas. This research will be carried out using a qualitative research method with a descriptive approach. The qualitative-descriptive method is supported by UAV (Unmanned Air Vehicle)-based mapping method in the form of a drone. The results of mapping data identification and descriptive analysis show that the position of Sembiran Village is indeed right in the hills/mountains with steep contours, the houses in the village place Merajan in the highest position in each yard, and the unique position of Pura Desa as a village sacred place is positioned below settlement.

Keywords: *Drone, Mapping, Sembiran, Settlement, Characteristics.*

1. INTRODUCTION

Bali is known to be rich in natural beauty, customs and cultural diversity. There are many traditional traditional villages that have traditions and cultures that look for village characteristics. One of the traditional traditional villages in Bali in the highlands (mountains) is the Sembiran village. Sembiran Village is 30 km east of Singaraja City, Buleleng Regency. Sembiran village is located at the upper end of a dry mountain slope that climbs sharply and extends to the ridge of the mountain. From there you can see a wide view to the corners of the village with settlements or housing with tiled roofs and corrugated zinc plates, including towering palm trees and the roofs of the pagoda towers of several temples. The back area is a flat and green sea [1].

Sembiran is a village located in a highland area (mountains or hills) located in the Tejakula district. Sembiran village is known as an old settlement relic from the megalithic century.

Sembiran village is located in Tejakula District and is located in the eastern part of Buleleng Regency. The boundaries of the Sembiran area are: to the north is the Bali Sea; to the east are the villages of Pacung; Julah and Madenan, to the south it is bordered by Satra Village, Kintamani District, Bangli District and to the west is the Tajun village of Kubuaddan sub-district. Sembiran village area is a hilly area overgrown by trees. The road to Sembiran Village is mostly hot mix asphalt. From higher ground, the paved road looks beautiful winding while the friendly roofs are reddish in color with greenish tones of various types of trees. The beautiful natural conditions are not balanced with adequate settlement arrangements, less organized, and huddled together, so that it seems irregular settlement patterns.

The density of residential areas in Sembiran village and its location on the slopes of the mountains are one of the factors causing difficulties in structuring settlements. On the slopes of the mountains it is difficult to find flat and large plots of land, so the houses that are erected tend to be narrow or small. The soil structure is

solid solid soil and makes it easier to make building construction [2]. Sembiran village is one of the oldest villages in Buleleng, Bali. One of the clues found many Megalith objects (large stone objects or buildings), for example, standing stones, pundan berundhak-undhak which according to historians is about 2,000 years BC or the Neolithic era. In connection with the discoveries that lead to prehistoric times, the village of Sembiran is referred to as one of the atua villages. Sembiran Village is also called the 'Bali Aga' Village which can be interpreted as Desa Mula. Some sources also say that the word 'Aga' is also translated as mountain (Sanskrit), so that the village of 'Bali Aga' can be interpreted as a village in Bali which is located in a mountainous area [2]. The area of Sembiran Village is divided into six hamlets, namely 1. Kanginan Hamlet, 2. Regional Hamlet, 3. Dukuh Hamlet, 4. Anyar Hamlet, 5. Bukit Seni Hamlet and 6. Panggung Hamlet. In accordance with the administrative structure of the Traditional Village, the six hamlet areas are divided into thirteen (13) adat banjars, with the settlement locations as follows [2].

Understanding the general characteristics of Sembiran Village as described earlier, leads to an understanding that in detail, studies regarding settlements in Sembiran Village have not been carried out. The characteristics that characterize the settlements of Sembiran Village have not been clearly described. The purposes of the study is to identify detailed characteristics of Sembiran Village especially on Settlements. Aspects of the Settlement that need to be study are: (1) Settlement Layout; (2) Settlement Space Hierarchy; and (3) Settlement Landscape Condition, and other characteristics that can be found during study. With the help of nowadays technology, especially drone or UAV as a tools that can be used for collecting visual data. Researchers hope to find some unique characteristics of the settlements of Sembiran Village and can be captured and understood visually through digital data output.

2. MATERIAL AND METHODS

2.1. Balinese Traditional Settlements

The pattern of settlements located in the hills follows the existing contours or transitions, so that the forms of settlements are lined up and have laws [3]. The entire population is *Bali Aga / Bali Mula* / Old Bali settlements. Traditional Balinese houses generally consist of several masses that form a distinctive yard pattern. The collection of houses and yards will form a uniform built environment and form a distinctive settlement pattern. However, along with the development of settlements, settlement patterns are assumed to have undergone a lot of development. The description of the traditional settlements of the Bali Aga/Mula/Old era is as follows; a. A higher place is always a purified place. b. The direction of facing the house is not directly to the main road but through small streets in front of the house (alley). c. Mountains as a shared orientation. d. The house is made with a low roof and minimal ventilation. e. *Bebaturan* is a building floor generally made of compacted clay. There are also those who use ideals (unburned bricks). The forms of houses in a yard (natah) in traditional Balinese settlements are simple houses. Generally in one arrangement there are many buildings with their respective functions [4]. The settlement pattern of the higher plains in Bali has the main value, the people in the plains (middle) have middle-income values and the people and lowland areas (towards the sea) who are less able, have disgraceful values. Based on the rules of the difference, the rules are linear settlement patterns [5] (See Fig. 1).

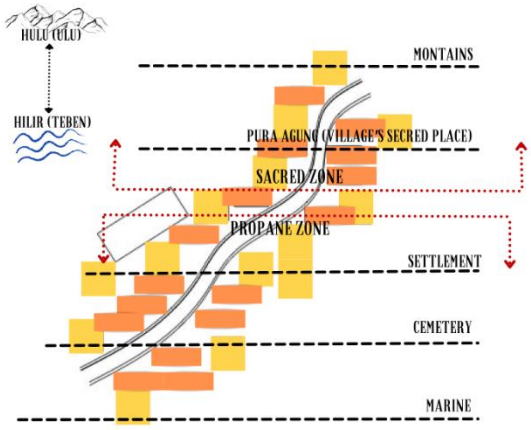

Figure 1 Bali aga settlements layout and space hierarchy.

2.2. Study Area

The research was location in Sembiran Village, Buleleng Regency, Bali Province. This research was conducted in November 2021, consisting of preparation, determination of AOI (Area of Interest), taking aerial photos with UAV, and data processing. The research location can be seen in figure 2.

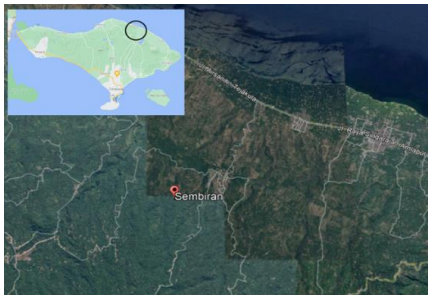

Figure 2 Research location at sembiran village, buleleng regency.

2.3. Data Processing Workflow

UAVs are already widely used for various purposes, including the digital reconstruction of architecture [6]. a general workflow is to be followed to process UAV imagery using machine learning and statistical modes. The workflow contains the following steps: (1) collecting UAV data, considering pre-flight preparation, mission planning, and system characteristics; (2) UAV data processing followed by image pre-processing and photogrammetry processing; (3) machine learning and statistical models, including classification and regression methods, according to the desired study goals, and the accuracy assessment of the final products [7]. In this study, the workflow data used were UAV data collection, UAV data processing, and Settlement Pattern Analysis based on mapping results (figure 3).

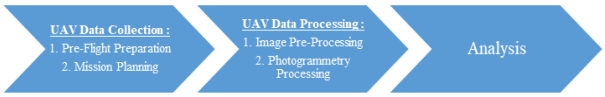

Figure 3 Data processing workflow.

2.4. Data Collection

Some strategies must be taken into consideration for accurate UAV data collection to ensure a safe survey. There are three primary phases, including pre-flight preparation, mission planning, and platform and sensor characteristics. Before an actual UAV flight, four major phases should be considered, namely UAV regulations, study area characteristics, weather conditions, and field data collection. These phases are essential for accurate UAV data collection and lead to a safely operated survey without collection mistakes [7]. Data collection in this study used DJI Phantom 4 Pro and processed with PIX4DMapper and ArcGIS software. The following table is the equipment used in data collection.

Table 1. Data collection equipment

UAS	Attributes and Parameter
Platform	DJI Phantom 4 Pro
Focal Length	9 mm
Camera Angle	45o
Flight Height	30-50 m

3. DATA PROCESSING

The flight was planned to cover a 38-hectare area, with 30-50 m of average height. The results of taking photos with the UAV are then carried out radiometric and geometric corrections to adjust the shape of the photo. Some external factors, such as atmospheric effects (e.g., spectral variability of the surface materials, absorption, and scattering), lead to spectral image degradation [8]. Processing the photo results is done with the Pix4D mapper software and visualizing the mapping results with ArcGIS. Besides using software as analysing images, In processing the data, a description approach will also be used which targets aspects of the spatial hierarchy, layout, and environmental conditions. Zig zag process method in data processing is also carried out The zigzag process is the process of going to the field to make observations, interviews, and document studies, then returning to the work room to analyze the data, then returning to the field doing the same process, and returning to the workspace, this process continues until it finds the most appropriate data. and is sufficient to answer the research question [9].

4. RESULTS AND DISCUSSION

4.1. Orthomosaic and DSM Result

Orthomosaics obtained from the UAV imagery can reach a resolution of a few centimeters [10]. Aerial photography of Sembiran Village consists of 237 images. The orthomosaic process of UAV photos with PIX4D Mapper produces high-resolution aerial photos can identify settlements in Sembiran Village. Figure 4 shows a sample of orthomosaic results from the processing.

Figure 4 Orthomosaic result of sembiran village.

Next is the initial processing. This stage is the stage of calculating or extracting key points in an image which later these key points will be matched back to one or more images. We can also choose how the internal and external parameters of the camera are optimized, and the optimization step consists of running Automatic Aerial Triangulation, Bundle Block Adjustment, and camera calibration until optimal reconstruction is achieved. Next, a DSM is interpolated from this point cloud [11]. The original images are stitched together, using the elevation information from the DSM to form an orthomosaic. Table 2 shows the number of points extracted from the orthomosaic process. These points are then processed to produce a DSM map for the Sembiran Village (figure 5).

Table 2. Result of point extraction

Parameter	Value
Number of 3D Densified Points	1,471,850.00
Average Density (per m3)	28.72

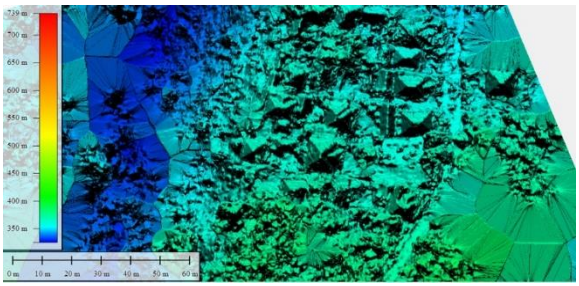

Figure 5 DSM result of Sembiran Village.

4.2. Visualization and Topographic Cross-Section

Visualizing process of the photogrammetry results using ArcGIS software. At this stage, orthomosaic and DSM results previously converted into a Digital Elevation Model (DEM). The aim is to determine the cross section of Sembiran Village and the position of the settlement. Figure 6 and Figure 7 below is the result of the visualization with ArcGIS of the Sembiran Village map.

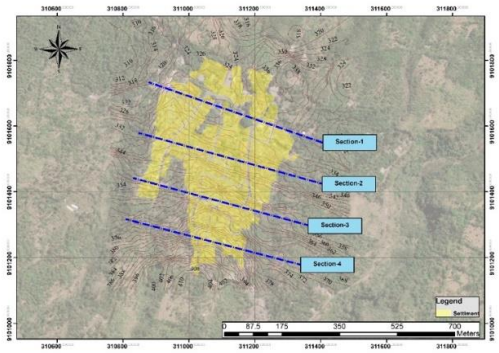

Figure 6 Visualization of Sembiran Village Map.

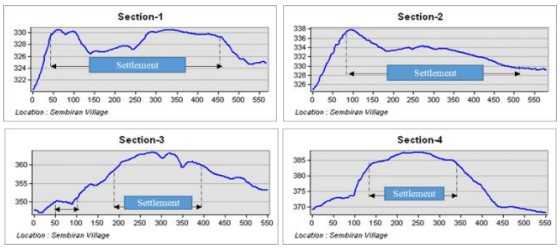

Figure 7 Cross section of Sembiran Village Settlement Area.

4.3. Settlement Layout and Space Hierarchy

Based on orthomosaic data, visualization of drone photos, and topographical pieces that have been carried out, conditions related to the characteristics of spatial layout in settlements have been found. Characteristics of the layout of the space or building in Sembiran Village is referring to Hulu (Higher Ground = Sacred) - Teben (Bottom Area/Lower Ground = Profane), in accordance with what is applied to the Bali Aga settlement. Based on drone data, the position of the Holy Places in each of the residents' home yards in Sembiran Village is seen standing in the highest area of the yard. This data also shows a clear difference with the characteristics of traditional Balinese settlements on the plains where the concept of the plain is to divide the yard into 9 zones (Sanga Mandala) and the area of the shrine is positioned based on the North-East (Kaja-Kangin) cardinal directions and not based on altitude.

Another unique thing found through drone data is the Position of Village's Main Sacred Place, namely the Pura Desa Sembiran or Sembiran Village Temple, which is located in the southern area of the settlement monitored by drones. This indicates that the Hulu (The Sacred Places) of the village settlements are under their settlements or under their settlements, so that the Hulu-Teben spatial hierarchy adopted commonly by the traditional Balinese mountain settlements (Bali Aga) does not seem appropriate. This condition demands further study (Figure 8).

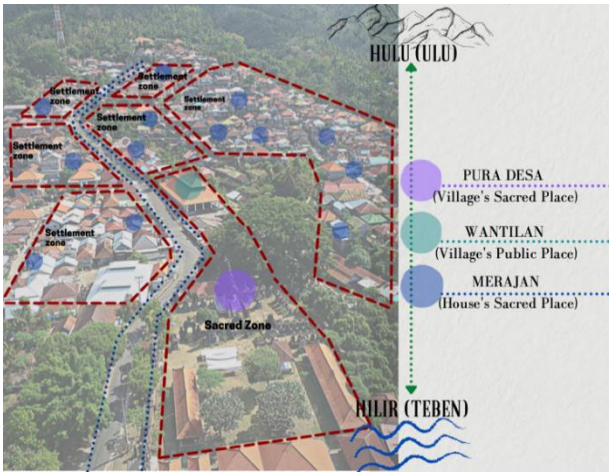

Figure 8 Analysis on Sembiran Village Settlement layout and space hierarchy.

4.4. Settlement Landscape Characteristic

Based on orthomosaic data, visualization, and topographical sections, several characteristics are known. The characteristics in question are

characteristics related to the landscape condition of the land used as settlements in Sembiran Village. The data shows that the landscape condition of the residential area of Sembiran Village is at an altitude of 325 - 385 meters above sea level. And it is very clearly seen in the drone photo that the settlement of the village of Sembiran stands on arid highland hills. Based on the location of the settlements seen in the contour data, village settlements tend to stand right on tops or ridges. In ideal building conditions, this situation actually makes it difficult to develop a house or build an ideal house, because it must take into account contours and use transitions. This condition is something that needs to be explored further qualitatively regarding the reasons behind the selection of the contour position of the hillside as a residential area for the residents of the village of Sembiran (Figure 9 & 10).

Figure 9 Sembiran Village Settlement landscape conditions (map photo).

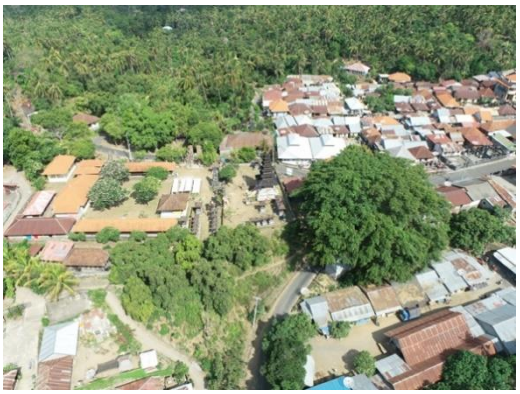

Figure 10 Sembiran Village Settlement landscape conditions (perspective).

5. CONCLUSION

From the discussion that has been mentioned previously, several conclusions can be drawn. The first conclusion is that the Sembiran Village Settlement does have characteristics that are in accordance with the Traditional Balinese Settlement in the Mountains *(Bali Aga).* The location of the settlements which instead chose a position on the ridge that was difficult for the construction or development of houses, and the position of the Pura Desa which was actually under the settlement. These two things provide the special characteristics of the Sembiran Village settlement that need to be studied more deeply. These special characteristics then become the second conclusion. In general, the settlements of Sembiran Village have unique characteristics according to the location of its establishment, the location of the sacred area of house and village, and other is its environmental conditions. Through a deeper study related to the previously described aspects, other settlement facts will be revealed so that in the future, this research will have sufficient depth of knowledge regarding the Sembiran Village Settlement Conditions, History, or other Architectural Field of Study.

ACKNOWLEDGMENTS

Researchers would like to thank the Head of Sembiran Village and several Sembiran Village Leaders for allowing the research team to study the Sembiran Village Settlement area. Also, the research team would like to thank the Ministry of Education and Culture, Research and Technology of the Republic of Indonesia for the opportunity given to the Department of Architecture, University of Warmadewa to carry out the Independent Campus Competition Program (PKKM) so that it can carry out research in Sembiran which is a series of the Humanitarian Project PKKM (PK) program carried out by the architecture students.

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