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Development of Village Information System Based on UAV Image and Geographic Information System (Case Study: Katonsari Village of Demak Regency)

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Abstract

To display comprehensive information, the Village Information System (VIS) does not only display statistical data. VIS that can manipulate data and spatial information is not yet popular. Generally spatial data in the form of maps are only used complementary data rather than arranged in the form of spatial databases. The Village Information System that was built for Katonsari Village of Demak Regency of Central Java Province as a case study area. Spatial data for the system are based on aerial photogrammetry of Unmanned Aerial Vehicle (UAV). Non spatial data are based on sub-district administration book and random sampling survey. Based on the mapping with the UAV, the remaining rice field are only around 50 %, while the remainder is used for residential and factory settlement. The UAV also provides information the land and building tax data made by government is no longer in line with that current conditions. Based on the results of these studies it was concluded that UAVs was efficient, fast and accurate spatial data sources for Village Information System. VIS can provide village potentials in the form of GIS more efficiently and easy to access.

Keywords: Village Information System, GIS, UAV, Land and Building Tax.

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1. Introduction

District or City Government as an autonomous region is required to be able to develop and optimize all regional potentials to improve the welfare of the community [1]. In connection with the regional development goals as mandated in the law, the acceleration and optimization of the development will be largely determined by the capacity and capability of natural and human resources. Limitations in ownership of natural resources and human resources, both in quality and quantity, because they can cause setbacks in the dynamics of regional economic development, as well as regional discretion to direct its economic development programs and activities. The Act also explains that regional development planning is based on data and information that is accurate and

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can be accounted for. Furthermore, with the enactment of Law no. 6 of 2014 concerning Villages, further strengthens the reasons for the smallest unit of State administration to increase development in their respective regions [2]. In this regard, each region is obliged to collect data on all the potentials and assets of the regions that exist to support the development of the region. Then Law Number 4 of 2011 concerning Geospatial Information, among others, regulates all data that contains spatial elements (spatial / geographical) needs to be mapped in the framework of providing national geospatial data and information relevant to the reality in the field [3].

Based on the three laws, it can be concluded that the regional government is obliged to provide data and map the information that is the basis in its development planning. The data collection and mapping starts from the smallest unit of the regional administrative unit, namely village level [4]. As a basis for data collection and mapping for regional development is the mapping of village potentials and assets, where by mapping the village's potentials and assets, real information available in the field can be presented in accordance with the actual conditions so as to produce accurate, reliable and accountable information to be used as a basis in better village planning and governance [5]. With the Village Information System (VIS), it is able to provide broader information not only for the village government but can be enjoyed by the village community

The Village Law emphasizes the importance of Village Information System in village planning and development, therefore Article 86 paragraph (2) and paragraph (5) requires the Government and Local Government to develop VIS, and its management is carried out by the Village Government so that it is accessible to the village community and other stakeholders [6]. VIS development includes the construction of hardware and software facilities, networks, data and human resources. Data needed in the village information system includes village data, Village Development data, Rural Areas, as well as other information related to Village Development and Rural Area development [7]. The data used in building the village information system has more value when paired with spatial data in order to answer the accuracy of the position of each data.

Then with the support of rapidly developing internet technology, making information can be accessed freely and openly through various devices [8]. Communication is one of the important things in describing something, such as an intermediary, to present something to the public. So as to facilitate communication within a village between village officials and residents, a communication medium is needed, namely the Website and the Village Information System [9]. But the most important thing in an Information System is the ability of the system in decision making. Every decision will be more

accurate if it is based on geospatial, so the SID that is developed should be based on geospatial from the village area. Further development by creating a WebGIS-based system which is the implication of geospatial-based VIS [10].

Katonsari Village is a village located in Demak District, Demak Regency. This village has a strategic area because it is near the highway that connects the city of Semarang and the city of Surabaya. But until now this village does not have a village information system. Katonsari Village, located in Demak District, Demak Regency, is a village that previously had a village map based on satellite imagery on a scale of 1: 5,000 [11]. Then with this mapping, there will be many benefits including land use mapping, RW boundary mapping, village facility and infrastructure mapping. To get a village map with a detailed scale 1: 1,000 scale maps are needed. One method for data acquisition includes using a UAV.

The village information system can be accessed by the village community through a geospatial-based website or WebGIS [12]. According the aforementioned explanation, a research has been carried out "Development of Village Information System Based on UAV Image and Geographic Information System" (Case Study: Katonsari Village of Demak Regency).

2. Methods and Equipment

2.1. Methods

The general research methodology is divided into 4 stages as follows:

1. The Preparation Phase includes the initial data collection and literature study, preparing equipment and materials and preparing permits to the study location village.

2. The data collection stage includes aerial photography with UAVs, Ground Control Point measurements and non spatial data collection from Katonsari Village.

3. Data processing activities include: GCP data processing, UAV data processing, UAV aerial photo rectification, Family Card (KK) database processing and Land and Building Tax (PBB), geo data ase and topology, WebGIS creation and Website development.

4. The final step is to prepare the research output in the form of a Village Information System that has been integrated with GIS using rectified UAV aerial photo data.

The location of this research is in Katonsari Village, Demak District, Demak Regency, which is located between coordinates 6 ° 54'34.86 "- 6 ° 54'5.59" latitude and 110 ° 36'32.38 "- 110 ° 37 '39, 2 "East. Katonsari Village is on the North Coast Line (Pantura Line), which connects Semarang City and Demak Regency. Katonsari Village is located

about 2.5 km from Demak Square and the Great Mosque of Demak and is located about 3 km from the central government of Demak Regency. The location of the study which is shown in Figure 1.

Equipment for research generally consists of hardware: Desktop Personal Computers, Laptops, GPS Geodetic TOPCON Hyper SR and Drone Dji Phantom 4 Pro. The software consist of: Ms. Office 2010, Agisoft PhotoScan 1.4.0, Topcon Tools, ArcGIS 10.4, DJI GO 4 and DroneDeploy

Figure 1: Research Location Katonsari Village, Demak District, Demak Regency.

2.2. Spatial data collection

Spatial data for VIS was aerial photography data from UAV. UAV mapping consist of preparation, aerial photo acquisition and orthophoto processing. A preliminary survey of the determination of the UAV flight path plan was conducted as a first step before making a flight plan. This step aims to determine the area to be passed by the UAV and determine the point to fly the UAV. Determination of the location that will be used as a UAV flight point must pay attention to several important things, among others: pay attention to the shape of the topography of the surrounding area, objects around the location that are expected to become obstacles such as the cellular phone tower, trees and others. Then to find the ideal location, choose an open place, among others, around the fields or field land.

The process of making an airway plan is carried out through the Drone Deploy application on the Smartphone. The process of making flight path plans is carried out by means of flight height input, front overlap, side overlap, and flight path area coverage. The flight plan and flight path process is obtained from the results of preliminary surveys

that have been carried out. In this study, the flight plan is divided into 17 flight sessions with a flight height of 100 m above ground level. Whereas the front overlaps 75% and the side overlaps 65%.

The UAV flight process requires several supporting devices, including: aircraft, remote control, smartphone and USB cable. The device has different functions including, the aircraft functions as a vehicle for taking aerial photographs, the remote control functions as a tool to control the UAV, the smartphone functions as a medium to see the display run by the UAV and the USB cable functions to connect the remote control and smartphone.

The acquisition of aerial photographs was carried out after the process of making the flight plan and calibration was completed. The process of acquiring aerial photographs is carried out using the DroneDeploy application which already has a flight path plan that was previously made in the process of making the flight path plan. Every flight plan for the initial flight position must be in the middle of the area and in a spacious area so that there are no obstacles or lost signals at the time of acquisition.

2.3. Non spatial data collection

Non spatial data collection consist of collecting Family Card and Tax of Land and Building data. Collecting family card aims to identify profile of the population in Katonsari Village as well as to identify the location of the houses of each family head. Land and Building Tax data were obtained from the Katonsari Village Office. The Land and Building Tax data is very important information for the village and will be used for the purposes of making a village information system specifically about the Land and Building Tax.

2.4. Data Processing and Development of WebGIS

The data processing stage generally includes the following processes:

1. The process of making orthophoto is done using Agisoft Photoscan Professional software

2. Provision of corrections using GCP GPS survey results

3. Digitization on screen map from aerial photographs of UAVs.

4. The resulting digitization of maps from UAV aerial imagery will then be used for the development of Geodatabase and Topology.

In this research, WebGIS uses ArcGIS Online which is directly made from browsers like Google Chrome, Mozilla Firefox or Internet Explorer. To display files that have

been created on ArcGIS Desktop, the file must be changed in ZIP format first. In the development an online map using ArcGIS Online, the steps that users must take are to log in to the arcgis.com website through a browser. After that, go to the content page in your ArcGIS Online account and create a new folder and upload the geodatabase file in ZIP format and select the content with the Geodatabase File because the uploaded file is a geodatabase file.

After the geodatabase file upload process is complete, the overview automatically opens in ArcGIS Online to see the results of the uploaded data. Geodatabase files that have been uploaded are then processed by a symbology or visualization process by entering the visualization menu after which the symbology can be done as desired. The visualization menu display which are shown in Figure 2.
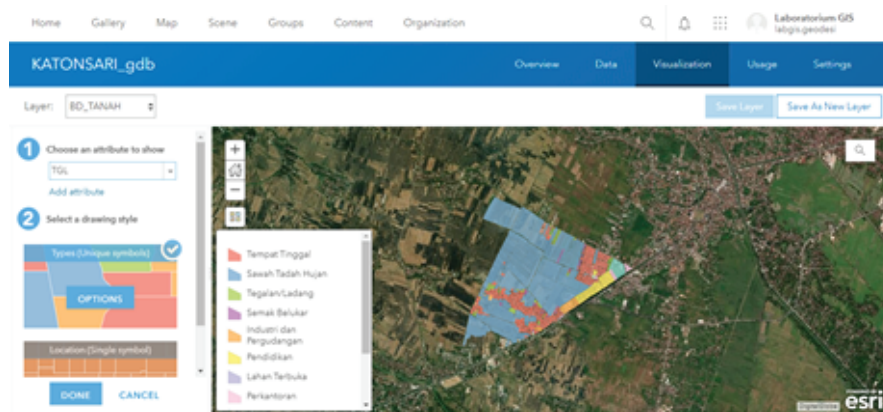

Figure 2: Symbology Process.

After the symbology process is completed, the next step is to open the uploaded data in the Open in Map Viewer menu in the overview menu, which are shown in Figure 3.
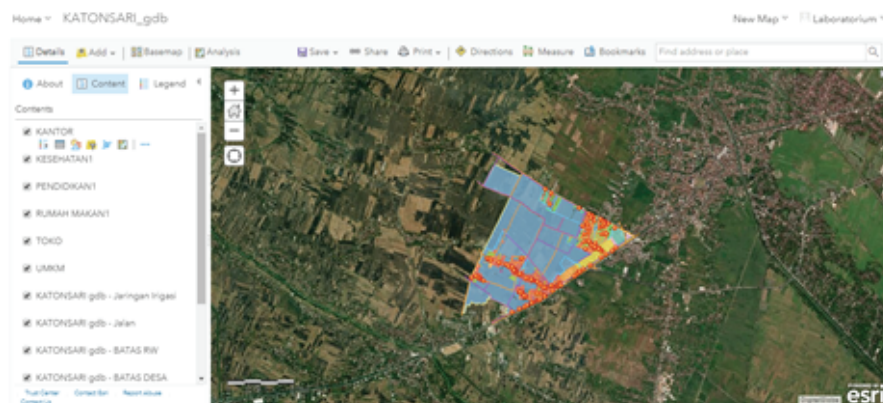

Figure 3: Display Map Viewer.

In the Map Viewer view, you can set the legend, label, edit the base map display and other options. After the editing process is complete, the map results can be saved in the form of a web map. The next step the map is saved then the next process is making a web application by selecting Create Web App Using the Web App Builder because with this menu to create a map application, various features are provided as needed. Then the theme, widget, and attribute settings are made in the web app builder according to the desired appearance as which are shown in Figure 4.
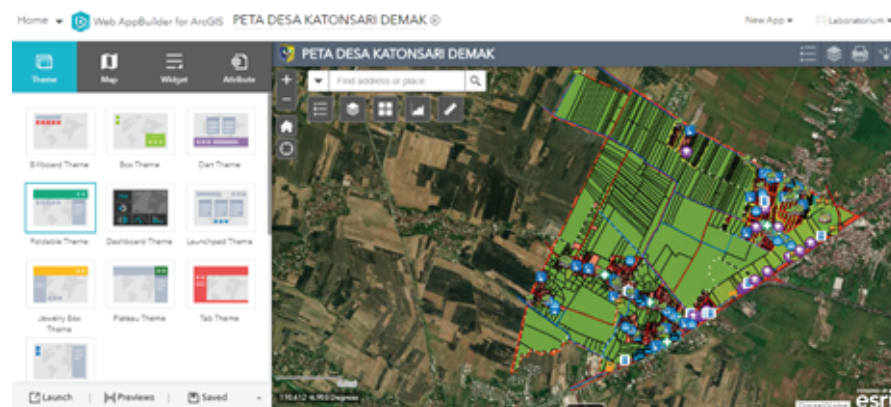

Figure 4: Setting the map application display.

After setting the map application display is complete, the next stage of the map can be saved then copy the URL provided and can be combined on the website to be created. As the making of WebGIS is completed, the next step is to create a Village Website. This website is created using web development platforms namely php and html. Katonsari Village map application that has been made will then be embedded into a website created using the.com domain. Site map from the Katonsari Village website page can be accessed at the address http://katonsaridemak.com.

2.5. Application Testing

### 2.5.1. Testing Application with a Desktop Personal Computer

Map application testing is done using a desktop personal computer or laptop device in the form of testing the function of the buttons provided on the map application. The Katonsari Village website is opened using a browser on a laptop or a desktop personal computer. Display map if opened with a Desktop Personal Computer which are shown in Figure 5.

Figure 5: Map application display if opened using a desktop PC.

2.5.2. Application Testing with an Android_Based Smartphone

Testing is done by opening the Katonsari Village website through a browser on an android-based smartphone. The initial appearance of the map application is opened with the smartphone which are shown in Figure 6.
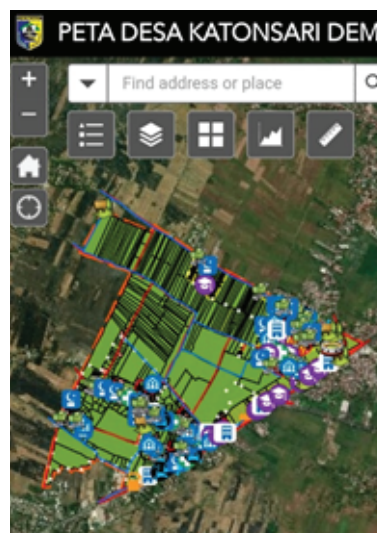
Figure 6: The initial appearance of the map application is opened with the smartphone.

3. Results and Discussion

3.1. UAV Aerial Photography

This study produced aerial photographs with a total of 3,368 photos obtained from 17 flights. The number of photos produced at the time of data acquisition is influenced by

parameters when planning the flight path, namely altitude, side overlap, front overlap. The higher the altitude, the fewer photos are produced and also the greater the side overlap and front overlap, the more photos are produced. In general, the results of aerial photographs are quite clear because the weather when shooting is very good and there are no clouds.

3.2. Development a Village Information System

Based on the activities carried out, a WebGIS-based Katonsari Village Information System was built. The results of the study are in accordance with the methodology and achievements of the planned activities. The output produced in this activity is the establishment of the Village Information System which is realized in the WebGIS Katonsari Village which can be accessed via the internet with the page http://katonsaridemak.com.

Katonsari Village Online Map presents village information into 9 (nine) layers, namely: Toponimy Layer, Road Layer, River Layer, Village Boundary Layer, Citizen Association (RW) Boundary Layer, Neighborhood Association (RT) Boundary Layer, Population Parcel Layer, Land Layer and Land Use Layer

From the nine layers that have been built, visualization of the conditions and potential of Katonsari Village which are shown in in this online map. Furthermore, this information becomes public information for the people of Katonsari Village so that what is needed can be sought from the nine layers.

3.3. Website Katonsari Village Results

Based on the research activities, outputs have also been carried out as well as socialization, training and promotion to Katonsari villagers represented by village officials, Neighborhood Association (RT) and Citizen Association (RW) representatives so that the village information system becomes a spatial information media for village activities and village profiles in an online map formed. From the socialization and discussion with Katonsari villagers in general they understood the importance of the Village Information System. In addition, the community also requested that the Research Team be able to assist the Katonsari Village community at any time needed so that the utilization of the Village Information System was truly optimal

4. Conclusion

Based on the research conducted, the following conclusions are the following:

1. To support the making of an online map of Katonsari Village, Demak Regency can be done by using aerial photographs of UAV photographs. The geometry research results of rectification are good enough to make a 1: 1,000 scale Village Map.

2. Village maps obtained using UAV aerial photographic data can be used to create the Katonsari Village Information System in Demak Regency.

Funding

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