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Participatory mapping and unmanned aerial vehicle (UAV) images for developing village level coastal geoinformation

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Abstract: Village maps can provide geospatial data and information that would enable them to become an important instrument in regional development planning. The purpose of this study was to produce geospatial data and information on coastal village resources based on the Indonesian Geographic Information Agency (BIG) reference guidelines. The study was conducted in Langnga Village, Mattiro Sompe District, Pinrang Regency, South Sulawesi Province, Indonesia. This research used raster and vector data. Raster data consisted of high-resolution images obtained from Unmanned Areal Vehicles. The ground truthing used open access applications and interviews with the community. The licensed Arc.GIS 10.5 software was used for the spatial analysis. The dominant land cover/land use categories were aquaculture ponds and rice fields. These areas have historically undergone a dynamic change of land use from rice fields to ponds and back again. Other land uses were settlements inhabited by farmers and fishermen. White sand beaches are one potential resource in this villages, but they are prone to abrasion. The spatial information contained in the village resource and boundary map can be considered as a breakthrough step and could become a pilot for other villages to follow.

1. Introduction

Remote sensing technology has been used in many fields, including the mapping of coastal resources, particularly in Indonesia. Nowadays, the availability of very high-resolution images which are recorded using dynamic remotely operated navigation equipment (drones) or unmanned aerial vehicles (UAVs) has provided a new perspective for more detailed information. Several studies have been conducted using UAVs with different spatial resolution and other specifications [1–3].

Various types of satellite have been developed to date and the data they produce are often used for the exploration of natural resource through remote sensing technologies. These data include Landsat, ASTER, SPOT, ALOS, GeoEye, Pleiades, IKONOS, Quickbird, Worldview, and Sentinel-2 imagery. Landsat and Sentinel 2a satellite images are currently among the satellite images that are most often selected to explore earth surface information. One reason for this preference is the convenient

IOP Conf. Series: Earth and Environmental Science **370** (2019) 012003 doi:10.1088/1755-1315/370/1/012003

acquisition of image data, as both are open source, despite the limitation inherent in their relatively low spatial resolutions.

Several previous studies have focused on the use of remote sensing technology for the provision of spatial information on coastal areas and small islands [2,4–6]. The main use of UAV technology in coastal areas and small islands has been to map and monitor coastal environments. The use of satellite image and UAV data could be applied as an alternative for providing spatial data more effectively and efficiently.

In this study, the mapping of coastal resources was carried out in Langnga village, in Mattiro Sompe District, Pinrang Regency, South Sulawesi Province, Indonesia. The maps of coastal resources and village boundaries are an illustration of the earth's surface presented in a flat plane. They contain village-related information in the form of basic and thematic geospatial information. The basic geospatial information regarding the land area is in the form of coastlines, hypsography, inland and coastal waters, topographical names, boundaries, transportation and utilities, buildings and public facilities, and land use. Geospatial data and information are needed to accelerate the development of Langnga village. This research aimed to mobilize community participation at sub-district/district level in mapping the geospatial-based resources and boundaries of Langnga Sub-district. The production of maps showing the sub-district boundaries and the resources within the area was intended to support efficient and effective decision-making processes at the district, provincial and national levels. Very few villages in the province of South Sulawesi have geospatial information showing the conditions and potential resources within their boundaries. It is expected that this participatory approach will become a reference for other villages.

2. Material and Methods

2.1. *Study area*

This research was conducted from April to June 2019 in three stages: pre-image processing stage, field data retrieval, and data processing. Field data collection was carried out during May and June 2019 in Langnga village, Mattiro Sompe District, Pinrang Regency, South Sulawesi, Indonesia.

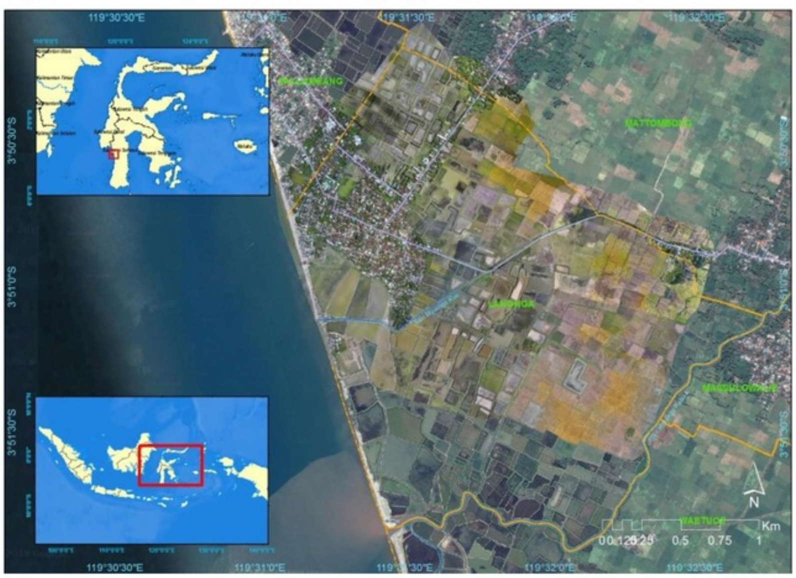

Figure 1. Map of the research location in Langnga village, Mattiro Sompe District, Pinrang Regency, South Sulawesi, Indonesia (*Source: field data from UAV, 2019*)

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2.2. *Data collection*

The data collected during this study consisted of primary data and secondary data. Primary data were collected directly in the field at the time of research, while the secondary data used were the Sub-district/ District administrative data obtained from the 2017 RBI KSP Map of Mattiro Sompe District, Pinrang Regency.

The digital data used in this study were high resolution unmanned aerial vehicle (UAV) images from DJI Phantom 3 Advanced and DJI Phantom 4 UAVs (Table 1). The data were recorded during May and June 2019. The tools used for data processing were a set of computers with licensed ArcGis 10.5 software.

Table 1. Specification of UAV DJI Phantom 3 Advanced and DJI Phantom 4.

Characteristic	**Details**
UAV DJI Phantom 3 Advanced	
Weight	1280 g
Max. Speed	16 m/s (ATTI *mode, no wind*)
Max. Service Ceiling Above Sea Level	6000 m (*Default altitude limit*: 120 m *above take-off point*)
Max. Flight time	*approximately*23 *minutes*
GPS Mode	GPS/GLONASS

Characteristic	**Details**
Sensor	*Sony* EXMOR 1/2.3 ” *Effective pixels:* 12.4 M (*total pixels*: 12.76 M), *Sensor width* 6.16 mm, *Sensor height* 4.62 mm
Lens	FOV 94° 20 mm (35 mm *format equivalent*) f/2.8 (*Focal lenght*3.61mm)
Image Max. Size (width x height)	4000 x 3000
Pixel size	1.56 x 1.56 *micro meter*
Supported File Formats	*Photo*: JPEG, DNG; *Video*: MP4, MOV
DJI Phantom 4	
Weight	1380 gram
Max. Speed	20 m/s
Max. Flight time	± 28 minutes
GPS Mode	GPS/GLONASS
Sensor	1 / 2.3” CMOS, *Effective pixels: 12.4 M*
Lens	FOV 94° 20 mm *(35 mm format equivalent) f/2.8 focus at* ∞
Image Max. Size (width x height)	4000 x 3000 pixels
Supported File Formats	*Photo*: JPEG, DNG; *Video*: MP4, MOV

The design of flight paths (flyways) determines the success of aerial photography, both in terms of flight quality and safety. This is because the process of designing flyways is closely integrated with the capacity of the tools and the characteristics of the photographed area. Flyways were designed using Mission Planner software, which refers to the input criteria provided in the form of flight height, flight speed, the overlap between photos, and the number and height of the flying lanes that are covered (Figure 2). Field surveys were conducted to obtain data on facilities and infrastructure and plotted using coordinates obtained using a handheld GPS unit.

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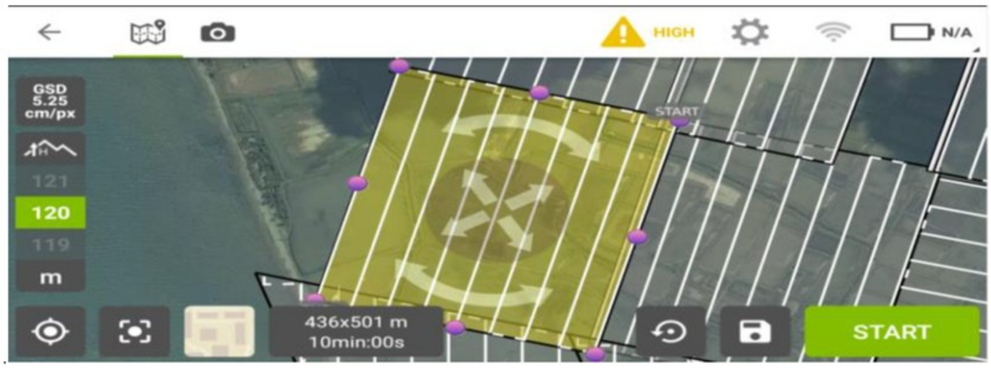

Figure 2. The display of the Pix4D capture application that shows the flight path number, flight height, area covered and approximate duration of aerial photography shooting

2.3. *Participatory Village Mapping*

Participatory mapping was done by gathering key informants who understand the boundaries of the area, such as the village head, and the heads of the neighbouring villages (Pallameang and Mattombong). Village boundaries were determined using a printed map (A0 size). The respondents marked the boundaries of their respective villages directly and these were then agreed upon together. A regional boundary database was obtained through drawing boundaries on the image by the respondents, while the toponymy database was developed through interviews. In addition, the designation of village boundaries was also carried out using a digital map (Figure 3).

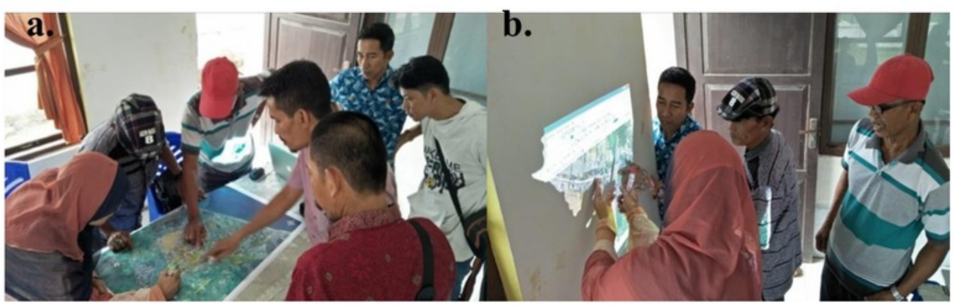

Figure 3. These photographs show the process of determining the boundaries between Langnga village and the surrounding villages. Determination of village boundaries was attended by village heads, community leaders, and village government officials and facilitated by a team of spatial experts, a) using printed maps, b) using digital maps - processed images from an unmanned aerial vehicle (UAV).

2.4. *Processing of Unmanned Aerial Vehicle (UAV) Images*

The UAV images used were aerial photographs in digital form with high spatial resolution of around 5.25 cm taken from a height of around 120 m. The amount of overlap between photos was determined as 80%. The Android and IOS based Pix4D Capture application was used to estimate the number of photographs and flight duration.

Aerial photographs acquired using UAVs at the study location were processed to produce an orthomosaic, i.e. combined using the Pix4D mapper software to produce a single orthophoto or georeferenced UAV image with geographic information. The resulting UAV image was used in the image classification process for the coastal area of Langnga Sub-district.

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Image processing was carried out using ArcGis10.5 software. The coordinate system used for geometric correction was Universal Transverse Mercator (UTM), zone 50 South (South UTM 1984). Image processing in the form of visual interpretation was done through on-screen digitizing. The sub-district map database contains data of transportation networks, hydrographic networks, land use and land cover, facilities and infrastructure, and boundaries and toponymy. The six databases were produced using different methods, including aerial photo data extraction, field surveys, and participatory mapping. The elements of the resulting sub-district map database were then presented through map symbolizing and layout processes. Both processes were carried out with reference to the guidelines regarding symbol and layout specifications in regulation Perka BIG No. 3 on Village Mapping.

3. Results and Discussion

3.1. *Orthomosaic*

Aerial photography of Langnga village produced a total of 4,325 images. Extracts from the orthomosaic produced by this study are presented in Figure 4. The orthophoto images acquired using the DJI Phantom 3 and 4 produced a very high GSD (image spatial resolution) of 5.25 cm2/pixel. Other research also shows orthophoto images can have very high spatial resolution. GDS values of 2.6 cm2 and 0.78 cm2 were acquired at 80 m and 30 m respectively by [7] while a spatial resolution of 1.1 cm2 with acquisition at 69 m was produced by [8]. The high spatial resolution generated from orthophoto images using UAV is intrinsically related to the flying height and specifications of the UAV sensor being used.

Figure 4. Extracts from the UAV orthomosaic imagery of Langnga village

3.2. *Geoinformation*

The orthomosaics were geometrically corrected based on the 2017 One Map Policy (KSP) from the Geospatial Information Agency (BIG). The resulting maps were then compressed and exported into *ecw* format using image processing software to reduce the file size.

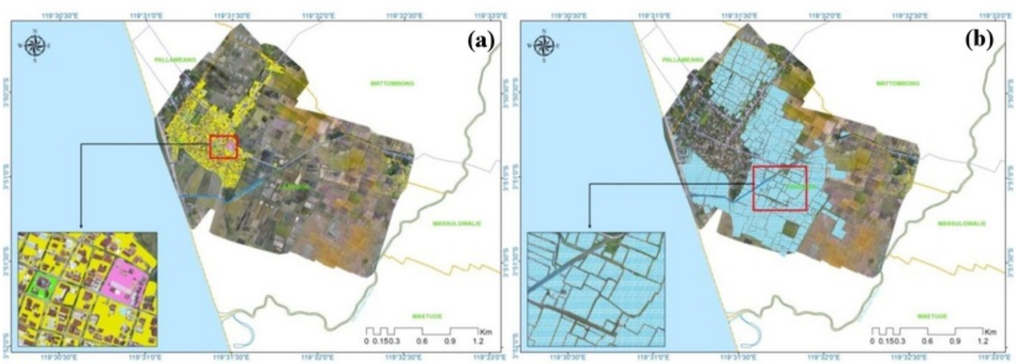
UAV data with a high spatial resolution make it easier to interpret land use from various basic elements of interpretation. Re-digitizing was necessary to border the area by revising the boundaries of Langnga village, Mattiro Sompe District, Pinrang Regency. Based on a comparison between the data obtained from this study and the village boundary data from BIG, the village boundaries have changed. The area of Langnga village in the BIG administrative database is 540.68 hectares, while the results of participatory mapping resulted in an area of 585.95 ha, a difference of 45.27 ha.

A classification of land use in Langnga village using 6 classes is presented in Table 4. This classification is based on visual interpretation using key interpretive elements based on a knowledge of field conditions.

Table 2. The extent of six land use categories in Langnga village based on visual interpretation

No	Class	Area (Ha)
1	Aquaculture	148.088
2	Rice field	120.151
3	Settlement	18.327
4	Road network	7.897
5	House yard	31.502
6	Public and social facilities	2.86

The maps of potential resources in Langnga village comprised areas used for aquaculture, rice fields, settlements, road networks, house yard, public and social facilities (Figure 5). The rice fields polygons in Figure 5 were characterized by the shapes formed by the embankment (barrier), forming regular rectangular patterns with smaller unit areas than for the ponds, and a pale or brown colour (rice fields which are ready to be planted), along with smooth texture. The appearance of the settlement layer shown in Figure 5 is characterized by dense groups of buildings in the village. There is a pattern of connecting roads between settlement groups. The visible hue was brownish. These areas have historically undergone a dynamic change of land use from rice fields to ponds and back again. Other land uses were settlements inhabited by farmers and fishermen. White sand beaches are one potential resource in this villages, but they are prone to abrasion.



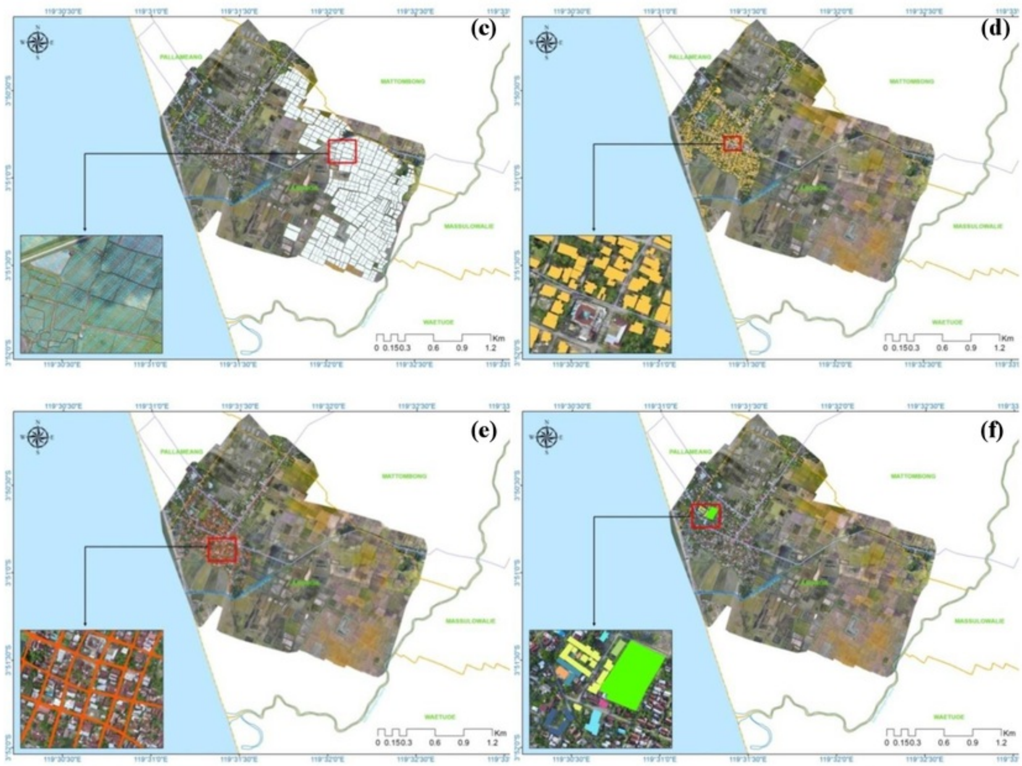


Figure 5. Langnga village resource maps: (a) House yard, (b) Aquaculture, (c) Rice field, (d) Settlement, (e) Public and social facilities, and (f) Road network.

The results show that mapping using UAVs can be used as an alternative village map-making method with good geometric accuracy. The maps produced can comply with the standards set in regulation Perka BIG No. 3 of 2016 on Technical Specifications for Village Map Presentation. This method also has advantages related to flexibility and can provide higher quality data than the high-resolution satellite imagery.

4. Conclusion

UAV / Drone technology can be used as an alternative method of providing images with a very high spatial resolution to map village potential and boundaries with high accuracy. The use of UAV or drone technology in this study has proved the ability to produce images with a very high spatial resolution (5.25 cm^2/pixel). UAV data retrieval is influenced by both natural and technical factors, such as weather factors, topography, overlap, flight speed, and flying height. The land cover classification for Langnga village using UAVs comprised 6 classes (aquaculture, rice fields, settlements, road networks, house yard, public and social facilities). Such maps of village boundaries and resources could be used as a basis for spatial planning, for example identifying suitable spaces for planting fruits, vegetables and herbs.

References

[1] Kachamba D J, Ørka H O, Gobakken T, Eid T and Mwase W 2016 Biomass estimation using 3D data from unmanned aerial vehicle imagery in a tropical woodland *Remote Sens.* **8** 1–18
[2] Anggoro A, Siregar V P and Agus S B 2018 Multiscale Classification for Geomorphic Zone and

Benthic Habitats Mapping Using Obia Method in Pari Island *J. Penginderaan Jauh dan Pengolah. Data Citra Digit.* **14** 89–93

[3] Waite C E, van der Heijden G M F, Field R and Boyd D S 2019 A view from above: Unmanned aerial vehicles (UAVs) provide a new tool for assessing liana infestation in tropical forest canopies *J. Appl. Ecol.* **56** 902–12

[4] Nurdin N, Komatsu T, Agus, Akbar AS M, Djalil A R and Amri K 2015 Multisensor and multitemporal data from Landsat images to detect damage to coral reefs, small islands in the Spermonde archipelago, Indonesia *Ocean Sci. J.* **50** 317–25

[5] Nurdin N, Amri K, Djalil A R, Jaya I, Aris A and Akbar M A S 2014 Geospatial dynamic of seagrass in outer zone, Spermonde Archipelago, Indonesia using Landsat data from 1972-2013 *Ocean Remote Sensing and Monitoring from Space. Proceedings of SPIE* vol 92610N-1, ed R J Frouin, D Pan, H Murakami and Y B Son (The International Society for Optical Engineering) pp 1–13

[6] Siregar V P, Wouthuyzen S, Sunuddin A, Anggoro A and Mustika A 2013 Shallow water habitat mapping and reef fish stock estimation using high resolution satellite data *J. Ilmu dan Teknol. Kelaut. Trop.* **5** 453–64

[7] Casella E, Rovere A, Pedroncini A, Mucerino L, Casella M, Cusati L A, Vacchi M, Ferrari M and Firpo M 2014 Study of wave runup using numerical models and low-altitude aerial photogrammetry: A tool for coastal management *Estuar. Coast. Shelf Sci.* **149** 160–7

[8] Caprioli M, Trizzino R, Pagliarulo R, Scarano M, Mazzone F and Scognamiglio A 2015 Management of Environmental Risks in Coastal Areas *ISPRS - Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **XL-3/W3** 263–8

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