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REVIEW OF THE USE OF DRONES AND NON-METRIC CAMERAS FOR THE PROVISION OF LARGE-SCALE GEOSPATIAL DATA ACCORDING TO BIG REGULATION NO. 1 OF 2020

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ABSTRACT
Currently, the need for large-scale mapping for the entire territory of Indonesia is urgent. Therefore, accelerating the provision of large-scale Geospatial Data (DG) is essential for better spatial planning and regional development. The use of drone technology with non-metric cameras is starting to be used for the provision of large-scale DG. To regulate the use of drones and non-metric cameras, the Geospatial Information Agency issued the Head of Geospatial Information Agency Regulation No. 1 of 2020. The purpose of this paper will review the use of drones with non-metric cameras that have been regulated in the agency's regulations. The method used in this paper uses qualitative research with a data collection strategy or source using the literature method. The results show that the use of direct georeferencing in BIG Regulation No. 1 of 2020 has fulfilled the horizontal and vertical geometry accuracy requirements stipulated in BIG Head Regulation No. 6 of 2018 on Base Map Accuracy. The GSD value requirement in BIG Regulation No 1/2020 is too high compared to the GSD value requirement specified in the ASPRS Accuracy Standards for Digital Geospatial Data. This agency regulation is a standard / reference that must be met for all mapping industry players. Therefore, the implementation of this agency regulation requires further study to truly support the issue of accelerating large-scale mapping.
Keywords: *Drones, Non Metric Camera, Geospatial Data*

INTRODUCTION

The utilization of aerial photography technology with non-metric cameras carried by unmanned aircraft or drones is growing very rapidly. However, non-metric cameras are actually not intended for mapping activities due to the large value of camera distortion. In contrast, metric cameras have information related to camera calibration (Kolbl, 1976). On the one hand, the use of drones and non-metric cameras can produce a more detailed view of the earth's surface with very good resolution (Syetiawan & Gularso, 2020). In addition, drones also provide technology that is much cheaper than terrestrial measurements or using other aircraft (Chao et al., 2010).

Currently, the need for large-scale mapping for the entire territory of Indonesia is urgent. Therefore, accelerating the provision of large-scale Geospatial Data (DG) is essential for better spatial planning and regional development. The use of drone technology with non-metric cameras is starting to be used for the provision of large-scale DG (Darwin et al., 2014). In addition, drone technology is widely used for activities related to spatial planning (Arifati et al., 2017), plantations (Syetiawan & Haidar, 2019), cadastral mapping (Junarto et al., 2020), and regional administrative boundary mapping (Suciani & Rahmadi, 2019).

Non-metric cameras and drone vehicles on the market are of various types and price variations. On the other hand, the government encourages to produce Geospatial Data that has the same reference and standards. To regulate the use of drones and non-metric cameras, the Geospatial Information Agency issued Geospatial Information Agency Head Regulation No. 1 of 2020. This Geospatial Information Agency Regulation No. 1 of 2020 regulates the basic Geospatial Data collection standards for making large-scale base maps using drones and non-metric cameras. The availability of a base map is very important because it is used as a reference in making thematic maps.

Unfortunately, the available Geospatial Data is still limited. Therefore, the policy issued by the government is needed to provide guidelines to geospatial industry players and the government in providing Geospatial Data. The policy issued can be a momentum for accelerated activities so that space utilization and land use for regional and infrastructure development can be carried out properly. This agency regulation has been running for one year since it was issued, so it requires a study to see the effectiveness of the regulation. The purpose of this paper will review the utilization of drones with non-metric cameras to produce Geospatial Data that has been regulated in the agency's regulations.

RESEARCH METHODS

The method used in this research uses qualitative research with data collection strategies or sources using the literature method. This literature method is a method of collecting library data, or research whose research object is explored through various library information. The literature information explored in this paper is to produce a comprehensive understanding of the content of the agency's regulation on the provision of large-scale DG using drones with non-metric cameras. This paper will review the spatial policy that has been legalized by the authorized institution/body, in this case the Geospatial Information Agency. The spatial policy becomes mandatory as the basis for the implementation of large-scale DG provision carried out by mapping industry players. Therefore, it is necessary to review the spatial policy in the literature method. There are several things discussed in this research, related to the use of non-metric cameras and GNSS antennas carefully. The hope is that the Geospatial Data produced can provide a picture that is close to the truth with the appearance of objects on earth.

RESULTS AND DISCUSSION

Mapping History

Topographic map making in the past used conventional instruments such as leveling, stadia, and chains. With the development of the times, topographic map making now utilizes satellite and laser technology such as Global Navigation Satellite (GPS), Terrestrial Laser Scanner (TLS), and Electronic Distance Measurement (EDM). To produce reliable Geospatial Data, topographic maps require a high level of accuracy. For this reason, topographic mapping quality control consists of horizontal elements and vertical elements. Horizontal elements refer to the horizontal position of fixed control points, while vertical elements are related to the elevation of the pillars. To produce topographic maps with high accuracy, angular measurements must be made using a theodolite, then horizontal distances are measured using an electronic distance measuring device, and elevations are measured by differential leveling. Topographic

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mapping is suitable for relatively small areas and produces a high degree of accuracy, but is not practical for large areas. Therefore, topographic mapping using aerial photography technology emerged.

Topographic maps created with aerial photographs utilize the principle of visual stereoscopic. Visual stereoscopic refers to the visualization of topographic relief by using images taken at different perspectives. For topographic mapping, stereoscopic is a tool that uses separate perspectives taken by two cameras to create a three-dimensional space. Topographic mapping using stereo aerial photographs requires at least four steps, namely: first, the photos are acquired with at least 50% end lap along the flight line; second, find the control points on the ground (their locations are visible in the photos and on the ground); third, calculate and recreate the control points in stereoplotting; fourth, determine the geometry of the aircraft conditions(tilt, row, and yaw). Topographic mapping using aerial photography requires high costs, so topographic mapping using drones emerged (Smith, 2206). Drone systems have advantages in several mapping applications. This is seen compared to conventional aerial surveys that offer accurate maps, but are very expensive and have limited endurance for only a few hours. Drone systems can be flown on either high or low platforms. Low-altitude systems have advantages in conducting photogrammetric surveys in cloudy weather, providing different views and oblique images of the surveyed objects, providing low cost and easy maintenance for engineering application systems such as topographic mapping, both large and small scale (Darwin et al., 2014).

Drone Specifications Using Non Metric Camera for Large Scale Mapping

Direct Georeferencing

Drone technology produces very good spatial resolution and makes it easy to identify objects. Unfortunately, the use of drone technology requires positional accuracy so that a Ground Control Point (GCP) is needed as a georeferencing process on each photo. To make the orthopoto results more accurate, the number of ground control points required is at least three GCPs for each photo (Oniga et al., 2018). The use of GCPs must be as efficient as possible, as it is related to the cost and time of Geospatial Data collection. Therefore, an alternative technology is needed using Direct Georeferencing technique. Direct Georeferencing on drones is an aerial photo restitution technique by reducing the use of GCPs. In this direct georeferencing technology, the drone carries a thorough GNSS antenna. Therefore, each pixel can be geo-referenced to the earth's coordinate system without the need for ground information (Rabah et al., 2018).

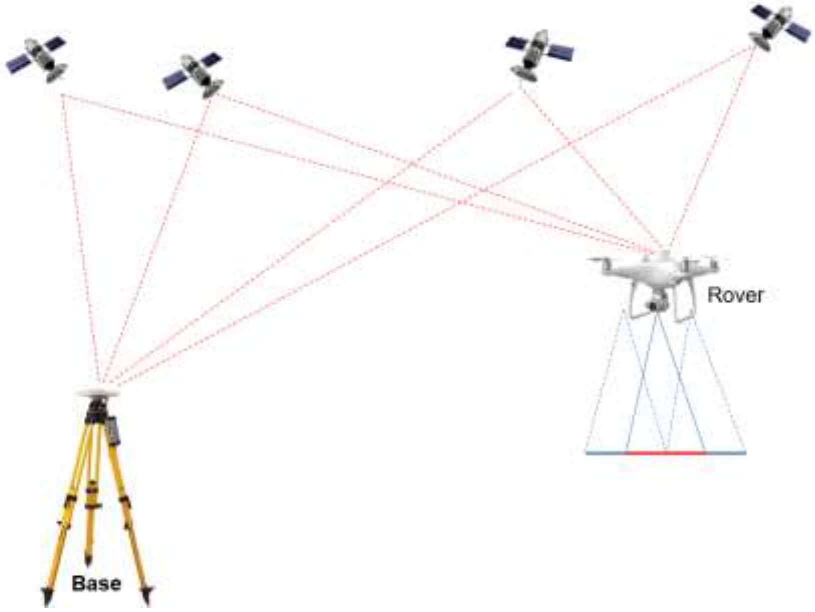

Figure 1. Illustration of the Direct Georeferencing Technique

The Direct Georeferencing method reduces the use of GCPs while maintaining the accuracy of DG results. The Direct Georeferencing technique on drones produces high accuracy maps for relatively small mapping areas (Syetiawan & Gularso, 2020). A study has compared the accuracy resulting from drones with direct georeferencing and drones with GCP. The results show that direct georeferencing with drones can achieve horizontal accuracy comparable to that obtained using GCPs (Hugenholtz et al., 2016). This may indicate that the use of direct georeferencing can cut down time in the provision of large-scale DGs and produce large-scale DGs with high precision. The use of direct georeferencing in BIG Regulation No. 1 of 2020 has met the horizontal geometry accuracy at a scale of 1:1,000 class 1, and vertical accuracy at a scale of 1:5,000 class 1 that has been regulated in BIG Head Regulation No. 6 of 2018 concerning Base Map Accuracy (Syetiawan & Gularso, 2020). However, mapping using drones needs to be considered, among others, related to the sensors used, the size of the area to be photographed, land cover conditions and terrain because the study area is in a small place, urban and flatland.

Ground Sampling Distance

Ground Sampling Distance (GSD) is the pixel size value of an aerial camera that has been projected on the ground. GSD is very closely related to the camera used. In Agency Regulation No. 1 of 2020, it is stated that the GSD value generated from drones using non-metric cameras is ≤ 3 cm for a scale of 1:1,000 while the standard determined by ASPRS 2014 (can be seen in table 1) GSD value is 12.5 to 25 cm for a scale of 1:1,000 (Whitehead & Hugenholtz, 2015). According to Rokhmana (2015) said that the quality of the horizontal position of aerial photographs from drones is usually capable of being in the range of 2 x Ground Square Distance (GSD), while vertical accuracy is usually in the range of 3 x GSD or in the range of 0.5 - 2.5 meters. So, when viewed from the 2014 ASPRS standard and Rokhman (2015), the GSD value requirement in Agency Regulation No. 1 of 2020 is too high, which has an impact on the specifications of non-metric cameras used to perform large-scale mapping on drones.

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Tabel 1.
ASPRS *Accuracy Standards for Large-Scale Maps* Tahun 2014

ASPRS 2014				***Equivalent to map scale in***		***Equivalent to map scale in NMAS***
Horizontal Accuracy Class RMSEx and RMSEy (cm)	***RMSEr (cm)***	***Horizontal Accuracy at the 95% Confidence Level (cm)***	***Approximate GSD of Source Imagery (cm)***	***ASPRS 1990 Class 1***	***ASPRS 1990 Class 2***	
0.63	0.9	1.5	0.31 to 0.63	1:25	1:12.5	1:16
1.25	1.8	3.1	0.63 to 1.25	1:50	1:25	1:32
2.5	3.5	6.1	1.25 to 2.5	1:100	1:50	1:63
5.0	7.1	12.2	2.5 to 5.0	1:200	1:100	1:127
7.5	10.6	18.4	3.8 to 7.5	1:300	1:150	1:190
10.0	14.1	24.5	5.0 to 10.0	1:400	1:200	1:253
12.5	17.7	30.6	6.3 to12.5	1:500	1:250	1:317
15.0	21.2	36.7	7.5 to 15.0	1:600	1:300	1:380
17.5	24.7	42.8	8.8 to 17.5	1:700	1:350	1:444
20.0	28.3	49.0	10.0 to 20.0	1:800	1:400	1:507
22.5	31.8	55.1	11.3 to 22.5	1:900	1:450	1:570
25.0	35.4	61.2	12.5 to 25.0	1:1000	1:500	1:634
27.5	38.9	67.3	13.8 to 27.5	1:1100	1:550	1:697
30.0	42.4	73.4	15.0 to 30.0	1:1200	1:600	1:760
45.0	63.6	110.1	22.5 to 45.0	1:1800	1:900	1:1,141
60.0	84.9	146.9	30.0 to 60.0	1:2400	1:1200	1:1,521
75.0	106.1	183.6	37.5 to 75.0	1:3000	1:1500	1:1,901
100.0	141.4	244.8	50.0 to 100.0	1:4000	1:2000	1:2,535
150.0	212.1	367.2	75.0 to 150.0	1:6000	1:3000	1:3,802
200.0	282.8	489.5	100.0 to 200.0	1:8,000	1:4000	1:5,069
250.0	353.6	611.9	125.0 to 250.0	1:10,000	1:5000	1:6,337
300.0	424.3	734.3	150.0 to 300.0	1:12,000	1:6000	1:7,604
500.0	707.1	1223.9	250.0 to 500.0	1:20,000	1:10000	1:21,122
1000.0	1414.2	2447.7	500.0 to 1000.0	1:40000	1:20000	1:42,244

Geospatial Data Accuracy

The class system for base map accuracy in Indonesia refers to the ASPRS *Accuracy Standards for Large-Scale Maps* in 1990. The document states that map accuracy can be defined at a lower spatial accuracy, which is twice that of class 1 (for class 2), three times that of class 1 (class 3), and so on. The distinction of each class is also outlined in the *Draft for Review of ASPRS Accuracy Standards for Digital Geospatial Data* released in 2013 to adapt the latest mapping technology, stating that class 1 is recommended for high accuracy surveys such as *engineering* purposes, class 2 for high accuracy mapping standards, and class 3 for low accuracy visualization. This means that although a class system is used, the use of maps for each class is clearly regulated. However, in the latest ASPRS document, ASPRS *Positional Accuracy Standards for Digital Geospatial Data*, the class system is no longer used. ASPRS states that the class system is no longer relevant to current technology. This means that Agency Regulation No. 1 of 2020 using the class system also needs to be considered in reference to the changes in standards issued by ASPRS. The adjustment can be in the form of eliminating the class system so that the map accuracy is absolute for each scale. In addition, it can also maintain the class system by including limitations on the use of each class as stated in the 2014 ASPRS *draft for review*.

Table 2.
Research Results on Non-Metric Drone and Camera Technology

No	**Research Results**	*Horizontal Accuracy*	*Achievable Map Scale*	*Source*
1	The test was conducted using a DJI Phantom 3 Professional. Furthermore, it was processed using dronedeploy and Agisoft on two different topographic areas. The ICP points used totaled 5 points.	15 - 30 cm	1:1,000 Class 1	Adi et al. (2017)
2	Aerial photo measurements using Mavic Pro 2 on an area of 35 ha with a spatial resolution of 4.4 cm/pixel. The ICP points used totaled 12 points	5 cm	1:1,000 Class 1	Prayogo et al. (2020)
3	The use of a canon powershoot A2500 compact camera resulted in a mapped area of 85 ha with a GSD value of 10 cm.	65 - 97 cm	1: 1.000 Class 3	Meiarti et al. (2019)
4	The use of a sony a 6000 camera resulted in a GSD of 7.83 cm/px with an area coverage of 8.46 km2. The ICP points used totaled 13 points	165 cm	1: 5.000 Class 2	Mustofa & Widartono, (2019)
5	The use of DJI Phantom 4 Pro to map the mining area with a GSD of 14 cm. The ICP points used totaled 15 points	33 cm	1: 1.000 Kelas 2	Fitriawan et al. (2020)

Table 2 shows several studies related to the use of drones and non-metric cameras that produce a wide range of horizontal accuracy. Meanwhile, to produce horizontal accuracy as in Table 2, the GSD value of the non-metric camera is required. Mentioned in Agency Regulation No. 1 of 2020 to produce a map with a scale of 1:1,000 requires a GSD value of ≤ 3cm and a map with a scale of 1:5,000 requires a GSD value of ≤ 10cm. However, in the research reviewed in Table 2, the GSD value used is more than that required by the agency regulation but still produces relatively good horizontal accuracy in accordance with BIG Head Regulation No. 6/2018 on Base Map Accuracy. Regarding the specifications of the non-metric camera, the regulation requires a camera with a fixed lens. Whereas in table 2, there is research using canon powershoot A2500, sony a 6000, and DJI Phantom 4 Pro which are cameras with non-fixed lenses. However, cameras with a changing focus (non-fixed) can produce accurate DG. Thus, the requirements for GSD values and non-metric camera specifications stipulated in Agency Regulation No. 1/2020 are too high. As a result, many mappers may not be able to fulfill the requirements according to the regulation.

Large-scale DG provision using drones with non-metric cameras can shorten the time compared to terrestrial methods (Thomas et al., 2020). Drone technology with non-metric cameras supported by photogrammetric processing software makes it faster and more flexible to obtain high resolution digital and optical images. It can support the application of large-scale mapping (Zongjian, 2008). The use of direct referencing on drones can reduce the use of GCPs but still produce DG with high precision and relatively shorter time required. The use of Direct Georeferencing is suitable in conditions where it is not possible to measure GCPs (Syetiawan & Gularso, 2020).

CONCLUSION

Agency Regulation No. 1 of 2020 concerning Basic Geospatial Data Collection Standards can answer the issue of accelerating large-scale mapping, especially in this case drones using non-metric cameras. The provision of large-scale DG using drone technology with non-metric cameras requires a relatively shorter time than the terrestrial method. Regarding the GSD value requirement stipulated in the agency's regulation, the specifications are too high. This causes the use of non-metric cameras to have a high resolution so that the costs incurred are also relatively expensive. In addition, non-metric cameras with changing focus(non-fixed) are capable of producing precise DG. Meanwhile, the regulatory body specifies that non-metric cameras must have fixed lenses. The GSD value requirements and non-metric camera specifications can make obstacles for geospatial industry players to carry out mapping using drones with non-metric cameras. Because not all mapping industry players can meet these requirements. For this reason, Agency Regulation No. 1 of 2020 should not regulate each stage but only regulate the output results through accuracy tests. This agency regulation is a standard / reference that must be met for all mapping industry players. Therefore, the implementation of this agency regulation requires further study to truly support the issue of accelerating large-scale mapping.

REFERENCES

Adi, A. P., Prasetyo, Y., & Yuwono, B. D. (2017). Pengujian Akurasi Dan Ketelitian Planimetrik Pada Pemetaan Bidang Tanah Pemukiman Skala Besar Menggunakan Wahana Unmanned Aerial Vehicle (Uav). *Jurnal Geodesi Undip*, *6*(1), 208–217.

Arifati, A., Wardana, R. Alihusni, Laksana, I., & Ratri Maarifatun Nisaa. (2017). Aplikasi Uav (Unmanned Aerial Vehicle) Untuk Mendukung Pemantauan Tata Ruang. *Seminar Nasional Geomatika 2017: Inovasi Teknologi Penyediaan Informasi Geospasial Untuk Pembangunan Berkelanjutan*.

Chao, H., Cao, Y., & Chen, Y. (2010). Autopilots For Small Unmanned Aerial Vehicles: A Survey. *International Journal Of Control, Automation And Systems*, *8*(1), 36–44. Https://Doi.Org/10.1007/S12555-010-0105-Z

Darwin, N., Ahmad, A., Aziz, W. A., & Akib, W. M. (2014). The Potential Of Low Altitude Aerial Data For Large Scale Mapping. *Jurnal Teknologi*.

Fitriawan, D., Senov, H. T., & Permana, R. (2020). Pemanfaatan Teknologi Foto Udara Penginderaan Jauh Unmanned Aerial Vehicle (Uav) Untuk Pengumpulan Data Geospasial Di Area A Warisan Dunia Tambang Batubara Ombilin Sawahlunto (Wtbos). *Jurnal Azimut*, *3*(1), 37–50.

Hugenholtz, C., Brown, O., Walker, J., Barchyn, T., Nesbit, P., Kucharczyk, M., & Myshak, S. (2016). Spatial Accuracy Of Uav-Derived Orthoimagery And Topography: Comparing Photogrammetric Models Processed With Direct Geo-Referencing And Ground Control Points. *Geomatica*.

Junarto, R., Djurdjani, Permadi, Fajar Buyung, Ferdiansyah, D., Admaja, Pandu Kuncoro, Sholikin, Ahmad Rasis, & Rahmansani, R. (2020). Pemanfaatan Teknologi Unmanned Aerial Vehicle (Uav) Untuk Pemetaan Kadaster Utilization Of Unmanned Aerial Vehicle (Uav) Technology For Cadaster Mapping. *Bhumi: Jurnal Agraria Dan Pertanahan*, *6*.

Kolbl, Orro R. (1976). Metric Or Non-Metric Cameras. *Xiii Congress Of The International Society For Photogrammetry*.

Meiarti, R., Seto, T., & Sartohadi, J. (2019). Uji Akurasi Hasil Teknologi Pesawat Udara Tanpa Awak (Unmanned Aerial Vehicle) Dalam Aplikasi Pemetaan Kebencanaan Kepesisiran. *Jurnal Geografi, Edukasi Dan Lingkungan*, *3*(1), 1–17.

Mustofa, M. A., & Widartono, B. S. (2019). *Pembuatan Peta Ortofoto Menggunakan Wahana Pesawat Tanpa Awak Skyhunter Aero 1800 Dan Sensor Kamera Sony Alfa 6000 (Studi Desa Wukirsari Kecamatan Imogiri Kabupaten Bantul)*. Universitas Gadjah Mada.

Oniga, V.-E., Breaban, A.-I., & Statescu, F. (2018). Determining The Optimum Number Of Ground Control Points For Obtaining High Precision Results Based On Uas Images. *Proceedings* , Vol. 2. Https://Doi.Org/10.3390/Ecrs-2-05165

Prayogo, I. P. H., Manoppo, F. J., & Lefrandt, L. I. R. (2020). Pemanfaatan Teknologi Unmanned Aerial Vehicle (Uav) Quadcopter Dalam Pemetaan Digital (Fotogrametri) Menggunakan Kerangka Ground Control Point (Gcp). *Jurnal Ilmiah Media Engineering*, *10*(1), 47–58.

Rabah, M., Basiouny, M., Ghanem, E., & Elhadary, A. (2018). Using Rtk And Vrs In Direct Geo-Referencing Of The Uav Imagery. *Nriag Journal Of Astronomy And Geophysics*.

Rokhmana, C. A. (2015). The Potential Of Uav-Based Remote Sensing For Supporting Precision Agriculture In Indonesia. *Procedia Environmental Sciences*, *24*, 245–253.

Smith, S. E. (2206). Tpographic Mapping. In *Environmental Soil-Landscape Modeling*. U.S: Crc Press.

Suciani, A., & Rahmadi, M. Taufik. (2019). Pemanfaatan Drone Dji Phantom 4 Untuk Identifikasi Batas Administrasi Wilayah. *Geografi*, *11*.

Syetiawan, A., & Gularso, H. (2020). Precise Topographic Mapping Using Direct Georeferencing In Uav. *Iop Conference Series*.

Syetiawan, A., & Haidar, M. (2019). Pemetaan Perkebunan Sawit Rakyat Dari Foto Udara Non Metrik Menggunakan Analisis Berbasis Objek. *Majalah Ilmiah Globë*, *21*.

Thomas, D. O., Stallings, C., & Wilkinson, B. (2020). Unmanned Aerial Vehicles Can Accurately, Reliably, And Economically Compete With Terrestrial Mapping Methods. *Csp Journals*.

Whitehead, K., & Hugenholtz, Chris H. (2015). Applying Asprs Accuracy Standards To Surveys From Small Unmanned Aircraft Systems (Uas). *Photogrammetric Engineering & Remote Sensing*.

Zongjian, L. (2008). Uav For Mapping —Low Altitude Photogrammetric Survey. *The International Archives Of The Photogrammetry, Remote Sensing And Spatial Information Sciences.*