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Efficiency Analysis of Open Polygon Method in Land Mapping in Mojoroto Kediri

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ABSTRACT

In the building establishment process, the geotechnical characteristics of soil have a significant impact on the structural performance of buildings. Therefore, soil mapping becomes a critical step in understanding the properties of soil that can affect foundation and structural stability. The mapping method used is open polygon mapping, which allows flexibility in determining land boundaries. Measurements were taken at three survey points: roadside, middle of the field, and edge of the field. The mapping results reveal variations in soil characteristics that need to be considered in development planning to ensure solid and stable building foundations. The implementation of Geographic Information Systems (GIS) in this process facilitates deeper data analysis and better visualization of field conditions. The mapping results show significant variations in ground elevation at each survey point, emphasizing the importance of understanding the area's topography. Additionally, area measurements were conducted using open polygon data, providing fundamental information for area development planning. Contour maps generated through Surfer software provide clear visualization of ground elevations at each survey point, enhancing understanding of the area's topography. This research contributes significantly to understanding soil characteristics and topography in the rear area of Mojoroto. It is expected to serve as a guide for area development planning, ensuring the stability and safety of future building structures. Thus, soil mapping is a critical step in ensuring the safety and sustainability of future buildings and contributes to sustainable area development planning.

Keywords: *Polygon; System Information Geospasial; Contur Map*

INTRODUCTION

The utilization of land in the mapped area shows promising potential for housing development and other structures. Developers can utilize advanced land mapping data to identify suitable locations for residential construction, considering factors such as population density, accessibility, and environmental sustainability. Efficient land use enables planned residential development that provides comfortable and adequate housing for the local community, while also ensuring environmental preservation and local ecosystem balance [1]. Moreover, proper

land use can enhance the local economy by increasing property values and developing supporting infrastructure. Thus, housing development in mapped regions not only benefits socially and economically but also supports sustainable and high-quality local community growth [2].

Land mapping is an essential activity with various benefits. These include aiding in spatial planning, natural resource management, disaster mitigation, infrastructure development, property investment, research, and education. This information helps make spatial planning more targeted and efficient, thereby minimizing future spatial conflicts [3]. Land mapping data also assists in planning road networks, bridges, drainage channels, and other transportation systems. With accurate mapping, infrastructure development can be carried out more efficiently, reducing costs, minimizing error risks, and speeding up construction [4]. Recent advancements in land mapping have achieved unprecedented accuracy levels through the use of advanced technologies such as high-resolution satellite imagery, advanced data processing, and artificial intelligence algorithms. These methods allow researchers and agricultural professionals to gain deep insights into soil structure, texture, and nutrient content accurately and efficiently [5].

The field soil mapping research for housing construction is a crucial step in the planning and development process. This research is important to determine the suitability of the land for the type of building to be constructed, considering factors such as soil stability, slope, and soil composition, which must be evaluated to ensure the land can safely support the building structure. Mapping the soil also helps identify potential risks such as landslides, floods, or erosion, so that preventive measures can be planned and implemented to reduce potential future losses. Data from soil mapping provides the necessary information for building design and technical planning; for instance, information on soil types and topography helps civil engineers design appropriate and stable foundations. This research also ensures compliance with local zoning and building regulations, as local governments often require geotechnical studies before issuing building permits.

By knowing the soil characteristics, developers can optimize construction costs since land that requires extensive repairs or adjustments can significantly increase construction costs. Additionally, soil mapping helps preserve the environment by understanding how construction can impact the local ecosystem, allowing for mitigation measures to be taken to reduce negative impacts. This research involves various methods, including topographic surveys, soil testing such as standard penetration tests and laboratory soil analysis, and the use of GIS (Geographic Information System) technology to accurately map data. All the collected information will be used to ensure that housing construction is carried out in a safe, efficient, and sustainable manner[6].

MATERIAL AND METHOD

The method used in this research is direct field measurement method using open polygon measurement technique. An open polygon is a polygon where not all sides are connected, thus there are gaps or holes. The calculation of the area of an open polygon differs from that of a closed polygon, as its area cannot be computed using basic geometric formulas [7]. Polygon correction is the process of adjusting a polygon to match desired values, locations, or shapes. Correction can be performed using various methods and tools. The objectives of polygon correction can vary depending on specific needs [8].

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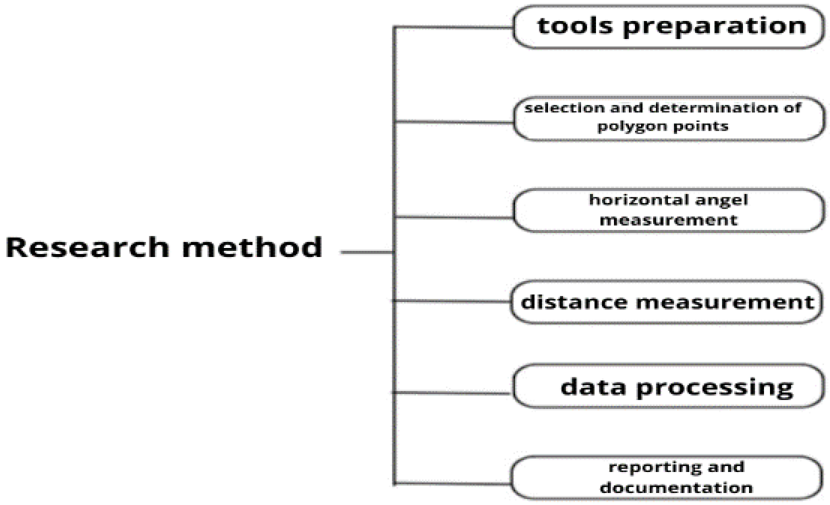

Figure 1. Research Flow Chart

Equipment

The equipment used in conducting soil survey research are as follows:
The tools we use in the land measuring practicum include a theodolite, which is a tool used to measure the vertical (altitude) and horizontal (azimuth) angles of the position of an object. Theodolite can rotate along its horizontal and vertical axes. Theodolite has many similarities with transit. Second, there is a tripod which is used as a support tool for the theodolite tool to stabilize the installed tool. With the right settings, a stable stand will be obtained. Then the Surveying Rod which functions to measure land elevation, the Waterpass tool which functions to measure an object in a flat position, both vertically and horizontally, next we also use the Tape Measure to measure distance, then there is the Compass which functions to determine the cardinal direction and direction. geographical, Umbrella to protect the theodolite tool from the heat of the sun, then finally there are writing utensils and testing forms which are useful for recording measurement results.

Data Testing Procedure

To test data using a theodolite, the first step is to properly set up the equipment. First, select a suitable location to set up the theodolite. Ensure the location is free from obstructions that could hinder the view of the target to be measured, then mark it with an umbrella stake. Next, prepare the tripod on a flat and stable surface [9]. Ensure all tripod locks are securely tightened to prevent any shifting during measurements. Level the tripod using a waterpass to ensure it is in the correct horizontal position. Adjust the height of the tripod legs if necessary to achieve the correct level. Mount the theodolite onto the tripod by placing it on the tripod platform and securely tightening the locking screws [10].
Next, level the theodolite using level readings (nivo) and vertical angle readings to adjust the horizontal and vertical levels of the instrument, ensuring it is fully leveled before proceeding. Zero the instrument using a compass to establish the initial point angle [11]. Once the theodolite is fully leveled, initialize the instrument by setting the horizontal and vertical angles to zero or the initial position [12].
The next step is to determine the initial azimuth and horizontal angle. Ensure the theodolite is mounted on the tripod and placed on a flat and stable surface. Use the available level or nivo readings on the theodolite to ensure the instrument is fully leveled. Once leveled, set the horizontal angle to zero or the initial position. This will serve as the starting reference for subsequent measurements [13]. Determine the reference point or direction to be used as the initial azimuth, which is the magnetic north direction predetermined beforehand. Use a

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direction-finding tool or compass to point the theodolite towards the predetermined reference point. Once the theodolite is aligned with the reference point, read the value of the initial azimuth on the scale or digital display available on the theodolite [14]. This provides the direction or angle between the theodolite's direction and the reference point. Record the measured initial azimuth value, as it will be used as a reference for further measurements [15]. To measure horizontal angles to other points, direct the theodolite towards those points and read the horizontal angle value displayed on the theodolite's scale or digital screen.

DATA PROCESSING

Data processing is a crucial stage in the soil mapping and survey process. Data collected from the field must be carefully processed to ensure accuracy and consistency before being used for map creation or further analysis [16]. The first step involves data collection and storage, where data is gathered using surveying tools such as theodolites, total stations, or GPS, and stored in both physical and digital forms.

Next, data verification and validation are conducted to check for measurement or recording errors and ensure accuracy by comparing the data with existing references [17]. The data processing process involves coordinate conversion, mathematical calculations to transform raw data into usable information, and the use of software such as AutoCAD or ArcGIS for plotting points and lines.

Subsequently, processed data is used to create maps and digital elevation models (DEM) that depict the topography of the surveyed area [18]. Data analysis is then performed to understand surface features such as slopes, elevations, and landforms, as well as to determine land use. Error analysis is also essential to ensure the accuracy of the final data.

The results of data processing and analysis are compiled into detailed reports, including generated maps, data tables, and explanations of the methods used. Data visualization techniques such as thematic maps, diagrams, and graphs are utilized to present findings clearly and comprehensibly [19].

Finally, processed data is stored in a secure and accessible format for future use, managed using data management systems to ensure efficient organization and access [20]. By following these steps, soil survey data can be processed accurately and efficiently, yielding reliable maps and analyses for various purposes such as development planning, scientific research, and natural resource management.

RESULTS AND DISCUSSION

FIELD RESULT

The results of the field data testing will be presented in the table below:

Tabel 1. Field Result Data 1

Point		Thread			Angle						Information
Height	Target	Top	Middle	Bottom	Vertical			Horizontal			
mm		mm	mm	mm	°	'	"	°	'	"	
					0	0	0	0	0	0	
P1	P2	1400	1165	930	88	42	58	182	33	48	Field
1460	T1	1650	1623	1595	90	0	0	110	28	23	Road
	T2	1750	1683	1615	90	0	0	110	39	44	Road
	T3	1365	1335	1305	90	0	0	254	56	25	Road
	T4	1145	1113	1080	90	0	0	161	57	19	Field

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	T5	605	508	410	90	0	0	161	30	55	Field
	T6	360	240	120	90	0	0	189	40	36	Field
	T7	1350	1145	940	88	45	26	182	8	34	Field
	T8	1530	1310	1090	88	42	8	170	6	16	Field
	T9	1400	1185	970	88	44	42	177	28	45	Field
	T10	1450	1155	860	88	41	24	186	33	57	Field

Tabel 2. Field Result Data 2

Point		Thread			Angle						Information
Height	Target	Top	Middle	Height	Target			Top			
mm		mm	mm	Mm	°	'	"	°	'	"	
					0	0	0	0	0	0	
P2	P1	2900	2700	2500	90	0	0	0	0	0	Field
	T1	1510	1450	1390	90	0	0	129	12	24	Field
1410	T2	1530	1430	1330	90	0	0	148	38	42	Field
	T3	1410	1315	1220	90	0	0	162	30	34	Field
	T4	1180	1085	990	90	0	0	193	9	42	Field
	T5	900	780	660	90	0	0	214	2	8	Field
	T6	980	740	500	90	0	0	186	40	20	Field
	T7	1170	910	650	90	0	0	174	11	14	Field
	T8	1460	1315	1170	90	0	0	157	38	12	Field
	T9	1640	1415	1190	90	0	0	149	45	47	Field
	P3	1230	890	550	90	0	0	174	42	46	Field

Tabel 3. Field Result Data 3

Point		Thread			Angle						Information
Height	Target	Top	Middle	Height	Target			Top			
mm		Mm	mm	Mm	°	'	"	°	'	"	
					0	0	0	0	0	0	
P3	P2	2400	2055	1710	90	0	0	0	0	0	Field
	T1	730	565	400	90	0	0	269	21	56	Field
1450	T2	860	753	645	90	0	0	245	16	34	Field
	T3	1120	1043	965	90	0	0	264	16	8	Field
	T4	1130	1054	978	90	0	0	231	37	50	Field
	T5	1349	1311	1272	90	0	0	267	27	17	Field
	T6	1297	1239	1180	90	0	0	203	15	10	Field
	T7	1470	1404	1338	90	0	0	157	54	54	Field
	T8	1587	1539	1490	90	0	0	123	14	10	Field
	T9	1765	1695	1624	90	0	0	102	20	3	Field

From the measurement results using the theodolite table above, it is known that the Measurement data from the edge of the road, the center of the field, to the edge of the field with the tool height at P1 1460mm, P2 1410mm, and P3 1450mm can show the number of thread heights, middle. With this data, we can create a polygon graph and contour map.

GRAFIK POLIGON

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From the mapping practicum research we conducted, the following is the result of the open polygon graph.

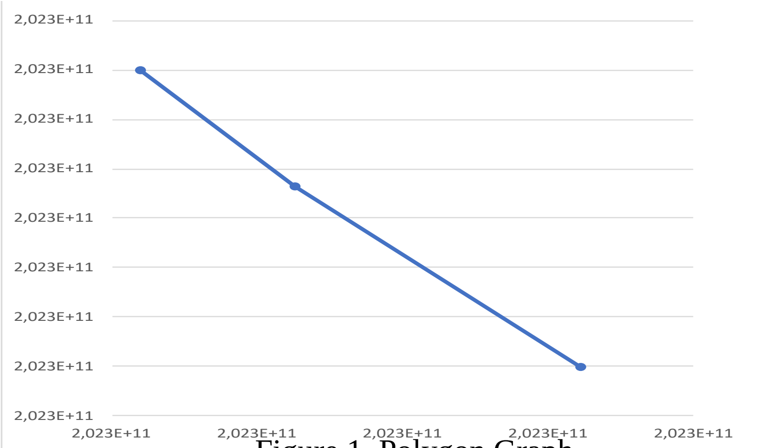

Figure 1. Polygon Graph

An open polygon is a polygon that does not have a closing point at the end of measurements. Open polygons are used as a basic framework for mapping an area and aid in determining the positions of control or reference points in the measurement of specific fields. As seen in the results obtained during our land surveying practicum.

CONTOUR MAP

In this project context, contour maps of open polygons are created using measured elevation data along contour lines. The software used is Golden Surfer, specialized software designed for mapping and analyzing geospatial data. Golden Surfer is commonly used by professionals in fields such as geology, geophysics, and environmental science [20].

The method employed to generate contour maps is kriging gridding. Kriging is selected based on semivariogram analysis, a crucial step in geostatistics for understanding the spatial variability of existing data. Kriging is one of the most advanced interpolation techniques as it considers the distances between data points, spatial variability, and spatial data structure to produce the most accurate estimations at unsampled locations [21].

Contour Map P1

From research in the mapping practicum, the following are the results of a contour map on P1 of 10 points.

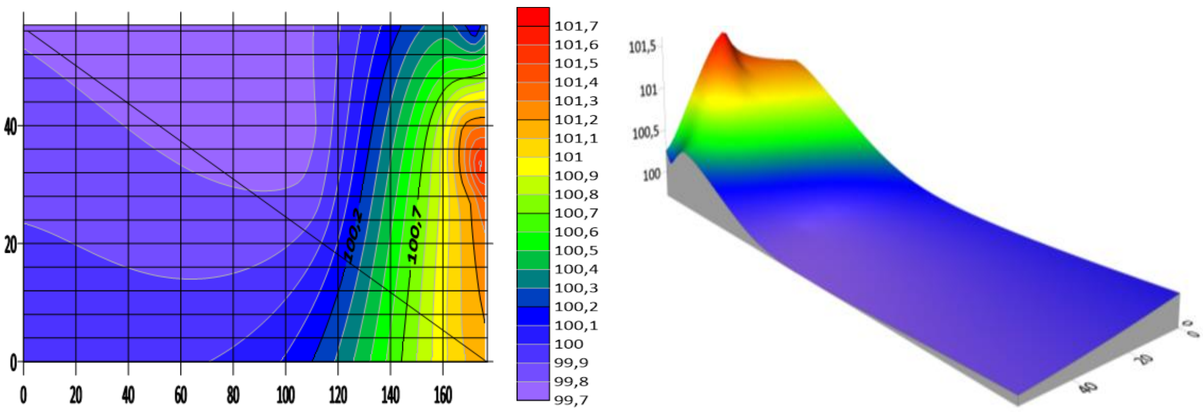

Figure 2. Picture and Dot Graph P1

Point P1 is located at the roadside, with its highest point at 101.7 and its lowest point at 99.7

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above the ground level at point P1 (roadside).

Contour Map P2

From research in the mapping practicum, the following are the results of a contour map on P2 of 10 points.

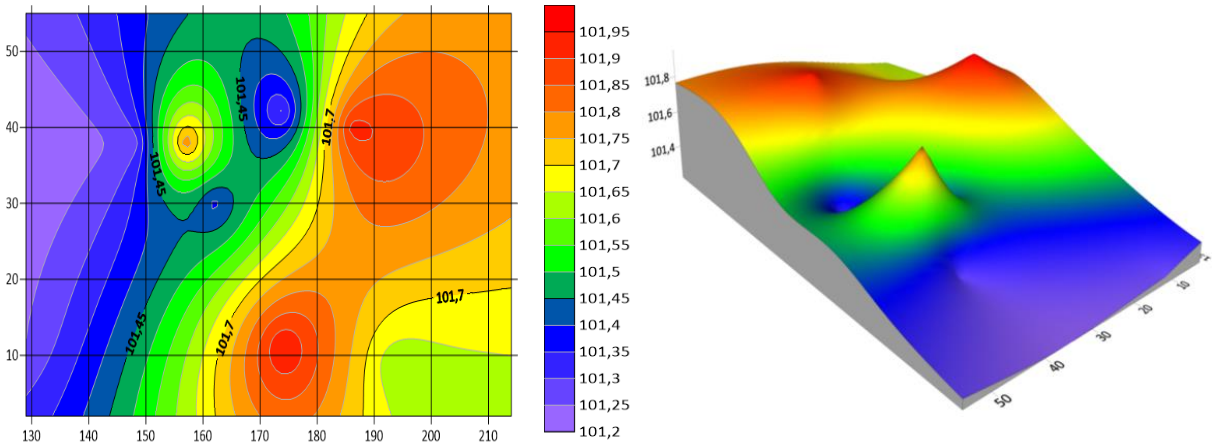

Figure 3. Picture and Dot Graph P1

Point P2 is located in the middle of the field, with its highest point at 101.95 and its lowest point at 101.2 above the ground level at point P2 (middle of the field).

Contour Map P3

From research in the mapping practicum, the following are the results of a contour map on P3 of 10 points.

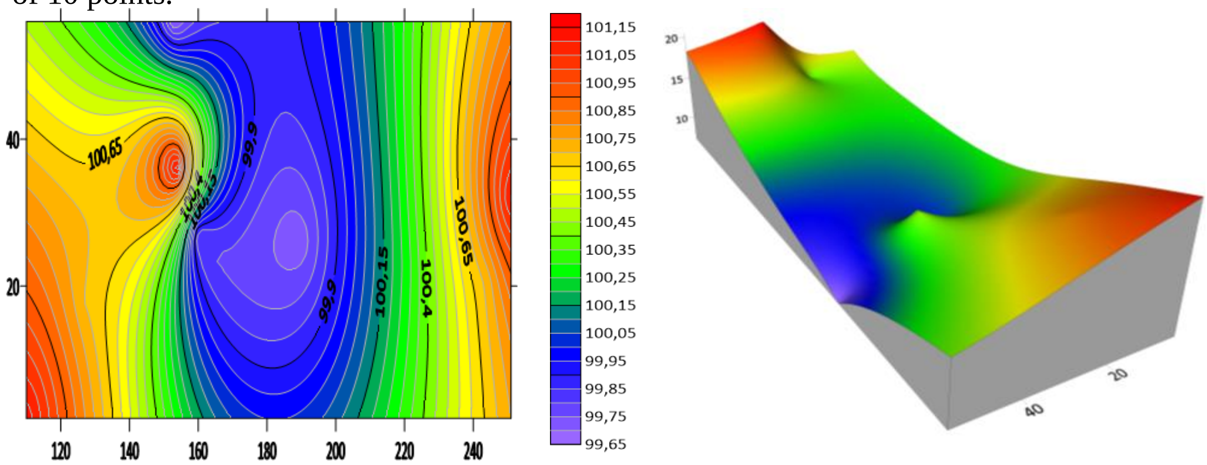

Figure 4. Picture and Doth Graph P2

Point P3 is located at the edge of the field, with its highest point at 99.65 and its lowest point at 101.15 above the ground level at point P3 (edge of the field).

CONCLUSION

The utilization of land for housing development, supported by comprehensive land mapping, reveals significant potential for creating sustainable and efficient residential areas. Advanced land mapping technologies, such as high-resolution satellite imagery and AI algorithms, enable precise identification of suitable locations for housing based on critical factors like population density, accessibility, and environmental sustainability. This planned approach ensures comfortable and adequate housing for the community while preserving the environment and balancing local ecosystems. Proper land use planning also fosters economic growth by increasing property values and facilitating infrastructure development, thereby enhancing the local economy. Land mapping, essential for spatial planning and natural resource management, aids in mitigating disasters and developing efficient transportation systems, reducing costs, and speeding up construction. Soil mapping is a crucial step in housing construction planning. It evaluates soil stability, composition, and risks like landslides or floods, ensuring safe and cost-effective construction. Compliance with local zoning and building regulations is also ensured, preserving the environment and minimizing negative impacts. The field research method used in this study involved direct measurement using open polygon techniques, employing tools like theodolites, tripods, surveying rods, waterpass, tape measures, and compasses. Accurate setup and leveling of theodolites, along with data processing using software like AutoCAD and Golden surfer, enabled the creation of reliable maps and digital elevation models. The results, including field measurement data, open polygon graphs, and contour maps, demonstrate the effectiveness of these techniques in providing detailed insights into land topography and soil characteristics. These findings support informed decision-making for sustainable housing development, contributing to high-quality local community growth.

REFERENCE

[1] H. Z. Adzim, A. P. Wijaya, dan S. Qoyimah, “Pemetaan Kesesuaian Lokasi Pembangunan Kawasan Perumahan Menggunakan Metode Analytical Hierarchy Process di Kawasan rawan banjir dan longsor (Studi Kasus : Kabupaten Purworejo) Mapping the Suitability of Residential Development Sites Using the Analytica,” vol. 4, no. 1, hal. 1–11, 2023.

[2] A. Mulyani, E. Suryani, dan H. Husnain, “Pemanfaatan Data Sumberdaya Lahan untuk Pengembangan Komoditas Strategis di Indonesia,” *J. Sumberd. Lahan*, vol. 14, no. 2, hal. 79, 2020, doi: 10.21082/jsdl.v14n2.2020.79-89.

[3] H. Rakuasa dan A. Rifai, “Pemetaan Kerentanan Bencana Tanah Longsor Berbasis Sistem Informasi Geografis Di Kota Ambon,” *Semin. Nas. Geomatika*, no. April, hal. 327, 2021, doi: 10.24895/sng.2020.0-0.1148.

[4] M. J. Andries, “Kajian Awal Penyusunan Algoritma Perhitungan Luas Tanah dan Faktor Koreksi dengan Metode Poligon Terbuka dan Tertutup,” *J. Ind. Eng. Manag. Syst.*, vol. 11, no. 1, hal. 47–64, 2017.

[5] W. Partono, M. Irsyam, R. Nazir, M. Asrurifak, F. Kistiani, dan U. C. Sari, “Pengembangan Peta Percepatan Gerakan Tanah Puncak Kota Semarang berdasarkan Peraturan Gempa Tahun 2019,” *Media Komun. Tek. Sipil*, vol. 27, no. 2, hal. 203–212, 2019.

[6] F. J. Amarrohman, B. D. Yuwono, M. Awaluddin, Y. Prasetyo, H. S. Firdaus, dan N. Bashit, “Pemetaan Dan Pengukuran Untuk Konstruksi Teknik Sipil,” *J. Pasopati*, vol. 1, no. 1, hal. 28–33, 2019.

[7] I. Y. N. Afani, B. D. Yuwono, dan B. Nurhadi, “Optimalisasi Pembuatan Peta Kontur

Skala Besar Menggunakan Kombinasi Data Pengukuran Terestris Dan Foto Udara Format Kecil," *J. Geod. Undip*, vol. 8, no. 1, hal. 180–189, 2019.

[8] P. Zona, N. Tanah, K. Agraria, D. A. N. Tata, B. P. Nasional, dan K. Pengantar, "Berdasarkan Jaringan Syaraf Tiruan Berbasis Graphical User Interface Untuk Pembuatan," 2020.

[9] H. Rohman, E. A. Sandi, dan W. N. Wari, "Desain Peta Situasi Jalan Dengan Metode Poligon Terbuka (Studi Kasus Jalan Lingkungan Politeknik Negeri Banyuwangi)," *J. Ris. Tek. Sipil dan Sains*, vol. 2, no. 1, hal. 40–47, 2023, doi: 10.57203/jriteks.v2i1.2023.40-47.

[10] R. Basaria, A. Setiawan, dan E. Sediyono, "Penentuan luas wilayah Kabupaten dan Kota di Provinsi Sulawesi Tengah menggunakan metode poligon dengan bantuan google earth," *J. Mercumatika J. Penelit. Mat. dan Pendidik. Mat.*, vol. 3, no. 1, hal. 9–22, 2018.

[11] H. Rakuasa dan A. Rifai, "Pemetaan Kerentanan Bencana Tanah Longsor Berbasis Sistem Informasi (Mapping of Landslide Disaster Vulnerability Based on Geographic Information System in Ambon City)," *Semin. Nas. Geomatika 2020 Inf. Geospasial untuk Inov. Percepatan Pembang. Berkelanjutan 4.*, no. April, hal. 327–336, 2021.

[12] AGUS KUSWANTO KUSWANTO, Wahyu Garinas, dan Syabarudin Zikri, "Proses Pengambilan Data Dan Pemanfaatan Geolistrik Metoda 4-D Untuk Pemetaan Geologi Bawah Permukaan," *Maj. Ilm. Pengkaj. Ind.*, vol. 12, no. 1, hal. 47–56, 2023, doi: 10.29122/mipi.v12i1.501.

[13] U. Hasdiana, "Korelasi Perlakuan Lapang terhadap Galat Tereduksi Poligon Terbuka," *Anal. Biochem.*, vol. 11, no. 1, hal. 1–5, 2020, [Daring]. Tersedia pada: http://link.springer.com/10.1007/978-3-319-59379-1%0Ahttp://dx.doi.org/10.1016/B978-0-12-420070-8.00002-7%0Ahttp://dx.doi.org/10.1016/j.ab.2015.03.024%0Ahttps://doi.org/10.1080/07352689.2018.1441103%0Ahttp://www.chile.bmw-motorrad.cl/sync /showroom/lam/es/

[14] M. Arif, R. Hartono, dan D. Arinta, "Pengembanan Laboratorium Geografi Berbasis Mobile Virtual Pada Materi Pembelajaran Praktikum Ilmu Ukur Tanah," *J. Dimens. Pendidik. dan Pembelajaran*, vol. 11, no. 2, hal. 181–191, 2023, doi: 10.24269/dpp.v11i2.7006.

[15] I. G. K. Artika dan W. Utami, "Percepatan Pembenahan Data Bidang Tanah Kluster 4 melalui Survei Data Pertanahan," *BHUMI J. Agrar. dan Pertanah.*, vol. 6, no. 1, hal. 66–79, 2020, doi: 10.31292/jb.v6i1.425.

[16] P. Prabowo, F. Murdapa, dan E. Rahmadi, "Pengujian Akurasi Dan Ketelitian Planimetrik Pada Pemetaan Bidang Tanah Skala Besar Menggunakan Wahana Udara Dji Phantom 4," *J. Geod. Geomatics*, vol. 1, no. 1, hal. 9–17, 2021, [Daring]. Tersedia pada: https://journal.eng.unila.ac.id/index.php/jgg/article/view/1917

[17] E. Ihda, B. Sudarsono, dan M. Awaluddin, "Analisis Pengukuran Bidang Tanah Dengan Menggunakan Gps Pemetaan," *J. Geod. Undip J. Geod. Undip*, vol. 4, hal. 86–94, 2019.

[18] A. Nugroho, M. S. Tazakka, dan B. A. Tirta, "Pentingnya Pelaksanaan Penyelidikan Tanah yang Tepat untuk Proyek Geoteknik di Kawasan Waterfront Area , Studi Kasus Jetty," *TAU SNAR-TEK 2019 Semin. Nas. Rekayasa dan Teknol.*, no. November, hal. 122–128, 2019.

[19] N. M. Larasati, "Analisis Penggunaan Dan Pemanfaatan Tanah (P2T) Menggunakan Sistem Informasi Geografis Kecamatan Banyumanik Tahun 2016," *J. Geod. Undip*, vol. 6, hal. 89–97, 2020.

[20] M. Latif, W. G. Pamungkas, dan H. Masvika, "Pelatihan Ilmu Ukur Tanah bagi Mahasiswa Universitas Muhammadiyah Semarang (UNIMUS) dan Praktisi Konstruksi," *J. Pengabdi. KOLABORATIF*, vol. 2, no. 1, hal. 33, 2024, doi: 10.26623/jpk.v2i1.6865.