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Cave Passage Levels and the Correlation Between Cave Lenght, Dry Valley and Clungup River in Sendang Biru Karst Area, Malang - Indonesia

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Abstract

Karst topography has various forms such as dry valleys, cave passages and surface rivers. The condition of these karst features has dynamic development. This research wants to see the condition of the existence of surface rivers, valleys and the existence of cave passages that allow the connection between surface and subsurface systems. The purpose of this study is to analyze the frequency of cave cave passages, dry valleys, and surface rivers to interpret the cave levels and the correlation between cave lenght and surface rivers and dry valley in karst area. The method used in this research is analyzing and doing review of cave mapping data and the data collection of surface rivers and dry valleys taken by the help of DEMNAS, which then identified the existence of surface rivers and valleys. The cave lenght analysis was done by calculating the lenght in each segment elevation. The analysis used was correlation test using SPSS. Graphic analysis helped in providing an overview of the correlation of cave lenght , surface rivers and valleys existence. The result of the search showed that Clungup river comes from karst area with recharge from karst springs. The dry valley at the research site connects to Krompyang cave. The existence of dry valley and surface river have similar profile. The cave passages develop in several elevations. The analysis of these three features showed that there were 4 level patterns developed in Karst area of Sendang Biru. While the results of the correlation test between dry valley and Clungup river showed a sig value = 0.000 which was sig value = 0.000 < 0.05 that indicated a correlation between the 2 features. However, the cave length feature does not have a significant value with the Dry Valley and Clungup River, because rivers and valleys have similarities in geomorphic processes on the karst surface.

Keywords: Cave Lenght, Rivers, Dry Valley, Karst

1. INTRODUCTION

Karst areas are formed by dissolution process (Ford & Williams, 2007). Rocks in this area will dissolved in water. The existence of this dissolution process forms unique karst phenomena such as the existence of dry valleys, dolines domes, caves and others (Haryono et al., 2016). The dissolution process occurs in the karst area will shape the surface morphology eroded and this too happens under the surface. The cave passages will also be eroded by the dissolution process under the surface. These indicate a negative formation by the existence of karst valleys and cave passages. There are many karst phenomena in several areas such as on Java Island spotted in Gunung Sewu karst, Gombong karst and Southern Malang karst.

Studies on cave morphometry commonly done by other researchers, such as cave morphometry to see cave quantitative data in Donomulyo South of Malang (Labib et al., 2019), while to analyze cave morphometry based on the cave levels (Pardo-Iguzquiza et al., 2011; Piccini, 2011). Besides, he cave levels conditions can also be associated with river terrace (Wagner et al., 2011) which almost have similar characteristics to the cave levels inside. This study is different from the previous study in the perspective of cave passages

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levels and rivers. This study aims to see the presence of surface rivers, valleys and cave passages that allow the connection between the surface and subsurface systems. Therefore, a more in-depth analysis is needed related to the correlation between these features.

Southern Malang karst is the part of Java southern mountains in the forms of karst hills of Wonosasi Formation (Suyanto et al., 1992), on of karst blocks in South Malang is Sendang Biru karst block (Figure 1), this area has morphology such as karst valleys and caves (Suprianto et al., 2017). The existence o this karst valley can be seen in the existence of rivers that are dry during the dry season (Salaka, 2018). Several caves have been identified by researchers (Sahrina et al., 2022; Salaka, 2018; Suprianto et al., 2017). The existence of these appearances is as the results of dissolution process occurs up now. The purpose of this study is to analyze the frequency between cave passages, valleys and surface rivers and the correlation between cave passages and surface rivers in karst areas.

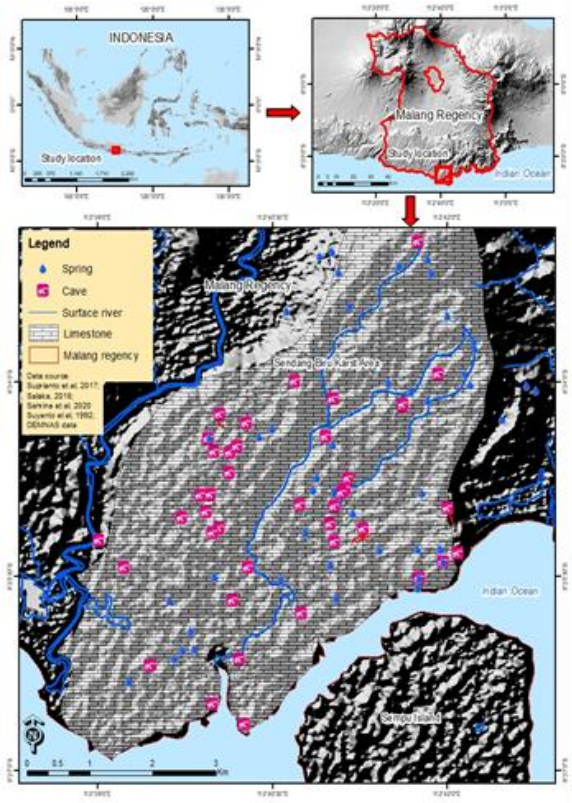

Figure 1. Study Location

2. METHOD

The method used in this research is collecting data from previous studies ,a study of cave mapping had been done before by the researcher (Salaka, 2018; Suprianto et al., 2017). The data collection of surface rivers and dry valleys taken by the help of DEMNAS, (https://tanahair.indonesia.go.id/) which then identified the existence of surface rivers by the help of administrative maps from geo-spatial agency. The utilization of caves paid attention to the identified cave centerline. For providing the height and lenght values of surface rivers and valleys were done by digitizing on screen to provide a graph on the existence of height and lenght of the surface rivers. The GIS (Geographic Information System) was used in identifying cave condition analysis (Jacoby et al., 2011; Suprianto & Labib, 2019), this was done on cave levels studies (Labib et al., 2021), cave morphometry cave (Labib et al., 2019).

The analysis of cave lenght frequency was done by calculating the lenght in the elevation of each segment divided by the the whole lenght system (Labib et al., 2021), this too was done to calculate valleys and surface rivers frequency. The analysis used was correlation test using SPSS. This correlation test was carried out using the Pearson correlation method to determine the relationship between variables. The graph analysis helped in providing the overview of the correlation between the existence of cave lenght, surface rivers, and dry valley. The limitations of this research were carried out in the Sendang Biru karst area, by taking data from the Clungup River in the karst area, caves that had been previously mapped, and one valley that presented the appearance of a dry valley.The study flow chart can be seen in figure 2.

Figure 2. Flow Study

3. RESULTS AND DISCUSSION

RESULT

The Condition of Clungup River and Dry Valley

Sendang Biru is a block karst area which is separated by Penguluran river, from other blocks. There are springs distribution in this area which taken place in slope area in Sitiarjo Village and Tamban Hamlet, Tambakrejo Village, besides in the downstream area of the karst block, there is a spring which utilized by the local people. The existence of this surface river in this karst area, Clungup river, flows from the upstream to the downstream towards the beach. Clungup river has a spring recharge from Pasyen spring and Mbeng spring in the upstream, besides there are caves that supply the surface river water flow; such as Suro cave. The downstream are also supplied by Sendang Biru spring. This surface river is interesting because it comes from the karst area itself, without any contact to another area; so that during the rainy season, the spring and Clungup river water debit will increase. In dry season, Clungup

river will be dry without any water flow. Karst area is identic with the dry valleys, one of the valley is connected to Krompyang cave. In rainy season water will enter that cave. The profile of Clungup river and valleys can be seen in Figure 3, in the upstream section, there was a sharp elevation, while in the downstream area, the condition was getting flat.

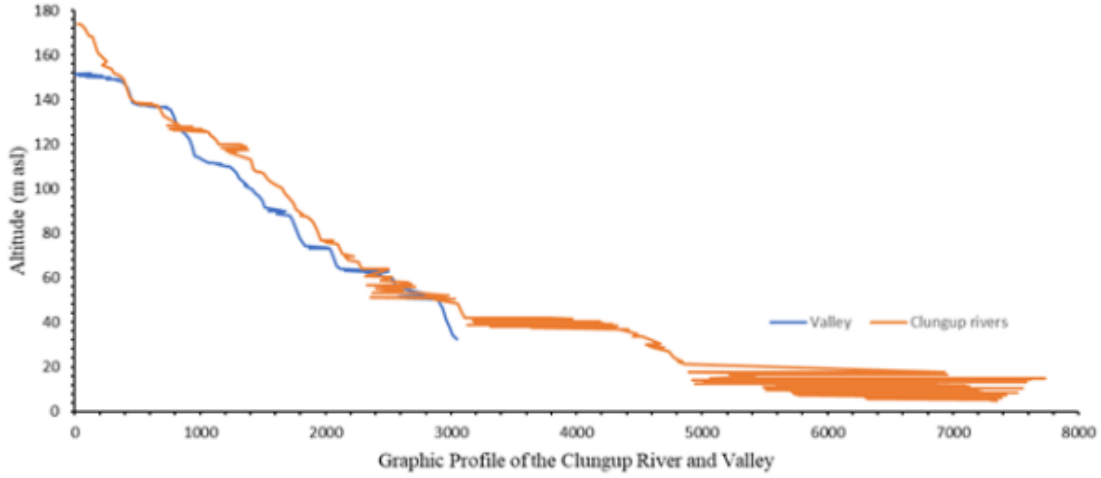

Figure 3. Clungup River and Valley in Sendang Biru Karst Profile

Cave Passage

The existence of caves in Sendang Biru Karst area developed in several elevation. The caves have different elevation passages in each segment which make them into vertical passage such as found in Pak Mul Cave, Kedung Pitu Cave, Ledrek Cave, bah Wajib Cave, Mata Tempeh Cave, Watu Jaran Cave and Sumur Windhu Cave. These different elevation make two level cave, such as found in side view map of Kedung Pitu Cave, Mbah Wajib Cave, Harta Cave and Mata Tempeh Cave. It was found that on the first level, developed dry passage without any subterranean river on it; while on the second level, there was subterranean river found, such as in Mbah Wajib Cave (Sahrina et al., 2023), Kedung Pitu Cave (Suprianto et al., 2017), Harta Cave (Salaka, 2018). The development of several elevation on caves showed that vertical passage can develop in coastal area such as found in Sumur Windu Cave and Watu Jaran Cave, formed into single passage. The distribution of cave passages in Sendang Biru Karst area can be seen in Figure 4.

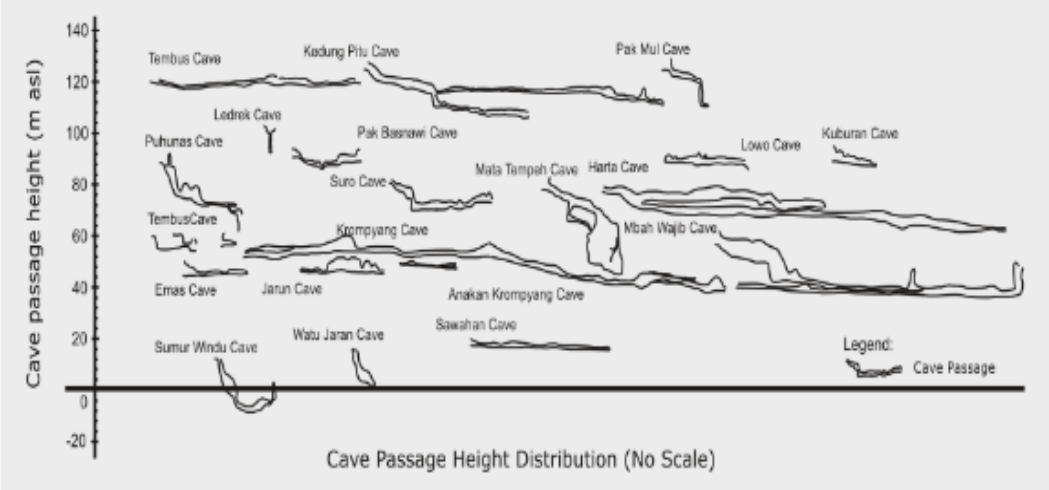

Figure 4. Mapped Caves (Salaka, 2018; Suprianto et al., 2017)

The Analysis of Cave Passage Frequency, Dry Valley, and Clungup River

The previous mapped caves, later identified based on the results of the survey of the cave mapping. GIS (Geographic Information System) was used to collect the flat distance on the cave map, because earlier in field measurement process still used distance and passage slope. On each cave segment had a flat lenght that became a reference in analyzing the cave passage frequency. The researchers also made the profile of dry valley and Clungup River to be analyzed on the cave passage before. Figure 5 shows the cave passage frequency, dry valley and Clungup River in Sendang Biru karst. The cave passage had an elevation range of 132 msal to -9 msal, the dry valley has an elevation range of 152 msal to 32 msal, and the Clungup River had an elevation rage of 174 msal to 5 msal. This varied based on the available data, such as the found and mapped caves which didn't cover some elevations, as well as the dry valley which stopped at the entrance of flow surface into Krompyang Cave, at Clungup River which had ideal range from upstream to downstream, considering that the source of surface flow comes from karst springs.

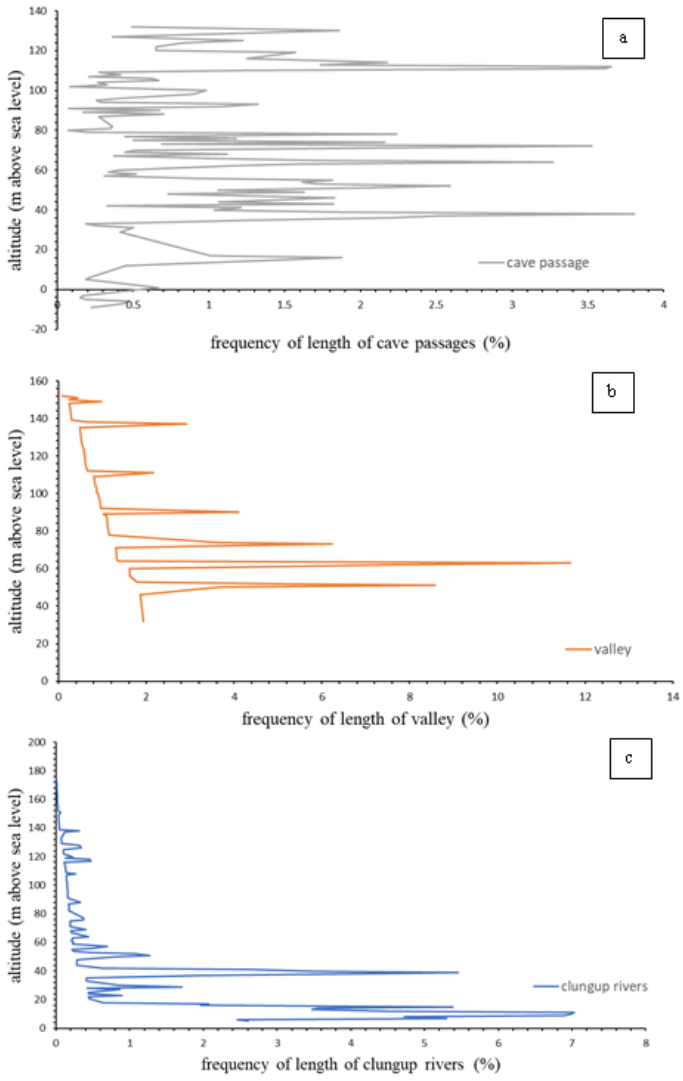

Figure 5. (a) cave passage frequency (b) valley lenght frequency (c) Clungup River lenght frequency in each elevation

The Correlation of Cave** lenght**, Clungup River, and Dry Valley

The calculation results of cave lenght, Clungup River, and Dry Valley frequency, later was tested using correlation and SPSS. The data used was by taking he same elevation and tested the normality of the previous data, so the collected data reached 21 points which got the same elevation between the three features. The test results as shown in Table 1, showed the value of Sig. (2-tailed) for cave lenght while the dry valley was at 0.540 which indicated insignificant (0.540>0.05). For Cave lenght and Clungup River, the value of Sig. (2-tailed) was 0.681 which indicated insignificant (0.681>0.05), and the Sig. value (2-tailed) for Clungup River and dry valley was 0.000, which showed that the data was significant (0.000<0.05). From these results, showed that dry valley had correlation with Clungup River. This can happen because dry valleys and rivers are landscape features that exist on the surface, and experience the same process in the regional area of Sendang Biru Karst, while cave passages are formed below the surface, which has a process of sedimentation and rock dissolution in the cave.

Table 1. Cave Lenght, Clungup River and Dry Valley Correlation Test

		Cave lenght	Clungup River	Dry Valley
Cave Lenght	Pearson Correlation	1	-.140	-.208
	Sig. (2-tailed)		.681	.540
	N	11	11	11
Clungup River	Pearson Correlation	-.140	1	.985**
	Sig. (2-tailed)	.681		.000
	N	11	11	11
Dry Valley	Pearson Correlation	-.208	.985**	1
	Sig. (2-tailed)	.540	.000	
	N	11	11	11

** Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

The karst landscapes developed due to some following factors. Those were in the form of soluble rocks, sufficient rainfall volume, exposed rocks at an elevation which allowed water circulated/ drainage vertically (Haryono & Adji, 2004). In the karst area that were formed by the same physiography conditions, would have similarity on the rainfall distribution and the soluble rocks, and these allowed the developing landscape to have similarity due to the similar process. This could be seen in several cases of identifying cave levels and marine terrace which has the same level pattern (Labib et al., 2019; Piccini, 2011), and so did with the cave levels, river terrace and flat land which had same pattern (Wagner et al., 2011).

Sendang Biru karst had mapped cave passage distribution, in the number of 19 caves (Salaka, 2018; Suprianto et al., 2017), which then been identified the field results by using GIS (Geographic Information System). The same thing was done by looking at the surface rivers in Clungup River and dry valley. From the profile graph; dry valley, cave passages and Clungup River had similar pattern. This indicated the same developing process of Sendang Biru karst area development. Figure 6 showed that similar patterns formed in several caves levels, rivers, and dry valleys. At the first level, it is located at the highest area and has a vertical passage and a non-sloping surface, at the second level there are more descents, allowing vertical passage to develop at that height, also seen in the steep valley. At the third

level, horizontal passage develop and the surface configuration begins to slope. At the fourth level, the surface river begins to slope and there are also vertical and horizontal passage.

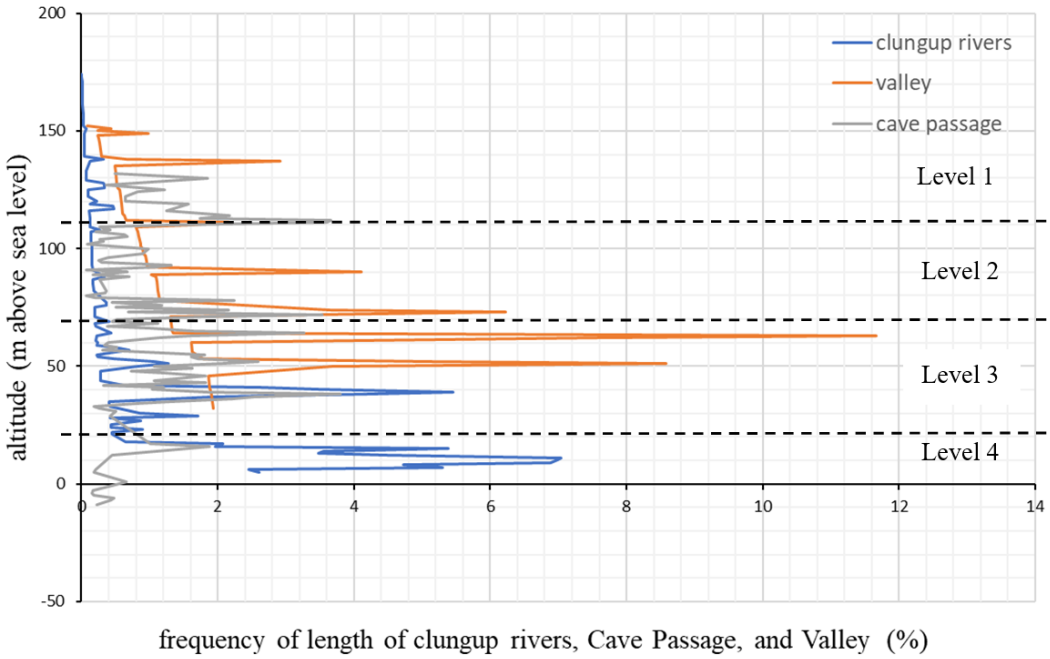

Figure 6. An Interpretation of Level Pattern Developing in Cave Passages, Surface Rivers, and Dry Valley

The development of the cave levels was done from a graphic interpretation which shown in Figure 6. However, each feature can be seen connected one another. The correlation test results showed the existence of correlated and uncorrelated features. Dry valley and Clungup River had strong correlation, In the cave lenght feature there is no relationship with the dry valley and surface river. In addition, the relationship between the cave and the dry valley and surface river is very low. The condition of the relationship between the dry valley and the clungup river can be seen from the profile of the two features which show similar patterns, in addition the development process of the dry valley and river has the same process in forming the Valley figuration in the karst area, in contrast to the cave passage which has the dimensions of the passage which in conditions saturated with water, the dissolution process will stop, while the level of the cave shows the cave passage, dry valley, and surface river that develop at that level.

4. CONCLUSION

Karst area had features like caves, dry valley, and surface river. These developing features were based on factors that shaped that karst area itself. In the area which had same physiography and in the same block, had the same factor in the process of karst development. Sendang Biru Karst block had cave, dry valley, and surface rivers. These features were identified based on the lenght frequency by looking at the elevation on each segment, which showed the correlation between dry valley and Clungup River, but with the cave lenght there is no relationship and low correlation. These there feature frequency can also be seen in the graph. To do more-in-depth exploration of the correlation, needs more basic data related to the existence of surface river and dry valley in Sendang Biru Karst area, besides other caves still need to be explored and mapped in detail, to get more data in analyzing the correlation between those karst features.

REFERENCES

Ford, D., & Williams, P. (2007). *Karst Hydrogeology and Geomophology*. British library.

Haryono, E., & Adji, T. (2004). *Geomorfologi dan Hidrologi Karst*. kelompok Studi Karst Fakultas Geografi UGM.

Haryono, E., Hakim, A. A., & Sasongko, M. H. D. (2016). *Karakterisasi Geodiversitas. In E. Haryono et al (Ed.)*, Pedoman Praktis Survei Terintegrasi Kawasan Karst (pp. 1–18). Badan Penerbit Fakultas Geografi (BPFG).

Jacoby, B. S., Peterson, E. W., Dogwiler, T., & Kostelnick, J. C. (2011). Estimating the Timing of Cave Level Development with GIS. *Speleogenesis & Evolution of Karst Aquifers*, 11(11), 52–61. http://www.speleogenesis.info/directory/karstbase/pdf/seka_pdf10280.pdf

Labib, M. A., Haryono, E., & Sunarto. (2019). The development of cave passage in Donomulyo, Malang-Indonesia. E3S Web of Conferences, 76. https://doi.org/10.1051/e3sconf/20197604010

Labib, M. A., Haryono, E., Suprianto, A., Hidayat, K., Irianto, P. A., Masruroh, I. D., & Prasetyo, D. (2021). Identifikasi Kenampakan Morfologi Gua Banyu dan Sekitarnya di Kecamatan Donomulyo Kabupaten Malang. *Geodika: Jurnal Kajian Ilmu Dan Pendidikan Geografi*, 5(2), 185–195. https://doi.org/10.29408/geodika.v5i2.3323

Pardo-Iguzquiza, E., Durán-Valsero, J. J., & Rodríguez-Galiano, V. (2011). Morphometric analysis of three-dimensional networks of karst conduits. *Geomorphology*, 132(1–2), 17–28. https://doi.org/10.1016/j.geomorph.2011.04.030

Piccini, L. (2011). Recent developments on morphometric analysis of karst caves. *Acta Carsologica*, 40(1), 43–52. https://doi.org/10.3986/ac.v40i1.27

Sahrina, A., Fadlan, M. S., Withuda, F. A., Labib, M. A., Fitriani, D., & Ma'Asika, N. M. (2022). Elaborative Analysis of Caves As Specified Tourism Destination in Malang Regency – Indonesia. *Geojournal of Tourism and Geosites* , 41(2), 368–375. https://doi.org/10.30892/gtg.41205-83 9

Sahrina, A., Masruroh, H., Rosyida, F., Withuda, F. A., Prasetyo, D., Labib, A., Sukoco, G., Ahmad, A. A., Study, G., Malang, U. N., Malang, U. N., & Java, E. (2023). the Passage Characteristics and Potential of Mbah Wajib Cave in Tambakrejo Village - Sumbermanjing Wetan District – Malang. *Jurnal Geografi Gea*, 23(1).

Salaka, M. J. (2018). *Eksplorasi Kawasan Karst Sendang Biru Kabupaten Malang* (Issue October 2018). CV. Komojoyo Press.

Suprianto, A., & Labib, M. A. (2019). Estimasi Penentuan Tingkatan dan Pola Lorong Gua Banyu dan Sekitarnya dengan Menggunakan GIS. *JPIG (Jurnal Pendidikan Dan Ilmu Geografi)*, 4(1), 1–8. https://doi.org/10.21067/jpig.v4i1.3086

Suprianto, A., Prasetyono, D., Hardianto, A. S., Labib, M. A., Efendi, S., Hidayat, K., Triyono, J. A., & Ahmad, A. A. (2017). Identifikasi Hubungan Kelurusan dan Pola Lorong Gua Karst di Kecamatan Sumbermanjing Weta Kabupaten Malang [Identification of Straightness Relationship and Passage Pattern of Karst Cave in Sumbermanjing Wetan District, Malang Regency]. *Prosiding Seminar Nasional Geotik*, 20–30.

Suyanto, Hadisantono, R., Kusnama, Chaniago, R., & Bahruddin, R. (1992). *Geologi Lembar Turen, Jawa*.

Wagner, T., Fritz, H., Stüwe, K., Nestroy, O., Rodnight, H., Hellstrom, J., & Benischke, R. (2011). Correlations of cave levels, stream terraces and planation surfaces along the

River Mur-Timing of landscape evolution along the eastern margin of the Alps. *Geomorphology*, 134(1–2), 62–78. https://doi.org/10.1016/j.geomorph.2011.04.024