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Public Participation in Identifying Sendang Biru Spring Catchment in Karst Area of Southern Malang, Indonesia

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Abstract: *Sendang Biru is a spring which located in Southern Malang karst area.This spring is utilized by the local people to fulfill their daily needs. The aim of this research is to determine the catchment area of Sendang Biru Spring by using public participation approach. The method used was public participation approach in research by identifying the problem and the condition. Furthermore, deciding the research spots that later will be checked. The results of the research is obtained by mapping the injection locations, namely Mbah Wajib Cave, Limbah Cave, and Swallow Hole. The injection was done in rainy season, in order to wait for the existence of water flow from the surface into the cave. It was done by the researcher along with the local people that usually make use of the spring. People and other related parties know that Sendang Biru has catchment area in Mbah Wajib Cave, and swallow hole. It can be seen visually that the solution poured/injected in these locations shows the connectivity with Sendang Biru Spring.*

Keywords: *public participation, karst, water catchment area*

Introduction

Sendang Biru Karst is located in the Southern part of Malang which is also part of South uplifted mountains in java Island[1] and has approximately 10° slop direction to the south[2]. Karst area in South Malang located in Wonosari formation, the result of the

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[2] Sjarifudin, M Z, and S Hamidi. *Geologi Lembar Blitar, Jawa*. Bandung: Pusat Penelitian dan Pengembangan Geologi, 1992.

collecting data is there are many caves, spring,and subterranean water in this formation[3]. The karst distribution extends from Donomulyo, Bantur, Gedangan, and Sumbermanjing Wetan regency. One of them is Sendang Biru karst taken place in Sumbermanjing Wetan.

The karst features landscape become attractive object to be observed more, as well as the connectivity among the karst features. Karst features such as spring, surface and under the surface have its connectivity. It goes along the study about these features related to the system in Pindul Cave and the surrounding area taken place in Basin Wonosari showed connectivity with the cave passages[4], it is showed in Jonggrangan karst[5], in Karangbolong karst[6], and in Gunungsewu karst[7]. The identifications that have been done provided information about the connectivity between these karst features.

The result of the identification that have been carried out in Sendang Biru [8] karst provided an overview about the connecting features. Sendang Biru is one of the springs

[3]Impala. *Studi Potensi Kawasan Karst Inventarisasi dan Pendataan Ponor, Mata Air, dan Telaga/Danau Karst Serta Pemetaan Fauna Gua Dan Studi Masyarakat Di Desa Kedungsalam, Kecamatan Donomulyo, Kabupaten Malang*. Malang: Mahasiswa Pecinta Alam Impala Universitas Brawijaya, 2012; Labib, Mohammad Ainul. *Speleogeomorfologi Karst di Kecamatan Donomulyo Kabupaten Malang*. . Yogyakarta: Universitas Gadjah Mada , 2016; Labib, Mohammad Ainul., Dwi Fitriani, Agung Suprianto, Alfi Sahrina, Syaiful Effendi, Khoirul Hidayat, Prasetyo Adi Irianto, Andika Aulya, Ayu Romadhoni, & Joko Agus Triyono. Karakteristik Lorong Vertikal Dan Chambers Gua Karst Kabupaten Malang. *Jurnal Geografi, Edukasi Dan Lingkungan (JGEL), 4(2),* 2020: 50–60. https://doi.org/10.29405/jgel.v4i2.4808; Salaka, MPA Jonggring. *Eksplorasi Kawasan Karst Sendang Biru Kabupaten Malang*. Yogyakarta: CV. Komojoyo Press, 2018.; Sahrina, Alfi, Dwi Fitriani, Agung Suprianto, and Mohammad Ainul Labib. "Potential and Challenges of Karst Water Resources in Sumbermanjing Wetan District of Malang Regency." *IOP Conference Series: Earth and Environmental Science, 412(1),* 2020. https://doi.org/10.1088/1755-1315/412/1/012032

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that has to be identified (Picture 1). Sendang Biru spring clear water is usually utilized by the local people of Tambakrejo Village. Most of them used the water to fulfill their daily needs, tourism needs, local industries, etc. The karst features in this spring are in the form of swallow hole, caves, subterranean river, and pond. Salaka (2018)[9] explained that some caves in Sendang Biru spring karst area were used as landfill, fish waste, and detergent residue disposal.

The importance of springs in this research locations, made groups of people or environmental community wanted to learn about Sendang Biru spring and its surroundings. This kind of activity involving the community had been conducted by doing survey of natural resources inventory[10] and by working on the community to be able to access water sources in the caves[11] . This made he local people and the community eager to identify the connectivity of karst features, by doing so certainly can keep the area of the spring and it surroundings.

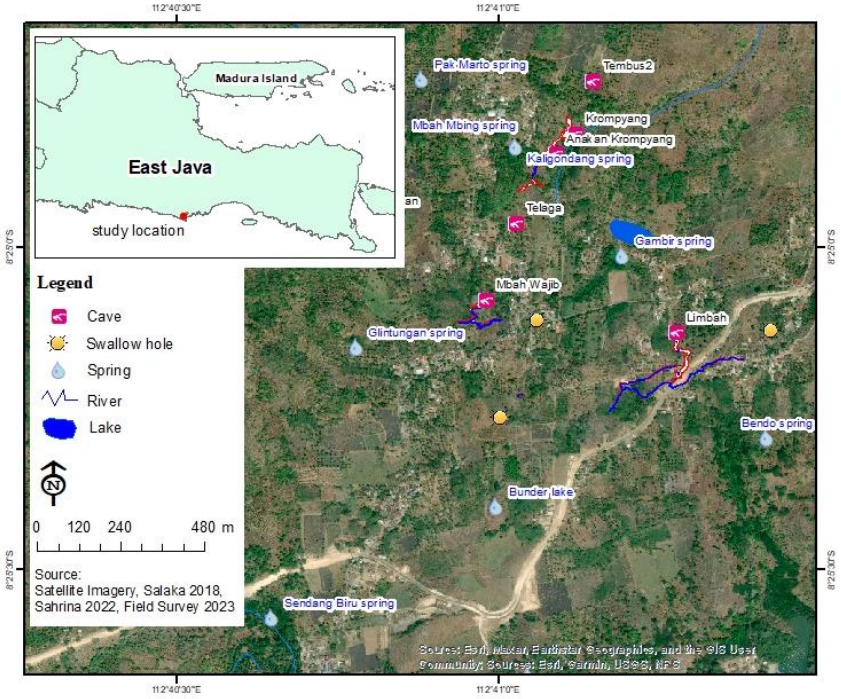

Figure 1. The Existence of Karst Features Surrounds Sendang Biru Spring Karst

Method

Public participation approach in this research was conducted to ease and cultivate

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environmental aspect to the local people. Identifying the connectivity between karst features and Sendang Biru Spring can be used as new information for the local people and the environmental community related to the connectivity aspect of karst area. Tracer test conducted in three locations near Sendang Biru Spring, namely Mbah Wajib Cave, Mbah Laipan Swallow Hole, and Limbah Cave. To record the water color changing can be done by monitoring to see the water changing, after been injected by the solution in pouring spots. The people involvement in planning activity, action, monitoring, and taking the results were the way to get the community involved in this research. Figure 2 shows the research activities by sing public participation approach. Visualization of the location and the connectivity between the karst features and Sendang Biru Spring using ArcGis application, where the data been added, to determine the location and direction of Sendang Biru Spring

Figure 2. Research Design of Public Participation Activity

Result

Finding Problem

Sendang Biru Spring is the only water source to the Sendang Biru people. One of the communities called Bhakti Alam Sendang Biru which is engaged in observation and the environment, wanted to determine which area that become te source of Sendang Biru Spring, so that it can protect the area from human damage. In addition, to reduce pollution in certain areas considering that the caves in springs area mostly used as landfill, which later can decrease the quality of Sendang Biru Spring

Planning

The result of endokarst landscape in Sendang Biru Karst become the background of action determination in checking he flow of subterranean river that connected to Sendang Biru Spring, The theme of this action is “Padha Njaga Weninge Tirta”, which means "Together We Keep the Spring Clean" in Javanese. The aspects that will be paid attention are the involvement of stakeholders, communities, spring managers and other parties who will be involved in maintaining the source. The locations that will be used for injection can be seen in Table 1.

Table. 1 Pouring Planning in several Spots of Karst Features

Pouring Time	Pouring Location	Pouring Spots
November 2022	Mbah Wajib Cave	Mouth cave where the water flows
Desember 2022	Swallow Hole Mbah Laipan	In Rainy season, there surface river that comes from Gambir Spring that goes into the swallow hole
Januari 2023	Limbah Cave	Injection in subterranean river, because there is no water inside the cave.

Socialization and Coordination

The identification of Sendang Biru Spring was done by conducting tracer test carried out by giving prior socialization about the planned activity by the community. It is conducted in the village hall, attended by the elders of Tambakrejo, village officers, PDAM Sendang Biru Spring, KUD (Village Unit Cooperative), Bhakti Alam Sedang Biru Community, and other communities. It given to provide an overview of the methods and materials used, as well as the location of the injection spots in several caves and ponds. Figure 3 shows the socialization and coordination activities before pouring activities in Karst features.

Figure 3. Sosialization and Coordination dan Koordinasi of Some Parties Utilizing Sendang Biru Spring Related to the Water Tracer Test

Community participation in research

The activity of pouring solution in several spots have been scheduled participatively by local people. The first location done in Mbah Wajib Cave in November 11th 2022 in the afternoonafter socialization. The second location isswallow hole, where the surface water from Gambir Spring goes into the swallow hole. In this location, observation spots done in Sendang Biru and Bunder Pond, because the position is near the second pouring spots. The third location is done together by entering Limbah Cave first, because the subterranean river taken place in the T-junction of the passage. Figure 4 shows the local people participation in identifying Sendang Biru Spring catchment.

Figure 4. The local people participation in Identifying Sendang Biru Spring Catchment

Monitoring

After injecting several spots, observation of the Sendang Biru Spring being conducted. It is done by the community and the representatives who had previously participated in previous pouring activity. In the first pouring conducted at Mbah Waib Cave, the result was the solution came out in November 12th 2022 around 7 in the morning Indonesian Time. In the second pouring which located in swallow hole, the result was the solute came out from Sendang Biru in January 15th, 2023, around 9.15 morning Indonesian Time, it appeared in Bunder Pond, but was not detected the time. At the third location in the subterranean river of Limbah Cave, the solution came out in January 28h, 2023, 15:14 Indonesian Time. Figure 5 shows some of the results of the connectivity between karst features and Sendang Biru Spring.

Figure 5. The Results of Connectivity between Karst Features and Sendang Biru Spring

Table 2 shows the results of monitoring or observing the results of the tracer tests connected to Sendang Biru Spring. In pouring process taken place in subterranean river, the time span of occurrence is faster than the one in the swallow hole. The swallow hole may still be stuck in a condition that results in slow water flow. In Bunder pond, no pouring is done because when pouring in the swallow hole there is a connection with the bunder lake, so that it becomes one system with Sendang Biru Spring.

Table. 2 The Results of Pouring the Solution

Pouring Location	Pouring	Pouring Spots	Outcomer	Time Span	Connectivity
Mbah Wajib Cave	November 11th, 2022 15:00 Indonesian Time	mouth cave	November 12th, 2022 07:00 Indonesian Time	± 16 hrs	connected to Sendang Biru
Swallow Hole Mbah Laipan	January 13th, 2023 16:50 Indonesian Time	swallow hole	January 15th, 2023 09:15 Indonesian Time	± 40 hrs 25 mins	connected to Sedang Biru and Bunder Pond
Limbah Cave	January 27rd, 2023 15:58 Indonesian Time	subterranean river	28 Januari 2023 jam 15:14 WIB	± 23 hrs 16 mins	connected to Sendang Biru

Results and evaluation of community action

The research activity on identifying the connection to the blue spring water carried out by the community and the community can certainly explain several aspects related to the catchment area of the Sendang Biru Spring water. Previously, the community only suspected the connection with several locations in the karst feature, such as the proximity between karst features that could be connected, the same change in turbidity if the catchment area changed. With this inference and proven by water tracer tests, the community can gain an understanding of the input or recharge of the spring water of Sendang Biru. Many karst features can be identified more to determine the overall catchment area or recharge of Sendang Biru Spring. Figure 6 shows an overview of the location and direction of the connectivity to Sendang Biru. Of course, the identification area is still around Sendang Biru Spring area, and could be extended to other areas.

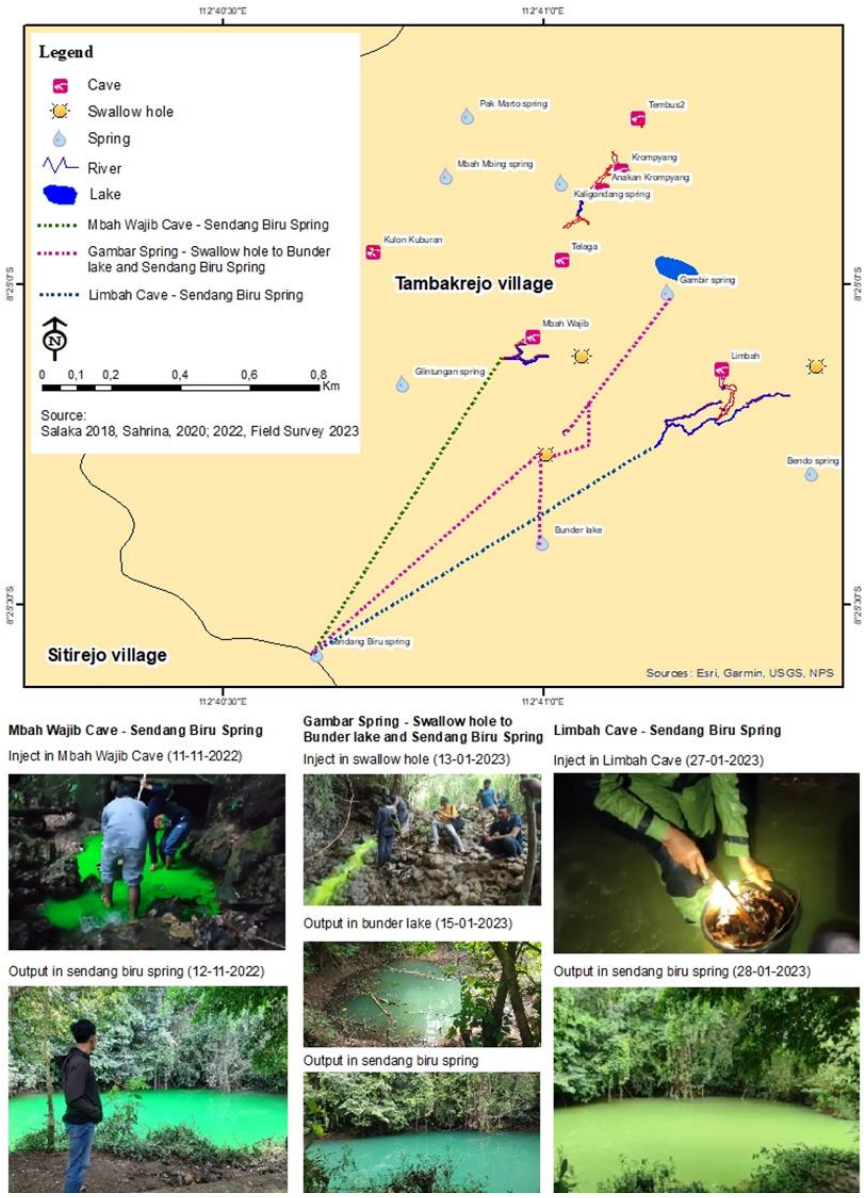

Figure 6. An Overview of Sendang Biru and Karst Features

A public participation research definitely become a lesson for the local people to determine the condition of catchment area of Sendang Biru. The result found is there are many connectivities between the springs. The surface landscape still have to be observed more, to preserve these water resources, many ways needed so that the springs remain sustainable, here are some ways to do:

- Cleaning the condition of the cave from garbage inside the cave.
- Socializing that caves and swallow hoes are inseparable parts of Sendang Biru Spring.
- Socializing the people to protect the environment.
- Cooperating with stakeholders and government to protect water catchment area.

Discussion

The public/environmental community participation approach in research activities is needed to be able to make findings about the conditions in the area they live in. People who live in Tambakrejo Village with the characteristics of the karts landscape must certainly see the conditions of its surrounding area, the number of caves that develop[12], the presence of springs [13] [14], and the existence of subterranean rivers [15]must be understood by people who live in the karst area of Sendang Biru. Of course, each karst feature is connected to other karst features

By knowing the surrounding area of Sendnag Biru Spring, the community can maintain the surroundings so that pollution does not occur. Considering that these karst features can make the entry of pollutants into the groundwater system such as swallow holes, caves/subterranean rivers [16] [17]. In addition, it can protect the surrounding environment by not logging or changing land morphology, considering that some locations that experience morphological changes affect caves/ swallow holes covered with soil or tree trunks[18]. By looking at these conditions, the community can be educated regarding preserving the karst ecosystem so that it can be well maintained. Education in Sendang Biru Karst has been carried out by Sahrina et al., (2022)[19] by providing an overview of the conditions that occur in Sendang Biru karst to community groups and environmental communities.

The role of the environmental community by conducting this research is to mitigate the problems of water resources in Sendang Biru Karst. The role of the community can be done by not doing littering in the swallow hole/ cave, this is also

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conveyed by Wijayanti et al., (2022)[20] because it becomes a place for water to enter. The role of the community in mitigating drought disasters by protecting and preserving water sources with one of them maintaining the function of water areas[21]. Arida (2022)[22] explains the role of community organizations with watershed management through agro-forestry and spring conservation, by optimizing in forest rehabilitation, land and water resource conservation. Of course, the surrounding area in the karst area of Sendang Biru being deforestation in the catchment area to optimize water resources in the karst area.

The involvement of community groups in research related to water catchment areas can be used as environmental supervisors around the springs. Generally, monitoring of water resources is related to water use, but monitoring in this area is related to the behavior of the surrounding community in preserving water resources[23] [24]. Given the karst area features in the form of caves/swallow holes in South Malang are widely used for garbage disposal[25] [26]. Of course, with the supervision of the community group, they can be more careful in protecting the spring.

Conclusion

The observation of water resources in karst areas can be carried out by the community or environmental community through research activities in identifying of spring catchment areas. Sendang Biru Spring is a spring that is needed by the community in Tambakrejo village, definitely in conducting observations related to the surrounding area of the spring can be done by the surrounding community. observations related to water resources in karst areas can be carried out with water tracer tests, by pouring solution in locations where connection is possible. The results of the identification carried

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out by the community showed that there is a connection between other karst features and the Sendang Biru Spring, namely Mbah Wajib Cave, Limbah Cave, and mbah Laipan swallow hole. There are many other karst features that have not yet been identified, so this research can still be continued. However, knowing the catchment area can be used as a means of education by the community in preserving Sendang Biru Spring water. In addition, community groups can certainly become supervisors to maintain the quality and quantity of Sendang Biru Spring water.

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