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Ground water potential assessment of Jatijajar-Ayah-Karangbolong mountain area, South Gombong

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Abstract. South Gombong is an area of central Java having quite potential natural resources including ground water. A geohydrological survey has been conducted to explore and analyze ground water potential of South Gombong mountain area. Geological knowledge of the area indicates the presence of Karst topography generated from limestone rocks exposed to the earth surface and tropical climatological process. The ground water resource and reserve that formed particularly in the Karst area has been utilized for various purposes, such as for agricultural land, use for drinking water, and others. The survey, as well as data and information analysis, have been performed, outputting figures of how significant the ground water resources in the area are. It is concluded that detailed study and understanding about Karst and its ground water formation are important to develop and to preserve the existence of ground water in the area for living.
Keywords: ground water, karst topography, resource and reserve

1. Introduction

A geological survey has been conducted to collect geohydrological information around Jatijajar, Buayan, Ayah, and Karangbolong areas, located in the hills and mountains in South Gombong. As part of the task, the survey team also conducted geological observations and research in the area.

In general, the communities in South Gombong have diverse livelihoods and development of the area. Among others are agricultural activities (planting rice, vegetables, corn, cassava, etc.), as well as mining igneous, volcanic rocks, and sediment (limestone) as building materials for tourism ventures (Jatijajar Cave, Ayah Beach), etc. These activities require water resources for various purposes, such as for rice cultivation, vegetables, drinking water sources, etc. It becomes a problem when the water source is disrupted due to the specific geological conditions of the soil and rocks around the area.

Geologically, the area of South Gombong is a hill formed by volcanic rocks (breccias, igneous rocks) and sedimentary rocks (limestones, sandstones, napal, etc.) that form geological conditions with distinct groundwater potentials, especially in the areas where stratigraphically limestone sedimentary rocks are located on the surface of the earth. This specific geological condition of the area is interesting to be studied as a mean to exploit and develop the potential of groundwater resources (geohydrology), particularly to acquire, develop efforts, and conserve groundwater sources for various activities requiring water as the basic need of life. Groundwater in this area has been utilized for numerous purposes, such as water sources for rice paddy fields, vegetables, drinking water, small industries, etc.

By understanding the geological condition, especially geohydrological properties, it is expected to be able to maintain, develop, and preserve the groundwater sources in this area for various needs.

Geohydrological research requires to be developed and deepened as a significant consideration in the discovery, mining, and utilization of groundwater sources for the people in this area.

2. Research Method

2.1. Regional Geology

The geological map areas are located in South Gombong (Kebumen District) covering five main areas, i.e.surrounding Ijo Tunnel, Jatijajar Cave, Ayah Beach, Karangbolong, and Buayan District. Figure 1 depicts the region's topographic appearance from an aerial photograph.

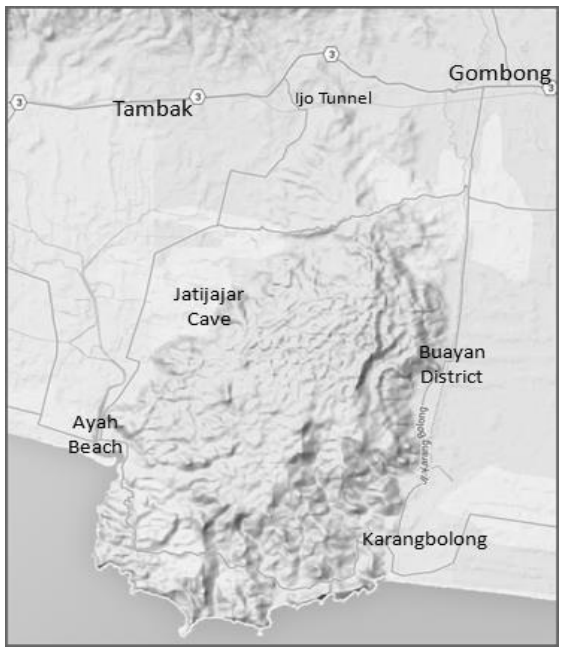

Figure 1. Geological map of South Gombong area, Kebumen District.

Volcanic activities have affected the Gabon Formation, resulting in the andesite rock intrusions. Above the Gabon formation, sedimentary rock deposits were formed around Central Miocene and are grouped into the Kalipucang Formation. Lithologically, the rocks constituting this structure include coral (non-clastic) limestone, local clastic limestone, and formed bitumen shaleat the bottom. When this lithology was exposed above the sea level to turn into the mainland,it developed karst topography.

In the final Miocene, sediments were deposited and formed coalescence of sandstone, claystone, marl, and tuffs with breccia inserts. The deposition process is influenced by turbidity currents and underwater seepage. These rocks are grouped in the Halang Formation, stretching along the northern part of this area. Unconformably, in the Quaternary period until now, alluvial deposits are reserved, composed by loose deposits of clay, silt, sand, gravel, and crust with various compositions of older rock formations.

2.2. Geology and Geohydrology of South Gombong Area

2.2.1. Local Geology

Observations, investigations, and comprehending aspects of geohydrology of the area were also conducted along with the geological surveys. The agricultural activities of the community around South Gombong and the exploitation of drinking water by a Drink Water Company (PAM, Perusahaan Air Minum) are appealing to be developed further. Therefore, an advanced research is highly feasible and recommended to maintain the supply of water resources for agricultural activities, the provision of

drinking water, and other activities such as for small industries (livestock, building material production, cave tours, etc.).

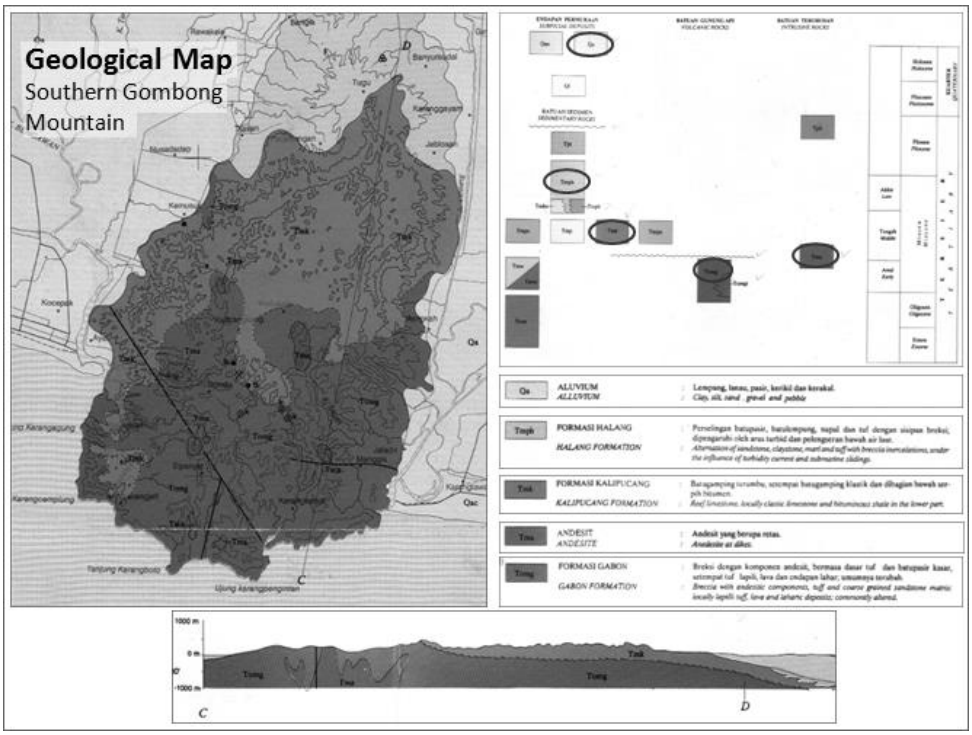

Figure 2. Regional geological maps and stratigraphy as well as geological sections of South Gombong area [1].

The observation of geohydrological aspects of this area is carried out by considering the appearances of morphology, rock composition, and stratigraphic learning to understand the genesis and the formation process of rocks found in the area. Along with these geological mapping activities, observations of issues related to the use of water resources were also covered, such as problems concerning irrigation of rice fields and vegetable plantations, provision of drinking water, livestock, and mining of construction materials (igneous rock blocks, limestone, sand, etc.).

Based on the observations of comprehending the community activities, it is clear that the need for water depends on the presence of the springs, especially in the hills. Rice fields and vegetable crops in the rather high areas use the water source coming from the springs of the surrounding. Figure 2 shows a geological map on the plateau around Buayan-Karangbolong-Ayah region. The agricultural area on the plains is quite high up, but it can still grow because the source of irrigation comes from the springs in the vicinity. Appendix of this paper shows photographs around the plateau with springs as the source of agricultural water, drinking water, etc. throughout the area of Buayan, Karangbolong to Ayah.

2.2.2. South Gombong Geology and Ground Water Potential

Based on the observations and early geological research around South Gombong area, an overview of geological state can be derived to interpret the subsurface conditions. Figure 4 shows a model of the geological map of the "X" area in South Gombong that is depicted based on data and information from the field. Figures 3 and 4 show the initial geological analysis gained from field observations, illustrated by the interpretation results. Real and accurate conditions can be obtained by drilling, for example, to collect data and information related to subsurface conditions, in particular, to know more specific situations about the geohydrology reservoir in this area.

The process of forming other sediments continued until the end of the Miocene, subsequently underwent geological tectonic processes such as lifting, folding, fracturing, and various structural

manifestation. The raised rocks then suffered weathering, erosion, transportation, and sedimentation which until now form alluvial, eluvial, and colluvial deposits.

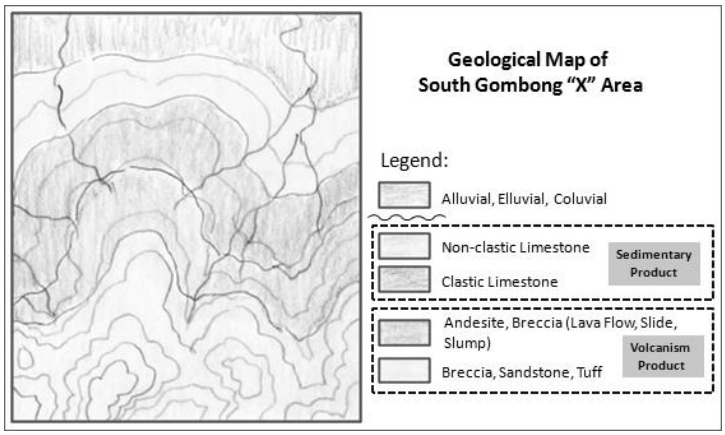

Figure 3. The geological map of South Gombong "X" area as the model of the study area, drawn based on field data and information.

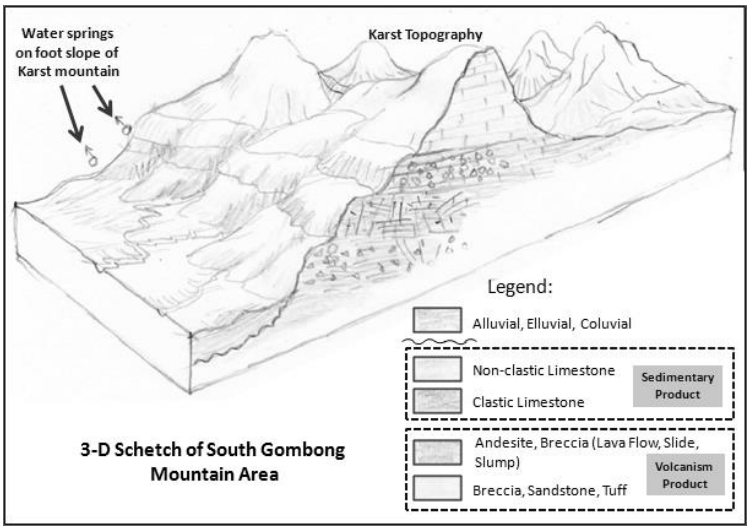

Figure 4. A three-dimensional view showing the cross-section model of the geological map of South Gombong "X" area

3. Results and Discussion

3.1. Geohydrology Assessment of South Gombong Area

Due to the influence of weather (tropical) in the presence of rain, the stretch of clastic limestone, especially in the area of Buayan to the south coast, forms the topography of Karst. Karst is a German word derived from Slovenian (Kras) which means rocky, arid land. This term in its home country is not really related to limestone and the dissolution process, but nowadays 'Kras' has been adopted for the landform of the process of solubility. Researchers define karst as a field with typical hydrological conditions as a result of soluble rocks and has well-developed secondary porosity:

Karst is characterized by:
1) the presence of a closed basin and or a dry valley in various sizes and shapes,
2) the scarcity or absence of drainage/river surface, and
3) the presence of caves from the underground drainage system.

Characters 1, 2, and 3 are evident on the limestone hillsides of South Gombong mountain area which in geomorphological units have been referred to as Karst hill units. Character 1 in this mapping area forms a valley as a plateau with springs at the base of the hillside slopes. The highlands have been managed by local people into the agricultural land. The results are interpretations as expressed and described in Figures 3, 4, 5, 6

3.2. Karst Hydrology and Utilization of Water Resource

Concerning the utilization of the highlands of this area into agricultural land as well as the acquisition of drinking water sources from groundwater emerging at the bottom of the hill slopes, in-depth research is required for the development and preservation of groundwater sources. The basic hydrological and geological knowledge of the area needs to be studied more carefully for the development of such utilization.

Hydrology is specifically categorized as the study of water phenomena on land/earth, descriptions of the effect of soil properties on water, the physical influence of water on the terrain, as well as the study of the relationship of water to life. Karst is known as a unique area and is characterized by exocarst topography such as karst valley, doline, uvala, polje, karren, cone karst, and the development of a much more dominant underground drainage system than its surface flow system [2].

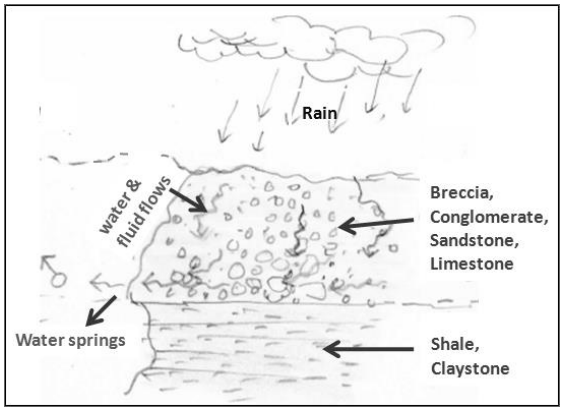

Figure 5. Natural groundwater formation and the emerging water springs.

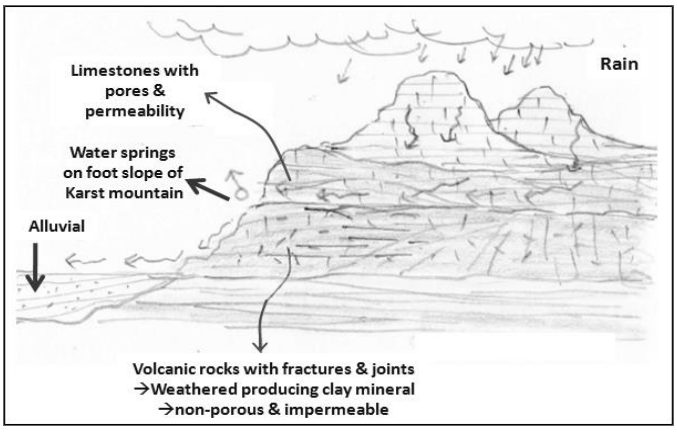

Figure 6. A cross-section of geological model of the South Gombong "X" area, potentially streamed by ground water, emerging as springs and rivers in the highlands.

The hydrologic cycle is the circulation of water on earth from the atmosphere, on the surface of the earth, and below the earth's surface. During the cycle, the water can change its form to solid, liquid, or gas phase, depending on the environmental conditions of the hydrological cycle. The amount of water

in the hydrological cycle is always fixed and only changes its position from time to time due to weather effects [3].

Researcher [7] describes that there are three main components of the karst hydrological system: aquifers, surface hydrological systems, and subsurface hydrological systems. In karst, the subsurface basin can be identified by looking for links between swallow holes and springs. This subsurface basin can be correlated with the surface flow drainage (watershed) if the fluid alleyways below the surface are primarily sourced to surface streams entering through the ponor. However, in general, the boundaries between the surface and subsurface watersheds are not the same. Subsoil systems, especially those with low groundwater slopes, can have multiple paths and outlets (springs). Furthermore, as the development of the dissolving process continues, the groundwater, aquatic, and underground rivers in karst aquifer can also change over time.

Based on the aforementioned description, it is apparent that the utilization and development of groundwater sources in this area requires in-depth studies, including subsurface surveys (geochemistry, geophysics, and even exploratory drilling) because thorough knowledge is remarkably useful in the utilization of groundwater resources, not only for agricultural land needs but also more importantly, as a source of drinking water.

4. Conclusion

Based on the survey, analysis, and evaluation of data obtained from the hills and mountains in South Gombong area, several things can be concluded: Geologically, this area is composed by a number of rocks from volcanic species to sediments that can be used as a basis for understanding specific things such as potential aspects of water resources.The limestone layer as one of the units showing the clastic and non-clastic species lies above the volcanic rock, covered by other types of sedimentary rocks formed by different compositions and genesis.Due to the removal of layers of rock to become a flat land, the process of weathering, erosion, transportation, and deposition, a specific geomorphological topography and appearance has formed. In particular, the limestone distribution forms the topography of Karst.The observations and field survey results show the existence of utilization of karst highlands for agricultural land as well as the use of springs for drinking water.Concerning the growing need of water resources as a source of irrigation for agricultural land, drinking water, and other purposes such as small industries, it is necessary to develop water supply procurement from existing groundwater sources.This deep understanding of the hydrogeology of the region is expected to facilitate the development of water supply procurement for various purposes and conservation of water resources in this area.

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