THE ERUPTION IMPACTS TO THE SPRINGS OF MT. MERAPI

By Listiyani Retno Astuti

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T. Listyani R.A.
Geological Department, College of Technology STTNAS Yogyakarta
Email : listyani_theo@yahoo.co.id

Abstract

Spring is a natural phenomenon that is commonly found on the slopes of a volcano. Springs appearance in Mt. Merapi are controlled by the local geological conditions, including geomorphology, lithology and geological structure. This research carried out by hidrogeological survey of several springs at southern slope area of Merapi Mt. before eruption, combined with secondary data of springs after eruption. Sampling have been taken together with hydrogeological survey by collecting data of hydrogeological characteristics such as aquifers condition and hydrochemical of springs.

The condition of existing springs in this area are also influenced by the eruption activities of Mt. Merapi. Changes in quantity and quality due to a fairly powerful eruption activities for approximately one month since October 26th, 2010. Some springs in the vicinity of Mt. Merapi still produce, although they reduce the discharge. There is Umbul Lanang spring that showed increasing of discharge. However, in general, many springs damaged and even do not produce water any more since buried by volcanic materials. Most of the pipelines do not function because of twofold; the volcanic materials broke or mud clogged them. Some of the pipe was totally destroyed by volcanic materials, or by hitting of cold lahars of Merapi.

Key words : Merapi, eruption, spring, impact, volcanic material

Abstrak

Mata air merupakan fenomena alam yang umum ditemukan di lereng gunung berapi. Pemunculan mata air di G. Merapi dikontrol oleh kondisi geologi daerah tersebut, meliputi geomorfologi, litologi maupun struktur geologi. Penelitian ini diawali dengan survey hidrogeologi di lereng selatan G. Merapi sebelum erupsi, dikombinasikan dengan data-data sekunder kondisi mataair pasca erupsi Merapi. Pengambilan sampel dilakukan pada saat survei hidrogeologi dengan melakukan pendataan geohidrologi, seperti kondisi akifer dan hidrokimia mataair.

Kondisi mata air yang ada di daerah ini juga dipengaruhi oleh aktivitas erupsi G. Merapi beberapa waktu yang lalu. Perubahan kuantitas dan kualitas terjadi akibat aktivitas erupsi yang cukup dahsyat selama kurang lebih satu bulan sejak 26 Oktober 2010. Beberapa mataair di sekitar G. Merapi masih berfungsi, walaupun dischargenya berkurang. Adapula mata air yang menunjukkan kenaikan discharge (Umbul Lanang). Namun, secara umum banyak mata air yang rusak bahkan hilang karena tertimbun material vulkanik. Jaringan perpipaan banyak yang rusak, pipa air bersih dari sejumlah mata air tidak berfungsi. Sekalipun ada yang tidak jebol, namun pipa tersumbat lumpur. Beberapa pipa hancur diterjang material vulkanik, atau karena dihantam lahar dingin Merapi.

Kata kunci : Merapi, erupsi, mata air, dampak, material vulkanik

Introduction

On October 26th and November 5th, 2010 Mt. Merapi at boundary of Central Java and Yogyakarta Special Regency went off. According to Jatim Explore (Anonim, 2010a), until November 19th, 2010 at least 275 people died and about 300.000 people displaced within a radius of 15 – 20 km from the peak for nearly a month. In late November 2010 the dangerous activity of Mt. Merapi was reduced. Although it has not been officially declared as safe by Center of Volcanology and Geological Hazard Mitigation, most residents had returned home and immediately struggled to overcome the water crisis. Pyroclastic flows, hot clouds called "*wedhus gembel*" and cold boulder lahars slide down the slope through some rivers to the foot of Mt. Merapi. Volcanic ash stored up most open water reservoir, in addition to destroyed almost all of plants and crops. There was a newspaper revealed two threats at the western part of Mt. Merapi peak, such as sulfuric poisoning and lack of water. It is estimated about 20 – 30% of total evacuee in 3 – 6 months later lived under the threat of water crisis. Ironically, just after the evacuation, they needed water in the amount more than normal, especially for washing the furnishing, in addition to cultivating and breeding. The lack of water has became main problem for many people surrounding Mt. Merapi.

As in other volcanic regions, the slope of Mt. Merapi has many springs, especially in the slope break. The 2010 eruption activity of Mt. Merapi effected some impacts to many springs in its vicinity. For this reason, the research have been done to understand about springs condition and the impact of the eruption. The spring condition summarized based on field survey at some springs at southern slope of Merapi before eruption as well as by searching of several on-line sites related with post-eruption springs (Figure 1).

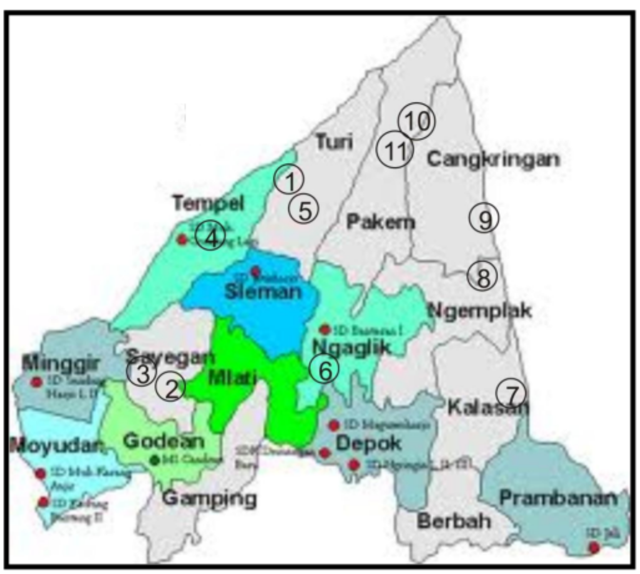

Figure 1. Admisnistrative map of Sleman District and stop sites of groundwater research at southern slope of Mt. Merapi.

(1) Stop site

Theory

Merapi is a famous but hazardous volcano in the world. It has a special character called Merapi type. Based on its eruption characteristic, this active volcano categorizes into volcano with lava dome (Zaennudin, 2010). Morphologically, this volcano is conical in shaped with lava dome on its summit. Within five decades this volcano had built new lava dome and produced several events of dome collapsed pyroclastic flows.

Lava dome forming is often followed by lava flows and or pyroclastic flows generated by dome collapse or lava avalanche. Thin ash fall deposits are generally related to pyroclastic flows which is distributed locally depends on prevailing wind during the emplacement of the pyroclastic flows. Pyroclastic flow deposits are usually found in valleys close to the lava dome or lava flows up to 5 km away (Zaennudin, 2010). Then, the pyroclastic flows might be annoyed hydrologic or hydrogeologic system at this area.

The southern slope area of Merapi are part of groundwater basin which geologically belong to volcanic aquifer system. Many springs exposed on this area, with low to high discharge, spread from middle slope until foot slope. According to Deny Juanda (2006), springs of volcanic system have vary in discharge from several up to tens or even hundreds liter per second. This volcanic sedimentary sequence caused much groundwater accumulation at the foot slope indicated by many significant discharge springs. Generally, springs appear at middle part of the mountain, controlled by different permeability rocks contact, or breaking of slopes.

Volcanic terrains are built up by lava rocks, or pyroclastic deposits, or both, in varying proportions. Many predominantly volcanic formations include also sedimentary rocks, such as river alluvium, ancient soils, and lake and marine deposits. Volcanic rocks have widely varying hydrologic properties, making predictions about groundwater possibilities uncertain. Some lavas contain excellent aquifers; other are practically impermeable (Mandel and Shiftan, 1981; Figure 2). Deny Juanda (2006) reveal that volcanic aquifer system consist of pyroclastic deposits usually with more than 1 m weathered zone, porous, uncompacted, intercalated with impermeable lava.

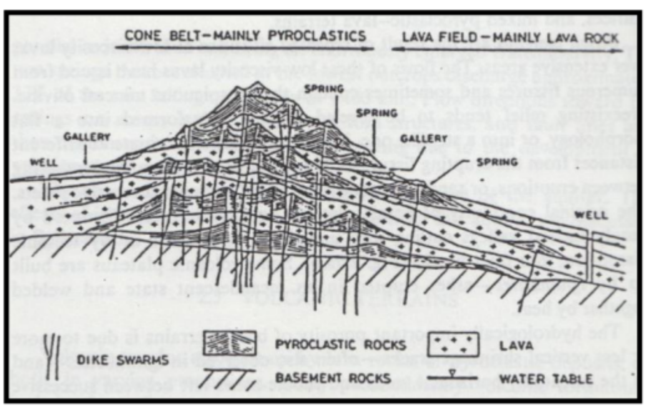

Figure 2. Type of aquifer system in volcanic terrain (Mandel dan Shiftan, 1981).

Method

Geological field survey have been carried out several weeks before Merapi eruption at many springs at the southern slope area. This survey have been done to observe hydrogeological appearance of springs. The observation concerned to describe geomorphology, stratigraphy as well as geological structure characteristics. Some places have been visited were : Bedog (Godean), Klangkapan (Seyegan), Lumbungrejo (Tempel), Pajangan (Ngaglik), Umbul Joholanang (Prambanan), Wonokerto (Turi), Umbul Lanang and Umbul Wadon (Kuning River) springs. The data sampling have been analyzed as springs condition before eruption.

Then, the springs data after eruption got from secondary data. The impact of eruption to the springs can be understood from secondary data by searching websites, related with springs after Merapi's eruption. Some condition should be compared by analizing of available information from websites and the results of previous field survey.

Research designed as hydrogeological survey before eruption, combined with analysis of secondary data about springs after eruptions. The amount of existing and damaged/missing springs are difficult to know because of limitation of data. Some research questions can be summarized below :

1. Are there any geological condition influenced the springs appearance at the slope of Mt. Merapi?
2. What do the aquifer characteristics of springs?
3. Was the eruption of Merapi influenced spings's discharge?
4. How about the impact of eruption to the springs?
5. What kind of these impacts?

Discussion

Hydrogeological survey has been carried out before eruption. This research show that geological factors influenced the occurence of springs. The aquifers of springs of Merapi Mt., especially at southern slope of this mountain usually have intergranular / matrix aquifer. These aquifers consist of andesite breccias, sandstones as well as alluvial sediments or thick soil covering its bed rocks. The springs usually have Na, Mg cations and HCO_3 and anion dominantly. Sulphate exist significantly only in springs at northern region (Turi or Kuning River) (Listyani, 2010).

Many springs appear at some places around Mt. Merapi. This appearance controlled by geological condition. This paper should be discussed about this phenomena and the impact of eruption to springs, by choosing any examples ones.

The springs usually appear at break of slope, or at different permeability rocks contact. At many places at the southern slope of Merapi, springs occured as concentration pf groundwater flow through inter granular or crack porosity. Mostly, springs flow out of andesite breccia in addition to volcanic sandstone. The weathering strong supported to the springs occurence. Some springs appear between alluvial deposits. Hydrolic characteristics show permeability of aquifer as high as $0,11.10^{-2}$ cm/s to $17,2.10^{-2}$ cm/s (Listyani, 2010).

Here are some explanation about springs which have been chosen for examples, mostly from the southern part of Merapi.

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1. **Springs at Umbulharjo Village, Cangkringan (Kuning River)**

There are many springs found at the upstream of Kuning River. Two of the most discharge springs are Umbul Wadon and Umbul Lanang (Figure 3). Before eruption, these two springs are already discharge large discharge of groundwater from volcanic aquifer.

Figure 3. Upstream of Kuning River has many springs, the high discharge of them are Umbul Lanang (a) dan Umbul Wadon (b). Photograph was taken before eruption.

Joewono (2010) on October 28th, 2010 revealed that Mt. Merapi explotion didn't deteriorate Umbul Wadon spring which is menyebutkan bahwa letusan Gunung Merapi tidak sampai merusak mata air Umbul Wadon, which became mainstay for residents of Merapi sloping area and also Regional Water Company of Sleman District for supplying raw water. Umbul Wadon spring at the base of Kuning River (Figure 4) didn't get any problem in its discharge as well as quality. The water usually distributes to Pakem, Ngemplak, Sleman, Mlati, Depok and Kalasan Sub Districts. Nevertheless, most refugees of Hargobinangun Village have difficulty in clean water supply because of volcanic ash polution in river or springs.

Figure 4. Landform of Kuning River at southern slope of Merapi. There is several springs appear along the river, even in high discharge such as Umbul Wadon and Umbul Lanang.

Until Sunday, 12th of December, 2010, as Estily (2010) and also TvOne (Anonim, 2010b) said, Umbul Wadon and Umbul Lanang still safe although almost all of drainage pipes have been broken by eruption materials. The two springs themselves didn't buried by laharic materials. These springs provide water supply for people of Sleman Regency and Yogyakarta City, in addition to the agricultural irrigation at northern part Sleman Fortunately, the water discharge discharged by Umbul Lanang even increase from 15 l/s before eruption up to 400 l/s, while Umbul Wadon buried slightly by Merapi materials, its discharge become reduced. Before eruption, water discharge of Umbul Wadon reached 350 to 400 l/s (Chair of Sleman Energy & Mineral Resource Agency *vide* Estily, 2010).

In order to get clean water, the people at Umbulharjo used water stored in drums as governmental subsidy (Figure 5). Actually, this water provided by Indonesia Red Cross has been insufficient yet, so the people must take the water from the springs. However, JPNN (Anonim, 2010d) reported on 22nd of December, 2010 that water pipes at Kuning River were broke.

Figure 5. The people at Umbulharjo, flocked to take clean water after stored in water tanks.

2. Springs at Turgo Area

The 2010 Merapi eruption left less amused thing for citizens of Turgo area (small country at Purwobinangun Village, Pakem Sub District, caused water drainage were broken apart stricken by cold lahar of Boyong River. The spring at this area, namely Candi Spring, difficult to reach because it is located at steep slope, about 5 km from Merapi summit (Budiharto, 2011). This spring drain the water after the people worked together to repaired the pipelines (Figure 6).

Figure 6. People at Turgo worked together to improve pipelines from Candi Spring (Budiharto, 2011).

3. Springs at Turi Sub District

Turi region has several springs whose discharge generally small to medium. One of them can be found at Manggungsari (Figure 7). At this small country, at least there are two springs support residents life. These springs appear from massive, clastic volcanic andesite breccia, with pebble to cobble fragments, and coarse sandy to clayey matrix. The top of aquifer layers have measured permeability as high as $1{,}69.10^{-2}$ cm/s (Listyani, 2010).

Figure 7. Several springs appear from volcanic breccia aquifer at Turi, Sleman (picture is taken before eruption).

Water pipe line at Wonokerto Village, Turi Sub District used for needs of residents were also broke because of Merapi eruption (Purwoko, 2011). Prior to this hazard, the water supply here were depended on their 27 own springs. But now, 20 of them broke, and the rest still produce water although their location have shifted from river banks to the cliff because of the deepening of river effected by laharic erosion.

4. Some springs at Magelang

People at the another area like Magelang, for example at Srumbung, Dukun, dan Sawangan Sub Districts (Magelang District) had experience in water shortage because the installation of water pipelines damaged caused by hitting of cold laharic flood or mud clogging. Several springs even do not produce water any more because of volcanic materials burial. The laharic materials also clogged irrigation channels, make difficulty in cultivation. Water pipeline passing through the river drifted due to hitting of cold lava flood effected the clean water supply to homes totally stopped. Some residents were forced to take water on foot so far (Figure 8).

Figure 8. People of Tontro got difficulty for gaining clean water. They must go on foot as far as 1 – 2 km to reach the spring (Anonim, 2011).

The eruption of Merapi has made clean water means damaged, so that most water sources from a number of river discharge decreased (Anonim, 2011). The trees in the forest parks also damaged by the eruption. During this time, the existence of these trees were were enough to retaining water stored in soil. There were significant damage resulted by eruption (Zakaria, 2011). The eruption indicated by surge of hot clouds, lava slides, and volcanic ash rain, estimated to have polluted the water sources, for example at Ngargomulyo Village (Anonim, 2010c). But in some places, the eruption didn't damage water source. Some water sources condition at Magelang and their condition after eruption summarized in Table 1 below.

Table 1. Water source condition at Magelang District after eruption.

Water source	Consumer	Explanation
Cacaban Sring (5 km westward from summit)	Tontro small country (Sumber Village), Karanganyar (Ngargomulyo Village)	Infrastructure / water pipes were damaged by hitting of cold laharic flow (Anonim, 2011).
Ngandong Spring; Lamat River, 6 km westward from summit	Bojong Country (Ngargomulyo Village).	- The damage of infra structure caused by cold laharic flood - Main water reservoir covered by bamboo trees fallen by volcanic ash rain (Anonim, 2011).
Blongkeng Spring	Bojong Country (Ngargomulyo Village, Dukun Sub District)	- Spring damaged by laharic flow. - Water flow broke down (Anonim, 2011).
Luwih Spring	Dukun Sub District	- The spring still flow. - The eruption didn't effect the spring (Atmoko, 2010).
Gemer Spring (3 – 4 km south west; between Blongkeng & Lamat Rivers)	Gemer Country, Ngargomulyo Village	- Spring resisted from eruption - The eruption materials poisoned and clogged local water distribution - Water supply dropped far below normal, cause of volcanic ash burial as thick as 10-12 cm. (Anonim, 2010a).
Blongkeng & Lamat Rivers	Ngargomulyo Village	- Cold lahar and sulfuric water dominantly. - Distributive pipelines were damaged. - Water crisis and threat of diseases (Anonim, 2010a).
Springs & streams	Sengi Village	- Water sources don't produce water any more. - Pipelines damaged. (Zakaria, 2011).
Springs & streams	Gowok Country, Sengi Village, Dukun Sub District	Most of water sources broke, buried by volcanic materials (Zakaria, 2011).
Springs & river (west part of Merapi)	Kamongan Village; Jrakah Country (Kaliurang Village), and many small countries in Kemiren Village, Srumbung Sub District.	- Springs closed by sands and volcanic materials. - Almost all of pipelines were damaged by lahar. - Mud clogging in pipelines (Anonim, 2010e). - Many wells became dry (Setiabudi, 2010).

Conclusion

1. Geological condition, including geomorphology, litology and geological structure influence springs appearance at the slope of Mt. Merapi. Most of them appear at break of slope or at different permability rocks contact.
2. Physical characteristic of aquifer showed by andesite breccia which strong weathered in addition to sandstones and alluvial sediments or soil.
3. The eruption of Merapi influenced spings's discharge, either increased or decreased the discharge.
4. Although there were springs resist flowing, the common impact is the destruction of infrastructure, especially the damage of pipelines make the water distribution didn't smooth. This damage usually caused by pyroclastic materials or laharic hitting in addition to mud clogging.
5. The other impact was some springs do not produce water any more caused by pyroclastic sediments burial.

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