Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN: 2550-0023

Vol 20, No 2, 2023, *481-493*
Article available at *homepage presipitasi*

Regional Case Study

The Impact of Mountain Semeru's Eruption on Groundwater Resources in the Rejali Watershed in 2021

Aulia Agustin Qurotala'yun[1*], Riyanto Haribowo[2], Abu Bakar Sambah[3]

[1] Management of Environmental Resources and Development, Universitas Brawijaya, Malang, Indonesia
[2] Faculty of Engineering, Universitas Brawijaya, Malang, Indonesia
[3] Faculty of Fisheries and Marine Sciences, Universitas Brawijaya, Malang, Indonesia
* Corresponding Author, email: auliaagustinq@student.ub.ac.id

Abstract

Mount Semeru is an active volcano and the highest on the island of Java with an altitude of 3726 meters above sea level (masl). The last major activity of Mount Semeru which occurred on 04 December 2021, there was an eruption or Hot Cloud Fall (GAP). According to the Centre for Volcanology and Geological Hazard Mitigation (PVMBG, 2021), the GAP in this incident was directed towards the southeast of Mount Semeru, namely Curah Kobokan with a glide distance of up to 11 km. The area affected by GAP is a small part of Malang Regency and Lumajang Regency. The purpose of this study is to analyze the quality of groundwater resources in the Rejali watershed after the eruption of Mount Semeru in 2021. This type of research is quantitative research. All data obtained is processed using the Pollution Index (IP) method listed in the Decree of the Minister of Environment Number: 115 of 2003 concerning Guidelines for Determining Water Quality Status. The groundwater quality parameters used are pH, BOD, DO, TDS, Fe, Mn, TSS, and COD. The results of this study are, the pollution index value in segments 1-3 is moderately polluted, and in segments 4-5 is lightly polluted.

Keywords: Environment; water quality; eruption

1. Introduction

Mount Semeru is the highest volcano on the island of Java with an altitude of 3726 meters above sea level and geographically located at 08°06.5' S and 112°55' E. Administratively it is located in the province of East Java between two regencies, namely Malang City and Lumajang City. According to the Ministry of Energy and Mineral Resources (ESDM, 2014) this mountain is included in an active volcano with conical or strato-shaped characteristics. There are two types of eruptions on Mount Semeru, namely vulkanian and strombolian which are destructive and form domes with lava tongues. This type of eruption is classified as a small explosive, this is what distinguishes Mount Semeru from other volcanoes, namely that the volcano actively releases material or gas approximately 3 times every hour with a relatively small force. A continuous activity like this causes Mount Semeru to rarely erupt on a large scale because the accumulated material is ejected little by little. The materials released by Mount Semeru during the eruption varied in the form of ash, rocks, gravel, cobbles, and sand.

According to the National Disaster Management Agency (BNPB, 2021), the eruption of Mount Semeru was only recorded in 1818 until the last recorded eruption was in 2008. The last macro activity that occurred on December 4, 2021, has been an eruption or Hot Cloud Drop (GAP) which caused quite a lot of loss. According to the Center for Volcanology and Geological Hazard Mitigation (PVMBG, 2021), the GAP on the incident on that date headed southeast of Mount Semeru, namely the Kobokan Fall

with a sliding distance of up to 11 km. Even a few days after the eruption, with bad weather conditions, Mount Semeru's activity was observed to still fluctuate, which was marked by the presence of several earthquakes, avalanches, and cold lava floods. At that time Mount Semeru was in level II or alert status, until December 16 2021 there was an increase in status to level III or alert.

The areas affected by the hot cloud fall during the eruption were a small part of Malang City and Lumajang City. The areas of Malang district that were affected by the ash rain included Tirtoyudo District, parts of Ampelgading District, Tirtoyudo District, Dampit District, Turen District, Wajak District, Bantur District, Pegelaran District, and Kepanjen District. Meanwhile, the areas in Lumajang City which were severely affected were in the Pronojiwo Subdistrict, namely Supiturang Village, Oro-Oro Ombo Village, Pronojiwo Village, and Sumberurip Village. As well as in Candipuro District, namely in Sumber Wuluh Village, and Sumber Mujur.

According to Brahmantya (2010) at Merapi Volcano, most of the parameters measured were at or above the Class II water quality threshold. After the eruption, there was an increase in the concentration of Fe (iron). This is comparable according to Indirawati (2020), the quality of public drinking water sources which may contain toxic ions and metals can be disrupted due to changes in environmental quality due to volcanic eruptions. Long-term exposure to volcanic ash can accumulate in the soil layers, and the combination of Pb in dust and Pb in rocky soil layers can cause an increase in Pb levels in water supplies. It is feared that public health will be disrupted in the long run if people use clean water without cleaning it first. For this reason, further research is needed to analyze the impact of the eruption of Mount Semeru on the quality of groundwater resources in the Rejali watershed in 2021.

2. Methods

The type of research used in this research is quantitative research. Using a field survey approach, laboratory tests, and a GIS (Geographic Information System) approach. The groundwater quality parameters used in this study were groundwater depth, groundwater level, pH, BOD, DO, TDS, Fe, Mn, TSS, and COD. Sampling points in this study first made a radius map of several kilometers from the peak of Mount Semeru. Water sampling is limited to shallow groundwater by taking groundwater samples from residents' wells. Comparison and calculation of quality standard values using quality baskets of class I, because the sampled groundwater or well water is water that is used daily by residents for consumption and other household needs.

The point is considered to represent the existing population from upstream to downstream. The distribution of groundwater sampling points in this study are:

a. 10-13 km radius located in parts of Supiturang Village, Pronojiwo District, and parts of Sumbermujur Village, Candipuro District
b. 13-16 km radius located in parts of Sumberwuluh Village, Penanggal Village, and Sumberrejo Village, Candipuro District
c. 16-19 km radius, located in parts of Sumberwuluh Village, Jugosari Village, Candipuro Village, and Sumberrejo Village, Candipuro District.
d. 19-22 km radius, located in parts of Jugosari Village, Gondoruso, Kalibendo, Pasirian District, and parts of Jarit Village, Candipuro Village, and Candipuro District.
e. 22-25 km radius, located in parts of Gondoruso Village, Pasirian Village, Kalibendo Village, and Pasirian District.
f. 25-28 km radius, located in parts of Bades Village and Selok Awar-Awar Village, Pasirian District.
g. 28-31 km radius, located in a small part of Bago Village, Pasirian District.

All data obtained is processed using the Pollution Index (IP) method. According to Nemerow (1974) stated in the Decree of the State Minister for the Environment Number: 115 of 2003 concerning Guidelines for Determining Water Quality Status, this index is expressed as the Pollution Index which is used to determine the level of pollution relative to the permissible water quality parameters. The

Pollution Index (IP) can be developed for several uses, both for all water bodies and parts of rivers and groundwater.

If Lij represents the concentration of water quality parameters listed in the Water Allotment Standard (j), and Ci represents the concentration of water quality parameters (i) obtained from the analysis of the water portion at a sampling location, then PIj is the Pollution Index for the designation (j) which is a function of Ci/Lij.

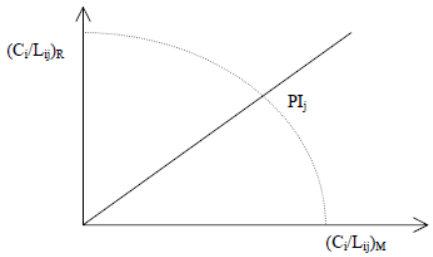


Figure 1. Index statement for a designation (j)

$$PI_j = \sqrt{\frac{(C_i/L_{ij})_M^2 + (C_i/L_{ij})_R^2}{2}} \quad (1)$$

This method can directly relate the level of pollution with whether or not rivers or groundwater can be used for certain uses and with the values of certain parameters. Evaluation of the PI value is:

$0 \le PI_j \le 1{,}0$ → meet the quality standard (good condition)

$1{,}0 < PI_j \le 5{,}0$ → lightly polluted

$5{,}0 < PI_j \le 10$ → moderately polluted

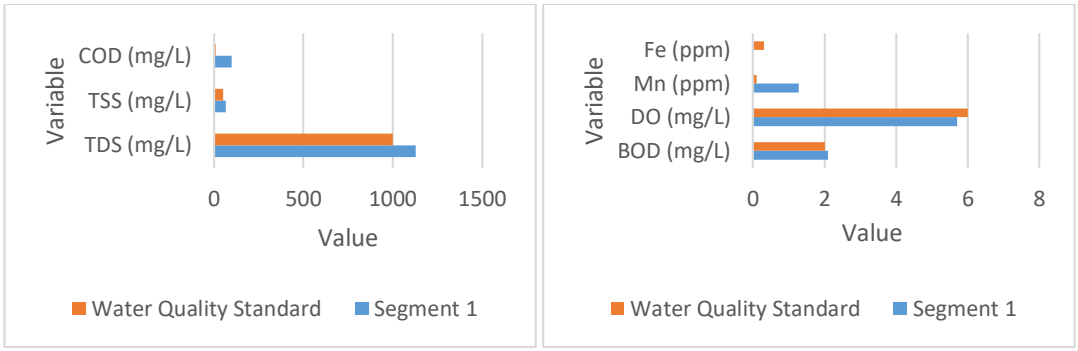
$PI_j > 10$ → heavily polluted

3. Result and Discussion

One of the factors that caused changes in water quality in the Rejali watershed was the Mount Semeru eruption that occurred in December 2021. GAP material during the eruption damaged many houses, rice fields, plantations, and access roads for residents, and not a few materials entered the wells. Water that is known for volcanic ash needs to be tested for water quality because ground or surface water that has been mixed with volcanic ash has very high turbidity (Nugraha, 2015). The following are the results of the calculation of the groundwater Pollution Index in the Rejali watershed.

Table 1. Results of Calculation of Groundwater Pollution Index for the Rejali Watershed

Variable	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Water Quality Standard
TSS (mg/L)	66	63	56	48	46	50
TDS (mg/L)	1129	1263	1025	536	237	1000
COD (mg/L)	100	71	23	9.4	9.7	10
BOD (mg/L)	2.09	2.04	4.32	3.16	5.3	2
DO (mg/L)	5.7	5.97	4.2	4.9	3.4	6
Mn (ppm)	1.272	3.287	1.0952	0.0277	0.0335	0.1
Fe (ppm)	0.0157	0.43	0.1654	0.0061	0.0203	0.3
Pollution Index Value	6.680	8.7871	6.332	2.061	3.166	-
Explanation	moderately polluted	moderately polluted	moderately polluted	lightly polluted	lightly polluted	-



(a) (b)

Figure 2. Comparison of segment 1 groundwater quality test results with water quality standards

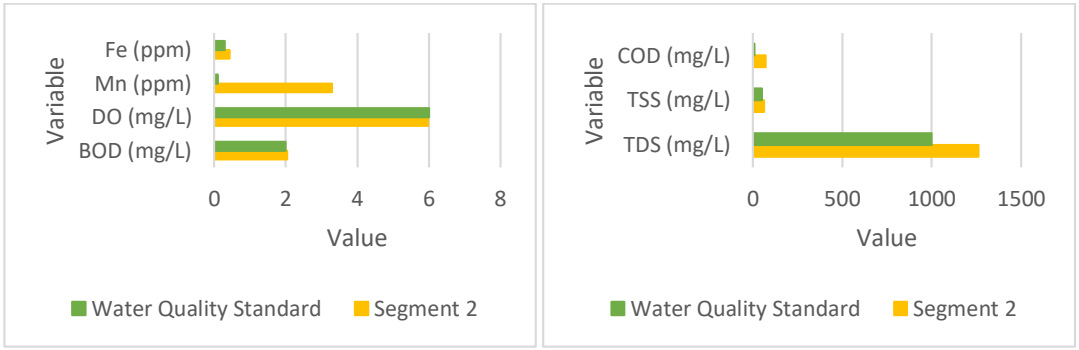
The first sampling area is the upstream part of the Rejali watershed, precisely at a radius of 10-13 km from Mount Semeru at the point S 8.168° and E 113.013° with an elevation of 726 meters above sea level. This sampling site is included in the Kajar Kuning Hamlet area, Sumberwuluh Village, Candipuro District. It is one of the residential areas affected by the greatest eruption impact. It is known that the slope of this area is 0-8%, which means it is flat. The eastern and southeastern parts of the settlement are mountains, and the other parts are surrounded by rice fields. The landform of the area is a volcanic landform where the location is included in the lower volcanic slope (V5). The constituent material or geology is Semeru Volcano sediment (Qvs) with a complex soil type of grey regosol and lithosol.

Sampling was carried out on 30 December 2021 at 14.27 WIB, which at that time was the rainy season. The groundwater temperature at that hour was 25.7°C, with a groundwater depth of 96 cm and a groundwater level of 204 cm. It is known that the value of water temperature can also affect the value of dissolved oxygen (DO), if there is an increase in temperature, there will be a decrease in the solubility of oxygen in water. The value of dissolved oxygen in segment 1 is 5.7 mg/L, meaning that with this value the dissolved oxygen in segment 1 is in poor condition because according to the value of class I quality standards the minimum allowable limit is 6l mg/L. If the dissolved oxygen content in the water decreases, the ability of aerobic bacteria to break down organic waste material also decreases.

The value of dissolved oxygen also affects the value of BOD, namely the less the amount of DO, the greater the value of BOD. The higher the BOD value indicates the higher the activity of organisms to decompose organic matter or it can be said that the greater the content of organic matter in a water body. The BOD value of segment 1 is 2.09 mg/L, meaning that the BOD value of water in the segment is not good and there is water pollution by organic substances. The value of chemical oxygen demand/COD in segment 1 is known to be 97 mg/L. This means that the COD value in Segment 1 water exceeds the existing quality standard value. This indicates that there is a large amount of oxidized organic matter. This condition will also affect the DO value. This is by the condition of the research results that the COD value exceeds the quality standard and the DO value decreases or is less than the quality standard.

The pH value in Segment 1 is known to be 7.97, which means that the water in Segment 1 has alkaline properties. The pH value in a water body is related to the value of carbon dioxide (CO^2) and alkalinity. This means that the higher the pH value, the higher the alkalinity value and the lower the free carbon dioxide content in the water. It is known that the value of iron (Fe) in segment l is 0.0157 mg/L, which means that the content of hot cloud fallout material in well water does not affect the value of iron content in water. The value of iron in water depends on the pH and dissolved oxygen conditions. Segment 1 has a pH value of more than 7 causing low iron values so that metals including iron do not dissolve easily in water. Iron values are also influenced by the geological conditions that are traversed, as for segment 1 the material in the well water is mostly ash, which means that the iron contained in the ash does not participate or is not easily dissolved in the groundwater in that segment. The manganese / Mn value in segment 1 water is 1,272 mg / L, which means it does not meet the quality standards, the large amount of ash in the well water affects the manganese content.

The TSS value in segment 1 is 66 mg/L, while the TDS value is 1129 mg/L. This means that the TSS and TDS values in Segment 1 are not good and exceed the existing quality standards, so the presence of volcanic ash material is proven to pollute or affect the well water, especially from the TDS and TSS parameters. This is evidenced by the condition of the well water in the segment is murky even though two well drains have been carried out, which means that before the well water is drained, the TDS and TSS content is higher. According to the value of the results of the calculation of the pollution index derived from the overall values of the parameters used, the upstream part of the Regoyo watershed groundwater precisely in segment 1 is moderately polluted, namely with a value of PI_j = 6.6802. This is due to the value of all parameters, namely TSS, TDS, COD, BOD, and Mn exceeding the specified quality standard limits and DO values that are less than the predetermined quality standard values, except for Fe values. It is known that the well water that is the sampling site is a mosque well, which is used for worship and sometimes the community around the mosque also uses it for daily needs.



(b) (b)

Figure 3. Comparison of segment 2 groundwater quality test results with water quality standards

The second sampling area at point S 8.187° and E 113.037° with an elevation of 443 masl. This segment 2 sampling point is included in the 13-16 km radius of Mount Semeru and is an area of Kamar Kajang Hamlet, Sumberwuluh Village, Candipuro District. It is known that the depth of groundwater in the wells in this segment is 205 cm with a groundwater level of 593 cm. The average well depth in this area can reach more than 7 meters, so it is rarely found, and only a few people still use wells to meet their daily needs. Most people in this area use PDAM water instead of wells. It is known that the western part of this settlement is a mountain range and the other part is surrounded by rice fields and moorland. The landform of the area is a volcanic landform in which the location is included in the foot of Mount Semeru (V6) with the constituent material or geology, namely the deposits of Mount Semeru (Qvs). It is known that the soil type of this area is yellowish-brown regosol.

Sampling was carried out on 30 December 2021 at 13.25 WIB. The groundwater temperature at that hour was 25.6°C. A decrease in dissolved oxygen value can occur when there is an increase in temperature. The dissolved oxygen value in segment 2 is 5.97 mg/L, meaning that with this value the dissolved oxygen in segment 2 does not meet the quality standards. The less the DO value, the greater the BOD value. The BOD value of segment 2 is 2.04 mg/L, meaning that the BOD value of water in the segment is quite good and there is no water pollution by organic substances. The chemical oxygen demand/COD value in segment 2 is known to be 71 mg/L, meaning it exceeds the existing quality standard value. This indicates that there is a large amount of oxidized organic matter. This condition will also affect the DO value or more precisely will reduce the level of dissolved oxygen. This is evidenced by the DO value contained in the water in sample 2 not meeting the quality standards.

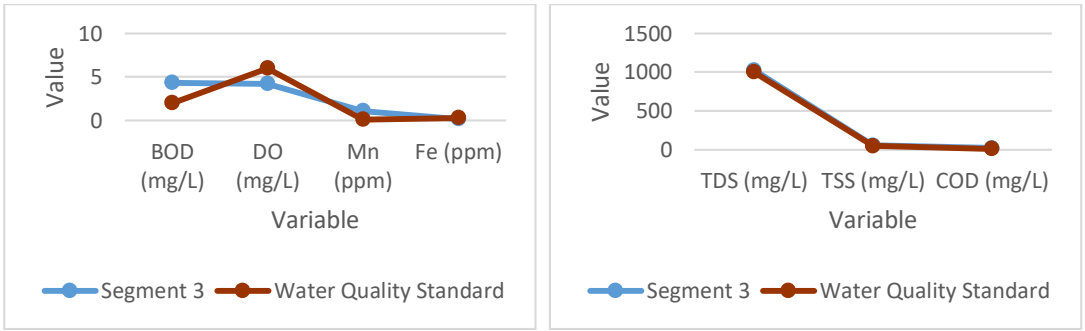
The pH value in Segment 2 is known to be 5.71, which means that the water in Segment 2 has an acidic nature. According to Sutriati and Armaita (2012) volcanic eruptions that generally emit sulfur dioxide gas can cause a decrease in the pH value of water. If the pH content is less than 6.5, it can cause corrosion of metals, such as drinking water channels that can dissolve lead, copper, cadmium, or others that are toxic. In line with this, it is known that the iron (Fe) content in segment 2 groundwater is 0.43

mg/L, meaning that it exceeds the existing quality standards. This means that the content of hot cloud material in the well water affects the iron content of the well water. Following the content of volcanic ash material contained Mn and Fe, which caused the high Fe value in this segment. It is known that segment 2 is one of the most severely affected segments and the GAP material damaged many houses, damaged residents' access and not a few materials entered the wells. According to Nugraha (2015), well water that has high iron (Fe) when used for consumption of daily needs can cause taste, color, deposition on pipe walls, bacterial growth, and turbidity. If consumed continuously, it can damage the intestinal wall and reduce lung performance in humans, and can also affect growth performance and inhibition of fixation of other elements in plants.

The value of iron in water depends on pH conditions and dissolved oxygen. As for Segment 2, the material in the well water is mostly ash but the amount of ash that enters the well is not as much as in Segment 1. The manganese (Mn) value in segment 2 water is 3,287 mg/L which means it does not meet the quality standard, and the large amount of ash in the well water affects the manganese content. According to Nugraha, 2015 high manganese content causes a bitter taste when drunk, makes brownish stains on clothes and if consumed continuously can cause esophageal disorders, manganism disease, spinal disorders, epilepsy, hepatitis, and other diseases.

The TSS value in segment 2 is 63 mg/L, while the TDS value is 1263 mg/L. This means that the TSS and TDS values in segment 2 are not good and exceed the existing quality standards, so the presence of volcanic ash material is proven to pollute or affect the well water, especially from the TDS and TSS parameters. This is evidenced by the murky condition of the well water in that segment. According to Nugraha (2015), the risk of gastrointestinal disease increases if the water consumed is cloudy because suspended solids can be attached to viruses and bacteria. Suspended solids can be protective against viruses and bacteria so that they can interfere with water disinfection with chlorine, and can also protect bacteria from ultraviolet light to sterilize water.

The results of the calculation of the pollution index derived from the overall values of the parameters used in segment 2 are moderately polluted, with a value of PI_j = 8.787. This is because all parameter values exceed the predetermined quality standards and the DO value is less than the predetermined quality standard value. The pollution index value of segment 1 with segment 2 is greater in segment 2, even though the most severe impact of GAP occurs in segment 1. This is because the well water samples taken in Segment 1 have been drained several times, while in Segment 2 no effort has been made, so the water is still in its original condition.



(a) (b)

Figure 4. Comparison of segment 3 groundwater quality test results with water quality standards

The third sampling area is the central part of the Rejali watershed, which is precisely a radius of 16-19 km from Mount Semeru at the point S 8.193 ° and E 113.054 ° with an elevation of 356 meters above sea level. This sampling site is still included in the area of Sumberwuluh Village, Candipuro District. Settlements in this area are surrounded by rice fields with a slope of 0-8% which means flat. The landform of the area is a volcanic landform in which the location is included in the foot of Mount Semeru (V6) with

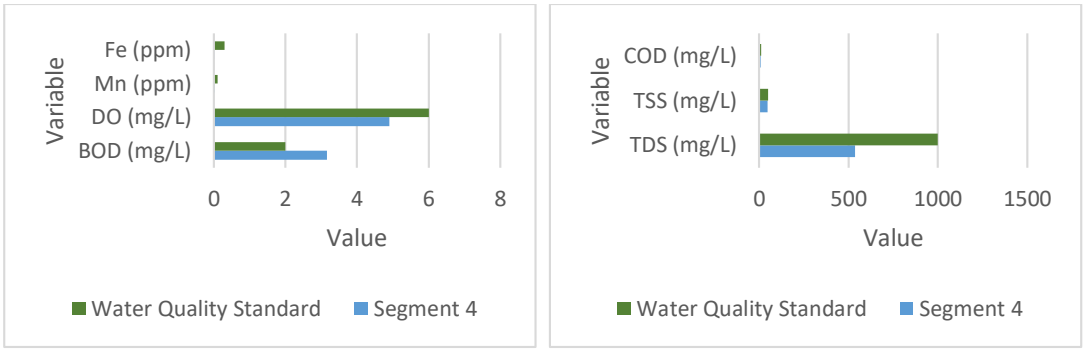
the constituent material or geology of Mount Semeru deposits (Qvs). It is known that the soil type of this area is yellowish-brown regosol.

Sampling was carried out on 30 December 2021 at 12.15 WIB. The groundwater temperature at that hour was 27.3°C, with a groundwater depth of 183 cm and a groundwater level of 182 cm. It is known that the dissolved oxygen value in segment 3 is 4.2 mg/L, meaning that with this value the dissolved oxygen in segment 3 is in poor condition. The BOD value of segment 3 is 4.32 mg/L, meaning that the BOD value of water in the segment is not good and there is water pollution by organic substances. The chemical oxygen demand (COD) value in segment 3 is known to be 23 mg/L. According to quality standards, good water has a COD value of 10 mg/L, meaning that the COD value in segment 3 water exceeds the existing quality standard value. This indicates that there is a large amount of oxidized organic matter. This condition will reduce the level of dissolved oxygen, according to the results in the field, namely the DO value is less than the quality standard value, while the COD value exceeds the quality standard.

The pH value in Segment 3 is known to be 7.17, which means that the water in Segment 3 has alkaline properties. The high pH value is proportional to the increase in alkalinity content and causes a decrease in the value of free carbon dioxide levels in the waters. It is known that the value of iron (Fe) in segment 3 is 0.165 mg/L, which means that the content of hot cloud fallout material in the well water does not affect the value of iron content in the water. The value of iron in water depends on pH and dissolved oxygen conditions. Segment 3 has a pH value of more than 7 causing low iron values so that metals including iron do not dissolve easily in water. As for segment 3, the material in the well water is mostly ash, which means that the iron contained in the ash is not easily dissolved in the groundwater in that segment. The manganese (Mn) value in segment 3 water is 1,095 mg/L, while the manganese content allowed in the quality standard is 1 mg/L. This means that the manganese content in this segment does not meet the quality standard, the amount of ash in the well water affects the manganese content.

The TSS value in segment 3 is 56 mg/L, while the TDS value is 1025 mg/L. This means that the TSS and TDS values in segment 3 are not good and exceed the existing quality standards, so the presence of volcanic ash material is proven to pollute or affect the well water, especially from the TDS and TSS parameters. This is evidenced by the slightly cloudy condition of the well water in that segment. During the post-eruption period, the water was much murkier, and this turbidity lasted for approximately 7 days. When the water samples were taken in less turbid conditions, this can happen because it is known that water can recover itself (self-purification) from pollutants. Self-purification can occur, but note that it takes time and is not contaminated with another source of pollution that causes water contamination. And according to Noviriana (2010), the longer the distance the water flows, the better the self-purification ability.

According to the value of the results of the calculation of the pollution index derived from the overall values of the parameters used, the middle part of the Regoyo watershed groundwater, precisely in segment 3, is moderately polluted with a value of PI_j = 6.33. This is due to the value of all parameters, namely TSS, TDS, COD, BOD, and Mn exceeding the specified quality standard limits and DO values that are less than the predetermined quality standard values, except for the Fe value or iron content whose content still meets the quality standard limits.



(a) (b)

Figure 5. Comparison of segment 4 groundwater quality test results with water quality standards

The fourth sampling area at a radius of 19-22 km from Mount Semeru at point S 8.226° and E 113.087° with an elevation of 179 masl. This sampling site is included in the Karang Anyar Hamlet, Kalibendo Village, Pasirian District. Settlements in this area are surrounded by moorland and rice fields with a slope between 0-8% which means flat. The landform of the area is a volcanic landform in which the location is included in the plain of the foot of Mount Semeru Volcano (V7). The constituent material or geology is the deposits of Mount Semeru Volcano (Qvs), and the soil type of this area is a greyish-brown regosol.

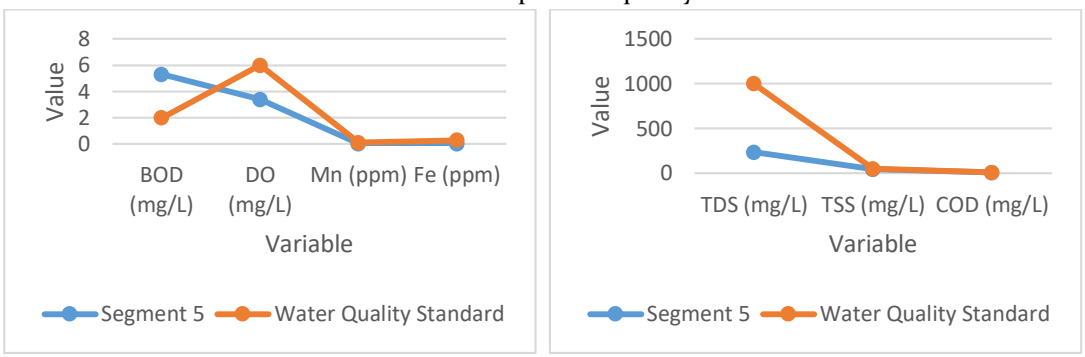
Sampling was carried out on 30 December 2021 at 09.32 WIB. The groundwater temperature at that hour was 26.7°C, with a groundwater depth of 125 cm and a groundwater level of 365 cm. It is known that the value of water temperature can also affect the value of dissolved oxygen (DO), the dissolved oxygen content will decrease when there is an increase in temperature. The value of dissolved oxygen in segment 4 is 4.9 mg/L, meaning that with this value the dissolved oxygen in segment 4 is in poor condition, because according to the value of class I quality standards the minimum allowable limit is 6 mg/L, and if it is less than this figure then it is said to be less eligible for water designation for consumption in terms of its dissolved oxygen value.

The BOD value of segment 4 is 3.16 mg/L, meaning that the BOD value of water in the segment is not good and there is water pollution by organic substances. The high BOD value indicates an increase in the activity of organisms to decompose organic matter. Therefore, high BOD content can reduce the amount of dissolved oxygen in a water body. The chemical oxygen demand (COD) value in segment 4 was found to be 9.4 mg/L. According to the quality standard, good water has a COD value of less than 10 mg/L, meaning that the COD value in segment 4 water is good and meets the existing quality standard value. This indicates that a small amount of organic matter is oxidized. This condition will also affect the DO value or more precisely will reduce the level of dissolved oxygen. However, this condition is different from the results in the field, namely the DO value is less than the quality standard value, while the COD value is good and does not exceed the quality standard, to find out the cause, further and more specific research can be done.

The pH value in Segment 4 is known to be 8.82, which means that the water in Segment 4 has alkaline properties. A pH value of more than 8.5 can produce toxic trihalomethane which forms crust or deposits on water pipes or equipment made of metal (Sudadi, Purwanto. 2003). It is known that the value of iron (Fe) in segment 4 is lo.0061 mg/L, which means that the content of hot cloud fallout material in well water does not affect the value of iron content in water. Iron values in water depend on pH and dissolved oxygen conditions. Segment 4 has a pH value of more than 7 causing low iron values so that metals including iron do not dissolve easily in water. Iron values are also influenced by the geological conditions that are traversed. It is known from the results of research in the field, in segment 4 the material in the well water is visibly clear and not affected by eruptions such as the presence of hot cloud material.

The manganese (Mn) value in segment 4 water is lo.0277 mg/L, while the manganese content allowed in the quality standard is 1 mg/L. The TSS value in segment 4 is 48 mg/L, while the TDS value is 536 mg/L. This means that the TSS and TDS values in segment 4 are good and do not exceed the existing

quality standards, so the presence of volcanic ash material does not pollute or affect the well water, especially from the TDS and TSS parameters. This is evidenced by the condition of the well water in the segment which is clear, colorless, and tasteless. According to residents, after the eruption, ash rains reached the area but with a small intensity and not for long. According to the results of the calculation of the pollution index derived from the overall values of the parameters used, the downstream part of the groundwater of the Regoyo watershed, precisely in segment 4, namely between the 19-22 km radius of Mount Semeru, is lightly polluted with a value of PI_j = 2.061. This is because the values of all parameters, namely TSS, TDS, COD, Mn, and Fe do not exceed the specified quality standard limits, except for the BOD value and DO value which are less than the specified quality standard value.



(a) (b)

Figure 6. Comparison of segment 5 groundwater quality test results with water quality standards

The fifth sampling area is included in the downstream part of the Rejali watershed, with an elevation of 133m above sea level. The sampling point of segment 5 is included in the radius of 22-25 km from Mount Semeru and is an area of Bades Village, Pasirian District, and the distance between the location point and the sea is -+6.5 km. The depth of groundwater at the sampling point is 388 cm with a groundwater level of 102 cm. The appearance of conditions around the sampling point is rice fields and moor people. The landform of the area is a volcanic landform where the location is included in the Mount Semeru fluvial plain (V8) with the constituent material or geology, namely Mount Semeru deposits (Qvs). It is known that the soil type of this area is greyish-brown regosol.

Sampling was carried out on 30 December 2021 at 11:31 WIB. The groundwater temperature at that hour was 29.4°C, an area close to the coast so the water temperature may be higher when compared to other sampling points. An increase in temperature affects the dissolved oxygen content, it is known that the dissolved oxygen value in segment 5 is 3.4 mg/L, meaning that with this value the dissolved oxygen in segment 5 is in poor condition. The dissolved oxygen value also affects the BOD value, i.e. the less the amount of dissolved oxygen (DO), the greater the BOD value. This is following the conditions in the field, where the small DO value is inversely proportional to the BOD value, which is 3.16 mg/L, meaning that the BOD value of water in the segment exceeds the quality standard and is not good and there is water pollution by organic substances. The value of chemical oxygen demand (COD) in segment 5 is known to be 9.7 mg/L. Chemical oxygen demand is a test that determines the total amount of oxygen required by oxidant materials to oxidize organic materials contained in water, both those that can be decomposed biologically and those that cannot (Nurdijanto, 2000). According to quality standards, good water has a COD value of 10 mg/L, meaning that the COD value in Segment 5 water meets the existing quality standard value. This indicates that a small amount of organic material is oxidized. This condition will also affect the DO value or more precisely will reduce the level of dissolved oxygen. This condition is different from the results in the field, where the DO value is less than the quality standard value, while the COD value does not exceed the quality standard.

The pH value in Segment 5 is known to be 7.63, which means that the water in Segment 5 has alkaline properties. The pH value can be related to the value of carbon dioxide (CO^2) and alkalinity. This means that the higher the pH value, the higher the alkalinity value and the lower the free carbon dioxide

content in the water. It is known that the value of iron (Fe) in segment 5 is lo.0203 mg/L, which means that the content of hot cloud fallout material in well water does not affect the value of iron content in water. The value of iron in water depends on the pH and dissolved oxygen conditions. Segment 5 has a pH value of more than 7 causing low iron values so that metals including iron do not dissolve easily in water. As for segment 5, the material in the well water is clear and not affected by the eruption such as the presence of hot clouds.

The manganese (Mn) value in segment 5 water is lo.0335 mg/L, meaning it does not meet the quality standards. The TSS value in segment 5 is 46 mg/L, while the TDS value is 237 mg/L. This means that the TSS and TDS values in segment 5 are good and do not exceed the existing quality standards, so the presence of volcanic ash material does not pollute or affect the well water, especially from the TDS and TSS parameters. This is evidenced by the condition of the well water in the segment which is clear, colorless and tasteless as in segment 4. According to residents, after the eruption ash rain reached the area but with a small intensity for a very short time, but several other residents in the area said that there was no ash rain in their area. According to the results of the pollution index calculation derived from the overall values of the parameters used, the downstream part of the Regoyo watershed groundwater in segment 5 is lightly polluted with a value of PI_j = 3.1658. This is because the values of all parameters, namely TSS, TDS, COD, Mn, and Fe do not exceed the specified quality standard limits, except for the BOD and DO values which are less than the specified quality standard values.

Groundwater sampling in segment 6, radius 25-28 km was not conducted due to the small coverage area included in the Rejali watershed with only a few settlements and dominated by rice fields. In these settlements, no one uses wells to fulfill their daily needs, the community uses water from the PDAM. Sampling of groundwater in segment 7 with a radius of 28-31 km was not carried out because the area that covers the Rejali watershed is only the mouth of the Regoyo River which leads to the Bambang Sea, and is the downstream part of the Rejali watershed. The following is a map of groundwater quality in the Rejali watershed:

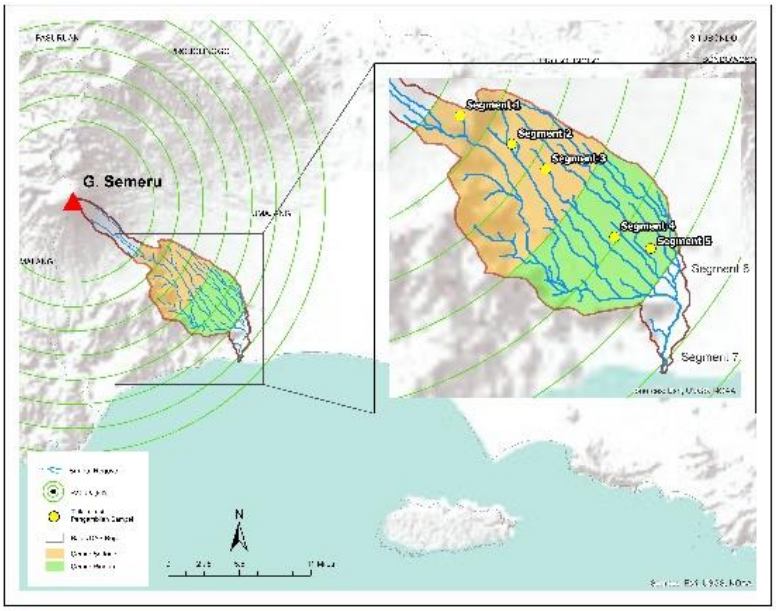


Figure 7. Groundwater quality map of rejali watershed

4. Conclusions

The impact of the eruption of Mount Semeru on groundwater resources in the Rejali watershed using the Pollution Index method, namely, the value of the pollution index in the upper part of the watershed, namely segments 1-3, is moderately polluted and in the lower part of the watershed, namely in segments 4-5, is lightly polluted. Suggestions based on the results of the study, namely to find out other polluting substances, it is necessary to add parameters or test water quality thoroughly and sampling is

only taken at the time after the eruption, therefore it is necessary to take water samples before the event to find out or as a comparison of water quality before and after the eruption event.

References

Alkadri, S.P.A. & Asmara, K.D. 2020. Pelatihan pembuatan eco-enzyme sebagai hand sanitizer dan disinfektan pada masyarakat dusun margo sari desa rasau jaya tiga dalam upaya mewujudkan desa mandiri tangguh covid-19 berbasis eco-community. Buletin Al-Ribaath 17, 98-103.

Badan Pusat Statistik 2018. Statistik lingkungan hidup indonesia (SLHI) 2018. Badan Pusat Statistik, 1–224.

Dewi, D.M. 2021. Pelatihan pembuatan eco enzyme bersama komunitas eco enzyme lambung mangkurat kalimantan selatan. Jurnal Pengabdian Inovasi Lahan Basah Unggul 1(1), 67-76

Dewi, P.A.V.H., and Sutama, I.W. 2022. Pengolahan sampah organik melalui konsep eco-enzyme bagi rumah tangga di desa dalung masa pandemik. Empowerment: Jurnal Pengabdian Masyarakat 5(1), 93-100.

Farma, SA 2022. Application of eco enzyme biotechnology as waste management organic for preparation the development of talang lake tourism kabupaten solok west sumatera. Pelita Eksakta 5(1), 59-64.

Fatimah, F., Sukarno, A.R., Puspitasari, M.R., Pitaloka, Y., Asmoro, N.W. 2022. Pemberdayaan masyarakat melalui pembuatan eco-enzyme dari limbah sampah organik dapur kelompok PKK dusun walang sukoharjo. Literasi: Jurnal Pengabdian Masyarakat 2775-3301, 490-496.

G.Rosnina, A., Wirda, Z., Nilahayati, A., Dewi, S., Zuriani. 2022. Aplikasi pupuk eco-enzyme pada lahan marginal di desa reuleut barat muara batu aceh utara. Global Science Society: Jurnal Ilmiah Pengabdian Kepada Masyarakat 4(1), 78-83.

Harahap, R.G., Nurmawati, Dianiswara, A., Putri, D.L. 2021. Pelatihan pembuatan eco-enzyme sebagai alternatif disinfektan alami di masa pandemi covid-19 bagi warga km.15 kelurahan karang joang. Sinar Sang Surya: Jurnal Pengabdian Masyarakat 5(1), 67-73.

Larasati, D., Astuti, A.P., and Maharani, E.T. 2020. Uji organik produk eco-enzyme dari limbah kulit buah (studi kasus di kota semarang). Seminar Nasional Edusainstek. ISBN 978-602-5614-35-4, 278-283.

Mahdia, A., Safitri, P.A., Setiarini, R.F., Maherani, V.F.A., Ahsani, M.N. & Soenarno, M.S. 2022. Analysis of ecoenzymes effectiveness as cleaning chicken coops from citrus fruit waste (citrus sp.). Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan 10(1), 42-46.

Maulana, R. & Khumaeroh, M.S. 2021. Training for making eco-enzyme in the middle of covid-19 pandemic. Proceedings UIN Sunan Gunung Djati Bandung 1(36), 159-167

Nurfajriah, Mariati, F.R.I., Waluyo, M.R., Mahfud, H. 2021. Pelatihan pembuatan eco-enzyme sebagai usaha pengolahan sampah organik pada level rumah tangga. Jurnal Ikraith-Abdimas 3(4), 194-197.

Nurhamidah, Amida N., Rohiat, S., Elvinawati. 2021. Pengolahan sampah organik menjadi eco-enzyme pada level rumah tangga menuju konsep eco-community. ANDROMEDIA: Jurnal Pengabdian Masyarakat Rafflesia 1(2), 43-46.

Nurpratiwiningsih, L., Suhandini, P., Banowati, E. 2015. Pengelolaan sampah rumah tangga berbasis masyarakat di kelurahan sekaran kecamatan gunungpati kota semarang. Journal of Educational Social Studies 4(1).

Penmatsa, B., Sekhar, D.C., Diwakar, B.S. & Nagalakshmi, T. V. 2019. Effect of bio-enzyme in the treatment of fresh water bodies. International Journal of Recent Technology and Engineering 8(1), 308–310.

Pramadianto, F. and Widowati, N. 2016. Kinerja pengelolaan sampah rumah tangga kota semarang. Journal Of Public Policy And Management Review 5(4), 234-244.

Putri, A.R.R., Wulandari, A.S., and Istikorini, Y. 2022. The role of rhizobacteria and ecoenzyme in agarwood growth (aquilaria malaccensis lamk.). IOP Conf. Series: Earth and Environmental Science 959:012007.

Ramadan, B.M., Rachman, I., Ikhlas, N., Kurniawan, S.B., Miftahadi, M.F., Matsumoto, T. 2022. A comprehensive review of domestic-open waste burning: recent trends, methodology comparison, and factors assessment. Journal of Material Cycles and Waste Management 24, 1633-1647.

Rambe, T.R. 2021. Sosialisasi dan aktualisasi eco-enzyme sebagai alternative pengolahan sampah organik berbasis masyarakat di lingkungan perumahan cluster pondok II. Jurnal Pengabdian Kepada Masyarakat 2(1), 36-41.

Rohyani, I.S., Anjani, N., Sari, I.P., Atika, B.D.N., Wulandari, N.Y. 2022. Pemberdayaan masyarakat dengan pembuatan ekoenzim berbasis rumah tangga di desa lanjut. Jurnal Pengabdian Magister Pendidikan IPA 5(1), 214-217.

Septiani, U., Najmi, Oktavia, R. 2021. Eco-enzyme: pengolahan sampah rumah tangga menjadi produk serbaguna di yayasan khazanah kebajikan. Seminar Nasional Pengabdian Masyarakat UMJ 2714-6286

Siswanto, A.P., Yulianto, M.E., Ariyanto, H.D., Pudiastutiningtyas, N., Febiyanti, E., Safira, A.S., Wardhana, M.I.S. 2022. Pengelolaan sampah organik menggunakan media maggot di komunitas bank sampah polaman resik sejahtera kelurahan polaman, kecamatan mijen, kota semarang. Jurnal Pengabdian Vokasi 2(3), 193-197.

Subandriyo, Anggoro D.D., Hadiyanto. 2012. Optimasi pengomposan sampah organik rumah tangga menggunakan kombinasi activator EM4 dan MOL terhadap rasio C/N. Jurnal Ilmu Lingkungan 10(2), 70-75.

Sujarta, P., and Simonapendi, M.L. 2021. Pelatihan pengolahan sampah organik dengan konsep eco-enzym. Jurnal Pengabdian Papua 5(1), 34-39.

Supriyani, Astuti, A.P., Maharani, E.T.W. 2020. Pengaruh variasi gula terhadap produksi ekoenzim menggunakan limbah buah dan sayur. Seminar Nasional Edusaintek FMIPA UNIMUS 2685-5852, 470-479.

Susilowati, L.E., Ma'shum, M. & Arifin, Z. 2021. Pembelajaran tentang pemanfaatan sampah organik rumah tangga sebagai bahan baku eko-enzim. Jurnal Pengabdian Magister Pendidikan IPA 4(4), 356-362.

Utami, M.M.I.P., Astuti, A.P., Maharani, E.T.W. Manfaat ekoenzim dari limbah organik rumah tangga sebagai pengawet buah tomat cherry. Seminar Nasional Edusaintek FMIPA UNIMUS 978-602-5614-35-4, 380-392.

Vama, L. & Cherekar, M.N. 2020. Production, extraction and uses of eco- enzyme using citrus fruit waste: wealth from waste. Asian Jr. of Microbiol. Biotech. Env. Sc. 22(2), 346–351.

Yuliani, F., Kristiowati, D., Hermyantono, C. 2022. Pelatihan pembuatan cairan serbaguna eco-enzyme dari sampah organik dan cara pemanfaatannya di desa gondangmanis, bae, kudus. Prima: Journal of Community Empowering and Services 6(1), 37-45.

Aisyah, N., & Purnamawati, D. I. 2012. Tinjauan dampak banjir lahar kali putih, kabupaten magelang pasca erupsi merapi 2010. Jurnal Teknologi Technoscientia 5, 19-30.

Asdak, Chay. 2007. Hidrologi dan pengelolaan daerah aliran sungai. Yogyakarta: Gadjah Mada University Press.

Brahmantyo, Y., & Purnama, I. L. S. 2013. Kualitas airtanah sub DAS code kota yogyakarta pasca erupsi merapi tahun 2010. Jurnal Bumi Indonesia 2(1), 77488.

Effendi, Hefni. 2003. Telaah kualitas air bagi pengolaan sumber daya dan lingkungan perairan. Yogyakarta: Kanisius.

Firanty, M. 2021. Studi kualitas air danau lau kawar, pasca erupsi gunung sinabung di kecamatan naman teran, kabupaten karo, provinsi sumatera utara.

Indirawati, S. M., & Sembiring, H. 2020. Jarak sumber air baku air minum dari pusat erupsi dan risiko kesehatan masyarakat di wilayah pasca erupsi sinabung. Jurnal Kesehatan Lingkungan Indonesia 19(2), 103-110.

Keputusan Menteri Negara Lingkungan Hidup Nomor : 115 Tahun 2003 Tentang Pedoman Penentuan Status Mutu Air.

Kusumosubroto, H. 2010. Sistem pengendalian aliran lahar hujan gunung merapi sebelum dan setelah letusan.

Megawati, S., & Soedjono, E. S. 2011. Studi pengaruh lahar dingin pada pemanfaatan sumber air baku di kawasan rawan bencana gunung api (Studi kasus: gunung semeru). Jurusan Teknik Lingkungan, FTSP ITS Surabaya.

Noviriana, Hendrasarie Cahyarani. 2010. Kemampuan self purification kali surabaya ditinjau dari parameter organik berdasarkan model matematis kualitas air. Jurnal Ilmiah Teknik Lingkungan 2(1).

Nugraha, L. C. 2015. Pengaruh abu vulkanik terhadap kualitas air sumur akibat dampak erupsi gunung kelud 2014. Universitas Islam Indonesia

Nurdijanto. 2000. Kimia lingkungan. Pati: Yayasan Peduli Lingkungan.

Muzambiq, S., Nurfahasdi, M., & Amida, S. F. M. T. N., 2022. Studi analisis kualitas air lau borus (outlet danau lau kawar), pasca erupsi gunung sinabung di kecamatan naman teran, kabupaten karo, provinsi sumatera utara. Widya Teknik 21(1), 28-33.

Peraturan Pemerintah Nomor 82 Tahun 2001 Tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air.

Ratih, S., Awanda, H. N., Saputra, A. C., & Ashari, A. 2018. Hidrogeomorfologi mataair kaki vulkan merapi bagian selatan. Geomedia: Majalah 117 Ilmiah dan Informasi Kegeografian 16(1).

Setyowati. 2015. Status kualitas air das cisanggarung, jawa barat. Jurnal Teknik Lingkungan 1(1), 37- 45

Setyawati, S., & Ashari, A. 2017. Geomorfologi lereng baratdaya gunungapi merapi kaitannya dengan upaya pengelolaan lingkungan dan kebencanaan. Geomedia: Majalah Ilmiah dan Informasi Kegeografian 15(1).

Subagyono, Kasdi. 2013. Dampak erupsi gunung merapi terhadap sumberdaya air. Bogor: Balai Besar Pengkajian Dan Pengembangan Teknologi Pertanian.

Sutriati, Armaita. 2012. Kualitas air sungai dan air sumur paska letusan gunung merapi tahun 2010. Buletin Geologi Tata Lingkungan 22(3), 129-142.

Wasis, A. M., & Juwono, A. S. 2017. Studi karakterisasi fisik dan kimiawi debu gunung semeru. Prosiding Seminar Nasional XII "Rekayasa Teknologi Industri dan Informasi 223-228, 2017.