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Analysis of the Characteristics of Geothermal Manifestations in Kalewaha, South East Minahasa District, for Tourism Object Development

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Abstract: In North Sulawesi there are nine points location that have considerable geothermal potential but have not developed optimally one of them in Southeast Minahasa that has never been done research. The purpose (Aims or Objective) of this research is to know the nature of manifestation of hot springs using limited physical, chemical, and microbiological parameters and to know the quality of water manifestation for the development of geothermal potential in tourism sector. The research method is (The method of this research use was) direct field research, sampling and analysis in the laboratory. Results of Physical, Chemical, and Microbiological analysis of low-fueled research areas with temperature manifestation of 40 ° C, pH 6.8, Color 5 TCU, 93 mg / L Density, Substances Dissolved (TDS) 1320 mg / L, Sulfate 623 mg / L, Bicarbonate 235 mg / L, Chloride 70,6 mg / L, Nitrite <0,001 mg / L, E. coli 1305 MPN / 100mL, Total Coliform 8650 MPN / 100mL and good quality, Kalewaha Hot Spring can be developed and utilized for Hot water bath activities.

Keywords*: Geothermal, Water Properties, Water Quality, Hot Water Tour, Kalewaha Hotspring.*

Introduction

According to the Chairman of the Indonesian Geothermal Association (API), Purnomo Abadi, Indonesia's geothermal energy potential, which reaches 40 percent, is the largest in the world. However, in terms of geothermal energy development, Indonesia still ranks third after the United States and the Philippines (Christina, 2013). Given the significant geothermal energy potential in Indonesia, there is a need for research in geothermal potential areas to maximize their development and utilization. The potential geothermal locations are identified by the presence of surface manifestations, and one such type of manifestation is hot water springs caused by geological activities, such as volcanism and tectonism.

These geological activities heat the subsurface water, causing it to emerge on the surface as hot water springs. One of these hot water springs is located in Desa Lobu 2, Touluaan sub-district, Southeast Minahasa district. This area is where the researcher resides, and it can be reached by motor vehicle in approximately 10-15 minutes from the village settlement. Naturally, in the area surrounding the hot water spring, various processes can be correlated, such as an alteration process in the rock, mineral precipitation in the fluid flow path, reservoir changes due to natural processes, weathering, climate changes, and earthquakes. As a result, at a certain distance, the river water becomes warm due to its contamination with the hot water spring (Sihotang, et al., 2022).

The local community utilizes this warm river water for washing clothes and for bathing in the hot spring, which is referred to as the "Kalewaha hot spring". The research aims to investigate the physical, chemical, and microbiological properties of the Kalewaha hot spring water source, as well as assess the water quality in accordance with Government Regulation No. 82 of 2001. The objective is to enable its development into a hot spring bathing tourist attraction that offers improved facilities compared to its current relatively basic conditions.

This research has received support and collaboration from the Southeast Minahasa district government, specifically the Environmental Agency and the Tourism and Culture Office. They are planning to develop a tourist attraction in Kalewaha, as outlined in the Regional Spatial Plan (RTRW) No. 3 of 2013, with the research site already designated as a location for Tourism Object Development.

Methods and Materials

The research site is administratively located in the North Sulawesi Province, Southeast Minahasa Regency, precisely in Kalewaha, Lobu 2 Village, Touluaan Sub-district.

In conducting research, there are five (5) stages as follows:

1. Conducting an initial field study to formulate a research idea. This is followed by an initial survey of the research site to assess the conditions of the location where the research will be conducted.
2. Conducting a literature review and accessing various sources of information, research reports, and papers related to the research topic from the internet.
3. Carrying out direct field research by establishing an observation route, recording geological phenomena, conducting environmental observations, and collecting water samples. The water samples are measured on-site at the Kalewaha hot spring source, and additional samples are taken for examination and analysis in the laboratory.
4. Performing laboratory analyses, including various tests to determine the properties of the water. This includes assessing the physical properties of the hot spring water, such as color, turbidity, odor, and temperature. Chemical analysis covers pH, hardness, and nitrite levels, while biological analysis includes MPN Coliform and Coliform count. These analyses are conducted in two places: first, directly at the research site, and second, in the Physics Laboratory at FMIPA Unima.
5. Evaluating the quality of the manifestation water by referring to Government Regulation No. 82 of 2001.

Result and Discuss

The Physical Characteristics of Kalewaha Hot Spring Water

The geothermal manifestation source of Kalewaha hot spring originates from groundwater that permeates the Earth's crust and is heated by the high-temperature rock surfaces with heat derived from the magma of the stratovolcano, Mount Soputan, which is situated within the research area. At the surface layer of the ground, the manifestation is predominantly characterized by sand, which is a product of Mount Soputan's volcanic explosions (Jarot , et al., 2019).

The hot spring manifestations are concealed beneath the rocks and are fed by river water and another hot spring source, Hot Spring X (*another hot spring source located in the Lobu 2 area*), which is within a distance of less than 300 meters from the Kalewaha hot spring. Based on the physical analysis conducted in the field, the Kalewaha hot spring water is odorless and colorless. The analysis of water odor and color is of a relative nature as it is carried out directly using visual and olfactory senses without specific standard parameters. Subsequently, the research continues to determine the manifestation's temperature, which can be observed in Figure 4.1 below:

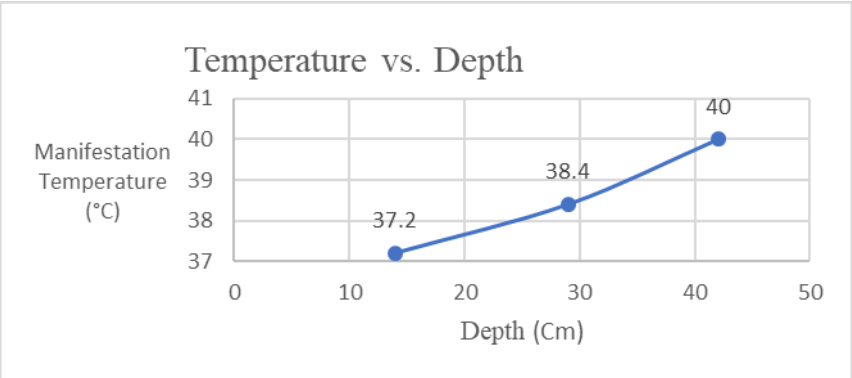

Figure 4.1: Temperature vs. Depth Graph

The depth from the surface of the Kalewaha hot spring to the water outlet from the surface layer of the ground that can be reached is 42 cm. According to Figure 4.1, at point 1, at a depth of 14 cm from the manifestation's surface, the temperature (Tm) is 37.2°C. At point 2, at a depth of 29 cm from the manifestation's surface, Tm is 38.4°C. At point 3, at a depth of 42 cm from the manifestation's surface, Tm is 40°C. The samples were taken at a depth of 42 cm at the water outlet area in the surface layer of the ground with a Tm of 40°C to minimize contamination from the river water.

Table 4.1 Observation Data at the Location

No	Variable	Instrument	Result
1	Tm (Manifestation)	Thermometer	40°C
2	T_0 (Air)	Thermometer	25,6°C
3	pH	pH meter	6,8
4	Coordinates	GPS	X = 0682703 Y= 0120395
5	Elevation	GPS	360

Note: The result values are the average of three measurements.

Based on direct observations at the research location with coordinates X= 068270 and Y= 0120395, and an elevation of 360, as well as a manifestation temperature of 40°C. Further physical parameters were tested in the laboratory, including Color, Hardness, and quantity of Dissolved Substances. These can be seen in Table 4.2 below:

Table 4.2 Physical Parameter Analysis Table in the Laboratory

No	Parameter	Analysis Result	Standard Limits Class II
1	Color	5TCU	-
2	Hardness CaCO3	94 mg/L	-
3	Total Dissolved Substances	1320mg/L	1000mg/L

Based on the physical analysis in the laboratory presented in Table 4.2, the color of the kalewaha sample yielded a result of 5 TCU. Southeast Minahasa Regency uses Government Regulation No. 82 of 2001 for Class II water quality standards, and this regulation does not specify requirements for this parameter. However, the researcher still analyzed the color to gather supporting data since water color quality is crucial for a hot spring bathing site, especially for marketing purposes.

The maximum color requirement for drinking water is 15 TCU. Therefore, it can be concluded that the color of the manifestation water does not exceed the established drinking water standard and is of very high quality for use as a hot spring bathing facility. The hardness value ($CaCO_3$) from the analysis is low, which is 94 mg/L, and Southeast Minahasa Regency also follows Government Regulation No. 82 of 2001 for Class II water quality, which does not specify requirements for this parameter.

Nevertheless, the researcher still analyzed it because high hardness values (> 500 mg/L) can lead to mineral deposits that can clog pipes and faucets and cause issues if ingested. The hardness in kalewaha's manifestation water is low, making it suitable for use in hot spring bathing. The Total Dissolved Substances (TDS) analysis yielded a result of 1320 mg/L, which exceeds the water quality standard set by Government Regulation No. 82 of 2001 for Class II water, which is 1000 mg/L. The high TDS value is due to inorganic materials that have

contaminated the manifestation water because the water was already being used by the community for bathing, as seen in Figure 4.2.

Figure 4.2 Local Residents Bathing at the Research Location

The Chemical Properties of Hot Spring Manifestation

The Chemical Properties of Hot Spring Manifestation in Kalewaha, which were investigated, include pH, Chloride, Bicarbonate, Sulfate, and Nitrite. The direct field research at the Manifestation location revealed an acidic pH level of 6.8, which complies with the established water quality standard of pH 6-9. Subsequently, the chemical properties of Chloride, Bicarbonate, Sulfate, and Nitrite were analyzed in the laboratory. The laboratory analysis results can be observed in Table 4.3 below:

Table 4.3 Laboratory Chemical Analysis Table

No	Parameter	Analysis Result	Standard Limits Class II
1	Sulfate	623 mg/L	-
2	Bicarbonate	235 mg/L	-
3	Chloride	70,6 mg/L	-
4	Nitrite	< 0.001 mg/L	0.06 mg/L

From Table 4.3, the chemical analysis results show a high level of sulfate (SO_4^{2-}) at 623 mg/L compared to bicarbonate (HCO_3^-) with an analysis result of 235 mg/L and chloride (Cl^-) with an analysis result of 70.6 mg/L. Therefore, it can be concluded that the manifestation in Kalewaha is acidic. For the parameters of sulfate, bicarbonate, and chloride, there are no specified standard values for Class II water quality, so the levels obtained from the analysis can be used for their intended purpose, which is for the hot spring bathing site. Nitrite ($N\text{-}NO_2$) yielded an analysis result of < 0.001 mg/L, in compliance with the water quality standard set by Government Regulation No. 82 of 2001 for Class II water, which is 0.06 mg/L.

The Microbiological Properties of the Hot Spring Manifestation

The microbiological properties of the hot spring manifestation investigated include E. coli and Total Coliform, using data obtained from laboratory analysis. These results are presented in Table 4.4 below:

Table 4.4 Laboratory Microbiological Analysis Results

No	Parameter	Analysis Result	Standard Limits Class
1	E. Coli	1305 MPN/100mL	-
2	Total Coliform	8650 MPN/100mL	5000 MPN/100mL

Based on the microbiological analysis in Table 4.4, the bacterial count for E. Coli was found to be 1305 MPN/100mL. E. Coli is an example of fecal coliform bacteria, and according to the water quality standard set by Government Regulation No. 82 of 2001 for Class II water, the maximum allowed level is 1000 MPN/100mL. The Total Coliform count was exceptionally high, at 8650 MPN/mL.
This indicates that the microbiological analysis results for both E. Coli and Total Coliform have exceeded the established water quality standards. This contamination is likely due to the use of the hot spring water from source X for agricultural activities by the local community and contamination from the nearby river. The river water itself is contaminated with animal feces, particularly from pig farming in the vicinity.

Water Quality of the Hot Spring Manifestation

Based on direct field measurements at the Kalewaha hot spring, which has a low enthalpy, a temperature of 40°C at a manifestation depth of 41 cm from the surface of the soil layer, the water is found to be colorless, odorless, with a pH of 6.8. The physical analysis results show a color of 5 TCU, hardness of 94 mg/L, and total dissolved substances of 1320 mg/L. The chemical analysis indicates sulfate at 623 mg/L, bicarbonate at 235 mg/L, chloride at 70.6 mg/L, and nitrite at < 0.001 mg/L. In terms of microbiological analysis, E. coli is present at 1305 MPN/100mL, and Total Coliform is at 8650 MPN/100mL. Referring to the water quality standards set by Government Regulation No. 82 of 2001, particularly for Class II water, it can be concluded that the quality of the geothermal water manifestation in Kalewaha is not heavily contaminated and is suitable for use as a hot spring bathing attraction.

Conclusion

The results of the analysis of the Physical, Chemical, and Microbiological Properties in the Kalewaha geothermal potential area indicate that it can be developed for the tourism sector, specifically for hot spring bathing.
The water quality at the Kalewaha hot spring is considered good, not heavily contaminated, and suitable for the development of a tourism attraction, particularly for hot spring bathing.

Suggestion

For a more accurate and successful development of the geothermal potential, especially for tourism purposes, it is advisable for the government to conduct further and more detailed research encompassing various disciplines such as geology, geophysics, and geochemistry. It is also recommended to investigate the hot spring's discharge rate and to collect samples before they are used by the community for bathing, to obtain more precise data.
In addition, it is advised for the local community to maintain cleanliness at the hot spring location and to avoid disposing of animal waste and agricultural residues into the river and the hot spring source X, which flows towards the Kalewaha hot spring manifestation. This would contribute to preserving the quality and sustainability of the geothermal resource for tourism purposes.

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