Correlation between Rainfall, Flow Rate and Phosphate towards Coliform Bacteria in The Way Sekampung River, Lampung

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Abstract. The Way Sekampung River is a source of drinking water for the people of Lampung. However, the activities of residents around the Way Sekampung River generate waste, such as feces and phosphate. Disposal of feces in surface water presents risks if the community consumes the water. The amount of phosphate in water bodies usually comes from fertilizer runoff from agriculture, human and animal waste, but when the amount of phosphate is high, it leads to very large algae growth and leads to lack of light and when the algae die, the bacteria break them down with the help of dissolved oxygen in the water River flow can affect the presence of coliform bacteria in the water and the phosphate, the river flows are influenced by rainfall. Today rainfall can change because of climate change. This study aims to conduct research on whether there is a correlation between in rainfall changes, flow rate, phosphate towards coliform bacteria that affect the water quality in the Way Sekampung river, Lampung. Purposive sampling technique is used to select the location of the sampling points based on the uses of the surrounding land. The number of coliform bacteria is estimated by the most probable number method. Rainfall data is obtained by month from the Meteorology and Geophysics Agency. Data analysis using statistics to determine the correlation between these variables. The conclusion of this study is at the first location to the last location there is a relationship between rainfall, water flow velocity and coliform bacteria. However, for phosphate, it does not show the relationship between Coliform bacteria.

Keyword: Rainfall, Flow rate, Phosphate, Coliform Bacteria, River

1. Introduction

The Way Sekampung River is a river that passes through 8 autonomous regions or regencies/cities starting from the upstream in Tanggamus Regency, the middle part in Central Lampung Regency, and downstream in East Lampung [1]. The Way Sekampung River has an important role for the community in Sumur Kucing Village, Pasir Sakti, East Lampung. The water is used by the community to support daily life such as drinking water sources, agriculture, animal husbandry, fisheries, and so on. However, the water quality status of the Way Sekampung River has decreased with the status of light to moderate pollution as indicated by the TDS, Ammonia, and Nitrite parameters which exceed the quality standard. These parameters are the occurrence of land use in Sumur Kucing Village, most of the area in the village is 938.30 hectares of rice fields, 413.11 hectares of gardens, 96.26 hectares of settlements, 74.09 hectares of ponds, and 70.57 hectares of ex-mining sand ponds, the result according to 90% accuracy of land use map [2].
Another parameter that could reduce the status of water quality from human activities that is frequently observed other than nitrate is phosphate. Phosphate commonly

comes from the content material of fertilizers and household waste that may potentially harm the nutrient levels withinside the water, as a result affecting water excellent [3]. The amount of phosphate in water bodies usually comes from runoff of agricultural fertilizers human and animal feces. When phosphate counts are high, it causes significant algae growth and results in a lack of light. If algae die, bacteria break them down with the help of dissolved oxygen in the water. [4]. River flow can affect the presence of coliform bacteria in the water and the phosphate, and then river flow is influenced by rainfall [5]. This study aims to research whether there is a correlation between rainfall changes, flow rate, phosphate towards coliform bacteria that affect the water quality in the Way Sekampung River, Lampung.

2. Research Methods

The sampling point is obtained from analysis based on land use maps and the results of observations that have been made in terms of accessibility, time, and cost. Purposive sampling method was used in determining the sample point of river water in this study. Purposive sampling is taking a water sample point based on several assessments by researchers. The assessment is in the form of land use around the Sekampung River in the form of accessibility, time, and cost. Determination of sampling points based on representatives of land use around the river in the form of rice fields, gardens, ponds, and settlements. Figure 1 is sampling location.

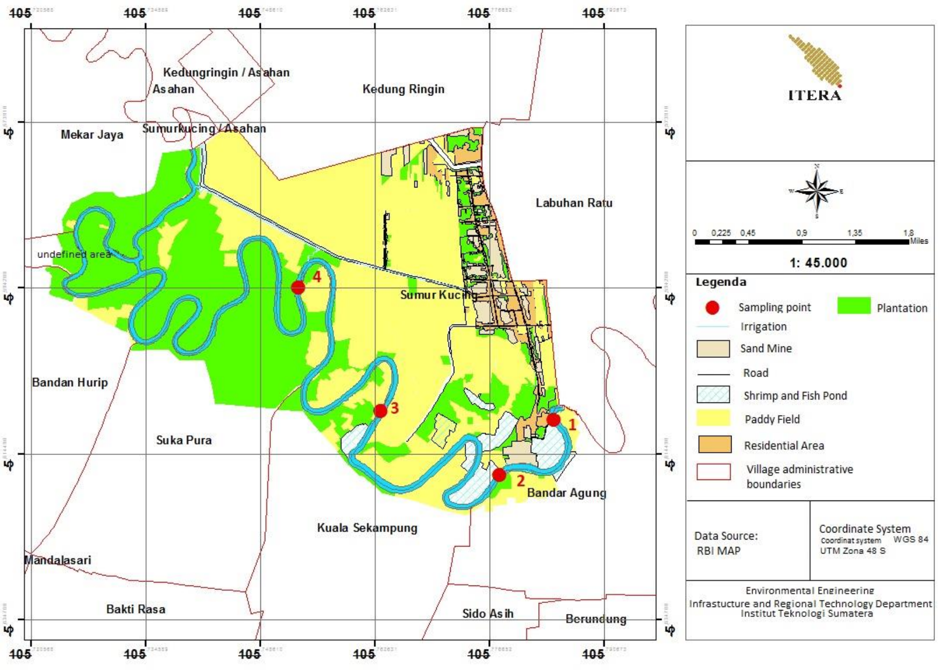

Figure 1. Sampling Location

Sampling of river water is carried out in integrated samples (combined samples of places) which are taken from different points/locations and simultaneously taken with a combination of momentary samples based on SNI 03-7016-2004, namely the sampling rules for the purpose of observing water quality in the watershed areas. The sampling point refers to SNI 6989.57:2008 which is a method of taking surface water samples taken directly at representative points of water quality in the area. Sampling of water samples was carried out regularly every week for 4 times. After determining the sampling position, sampling water samples and ex-situ testing of water samples is then carried out ex-situ testing at the UPTD Environmental Laboratory of Lampung Province. Descriptive analysis method is used in the analysis of this research. The number of coliform bacteria is estimated by the most probable number method (APHA 1999, 9222B). Phospate analysis using SNI 6989-31:2021 (a spectrophotometer with ascorbic acid reduction method). Rainfall data is obtained by month from the Meteorology and Geophysics Agency. Data analysis using statistics to determine the correlation between these variables. The hypothesis of this research is that there is a relationship between rainfall, flow rate, phosphate, and coliform bacteria in the waters of the Way Sekampung river, because in several studies studied there is a correlation between rainfall and flow discharge with coliform bacteria but have not added other parameters such as phosphate in their research.

3. Result and Discussion

3.1 Sampling Area

At the research location in Sumur Kucing Village, four sampling point locations were selected. The first location is the downstream part where many residential area are found. In this section, when sampling, you can see aquatic plants on the banks of the river such as water hyacinth, which can be seen in the image below. Water hyacinth is a plant that grows very fast in waters and can absorb and accumulate pollutant substances in the waters into the structure of the plant body [6].

Figure 2. First location

The second location is near a shrimp and fishponds. Shrimp and fishponds can cause environmental problems, such as excessive use of fertilizers and pesticides. The water from aquaculture is discharged directly into rivers, causing eutrophication from increasing high concentrations such as nitrate and nitrite as ammonia. In addition, ponds also have the potential for pollutants originating from the metabolites of feed residues so that microbes and sediment from pond wastewater contain microbes that carry disease and also to the environment [7]. Here is a picture of the second location.

Figure 3. Second location

Third and fourth location is near paddy field and agriculture area. Waste disposal in agriculture and plantations contributes to nitrate in the waters because of the use of fertilizers. Not all the particulates that enter the soil will be used by plants as the main source of food but will cause them to accumulate and be stored mostly in the soil and to some extent will be released into the waters. Erosion and abrasion reactions on agricultural land and plantations can cause soil containing nitrates to flow into water bodies and carried over to the sea. Fertilizers and pesticides used in agriculture and plantations are agrochemicals. Nutrient fertilizers in agriculture and plantations are known in the form of macronutrient fertilizers and nutrient fertilizers Components N, P, K, Ca, Mg, in addition to C, H and O, are macronutrient fertilizers needed by plants that function in the photosynthesis process as well as micronutrient components in the form of S, Zn, Si Co, and Al [8].

Figure 4. Third and Fourth location

3.2 Data Result

The data obtained from the results of the analysis are listed in Tables 1 - 4, Coliform bacteria data from tables 1 - 4 are still below National Water Quality Standard, the value of the National Water Quality Standard for class 1, which is 1000 MPN/100 ml and class 2 is 5000 MPN/100 ml. The highest number of coliform bacteria was in the second point of the four collections, the value was from 28 MPN/100 ml - 45 MPN/100 ml. The water quality can still be fit for consumption by residents as a source of raw water.

The average of water flow velocity from the data obtained table 1 - 4 is 0.38 m/s in the first week, the second week the value is 0.32 m/s, the third week is 0.3 m/s and the fourth week is 0.35 m/s. The velocity of river flows for aquatic life is grouped into 3 criteria, that is the rate between 0.1 to 0.25 m/s are slow, the rate between 0.25 to 0.50 m/s are medium, and the rate between 0.5 to 1.0 m/s are fast rate [9]. Way Sekampung River has medium flow rate. Velocity is influenced by many things including friction with land, wind, river contours, river location and also disturbances such as weeds, garbage or algae that grow in rivers [10].

The results from table 1 – 4 that the phosphate value in the Way Sekampung River is 1 mg/l. The national water quality standard states that the value of phosphate levels for classes 1 and 2 is 0.2 mg/l. The phosphate value in the Way Sekampung River has passed the quality standard. It might be influenced by agricultural land, rice fields, sand mining, fish, and shrimp ponds, and the residential area near the river.

Phosphate in water is a type of orthophosphate (PO_4). The orthophosphate content in water indicates the fertility of water [11]. Phosphate levels in water bodies generally derive from agriculture, human and animal waste, detergent, vegetable processing, and fertilizer spills from the pulp and paper industry. Aquatic organisms require phosphate levels throughout their lives, but their presence in excessive concentrations can have dangerous effects. High levels of phosphate lead to the overgrowth of algae and reduced sunlight entering the water. When algae die, the bacteria break down the algae with dissolved oxygen in the water [12].

Table 1. First Week

Sample	Flow rate (m/s)	Presipitation (mm)	Coliform (MPN/100ml)	Phosphate (mg/L)
1	0.42	11	23	1
2	0.3	2.06	28	1
3	0.3	4	23	1
4	0.34	18	25	1

Table 2. Second Week

Sample	Flow rate (m/s)	Presipitation (mm)	Coliform (MPN/100ml)	Phosphate (mg/L)
1	0.37	11	39	1
2	0.42	2.06	37	1
3	0.31	4	32	1
4	0.37	18	36	1

Table 3. Third Week

Sample	Flow rate (m/s)	Presipitation (mm)	Coliform (MPN/100ml)	Phosphate (mg/L)
1	0.35	11	27	1
2	0.23	2.06	45	1
3	0.25	4	25	1
4	0.3	18	32	1

Table 4. Fourth Week

Sample	Flow rate (m/s)	Presipitation (mm)	Coliform (MPN/100ml)	Phosphate (mg/L)
1	0.38	11	43	1
2	0.33	2.06	41	1
3	0.34	4	30	1
4	0.36	18	32	1

The value of Presipitation data is the same every four weeks, because it is obtained from the average value of rainfall at that location.

3.3 Statistic Analysis

When the multiple correlation multivariate analysis was performed, there was a variable that had a constant value, namely phosphate. Therefore, at the time of the summary model, the phosphate value could not show a correlation with coliform bacteria.

At the 1st location, a statistical analysis result was obtained which stated that the magnitude of the relationship between rainfall and water velocity on coliform bacteria in the waters showed a correlation coefficient (R) is 0.5. This shows a moderate effect. While the simultaneous contribution or contribution of rainfall and water velocity variables to coliform bacteria is 25% while 75% is determined by other variables.

Table 5. Statistic Analysis for first location

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	**.500**[a]	.250	-1.249	3.54347	.250	.167	2	1	.866

a. Predictors: (Constant), Presipitation, Flowrate

In the second location, the results from the summary model show that the magnitude of the relationship between rainfall and water velocity against Coliform bacteria calculated by the correlation coefficient (R) is 0.803, this indicates that there is a strong influence. Meanwhile, the contribution or contribution of the simultaneous variable of rainfall and water flow velocity to Coliform bacteria is 64.4% while 35.6% is determined by other variables.

Table 6. Statistic Analysis for second location

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	**.803**[a]	.644	-.067	3.04059	.644	.906	2	1	.596

a. Predictors: (Constant), Presipitation, Flowrate

At the 3rd location, the results from the summary model show that the magnitude of the relationship between rainfall and water velocity against Coliform bacteria calculated by the correlation coefficient (R) is 0.551, this indicates that there is a medium influence. Meanwhile, the contribution or contribution of the simultaneous variable of rainfall and water flow velocity to Coliform bacteria is 30.3% while 69.7% is determined by other variables.

Table 7. Statistic Analysis for third location

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	**.551**[a]	.303	-1.090	13.00551	.303	.218	2	1	.835

a. Predictors: (Constant), Presipitation, Flowrate

At the 4th location, the results from the summary model show that the magnitude of the relationship between rainfall and water velocity against Coliform bacteria calculated by the correlation coefficient (R) is 0.626, this indicates that there is a strong influence. Meanwhile, the contribution or contribution of the variable rainfall and water flow velocity to Coliform bacteria was 39.2 while 60.8% was determined by other variables.

Table 8. Statistic Analysis for fourth location

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	**.626**[a]	.392	-.823	8.71424	.392	.323	2	1	.779

a. Predictors: (Constant), Presipitation, Flowrate

4. Conclusion

This study concludes that there is a relationship between rainfall, water flow velocity, and coliform bacteria from the first location to the last location. However, phosphate does not show the relationship between Coliform bacteria because it has a constant value in laboratory test results. The relationship between rainfall and water velocity on coliform bacteria in the waters showed a correlation coefficient (R) is 0.5 at first location, 0.803 at second location, 0.551 at third location and 0.626 for the last location. The strong influence between Coliform bacteria, rainfall and water velocity is at second location and four location, which is two of them dominate agriculture area and ponds. Agriculture and ponds area have the potential for pollutants originating from the metabolites of manure and feed which contains residues of microbes. For a good future of water quality is to control the use of fertilizers on agricultural land and manage wastewater from fish and shrimp ponds as well as industry and housing around the Way Sekampung river.

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