RELATIONSHIP BETWEEN POLLUTANT SOURCES AND WATER QUALITY OF DUG WELL BASED ON BIOLOGICAL PARAMETERS OF *E. Coli*

Deni Rusmaya*, Lili Mulyatna, Putri Ayu Lestari

Department of Environmental Engineering, Universitas Pasundan, Indonesia

Abstract

Water from dug wells is one of the sources of clean water used by the community both in villages and cities. Groundwater consumed by the community must have quality in accordance with the specified requirements. One of the important parameters is the presence of *Escherichia coli bacteria (E.coli).* The aims of this study is to identify the presence of *Escherichia coli bacteria* in dug well. In addition, to determine the correlation between the distance of the pollutant source (cowshed and septic tank) and the well. The analytical method used is *univariate descriptive method* and quantitative analysis. The results showed from 7 wells that were used as research objects, there were 4 wells positive for *E. Coli bacteria* and 3 wells were negative for *E. Coli bacteria.* The correlation value test showed that the pollutant source from cowshed had a coefficient of determination of $R^2 = 0.911$ or 91.1% which means that there is a strong relationship between the presence of *E.Coli* bacteria in the well and cow dung. As for the pollutant source from the septic tank, the results of the correlation test show the value of $R^2 = 0.201$ or 20.1% which means that the relationship between the presence of E. Coli bacteria and the septic tank is not strong. Septic tanks construction that conform to standards are one of the factors that cause dug well water quality to remain protected from pollutants.

Keywords: *cow shed, dug well, Escherichia Coli (E.Coli), septic tank*

Introduction

Water is one of the most important natural resources for life. Water is a component of the environment that is needed for the survival of humans and other creatures. This is proofed by the presence of water in the organism's body. About 70% of human body weight consists of water. In water there are also living things that greatly determine the water's characteristics chemically, physically, and biologically (Soemirat, 2011).

Groundwater is currently polluted by various kinds of waste, both human domestic waste and waste from other activities (agriculture, livestock and industry) so that groundwater quality has decreased. This needs serious attention because groundwater is a source of water that is easily obtained so that the community widely uses it both in the city and in the village.

Excessive extraction of groundwater (exploitation) is also the cause of the lowering of the ground water level. If this condition is left unchecked, there is the potential for sea water intrusion and land subsidence, which will negatively impact the community.

People who use dug well water often do not know the quality of ground water used. In general, people think that the water they use is of good quality. People often directly use water for cooking and drinking purposes without any processing so that it has the potential to be the

*)Corresponding Author:
E-mail: denirusmaya@gmail.com

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cause of *water borne diseases*. One of the diseases caused by consuming water whose quality does not meet the quality standards is diarrhea. Diarrhea is caused by bacteria.

Dug well that have been used for a relatively long time can affect pollution in terms of distance and bacteriological cycles, because pollutant sources seep more easily into the well following the flow of ground water that is concentrated towards the well (Chandra,2006).

Based on data obtained from the Pangkalan Baru Health Center in 2019, there were 24 cases of diarrhea in Padang Baru Village. In the initial search results, the people in the village use water sources that come from dug wells close to the cowshed and the location of the septic tank.

Based on this, it is necessary to conduct research to examine whether there is a relationship between the presence of *Escherichia Coli* (*E.Coli*) bacteria that causes diarrhea from cowshed and septic tanks with *E.Coli* content in resident water sources (dug wells).

Methodology

Research Location

This research was conducted in Padang Baru Village, Pangkalan Baru District, Bangka Tengah Regency. The water samples came from the local area dug wells and are still used by the community for their daily needs.

Figure 1. Sampling Point in Padang Baru Village

Table 1. Location of Sampling Points

No	Source Name	Point Coordinates
1	Dug Well 1	S: 02°10.046' E: 106°09.566'
2	Dug Well 2	S: 02°09.987' E: 106°09.163'
3	Dug Well 3	S: 02°09.955' E: 106°09.266'
4	Dug Well 4	S: 02°09.950' E: 106°09.205'
5	Dug Well 5	S: 02°09.943' E: 106°09.189'
6	Dug Well 6	S: 02°10.161' E: 106°09.432'
7	Dug Well 7	S: 02°09.984' E: 106°09.393'

The number of sample points is 7 dug wells with 1 dug well (dug well 7) as a control (a dug well that is considered unaffected because its location is far from the pollutant source).

Tools and Materials

Data collection for this research includes:

- Secondary data collection obtained from various literatures and government agencies includes:
  a. Bangka Tengah Regency Profile
  b. Padang Baru Village Profile
  c. Health Data from Pangkalan Baru Health Center
- Primary data collection obtained through:
  a. observation/interviews with the community to find out the location of dug wells that are still in use
  b. Determination of the sampling location using the *Global Positioning System* (GPS) tool.
  c. Sampling of water from selected dug well locations

d. Collecting data on the physical condition of the well by direct observation and documenting it

- The method used in the laboratory test is the Jumlah Perkiraan Terdekat (JPT) or *Most Probable Number* (MPN) method. The MPN method is an indirect calculation method. The MPN method consists of two stages: the *presumptive test* and the *confirmed test*.

Data analysis was carried out using *univariate descriptive* analysis and quantitative analysis methods. *Univariate* analysis is a descriptive data presentation by showing only one variable presented in the form of a frequency distribution table and percentage analysis, namely the number of *E.Coli bacteria* in well water. The results obtained will be compared with the normal limit for the number of *E.Coli* according to the Decree of the Minister of Health no. 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for *Sanitary Hygiene*, Swimming Pools, *Solus Per Aqua*, and Public Baths.

Quantitative analysis is used to examine a particular population or sample, sampling techniques are generally carried out randomly, data collection using research instruments, data analysis is quantitative with the aim of testing predetermined hypotheses.

The research method quantitatively and using a descriptive approach was chosen in order to see the relationship between pollutant sources and the content of *E.Coli* in resident wells.

Results and Discussion

Depth and Water Level of Wells

Based on the results of measurements in the field, each data is obtained from the distance from the pollutant source to each well. The complete measurement results are presented in table 2 below.

Table 2. Distance from Pollutant Source to Well

No.	Source Name	Distance from Cowshed - Well (m)	Septic Tank Distance - Well (m)
1	Well 1	9	9.7
2	Well 2	9.8	
3	Well 3		7
4	Well 4	40	24
5	Well 5	25	
6	Well 6		20
7	Well 7		50

The well which is farthest from the cowshed is well 4 with a distance of 40 m and the closest distance to the cowshed is well 1 as far as 9 m. The furthest distance between the septic tank and the well is also measured in well 4 with a distance of 24 m while the distance from the closest septic tank to the well is in well 3 which is 7 m. Well 7 is a control well with no cowshed and no septic tank . The measured distance is 50 m.

In field identification activities, well depth observations were also carried out. This is done to see the relationship between the depth of the well and the measured amount of *E.Coli*. The data from the measurement of the depth of the well is presented in table 3 below.

Table 3. Elevation Water in the Dug Well

No	Source Name	Well Depth (m)	Water Level Elevation in Wells (masl)
1	Well 1	6	24.9
2	Well 2	9	25.6
3	Well 3	9	24.5
4	Well 4	5	29.5
5	Well 5	8	28.9
6	Well 6	8	29.7
7	Well 7	9	25.0

The deepest dug wells are dug well 2, dug well 3, and dug well 7 with a measured depth of 9 m. Meanwhile, the dug well with the lowest depth is well 4 with a measured depth of 5 m.

The results of the complete *E.Coli bacteriological test* in dug well water in Padang Baru Village are presented in table 4 below.

Table 4. Laboratory Test Results of *E.Coli bacteria* from dug Well Water Samples (DLH Laboratory of Bangka Belitung Islands Province, 2019)

No	Sample	Positive Amount			MPN Index / 100 ml
		10 ml	1 ml	0.1 ml	
		3	0	0	7.80
1	Well 1	2	0	0	4.50
		2	0	0	4.50
		0	0	0	< 1.80
2	Well 2	1	0	0	2.00
		0	0	0	< 1.80
		0	0	0	< 1.80
3	Well 3	0	0	0	< 1.80
		0	0	0	< 1.80
		0	0	0	< 1.80
4	Well 4	0	0	0	< 1.80
		0	0	0	< 1.80
		5	2	1	70.0
5	Well 5	5	4	4	350
		3	1	2	17.0
		1	0	0	2.00
6	Well 6	1	0	0	2.00
		0	0	0	< 1.80
		0	0	0	< 1.80
7	Well 7	0	0	0	< 1.80
		0	0	0	< 1.80

Notes:
- The sample of each well uses 3 times the sampling test at the same time
- For the test results numbers are matched with the MPN. Table
- The number of test results analyzed is the Affirmation stage

The results of the examination showed that the samples of wells 3, wells 4 and wells 7 did not contain *E.Coli bacteria* . Meanwhile, well 1, well 2, well 5 and well 6 are positive for bacteria *E. Coli* . Based on these results, it can be estimated that there has been contamination of dug well water by domestic household wastewater or by cow dung.

Relationship between Cowshed and dug Well Water Quality

To see the effect of the presence of cowshed on water quality with *E. Coli* bacteria parameters used samples from wells 2 and well 5. Results of laboratory analysis can be seen in the following graph.

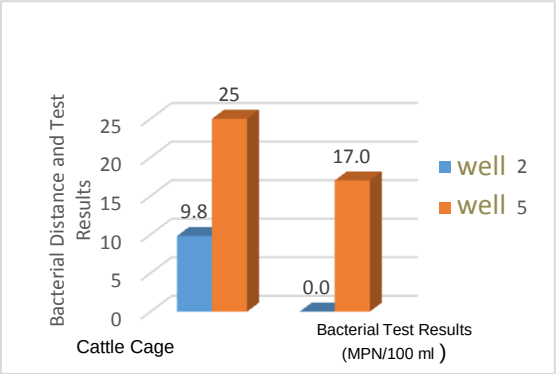

Figure 2. Value of Bacterial Test Results Based on the Distance of Well 2 and Well 5

In the picture it can be seen that well 2 with a distance of 9.8 m based on the results of laboratory analysis has a number of *E. Coli bacteria* 0 MPN/100 ml based on the table MPN. Meanwhile, well 5 with a distance of 25 m showed very different results where the well water contained *E. Coli* with an amount of up to 17 MPN/100 ml. This condition contradicts the theory, which states that the farther the distance from the well to the pollutant source (cow pen), the safer the well's water quality.

Based on the results of observations, the condition of the dug well construction in well 2 is different from the construction in well 5. The construction of dug well 5 has a floor of the well from the ground directly so that it is not watertight, while for well 2 the floor of the well is watertight because it is hardened with cement and sand. This result is in line with the statement that the physical building of the well that does not meet the standards will make it easier for bacteria to seep and enter the well (Tutut, 2015).

The condition around the location of well 5 where a lot of cow dung was found scattered was also a factor that caused the high value of *E. Coli bacteria* in well 5. For a more detailed description of the conditions around well 5 can be seen in Figure 3.

Figure 3. Scattered Cow Dung Around Well 5

According to Nurhadini (2016) dug wells as a source of clean water must be supported by construction requirements, site requirements for the construction of a dug well, this is necessary so that the quality of dug well water is safe in accordance with the established rules. The results of Marsono's research (2009) stated that the construction of wells must follow health standards, physical wells that do not meet the standards will make it easier for bacteria to seep and enter the well. Construction conditions that do not meet the requirements indicate a risk of contamination of clean water sources by polluters (Wirawaty, 2012).

Relationship between Septic Tank and Well Water Quality

The effect of the presence of a septic tank on the water quality of dug wells was investigated with samples from wells 3 and well 6. The results of laboratory analysis can be seen in the following figure.

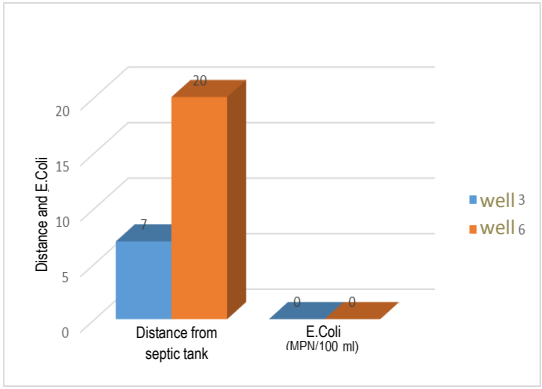

Figure 4. Value of Bacterial Test Results Based on Distance from Wells to Septic Tanks at Wells 3 and 6

The graph shows that well 3 with a distance of 7 m has *E. Coli bacteria values* < 1.8 MPN/100 ml or 0 MPN/100 ml. For well 6 with a distance of 20 m has the same results, namely < 1.8 MPN/100 ml or 0 MPN/100 ml.

The lab analysis results, which showed that there were no *E.Coli* bacteria, indicated that the septic tanks owned by the residents were standard so they were watertight. Another thing that supports this is the type of soil that is in the location is included in the Regosol soil type where this soil has a low force in holding water and has poor permeability.

Relationship between Cattle Cages and Septic Tanks with Well Water Quality

There are also wells used by residents that have 2 sources of pollution at once, namely cattle pens and septic tanks. The wells are well 1 and well 4. The results of the analysis are shown in the following figure.

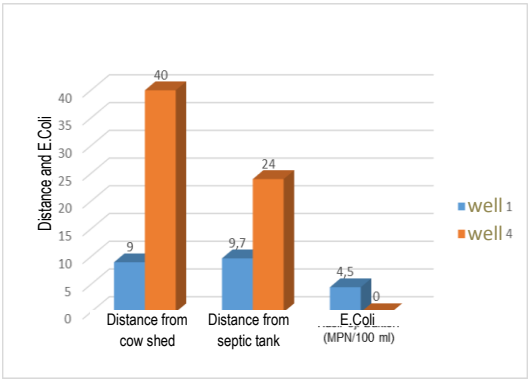

Figure 5. Value of Bacterial Test Results Based on Distance from Wells to Cattle Cages and Septic Tanks

Well 1 has a well distance of 9 m from a cattle pen and a 9.7 m (≤ 10 m) septic tank. From this distance, the results of laboratory tests for well 1 are 4.5 MPN/100 ml. Well 4 has a well distance of 40 m from a cattle pen and a 24 m (≥ 10 m) septic tank. From this distance, the results of laboratory tests for well 4 are < 1.8 MPN/100 ml or 0 MPN/100 ml. Distance is very important to prevent water pollution. Based on SNI 03-2916-1992 Dug Well Planning, the minimum distance of the pollutant source (septic tank) from the well is 10 m.

Correlation Result of Well Water Quality with Cattle Cage

A correlation test was conducted to see the relationship between the quality of well water and sources of pollution (cow pens). The test results are shown in the following image.

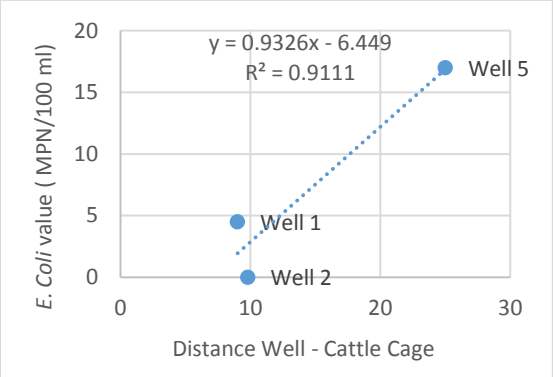

Figure 6. Correlation Graph of Cattle Cage Distance with Well Water Quality

The value of the coefficient of determination from the above equation is R^2 = 0.911 or 91.1%, meaning that the independent variable (distance) is very influential on the dependent variable (*E.Coli* content). An R value of more than 0.67 is categorized as strong according to Chin (1998).

Pollution caused by bacteria to water in the soil widens to 2 meters at a distance of 5 meters from the source of pollution and narrows to a distance of 11 meters in the direction of the flow of the soil (Marsono, 2009).

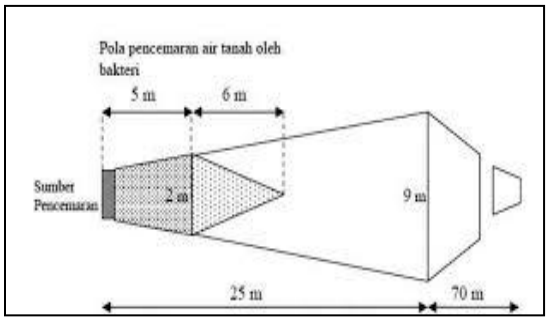

Figure 7. Distribution Pattern of Microorganisms and Chemicals in Pollution of Surrounding Groundwater (Marsono, 2009)

Correlation Result of Well Water Quality with Septic Tank

To see the relationship between well water quality and pollutant sources (septic tanks), a correlation test was conducted. The results of the correlation analysis are shown in the following figure.

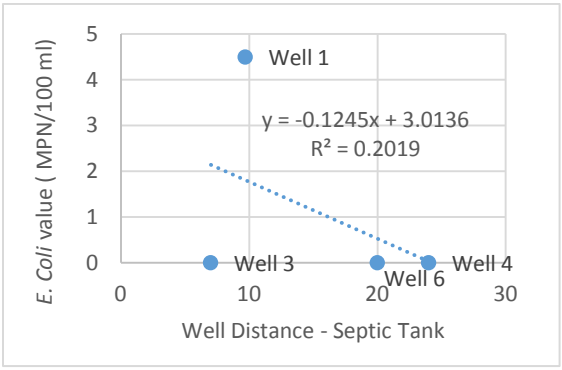

Figure 8. Correlation Graph of Septic Tank Distance with Well Water Quality

The value of the coefficient of determination from the above equation is R^2 = 0.2019 or 20.19%, meaning that the independent variable (distance) has no effect on the dependent variable (*E.Coli* content). An R value of less than 0.33 is categorized as weak according to Chin (1998).

This is in line with the results of research conducted in other location (Yustiani, 2017) if the distance from the dug well to the pollutant source is > 10 m, the amount of *E. Coli* contained in the dug well water tends to be low. On the other hand, if the distance between the well and the pollutant source is < 10 m, the *E. Coli* content in the well water is quite high.

Analysis of Laboratory Test Results Related to Health

Based on the results of laboratory tests, 5 wells (well 2, well 3, well 4, well 6 and well 7) in Padang Baru Village are suitable for

consumption because they contain *E. Coli bacteria.* < 1.8 MPN/100 ml or 0 MPN/100 ml. Meanwhile, 2 wells (well 1 and well 5) were contaminated with *E. Coli* bacteria.

Based on this, the cause of diarrhea is estimated because residents consume water contaminated with *E.Coli*. Another thing that can also be a cause of diarrheal disease can come from outside the environment they live in. Therefore, according to Blum (1974), the factors that influence health are the environment, behavior/lifestyle, health services and heredity.

Conclusion

Based on the results of the study, it can be concluded that the pollutant source (cowshed) affects the quality of well water (contains *E.Coli* bacteria) while the pollutant source (septic tank) does not affect the quality of well water (does not contain *E.Coli* bacteria). Distance is one factor that influences the process of well water pollution. Well construction and construction of septic tanks that meet the standards are able to prevent the pollution process from occurring.

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