The presence of E. coli as Bio-indicator of groundwater pollution in Tanah Sareal District, Bogor City, Indonesia

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Abstract. Settlement condition and human activities can cause contaminated of groundwater. Tanah Sareal Sub District in Bogor City is one of most populated area. Generally, community utilizes groundwater for the purposes of daily life. This research aims to evaluate the groundwater microbial pollution in Tanah Sareal Sub District of Bogor City and factors affecting of E. coli contamination in the community of groundwater. The influenced by depth of groundwater and distance of the well from the septic tank. The analysis was carried out on 11 wells scattered throughout Tanah Sareal Sub District. The water samples were taken on 2 different times. The results of the analysis are compared with PERMENKES No. 32 year 2017. Most pollution caused by the activity around the location of samples that are in densely populated areas. According to data from the Bogor City Health Office in 2016 the largest diarrhea case was found in Tanah Sareal Sub District, which is 2119 cases. The quality of ground water in the district of Tanah Sareal classified as polluted and less feasible where all the sampling point number of total coliform and E. coli are high.

1. Introduction

In 2019, Indonesian population has reached 270,812,305 people, which ranked fourth as the highest populated countries in the world. High population will surely consistent with increasing consumption needs such as food, fresh water and housing areas. If the people can have met their basic needs, then the life itself will reach prosperity. One of the most important and highly utilized basic human needs is adequate fresh water on a daily basis [1]. One of many water sources utilized by human until today is ground water. Ground water has become the main water source, not only for most of Indonesian people, but also for most of the people in the world. Ground water volume decrease commonly caused by human activity that produces pollutions, even though water quality is not always the best in the absence of human interference [2].

Water pollution is one of the most critical issues facing humans all over the world, especially in developing countries since it affects the water quality which threatens public health, social welfare and the economic development [3]. The United Nations (2013) declared the improvement of drinking water sources to increase its accessibility by the population. In the developing countries, the accessibility to water is considered as one of the major challenges.

Fresh water that meet health requirement should be free of pollution, however drinking water must fulfill standard physical, chemical, and biological requirements otherwise it would endanger peoples’ health [4]. According to Indonesian Health Minister Regulation Number 492/MENKES/PER/IV/2010,
fresh water must fulfill physical requirements such as odorless, tasteless, colorless, and not murky. Drinking water bacteriology requirements state that it should not contain bacteria, meanwhile chemically, water should not contain toxic chemical compound and every compound dissolved in water should not exceed certain level [5].

Drinking water must be safe, which means it is free of pathogen microbe and dangerous compounds, especially dangerous microbes contamination such as pathogen bacteria that might be polluted the water caused by human and animal feces, such as Shigella sp., and Escherichia coli. Pollutant source that also has the effect on consumed water pollution are septic tank, drains, garbage dump, cattle pen, traditional market, etc. [6]

Water microbiology parameter test is commonly utilizing microorganism indicator. Microorganism indicator is usually used as E. coli and coliform total microbe parameters. The result of microbiology test shows that the existence and the inexistence of microorganism in water can be used as water quality indicator [7].

Bogor City is one of numerous cities in West Java Province. Bogor City that is located between Bogor Regency and the Capital of Indonesia has placed this city as a strategic place to develop and grow economic life. The existence of diarrhea cases in Bogor City occurred during 2011 until 2016 with the percentage of 50.59% - 69.10% [8]. The highest case was found in Bogor City (1976 cases) and Tanah Sareal (2119 cases). High diarrhea case in Tanah Sareal is produced by the existence of several factors, but mainly caused by a high level of ground water utilization as drinking water source (well water) during 2016 (Tanah Sareal Sub District in Figure, 2019) [9].

Based on the presented background, the conduction of this research is to acknowledge ground water quality based on the existence of Escherichia coli bacteria as indicator in Tanah Sareal Sub District of Bogor City. This research was also conducted to understand the quality of water used by the society of Tanah Sareal Sub District in Bogor City, based on ground water standard quality measurement issued in Ministry of Health’s Regulation Number 32 Year 2017.

2. Methods

2.1. Sampling location
Shallow ground water sampling (wells) was conducted in 11 spots with two sample taking activities. Ground water sampling determination was conducted with Stratified Random Sampling method in Tanah Sareal Sub District area. Sampling points and sampling areas can be seen in the following Figure 1 and Table 1 as follows:

| Sampling Point | Sampling Location                           |
|----------------|--------------------------------------------|
| 1              | RT 02/RW 03  | Kedung Badak Sub District, Cibuluh Village, |
| 2              | RT 01/RW 03  | Tanah Sareal Sub District, Warung Jambu Village, |
| 3              | RT 01/RW 04  | Sukaresmi Sub District, Kedung Halang Village, |
| 4              | RT 03/RW 02  | Sukadamai Sub District, Situ Pete Village, |
| 5              | RT 01/RW 04  | Kedung waringin Sub District, Benda Kaum, Village |
| 6              | RT 01/RW 08  | Kedung Jaya Sub District, Soleh Iskandar Village, |
| 7              | RT 01/RW 01  | Kayumanis Sub District, Poncol Village, |
| 8              | RT 02/RW 07  | Kencana Sub District, Lana Raya Village, |
| 9              | RT 04/RW 03  | Kebonpedes Sub District, Bondes Village, |
| 10             | RT 02/RW 07  | Mekarwangi Sub District, Masjid Village, |
| 11             | RT 03/RW 10  | Cibadak Sub District, Saremped Village, |
Figure 1. Water sampling location in Tanah Sareal Sub District Areas.

2.2. Total Coliform and E-Coli analysis method
The total number of Coliform and E-coli was analyzed by using APHA 9223-A method by using IDEXX Colillert. One hundred mL specimens of water were incubated with the Colilert®. After incubation, the water sample was examined under natural light for a colour change from clear to yellow caused by metabolization of ortho-nitrophenyl-β- galactoside (ONPG) by β-galactosidase, indicating a total coliform positive test [10]. Samples collected This method utilizes chromogenic-fluorogenic synthetic substrate such as β-D-galactopyranosidase (ONPG) and 4-methyl-umbelliferyl (MUG) enzyme to detect β-D-galactoxidation enzyme’s existence which is produced by Coliform bacteria, which was originally made from coliform bacteria. These specific enzymes produced by the bacteria will hydrolyze substrate and produce change of color, that shows positive result in 24-hour time [11].

The number of coliform and E. coli was counted based on MPN table and IDEXX Quanti-Tray 2000, with (positive) number of large well in vertical or Y axis (0-49) and (positive) number of small well on horizontal or x axis (0-48). The number seen on x and y axis meeting point is the total number of coliform or E. coli in MPN/100 ml [10].

2.3. Water quality measurement
Data analysis to explain ground water quality test based on Environmental Health standard quality for water media to fulfill hygiene and sanitation needs is Health Minister Regulation Number 32 year 2017.

3. Results and discussion
3.1. Determination of Coliform and E. coli bacteria existence with IDEXX Quanti-Tray
Coliform and E. coli existence test in shallow ground water of Tanah Sareal Sub District can be seen in Table 2. IDEXX Colilert uses Defined Substrate Technology® (DST®) technology to stimulate total coliform and E. coli bacteria detection. Two indicators of ONPG and MUG are the main source of carbon in colilert as metabolism source of coliform and E. coli bacteria. Coliform bacteria utilize β-D-galactocide to grow in colilert, and for ONPG metabolism that would change the color of the water from colorless into yellowish water [12]. Escherichia coli bacteria utilize β-D-glucuronidase to metabolize MUG and produce fluorescence. Because coliform and any other bacteria do not possess the
enzyme, other coliform bacteria will not interfere or show fluorescence. The obtained result was further referred with MPN (Most Probable Number) table in 100 ml of test sample, so that the number of population can be acknowledged [13].

Table 2. Water sample test result on Quanti-Tray 2000.

| No. | Location                                               | Sampling I | Sampling 2 |
|-----|--------------------------------------------------------|------------|------------|
|     |                                                        | Yellow Well| Fluorescent Well | Yellow Well| Fluorescent Well |
| 1   | Kedung Badak Sub District, Cibutuh Village, RT 02/RW 03 | 49/48      | 49/48      | 49/48      | 49/48      |
| 2   | Tanah Sareal Sub District, Warung Jambu Village, RT 01/RW 03 | 49/48      | 49/48      | 49/48      | 49/48      |
| 3   | Sukaresmi Sub District, Kedung Halang, RT 01/RW 04     | 49/48      | 49/48      | 49/48      | 49/48      |
| 4   | Sukadamai Sub District, Situ Pete, RT 03/RW 02         | 4/1        | 1/1        | 2/2        | ½         |
| 5   | Kedung Waringin Sub District, Bende Kaum Village, RT 01/RW 04 | 49/41      | 47/5       | 49/39      | 46/11      |
| 6   | Kedung Jaya Sub District, Soleh Iskandar, RT 01/RW 08  | 49/48      | 49/48      | 49/48      | 49/48      |
| 7   | Kayumanis Sub District, Poncol Village, RT 01/RW 01    | 40/5       | 3/0        | 42/9       | 3/1        |
| 8   | Kencana Sub District, Lana Raya, RT 02/RW 07           | 49/44      | 6/2        | 48/45      | 7/3        |
| 9   | Kebonpedes Sub District, Bondes Village, RT 04/RW 03   | 49/48      | 49/48      | 49/48      | 49/48      |
| 10  | Mekarwangi Sub District, Masjid Village, RT 02/RW 07   | 43/13      | 7/2        | 4/3        | 4/4        |
| 11  | Cibadak Sub District, Saremped Village, RT 03/RW 10    | 49/48      | 49/48      | 49/48      | 49/48      |

The obtained result is a qualitative result of color change. Of every tested sample, it was acknowledged that coliform (yellow well) and E. Coli (fluorescent well) bacteria was found as shown in Figure 2.

Figure 2. Colour Change and Fluorescence on Quanti-Tray 2000.
3.2. **Coliform and E. coli bacteria number measurement with MPN (Most Probable Number)**

Analysis result on Table 2 pictures that the existence of coliform and E. coli bacteria in ground water sample by using MPN method is effective to indicate coliform bacteria existence in the sample and the measurement of E. coli bacteria number. The utilization of this method is placed by counting the yellow colored sample seen in vertical area of MPN table. Meanwhile the yellow color on small box can be seen through horizontal MPN table [14]. To acknowledge the number of E. coli in the sample, the samples were exposed on ultraviolet ray with 365 nm of wave length, and the yellow colored or fluorescent box is counted with vertical number of MPN table and the small box was seen on horizontal area of MPN table. The MPN calculation result for 11 water sample is pictured in Table 3.

**Table 3. MPN calculation result.**

| No. | Location                                           | Sampling 1 Coliform (MPN/100 ml) | E. coli (MPN/100 ml) | Sampling 2 Coliform (MPN/100 ml) | E. coli (MPN/100 ml) |
|-----|---------------------------------------------------|---------------------------------|----------------------|---------------------------------|----------------------|
| 1   | Kedung Badak Sub District, Cibutuh Village, RT 02/RW 03 | > 2500                          | > 2500               | > 2500                          | > 2500               |
| 2   | Tanah Sareal Sub District, Warung Jambu Village, RT 01/RW 03 | > 2500                          | > 2500               | > 2500                          | > 2500               |
| 3   | Sukaresmi Sub District, Kedung Halang, RT 01/RW 04 | > 2500                          | > 2500               | > 2500                          | > 2500               |
| 4   | Sukadamai Sub District, Situ Pete, RT 03/RW 02 | 4                              | 2                    | 4                               | 3                    |
| 5   | Kedung Waringin Sub District, Bende Kaum Village, RT 01/RW 04 | 1203                            | 135                  | 1046                            | 152                  |
| 6   | Kedung Jaya Sub District, Soleh Iskandar, RT 01/RW 08 | > 2500                          | > 2500               | > 2500                          | > 2500               |
| 7   | Kayumanis Sub District, Poncol Village, RT 01/RW 01 | 86                             | 3                    | 108                             | 4                    |
| 8   | Kencana Sub District, Lana Raya, RT 02/RW 07 | 1553                            | 8                    | 870                             | 11                   |
| 9   | Kebonpedes Sub District, Bondes Village, RT 04/RW 03 | > 2500                          | > 2500               | > 2500                          | > 2500               |
| 10  | Mekarwangi Sub District, Masjid Village, RT 02/RW 07 | 128                             | 10                   | 109                             | 12                   |
| 11  | Cibadak Sub District, Saremped Village, RT 03/RW 10 | > 2500                          | > 2500               | > 2500                          | > 2500               |

The conducted MPN analysis shows a picture of bacteria number on water sample. Total coliform detection on water sample can provide water situation indication, and 11 water sample show numbers that exceeds standard quality as mentioned in Health Minister Regulation Number 32 Year 2017, where E. coli standard number should not exceed 0 MPN/100 ml and maximum Coliform standard number of 50 MPN/100 ml [15]. Based on the finding, we can say that water quality in Tanah Sareal as improper for drinking water source. The high number of coliform can be caused by the people’s activity and several pollutant sources located in the area, such as animal cattle, traditional market, septic tank, garbage dump, and industrial activities. The existence of coliform bacteria in the ground water can potentially cause health problems for the society. Ground water contamination is commonly caused by bad sanitation and the ability of contaminant to enter aquifer. Besides that, unregulated domestic waste and pollutant caused by garbage dump can worsen bacteria contamination in ground water [2].

4. **Conclusion**

The conclusion that can be made with the result of this research is that shallow water quality in Tanah Sareal Sub District is polluted and improper to be utilized as standard drinking water quality because it
is not fulfilled criteria of Health Minister Regulation Number 32 Year 2017 water standard. Almost every sampling spots show high coliform and E. coli concentration, while the areas with lowest contamination are Sukadama and Kayumanis Sub Districts. Because of that, a further processing activity should be conducted on shallow water sources before finally used to fulfil domestic needs. Well owners must be encouraged to test their water periodically to make sure it is safe to drink and may also disinfect the well.

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