Water quality study as a way of community behaviour in environmental management in east lombok regency

B L Widiyanti
Environmental Engineering Program, Faculty of Engineering, Universitas Hamzanwadi
*leea91819@gmail.com

Abstract. Groundwater is one of the natural resources that must be maintained and managed sustainably well. Groundwater quality monitoring is important to do given the increasing human population that affects the increasing demand for water, both in terms of quality and quantity. Groundwater is susceptible to pollution which will result in a decline in the value of its benefits. The objectives of the research are to analyze the quality of groundwater and community behaviour in densely populated residential areas in East Lombok Regency, West Nusa Tenggara Province. The research method is survey method. Results of groundwater quality testing compared to drinking water quality standard in accordance of PERMENKES 416/MENKES/PER/IX/1990. The results showed that in general if viewed from the physical and chemical aspects, groundwater in the research area is still below the standard of permissible quality, only in biological aspects that far exceeds the standard of non-piped water quality standard. To be able to utilize groundwater as drinking water should do the treatment. Community behaviour in managing and maintaining groundwater quality in general is good, but in the future it should be improved.

1. Introduction
The problem of clean water worthy of consumption that meets health and sanitation requirements need to get serious attention from the government and society because until now the development of drinking water and sanitation has not shown optimal results. Data from the Central Bureau of Statistics (BPS) states, at least until 2011 there were only 55% of the population who have access to drinking water and proper sanitation. Referring to the 2015 MDG target, at least 68% of Indonesians should have access to improved drinking water and sanitation [1-3]. Quite a lot of public until today who still consume drinking water that comes from sources with no guaranteed quality and not distribute through the pipeline system arranged by the state water company. People can only use a small amount of water, perhaps less than 40 litre/person, which is below the minimum standards required for personal hygiene [4]. This phenomenon occurs in rural areas that have adequate sanitation infrastructure or transportation for the infrastructure. This can also occur in urban areas, especially in densely populated and slum areas, which appear to be developing in urban fringes because of the development of urban economic activity and causes several problem such as over exploitation and decreasing its quality [5].

To meet water demand for both drinking water and other domestic needs, communities in rural areas, suburbs and densely populated settlements use free groundwater got from dug wells. The assumption is the groundwater quality of the dug well is much better than taking advantage of the surface water especially from the river. This is in fact not entirely true because the excessive use of
groundwater and density of settlements, and the lack of sanitation facilities, both in terms of quantity and quality, will affect the quality of the groundwater directly [7-10]. As a result, it will impact the life of the community itself, especially its health. The real effect seen in the development of certain types of diseases related to water as a medium for its spreading in the place (water borne disease) [11].

From data on diarrhea cases in Indonesia, the incidence rate of diarrhea (per 1,000 populations) in NTB province is high between 7-12 cases [12]. The high number because of two main causes: lack of clean water supply (56%) and local people not using goose neck toilets (24%). Based on data on the percentage of households by districts / municipalities and drinking water source in 2009 NTB Province, in East Lombok Regency there are 4 sources of drinking water for the community: (a) bottled/plated water of 16.15%, (b) Protected wells of 48.38%, (c) 26.47% sheltered springs and (d) unprotected wells/springs of 9% [13-15]. Relate the condition of the settlements with all the facilities that should own to the health of the inhabitants. The dense residential neighbourhoods in an urban area, will lead to the emergence of various types of infectious diseases that use abiotic environment (water, soil, air) as a medium of intermediary. The goal is testing groundwater quality related to the possibility of water pollution by domestic waste as manifestation of community behavior in environmental management.

2. Methods
The method used is a survey method accompanied by laboratory analysis. Selection of a research location by purposive sampling, determine 4 districts in East Lombok: Selong, Sukamulia, Masbagik and Labuhan Haji because there was a phenomenon of a densely populated residential development because of the large number of migrants to Selong Town which is the capital of East Lombok Regency for various purposes and activities. The tools and materials used in the research are: topographic map scale 1: 350,000, geological map scale 1: 200,000, GPS, Abney level, yallon, measuring tape, thermometer, pH Meter, a thermometer, a water sample bottle, recorder, camera, questionnaires and stationery. The total number of tested water samples is 25. From each location take 5-8 samples. The basis for selecting the number of samples is from the groundwater flow direction map. Analysis of groundwater quality data in the research area fully refers to PERMENKES No. 416/MENKES/KES/IX/1990 on drinking water quality standard. For observations, interviews and questionnaires will analyzed using non-parametric statistics.

![Figure 1. Groundwater sample location in East Lombok Regency.](image-url)
3. Results and Discussion

3.1. Condition of research area
East Lombok Regency location astronomically between 116 ° - 117 ° E and 8 ° - 9 ° S. The total area is 2,679.88 km², comprising land 1,605.55 km² (59.91%) and sea 1,074.33 km² (40.09%). Administratively, East Lombok Regency comprises 20 districts, 13 sub-districts, 106 villages, 772 neighbourhoods/hamlets with administrative boundaries as follows. North side: Java Sea, South: Indonesian Ocean, West side: Central Lombok Regency, and East: Alas Strait [16]. It has a tropical climate, characterized by two seasons, summer and rainy season. Average rainfall of 1882 mm/year with the number of rainy days per month was 15 days. The rainy season lasts between May - September, with an average rainfall ranges from 1000 to 2000 mm/year with rainy days of 100-200 days/ year. While the summer or dry season lasts between November- April [16].

3.2. Research area landform
Based on aspects of geomorphological, it can be specifically separated into four units, including: volcanic mountain topographic units, strong denudational corrugated topography, weakly denudational wavy topography, and fluvial plain topography. East Lombok topography lied at altitude between 0 - 3,726 meters above sea level with the slope of the slope varies from the slope class between 0-2% to the slope of more than 40% [17-18]. The most dominant type of soil in East Lombok was Volcanic Brown Forest Soil with area cover of 29,062 Ha or 18.10%. Volcanic Regosol Soil covered of 27,493 hectares or 17.12%, while the Volcanic Brown Mediterranean Soil cover of 1.075 Ha or 0.67%. The area of East Lombok Regency consists of 5 units of rocks: old volcano rocks, units of young volcanic rocks, southern breccia units and sandstone sand stone and limestone units, with the old dominant rock units that dominate [17].

3.3. Groundwater of research area
Groundwater basin (CAT) divided into two groups: discharge and recharge area. The distribution of the Basin of Mataram-Selong in the centre of Lombok Island with an area of 2,366 km², covering the municipality of Mataram, and some areas of west, central and east of Lombok. Potential unconfined aquifer reaches 662 m³/year and confined aquifer by 8 million m³/year. The groundwater basin of Tanjung-Sambelia in the northern part of Lombok with an area of about 1,124 km², covering some areas of West Lombok and East Lombok. Potential groundwater from an unconfined aquifer counted approximately 224 million m³/year, while groundwater depressed 22 million m³/year [19].

3.4. Groundwater quality of research area
Groundwater quality parameters include physical, chemical and biological parameters. Physical parameters include taste, smell, temperature, and electrical conductivity. Chemical parameters: Nitrate, Nitrite, Ammonium, COD and BOD, pH, Phosphate (total P). Furthermore for the biological parameter assessed was the content of coliform bacteria. It then compares the results of the water quality parameter analysis with water quality standard standards based on PERMENKES 416/ MENKES/KES/IX/1990 on water quality standards for drinking water. Groundwater quality influenced by several factors, such groundwater source factors, rock types, and environmental factors where the aquifer layer formed and deposited In this study, groundwater samples taken focused on densely populated residential areas. Most people take advantage of water that comes from dug wells as a source of daily water needs fulfilment. The condition of wells will affect the water quality.
Figure 2. Conditions of Dug Wells Belong to Villagers in East Lombok District.

The system of facilities and infrastructure of waste water management has not been optimal. This is because there is no technical handling pattern from the government in implementing waste water management. It also because of the behaviour of people who still choose a manual or local patterns (on-site system) in the household wastewater treatment, given that the potential land that is still very wide. The possibility for the occurrence of pollution from the intrinsic aspect of the geological conditions of the region, only for chloride content. In the study area there was no large industrial activity, only a few small scale industries households, so that pollution from the chemical aspect is also not visible. Pollution caused only by poor drainage system and poor sanitary conditions of housing, especially in densely populated settlements, both in urban and rural areas. We can see this from the high content of coliform bacteria from all groundwater samples coming from 4 research sites.

Water quality chemically tested parameter related to waste which a source of water pollution came from domestic waste (household). The result of disposal of dirty water from bathrooms, latrines and kitchens. Some parameters tested are inorganic chemical parameters, such as BOD, COD, Phosphate, NO₃-N, NH₃-N and NO₂-N. The basis of selection of parameters tested based on the assumption on the general composition of domestic wastewater parameters [6]. Water quality biologically tested by testing the content of water bacteria (coliform bacteria and coli stool bacteria). Groundwater quality derived from dug wells from 4 districts shows that quality is still below the water quality threshold issued by the government, as shown in Table 1. This shows that from the physical aspect, it still includes the water quality of the dug wells sampled by the test in the category of proper consumption.

Table 1. The quality of groundwater in East Lombok Regency.

| Parameter       | Masbagik | Sukamulia | Selong | Labuhan Haji | PERMENKES 416/MENKES/KES/IX/1990 |
|-----------------|----------|-----------|--------|--------------|----------------------------------|
| Physical:       |          |           |        |              |                                  |
| Temperature (°C)| 28.4-28.6| 27.3-28.7 | 27.3-28.1| 27.3-27.4    | Air temperature ± 3°C            |
| Taste           | No taste | No taste  | No taste| No taste     | No taste                         |
| Smell           | No smell | No smell  | No smell| No smell     | No smell                         |
| Color           | Clear    | Clear     | Clear  | Clear        | Clear                            |
| pH              | 7.25-7.57| 6.51-7.38 | 6.53-7.50| 7.16-7.39    | 6.5-8.5                          |
| Turbidity (NTU)| 0.27-0.35| 0.24-1.08 | 0.35-4.27| 0.24-2.51    | 5                                |
| EC (mmhos/cm)   | 262-550  | 296-959   | 232-399 | 257-326      |                                  |
| Chemical:       |          |           |        |              |                                  |
| BOD (mg/l)      | 15.3-19.9| 18.23     | < 2    | < 2-2.16     | 2                                |
| COD (mg/l)      | 29.1-42.6| 30.2-37.8 | < 4    | < 4-7.76     | 10                               |
| Phosphate (mg/l)| 0.46-0.98| 1.60-4.31 | 0.30-1.42| 1.18-1.71    | 0.20                             |
| Nitrate (mg/l)  | 5.12-11.9| 3.53-9.69 | 0.18-3.80| 1.38-3.14    | 10                               |
| Nitrite (mg/l)  | < 0.008  | 0.008-0.11| < 0.008| < 0.008      | 1.0                              |
| Ammonia (mg/l)  | < 0.02   | 0.02-0.45 | 0.02-0.08| < 0.02       | 0.5                              |
| Bacteriological:|          |           |        |              |                                  |
| Total coliform (MPN) | 170-16,000| 490-1,700 | 230-24,000| 230-16,000  | 50                               |

Groundwater quality in chemical aspects still meets the requirements for use as raw drinking water and daily water needs although for several samples shows the value of phosphate and nitrite is high.
All samples have bacterial content that far exceeds the allowed threshold. Thus, it can say that for consumption directly from sources originating from dug wells as raw drinking water not recommended. It must be through certain treatment, for example by cooking the water in advance with longer time, there is still a possibility of pathogenic bacteria that still alive, given its availability in water in large amount.

The range of mean values of soluble oxygen content shows considerable differences. In Masbagik and Sukamulia, the average value was over 12 mg/l, so it included these two areas in class IV for water quality based on BOD value. The total-phosphate content in the range of values is quite high and varied. Dissolved oxygen content of not less than 4 mg/l. BOD is the main measure of the strength of liquid waste. BOD is also a hint of the expected effect on the recipient body of water related to the reduction of its oxygen content. The range of mean values of soluble oxygen content shows considerable differences. In Masbagik and Sukamulia, the average shows a high value, more than 12 mg/l, so in general these two areas are included in class IV based on BOD value.

3.5. Community behaviour in the effort to maintain the quantity and quality of groundwater in the research area

Only 1 area (Masbagik) that awareness of society to build a communal waste treatment system already exists, precisely in North Masbagik Village. There are 10 families who have joined the group that built the communal septic tank, by paying Rp. 200.000./each family for construction cost, and contributing energy in the manufacture. The construction of a communal waste treatment system started by a group of youths in North Masbagik Village, and its manufacture done with a mutual help system, so that the sense of belonging also firmly entrenched, which used as a basis to maintain the existence and sustainability of this system, hoping other community members are also interested in adopting this system. The community can help other's families unable to join this communal waste collection system. The communal waste shelter on a vacant plot of land, in the middle of the village. The distance of the furthest well from the communal waste collection site was 50 meters, while the closest was 7 meters. Changing people’s behavior requires time and process and also support from all parties. Therefore, that must maintained is how institutions in villages and districts stronger and more intensive run the program. During community life, there are still cultural values that can a basic capital for the progress of life itself. The value of mutual cooperation never lost, although in some places may have started buried.

| Subdistrict | Knowledge | Attitude | Beliefs | Practice |
|-------------|-----------|----------|---------|----------|
| Masbagik    | 0.943     | 0.395    | 0.685   | 0.892    |
| Sukamulia   | 0.383     | 0.865    | 0.106   | 0.206    |
| Selong      | 0.053     | 0.064    | 0.314   | 0.351    |
| Labuhan Haji| 0.288     | 0.265    | 0.199   | 0.068    |

Table 2. Correlation matrix of behavioural variables with groundwater quality in research area.

The facts found that the extension activities, especially on the cleanliness of the environment, sanitation, clean water and so on, in 3 research locations (Masbagik, Sukamulia and Selong) have not done. Only people in Labuhan Haji were familiar with extension activities because this area had
received help in the WISLIC program. Before they implemented the program, the socialization of the program was often enough to categorize as an extension of the importance of clean and healthy water. When confirmed with the relevant agencies (Dinas Kesehatan), Community Health Center (Puskesmas) and Village Offices (Kantor Desa) in 3 locations, it was rare or even never conducted the environmental health, sanitation and clean water counseling. There is no official agenda for scheduling extension activities of environmental health.

District with total custom parameter values related to sanitation and hygiene issues is Selong, followed by Labuhan Haji and Sukamulia. Masbagik is the lowest value, although it is still within the same value interval to categorize well. Masbagik as an area with very high sanitation risk level, while it includes the other three districts in high sanitation risk. The belief in the groundwater's quality from owned dug wells and used in daily life, most of the people in Sukamulia neglect activities are likely to lead to the addition or inclusion of bacteria into used water sources such as sewerage systems of kitchen and bathroom are non-existent, or inadequate. At Selong and Labuhan Haji, all correlation tests for behavioural variables on bacterial content provide a low, even very low value. This suggests that the existing water quality, especially in terms of bacterial contents, is likely not caused by behavioural factors but because of environmental conditions of community living and the availability of sanitation facilities and the quality of existing sanitation facilities.

4. Conclusion

Referring to the water quality standard based on PERMENKES No. 416/MENKES/PER/IX/1990 on water quality standards for drinking water, showing that groundwater from the publicly owned water wells in the research areas physically and chemically still included in the category of proper for consumption, except for biological parameters of bacteria content whose value far exceeds the permissible threshold. It includes community behaviour in managing and maintaining the environment related in the category is good, only should further improved.

Acknowledgement

I give thanks to the people of East Lombok where this research done, especially for communities in the research sites that have accepted the author in a friendly and cooperative manner. Thank you also given to the Ministry of Research, Technology and Higher Education, because this research done with the help of research grants doctoral dissertation of fiscal year 2017.

References

[1] Supply W J W and Programme S M 2014 Progress on Drinking Water And Sanitation (Geneva: World Health Organization).

[2] WHO 2006 Meeting the MDG Drinking Water And Sanitation Target: The Urban And Rural Challenge of the Decade (Geneva: World Health Organization).

[3] Hutton G, Haller L, and Water S 2004 Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level (Geneva: World Health Organization).

[4] Matthews G A 2008 Attitudes and behaviours regarding use of crop protection products: A survey of more than 8500 smallholders in 26 countries Crop Prot. 27 (3): 834-846.

[5] Widiawaty M A, Dede M and Ismail A 2018 Comparative study modeling of ground water using geographic information system in Kayuambon Village, Bandung Barat Regency Jurnal Geografi Gea 18 (1): 63-71.

[6] Soemirat J 2011 Kesehatan lingkungan (Yogyakarta: Gadjah Mada University Press).

[7] Graham J P and Polizzotto M L 2013 Pit latrines and their impacts on groundwater quality: a systematic review Environ. Health Perspect. 121: 521-530.

[8] Howard G, Pedley S, Barrett M, Nalubega M and Johal K 2003 Risk factors contributing to microbiological contamination of shallow groundwater in Kampala, Uganda Water Res. 37 (14): 3421-3429.

[9] Mulyadi A, Dede M and Widiawaty M A 2019 Spatial interaction of groundwater and surface...
topographic using geographically weighted regression in built-up area Proceeding Sustainable Urban Water International Seminar (Bogor: Institut Pertanian Bogor).

[10] Kulabako N R, Nalubega M and Thunvik R 2007 Study of the impact of land use and hydrogeological settings on the shallow groundwater quality in a peri-urban area of Kampala, Uganda Sci. Total Environ. 381:180-199.

[11] Ashbolt N J 2015 Microbial contamination of drinking water and human health from community water systems Curr. Environ. Health Reports 2 (1): 95-106.

[12] Wilson J M and Chandler G N 1991 Hand-washing reduces diarrhoea episodes: a study in Lombok, Indonesia Trans. R. Soc. Trop. Med. Hyg., 85: 819-821.

[13] Leimona B, Joshi L and van Noordwijk M 2009 Can rewards for environmental services benefit the poor? Lessons from Asia Int. J. Commons 3: 82-107.

[14] Tambunan T T H 2011 The Impact of the 2008-2009 Global economic crisis on a developing country’s economy: studies from Indonesia J. Bus. Econ. 2 (3): 175-197.

[15] Sjah T and Baldwin C 2014 Options for future effective water management in Lombok: A multi-level nested framework J. Hydrol. 519: 2448-2455.

[16] Lombok Timur Gov. 2016 Lombok Timur dalam Angka Tahun 2016 (Lombok Timur: BPS Kab. Lombok Timur).

[17] Lombok Timur Gov. 2018 Statistik Daerah Kabupaten Lombok Timur 2018 (Lombok Timur: BPS Kab. Lombok Timur).

[18] Mutaqin B W 2019 Landscape evolution on the eastern part of Lombok (Indonesia) related to the 1257 CE eruption of the Samalas Volcano Geomorphology 327: 338-350.

[19] Setiawan O, Sartohadi J, Hadi M P and Mardiatno D 2019 Delineating spring recharge areas inferred from morphological, lithological, and hydrological datasets on Quaternary volcanic landscapes at the southern flank of Rinjani Volcano, Lombok Island, Indonesia Acta Geophys 67: 177-190.

[20] Q.-F. Wang et al., “Effects of multi-environmental factors on physiological and biochemical responses of large yellow croaker, Larimichthys crocea,” Chemosphere, vol. 184, pp. 907–915, 2017.