Coastal Groundwater Quality Identification of Ternate City

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Abstract: The south-east of Ternate City, North Maluku, is one of the densely populated areas which have a higher risk with domestic pollution, especially in the coastal area. The objective of the research is to determine the quality of coastal groundwater of Ternate City. Samples were taken from dug wells and it was measured using multi water quality parameters, for nitrate and chloride were tested in the laboratory. Data were compared with drinking water quality standards from the Health Ministry (Permenkes). The average pH of groundwater was 8,15 indicates it's slightly alkaline type. The temperature of groundwater varies between 28,7 – 31,1˚C. The salinity varies between 0,0294 -0,130 ppt, indicates as freshwater. Total Dissolved Solids varies between 0,367 $^{g}/L$ – 1,650 $^{g}/L$, while turbidity varies between 0,848 – 8,100 NTU and electrical conductivity (EC) varies from 0,572 $^{mS}/_{cm}$ – 2,590 $^{mS}/_{cm}$. Nitrate concentration varies between 6,493 – 4,824, and 5,152 $^{mg}/_{l}$ in average, while chloride concentration varies between 29,689 $^{mg}/_{l}$ and 709,694 $^{mg}/_{l}$. Chloride mean concentration in the groundwater was 146,731 $^{mg}/_{l}$ and the standard deviation was 214,765. The distribution of chloride and salinity increased as closer to the coastal line. The physicochemical characteristics (i.e., nitrate, chloride, salinity, pH, electrical conductivity (EC), turbidity, and temperature).

1 INTRODUCTION

The decreasing of groundwater quality could happen as the seawater moves forward to the land, especially in deep aquifers where the seawater mixed with groundwater because of the increasing of seawater level, land subsidence and constant groundwater uptake (Marintoh et.al., 2015; Ardaneswari et.al, 2016). Over uptake of the groundwater might cause the empty space of the land getting bigger inside the aquifers, thus seawater level getting higher compared to the groundwater. Seawater contains an element of salt, such as chloride (Cl) could leak to the groundwater and caused groundwater pollution (Marintoh et.al., 2015)

Alluvial and shallow aquifer areas were very vulnerable to nitrate pollution compared with deep and depressed aquifer (Voudouris et.al., 2004; Eldridge,2002 *in* Kite_powell, A and Harding, 2006). In Ternate island, coastal area was where the most population lives. Its slope and groundwater supply were factors that promote the site selection. Most of the area was quite flat compared to the middle or top slope which hilly and deep groundwater source. More and more residents lives and doing their activities on the coastal areas, make the higher its demands of groundwater, while the number of domestic waste was higher. This condition has made domestic waste contamination higher, and the seawater intrusion increases if the carrying capacity of the environment exceeded with the higher of groundwater consumption in the areas.

A large sum of chloride could cause salty taste, corrosion in hot water pipes. As a disinfectant, chlor could bound with organic material as halogen hydrocarbon (Cl-HC), which cause cancer (Soemirat, 1994). The main source of nitrate pollution came from organic and inorganic fertilizer, animal waste, domestic waste, septic tank system and industry (Mikkelsen, 1992 *in* Voudouris et.al., 2004). Nitrate is carcinogenic and could cause intestine cancer (Ida, 2009 *in* Kurniawan, 2017; WHO, 1996 *in* Voudouris et.al., 2004) A large sum of nitrate could cause glucose index (GI) problems, diarrhea with blood, convulsion and could lead to death. In chronical level could cause a headache, mentally disorder dan depression (Soemirat, 1994).

Salinity defined as total ion within water body that describes total solids after all the carbonates converted as oxide, bromide, and ionide replaced by chloride and organic matter has been oxidized

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(Effendi, 2003 *in* Ardaneswari et.al, 2016). Water type classified into four different type based on salinity, which are freshwater (<1.000 $^{mg}/_{l}$), brackish (1.000-3.000 $^{mg}/_{l}$), salty (3.000-35.000 $^{mg}/_{l}$) and very salty (>35.000 $^{mg}/_{l}$) (Ardaneswari et.al., 2016).

Electricity conductivity (EC) defined as the electrical conductivity ability which affects by ionized solute material and connects ion moves in the solution, thus could use to understanding the leachate distribution ((Lopes et.al., 2012; Reyes-Lopes et.al., 2008). Resistivity linearly with EC, as the bigger its EC, the bigger its TDS (Meilasari and Pandabesie, 2013).

2 METHOD

Area of studies is part of the coastal area in the south-east of Ternate City, North Maluku (Figure 1). This area is one of the densely populated which have higher risked with domestic pollution. Fifty-two wells were selected from the area to collect samples of pH, electrical conductivity, dissolved oxygen, turbidity, salinity, total dissolved solids, and temperature, while nine of them were added with nitrate and chloride parameters.

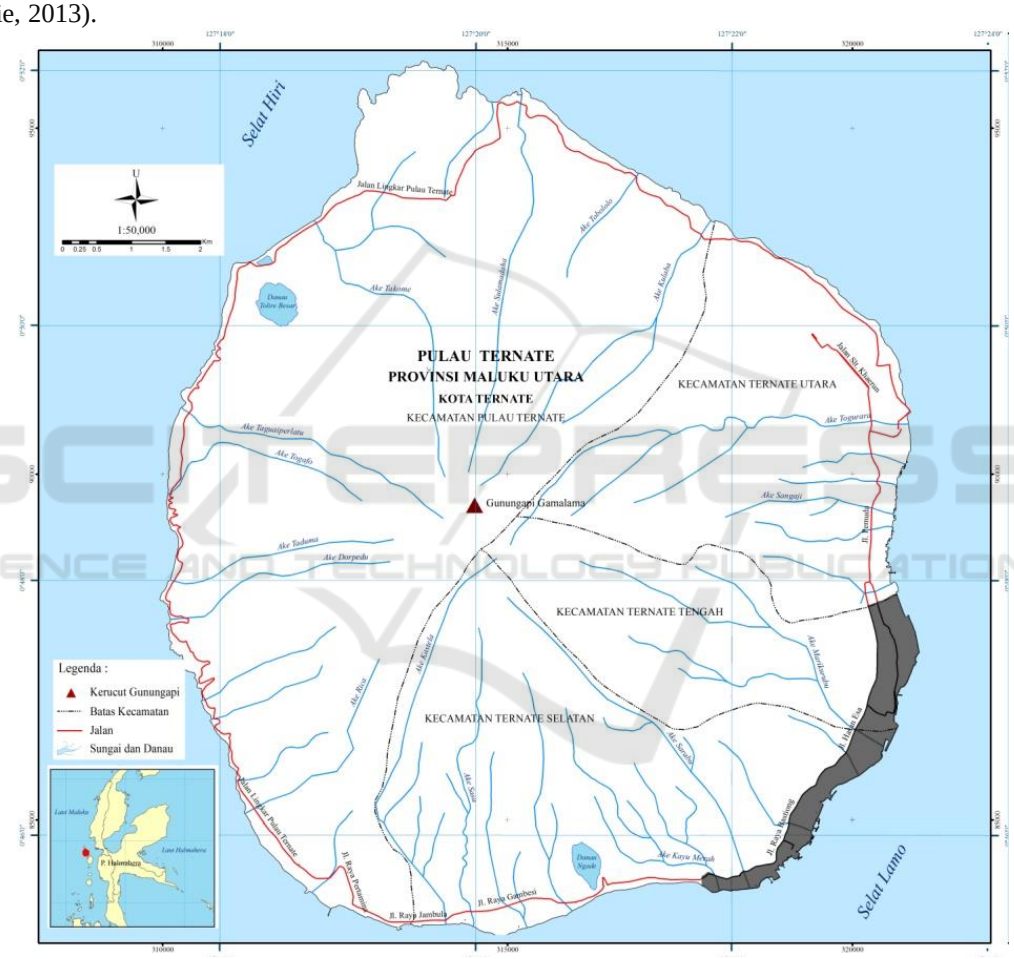


Figure 1. Location of Study Area

Primary data collections were wells location and physic-chemical groundwater quality. Primary data collection technique was purposively based its distance from the coastal line, while the other parameters were taken randomly. Samples position determined with GPS data, on-screen digitation and ground check. Secondary data were taken from government agency Dukcapil. The groundwater temperatures, pH, salinity, turbidity, TDS, DO and EC was in-situ measured from 52 wells. Nitrate and chloride were laboratories analyzed from 9 samples.

The water samples from the water body were collected from resident dug wells. The parameters pH, electrical conductivity, dissolved oxygen, turbidity, salinity, total dissolved solids, and

temperature were measured at the sampling site using multi water quality parameters, and other parameters like nitrate and chloride were analyzed in the laboratory. Data were compared to drinking water standard from the health ministry (Permenkes) No. 492 the year 2010

Fifty-two groundwater samples were collected from dug wells were analyzed for its salinity, pH, total dissolved solids (TDS), electrical conductivity (EC), turbidity, and temperature with multiparameter water sample were measured in situ, while nitrate and chloride samples analyzed in the laboratory. The average, maximum and minimum concentration are presented in table 1.

3 RESULT AND DISCUSSION

Table 1: Analysis of Water Sample.

Parameters	average	maximum	minimum	Standard deviation	variation
pH	8,15	10,62	5,11	1,416	2,005
Temperature (˚C)	28,756	31,070	26,840	0,784	0,615
DO ($^{mg}/_{l}$)	9,112	17,760	8,200	1,302	1,695
TDS ($^{g}/_{l}$)	0,367	1,650	0,233	10,196	0,39
Turbididty (NTU)	0,848	8,100	0,00	1,506	2,27
EC ($^{mS}/_{cm}$)	0,572	2,590	0,358	0,309	0,96
Salinity (ppt)	0,0294	0,130	0,020	0,160	0,00
Nitrate ($^{mg}/_{l}$)	5,152	6,493	1,394	1,551	2,407
Chloride ($^{mg}/_{l}$)	146,731	709,694	29,689	214,765	46,124

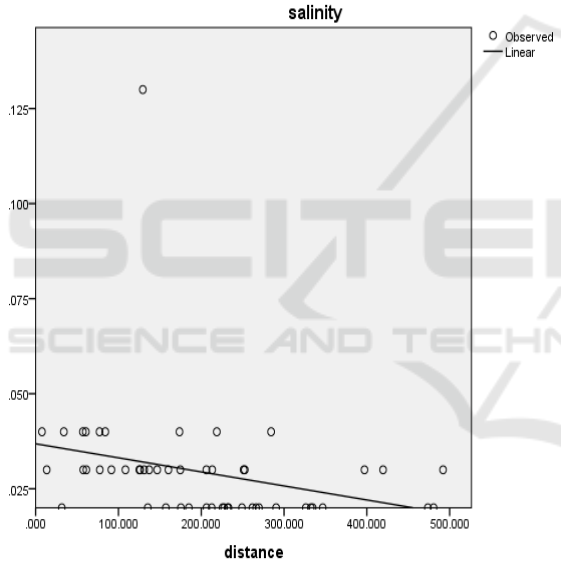
Based on Table 1, the average pH of groundwater is 8,15 indicates it's slightly alkaline type. The standard limitation for drinking water was 6,5 – 8,5 so that it can be concluded in a good condition. The temperature varies between 28,756 – 31,070˚C while dissolved oxygen (DO) varies between 9,112 $^{mg}/_{l}$ - 17,760 $^{mg}/_{l}$ and 9,112 $^{mg}/_{l}$ in average. Dissolved oxygen indicates oxygen dissolved in water. Higher DO indicated the higher its oxygen on the water and it's better for drinking water.

Total dissolved solids varies between 0,367 $^{g}/_{l}$ – 1,650 $^{g}/_{l}$, while turbidity varies between 0,848 – 8,100 NTU and electrical conductivity (EC) varies from 0,572 $^{mS}/_{cm}$ – 2,590 $^{mS}/_{cm}$. The TDS standard is 500 $^{mg}/_{l}$ or 0,5 $^{g}/_{l}$, which showed that the TDS of the water has exceeded the safety limit for drinking water. The total dissolved solid showed the amount of solid dissolved in the water, but in this case was not from the chloride which was still in a safe amount.

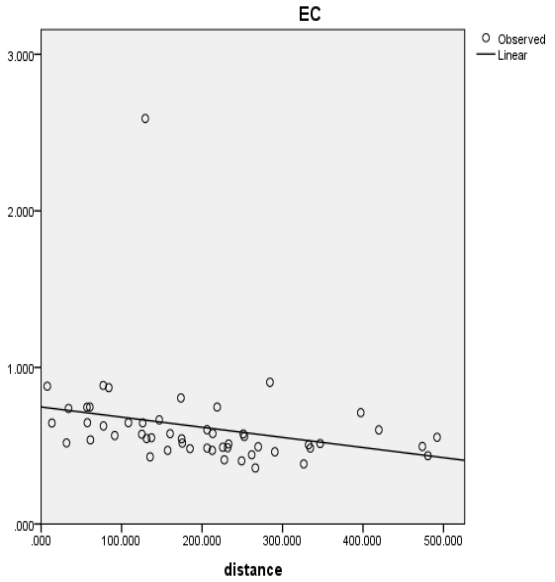
The salinity of the water varies between 0,0294 -0,130 ppt, indicates as freshwater. Low salinity showed there was not intrusion from the seawater. It was supported by the chloride data, which hasn't exceeded the safety limit for drinking water. Chloride varies from 29,689 – 709,694 $^{mg}/_{l}$and 146,731 $^{mg}/_{l}$ in average and the standard deviation was 214,765. Chloride were in safety limit for consumption as it does not exceed tolerance limit 250 $^{mg}/_{l}$ (based on drinking water standard from health ministry regulation No. 492 the year 2010), except for East Makassar that was higher. The higher the chloride might cause seawater intrusion because of exploitation risk (Vouduris et.al, 2000 in Vouduris, 2002). Chloride is one of important parameter in water quality assessment. Chloride could indicate a high degree of organic pollution as the higher its concentration. The distribution of chloride increased as it got closer to the coastal line as presented in Figure 2.

Nitrates varies 4,824 – 6,493 $^{mg}/_{l}$ and 5,152 $^{mg}/_{l}$ in average. Nitrate were in safety limit for consumption as it does not exceed tolerance limit 50 $^{mg}/_{l}$ based on drinking water standard from health ministry regulation No. 492 the year 2010. Based on drinking water standard from health ministry regulation No. 492 the year 2010, groundwater quality of study area was in good condition, as it has not exceeded the maximum standard for nitrate, chloride, pH, EC, and turbidity.

High chloride number might cause salty taste and corrosion in the hot water supply system (Soemirat, 1994). This condition as the salt content, as it showed in EC and TDS data which higher than the other samples, which is 2,59 and 1,65 while its salinity 0,13ppt. The salinity and EC tend to increase as it getting closer to the sea, but there wasn't any correlation between distance and salinity nor EC as it showed in figure 2.a and 2.b below.



(a)



(b)

Figure 2: Distribution of salinity (a), and EC (b) to the distance of wells to the sea.

The salinity and EC of the groundwater tend to be lower as it gets further from the ocean, but there wasn't any correlation between its distance and salinity nor EC as could be seen in Figure 2.

4 CONCLUSION

The physicochemical characteristics (i.e., nitrate, chloride, salinity, pH, electrical conductivity (EC), turbidity, dissolved oxygen (DO) and temperature) in the study area were within the acceptable limits health ministry drinking water standard No. 492 the year 2010. As the water quality of the area was still in good condition, it could be recommended as one of the water source for the community than the government public water utilities.

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