

RESEARCH ARTICLE

Groundwater Quality Assessment for Drinking Purpose Based on Physicochemical Analysis in Teluk Nilap Area, Rokan Hilir, Riau, Indonesia.

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Abstract

Groundwater is water resource that widely used for domestic purposes, including for drinking. However, the industrial and population growth causes the quality and quantity of groundwater to decline. In this case, the quality of drinking water in Indonesia must meet the requirements according to Health Minister Regulation No.492/MENKES/PER/IV/2010. This study aims are to determine the quality of groundwater in the research area based on physicochemical parameters and its evaluation for drinking water. Groundwater samples were taken from dug wells in Teluk Nilap area, Rokan Hilir, Riau. Groundwater samples have temperature average 30°C, TDS average 312,5 mg/L and pH average 5,6. Groundwater contain sulfate and nitrate with average value 48,8 mg/L and 11,86 mg/L, respectively. Groundwater water also have iron and lead metal above the permitted standard with average value 2,57 mg/L and 0,022 mg/L. Groundwater in the study is not recommended as drinking water.

Keywords: Groundwater, physical, chemical, drinking water

1. Introduction

Groundwater is one of the basic necessities for humans. Groundwater is a natural resource that needs to be preserved and it has various functions to support human life. Groundwater is the main water resource that used for drinking water by community. Groundwater has many advantages compared to the other water resource such as : groundwater quality is better than surface water quality, groundwater quality does not depend on the season, there is a large amount of groundwater reserves and easy to obtain. However, population and industrial growth have caused the quality and quantity of groundwater to decline. One of the contributing factor is the presence of pollutants from garbage disposal area (Satrio, et al., 2017), industrial activities (Nasliilmuna, et al., 2018) and domestic waste, both liquid and solid waste (Sasongko, 2014).

The use of groundwater for domestic purposes including for drinking must meet the requirements determined by national and international regulations. In this case, the quality of drinking water in Indonesia must meet the requirements for physical, chemical, and biological parameters according to the Health Minister Regulation No. 492/MENKES/PER/IV/2010. Drinking water must be free from harmful bacteria and chemical impurities. Drinking water also must be clean and clear, odorless and colorless, have no suspended matter or turbidity (Risky, D.P., et al., 2017). It is necessary to monitor the quality of groundwater intensively and continuously to ensure that the

groundwater used is suitable and safe for consumption. For this reason, a lot of research has been carried out on monitoring groundwater quality which used as a source of drinking water in various countries (Siringoringo, et al., 2019) ; (Ibrahim, M.N., 2019) ; (Khan, A., Khan, M.A., 2018) ; (Lalitha, B.V., 2016) ; (Annapoorna, H., Janardhana, M.R., 2015). Therefore, the aims of this research are to determine groundwater quality in study area based on physicochemical parameters and groundwater assessments for drinking purpose.

2. Study Area

Teluk Nilap is one the villages located in Kubu Babussalam Subdistrict, Rokan Hilir, Riau. Topographically, Teluk Nilap is low land with altitude about 6-10 m from sea level. The people of Teluk Nilap use groundwater for domestic purpose. However, at this time, the people in the study area feel a change in environmental condition including the decrease of groundwater quality. The groundwater looks brownish, oily, sticky to the skin and does not foam when given soap. Based on the regional map, stratigraphy of research area composed by young superficial deposits (Qh) and older superficial deposits (Qp) (Fig.1). The rocks in young superficial deposits are clays, silts and clean gravels, vegetation rafts and peat swamps. On the other hand, the older superficial deposits consist of clays, silts and clayey gravels, vegetation rafts.

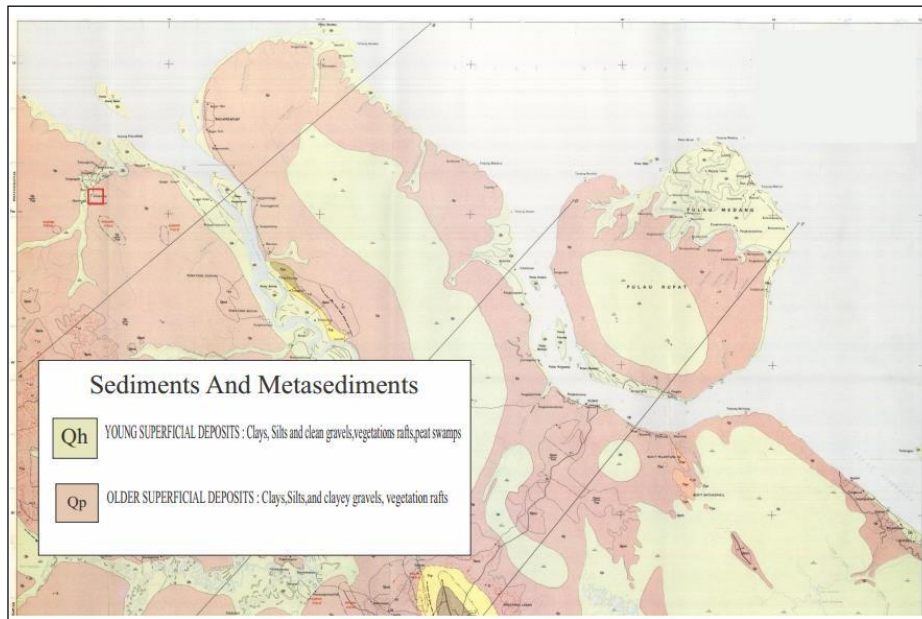


Fig. 1. Regional geological map of study area

3. Methodology

The groundwater samples were taken from dug wells in Teluk Nilap area with random sampling method. All samples were examined for physicochemical analysis in the Industrial Research and Standardization Laboratory, Padang. The temperature, TDS and pH of collected samples were determined by using thermometer, TDS meter and pH meter, respectively. Sulfate and nitrate concentrations were determined by using Spectrophotometer. Iron and lead concentrations were determined by using Atomic Absorption Spectrophotometer. The quantitative data on physicochemical parameters obtained then compared with the drinking water quality standards based on Health Minister Regulation No.492/MENKES/PER/ IV/2010.

4. Result and Discussion

4.1 Temperature

In general, temperature condition of groundwater is normal value, in range 27-31°C and average 30°C which meet the drinking water quality standard. The temperature standard permitted by Health Minister Regulation is air temperature $\pm 3^\circ\text{C}$. The research area is belongs to the tropical climate. Water temperature can be affected by season, latitude, altitude, cloud cover, flow and depth of water. The large amounts of dissolved chemicals (phenol, sulfur) and decomposition of organic matter by microorganism can also cause groundwater temperature value will be above standard limit (Mairizki, F., Cahyaningsih, C., 2016).

4.2 Total Dissolved Solid (TDS)

TDS values of groundwater also show the normal value with average 312,5 mg/L in range 101-809 mg/L. TDS standard permitted by Health Minister Regulation is 500 mg/L. Only 3 groundwater (20%) that have TDS value over the drinking water quality standard (Fig.2). All groundwater were classified as fresh water (TDS 0-2000 mg/L) (Putra, D.B.E., et al., 2019).

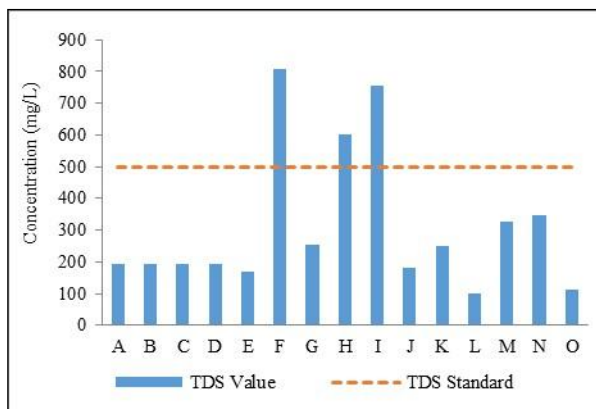


Fig 2. Total dissolved solid value of groundwater

TDS consist of soluble organic or soluble inorganic compounds, minerals and dissolved gases. Salts that dissolve in groundwater which contain magnesium, sodium, sulfate or chloride ions also increase the amount of dissolved solids in groundwater. The presence of TDS such as sodium sulfate and magnesium sulfate can cause a change in groundwater taste. In addition, the high concentration of total dissolved solids affect the clarity, groundwater color and hardness (Firdaus, et al., 2017).

4.3 pH

pH condition of groundwater in range 2,8-6,6 and average 5,6. pH standard permitted by Health Minister Regulation is 6,5-8,5. Almost all groundwater are acidic and do not meet drinking water quality standard (Fig.3). This is due to geological factors such as soil conditions. The study area is dominated by peat.

pH value will determine the corrosion properties. The properties of corrosion will be higher at low pH. Water with low pH also will easily dissolve the Fe metal that form ferrous and ferric ions which can cause the water become colored, smelly and have a taste (Putra, A.Y., Mairizki, F., 2019).

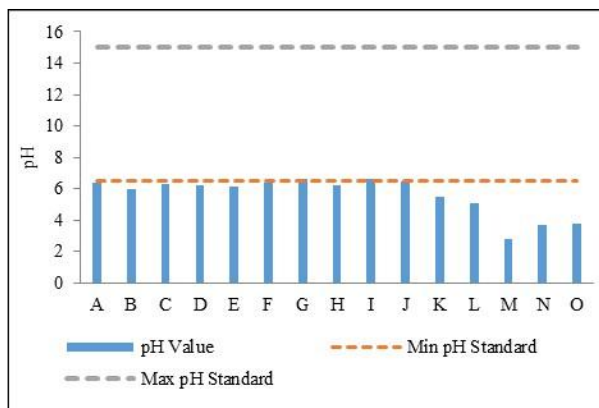


Fig 3. pH value of groundwater

4.4 Sulfate

Sulfate condition of groundwater show the normal value with average 48,8 mg/L in range 11,76-118,73 mg/L. Sulfate standard permitted by Health Minister Regulation is 250 mg/L. All groundwater meet the drinking water quality standard (Fig.4).

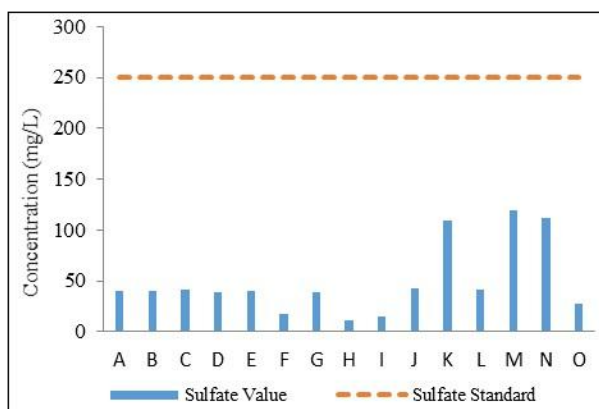


Fig 4. Sulfate value of groundwater

The presence of sulfate in groundwater can be influenced by the type of rock that the groundwater passes through. Sulfates are found in sedimentary and igneous rocks as sulfides metal. Sulfate is found in igneous rocks as feldspatoid, and also found in many evaporite sedimentary rocks as gypsum, anhydrite and barite. In weathering, sulfur is oxidized to produce sulfate ions which are carried by groundwater (Mutianto, H., 2010).

4.5 Nitrate

Nitrate condition of groundwater also show the normal value in range 1,828-20,852 mg/L and average 11,86 mg/L. Nitrate standard permitted by Health Minister Regulation is 50 mg/L. All groundwater have nitrate value below the drinking water quality standard (Fig.5).

The presence of nitrate in high amounts at groundwater indicated the decomposition of organic compounds through biological processes with very low dissolved oxygen. Nitrate content in groundwater can also come from agricultural materials such as nitrate fertilizers. Nitrate residue will be carried by rainwater into the soil which increasing nitrate values in groundwater (Sudaryanto, Suherman, D., 2008).

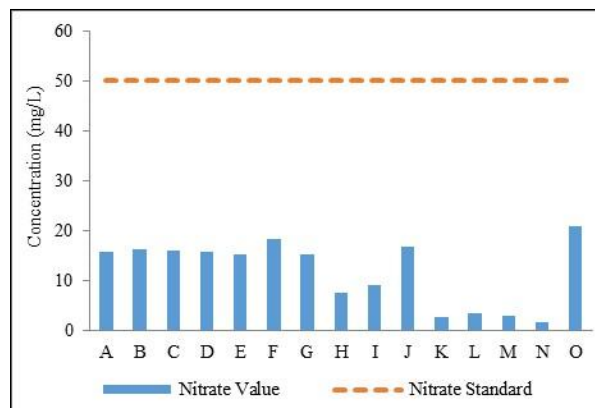


Fig 5. Nitrate value of groundwater

4.6 Iron

Most groundwater have high concentration of Fe metal with average 2,57 in range 0,18-6,87 mg/L. Fe standard permitted by Health Minister Regulation is 0,3 mg/L. Only 1 groundwater (6,67%) has Fe value below the drinking water quality standard while the others have high Fe metal content above the quality standard (Fig.6).

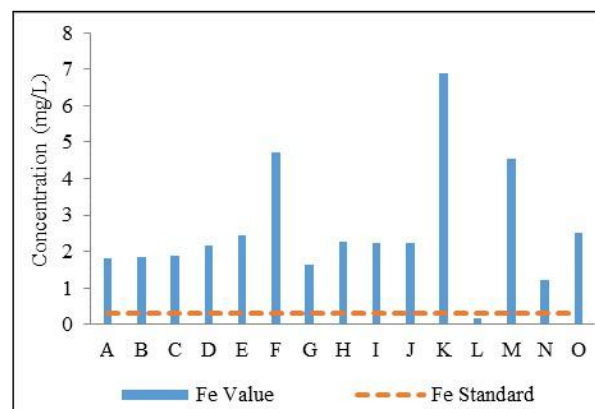


Fig 6. Fe value of groundwater

Heavy metals are naturally present in trace amounts in groundwater. The concentration of heavy metals in groundwater depends on the soil properties, the type of rock that the groundwater passes through and the influence of environmental pollution around the groundwater source. High concentration of iron metal will cause groundwater color will be yellowish, corrosion of metal objects, deposition of water pipe walls and accelerate the growth of Fe bacteria in groundwater (Rahadi, B., Lusiana, N., 2012).

4.7 Lead

Lead content in groundwater in range 0,0026 mg/L-0,1316 mg/L and average 0,022 mg/L. Lead standard permitted by Health Minister Regulation is 0,01 mg/L. 6 groundwater (40%) have Pb value above the drinking water quality standard while the others still have Pb metal content below the quality standard (Fig.7). This must be a concern because Pb can accumulate and pollute groundwater.

The heavy metal content cannot be removed and it is toxic and carcinogenic. In humans, heavy metal can disrupt health depend on the part which are exposed of heavy metals. Heavy metal can cause cancer, allergies and at high dose can cause death (Yandra, A.P., Mairizki. F., 2020).

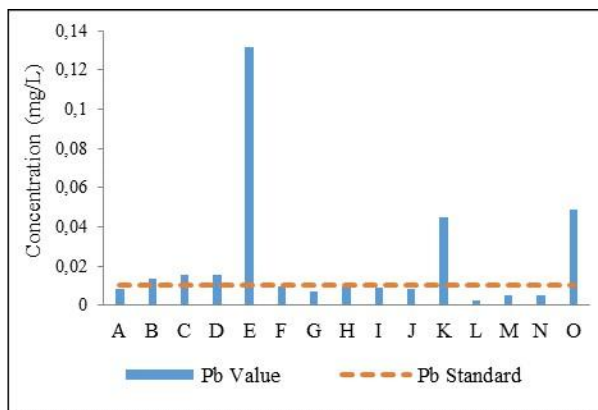


Fig 7. Pb Value of Groundwater

5. Conclusion

Groundwater samples were taken from dug wells in Teluk Nilap area, Rokan Hilir, Riau. All groundwater meet the requirements for drinking water quality according to the Health Minister Regulation No.492/MENKES/PER/IV/2010 in terms of physical parameters with temperature average 30°C and TDS average 312,5 mg/L. However, almost all groundwater does not meet the drinking water quality requirements based on its chemical parameters. All groundwater are acidic with pH average 5,6, containing sulfate and nitrate with average value 48,8 mg/L and 11,86 mg/L, respectively. Groundwater water also have iron and lead metal above the permitted standard with average value 2,57 mg/L and 0,022 mg/L. Therefore, groundwater in research is not recommended as drinking water.

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