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Submission date: 04-Oct-2021 03:25PM (UTC+0700)
Submission ID: 1664786357
File name: ination_of_the_water_quality_of_Panasen_River_as_a_source_of.pdf (386.73K)
Word count: 2741
Character count: 13955

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Abstract. The Panasen River is located in the upper part of Tondano Watershed. This river has an important role including being used as an irrigation water source. The purpose of this study was to assess the water quality of the river as a source of irrigation water in terms of the value of Sodium Adsorption Ratio (SAR) and the quality standard according to Government Regulation No. 82/2001 class III.The method used was field observation and laboratory analysis for river water samples. The measured parameters were Na, Ca, Mg, as well as other chemical parameters. The measured data were compared to the Quality Standards according to the regulation and using the SAR formula. The results showed that the SAR of river water varied from 0.10me/l to 0.40me/l. The results of the chemical analysis of 30 water quality parameters indicated that they generally met the requirements, except the chlorine (0.03-0.26 mg/l) that has exceeded the quality standard according to Government Regulation No. 82/2001 class III (0.03 mg/l). The high concentrations of chlorine caused by domestic sewage that goes into the body of water. It can be concluded that the river water still meets quality standards for irrigation water except chlorine.

1. Background

The river is the main body of aquatic ecosystem that has an important role in the hydrological cycle and functions as a catchment for the surrounding area. Consequently, the condition of a river is strongly influenced by the characteristics of the surrounding environment [1].

With the disposal of various types of waste and rubbish containing diverse types of pollutants into the river, both of which may decompose or which cannot be broken down, will lead to increasingly heavy burden which was accepted by the river. If the load is received by the river exceeds the thresholds that are set based on the raw quality, then the river is said to be contaminated, either by physical, chemical, or biological [2]. With the disposal of various types of waste containing various types of pollutants into the river, both biodegradable and non-biodegradable, it will cause more weight to be borne by the river. If the load received by the river exceeds the threshold set based on quality standards, then the river is said to be polluted, both physically, chemically, and biologically [2].

Irrigation water is water that is important for the growth and production of rice plant. The function of the irrigation water is as a solvent in which the minerals, and other dissolved elements can enter into plant cells [3].

The high activity around River Panasen has the potential to change the water conditions. Declining water quality is caused by contaminant sources that enter the water body. The estimation unit for water pollution can be classified in physical, chemical, and biological parameters. Physical parameters include increase in temperature, suspended solids, dissolved solids, DHL, and salinity. Chemical

parameters include an increase and decrease in water pH, reduced DO value, increase in BOD and the presence of dissolved heavy metals. Biological parameters are the increasing content of pathogenic bacteria in water [4].

The management of River Panasen as a source of irrigation water can be done properly if its water quality as a source of irrigation water is known. In this case, the water of River Panasen river needs to be analyzed against the parameters of the quality of irrigation water required in accordance with the Government Regulation No. 82 of 2001 Class III and the value of Sodium Absorption Ratio (SAR).

The quality of irrigation water for plant needs is relies heavily on the substances contained in it. In principle, irrigation water must not contain substances that harm plants, such as sulfur or chlorine. The water that is good for plants must contain nitrogen, phosphorus, potassium, and calcium, among others [5]. Physically, the irrigation water can also affect soil conditions. If the irrigation water contains Fe or Na which exceeds the quality standard, it can cause the soil to become dense, thereby reducing circulation of air in the soil. Likewise, if the irrigation water is contaminated with chemical elements originating from residential waste, the congestion will reduce fertility rates and plant growth and productivity. Therefore, this research is important to obtain the value of Sodium Adsorption Ratio (SAR) as one of the factors in determining the suitability of water for irrigation and determining the quality status of River Panasen as irrigation water. This research aims to :

1. Determine the water quality of River Panasen as a source of irrigation water in terms of the value of Sodium Absorption Ratio (SAR).
2. Determine the status of River Panasen water quality as a source of irrigation water in terms of physical, chemical and biological parameters according to the Government Regulation of the Republic of Indonesia Number 82 Year 2001 Class III.

This research was conducted on paddy fields that received water from River Panasen in the upstream region of the Tondano Watershed, Minahasa Regency. This research lasted for one year. Data collection in the field is carried out for six months. Water samples are taken twice, each every three months.

2. Materials, Tools and Methods

a. The materials used for this study are water samples of River Panasen, aquadest, tissue, name label to mark containers and writing instruments.
b. Tools for taking water samples (water sampler, ice box, GPS, pH meter, water thermometer), tools for in situ measurements (pH meter, DO meter, thermometer), and equipment in the laboratory, i.e., spectrophotometer.
c. Primary data for water quality were obtained by taking data directly in the field, i.e. water samples from River Panasen. The parameters observed were pH, temperature, salinity, SAR (Na, Ca and Mg), DO, BOD, COD, Boron, NO3, PO4, arsenic, cobalt, selenium, cadmium, chromium (VI), copper, lead, mercury, zinc, cyanide, fluoride, nitrite, free chlorine, sulfur as H2S, oil and fat, surfactant, fecal coliform, and total coliform. Sampling water is done using the composite sampling method. Taking the water sample was prepared in the field and analyzed in the laboratory. In situ measurements were carried out on the parameters of pH, Temperature, DO, DHL, and Salinity.
d. Water quality sampling uses the composite sampling method and refers to the Indonesian National Standard [6, 7].
e. Sampling points and samples of river water are determined based on river water flow [8].
f. Secondary data on River Panasen water quality which was taken periodically (time series data for three years).
g. Compare the measurement data for each water quality parameter with the quality standard, in accordance with the water class [9]
h. Calculate SAR that is more closely related to the percentage of sodium that can be exchanged in the soil using the formula as follows:

$$SAR = \frac{NA^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}} \quad (1)$$

where concentrations of Na_{+}, Ca_{2+}, and Mg_{2+} are expressed in milliequivalents per litre, as totals.

Water classification is based on SAR value; below 10 is very good, 10 to 18 is good, 18 to 26 is sufficient, above 26 is bad [10]. Low sodium water can be used for irrigation in almost all types of soils with the least risk to develop sodium exchange. Water containing moderate sodium content will pose a considerable risk because sodium in fine-textured soils have a high cation exchange capacity, except when there are gypsum in the soil. However, such water can be used properly on granuler or organic soils with good absorption. Water with high sodium content can cause sodium exchange which is harmful in most soils and requires special soil handling for good water flow, high meltdown, and the addition of some organic substances. Water that is very high in sodium is usually unsatisfactory for irrigation purposes, except when it has low and possibly moderate salinity, where liquefaction of soil calcium or use of gypsum or other repairs makes it easy to use the water.

3. Data Analysis

The data obtained in this study were analyzed using the Sodium Absorption Ratio (SAR) formula, then compared with Quality Standards according to Government Regulation No. 82/2001 Class III.

4. Results and Discussion

4.1. Results of Analysis of Irrigation Water Quality using Sodium Adsorption Ratio (SAR) Formula

Laboratory analysis of river water obtained the following results: the value of parameter Sodium in the locations of River Panasen 1, River Panasen 2, River Panasen 3, River Panasen 4, and River Panasen 5 were 0.46 mg/l, 1.57 mg/l, 1.54 mg/l, 1.51 mg/l and 1.67 mg/l, respectively. The value of parameter Calcium in the locations of River Panasen 1, River Panasen 2, River Panasen 3, River Panasen 4, and River Panasen 5 were 0.31 mg/l, 0.36 mg/l, 0.38 mg/l, 0.34 mg/l and 0.35 mg/l, respectively. The value of parameter Mg in the locations of River Panasen 1, River Panasen 2, River Panasen 3, River Panasen 4, and River Panasen 5 were 0.78 mg/l, 0.58 mg/l, 0.87 mg/l, 0.69 mg/l and 0.58 mg/l, respectively. The value of parameter SAR in the locations of River Panasen 1, River Panasen 2, River Panasen 3, River Panasen 4, and River Panasen 5 were 0.62 mg/l, 2.26 mg/l, 1.93 mg/l, 2.09 mg/l and 2.44 mg/l, respectively. All the paramaters value in milliequivalents per litre are presented in Table 1 and Figure 1.

Table 1. Sodium, Calcium, Magnesium and Sodium Adsorption Ratio (SAR) Concentrations

No	Location	Parameters			
		Sodium (Na) (me/l)	Calcium (Ca) (me/l)	Magnesium (Mg) (me/l)	SAR (me/l)
1	River Panasen 1	0.020	0.015	0.068	0.10
2	River Panasen 2	0.068	0.018	0.048	0.37
3.	River Panasen 3	0.067	0.019	0.072	0.31
4.	River Panasen 4	0.066	0.017	0.057	0.34
5.	River Panasen 5	0.073	0.017	0.048	0.40

Note : SAR (*Sodium Absorption Ratio*) is the ratio of natrium absorption.

According to [10], the value Sodium Adsorption Ratio (SAR) can be interpreted as follows. The value smaller than 3 me/l is good, from 3 me/l to 9 me/l is medium and above 9 me/l is bad. Excess sodium in irrigation water relative to calcium and magnesium or relative to the total soluble salt

content can adversely affect soil structure and reduce the rate at which water moves into and through the soil (infiltration, permeability), as well as reduce soil aeration [11].

Sodium Adsorption Ratio (SAR) in the diagram below (Figure 2) shows that it has not crossed the threshold or the specified standard value. According to Effendi [4], the high SAR value shows that sodium in irrigation water replaces calcium and magnesium ions in the soil and changes the structure of the soil which will eventually make the plant leaves burn and the tissue dies. It can be seen in the diagram above; the SAR value is still below the threshold so that the concentration of sodium is still less concentrated than calcium and magnesium ions. As comparative, Yusuf [12] obtained the SAR values of the Bening Upper River (0.61) and Bening Lower River (0.59) as a rice field irrigation source in South Mopuya II Village, North Dumoga Subdistrict, Bolaang Mongondow District, are still in good quality.

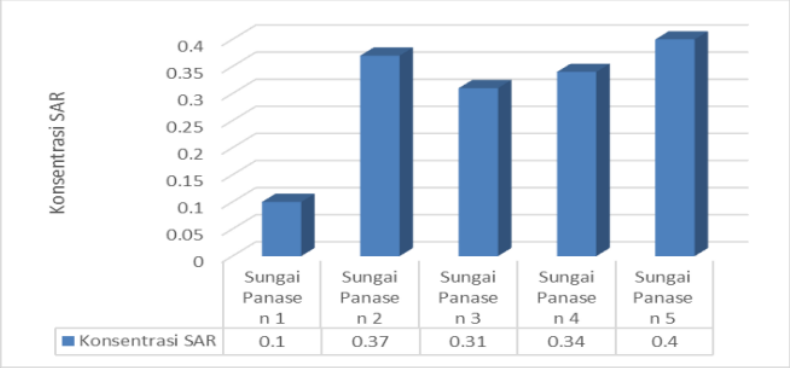

Figure 1. Sodium Adsorption Ratio (SAR) Concentration

Figure 2 shows that the concentration of Sodium Adsorption Ratio (SAR) in Panasen River 1, Panasen River 2, Panasen River 3, Panasen River 4, Panasen River 5 were 0.1 me/l, 0.37 me/l, 0.31 me/l, 0.34 me/l, and 0.4 me/l, respectively. Panasen River 5 has the highest SAR concentration and the lowest concentration was in Panasen River 1. Those five locations generally met the requirements because they were still below the threshold (Quality Standard <3 mg / l).

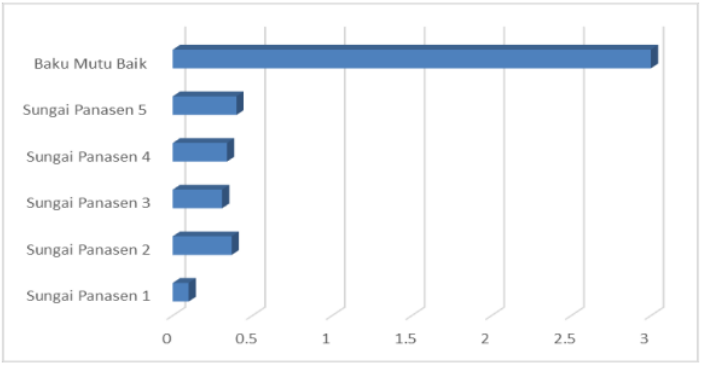

Figure 2. Sodium Adsorption Ratio (SAR) Concentration and Quality Standards

4.2 Results of Analysis of Irrigation Water Quality (Government Regulation No. 82 of 2001)

The results of the analysis of River Panasen water quality on 30 parameters indicate that the water generally meets the requirements according to quality standards, except the chlorine parameter that has exceeded the quality standard as stated in Government Regulation No. 82/2001. As presented in Figure 3, the quality standard for chlorine is 0.03 mg / l, while data from the analysis were in the range of 0.03 to 0.26 mg / l.

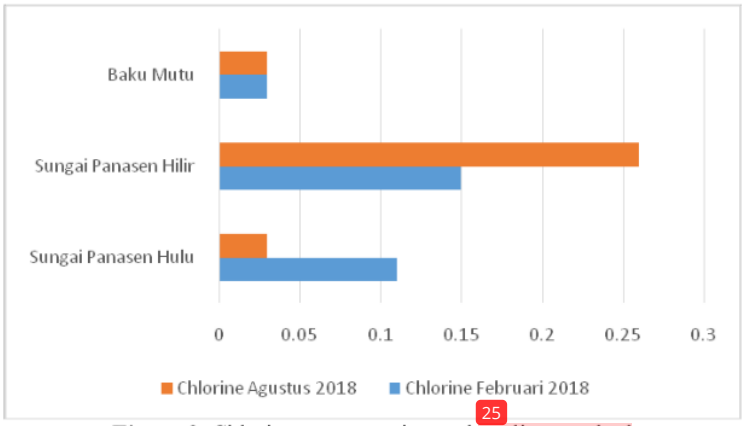

Figure 3. Chlorine concentration and quality standard (Government Regulation No. 82/2001 Class III)

The high concentration of chlorine was caused by domestic waste entering the water body. Besides being beneficial to humans, chlorine can also be toxic to the environment. The nature of chlorin as a strong oxidizer makes it easier for chlorine to bind to other compounds and is carcinogenic [13].

5. Conclusion

1. River Panasen as a source of irrigation water in terms of the value of Sodium Absorption Ratio (SAR) was considered good quality.
2. River Panasen as a source of irrigation water in terms of physical and chemical parameters according to the Government Regulation No. 82/2001 Class III was considered good quality but it has a high chlorine concentration was considered be toxic to the environment.

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