

# Determination of the water quality of Pindol river as a source of irrigation water in Bolaang Mongondow district, North Sulawesi province

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**Submission date:** 04-Oct-2021 03:26PM (UTC+0700)

**Submission ID:** 1664786365

**File name:** termination\_of\_the\_water\_quality\_of\_Pindol\_river\_as\_a\_source.pdf (565.75K)

**Word count:** 2461

**Character count:** 12106

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To cite this article: S Wantasen *et al* 2021 *J. Phys.: Conf. Ser.* **1918** 032029

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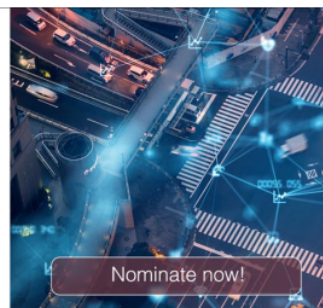


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## Determination of the water quality of Pindol river as a source of irrigation water in Bolaang Mongondow district, North Sulawesi province

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**Abstract.** Pindol River is a river that is a source of irrigation water and raw water in Bolaang Mongondow Regency. The Pindol River is a source of the Lolak Dam water supply. The Lolak Dam which will irrigate rice fields covering an area of around 3,714 ha in Bolaang Mongondow Regency. The purpose of this study was to assess the water quality of the river Pindol as a source of irrigation water in terms of the value of Sodium Adsorption Ratio (SAR). The used method was field observation and laboratory analysis for river water samples. Water quality was carried out using the Composite Sampling Method in the Pindol River at two sampling points and three replications. The measured parameters were Na, Ca, Mg, as well as other chemical parameters. The measured data Na, Ca, Mg were calculating using the SAR formula. The data generated from laboratory analyzed descriptive statistics. The results showed that the concentration Na was 0.991 meq/l to 1.040 meq/l, Ca 0.281 meq/l to 0.292 meq/l, Mg 0.345 meq/l to 0.354 meq/l and Sodium Adsorption Ratio (SAR) at the Pindol River varied from 1.76 meq/l to 1.84 meq/l.

### 1. Introduction

Pindol River is a source of the Lolak Dam water supply. The Lolak Dam which will irrigate rice fields covering an area of around 3,714 ha in Bolaang Mongondow Regency [1]. Appropriate land use and water management in irrigated area, knowledge of the chemical composition of the soil characteristics, water, climate, drainage condition and irrigation methods should be evaluated before implementation of irrigation projects [2].

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 [3]. 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. Water quality influences its suitability for a particular use, i.e. how well the quality fulfills the requirement of the user. Water quality deals with the physical, chemical and biological characteristics of water in relation to all other hydrological properties [4].

Water quality related problems in irrigated agriculture are identified as salinity, sodicity, specific-ion toxicity and impeded infiltration rate as well as hydraulic conductivity. Water classification is based on SAR value; below 3 meq/l is very good, 3-9 meq/l slight to moderate, above 9 meq/l is bad [5]. 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



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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 granular or organic soils with good adsorption. 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 [5]. *Sodium Adsorption Ratio (SAR)*: Is the estimation of the degree at which Sodium will be absorbed by the soil. It also influences infiltration rate of water. Irrigation water with a high SAR value suggests a sodium hazard, thus replacement of soil Ca and Mg with Na through cationic exchange. Such a situation is not desirable because it damages the soil structure and permeability which ultimately affects soil fertility conditions decreasing plant production [6].

The management of River Pindol 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 Pindol needs to be analyzed against the parameters of the quality of irrigation water required the value of Sodium Adsorption Ratio (SAR). Sodium adsorption ratio (SAR) is an easily measured property that gives information on the comparative concentrations of sodium, calcium and magnesium [7]. 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 Pindol as irrigation water. This research aims to determine the water quality of River Pindol as a source of irrigation water in terms of the value of Sodium Adsorption Ratio (SAR). This research was conducted on paddy fields that received water from River Pindol Bolaang Mongondow Regency, North Sulawesi Province.

## 2. Methods

The materials used for this study are water samples of River Pindol, aquadest, tissue, name label to mark containers and writing instruments. Tools for taking water samples (water sampler, ice box, GPS and in situ measurements (pH meter, and thermometer), and equipment in the laboratory, i.e., spectrophotometer. Primary data for water quality were obtained by taking data directly in the field, i.e. water samples from River Pindol. The parameters observed were pH, temperature, salinity, SAR (Na, Ca and Mg). Sampling water is done using the composite sampling method [8]. 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. Sodium Analyzed used Method Atomic Absorption Spectrophotometry Water quality sampling uses the composite sampling method in the Pindol River at two sampling points and three replications, water sampling location (Figure 1). Sampling points and samples of river water are determined based on river water flow [9]. Calculate SAR that is more closely related to the percentage of sodium that can be exchanged in the soil using the formula as follows:

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

where concentrations of  $Na^+$ ,  $Ca^{2+}$ , and  $Mg^{2+}$  are expressed in milliequivalents per litre, as totals.

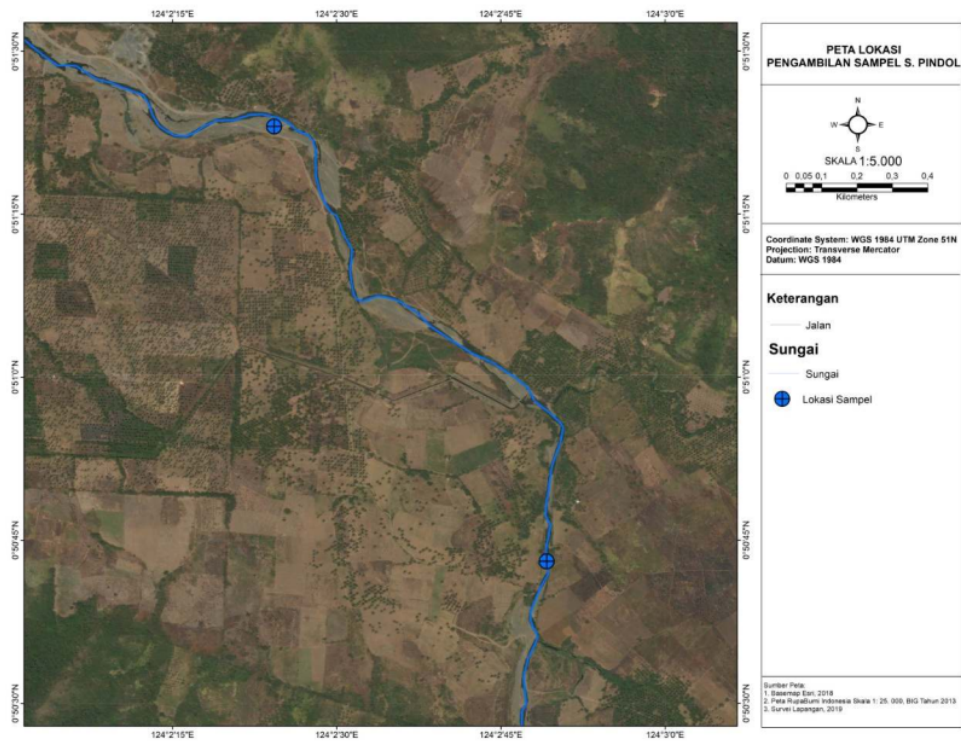


Figure 1. Map of water sampling location

### 3. Results and discussion

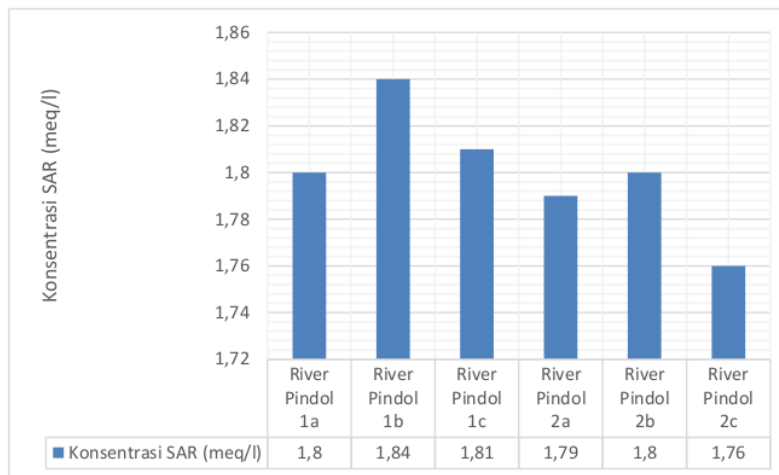
Laboratory analysis of river water obtained the following results: the value of parameter Sodium in the locations of River Pindol 1a, River Pindol 1b, River Pindol 1c were 1.019 meq/l, 1.040 meq/l, 1.026 meq/l and River Pindol 2a, River Pindol 2b, River Pindol 2c were 1.005 meq/l, 1.012 meq/l, 0.991 meq/l. The value of parameter Calcium in the locations of River Pindol 1a, River Pindol 1b, River Pindol 1c were 0.292 meq/l, 0.287 meq/l, 0.292 meq/l and River Pindol 2a, River Pindol 2b, River Pindol 2c were 0.281 meq/l, 0.281 meq/l, 0.281 meq/l respectively. The value of parameter Mg in the locations of River Pindol 1a, River Pindol 1b, River Pindol 1c were 0.346 meq/l, 0.351 meq/l, 0.348 meq/l and River Pindol 2a, River Pindol 2b, River Pindol 2c were 0.351 meq/l, 0.348 meq/l, 0.354 meq/l respectively. The value of parameter SAR in the locations of River Pindol 1a, River Pindol 1b, River Pindol 1c were 1.80 meq/l, 1.84 meq/l, 1.81 meq/l and River Pindol 2a, River Pindol 2b, River Pindol 2c were 1.79 meq/l, 1.80 meq/l, 1.76 meq/l respectively. All the parameters value in milliequivalents per litre are presented in Table 1 and Figure 1.

According to Ayers and Westcott [5], and Seid [2] the value Sodium Adsorption Ratio (SAR) can be interpreted as follows. The value smaller than 3 meq/l is good, from 3 meq/l to 9 meq/l is medium and above 9 meq/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 [10].

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

No	Location	Parameters			
		Sodium (Na) (meq/l)	Calcium (Ca) (meq/l)	Magnesium (Mg) (meq/l)	SAR* (meq/l)
1	River Pindol 1a	1.019	0.292	0.346	1.80
2	River Pindol 1b	1.040	0.287	0.351	1.84
3	River Pindol 1c	1.026	0.292	0.348	1.81
4	River Pindol 2a	1.005	0.281	0.351	1.79
5	River Pindol 2b	1.012	0.281	0.348	1.80
6	River Pindol 2c	0.991	0.281	0.354	1.76

\*Note: SAR (Sodium Adsorption Ratio) is the ratio of natrium adsorption.



**Figure 2.** Concentration of sodium adsorption ratio (SAR) in river Pindol

Figure 2 shows that the concentration of Sodium Adsorption Ratio (SAR) in River Pindol 1a, River Pindol 1b, River Pindol 1c, River Pindol 2a, River Pindol 2b, River Pindol 2c were 1,80 meq/l, 1,84 meq/l, 1,81 meq/l, 1,79 meq/l, 1,80 meq/l, 1,76 meq/l respectively. Pindol River 1b has the highest SAR concentration and the lowest concentration was in Pindol River 2c.

Sodium Adsorption Ratio (SAR) in the diagram (Figure 2) shows that SAR value meet quality requirement. According to Aboukarima [8], high sodium ion in irrigation water affects the hydraulic conductivity (permeability) of soil and creates water infiltration problems. This is because when sodium present in the soil in exchangeable form replaces calcium and magnesium, adsorbed on the soil clays and causes dispersion of soil particles (i.e. if calcium and magnesium are the predominant cations adsorbed on the soil exchange complex, the soil tends to be easily cultivated and has a permeable and granular structure). Due high value of SAR, the soil becomes hard and compact when dry and resultantly, reduces the infiltration rates of water and air into the soil affecting its structure. This problem is also related with several factors such as the salinity rate and type of soil. For example, sandy soils may not get damage as easily as other heavier soils when it is irrigated with a high SAR water. 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. Wantasen [13] obtained the SAR value of the River Panasen Upper Tondano Watershed (the value of parameter Sodium in the locations of River Panasen 0,1 meq/l to 0,4 meq/l), meet quality standards.

#### 4. Conclusion

One factor that determines the success and sustainability of irrigation projects is water quality. Water quality is also determined by Sodium Adsorption Ratio (SAR) value. SAR value affects soil conditions, especially related to soil structure and soil permeability and infiltration. Pindol River as a source of irrigation water in Bolaang Mongondow Regency has a SAR value that is classified as good quality.

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