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Study on the quality of irrigation water in the talawaan irrigation channel using the Sodium Adsorption Ratio (SAR) Method

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Abstract. The suitability of water for irrigation purpose can be determined using the Sodium Adsorption Ratio (SAR) method. The method describes the extent of sodium will be absorbed into the soil. This study aims to assess the water quality of the Talawaan river as a source of irrigation water using the Sodium Adsorption Ratio (SAR) method. The measurement was carried out by field observation at the tertiary channel and laboratory analysis of water samples obtained from the channel. The concentration of Na^+ , Ca^{2+} , Mg^{2+} were calculating using the SAR. Sampling of Water quality parameters was determined using the Composite Sampling, then analyzed with the UV-Spectrophotometry. The data referring to the standard values from Ayers and westcott. The results showed that the Sodium Adsorption Ratio (SAR) at the Talawaan irrigation varied from 1.33 meq/l to 1.55 meq/l. These results meets the requirements of the Ayers and Westcott standard standard, which stated that SAR at less than 3 meq/L is good quality standard (table 2). SAR value affects soil conditions, especially related to soil structure and soil permeability and infiltration.

1. Introduction

The Talawaan river plays an important role for the community in Talawaan village and its surrounding areas, namely being used as a source of irrigation water. The Talawaan Irrigation which will irrigate rice fields covering an area of around 1,705 ha in Minahasa Utara District [1]. Water management in irrigated areas is related to land use, the chemical composition of the characteristics of soil, water, climate, drainage conditions. This should be evaluated before implementing the irrigation project [2]. Water resources development is based on availability of water and environmental determining the quality river water requires knowing the characteristic of the river which is the source of irrigation water [3]. Types of waste that contain various types of pollutants into rivers, both biodegradable and non-biodegradable, will increase the burden that must be borne by the river. It's related to hydrological characteristic [4].

Surface water quality is very influential for the suitability of irrigation water in agriculture. To calculate this quality, water quality standard is used SAR is one of the factors used as a determinant of water quality suitability of paddy fields from several other determinants. This is used to measure water quality in agricultural irrigation which refers to the ability of water to absorb sodium, the smaller the SAR value is the better and higher the SAR value, the water quality can adversely affect plants and soil.



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Irrigation water classification is based on the SAR value: SAR value smaller than 3 meq/l is very good, 3-9 meq/l slight to moderate, and SAR value greater than 9 meq/l is bad [5]. Irrigation water quality with low sodium concentration is suitable for almost all soil type because it is loose in cation exchange. Otherwise irrigation water containing moderate to high sodium content will pose a considerable risk because sodium in the soils have a high cation exchange capacity, which can cause the soil. except to become dense which affect the structure and permeability of the soil. [5]. *Sodium Adsorption Ratio* It is an estimate of the rate of absorption of sodium by the soil. It also affects the water infiltration rate. Irrigation water with a high SAR value suggests a sodium hazard, poor quality of irrigation water applied to the soil, resulting in increased soil salinity. It will cause problems when a lot of salt accumulates in the root zone [6].

Each irrigation requires a specific management method and strategy because each irrigation has different types of plants to be irrigated. The important of management of irrigation water sources is based on the quality of water [3,7]. Plant growth and productivity is influenced by the permeability and fertility soil. Irrigation water quality determines soil conditions, causing solid soil structure when the irrigation water contains high sodium concentration. Dense soil structure affects air circulation in the soil, disturbed root development, resulting in low plant productivity. One of the parameters of irrigation water quality is measuring the value of the sodium adsorption ratio. This study to assess the Tertiary channel of the Talawaan river. The Na^+ concentration divided by the square root of one-half of the Ca^{2+} and Mg^{2+} method. This research was conducted on paddy fields that received water from Irrigation channel Talawaan Minahasa Utara District, North Sulawesi Province.

2. Methods

Primary data on tertiary channel of irrigation in the Talawaan irrigation channel using a water sampler and carrying out sample preparation. Water sampling was done using Grab sampling method and determined based on water flow [10, 11]. Sampling of Na, Ca, Mg in the field by composite sampling. It was carried out by mixing samples from three points, namely the left and right sides and the center of the irrigation channel and surface water, and next analysis in the laboratory.

Analysis of Na, Ca, Mg parameters in the laboratory was carried out using the ICP OES. Sodium Adsorption Ratio (SAR) was measured using the formula as follows [5,6,8,17]:

$$\text{SAR} = \text{Na}^+ \sqrt{(\text{Ca}^{2+} + \text{Mg}^{2+})/2} \quad (1)$$

where concentrations of Sodium adsorption ratio (SAR) are expressed in milliequivalents per litre. Na^+ , Ca^{2+} , Mg^{2+} are interchangeable cations.

Water quality sampling in the Talawaan Irrigation Channel at two sampling points. The location sampling is shown in Figure 1.

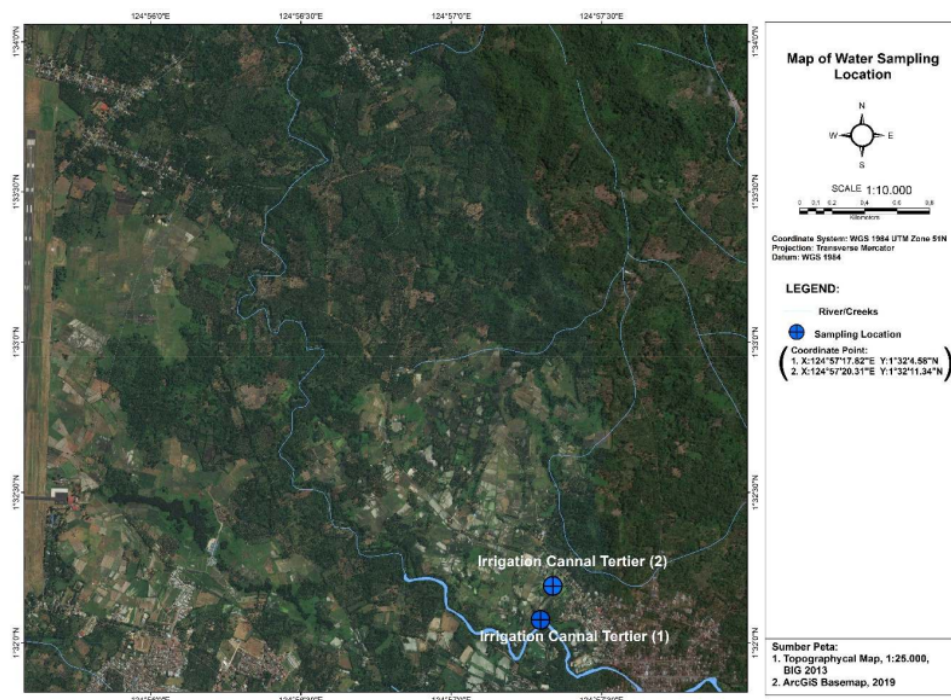


Figure 1. Map of water sampling location

3. Results and discussion

The results showed that the sodium concentration in the Talawaan irrigation channel in location 1 was 0.466 meq/L and at location 2 was 0.60 meq/L. The Calcium (Ca) parameter has the same concentration for both locations which is 0.31 meq/L. Likewise, the Magnesium (Mg) parameter also has the same concentration for both locations which is 0.29 meq/L. The concentration of Sodium Adsorption Ratio Tertiary channel Talawaan 1 was 1.55 meq/L and sampling point irrigation channel Talawaan 2 was 1.33 meq/L. Research data can be seen in Table 1.

Table 1. Concentrations of Na^+ , Ca^{2+} , Mg^{2+} and Sodium Adsorption Ratio (SAR)

No	Location	Parameters			SAR (meq/L)
		Sodium (Na) (meq/L)	Calcium (Ca) (meq/L)	Magnesium (Mg) (meq/L)	
1	Irrigation channel Talawaan 1	0.466	0.31	0.29	1.55
2	Irrigation channel Talawaan 2	0.60	0.31	0.29	1.33

Note : SAR (Sodium Adsorption Ratio)

The results of the research obtained by Ayers and Westcott [5], and Seid [2] the value Sodium Adsorption Ratio (SAR) less than 3 meq/L is good, SAR value from 3 meq/L to 9 meq/L is medium and SAR value above 9 meq/L is bad (Table 2). It is influenced and then affects to soil structure, infiltration, permeability and soil aeration. Furthermore has availability of oxygen and water in the root zone [6].

Table 2. Guidelines of Irrigation Water Quality [5]

Potensial irrigation problems	unit	Limiting Level		
		none	Slight to moderate	Severe
SAR		< 3	3 – 9	> 9
SAR= 0 -3 and $EC_w =$		>0.7	0.7 – 0.2	< 0.2
SAR = 3 -6 and $EC_w =$		>1.2	1.2 – 0.3	<0.3
SAR = 6 -12 and $EC_w =$		>1.9	1.9-0.5	<0.5
SAR= 12 -20 and $EC_w =$		>2.9	2.9-1.3	<1.3
SAR=20-40 and $EC_w =$		>5.0	5.0-2.9	<2.9
TDS	mg/l	<450	450-2000	>2000
pH			6,5 – 8,4	

Note: meq/L = miliequivalen per litre

Sodium Adsorption Ratio (SAR) in the diagram (Table 1) shows that SAR value meet quality requirement. According to Aboukarima [9], the quality of irrigation water containing high sodium ions affects the soil structure to become solid, this decreases the rate of water and air infiltration. Infiltration also affect the condition of sodium, magnesium, calcium and EC_w (Electrical Conductivity) or DLH in the soil. The content of SAR is also influenced by the infiltration process [12]. As comparative, Naray[13] obtained the SAR values in primary channel (0.230 meq/L), secondary channel (0.15 meq/L), and tertiary channel (0.20 meq/L) Molompar rice fields which are of good quality to become a source of irrigation for rice field in Molompar Village, Minahasa Tenggara District. Wantasen [14] obtained the SAR value of the Dumoga irrigation 2.33 meq/l and Wantasen [15] 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. However it is necessary to conserve water. Water conservation strategies can be managed based on space, hydrological aspects, integrated water management and goverment policies [16].

4. Conclusion

The results of the study using the SAR method indicated that the quality of irrigation water at the study site could be classified as good quality. The SAR value obtained for the irrigation channel Talawaan 1 and the irrigation channel Talawaan 2 were 1.55 meq/L and 1.33 meq/L, respectively. SAR value affects soil conditions, especially related to soil structure and soil permeability and infiltration.

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