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IRRIGATION SUITABILITY OF POND AND STREAM WATER IN ELAVANCHERRY GRAMA PANCHAYATH, PALAKKAD DISTRICT, KERALA

Vasudevan Pillai, K[1] & George K. Varghese[2]
[1]Dept of Physics, N. S. S. College, Nemmara, Palakkad (dt)
[2]School of Environmental Sciences, Mahatma Gandhi University, Kottayam, INDIA.

ABSTRACT
An assessment of water quality in the ponds and streams of Elavanchery grama panchayath for purpose of irrigation was made in the present investigation. Water samples collected at random from various locations from the ponds and streams were analyzed for electrical conductivity (Ec), total dissolved salts (TDS), sodium percent (SP), sodium adsorption ratio (SAR), residual sodium carbonate (RSC) and permeability index (PI). The analysis of the results revealed that water in Elavanchery is highly suitable for the purpose of irrigation without any treatment.

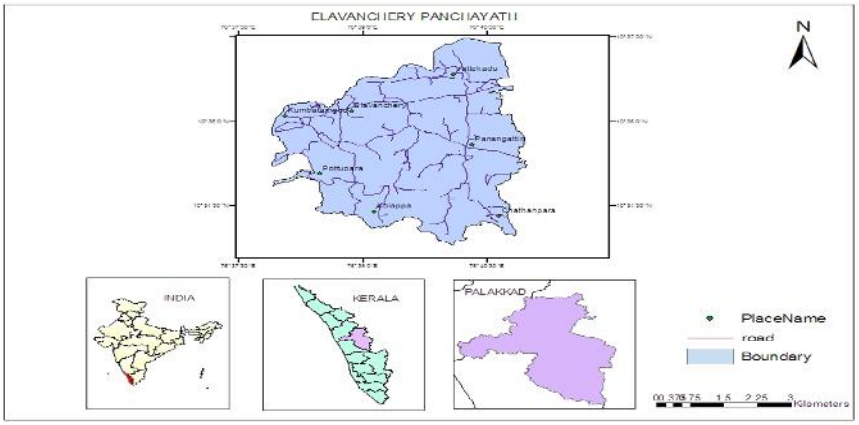
KEYWORDS: Water analysis; Elavanchery, Palakkad; Irrigation water quality; SAR; RSC, PI

INTRODUCTION

Water is a precious resource, which plays a major role in maintaining the balance of ecosystem. The human life and agricultural activity mainly depend on water sources. Water chemistry differs depending on the source of water, the degree to which it has been evaporated, the types of rock and mineral it has encountered, and the duration it has been in contact with reactive minerals (Plummer *et al.,* 2003). There are many underutilized water sources in Elavancherry grama panchayath of Palakkad district in Kerala state. However, no studies have so far been undertaken to find out the suitability of these water bodies as ideal water harvesting reservoirs. There are no reports on the physico-chemical properties or irrigation suitability of these water resources. Hence, the study aims to evaluate the water quality and irrigation suitability of water bodies viz., ponds and streams in the study area.

STUDY AREA

The area chosen for the present study is Elavanchery Panchayath, which comes under the Nemmara Block Panchayath of Chittur Taluk in Palakkadu district of Kerala State. The study area is enclosed between $10^{o}33'50"$ to $10^{o}37'29"$ North latitude and $76^{o}37'55"$ to $76^{o}40'58"$ East longitudes, covering an area of 32.18 Km^2. It has Pallasana Panchayath at north, Nelliyampathy Panchayath at south, Kollenkode at east, and Nemmara at west as boundaries. (Plate: 1)The area receives moderate to high rainfall during the southwest monsoon (June-August) and northwest monsoon (October - December) seasons. The major river flowing through the area is Gayathri River. The elevation varies between 110+ m in the south to 75+ m in the north above mean sea level. Temperature of the area varies from $23^{o}c$ to $41^{o}c$ (maximum in the summer seasons). General land use / land cover pattern of the area encompasses built up land, commercial land, natural vegetation and plantation crops. Paddy is grown as the major crop. Cashew nuts, areca nuts, coconuts and to a small extent rubber are cultivated as plantation crops. Along with these, banana, mango, jackfruit, tapioca, pineapple, and black pepper are also grown as mixed crops. Number of households in Elavanchery Panchayath is 3956. Total population of Panchayath is 20283. Among these, 9899 are male and 10384 are female (Census data, 2011). Most of the people are small scale farmers and agricultural laborers.



MATERIALS AND METHODS

Water samples were collected from the ponds and streams at various locations in the study area during the pre monsoon period [2009]. The samples were collected in air tight plastic containers and transported to the laboratory, where the samples were subjected to different analysis viz., pH, Conductivity, TDS, Na%, SAR, RSC and PI %

To determine the irrigation suitability of water, sodium adsorption ratio (SAR) (Richard 1954), residual sodium carbonate (RSC) (Eaton, 1950), Sodium percentage (%Na) (Wilcox, 1955) and permeability index (PI) (Doneen, 1966) were calculated using the following formulae (ions concentrations expressed as milli equivalents/ litre).The salinity hazard was calculated based on electrical conductivity value at 25^{o}C expressed as mmohs/cm.

$RSC = [CO_3^{2-} + HCO_3^{-}] - [Ca^{2+} + Mg^{2+}]$

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

$\%Na = (Na+K)\ 100/ (Ca+Mg+Na+K)$

$PI = Na+ (HCO_3)^{1/2}/(Ca+Mg+Na+K)$

RESULTS & DISCUSSION

pH

Normal range of pH in the irrigation water is 6.5 to 8.4 (Ayers and Westcot, 1985; KSPCBOA, 2000). All the water samples tested both in the case of pond and stream had a pH within this range.

Salinity

Electrical conductivity is a good measure of salinity hazard to crops as it reflects the TDS in water. An electrical conductivity (EC) of up to 700 µmohs/cm has no effects; whereas, an EC of 700 µmohs/cm to 3000 µmohs/cm has slight to moderate effect on plants. EC values of more than 3000µmohs/cm will severely affect the crop water availability (Ayers and Westcot, 1985). Water with a high salinity is toxic to most plants and poses a salinity hazard. According to the EC value, the waters have been classified as:

Class	EC value (µmohs/cm)	Suitability
1	<250	excellent
2	250- 750	good
3	750-2000	permissible (leaching is required if used)
4	2000-3000	doubtful (good drainageneeded if used)
5	>3000	unsuitable (good drainageneeded if used)

The EC of water samples from all the sources were below <250 µmohs/cm and was found excellent in quality. High sodium levels can contribute to salinity problems and interfere with magnesium and calcium availability and it also indicates sodium hazard. The Pollution Control Board has prescribed 26 as the maximum tolerance limit value of SAR (KSPCBOA, 2000). The sodium, potassium, magnesium and calcium content of samples from ponds and streams are presented in Table 1 and 2. As revealed in the present investigation, the SAR values of water from different sources are within the limit and hence highly suitable for the purpose of irrigation.

Sodium hazard (S) or sodium adsorption ratio (SAR)

Sodium adsorption ratio (SAR) is an important parameter for determining the suitability of groundwater for irrigation because it is a measure of alkali/ sodium hazard to crops (Subramani *et al.,* 2005).

The sodium adsorption ratio is an indicator of the relative proportion of sodium ions in a water sample to those of calcium and magnesium. Sodium replacing adsorbed calcium and magnesium is a hazard as it causes damage to the soil structure making it compact and impervious. SAR is an important parameter for the determination of suitability of irrigation water because it is responsible for the sodium hazard. The SAR is calculated from the ratio of sodium to calcium and magnesium. The latter two ions play a detrimental role as their presence counters the effect of sodium. The SAR values are grouped into four classes:

Class	SAR value		Hazard
1	1-10	low	Safe to irrigate with no structural deterioration but salt-sensitive plants may be affected depending on EC/TDS
2	10-18	medium	Hazard on fine textured soils with a high cation exchange capacity. Suitable on course textured soils with good drainage
3	18-26	high	Hazard on moist soils. Need to manage with amendments and drainage
4	> 26	Very high	Not suitable for irrigation

The SAR values indicate the degree to which irrigation water tends to enter into cation-exchange reactions in soil. Sodium replacing adsorbed calcium and magnesium, damages the soil structure by making it compact and impervious (Raju, 2006).The water samples in the present study possess low SAR (value within 10) and hence less likely to cause any structural degradation of susceptible soils. This crucial finding revealed that the water in the ponds and streams of Elavancherry is most suitable for irrigation.

Residual sodium carbonate (RSC)

Residual sodium carbonate (RSC) has been calculated to determine the hazardous effect of carbonate and bicarbonate on the quality of water for agricultural purpose. Residual alkalinity (RA) represents the amount of sodium carbonate and sodium bicarbonate in the water and is said to be present in a water sample if the

concentrations of carbonate and bicarbonate ions exceed the concentrations of calcium and magnesium ions. Residual alkalinity is usually expressed as milli-equivalents per litre (meq/L) of calcium carbonate. RSC gives an account of calcium and magnesium in the water sample as compared to carbonate and bicarbonate ions (Eaton, 1950). RSC value less than 1.25 indicates low hazard, whereas a value of 1.25- 2.5 indicates medium hazard and more than 2.5 indicates high hazard to crop growth and soil structure. Residual Sodium Carbonate (RSC) predicts the accumulation of sodium in the soil based on the potential precipitation of calcium/magnesium carbonate. According to RSC classification, the water samples, irrespective of the sources, are within low hazard category. In most cases, the RSC values were found negative. The negative RSC indicates that the water is unlikely to cause structural degradation.

Permeability Index (PI)

High sodium in the irrigation water can cause severe problems to soil permeability. Permeability is affected not only by high sodium but also by CO_3^{2-} and HCO^{3-} content in water. A part of $CO^{3—}$ and HCO^{3-} is precipitated as $CaCO_3$ (or) $MgCO_3$ removing Ca and Mg from irrigation water and leads to increased proportion of solution. The permeability index is influenced by Sodium, calcium, magnesium and bicarbonate contents of the soil. The WHO (1989) uses a criterion for assessing the suitability of water for irrigation based on permeability index. The permeability index (PI) values of the water samples of the ponds and streams in the study area indicate that the water is suitable for irrigation. The PI of the water samples recorded variations from 15% to 114% in the case of ponds and 56 to 104% with respect streams. Doneen (1966) evolved a criterion for assessing the suitability of water for irrigation based on the permeability index. Accordingly, water samples can be classified into class I, Class II and Class III orders. The water samples coming under Class I and Class II are categorized as good for irrigation with 75% or more maximum permeability. Class III water are unsuitable with 25% of maximum permeability. If permeability index value exceed 65, water is considered suitable for irrigation.

TABLE 1. Physico-chemical characteristics and Irrigation suitability of pond water in Elavancherry- analysis of pre-monsoon water quality

	Physico-chemical characteristics and Irrigation suitability							
Sample	pH	Conductivity	TDS	T- Hardness	Na%	SAR	RSC	PI %
EP 1	7.46	0.072	0.032	188	28.664	0.971	0.400	66.23
EP 2	7.11	0.019	0.082	40	45.698	0.963	0.160	112.79
EP 3	6.1	0.292	0.131	884	16.775	0.751	-16.86	15.71
EP 4	6.88	0.020	0.009	40	53.668	1.100	-0.240	96.57
EP 5	6.54	0.029	0.013	72	37.086	0.656	-0.719	70.40
EP 6	7.04	0.071	0.033	164	34.473	1.267	-0.240	68.68
EP 7	7.65	0.078	0.035	76	64.390	2.649	2.158	110.42
EP 8	7.55	0.048	0.021	108	37.189	1.080	0.559	84.46
EP 9	7.5	0.082	0.037	108	59.421	1.959	1.519	94.26
EP 10	7.23	0.148	66.000	380	30.576	0.955	1.119	50.90
EP 11	7.11	0.156	72.300	484	21.115	0.842	-7.273	29.51
EP 12	7.33	0.088	0.038	68	69.028	3.286	2.478	114.75
EP 13	7.33	0.069	0.031	168	34.146	1.168	-0.559	65.41

Salinity and indices such as, sodium absorption ratio (SAR), sodium percentage (Na %), residual sodium carbonate (RSC), and permeability index (PI) are important parameters for determining the suitability of water for agricultural uses (Gowd, 2005). Several authors have reported the suitability of water for irrigation from different parts of the world (Hussain and Hussain, 2004, Islam et al., 2003, Meena Kumari and Hosamani, 2004; Rajesh and Murthy, 2004; Singh, 1998; Usha Madhuri *et al*., 2004) and different sources (Malini *et al*., 2003, Rao and Devadas, 2005; Satya Narayan and Guru Prasad, 2006; Vishwanath and Ananthamurthy, 2005). In the present study SAR, RSC and PI were found in the permissible range for all the water samples collected from the ponds and streams in the study area. It is expected that the data generated with special reference to physico-chemical parameters of the water bodies is much useful to initiate a sustainable water management strategy for Elavancherry grama panchayath.

TABLE 2. Physico-chemical characteristics and Irrigation suitability of stream water in Elavancherry - analysis of pre monsoon water quality

	Physico-chemical characteristics and Irrigation suitability							
Sample	pH	Conductivity	TDS	T- Hardness	Na%	SAR	RSC	PI %
ES 1	7.09	0.0374	0.0163	144	21.052	0.580	-1.119	56.58
ES 2	7.39	0.0388	0.0176	112	27.425	0.693	-0.360	68.90
ES 3	7.28	0.0129	0.00588	44	29.450	0.492	0.000	104.85
ES 4	7.53	0.113	40	156	35.101	1.309	0.320	73.42

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