VARIATION IN THE QUALITY OF IRRIGATION WATER WITH INCREASING DISTANCE FROM SEA: A CASE STUDY IN KALUTHAWALAI VILLAGEOF BATTICALOA

Yogendran.M[1], Sugirtharan. M[2] and Pathmarajah.S[3]

ABSTRACT

Ground water is the source for irrigation in the coastal area of Batticaloa district. Intensive crop cultivation is occurring in some villages in the coastal areas namely, Kaluthawalai, Chettipalayam, Kaluwanchikudi etc. and farmers have no idea about the quality of irrigation water they use. Considering the general problems with irrigation water in the coastal area, the present investigation was carried out with a view of assessing the irrigation water quality closer to the seashore in Kaluthawalai village. Irrigation water samples were collected during July to August 2008. Samplings were done four times in 2 weeks interval and those were analyzed for chemical parameters. The quality characteristics of water collected at different locations were compared and correlated with the distance from the sea. Results showed that the pH greater than 7.0 indicating the alkaline nature and vulnerable to irrigation. The EC values increased with the increase in distance from the sea but not reached the permissible level. All the samples were under C_3 class (EC=0.75-2.25dS/m) according to the electrical conductivity values that indicating the moderate salinity will lead to increasing problem during continuous irrigation with this water. The concentrations of cations in water indicated that Ca was the dominant ion followed by Na and Mg. Total dissolved solids, cation concentration, Sodium Adsorption Ratio (SAR) and Ca/Mg Ratio of irrigation water in the study area were within the tolerant limit. There is non-significant relationship was observed between water quality parameters with the distance from the sea. Further, it is revealed that the groundwater of the study area is likely suitable for irrigation with the management practices against the salinity problem. However, over exploitation of ground water may lead to salt water intrusion near coastal area of the village.

Key words: Coastal area, Electrical conductivity, Ground water, Salinity

INTRODUCTION

In Sri Lanka, ground water from shallow dug wells, agro wells, waters from reservoirs has been the primary sources for irrigation and drinking purposes. Groundwater comprises the physical, chemical, and biological qualities. Temperature, turbidity, color, taste, and odor make up the list of physical water quality parameters. Higher amount of TDS and other parameters like salt, hardness, Na and variation in pH level are causing problem to the irrigation water. However, good quality of irrigation water is essential to maintain the crop productivity at high level. Poor quality water damages soils usually by making them saline or alkaline with salt accumulation (Ayres and Westcot, 1976). Naturally, ground water contains mineral ions. These ions slowly dissolve from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer. The suitability of water for irrigation is determined not only by the total amount of salt present but also by the kind of salt, various soil and cropping problems. Irrigation salinity occurs on certain irrigated lands resulting from the application of excess water, very often without adequate drainage infrastructure to remove excess water. If groundwater accession continues water will discharge at the soil surface or into surrounding streams, often carrying dissolved salts. Evaporation leaves these salts to accumulate on soil surfaces resulting soil salinity (Villholth, 2005).

Sea water intrusion is one of the causes for the ground water salinity. It is a natural phenomenon that occurs as a consequence of the density contrast between fresh and saline groundwater. When there is excessive pumping of fresh groundwater, sea-level change, or changing recharge conditions, the saline water can gradually move landward within the aquifer until a new equilibrium condition is achieved. This problem exists

[1] Hayley's Company Private limited, Colombo. (ms_yogendra@yahoo.com)
[2]Department of Agricultural Engineering, Eastern University, Sri Lanka.
[3] Department of Agricultural Engineering, University of Peradeniya, Sri Lanka.

in most of the coastal areas in Sri Lanka especially in dry zone. Salt water intrusion mainly due to intense withdrawals of groundwater has become the main environmental issues in the coastal area. As a result of pumping from the tube wells and land subsidence, seawater has been intruded along the coastal area. Kaluthavalai is one of the coastal area farming villages in Batticaloa district. Now they are using tube wells to irrigate their lands during morning and evenings. Even though, it has some advantages there are some limitations due to the continuous and over exploitation of underground water for irrigation. Due to this intensive and continuous exploitation of ground water near the sea shore, the sea water intrusion may occur and leads to ground water salinity. In this point of view, this study was carried out to assess the salinity of the well water and to findout the suitability of irrigation water in regards to salinity level and Sodium Adsorption Ratio (SAR), also aims to study the correlation between the irrigation water quality and the distance from sea.

MATERIALSAND METHODS

The study area

The study was carried out in Kaluthavalai village, which is situated in 25 km away from the Batticaloa town. There are 400 families are involved in vegetable cultivation as a livelihood occupation. Soil type of the study area is sandy regosol and terrain flat less than 10%. Several tube wells are used for irrigation purpose in this area. The crops such as chilli, brinjal, okra, cowpea, ground nut are found in the study sites.

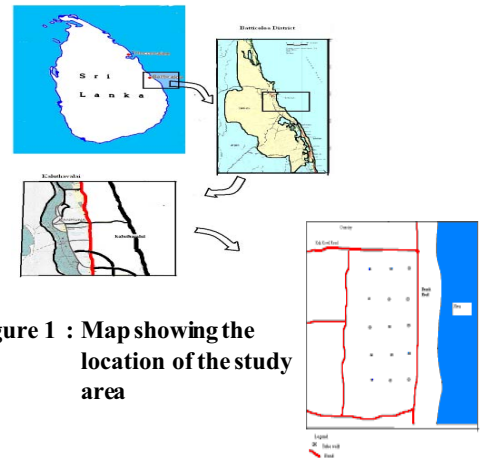

Figure 1 : Map showing the location of the study area

Water sample from irrigation wells were collected from 15 farmers' field. Five (5) locations were selected along the coastal line and 3 points in each location were identified at 100m distance away from sea. The study area was 500m from North to South and 300m from East to West. Sampling was done 4 times from each well in regular interval of 15 days during irrigation. Therefore 60 samples were (i.e 15x4) collected during this study. Each sample was collected in one litre plastic container (can). The container was rinsed 2 to3 times before collection of sample by water which is to be collected. Samples were collected during July and August 2008 and analyzed for pH, EC, TDS, Ca, Mg, Na concentration. The derived parameters viz. Sodium Adsorption Ratio and Calcium Magnesium Ratio were also calculated from the result obtained from the chemical analysis of the samples. Salinity levels of water also explained in terms of EC and TDS. Data obtained by the analysis of the irrigation water was analyzed to find out the correlation between the quality parameter and the distance from the sea.

RESULTSAND DISCUSSIONS

The result are presented under each of the variables are showing below;

Table1: Summaryof the irrigation waterquality near the sea at study area

Parameters	Min	Max	Mean
EC(dS/m)	1.16	1.73	1.44
TDS(meq/l)	0.56	0.86	0.72
pH	7.74	8.42	8.15
Na(meq/l)	1.10	3.16	2.80
Ca(meq/l)	6.00	8.04	6.69
Mg(meq/l)	1.40	2.60	2.10
SAR	1.11	1.56	1.34
Ca/Mg	2.46	5.16	3.20

Electrical Conductivity

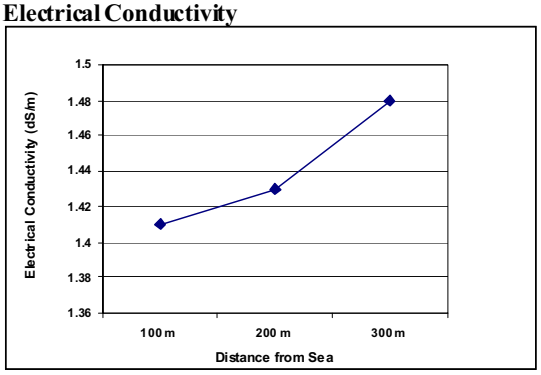

Figure 2: Variation in Mean EC values of irrigation water with the distance from sea.

The variation in the mean EC values were 1.41, 1.43 and 1.48 dS/m at the distance of 100m, 200m and 300m away from the sea respectively. However the minimum and maximum values were 1.16, 1.73 dS/m at the distance of 100m and 300m respectively. There was considerable increment in the EC value along the distance away from the seashore. According to the USDA (Richards, 1954) classification EC value of collected samples was under the C3 class. Salinity level or total soluble salt concentration in irrigation water can be classified in terms of EC values. For an instance, the collected water samples were showed the EC values in the range of 1.16- 1.73 dS/m indicating moderate salinity based on the Ayres and Westcot, FAO (1976) classification. Further, there was a positive correlation ($r=0.041$, $p<0.05$) observed between the EC value and distance from the sea.

pH

The pH between 6.0 and 7.0 is normally considered to be the most preferable for irrigation purposes. The figure 3 shows the mean pH of irrigation water were 8.2, 8.12, and 8.13 in the distance of 100m, 200m and 300m respectively. However, among the all sample pH values were ranged from 7.74 to 8.42 and it shows alkaline nature and leads to alkaline condition in soil during the continuous irrigation. Therefore, proper management against alkalinity will be essential for continuous cultivation in this area.

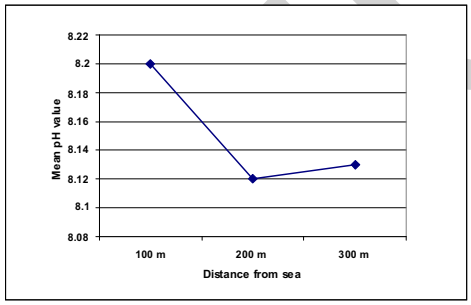

Figure 3: Variation in mean pH of irrigation water with the distance from sea

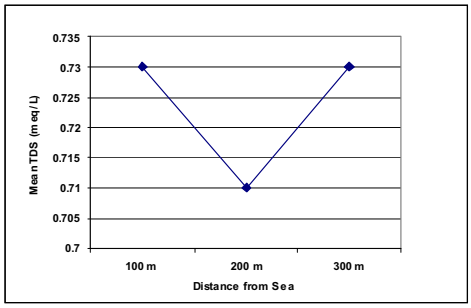

Figure 4: Mean Variation in TDS concentration of irrigation water with the distance from sea

Figure 04 shows that the mean TDS of irrigation water were 0.73, 0.71 and 0.73 meq/L with distances of 100m, 200m and 300m respectively. Among the all collected samples concentration of total dissolved solids were ranging from 0.56 to 0.86meq/l with an average of the 0.72 meq/l as in table 01. There was positive non significant correlation ($r= 0.20$, $p=0.05$) exist between TDS and distance from sea at study area.

Cation concentrations

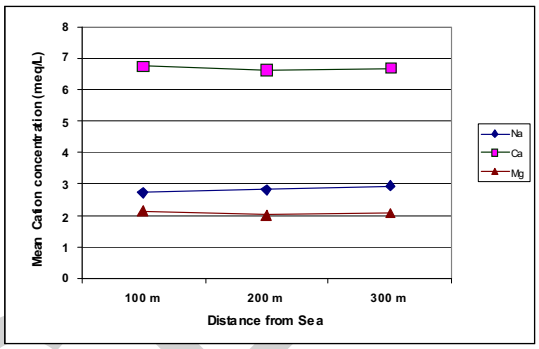

Figure 5: Mean Variation in Cation concentration along the distance from sea

Na Concentration

Mean Na concentration in irrigation water shows that the gradual increase in concentration 2.71, 2.81 and 2.96 meq/l at the distances of 100m, 200m and 300m respectively. Na concentration increasing with distance upto 300m, there is positively non significant correlation (0.22, $p<0.05$) was found in between Na concentration and the distance from sea.

Calcium Concentration in irrigation water

The mean Ca concentrations were 6.76, 6.64, and 6.68 (meq/l) at the distances of 100m, 200m and 300m respectively. There is significant negative correlation (-0.27, $p<0.05$) observed in between Calcium concentration and distance from sea. Ca concentration was reducing with the distance upto 200m and then slightly increasing upto the distance of 300m. The presence of Ca in water may be due to the mixing of Calcium from the sea water as well as from the rocks/ soil having calsic nature.

Magnesium Concentration in irrigation water

Mg concentration varied with distance from sea. The mean values were 2.13, 2.03 and 2.08 (meq/l) at the distances of 100,200 and 300m respectively.

Sodium Adsorption Ratio (SAR)

The results of the analysis of well water for shows that the mean SAR values were 1.33, 1.29 and 1.42 at the distance of 100m, 200m and 300m respectively. The data indicates a reducing trend of SAR upto the distance of 200m and then increasing from 200 to 300m distance. Non significant negative correlation ($r = -0.27$, $p<0.05$) was observed between SAR and distance from sea.

Ca / Mg ratio

It was observed that the mean values of Ca/Mg ratio of irrigation water were 3.20, 3.22 & 3.28 at the distances of 100m, 200m and 300m respectively. This might be due to the parent material inherently of calcic origin or the effect of salt water intrusion into the irrigation water source (Jeyakumar *et al*., 2002). Mg hazard in irrigation water is expected in the ratio of Ca/Mg less than one. However, all the water samples in the present study showed the mean ratios greater than one. Therefore, according to the mean values the water samples collected at study site showed less Mg hazard. Statistical analysis shows that there is non significant positive correlation (0.049, $P>0.5$) in between Ca:Mg ratio and distance from the sea.

CONCLUSION

The analysis of well water closer to the sea showed, there is fluctuation in the concentrations of most of the parameters studied with the distance from sea. Irrigation water of the study area contained desirable level of TDS, Na, Ca, Mg and Ca/Mg Ratio. But, there are moderate problems in irrigation water based on the EC, pH and SAR. Further, there would be a possibility of increasing salinity and sodicity hazards in the study area if this water is used continuously for irrigation. However, groundwater of the study area is suited for the irrigation by intermittent irrigation without allowing the land for drying. If not the evaporation of water from soil may accumulate salt at the surface of the soil. Adequate drainage and salt tolerance crops are most suitable option in this area. According to the cation concentration, high Ca concentration was observed than Mg. The SAR indicates a reducing trend up to distance of 200m and then increasing upto 300m distance. According to SAR, all water sample suitable for irrigation.

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