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Changes in well water quality with distance from the Mula right bank canal of Rahuri Tahsil, Maharashtra, India

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ABSTRACT

The changes in well water quality with increasing distance from canal was investigated in a canal length of about 25 Kilometers at Mula right bank canal command area of Rahuri Tahsil, Ahmednagar district of Maharashtra, India. Water samples were collected at 100 meter distances upto 500 meter away from the canal at 12 different sites on the canal distance. The samples were analyzed for some chemical parameters of the water and electrical conductivity (EC). Concentrations of Sodium (Na), bicarbonate (HCO_3^-), chloride (Cl^-), sulphate (SO_4^{2-}), nitrate (NO_3^-) and electrical conductivity decreased with increasing distance from the canal. The maximum value at the point closest to the canal were 14.76, 7.46, 3.27, 7.22, 1.02 meL^{-1} and 1.89 dSm^{-1} for Na, HCO_3^-, Cl^-, SO_4^{2-}, NO_3^- and EC, respectively. Values of 7.78, 5.17, 2.08, 3.61, 0.67 meL^{-1} and 1.07 dSm^{-1} for Na, HCO_3^-, Cl^-, SO_4^{2-}, NO_3^- and EC were obtained at the point 500 meters away from the canal. Potassium (K), nitrate (NO_3^-) and carbonate (CO_3^{2-}) in the well water were found in trace amounts. The study revealed that, there is a possibility of getting poor quality water near unlined canal due to the seepage effect. Therefore proper lining of canal is important to avoid the seepage effect near canal area. The effects of the use of well water on soil quality are discussed according to their characteristics.

KEY WORDS: Command area, Electrical conductivity, Ground water, Sodium hazard

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1. INTRODUCTION

Mula dam is the biggest irrigation project in Ahmednagar district constructed on the Mula river to serve for irrigation and domestic purposes. The total irrigable command area includes the villages of Ahmednagar district viz., Rahuri, Newasa, Shevgaon and Pathardi. The water from the Mula dam is diverted to the farmer's field by the two canals namely Mula right bank canal (MRBC) and Mula left bank canal (MLBC). The Mula canal system in Maharashtra has an irrigable command area of 82720 hectares [1]. The surface water resources of Maharashtra state are finite and the potential for increasing water supplies is limited. The difference between crop water requirements and surface water supply especially canal water supplies is met through exploitation of ground water. Therefore, ground water has gradually acquired a vital role in the development of agriculture and the rural economy of the command area.

The MRBC command area of Rahuri Tahsil has several shallow and deep wells which supplement the canal water irrigation. Irrigation causes the movement of pollutants from land into surface or ground water. For an example, irrigation waters transported in open, unlined canals can seeps into adjacent soils, eventually carrying soluble pollutants into ground waters causing changes in their quality [2]. In this view, this study was carried out at the MRBC command area to determine the seepage effect on well water quality with particular distances from the MRBC of the Rahuri tahsil and to correlate the well water quality parameters itself.

The study area

The study was carried out in the Mula right bank canal command of Rahuri tahsil, Ahmednagar district of Maharashtra state in India (Latitude 19°21' – 30", longitude 74° 36' – 30"). The area belongs to the semiarid climate with low average annual precipitation of 520 mm. Soil types in the study site are medium soil, black cotton soil and hard murum [1]. The cropping patterns in the study area are diverse, and the major crops are sugarcane, sorghum, fodder grass, cowpea, chickpea, onion, ground nut and wheat. This area has a complex geologic history with North to South slope.

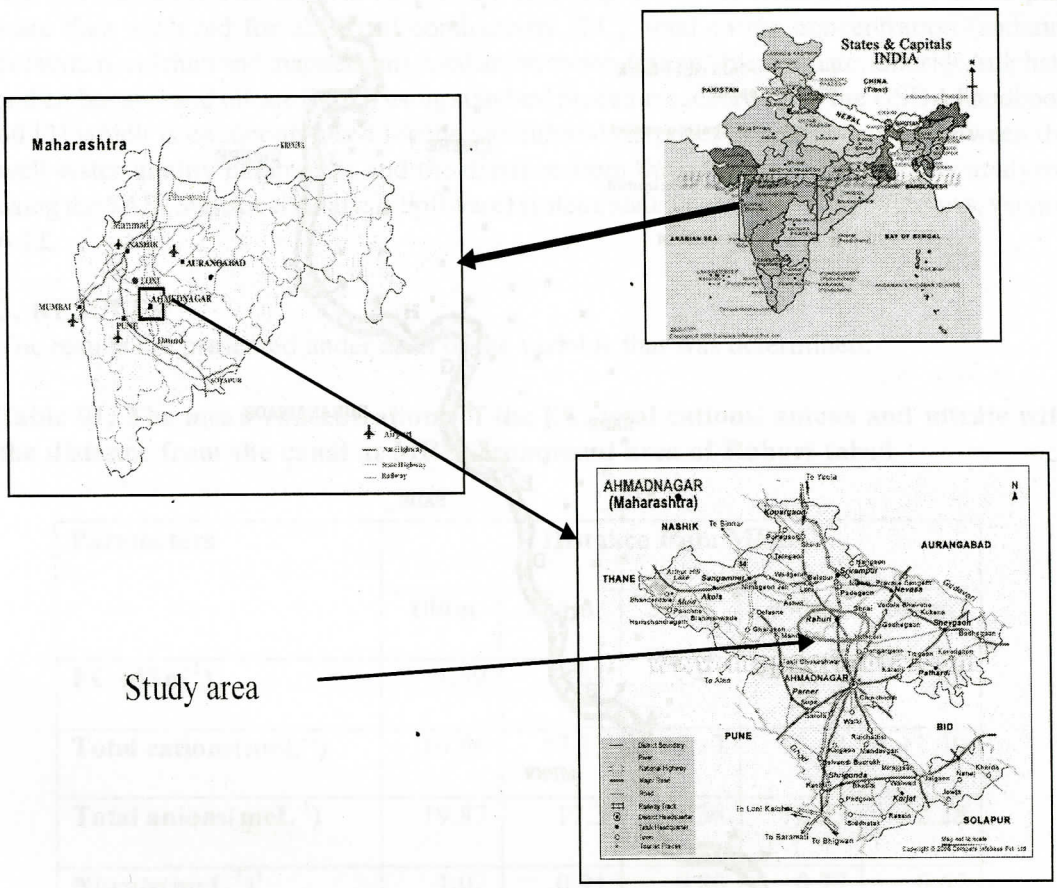

Fig 1: Map showing the location of the study

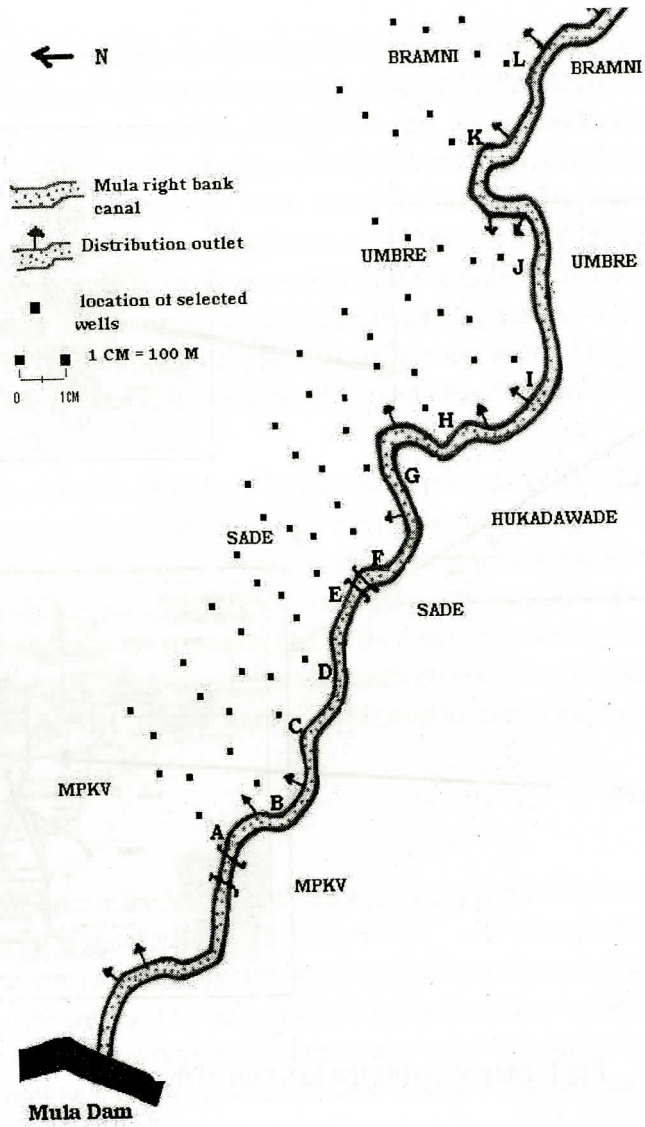

Fig 2: Map showing the locations of selected wells in the study area of MRBC, Rahuri Tahsil

2. MATERIALS AND METHODS

Water samples were collected in *rabi* or winter season during December 2006. Sixty samples of well waters were collected from MRBC command area at the distances of 100, 200, 300, 400 and 500 m from the canal at 12 different sites (Fig.02) on the canal distance. The samples were then analyzed for electrical conductivity (EC), total cation concentration (sodium, potassium, calcium and magnesium), total anion concentration (bicarbonate, chloride, sulphate and carbonate) and nitrate (NO_3^-) using standard procedure according to the USDA handbook 60 [3] which is commonly used for the agricultural purposes. The correlation between the well water quality parameters and the distance from the canal were statistically analyzed using the SAS (Statistical Analysis Software) system, statistical software for windows, version 6.12.

3. RESULTS

The results are presented under each of the variable that was determined.

Table 01: The mean concentrations of the EC, total cations, anions and nitrate with the distance from the canal at MRBC command area of Rahuri tahsil

Parameters	Distance from MRBC				
	100m	200m	300m	400m	500m
EC (dSm^{-1})	1.89	1.63	1.41	1.16	1.07
Total cations(meL^{-1})	19.96	17.37	15.17	12.68	11.79
Total anions(meL^{-1})	19.87	17.3	15.38	12.83	12.28
Nitrate(meL^{-1})[1]	1.02	0.91	0.80	0.77	0.67

meL^{-1} (milliequivalent per litre)

Electrical conductivity (EC)

The mean values of EC of the well waters varied in between 1.07 and 1.89 dSm^{-1} (Table 01). EC values were higher at the point closest to the canal (100m) than the other points (200 to 500m). Well water samples were under the high salinity class (C_3) based on USDA classification [3]. Further, there is a statistically significant negative correlation ($r=-0.42$, $p< 0.01$) was observed between the EC of well waters and the distance from the canal.

Total cation concentration

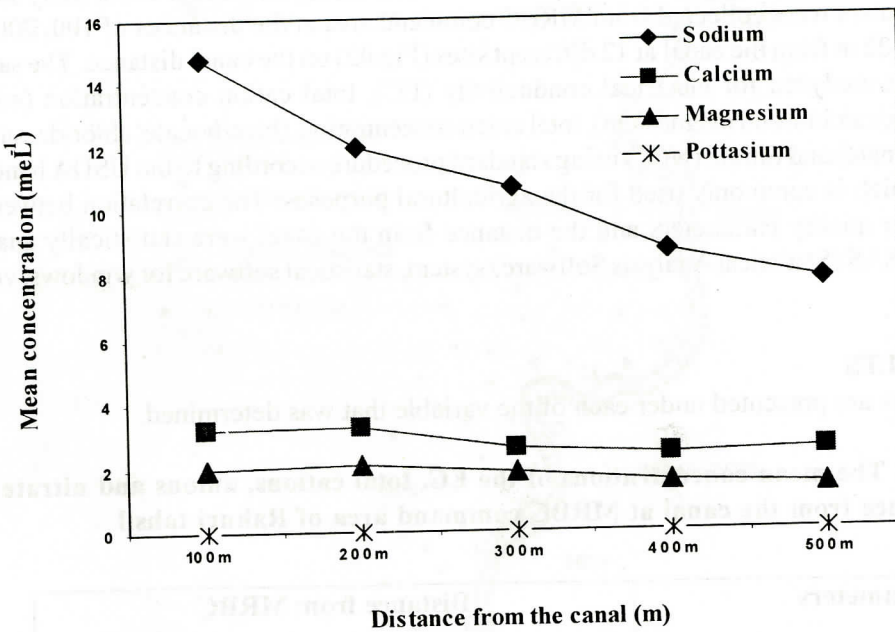

Figure 3: The mean concentration of cations in well water with the distance from canal

The mean total cation concentration were higher (19.96 meL^{-1}) closest to the canal whereas lowest (11.79 meL^{-1}) at 500m away from the canal. The concentrations of cation indicated that the dominant ion was sodium (Na) followed by calcium (Ca), magnesium (Mg) and potassium (K). Further there is an inverse relationship was found in between the distance from the canal and the total cation concentration of the well waters (Fig 03). Especially the sodium (Na) concentration had a significant negative correlation ($r=-0.37$, $p< 0.01$) with distance from the canal at the study area. Similarly Ca and Mg also showed inverse relationship ($r= -0.23$, $p= 0.06$ and $r= -0.28$, $p<0.05$, respectively) with the increasing distance from the canal.

Total anion concentration

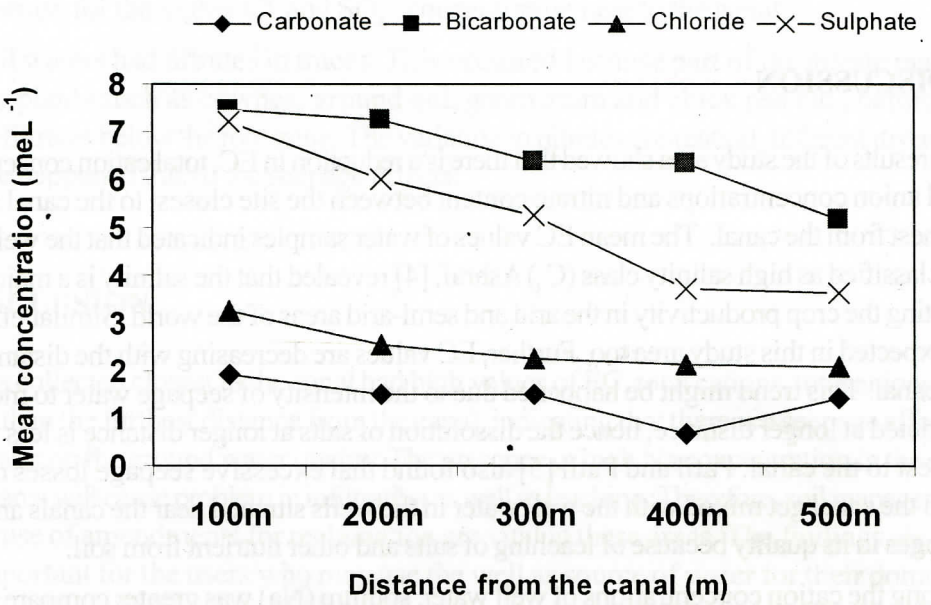

Figure 4: The mean concentration of anions in well water with the distance from canal

The mean total anion concentration for the point closer (100 meter) to the canal were higher (19.87 meL^{-1}) than those at the point furthest from the canal (Table 01). Amongst the anion concentration the dominant anion was bicarbonate (HCO_3^-) followed by sulphate (SO_4^{2-}), chloride (Cl^-) and carbonate (CO_3^{2-}). The carbonate was found in traces in the well waters of the study area. The HCO_3^-, Cl^- and SO_4^{2-} had significant negative correlation ($r=-0.32$, -0.43 and -0.80 at $p<0.01$, respectively) with increasing distance from the canal (Fig. 04) whereas non significant negative correlation ($r=-0.20$, $p>0.05$) was found for the CO_3^{2-} content of the well waters.

Nitrate

Nitrate concentration in the well waters of the command area of the present study was in trace amounts. The mean nitrate content varied between 0.67 and 1.02 meL^{-1} (Table 01). The higher mean values were observed closer to the canal. The values for 100m distance

varied between 0.90 and 1.13 meL^{-1} while that for 500m away from the canal were between 0.50 to 0.95 meL^{-1}. The nitrate concentration of the well water samples had significant negative correlation ($r=-0.71$, $p<0.01$) with the increasing distance from the canal.

4. DISCUSSION

The results of the study area showed that there is a reduction in EC, total cation concentration, total anion concentrations and nitrate content between the site closest to the canal and that furthest from the canal. The mean EC values of water samples indicated that the well waters are classified as high salinity class (C_3) Ashraf, [4] revealed that the salinity is a major factor limiting the crop productivity in the arid and semi-arid areas of the world. Similar effect will be expected in this study area too. Further, EC values are decreasing with the distance from the canal. This trend might be happened due to the intensity of seepage water to move was restricted at longer distance, hence the dissolution of salts at longer distance is less than the closest to the canal. Patil and Patil [5] also found that excessive seepage losses of water from the canal get mixed with the well water in the wells situated near the canals and cause changes in its quality because of leaching of salts and other nutrient from soil.

Among the cation concentrations of well water, sodium (Na) was greater compare to other ions. This could have resulted in well water due to the presence of high sodium (Na) in the soil derived during the canal water seepage. Generally high levels of sodium (Na) in irrigation water are undesirable because they can result in leaching problems in the irrigated soils. The higher Ca concentration may also attribute due to the presence of calcareous rocks in the study area.

The carbonates appeared in fewer amounts because of their fast reaction with cations such as Ca^{2+} and H^+ from water forming $CaCO_3$ and carbonic acid. Karanth [6] reported that HCO_3^- concentration in ground water is generally high due to the dissolved CO_2 in rain which enters as it enters the soil, dissolves more CO_2 and decay of organic matter may also release CO_2 for dissolution. This might be the cause for the higher HCO_3^- concentration in well waters of the present study. When the water contain high concentration of HCO_3^- it is converted to CO_3^{2-} and there is a tendency for Ca and Mg to precipitate as carbonates in soil solution, where by the concentration of Ca and Mg are reduced and the relative proportion of Na seems high.

Shallow ground water table with high EC of soils leads to secondary salinzation by the process of capillary fringe [7]. Under such condition salts like Cl^- and SO_4^{2-} in the subsoil get easily dissolved in seepage water from the canal and add into the well water. This may be the reason for the higher Cl^- and SO_4^{2-} concentration near to the canal.

The well waters had nitrates in traces. This occurred because part of the nitrate may be fixed by plants such as cowpea, ground nut, green gram and chick pea etc., before the water infiltrates below the root zone. The variation in nitrates contents at different distances might be happened due to the seepage effects.

5. CONCLUSION

Samples collected closest to the canal had high values of EC, total cations, total anions and nitrates than the furthest distance from the canal, indicating that there is a seepage effect of canal water on the ground water quality. The presence of high Na concentration in the soils at study area will cause problem in infiltration as well as leaching. Therefore, soil management and the use of amendments for reclamation are vital in these areas. The findings are also very important for the users who may use the well as source of water for their domestic purpose. The study revealed that the proper lining and maintenance of the canal will reduce the seepage losses to some extent.

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