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Quality of Irrigation Water of Kalamandaragi and Tengli West Sub-Watersheds of Kalaburagi District of Karnataka

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Abstract The pH of waters from open well and bore well ranged from 7.0 to 8.9 and electrical conductivity (EC_{iw}) values ranged from 0.2 to 2.4 dSm^{-1}. Among the different sources of irrigation, the mean values of EC_{iw} of open well were more than (0.83 dSm^{-1}) those of bore well (0.61 dSm^{-1}). Residual sodium carbonate (RSC) and sodium adsorption ratio (SAR) values were ranged from 0.0 to 19.4 $meql^{-1}$ and 0.3 to 14.8, $mmoll^{-1}$ respectively. Out of 88 water samples from open well (52 samples) and bore well (36 samples), 44.2% of water samples were good, 9.2% of water samples were highly alkali and 46.6% water samples were alkali, indicating 44.2% of water samples were suitable for irrigation.

Keywords pH, Electrical conductivity, Calcium + magnesium, Carbonate, Bicarbonate.

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Introduction

In recent times, great impetus has been given to irrigation to boost food production. Irrigation in Karnataka is in vogue since ancient times through reservoirs, tanks and wells. Currently about 2 mha area irrigated by different sources of water in Karnataka. Quality of irrigation water determines the performance of crop grown and soil quality will be affected adversely if poor quality water is used [1]. Regardless of its source, irrigation water contains some dissolved salts [2]. The amount and characteristics of these dissolved salts depend on the source and chemical composition. The most ordinarily dissolved ions in water are calcium (Ca^{2+}), magnesium (mg^{2+}), sodium (Na^{2+}), carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-). The concentration and proportion of these dissolved ions among other things determine the suitability of water for irrigation [3]. The

Table 1. Irrigation water classification (ICAR-CSSRI, Karnal).

Water quality		EC_{iw} (dSm^{-1})	SAR ($mmoll^{-1}$)	RSC ($meql^{-1}$)
A. Good		<2	<10	<2.5
		B.saline water		
i.	Marginally saline	2-4	<10	<2.5
ii.	Saline	>4	<10	<2.5
iii.	High SAR saline	>4	>10	<2.5
		C. alkali waters		
i.	Marginally alkali	<4	<10	2.5-4.0
ii.	Alkali	<4	<10	>4
iii.	Highly alkali	variable	>10	>4

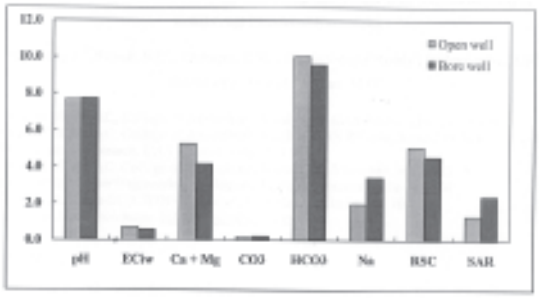

Fig. 1. Chemical composition of irrigation waters averaged across various microwatersheds of Kalaburagi and Chittapur talukas of Kalaburagi district. EC_{iw} in dSm^{-1}; $Ca^{2+} + Mg^{2+}$, CO_3^{2-}, HCO_3^- Na^+ and RSC values are in $meql^{-1}$; SAR in $mmoll^{-1}$.

north-eastern dry zone (zone-2) of Karnataka is essentially a rainfed and dry tract where irrigation is done through both open wells and bore wells. The information avilable in relation to the quality of irrigation water from these sources is meager. Hence, the study was undertaken with a view to study the

Table 2. Range, mean and cv (%) of chemical composition of irrigation waters of various sources in micro-watersheds of Kalaburagi and Chittapur talukas of Kalaburagi district. 'n' indicates number of open wells or bore wells in respective micro-watersheds.

Source of water		pH	EC_{iw} (dSm^{-1})	$Ca^{2+} + Mg^{2+}$	CO_3^{2-}	HCO_3^- $meql^{-1}$	Na^+	RSC	SAR ($mmoll^{-1}$)
				Kalaburagi taluk					
				Kalamandaragi micro-watershed					
Open well	Range	7.4-8.1	0.4-0.5	5.0-5.8	–	5.6-10.8	0.7-0.8	0.0-5.0	0.4-4.5
(n=4)	Mean	7.8	0.5	5.6	_	8.0	0.8	2.5	1.5
	CV (%)	4.2	12.8	6.8	_	32.4	7.7	95.5	140.3
Bore well	Range	7.1–8.9	0.3-1.6	2.6-13.8	–	4.8-18.4	1.2-3.6	0.6-4.6	0.8-3.2
(n=6)	Mean	7.7	0.9	7.5	_	9.9	2.5	2.6	1.5
	CV (%)	8.6	58.8	59.8	–	52.7	31.7	59.6	61.7
				Kalamandaragi Tanda-II micro-watershed					
Open well	Range	0.7-8.1	0.2-0.8	2.8-7.6	_	0.2-12.0	0.4-2.3	0.4-7.4	0.3-1.6
(n=17)	Mean	7.7	0.6	5.5	_	6.3	1.3	1.9	0.8
	CV (%)	4.1	29.3	27.2	–	38.8	37.3	84.0	39.0
Bore well	Range	7.2-8.3	0.3-0.7	0.6-7.4	01-0.3	1.9-14.0	1.4-3.5	0.8-6.6	0.6-3.2
(n=11)	Mean	7.9	0.4	3.1	0.2	5.2	2.3	2.2	1.6
	CV (%)	3.7	29.0	67.5	42.6	69.1	34.0	80.1	51.0
				Kalamandaragi Tanda-I micro-watershed					
Open well	Range	7.6-8.1	0.4-0.7	3.8-7.8	_	6.0-9.6	0.7-1.3	0.6-4.2	0.5-0.8
(n=5)	Mean	7.8	0.5	6.0	_	7.6	1.0	2.4	0.6
	CV (%)	2.9	21.1	29.2	_	19.0	24.5	58.5	22.5
Bore well	Range	7.9-8.4	0.4-0.6	1.0-5.2	–	2.9-6.4	1.9-2.8	1.2-4.2	1.1-3.4
(n=4)	Mean	8.2	0.5	2.4	0.2	4.9	2.3	2.6	2.3
	CV (%)	2.6	22.2	82.0	–	30.5	17.0	60.8	56.5
				Dongargaon micro-watershed					
Open well	Range	7.3-7.7	0.4-1.1	2.5-4.2	0.1-0.2	3.5-4.5	1.8-3.4	0.2-1.6	0.8-1.3
(n=4)	Mean	7.4	0.8	3.4	0.2	4.0	2.8	0.9	1.1
	CV (%)	2.7	41.5	27.6	28.6	10.2	24.9	73.5	19.6
Bore well	Range	–	–	–	–	–	–	–	–
(n=1)	Mean	8.1	0.6	1.5	0.3	2.2	4.7	1.0	2.7
	CV (%)	–	–	–	-	–	–	–	–

Table 2. Continued.

Source of water		pH	EC_{iw} (dSm^{-1})	$Ca^{2+} + Mg^{2+}$	CO_3^{2-}	HCO_3^- meql $^{-1}$	Na^+	RSC	SAR ($mmoll^{-1}$)
				Chittapur Taluk					
				Salahalli-2 micro-watershed					
Open well	Range	7.4-8.3	0.2-0.7	2.0-4.8	–	6.8-16.0	3.7-5.2	4.8-11.8	2.6-4.1
(n=4)	Mean	7.9	0.6	3.9	–	12.7	4.4	8.8	3.3
	CV (%)	4.9	43.3	33.1	–	32.8	14.6	35.3	20.3
Bore well	Range	–	–	–	–	–	–	–	–
(n=1)	Mean	7.2	0.3	3.0	–	9.2	2.9	6.2	2.4
	CV (%)	–	–	–	–	–	–	–	–
				Tengli-1 micro-watershed					
Open well	Range	7.2-8.1	0.2-2.4	1.4-13.8	–	6.8-26.0	0.6-2.1	5.4-20.2	0.3-2.6
(n=17)	Mean	7.6	1.5	8.0	–	20.4	1.2	12.4	0.8
	CV (%)	2.9	42.0	43.7	–	29.9	40.8	40.4	88.2
Bore well	Range	7.2-7.6	0.3-1.7	2.0-12.8	–	8.4-17.6	0.7-14.8	2.4-6.4	0.3-14.8
(n=4)	Mean	7.5	0.9	5.8	–	10.7	8.3	5.0	6.7
	CV (%)	2.5	62.6	87.8	–	43.0	89.8	37.2	96.3
				Tengli-2 micro-watershed					
Open well	Range	7.1-8.0	0.3-0.5	4.2-5.4	–	11.2-16.0	1.1-3.8	6.0-11.8	0.3-2.5
(n=6)	Mean	7.5	0.4	4.8	–	12.9	2.2	8.1	1.1
	CV (%)	4.3	18.8	9.6	–	13.8	44.4	26.4	83.1
Bore well	Range	–	–	–	–	–	–	–	–
(n=1)	Mean	7.5	0.6	6.2	–	15.6	2.2	9.4	0.6
	CV (%)	–	–	–	–	–	–	–	–
				Tengli West micro-watershed					
Open well	Range	7.3-8.1	0.3-1.2	3.4-6.2	–	6.4-10.4	1.3-3.1	0.2-7.0	1.0-1.7
(n=2)	Mean	7.7	0.8	4.8	–	8.4	2.2	3.6	1.4
	CV (%)	–	–	–	–	–	–	–	–
Bore well	Range	–	–	–	–	–	–	–	–
(n=1)	Mean	7.7	0.5	3.8	–	11.2	2.2	7.4	1.6
	CV (%)	–	–	–	–	–	–	–	–

quality of water from these sources for their suitability for irrigation.

Materials and Methods

Fresh water samples from open wells (52 nos.) and bore wells (26 nos.) were collected during summer months in capped high density PVC bottles fortified with 1 ml toluene to arrest any bacterial activity. The samples were analyzed for pH, electrical conductivity (EC_{iw}), soluble cations (Ca^{2+} +Mg^{2+}) and soluble anions (CO_3^{2-} and HCO_3^-) as per standard procedures outlined by Richards [4]. Calcium and magnesium were estimated by versenate method while Na and K were analyzed by flame photometry. The anions viz., CO_3^{2-} and HCO_3^- were estimated by titration with standard acid. Residual sodium carbonate (RSC) = (CO_3^{2-} + HCO_3^-) – (Ca^{2+} + Mg^{2+}) and sodium adsorption ratio (SAR) = (Na^+) / [$\sqrt{Ca + Mg}$)/2] were calculated from available analytical data and presented in $meql^{-1}$ and $mmoll^{-1}$ units, respectively. Underground water quality for its suitability for irrigation were categorized considering EC_{iw}, SAR and RSC based on the criteria as outlined by Minhas et al. [5] as detailed below. The water samples were later rated for the quality based on standards as in Table 1 set by the ICAR-Central Soil Salinity Research institute (ICAR-CSSRI, Karnal).

Results and Discussion

The data on chemical composition of irrigation water from open wells and bore wells indicated that the pH values of open well were ranged from 7.0 to 8.3 with an average value of 7.6. While these were 7.1 to 8.9 in bore wells with a mean value of 7.8. Among various sources of waters no wide variation in pH was observed. Comparatively EC_{iw} of water from bore well was low ranged from 0.3 to 1.7 dSm^{-1} than water from open well (0.2 to 2.4 dSm^{-1}). Relatively EC_{iw} values of open well were more than those of bore well (Fig. 1). Composition of Ca + Mg was also higher in open well than bore well but Na^+ concentration was higher in bore well waters that resulted in higher SAR values. Computation of SAR value provides a useful index of the Na^+ hazard when applied to soils as well as crops [6]. Though there were variations in SAR and RSC values in Kalamandaragi and Tengli west sub-watersheds (Table 2) however the mean SAR and RSC values in two sub watersheds were <1.5 $mmoll^{-1}$ and >6.03 $meql^{-1}$, respectively. As per the irrigation water classification criteria. (CSSRI, Karnal), out of 88 water samples from open well (52 nos.) and bore well (36 nos.), 44.2% of water samples were good, 9.2% of water samples were highly alkali and 46.6% of water samples were alkali, indicating 44.2% of water samples were suitable for irrigation.

It is evident from the current study that waters from both open well and bore well are suitable for irrigation and non-hazardous.

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