Quality Valuation of Groundwater for Irrigation at Dhanbad

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Abstract - **In the present study Wilcox's criteria for evaluating the suitability of groundwater for irrigation purpose on the basis of soluble sodium percent (SSP) has been applied at Dhanbad and different samples of the study area are classified on the basis of SSP.**

Keywords: Wilcox, Groundwater, Irrigation, Dhanbad, SSP

I. INRODUCTION

Water is the next important input to fertilizer for crop production. If low quality of water is utilized for irrigation, soluble salts and /or other toxic elements like arsenic may accumulate in the soil thus deteriorating soil properties and crop quality. Good quality water helps maintaining agricultural productivity and sustaining soil fertility.

The guideline for interpreting water quality can be used to identify potential problems in the use of the particular quality of water for crop irrigation. Usually the quality of groundwater for irrigation purpose is evaluated on the basis of total concentration of soluble salts or salinity hazards, exchangeable sodium or sodicity hazards, toxicity hazards due to specific constituents and other miscellaneous effects. Various authors have depicted popular criteria to evaluate the quality of irrigation water (USDA, 1954; Ayers et al., 1985; Shainberge and Oster, 1978).

High concentrations of exchangeable sodium in irrigation waters and soils cause the eventual deterioration of soil structure and resulting reduction in hydraulic conductivity. When calcium and magnesium are the predominant cations occupying soil exchange sites, soils tend to have a granular structure that is readily permeable to both air and water. As the concentration of exchangeable sodium in the soil increases, the ratio of sodium to calcium and magnesium ions rises and the number of exchange sites occupied by calcium or magnesium decreases. This causes soil mineral particles to disperse and hydraulic conductivity to decrease.

II. STUDY AREA

The Dhanbad district is situated in the state of Jharkhand and lies between 23º37'3" and 24º4' North latitude and between 86º6´30" and 86º50' East longitude. Dhanbad district shares its boundaries with West Bengal in the eastern and south part Dumka and Giridih district in North and Bokaro district in West. Its geographical length extending from North to South is 43 miles and the breadth stretching across East to West is 47 miles. Dhanbad comes under the Chota-Nagpur Plateau.

The climate is tropical in nature with hot summer. In winter, the minimum temperature remains around 8ºC with a maximum of 22ºC. Dhanbad town which have been taken into consideration for the study cover an area between G.T. Road and Bank More in N-S direction and between Govindpur East and Hirak Bye pass Road in E-W direction.

Two types of soil around the district, namely, Alfiso red sandy soil and Ultiso red and yellow soil. The Alfiso red sandy soil is found in north and northwest part of the district which is a densely wooded hilly terrain. The rest part of the district has cultivated lands having ultiso red and yellow soil. Although ground water potentiality is not very much encouraging for the whole district, even then Dhanbad town and its surrounding areas have moderately thick confined or unconfined aquifers beneath the surface. In the rest part of the district, the ground water is restricted to weathered zone having poor porosity. Over and above the soil of Dhanbad town and its adjoining areas has reasonably better water holding capacity compared to other part of the district.

The rocks beneath Dhanbad and its adjoining terrains are metamorphic rocks made up of older basement rocks-Mica-Schist, Amphibolites, quartze-felspatite, sniessis and granitite. These older basement rocks have been intruded by Dolerite and later on these rocks were again intruded by acid intrusive rock layers of quartzite, etc. Though, metamorphic rocks are impermeable but some associated fissured rock layers are in aquifers which might have joined with fault planes or shear planes but their exact location and depth are not known exactly. Their depth differs from place to place. Therefore, in deep borings for water, it has been found that at a particular location, no water is found, but in the same vicinity few meters near about water is found. Such phenomena have been found at many locations during deep tubewell boring for water. All these findings can be attributed to folding characteristic of rocks beneath the ground.

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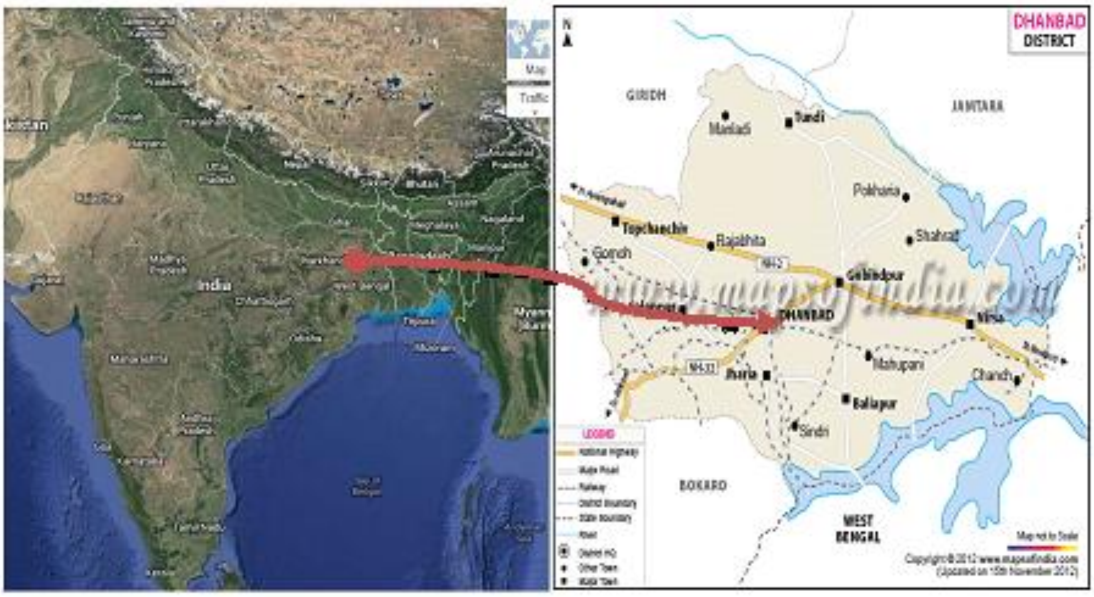

Figure - 1 Location of study area

III. METHODOLOGY

Conductivity had been analyzed at the site using field testing kit and the remaining parameters like calcium, magnesium and Sodium concentrations have been analysed in the laboratory as per the method described in APHA (1992).

The Wilcox's (1948) classification scheme for rating irrigation water on the basis of specific electrical conductance, soluble sodium per cent (SSP) has been used. Sodium concentration plays an important role in evaluating the groundwater quality for irrigation because sodium causes an increase in the hardness of the soil as well as a reduction in its permeability. The SSP or Na% of all the samples was calculated by the following formula:

$$SSP = (Na^{+}+K^{+})*100/(Ca^{2+}+Mg^{2+}+Na^{+}+K^{+})$$

where all concentrations are expressed in epm.

The following scheme of classification was given by the Wilcox:

Water Classes	SSP or Na%	Conductivity (micro-mhos/cm)
Excellent	<20%	250
Good	20-40%	250-750
Permissible	40-60%	750-2000
Doubtful	60-80%	2000-3000
Unsuitable	>80%	3000

IV. RESULTS AND DISCUSSIONS

Results of 24 samples in the study area show that SSP values in groundwater is varying from 6.51 to 92.43 with the average of 45.52 (Table-1). Its concentration is widely distributed with various proportions in the study area (Figure-2). Site wise variation of SSP using graphical presentation is shown in Figure-3 while individual site wise SSP class are presented in Table 3.

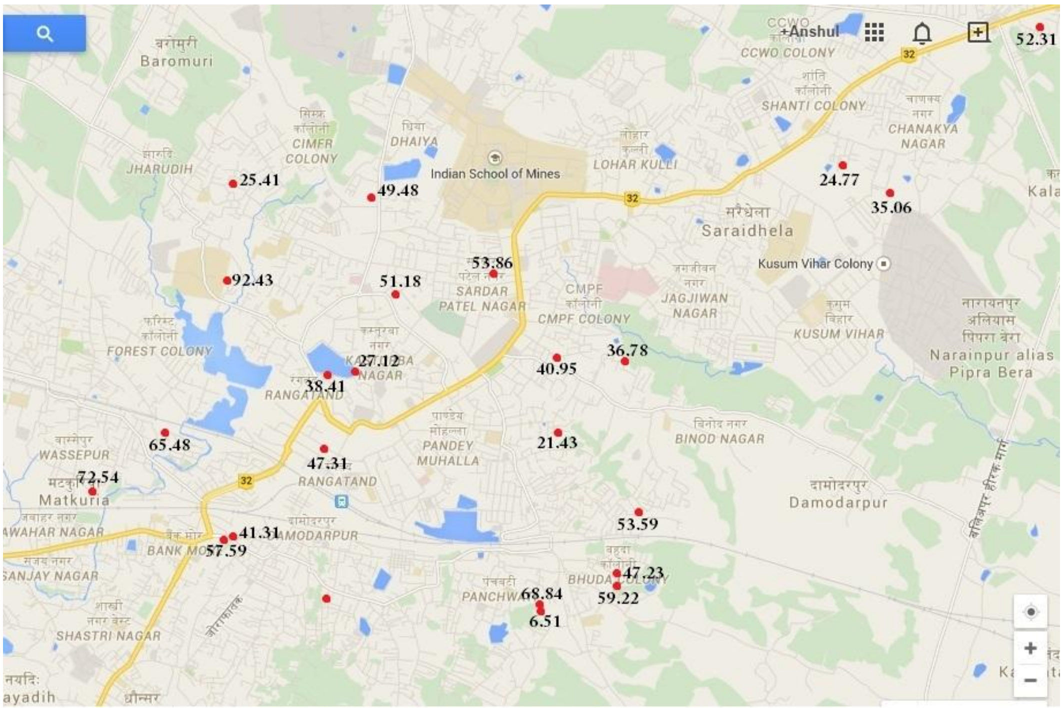

Figure - 2 Wilcox SSP Value at Various Locations

Table 1 - Statistical analysis of various parameters

Descriptive Statistics	Conductivity (µS/cm)	Na^{+} (meq)	Ca^{2+} (meq)	Mg^{2+} (meq)	Wilcox SSP
Minimum	107.49	0.06	0.70	0.02	6.51
Maximum	2460.63	13.64	10.04	3.48	92.43
Mean	869.00	4.43	3.02	0.98	45.52
Median	683.94	2.98	2.49	0.80	47.37
Standard Deviation	627.26	4.10	2.34	0.92	19.20
Kurtosis	1.45	0.47	3.10	2.92	0.42
Skewness	1.37	1.24	1.82	1.72	0.27
Coef. of Var. %	72.18	92.67	77.56	93.54	42.17

Table 2 - Individual site wise Wilcox SSP and related classification

Site No.	Sampling site	Wilcox SSP	Wilcox Classification	Site No.	Sampling site	Wilcox SSP	Wilcox Classification
1.	Polytechnic college	92.43	Doubtful to Unsuitable	13.	Chiragora	53.59	Excellent to Good
2.	Grewal colony	38.41	Excellent to Good	14.	Hari mandir	21.43	Excellent to Good
3.	Railway colony	47.52	Excellent to Good	15.	Telipara	36.78	Excellent to Good
4.	Bank more thana	41.31	Excellent to Good	16.	Heerapur	40.95	Excellent to Good
5.	Municipal office	57.59	Excellent to Good	17.	Saraidhela	35.06	Excellent to Good
6.	Washepur masjid	65.48	Permissible to Doubtful	18.	Steel gate	24.77	Excellent to Good
7.	Matkuria	72.54	Permissible to Doubtful	19.	Bhojpur mandir	52.31	Good to Permissible

8.	Barmasia	68.84	Permissible to Doubtful	20.	Dhaiya	51.18	Doubtful to Unsuitable
9.	Gandhi nagar	23.50	Excellent to Good	21.	Housing colony	53.86	Doubtful to Unsuitable
10.	Gaguatard	47.23	Good to Permissible	22.	CIMFR campus	49.48	Good to Permissible
11.	Tikkiapara	59.22	Permissible to Doubtful	23.	Bekar Bandh	27.12	Excellent to Good
12.	Barmasia	6.51	Excellent to Good	24.	Bishnupur	25.41	Good to Permissible

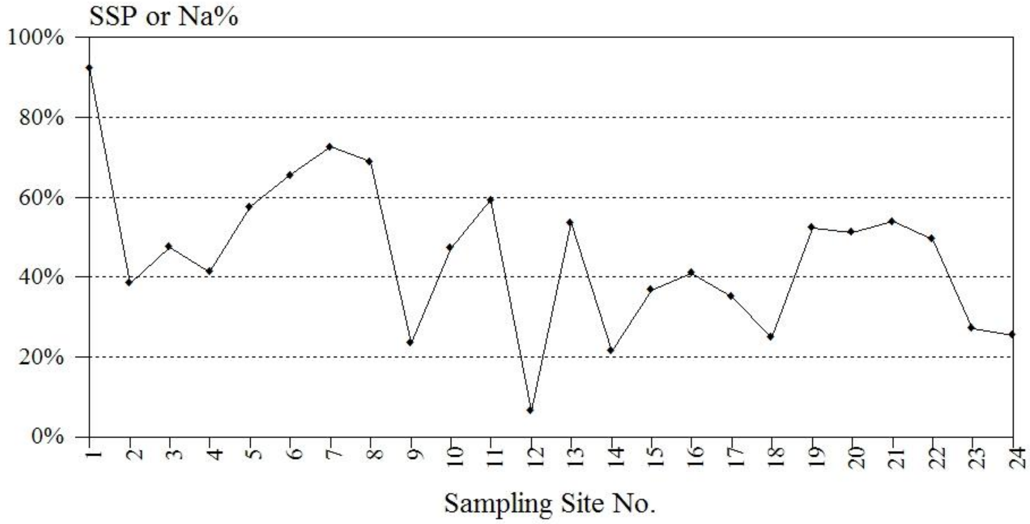

Figure - 3 Site wise variation of SSP

The hydro geochemical analysis according to Wilcox (1948) (Figure-4) reveals that about 54.17% samples are excellent to good, 16.67% samples are good to permissible, 16.67% are permissible to doubtful and 12.50% samples are doubtful to unsuitable (Figure-5). The groundwater near 3 stations (site no. 1, 20, 21) which fall in doubtful to unsuitable class (Figure-4) should be avoided for irrigation purpose and other surface water sources should be utilised to meet the irrigation needs.

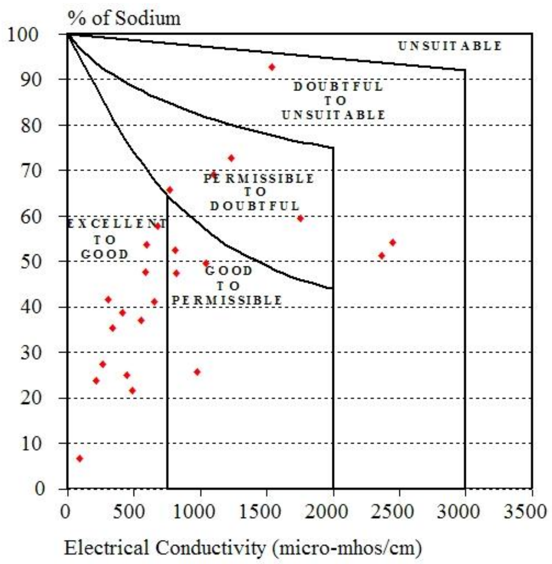

Figure - 4 Wilcox's SSP (Na%) plot

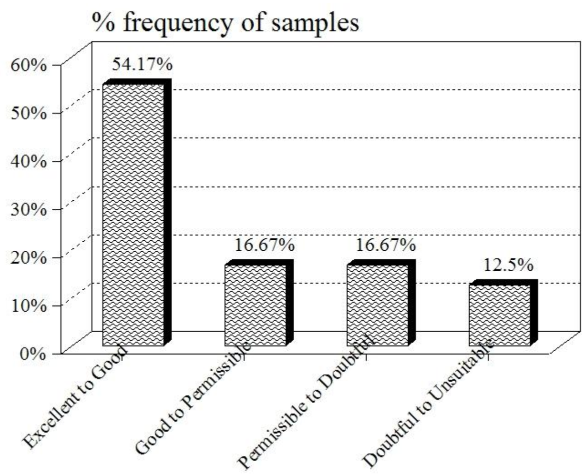

Figure - 5 % frequency of samples

V. CONCLUSION

The analytical results show that the overall quality of groundwater in the study area is Excellent-to-Good and Good-to-Permissible for the irrigational uses as classified by Wilcox. Precaution should be taken before using the groundwater for irrigation near the sites which fall under doubtful to unsuitable class.

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