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Kali Nadi water quality status in Muzaffarnagar district of Uttar Pradesh, India

SUSHIL KUMAR* AND G.R. SINGH
Department of Agricultural Chemistry and Soil Science, C.C.R. (P.G.) College, MUZAFFARNAGAR (U.P.) INDIA

ABSTRACT

Water is the most important natural resource which needs to be properly and scientifically utilized for improving the productivity, environment and economic condition of the rural area. The present study is conducted to kali Nadi water quality status in town of Muzaffarnagar, Uttar Pradesh, for irrigation purpose. The Kali Nadi water samples were analyzed for their chemical properties total salt (electrical conductivity), pH, Anions (Cl, HCO_3, SO_4, NO_3, F, B), Cations (Ca^{2+} + Mg^{2+}, Na^+, K^+). Water samples total salt (EC) 0.32 to 0.98 dSm^{-1}, pH 7.1 to 8.0, Potassium 4.6 to 11.73 mg L^{-1}, Sodium 25.30 to 134.78 mg L^{-1}, Ca +Mg 21.-57 mg L^{-1} to 63.46 mg L^{-1}, Bicarbonate 154.33 to 475.80 mg L^{-1}, chloride 13.14 to 31.85 mg L^{-1}, Sulphate 11.45 to 54.78 mg L^{-1}, Nitrate 6.82 to 58.90 mg L^{-1}, Floride 0.45 to 2.81 mg L^{-1} and Boron 0.54 to 4.10 mg L^{-1}. Correlation also works out between different parameters. The Nitrate, Sulphate, Chloride, Potassium. The correlation co-efficient (r) Among nine Kali Nadi water quality parameter namely total salt (Electrical conductivity), pH, Anions (Cl, HCO_3, SO_4, NO_3, F, B), Cations (Ca^{2+} + Mg^{2+}, Na^+, K^+) were calculated for correlation analysis. The EC shows good positive correlation with chloride, sulphate, Ca + Mg, Nitrate, bicarbonate, potassium, sodium and negative correlation with pH.

Key words : Kali Nadi Water quality assessment, Irrigation purpose and Correlation

INTRODUCTION

Water is a precious, finite, and in view of growing demand, ultimately scarce natural endowment. India which has 2.45 per cent of the world's land, resources has roughly, 4 per cent of the world's fresh water resources, whereas the country's population is 16 per cent of the world's population. Most of the rainfall, 76 per cent as per India Meteorological Department, in India occurs as a result of the southwest monsoon between June and September, except in the state of Tamil Nadu which falls under the influence of northeast monsoon during October and November. More than 50 per cent of precipitation takes place in about 15 days and less than 100 hours altogether in a year. There are significant variations in the endowment of waters not only in different regions of the country, but also in different periods of a year. More than 90 per cent of annual runoff in peninsular rivers and more than 80 per cent of the annual runoff in Himalayan Rivers occur during months of June to September. Consequently, several areas with high rainfall also experience shortage of water in other seasons, because of the nature of topography made more problematic by denudation of the landscape, compacted soil and high runoff. In such instances, floods in rainy season may be followed frequently by drought in the rest of the year, with negative effect on economy and public welfare. According to estimates, the replenishable groundwater resource of the country is 431.9 km^3 consisting of potential due to natural recharge from rainfall (342.4 km^3) and the potential due to recharge augmentation from canal irrigation system (89.5 km^3). The distribution of replenishable groundwater resource also is uneven. Out of the total replenishable groundwater resource from normal natural recharge is estimated 342.43 km^3; as much as 164 km^3 occur in the basins of Indus, Ganga, Brahmaputra and Meghna. In states of Andhra Pradesh, Punjab, Haryana and Jammu and Kashmir, the recharge from canal seepage and return flow of irrigation is significant ranging from 43 to 49 per cent.

Use of groundwater is likely to grow in the years ahead because of the untapped potential in northern, eastern and north-eastern parts of the country, as well as the ease and simplicity with which it can be extracted. This dependence on groundwater should make us worry about the emerging problems. Groundwater in India as elsewhere is affected by depletion due to overdraft, waterlogging, salinization and other forms of pollution. In many parts of the country, the groundwater extraction exceeds annual recharge.Although water quality in an area is governed by many factors, yet, changes in land use pattern, indiscriminate disposal of domestic and industrial waste in water bodies and application of chemical fertilizers is the main cause of deterioration of groundwater quality.

In many cases, groundwater resources have been rendered unsafe for human consumption as well as irrigation and industrial needs due to their poor quality.

*** Author for correspondence.**

Presence of soluble salts and the relative dominance of cations and anions in irrigation water affect the growth and yield of crops and physico-chemical characteristics of the irrigated soils. However, magnitude of the adverse effect also depends upon the alkalinity and contents of some toxic constituents in the water. Groundwater quality in Yamuna-Krishni sub-basin of Muzaffarnagar district is deteriorating due to industrial and sewage pollution (Umar and Ahmed, 2007). The depth of water table, hydraulic conductivity and impact of vadose zone and land use pattern serve as the major influential parameters in mapping the vulnerability assessment of groundwater. However, the impact of remaining parameters cannot be ruled out.

Muzaffarnagar district is a zone of intensive agriculture with cropping intensity of 149 per cent in which 57.4 per cent area is covered by sugarcane crop. The net sown area is 325927 ha, 77.33 per cent of the total area of the district (Sankhyakiya Patrika, 2006). Sugarcane is the main commercial crop, while the wheat and paddy are the other important crops of the district. Traditionally, sugarcane is assumed to be a water-guzzling crop, requires a considerable amount of water to flourish. Hence, sugarcane growing areas necessitate infrastructure like canals and installation of tubewells associated with the availability of mechanical power to lift the water for irrigation. The farmers in the study area have a tendency of flood irrigation, which requires a large quantity of water. Hence, the sustainable growth of this commercial crop and for other domestic requirements, availability of adequate quantity of water in terms of good quality draws the concern of researchers and planners. With rising trend in population and increase in the small land holding farmers, the study area is experiencing more demand of agricultural produce, resulting in an immense competition among the farming community. To grow more agricultural produce, farmers have a tendency to apply more chemical fertilizers with flood irrigation to major crops like sugarcane, wheat and paddy which are prominently grown in this region. The consumption of chemical fertilizers in the district area has raised to 108673 tonnes in 2005-06 from 34194 tonnes in 1979-1980, an increase of 318 per cent (Fertilizer Statistics, 1979-80 and 2005-06). In context to the availability of surface water, it is reducing day by day resulting in pressure to the groundwater resource. The recharge in this region is quite good *i.e.*, around 20 per cent of the inputs (irrigation and rainfall). Hence, increasing the possibilities of the recycling of groundwater which may carry or tend to concentrate the contaminants load supplied through chemical fertilizers and other anthropogenic sources, may deteriorate the quality of groundwater and subsequently of soil physico-chemical properties over long term use.

MATERIALS AND METHODS

Outline of study area :

Muzaffarnagar is an important district in western Uttar Pradesh and the town Muzaffarnagar is the district Headquarter. It lies between latitude $29^0$11'N and $29^0$43'N and longitude $77^0$04'E and $78^0$07'E. It forms a part of the Saharanpur division and is situated in the interfluves of Ganga and Yamuna rivers between the districts of Saharanpur on the north and Meerut on the south. On the west, the Yamuna separates it from district Karnal of Haryana and on the east; the Ganga forms the boundary between this district and the district of Bijnor. Almost all the villages of the area are approachable by motarable roads.

Collection of water and soil samples :

Twenty five irrigation water samples were collected from the Kali Nadi district Muzaffarnagar during 2007-2009 in which depending upon the availability in the district. The samples were collected in plastic bottles, which were thoroughly rinsed with water sampled. The bottles were carefully corked, properly labeled and brought to the laboratory for chemical analysis.

Kali Nadi, water samples were collected from the irrigation pipes installed temporarily at different locations across the district. analyzed for their chemical properties *i.e.* pH, total salt (Electrical conductivity), Anions (Cl^-, CO_3^-, HCO_3^-, SO_4^-, and NO_3^-,F & B), Cations (Ca^{++}, Mg^{++}, Na^+, K^+), (APHA, 1998). All the analysis of ground water was carried out in the laboratory of Department of Soil Science, C.C.R.(PG) College, Muzaffarnagar district (U.P), India by adopting the standard methods.

RESULTS AND DISCUSSION

The electrical conductivity of study area ranged from 0.32 to 0.98 dSm^{-1} (Table 1). Maximum value of 0.98 dSm^{-1} of Amberpur (Jansth) location, while minimum 0.32 dSm^{-1} of Husainbad (Budhana) location. The most influential water quality guide line on crop productivity is the water salinity hazards measured by electrical conductivity (EC). The primary effect of high electrical conductivity water on crop productivity is the inability of the plant to compete with ions in the soil solution for water (physiological drought) (Ahmed *et al.*, 2002).

Values of pH were measured at Kali Nadi water which ranged between 7.1 to 8.0 during soil sampling, respectively (Table 1). The ground water thus mildly

acidic to slightly alkaline to nature. From the point of view irrigation consumption, all the samples may be considered fit, as they are neither acidic or strongly alkaline (Umar and Alam, 2011).

The present study of all the Kali Nadi water samples range varied from 4.6 to 11.73 mg L^{-1} (Table 1). The minimum potassium content 4.6 mg L^{-1} in the samples of Inchauli (Jansath) location, while maximum 11.73 mg L^{-1} in the Amberpur (Jansath) location. By comparing observed value with the standard value it was found that potassium content of all Kali Nadi water samples were within permissible limit (7.9- 19.5 mg L^{-1} or 0.5 MeL^{-1}) as per standard set by BIS.

The sodium contents in the study area various from 25.30 to 134.78 mg L^{-1} (Table 1). The sodium content 134.78 mg L^{-1} was maximum in the samples of Amberpur (Jansath) location, while minimum 25.30 mg L^{-1} in the samples of Mandawli (Bhudhana) location. also reported the similar results of Pre- monsoon samples show marginally higher concentration of Na. This inferred by the fact that compare to 23 samples with Na values of > 200 mg/l (highest value being382 mg/l) in post monsoon, there are 26 such samples in pre monsoon with the highest value being 398 mg/l.

Ca^{+2} and Mg^{2+} cause by for greatest portion of the hardness occurring in natural water. Hardness of the water is objectionable from the view point of water use. Achrya *et al.* (2008). The Ca^{+2} and Mg^{2+} values of the water samples from 21.57 to 63.46 mgL^{-1} (Table 1). The lowest value of 21.57 mgL^{-1} from Husainbad (Budhana) where the highest value of 63.46 mgL^{-1} was recorded Kali Nadi water samples from Amberpur (Jansth) location.

The values of bicarbonate in the water samples varied from 154.33 to 475.80 mgL^{-1} (Table 1) of twenty five different locations. The lowest value of 154.33 mgL^{-1} was observed in the water sample obtained from Husainbad (Budhana) location, whereas the highest value of 475.80 mgL^{-1} was observed in Amberpur location. Similar results reported by Chauhan *et al*. (2010).

Chloride in water varied from 13.14 to 31.85 mgL^{-1} (Table 1). The lowest chloride content 13.14 mgL^{-1} was found in the Malira (Muzaffarnagar) location, while highest 31.85 mgL^{-1} Double (Muzaffarnagar) location. The range of permissible limit as per BIS and WHO of potable water is 250 mgL^{-1}. In the 20 per cent most of the case chloride concentration was within permissible

Table 1 : Physico-chemical characteristics of Kali Nadi water samples collected from different locations of Muzaffarnagar district

Sr. No.	Location	Tehsil	EC (ds/m)	pH	K (mg/l)	Na (mg/l)	$Ca^{2+}+Mg^{2+}$ (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	NO_3 (mg/l)	SO_4 (mg/l)	F (mg/l)	B (mg/l)
1.	Simbalki	Muzaffarnagar	0.45	7.9	7.3	68.54	40.69	237.9	21.3	15.5	21.62	1.61	3.35
2.	Khampur	Muzaffarnagar	0.51	7.4	6.8	59.8	43.38	213.5	28.4	13.12	28.83	2.35	2.27
3.	Saidpur	Muzaffarnagar	0.47	7.8	7.2	52.9	33.72	215.22	22.23	8.25	24.36	1.21	1.62
4.	Malira	Muzaffarnagar	0.56	7.8	7.2	66.24	48.63	282.43	13.14	19.84	29.31	0.97	1.73
5.	Sherpur	Muzaffarnagar	0.53	7.5	7.1	71.3	47.21	280.6	23.8	14.05	19.22	2.81	1.4
6.	Mimlana	Muzaffarnagar	0.67	7.8	7.3	98.9	42.8	298.9	23.08	13.6	49.01	0.96	0.76
7.	Matheda	Muzaffarnagar	0.49	7.4	7.2	57.5	47.97	225.7	24.85	9.3	23.21	1.48	0.97
8.	Shamli Adda	Muzaffarnagar	0.67	7.3	6.9	75.89	61.85	295.85	26.19	14.6	43.25	0.45	1.4
9.	Suzdu	Muzaffarnagar	0.61	7.8	7.8	71.3	46.51	301.95	14.92	12.4	29.31	2.27	1.84
10.	Vehlna	Muzaffarnagar	0.55	7.8	7.5	61.07	50.15	265.35	21.3	6.82	26.91	1.78	1.19
11.	Jarauda	Muzaffarnagar	0.43	7.5	6.9	36.91	42.48	195.2	22.15	9.3	24.03	2.31	1.84
12.	Lachhera	Muzaffarnagar	0.45	7.4	7.0	72.45	24.37	231.8	21.3	9.57	19.22	1.67	2.27
13.	Jiwna	Muzaffarnagar	0.49	7.3	6.9	80.04	27.95	253.15	17.75	11.2	23.06	0.51	1.4
14.	Double	Muzaffarnagar	0.62	7.6	5.0	77.05	43.77	256.2	31.85	15.5	54.78	0.84	2.48
15.	Begrajpur	Jansath	0.63	7.7	6.5	55.2	48.83	298.9	20.24	13.64	21.62	1.94	1.19
16.	Bopara	Jansath	0.51	7.8	5.8	39.1	45.44	225.7	24.85	12.4	24.03	0.78	0.97
17.	Nawla	Jansath	0.43	7.8	5.2	64.86	31.52	219.6	18.63	8.79	26.45	0.92	0.86
18.	Amberpur	Jansath	0.98	7.2	11.73	134.78	63.46	475.8	26.63	58.90	24.03	1.62	1.19
19.	Samoli	Jansath	0.46	7.7	7.3	32.2	43.62	212.89	24.85	11.16	21.62	0.71	1.3
20.	Inchauli	Jansath	0.43	8.0	4.6	34.5	41.99	201.3	23.08	8.15	24.03	0.55	3.89
21.	Mandawli	Budhana	0.38	7.1	7.4	25.3	37.55	180.51	16.17	7.44	19.22	1.35	1.94
22.	M. Khadar	Budhana	0.39	7.8	4.8	56.35	31.17	189.1	23.08	12.4	24.99	0.89	1.51
23.	Husainbad	Budhana	0.32	7.3	7.0	44.85	21.57	154.33	15.24	10.54	19.22	2.05	4.10
24.	Atali	Budhana	0.55	7.4	7.1	70.27	37.15	280.6	25.57	17.2	11.45	0.75	0.54
25.	Nagwa	Budhana	0.53	7.8	4.9	71.57	29.4	230.58	21.3	16.12	32.19	1.1	0.97

Table 2 : Correlation matrix among various parameters of Kali Nadi water quality

	EC	pH	K	Na	Ca +Mg	HCO_3	NO_3	Cl	SO_4
EC	1								
pH	-0.15	1							
K	0.62	-0.48	1						
Na	0.81	-0.17	0.52	1					
Ca + Mg	0.99	-0.15	0.63	0.87	1				
HCO_3	0.96	-0.15	0.69	0.84	0.98	1			
NO_3	0.81	-0.28	0.68	0.74	0.83	0.83	1		
Cl	0.35	-0.09	0.04	0.22	0.35	0.20	0.24	1	
SO_4	0.37	0.19	0.19	0.35	0.35	0.19	0.04	0.35	1

limit. It is observed that around 80 per cent of the water samples highest than the permissible limit of 250 mgL^{-1} was observed in the water samples obtained from different locations.

The sulphate of Kali Nadi water samples of the study area range from 11.45 to 54.78 mgL^{-1} (Table 1) at twenty five different locations. The value of all the water samples within the permissible limit (500 mgL^{-1}) as per the standard of WHO. If the presence of high concentration of sulphate in the study area can be attributed the discharge of domestic sewage and littering of organic waste in the regions. Similar results reported by Tank and Chandel (2010).

The nitrate content of Kali Nadi water samples in the study area varied from 6.82 to 58. 90 mgL^{-1} (Table 1). The maximum nitrate content 58.90 mgL^{-1} was found in water samples of Amberpur (Jansth), while minimum 6.82 mgL^{-1} in Vehlna (Muzaffarnagr) location. It was found that most of the water samples are below the permissible limit of Indian Standard (45 mgL^{-1}) and WHO (50 mgL^{-1}) in nitrate content.

The floride content of Kali Nadi water samples in the study area varied from 0.45 to 2.81 mgL^{-1} (Table 1). The maximum nitrate content 2.35 mgL^{-1} was found in Kali Nadi water samples of Sherpur (Muzaffarnagar), while minimum 0.45 mgL^{-1} in Shamli Adda (Muzaffarnagar) location.

The boron content of Kali Nadi water samples in the study area varied from 0.54 to 4.10 mgL^{-1} (Table 1). The maximum Boron content 4.10 mgL^{-1} was found in Kali Nadi water samples of Husainbad, while minimum 0.54 mgL^{-1} in Atali location.

Correlation :

The correlation co-efficient among nine Kali Nadi water quality parameter namely total salt (electrical conductivity), pH, Anions (Cl, HCO_3, SO_4, NO_3, F, B), Cations (Ca^{2+} + Mg^{2+}, Na^+, K^+) were calculated for correlation analysis. Interpretation of correlation gives a idea of quick water quality monitoring method. According to Table 2. The EC shows good positive correlation with chloride, sulphate, Ca + Mg, Nitrate, bicarbonate, potassium, sodium and negative correlation with pH.

Conclusion :

From the study it can be concluded that the Kali Nadi water of twenty five different locations (villages) of three Tehsil of Muzaffarnagar district is safe for irrigation purposes on the basis of most parameter, however its suitability is questionable on the basis of few parameters for irrigation.

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