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Assessment of Water Quality for drinking and Irrigation Use In Area Around Banne Watershed of Chhatarpur District, Madhya Pradesh, India

Saumya Vyas[1], Gyanendra Pratap Singh[2], H.U. Usmani[3]
[1]*(Research Scholar, Department of Geology, Govt. MVM/ Barkatullah University, India)*
[2]*(Professor, Department of Geology, Govt. Maharaja College/ Dr. Hari Singh Gour University, India)*
[3]*(Professor, Department of Geology, Govt. MVM/ Barkatullah University, India)*
[1]*Corresponding Author: saumya.vyas89@gmail.com*

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Abstract: *In the present study the ground water quality assessment of Banne watershed has been carried out. Ground water quality data collected from Central Ground Water Board, Bhopal for quantification as per World Health Organization (WHO) and Bureau of Indian Standards (BIS) along with identification of the latitude and longitude of the collected samples. Location map has been prepared using Arc GIS while plots and graphs prepared using Aqua Chem Software. All the twenty parameters necessary for quantification of water quality are analyzed for year 2015 pre-monsoon. On the basis of physiochemical characteristics of groundwater, it is concluded that concentration of cations and anions are within the permissible limits for drinking water standards except a few samples with problems of nitrate and fluoride. Calculated values for Gibbs ratio, establishes relationship between water composition and aquifer lithological units reveals that groundwater quality of the study area is largely controlled by rock type of the study area. Study reveals that ground water quality of Banne watershed is suitable for irrigation usage which is evaluated based on SAR, RSC, SSP, KR and PI values, out of which one sample for RSC falls under unsuitable category for irrigation. The U.S salinity diagram of the study area shows that the groundwater of the study area is low alkaline with medium to high salinity class i.e. C2S1 and C3S1 classes water of the study area should only used after proper soil management for C3S1 class.*

Keywords*: Bureau of Indian Standards; Groundwater quality assessment; Drinking water; Irrigation; Post-monsoon*

I. Introduction

Groundwater is generally less susceptible to contamination than surface water. As a result of precipitation, water flows through high gradient surface to low gradient until it percolates through sub-surface porous media. In this whole process of surface water movement before reaching underlying geological aquifer, water can remain in contact with minerals present in rocks and soil for extended period of time until the equilibrium is reached between water and minerals. This is how water becomes saturated with dissolved solids present in minerals of any area and hence water quality of any area depends upon chemical processes involved and underlying geology. Groundwater is the most valuable natural resource on the planet which plays vital role in domestic application and economic development. Nowadays groundwater is being affected by several factors deteriorating water quality. Rapid increase in population, urbanization, industrialization and agricultural activities are prime factors affecting groundwater quality as well as quantity. In past, several studies has been carried out under quantity of groundwater, now in recent years it has been recognized by many scientists and researchers that the quality of groundwater is nearly of equal importance as quantity of groundwater. Water quality of any area depends upon its physical, chemical and biological parameters of water. The values of these parameters are harmful for human health if they found more than limits. The optimal use of groundwater can be sustained only when the quantity and quality is completely assessed. The Indian standards for ground water suitability for drinking and irrigation purpose was adopted by Bureau of Indian standard. Weathering of soil and rocks, landfill site and mining activities are some common factors involved in pollution of aquatic system such increase in metal ion concentration in groundwater results in serious health problems. The arsenic, cadmium, chromium, copper, nickel, lead and mercury are most common heavy metal pollutants. Recently, many researchers have carried out study for quality standards of drinking water and irrigation using plots and indices (Rao and Rao 2010; Rao et al. 2012; Akbal et al. 2011; Nosrati and Van Den Eckhart 2012; Sharma et al, 2012; Gupta et al. 2012). The main objective of the study lies in evaluating the groundwater quality for drinking and irrigation purposes and comparing the chemical analysis of water quality data of groundwater of Banne watershed with specific water quality standards adopted by WHO and BIS.

a) Study Area

The selected study area is a Banne watershed located in the central part of the Chhatarpur district in Madhya Pradesh, India and falls under bundelkhand region. The present study area of Banne watershed is 756.21 sq km and located between 24° 41′ to 24° 53′ N latitude and 79° 38 ′ to 79° 52′ E longitude. The Chhatarpur district is divided into eight development blocks (Gourihar, Londi, Nowgaon, Chhatarpur, Raijnagar, Badamalhara, Bijawar and Buxwaha). The study area of Banne watershed shares its boundary with three blocks Chhatarpur, Bijawar and Rajnagar. The climate of watershed is characterizes by hot summers with maximum temperature 41.8°C during month of May while minimum temperature is 7.0°C during the month of January. The average annual rainfall in the study area is approximately 1036.84 (1985-2014 years). Erratic pattern of rainfall in the study area results in drought and which is frequent say once in every three years. According to the Central Ground Water Board (CGWB) rainfall is the only source of water for recharging groundwater in the area. In the district there are 2034 Tube wells/Bore wells and 80725 Dug wells. As the study area is a part of rural India, about 90 % of the rural population depends on natural sources to earn their livelihood. The declining trend of ground water level in Bundelkhand area is observed in past several years due to maximum groundwater abstraction for drinking, domestic and agriculture purposes. Nitrate enrichment in the water sample of chhatarpur area is due to intense use of fertilizers practice as maximum part of the district is occupied by agricultural land of land use/Land cover class while Fluoride concentration in water sample of the study area is due to rock-water interaction. Location map of the study area is shown in fig. 1.

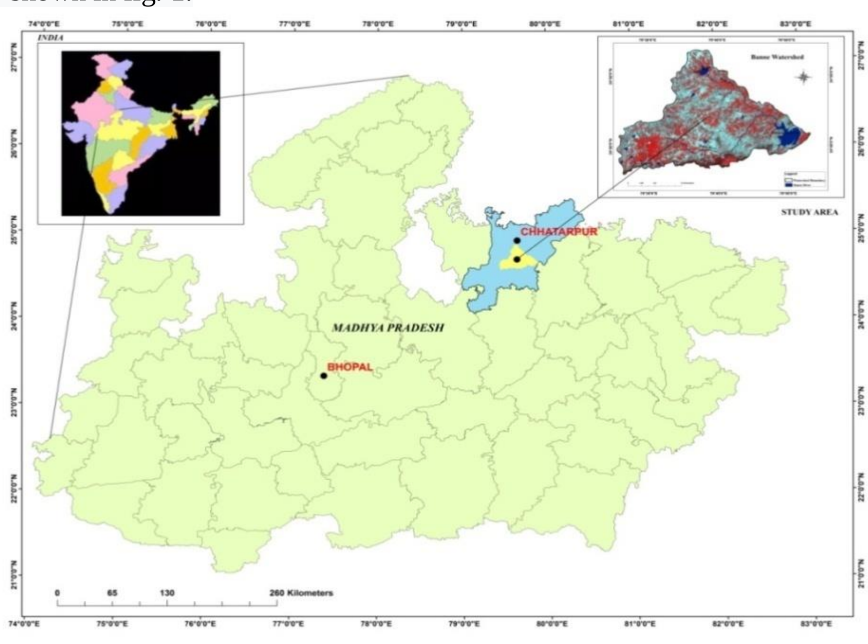

Fig.1. Location map of the study area

b) Geology of the study area

Chhatarpur district of Madhya Pradesh comes under Yamuna river system and has the Ken and Dhasan as main tributaries of the area. Geologically the district is occupied by Bundelkhand granite with criss-cross fracture and thin soil cover in the northern and north-central part, Bijawar towards south-eastern and Vindhyans towards southern parts of the district. The district is dominated by Bundelkhand granite which is pink in color, coarse grained with 20 m depth of weathering (CGWB 2009; Thakur 2010). Bundelkhand is overlain by Bijawar which constitute15% part of the district while Vindhyans constitute 20% part of the district in the form of ridges and alternating valleys represented by conglomerate, sandstone, shale and limestone in the sequence and the topography is highly dissected by the superimposed drainage system. The production of water for irrigation and drinking purpose is fulfilled by unconfined aquifer within granitic terrain associated with the river system.

c) Geomorphology of the study area

Physiographic units of Madhya Pradesh is divided into six range and regions, the satpura range, the vindhyan range, the malwa plateau, the bundelkhand region, the mahakoshal range, the river valleys. Geomorphic units in the district are The Panna range, The Central Plateau and Northern plains. The major part of the Banne watershed is occupied by pediplain with almost flat or gently sloping surface which is the end product of erosion. Groundwater prospect in the Banne watershed is along fractured and weathered zone of Bundelkhand granite which falls under moderate zone.

II. Material And Methods

Total 25 groundwater samples from dug-wells of study area were collected from Central Ground Water Board (CGWB) and analyzed for different chemical parameters associated with water quality index. Water sample location map has been prepared using Arc GIS software shown in Fig. 2, while plots and diagrams for water quality assessment such as Wilcox and Piper diagram are generated using Aqua Chem software which helps in water quality data analysis. All the parameters of groundwater samples are analyzed according to permissible and non-permissible water quality standards of WHO (1984) and BIS (1991).

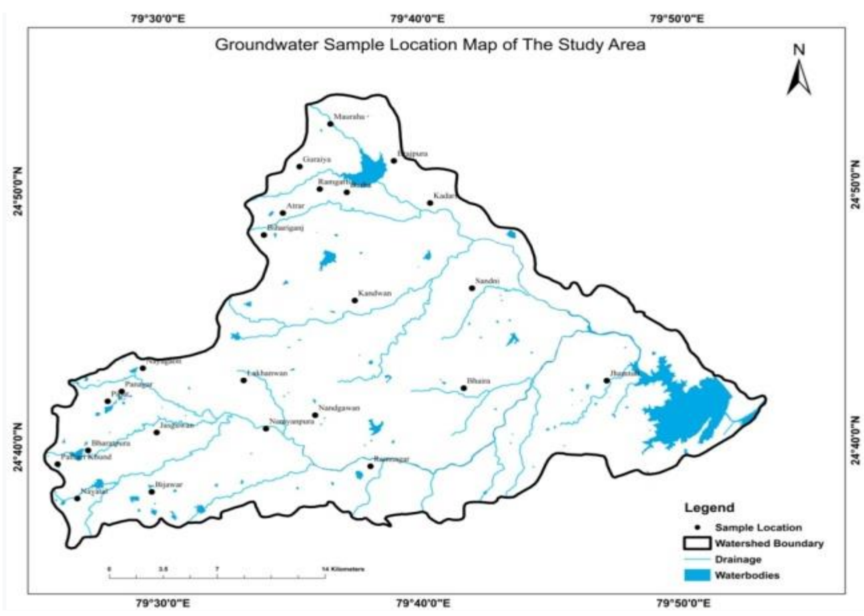

Fig.2. Water sample location map of the study area

III. Result & Discussion

The main aim of the present study is to explain the chemical characteristics of groundwater in the study area. Quality assessment has been carried out according to the Bureau of Indian Standards and World Health Organization. It is necessary to conduct investigation of collected water sample data to interpret observed geo-chemical parameters for ground water quality assessment to ascertain its suitability for drinking and agricultural purpose. To understand the criteria behind groundwater suitability for drinking and irrigation purpose chemical parameters like pH, electrical conductivity Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-} , $SO4^{2-}$, NO_3^{-} F^{-}, $CO3^{2-}$, $HCO3^{-}$ and various chemical index such as TDS, TH, SAR, SSP, RSC, PI and Kelly's ratio were calculated using standard procedure of water quality analysis. The data is presented in Table1.

Table 1: Minimum, maximum and average values of different parameters of water samples of Banne watershed area pre-monsoon season

S. no	Parameters	Min	Max	Average
1	Calcium (mg/l)	30	202	99.72
2	Magnesium (mg/l)	4	57	23.72
3	Sodium (mg/l)	2	85	24.2
4	Potassium (mg/l)	0.2	2	0.607
5	Chloride (mg/l)	14	259	115.04
6	Bicarbonate (mg/l)	114	378	212.8
7	Carbonate (mg/l)	42	42	1.68
8	Sulphate (mg/l)	24	156	68.68
9	Fluoride (mg/l)	0.05	1.54	0.55
10	Nitrate (mg/l)	5	130	42.28
11	pH (Hydrogen Ion Concentration)	7.2	8.4	7.59
12	Electrical Conductivity (EC) (μmhoscm^{-1})	420	1414	820.12
13	Total Dissolved Solids (mg/l)	273	919	532.76
14	Total Hardness (as CaCO3)	161	700	346.92
15	Sodium Adsorption Ratio (SAR)	0.4	2.26	0.57
16	Soluble Sodium Percentage (SSP) (%)	1.22	41.02	12.75
17	Residual Sodium Carbonate (RSC) (meql^{-1})	-9.04	2.96	-3.37
18	Permeability Index (PI) (%)	23.02	79.42	38.46
19	Kelly's Ratio (KR) (meql^{-1})	0.01	0.69	0.15
20	Gibbs Ratio (meql^{-1}) (GR) I	0.12	0.73	0.44
	II	0.026	0.54	0.17

Water Quality Analysis based on Absolute amount of Ions

Cations

The concentration of cations Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} ions detected in sample of groundwater in Banne watershed ranged from 30-202, 4-57, 2-85 and 0.2-2 mg/l and calculated mean values for the same parameters are 99.72, 23.72, 24.2, 0.607 mg/l respectively shown in Table 1. According to Duncan et al, 2000; Sharifi and Safari Sinegani

2012 they carried out research work in understanding water quality and suggests guidelines for management and discuss about the maximum permissible limit of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} cations concentration in groundwater should be 80, 35, 200 and 20 mg/l respectively. On the basis of above suggested guidelines of permissible limits about 56% samples with respect to calcium concentration and 16% samples for magnesium are unsuitable for irrigation purpose.

Anions

Among anions, the concentration of $HCO3^{-}$, $CO3^{2-}$, Cl^{-}, $SO4^{2-}$, NO_3^{-} and F^{-} ions discovered in the groundwater sample of Banne watershed ranged from 114-378, 42, 14-259, 24- 156, 5 - 130 and 0.05-1.54 mg/l and mean values calculated for concentration is 212.8, 1.68, 115.04, 68.68, 42.28 and 0.56 mg/l shown in Table 1. Groundwater suitability for irrigation usage, the maximum permissible limit of anions $HCO3^{-}$, $CO3^{2-}$, $SO4^{2-}$ and F^{-} is 250, 15, 250, 180 and 10 mg/l respectively (Duncan et al, 2000). On the basis of permissible limit 32% of water samples for bi-carbonate, 12% of water sample for Nitrate and 4 % for fluoride are unsuitable for irrigation. However, it should be noted that concentration of ions in groundwater itself is not sufficient to assess its suitability for irrigation. Interactions among ions are also major issue of concern which has been quantified in next sections for assessment of groundwater quality for irrigation usage.

Groundwater quality for drinking purpose

According to WHO (World Health Organization) and BIS (Bureau of Indian Standards) certain limits has been fixed for concentration of cations and anions in the groundwater. However, WHO sets international norms on water quality and human health these guidelines for drinking-water quality (GDWQ) promote the protection to public health by advocating for the development of locally relevant standards and regulations. In the present study water quality assessment for all the twenty five water samples of the study area has been carried out according to WHO and BIS standards for drinking water suitability. Average value of cations as well as anions has been calculated for each water samples of the study area which is found within permissible limits of GDWQ shown in Table 2. The overall groundwater quality of the study area is within permissible limit for drinking purpose except for few locations with problems of nitrate and fluoride.

Table 2: Quality of groundwater samples from Banne watershed area for drinking purpose (WHO, 1984 and BIS, 1991) pre-monsoon season

S.No.	Parameters	WHO		BIS		Average values of parameters in study area
		Highest Desirable Limit	Maximum Permissible Limit	Highest Desirable Limit	Maximum Permissible Limit	Pre-monsoon
1	Calcium (mg/l)	75	200	75	200	99.72
2	Magnesium (mg/l)	30	150	30	100	23.72
3	Sodium (mg/l)	-	200	-	-	24.2
4	Potassium (mg/l)	-	-	-	-	0.61
5	Chloride (mg/l)	200	600	250	1000	115.04
6	Bicarbonate (mg/l)	200	800	200	600	212.8
7	Sulphate (mg/l)	200	400	200	400	68.68
8	Fluoride (mg/l)	0.6	1.5	1	1.5	0.56
9	Nitrate (mg/l)	-	50	-	45	42.28
10	pH (Hydrogen Ion Concentration)	7.0	8.5	6.5	8.5	7.6
11	Total Dissolved Solids (mg/l)	500	1500	500	2000	616

pH

The hydrogen ion concentration of water is expressed in terms of pH value which is an expression of intensity of alkalinity of a solution. The logarithm of the negative reciprocal of the hydrogen ion concentration is called pH.

$$pH = -\log_{10}(H^+)$$

Hydrogen ion concentration of water is measured by using H meter in the lab at 25ºC. It is observed that value of pH in the water sample of Banne watershed ranged from 7.2-8.4 while mean value calculated for pH is 7.59 and concluded that all the water sample of the study area are within permissible limits of standard pH value (6-8.5) suitable for irrigation purpose (Ayers and Westcot, 1985).

Salinity Hazard

Excessive salt content in the groundwater used for irrigation will negatively affect the crop yield. Hence, assessment of salinity hazard is very important for irrigation water before its use. Continuous use of saline water for irrigation may leads to land degradation and water pollution. For the collected samples of Banne watershed the salinity hazard was determined by Electrical Conductivity and Total Dissolve Solids of a water sample. EC and TDS in the samples of study area ranged from 420 – 1414 µS/cm and 273 - 919 mg/l respectively. Average value calculated for EC and TDS for the groundwater sample of the study area is 820.12 and 532.76 respectively. According to the EC grading standards Wilcox plot (Fig.3) of water samples for the study area comes under C2, C3 zone of salinity hazard which shows medium to high salinity. Continuous use of this medium to high saline water for irrigation in the study area may increase the salinity hazard of the area. Hence in the study area water should not be used for irrigation unless proper soil conservation measures for area around samples with C3 Zone.

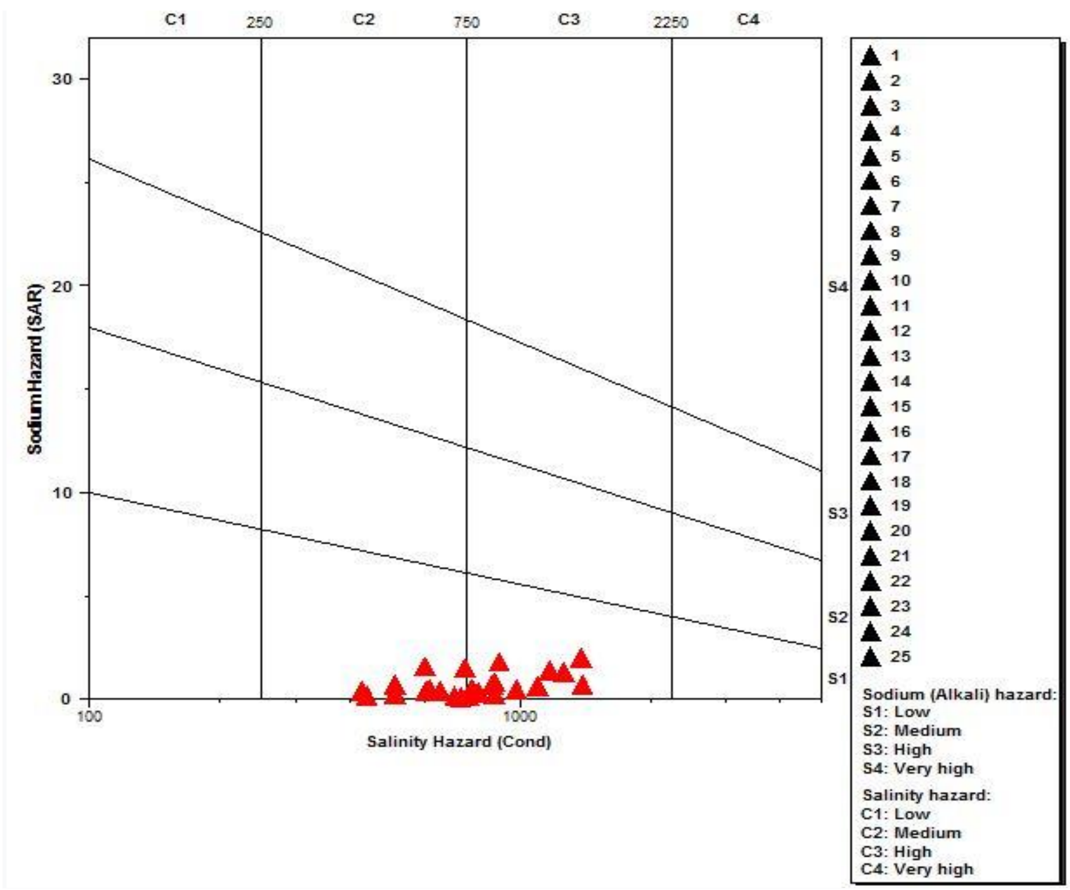

Fig.3. Classification of groundwater based on Wilcox diagram for Pre-monsoon season

Sodium Hazard (SAR)

Sodium adsorption ratio is a measure of alkali and sodium hazard in water. Value of SAR helps in determining the suitability of groundwater for irrigation, higher value of SAR indicates less suitability of groundwater for irrigation. Presence of calcium and magnesium in water regulates flocculation of clay aggregates in soil making it permeable. Higher concentration of sodium causes deficiency of Ca^{2+}, Mg^{2+} ions in water. Excessive sodium concentration replaces calcium and magnesium ion present in water causes dispersion of clay particles which influences structure of soil by leaving it impervious which results in damage of plants and hinder their growth (Arveti et al, 2011; Kell 1951; Domenico Schwartz 1990; Todd and Mays 2005). Assessment of sodium hazard is important in evaluating suitability of groundwater for irrigation and one of the important factors in determining sodium hazard is Sodium Adsorption Ratio (Todd and Mays 2005). The SAR values are calculated for each water sample by using following equation (Richards 1954):

$$\text{SAR} = \frac{Na}{\sqrt{(Ca + Mg/2}}$$

Where, the ionic concentrations are expressed in $meql^{-1}$.

According to (USDA 1954) SAR values for water sample are classified as <10 $meql^{-1}$ (excellent), 10-18 $meql^{-1}$ (good), 18-26 $meql^{-1}$ (doubtful) and > 26 $meql^{-1}$ are unsuitable for irrigation use. The SAR values of all the 25 water samples were calculated ranged from 0.04 – 2.26 $meql^{-1}$ and average value is 0.57 $meql^{-1}$respectively, all the water samples of the study area comes under low alkaline category (Fig.3) and falls under suitable zone for irrigation.

Soluble Sodium Percent (SSP)

According to Wilcox (1955) soluble sodium percent is another important parameter for assessing water quality for suitability of irrigation. The values of SSP calculated using following formula:

$$\text{SSP} = \frac{Na}{Ca+Mg+ Na} \times 100$$

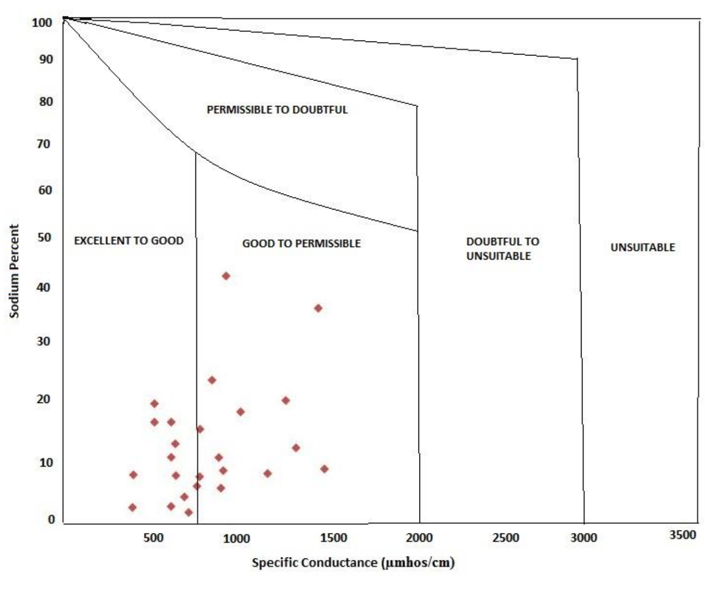

Fig.4. Quality of water in relation to Electrical Conductivity and Sodium Percent for Pre-monsoon season (Wilcox diagram)

All the ionic concentrations are expressed in $meql^{-1}$.

The values of sodium percent have been calculated for all twenty five water samples from the study area and maximum and minimum values of sodium percent is evaluated ranged from 1.43 – 41.35 $meql^{-1}$ and average value calculated as12.93 $meql^{-1}$.

Kelly's ratio (KR)

The Kelly's ratio of unity has suggested that the problem of sodium in water used for irrigation could workout conveniently on the basis of Kelly's ratio. Kelly's ratio was calculated based on following formula:

$$KR = \frac{Na}{Ca + Mg}$$

Where, all ionic concentrations are expressed in $meql^{-1}$.

Kelly's et al., (1940) demonstrated that the Kelly's ratio less than one indicates good quality of water for irrigation and the ratio ranging between 1-2 $meql^{-1}$ is marginally suitable while ratio beyond 2 $meql^{-1}$, the water becomes unsuitable. Kelly's ratio for all the samples of the study area falls within unity which indicates that water quality falls under suitable category for irrigation.

Carbonate and Bi-carbonate Hazard

Carbonate and Bi-carbonate concentration in water sample is another important parameter for assessment of groundwater suitability for groundwater for irrigation purpose. Higher concentration of carbonate and bi-carbonate in groundwater of any area is hazardous for irrigation because it has tendency to precipitate as calcite minerals (calcite and magnesite) when reacts with calcium and magnesium present in water (Bohn et al. 1985; Domenico and Schwartz 1990; Todd & Mays 2005). Higher concentration of bicarbonate also increases sodium hazard by sodium adsorption dominance causing clay dispersion, increases exchangeable sodium percentage of soil which in turn reduces soil permeability which will damage plants growth. In order to meet effects of interaction between Ca, Mg, Na, CO_3, HCO_3, on water quality for agriculture purpose some researchers (Eaton 1950; Doneen 1964) expressed their effects in terms of residual sodium carbonate and permeability index using the equation as follows:

Residual Sodium Carbonate (RSC)

According to USDA classification criteria water samples having RSC value <1.25 $meql^{-1}$ falls under good category of water quality for irrigation while water sample with value 1.25 - 2.5 $meql^{-1}$ falls under doubtful category and value >2.5 $meql^{-1}$ falls under unsuitable category for irrigation purpose.

$$RSC = (CO_3 + HCO_3) - (Ca + Mg)$$

Where, all ionic concentrations are expressed in $meql^{-1}$.

Residual sodium carbonate of all twenty five water samples of the study area is calculated ranged from -9.04 – 2.96 $meql^{-1}$ and it is observed that only one water sample falls under unsuitable category which is 2.96 $meql^{-1}$ while rest all the twenty four samples are free from RSC and falls under good category.

Permeability Index (PI)

The concentration of soluble salt, sodium, calcium, magnesium, bicarbonate in water may affect permeability of soil when it is used for long-term irrigation practices. Doneen (1964) has classified suitability of water for irrigation into three prominent classes based on maximum and minimum permeability index. Class I, II waters are good for irrigation with 75% permeability or more and Class III waters are unsuitable with 25% of maximum permeability. The permeability index has been calculated and plotted as chart known as doneen's chart. The PI is calculated by the following equation.

$$PI = \frac{(Na + K) + \sqrt{HCO3}}{Ca + Mg + Na + K} \times 100$$

Where, all the ionic concentration is expressed in meql^{-1}.

As per the calculated PI (Table), permeability index calculated for all twenty five water samples ranged from 23.09-79.42 meql^{-1} and average value calculated is 38.46 meql^{-1} and demarcated that each water samples of the study area falls under Class I and Class II category and are good for irrigation shown in fig.5.

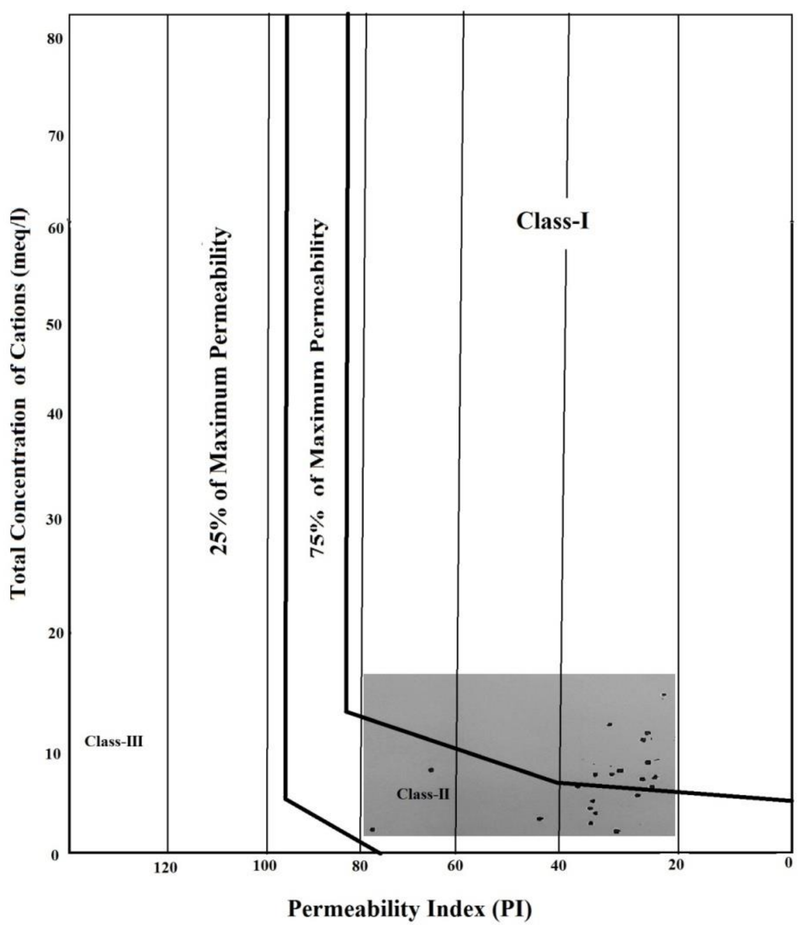

Fig.5. Doneen's Plot (Pre-monsoon season)

Table: 3 Calculation of SSP, SAR, RSC, PI and KR of groundwater of pre-monsoon season

PRE-MONSOON SEASON					
Sample	SSP	SAR	RSC	PI	KR
1	19.53	1.03	-7.13	32.01	0.24
2	16.43	0.62	-2.98	40.48	0.19
3	23.49	0.88	-1.81	51.8	0.3
4	7.55	0.27	-3.65	31.08	0.08
5	12.78	0.56	-3.31	36.75	0.14
6	2.06	0.06	-1.52	40.39	0.02
7	7.78	0.38	-6.7	24.92	0.08
8	1.22	0.04	-2.2	32.23	0.01
9	8.55	0.49	-9.04	23.09	0.09
10	20.07	1.1	-6.19	35.63	0.25
11	35.6	1.4	2.96	79.42	0.55
12	15.24	0.64	-1.92	43.32	0.17
13	41.02	2.26	0.88	68.82	0.69
14	16.42	0.73	-3.57	38.68	0.19
15	8.26	0.35	-4.93	28.16	0.09
16	10.51	0.37	-1.78	42.38	0.11
17	7.24	0.23	-2.58	36.02	0.07
18	10.47	0.48	-4.64	31.33	0.11
19	12.09	0.4	-2.42	40.28	0.13
20	3.84	0.13	-1.23	40.16	0.04
21	2.24	0.06	-1.78	38.93	0.02
22	5.65	0.21	-1.93	36.73	0.05
23	18.16	0.97	-7.53	30.53	0.22
24	7.42	0.4	-6.57	25.48	0.08
25	5.32	0.19	-2.9	33.1	0.05

Gibbs ratio

Gibbs (1970) has prepared a diagram and illustrated three distinct fields namely precipitation dominance, evaporation dominance and rock dominance areas to understand the reaction between the chemical constituents of water and respective lithologies of aquifer. Gibbs has illustrated three distinct field Ramesam and Barua (1973) carried out research work to emphasize the mechanism behind groundwater chemistry in north-western region and Viswanathaiah et al. (1978) carried out same research in Karnataka.

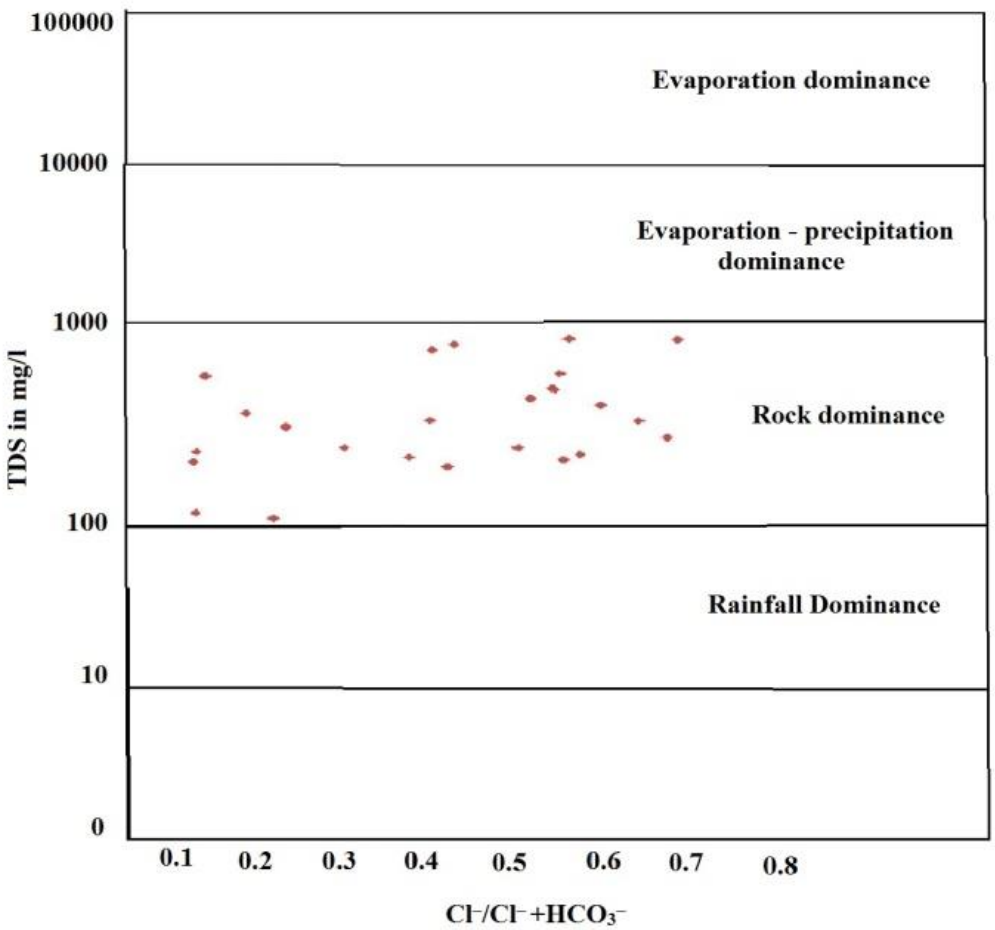

Fig.6. Gibbs diagram for Gibbs ratio I of the study area for pre-monsoon season
(Shows rocks controls the geochemistry of the groundwater of the study area)

Gibbs ratio for cation and anion of the water samples of the study area can be calculated using following formula:

Gibbs ratio I (for anion) = $Cl^- / Cl + HCO_3$
Gibbs ratio II (for cation) = $(Na^+ / K^+) / (Na^+ + K^+ + Ca^+)$

All ionic concentrations are in $meql^{-1}$

Calculated values for Gibbs ratio I in the present study area vary from 0.12 - 0.73 $meql^{-1}$ with an average value of about 0.44$meql^{-1}$ and values for Gibbs ratio II ranged from 0.026 - 0.54 $meql^{-1}$ with an average value of 0.17 $meql^{-1}$. Calculated values for Gibbs ratio elucidated that quality of groundwater of the study area is largely controlled by rock type of the study area. All the samples of ground water fall under rock dominance which has been illustrated in Fig 6 and 7.

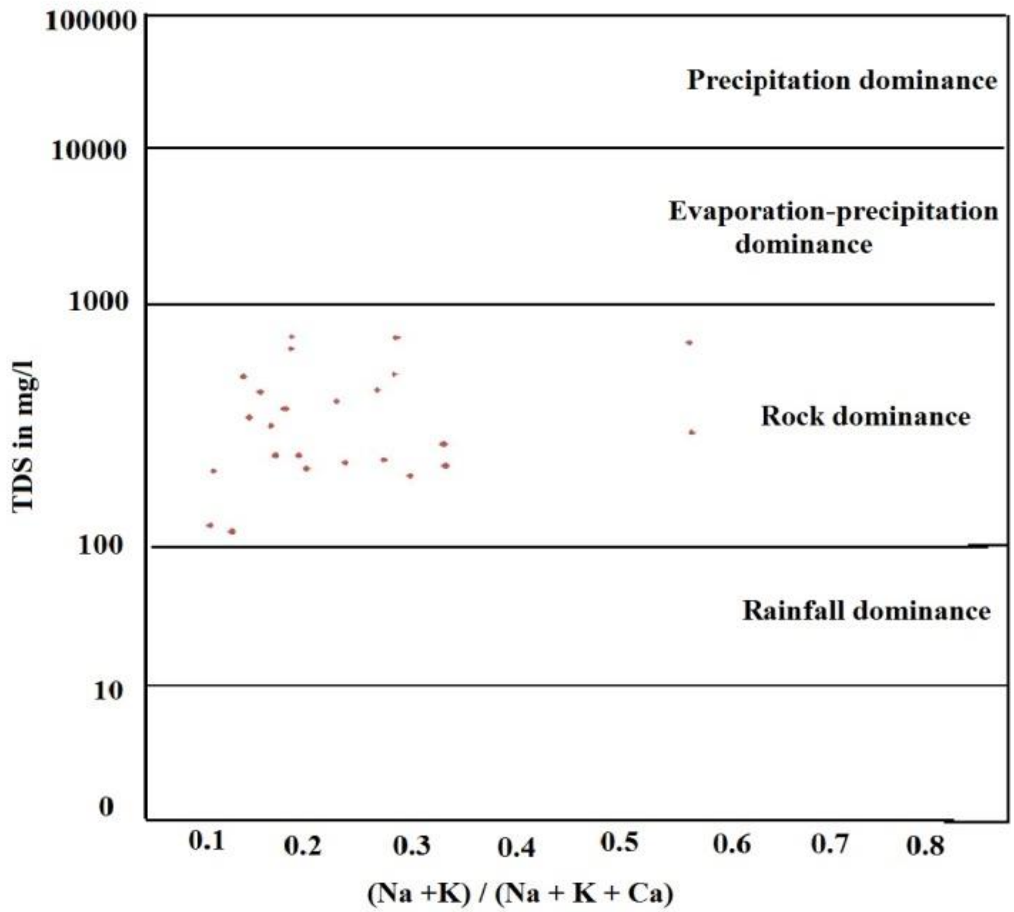

Fig.7. Gibbs diagram for Gibbs ratio II of the study area for pre-monsoon season
(Shows rocks controls the geochemistry of the groundwater of the study area)

Hydro-geochemical Facies

In order to understand composition and chemical relations between dissolved ions present in water, hydro-geochemical facies are represented graphically (Piper 1953). Ram Avtar et al. 2013 carried out research work for Bundelkhand region and observed that sample of the study area basically have four major categories (viz. $Ca–HCO_3$, $Na–HCO_3$, $Ca–HCO_3$, Ca–Cl) however few water samples are Na–Cl, Mg–Cl, $Ca–SO_4$. In the present study piper diagram has been prepared (shown in fig.8) to understand the hydro-chemical process involved in the study area resulting in the spatial and temporal variation. The resulted piper diagram of the study area indicates the presence of carbonaceous sandstone in the underlying aquifers and the weathering of carbonate minerals.

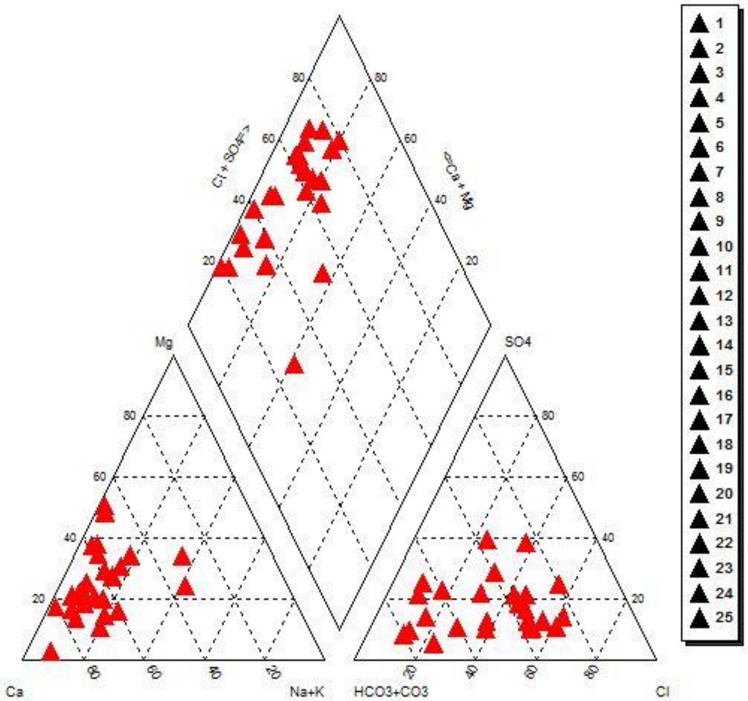

Fig.8. Piper Tri-linear Plot for groundwater samples of the study area (Pre-monsoon season)

IV. Conclusion

The water quality assessment of Banne watershed has been carried out to evaluate chemical composition of groundwater in the study area and its suitability for drinking and irrigation purpose. Cations and anions present in the water sample of the study area are within permissible limits for drinking water standards except a few samples for fluoride and nitrate concentration. As the study area forms part of rural India and maximum regional population depends upon agricultural land for earning their livelihood, higher concentration of nitrate in the water sample is due to intense farming practices in the study area. Concentration of calcium among cations is due to the weathering of carbonate minerals in the study area. The results are well supported by statistical analysis and through graphical methods, while suitability of groundwater in the study area for irrigation is calculated based on SAR, SSP, KR, RSC, PR. Sodium adsorption ratio of the study area provide information that the groundwater is low alkaline to moderately saline. Soluble sodium percentage has been calculated for all the twenty five water samples which falls in excellent to good, good to permissible category of groundwater suitability for irrigation and is represented using Wilcox diagram. Kelly's ratio of unity has been evaluated and all the water samples of the study area are less than one, which is classified as good category for irrigation. Water samples of the study area for RSC falls under good category except for one sample. Permeability ratio has been calculated and plotted using doneen's plot where most of the water samples falls under I category, having excellent permeability. Gibbs ratio of the study area determines that water quality is controlled by rock dominance in the study area. Based on all above parameters it has been concluded that most of the samples are within permissible limits and falls under suitable category for irrigation purpose while few samples that are exceeding the permissible limits are observed facing different geological processes and anthropogenic activities near the sample of the study area.

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