Trans.Inst.Indian Geographers
ISSN 0970-9851

Assessing the suitability of the Ujjani Dam water and its surrounding ground water for irrigation purposes using GIS techniques

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Abstract

The Ujjani Dam was constructed in 1980 on the Bhima River to cater the drought-prone areas of Pune, Solapur and Ahmednagardistricts of Maharashtra. The Ujjani Dam water is polluted due to the huge industrial waste, agricultural runoff and untreated waste water. The present study supports the identification of the impactof reservoir water on nearby ground water quality and thus explores its feasibility for irrigation suitability. In total, 63 water samples were selected by the random grid sampling method and analyzed for parameters such as pH, EC, TDS, TH, cations (Ca+2, Mg+2, Na+, and K+) and anions (HCO-3, Cl-, SO-4, and NO-3) using standard methods. To identify the suitability of water for irrigation purposes different irrigation indices were studied such as SAR, PI, Potential salinity, %Sodium, RSC, RSBC, KI, and exchangeable sodium ratio indices. In addition to these indices, conductivity and nitrate values trend was also analyzed to find out the appropriateness of water for irrigation. As per the irrigation indices, it has been observed that water is suitable for irrigation purpose on the basis of SAR, RSC,RSBC, and permeability index (PI).The study of USSL diagram supports salinity issues and high values of conductivity. The major key indicator of water pollution, nitrate is seen in almost throughout the study area and 67% of the water samples have concentrationsgreater than 45mg/l. The saline water and nitrate concentrations are principle factors that are impairing the suitability of water for irrigation. The salinity and nitrate pollution issue has been increasing with drainage and permeability issue after 1980 and this issue are getting aggressive due to continuous supply of irrigation water from reservoir. These interpretations elucidate that the critical values of salinitywill get worse if proper care is not taken in future.

Key words: *Ground water quality, Irrigation suitability, Ujjani reservoir, SAR, GIS*

Introduction

The Ujjani Dam is constructed in 1980 at the drought-prone area to provide water for drinking and irrigation purposes. This reservoir separates three districts, namely Ahmednagar, Pune, and Solapur. The dam is locatedonthe Bhima River near Ujjani village, Solapur. The Bhima Rivercontributesa major area in Maharashtra state after Krishna and Godavari rivers. The major tributaries of the Bhima River are Mula- Mutha,Pavana, Ghod ,Sina and Indrayani. The Mula-Mutha river flows through the urbanized and highly populated cities such as Pune and Pimpari-ChinchwadMunicipal Corporation

(PCMC), which contributes to a high amount of domestic effluent and industrial discharges into the river(Jadhav S and Jadhav M 2015; More et al. 2014;Eknath 2013). While intersecting with the Bhima River at Pargaon, the Mula –Mutha River carries a huge load of untreated waste water and deposits it at the Ujjani Dam. Also, the untreated domestic waste water from the nearby villages and agricultural runoff contributes to the high salt content of the Ujjani Dam(Kulkarni U D 2010). In addition to this,subsequent irrigations for crop production bring more salt to the land, which in the absence of adequate leachingdeposit in the area and transform it into more saline region.

As reservoir water is getting polluted continuously the nearby people are switching to ground water,that is dug wells and tube wells, for irrigation and drinking purposes and this is evident from the increase in the number of wells.So far, the geochemistry and the suitability of the groundwater for agricultural purposes in and around the Ujjani Dam (Yashwantsagar reservoir) have not been studied in great detail. The present study identifies the salt water intrusion from the Ujjani reservoir and the suitability of ground water samples for irrigation purposes. The similar studies related to ground water quality and its suitability for irrigation were performed(Singh et al. 2005; Sadashivaiah et al. 2008; Adhikary and Dash 2012; Haritash A K 2014)in different parts of India.

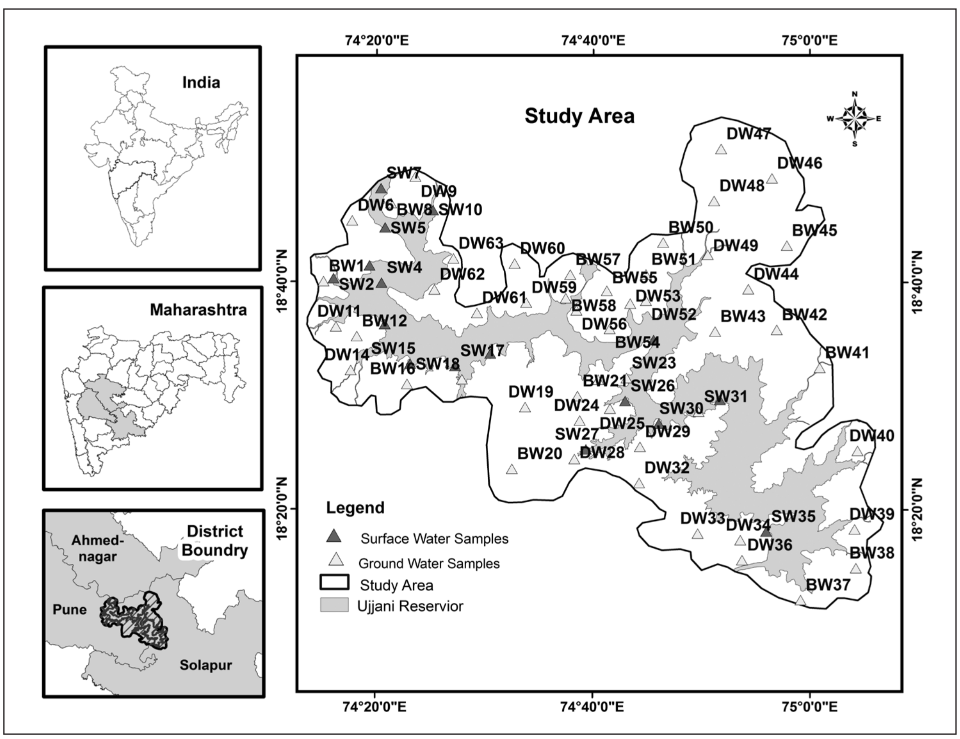

Fig. 1: Location map

Geology and stratigraphic summary of the study area

The study area (Figure1) for research is finalized on the basis of drainage pattern. The total study area is of 1105.73 sq.km^2 with74 ^{0} 44'57.72^{0}E to 75^{0}10'13.27^{0}E and 18^{0}2'9.26^{0}N to 18^{0}25'18.09^{0}N. The study area separates three districts as Pune, Solapur, and Ahmednagar. The Bhima River receives water from some major tributaries Mula-Mutha, Indrayani, Ghod, Kukadi, Bhama, Pawana, Sina, Nira, and Vel.

The study area consists of Deccan Traps covering different types of basaltic flows of late Cretaceous to early Eocene. It comprises simple basalt (Aa type), vesicular-amygdaloidal (compound pahoehoe) basalt flow, and red bole beds (Tachylitic bands) which are exposed in the road cuts and well sections. The district resource map (DST) showed that the area is divisible into five different formations from the base to the top, as upper Ratangarh formation (of two different types), Indrayani formation, Karla formation and Devighat formation (District Resource Map by Geological Survey of India).

Material and Method:

For this study, the water samples were collected from 63 locations as 16 samples of reservoir water and 47 of different dug well and bore well. The sampling was carried out during post-monsoon season November 2014, to identify the impact of rain water on the water quality. The groundwater samples were collected fromreservoir (surface water), dug wells, and bore wells using GARMIN GPS to locate the exact location. Methods of collection and analysis of water samples for pH, electrical conductivity (EC), Total solids (TS), Total dissolved solids (TDS), Total Hardness (TH), Ca, Mg, Na, K, Cl, HCO_3,SO_4,PO_4 and NO_4 are essentially the same as given by (APHA 1998). The samples were collected in 2 litercapacity polyethylene bottles. Prior to collection, the bottles were thoroughly washed with diluted HNO_3 acid and then with distilled water in the laboratory before filling bottles with samples. The parameters such ascalcium (Ca^{+2}) and magnesium (Mg^{+2}) were determined titrimetrically using standard ethylenediaminetetraacetic acid (EDTA), chloride (Cl^-) by standard $AgNO_3$ titration, bicarbonate (HCO_3^-) by acid titration of 0.02 N H_2SO_4 and sodium (Na^+) and potassium (K^+) by flame photometry. The anions such assulphates (SO_2^-), nitrate (NO_3^-), phosphate (PO_4^-) were determined by spectrophotometer, EC, pH and TDS measurements were performed in situ with portable meter and also it was carried out inside the lab to maintain the accuracy of the results. The analytical precision for ions was determined by the ionic balances, which is generally within ±5 %. The equipment and instruments were tested and calibrated with calibration blanks and a series of calibration standards as per specifications outlined in the standard methods of water (APHA 1998).

Result and Discussion

Physicochemical characteristics of water samples

Surface water

The backwater of the reservoir shows alkaline water with a range of 6.87 to 7.71.

While 81.25% samples showed values below 1000µS/cm for conductivity due to rainfall in monsoon. 63% samples showed concentration for cation as K<Na<Mg<Ca and 19% samples showed concentration as K<Mg<Na<Ca, while 13% samples showed concentration as K<Na<Ca<Mg and 6% as K<Mg<Ca<Na. Similarly, the anion showed the trend as $PO_4<NO_3<Cl<SO_4<HCO_3$ for 25% samples and $PO_4<NO_3<SO_4<Cl<HCO_3$ for 31% samples. The details of surface water samples is given in (Table1).

Ground water

In total, 47 samples (Table1) were analyzed to explain the characteristics of ground water. The conductivity of water is in the range of 413.10 - 3141 µS/cm. The water is more of alkaline in nature with a range of 6.74 - 8.30 pH. The cation concentration statesa maximum amount of calcium and a minimum amount of potassium. In case of the anion, the concentration of bicarbonate is seen in maximum and that of phosphate in the minimum. 36.59% samples show concentration range as K<Na<Mg<Ca and 17% samples show concentration range as K<Mg<Ca<Na and K<Mg<Na<Ca.14% samples show concentration as K<Na<Ca<Mg while remaining 14% samples showed concentration as K<Ca<Mg<Na and K<Ca<Na<Mg. In a case of anion 49% samples show values as $PO_4<NO_3<SO_4<Cl<HCO_3$ and 37% samples showed value as $PO_4<SO_4<NO_3<Cl<HCO_3$. 10% samples showed concentration as $PO_4<NO_3<Cl<SO_4<HCO_3$. And 4% samples had concentration as $PO_4<NO_3<HCO_3<Cl<SO_4$.

The concentration of nitrate is also found to be in critical amount. The average concentration of nitrate is 77.94 mg/l, which is more than Food and Agriculture Organization (FAO) prescribed limit. This may be because of the domestic effluents from the settlement and agricultural runoff from the nearby area.

Table 1 : Statistical data for chemistry of water in and around Yaswantsagar reservoir

Sample type	**Surface water (SW)**			**Bore well (BW)**			**Dug well (DW)**		
Parameters	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
pH	6.87	8.71	7.71	6.84	8.04	7.32	6.76	8.30	7.41
EC	438.60	1591.20	740.06	413.10	2091.00	1065.51	612.00	3141.60	1224.73
TS	201.11	613.02	299.36	22.05	1120.02	514.13	90.05	1550.45	626.75
TDS	201.00	613.00	299.13	22.00	1120.00	513.94	90.00	1550.00	626.30
TH	306.00	830.00	484.54	293.45	1250.71	681.39	401.93	1240.90	748.49
Ca	52.10	137.00	96.54	44.09	224.00	116.61	56.09	300.00	137.31
Mg	21.91	129.26	59.41	32.00	168.70	95.21	56.05	193.18	98.97
Na	27.34	119.60	51.20	16.31	302.00	85.85	33.77	308.70	105.11
K	0.06	0.35	0.25	0.03	0.21	0.09	0.00	8.19	0.49

HCO_3	210.00	550.00	379.38	223.00	825.00	472.47	150.00	650.00	477.67
Cl	59.98	229.93	98.36	39.98	375.00	187.63	97.00	509.84	216.67
SO_4	42.00	360.00	105.53	10.00	310.00	115.41	30.00	760.00	167.95
PO_4	0.00	8.72	3.17	0.23	8.63	4.58	0.34	9.86	4.73
NO_3	2.39	211.00	60.99	11.80	110.00	74.38	11.56	145.00	79.96

Suitability of water samples for irrigation purpose

The analysis of water samples for suitability of irrigation purpose is important as soil permeability plays an important role in cropping pattern and agriculture. For irrigation suitability, different indices were studied in detail and their values are given in Table 3.

1. Sodium adsorption ratio (SAR) and salinity index.

SAR is an important factor for the analysis of water quality as the sodium concentration expresses the reaction with the soil and reduction in soil permeability (Ravikumar and Somashekar 2011); and it is also a measure of alkali/sodium hazard to crops. SAR calculation(Figure 2 a) showed that the values extents in the range of 0.2 -5.18 and these are all below 10(Table2). The identified SAR values state that the value of Na^+ is relatively higher than Ca^{+2}(Subba Rao 2006).The cation-exchange complex becomes saturated with sodium if irrigation water is high in sodium and low in calcium. This damages the soil structure and the soil becomes compact and impervious due to the dispersion of clay particles (Kumar et al. 2009; Bhardwaj and Singh 2011).

$$\text{SAR} = \text{Na} + \sqrt{(Ca^{+2} + Mg^{+2})}/2 \quad 1$$

The US salinity hazard (USSL) diagram (Figure 3a) was plotted considering SAR values and conductivity value, and it was recognized thatout of the 63 samples, only 2 samples have values in C4S1 class as very high salinity hazard and low sodium hazard, 40 samples showed values as C3S1 with highsalinity hazard and low sodium hazard, and 21 samples with medium salinity hazard and low sodium hazard. As per the USSL class, it could be stated that the water having values in good class can be used for irrigation with little danger of harmful levels of exchangeable Na+.The doubtful waters can be used to irrigate salt-tolerant and semi-tolerant crops under favorable drainage conditions. The unsuitable waters are generally undesirable for irrigation and should not be used on clayey soils of low permeability. On the other hand, unsuitable water can be used for plants of high salt tolerance, when grown on previously salty soils to safeguard further reducing the fertile lands (Subba Rao 2006).

2. Percentage sodium and Sodicity Index.

Sodium concentration is very significant in classifying irrigation water. The high concentration of sodium affects plant growth and soil permeability. From the study it has been seen that samples showed % Na values in the range of excellent to permissible class (Table2). It helps to explain that water is suitable for irrigation purposes (Figure2 b).

Percentage sodium vs. conductivity plot (Wilcox) helps to identify the Sodicity Index (Figure 3 b). It states that all of the samples are in the class of excellent to permissible range and only four samples (5%) have reading as doughtful to unsuitable, which are DW7, DW21, DW19, and BW42.

$$\text{Na}\,\% = \text{Na}^{+} + \text{K}^{+} / (\text{Ca}^{+2} + \text{Mg}^{+2} + \text{Na}^{+} + \text{K}^{+}) \times 100 \quad (2)$$

3. *Residual sodium carbonate (RSC) and residual sodium bicarbonate (RSBC)*

RSC is used to quantify the effect of carbonate and bicarbonate on the quality of the water. An excess quantity of carbonate and bicarbonate is considered to be harmful, as excess carbonate combines with calcium and magnesium which shows adverse impact on the physical property of the soil and this forms a solid material like a black stain on the soil surface after drying (Eaton1950; Kumar et al. 2009; Kumar et al. 2007).

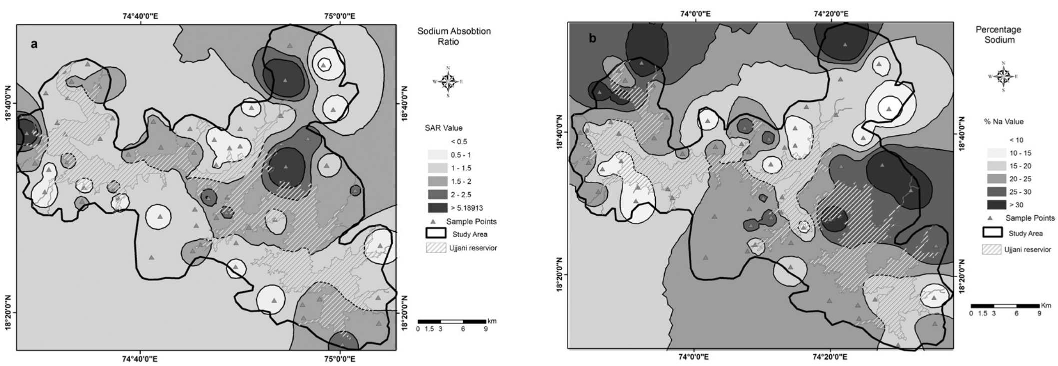

Fig. 2 : Iso-concentration map showing spatial variation in (a) SAR and (b) percent sodium.

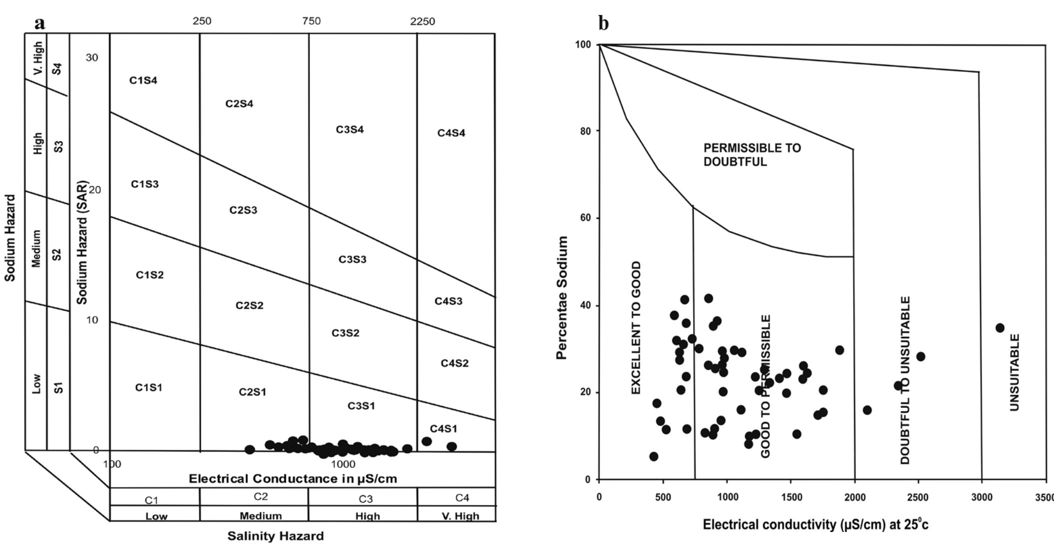

Fig. 3 : (a)US salinity hazard diagram and (b)Wilcox diagram for post-monsoon season.

RSC values showed that almost 56 samples were suitable for irrigation purposes (Table 2) while only 7 samples had RSC value more than 2.5. The concentration trend for RSC is displayed in (Figure 4 c).

$$\text{RSC} = (CO_3^- + HCO_3^-) - (Ca^{+2} + Mg^{+2}) \qquad 3$$

The residual sodium bicarbonate (RSBC) calculation was proposed by Gupta and Gupta (1987) to identify the suitability of water for irrigation. An RSBC value less than 5 is suitable for irrigation purpose. Almost all samples were suitable for irrigation purpose (Figure 4 d) but only three samples showed exceeding values for RSBC as 6.17, 5.62, and 5.87. The negative values of RSBC (Table 3) of all water samples from the study area reveal that HCO_3 is present in excess amount(Tanvir et al. 2014).

$$\text{RSBC} = \text{HCO}_3^- - \text{Ca}^{+2} \qquad 4$$

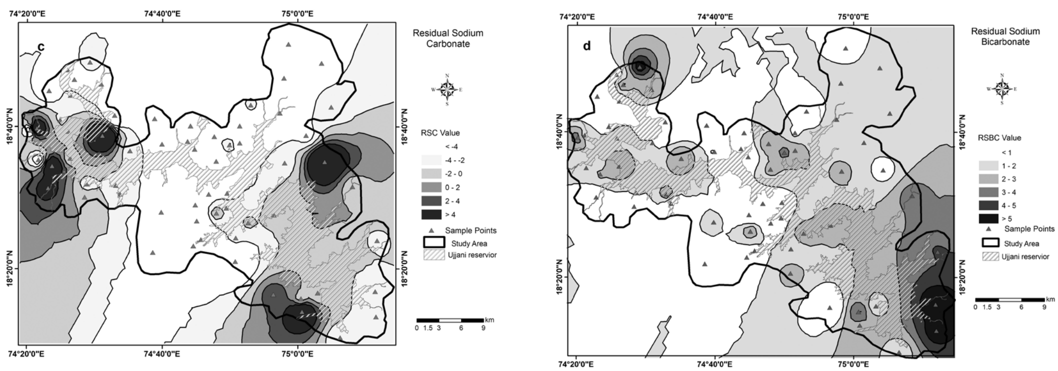

Fig.4 : Iso-concentration maps showing spatial variation in (c) RSC and (d) RSBC

Table 2 : SAR, percentage sodium, residual sodium bicarbonate

Sodium adsorption ratio (SAR)		
SAR	Water quality	Post-monsoon samples
<10	Excellent	63
10–18	Good	-
19–26	Doubtful/fair poor	-
>26	Unsuitable	-
Percentage sodium		
% Sodium	Water class	Post-monsoon samples
20	Excellent	32
20 – 40	Good	28
40 – 60	Permissible	3

60 -80	Doubtful	-
>80	Unsuitable	-
Residual Sodium Carbonate		
RSC	Water class	Post-monsoon samples
<1.25	Good	56
1.25 - 2.5	Doubtful	-
>2.5	Unsuitable	7

4. Kelly's ratio

In general, groundwaterwith Kelly's ratio (KR) greater than one is unfit for irrigation, as KR value more than 1 indicates that the amount of Na^{+} is in an excess amount (Tanvir et al. 2014). KR for study area ranges from 0.05 to 1.02 with an average of 0.29 (Figure 5 e). As per the criteria, all of the samples are suitable for irrigation purpose.

$$\text{Kelly's Ratio} = Na^{+} / Ca^{+2} + Mg^{+2} \qquad 5$$

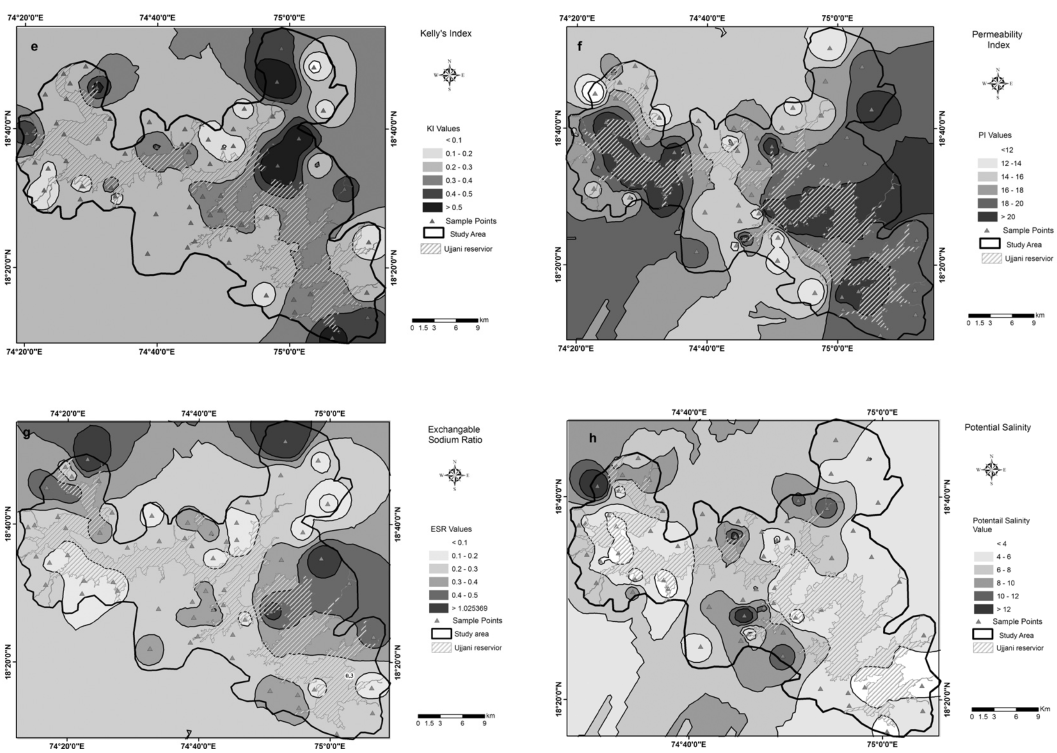

Fig.5 : Iso-concentration maps showing spatial variation in (e) Kelly's index(f) permeability Index,(g) exchangeable sodium ratio,(h) potential salinity.

5. Permeability index

The permeability index (PI) values also indicate the suitability of ground- water for irrigation. Doneen (1964) has evolved a criterion for assessing the suitability of water for irrigation based on PI (Table 3).As per permeability indices, the water samples may be subdivided into Class I, Class II and Class III. Almost all of the samples (Fig. 6) from the study area fall under Class I and Class II types, but only one sample DW7 showed Class III type of water; with 25% maximum permeability. Class I and ClassII types of water are suitable for irrigation with 75% of maximum permeability. The permeability values range on the basis of Doneen's chart and most of the groundwater samples in the study area are suitable for irrigation purposes as shown in (Figure5 f).

$$PI = Na^{+} + +\sqrt{HCO_3^{-}} \times 100/ Ca^{+2} + Mg^{+2} + Na^{+} \quad 6$$

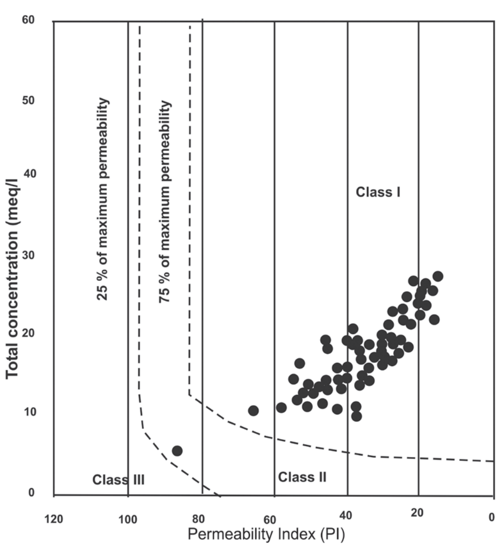

Fig. 6 : Doneen (1964) classification of irrigation water based on the permeability index

6. Exchangeable sodium ratio (ESR)

The ESR values calculated to determine the suitability of water sample for agricultural purposes, varied from 0.05 to 1 and its extent is displayed in (Figure5 g).

$$ESR = Na^{+}/ Ca^{+2} + Mg^{+2} \quad 7$$

7. Potential salinity (PS)

The PS value identified for the study area is in the range of 2.24 - 22 meq/l with an average of 6.47meq/l (Figure5 h).

$$\text{Potentail Salinity} = Cl^{-} + 1/2\, SO_4^{-2} \quad 8$$

8. *Conductivity*

The EC value lower than 250 µS/cm is suitable for crop and thus acceptable for irrigation purposes, but values more than 300 µS/cm is inappropriate for crop production (Westcott and Ayers 1984). The crop production declines with the high EC as it adversely affects the plants and its water intake ability (Zouahri et al. 2015). In the study area from the map it could be evident that almost more than 90% area has conductivity value greater than 300µS/cm (Figure 7 i). On the basis of conductivity, the water is unsuitable for irrigation. And this situation will be getting cumulative with excessive irrigation and insufficient drainage systems and high water table.

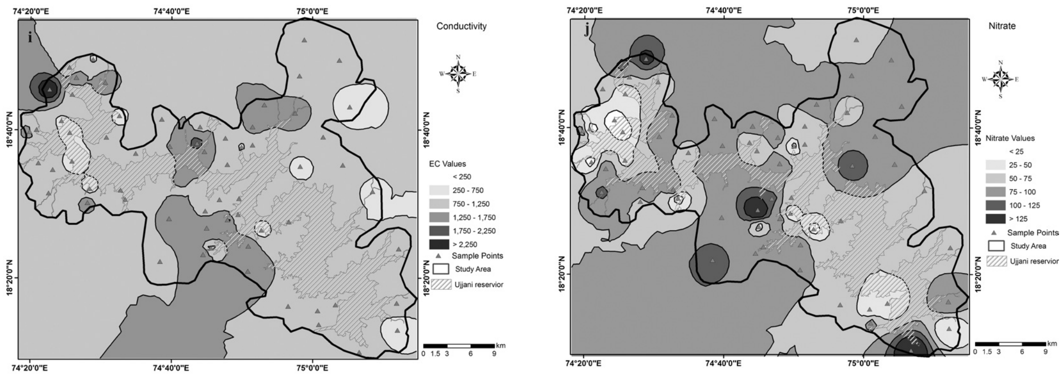

Fig. 7 : Iso-concentration maps showing spatial variation in (i) conductivity and (j) nitrate concentration.

9. Nitrate

The nitrate concentration plays a significant role in irrigation. The high concentrations of nitrogen and phosphorus in surface waters are major factors that contribute to eutrophication and hypoxia problems. Similarly excess nitrate concentration leads to leaching of salts which percolates beyond the root zone and not be available to the crop system. The concentration of nitrate is shown in (Figure 7 j) as per (BIS, 1991), the suitable quantity of nitrate is 45mg/l. From the map, it could be evident that a major of area is under nitrogen concentration stress, thus, contributing to an increase in the salt concentration.

Table 3 : Irrigation indices for water samples from study area.

Sr. No.	Sample name	SAR	%Na	RSC	RSBC	KI	PI	Potential salinity	ESR
1	SW1	0.90	17.36	12.67	1.33	0.21	20.69	4.66	0.21
2	SW2	0.96	19.59	-2.41	0.26	0.24	24.18	3.51	0.24
3	SW3	0.68	13.99	-2.12	2.72	0.16	25.37	2.40	0.16
4	SW4	2.23	36.03	-2.93	0.51	0.56	18.43	4.64	0.56
5	SW5	1.80	23.84	-7.59	3.00	0.31	14.01	10.23	0.31
6	DW6	1.49	19.04	-9.40	3.16	0.24	13.37	8.57	0.24
7	DW7	3.81	35.08	-7.57	-11.07	0.54	5.54	22.00	0.54
8	BW8	1.79	23.69	-6.92	3.96	0.31	14.53	7.62	0.31
9	DW9	1.76	25.09	-6.47	0.96	0.34	14.94	7.91	0.34
10	SW10	0.62	11.96	-2.05	3.79	0.14	24.72	2.54	0.14
11	BW11	0.67	11.44	11.49	2.20	0.13	19.07	3.57	0.13

12	DW12	1.76	23.56	6.18	-0.60	0.31	14.42	8.06	0.31
13	BW13	0.65	10.58	-0.23	-1.22	0.12	13.27	9.93	0.12
14	SW14	0.62	12.95	-3.56	1.24	0.15	22.77	2.77	0.15
15	SW15	0.68	15.17	-2.38	-0.58	0.18	25.93	3.13	0.18
16	DW16	1.72	23.00	-8.54	1.22	0.30	13.40	8.61	0.30
17	DW17	1.60	20.70	-3.75	-0.09	0.26	12.40	10.74	0.26
18	SW18	0.77	17.06	-3.52	0.84	0.21	22.26	2.71	0.21
19	DW19	2.66	28.03	-12.59	3.24	0.39	10.38	18.11	0.39
20	DW20	1.72	26.31	-4.85	-0.26	0.36	16.76	5.83	0.36
21	DW21	2.35	29.96	0.28	-0.70	0.43	11.04	11.16	0.43
22	SW22	0.75	17.59	-2.03	0.89	0.21	27.41	2.83	0.21
23	DW23	1.32	16.58	-12.37	2.82	0.20	11.95	12.74	0.20
24	DW24	1.85	24.75	-3.48	0.93	0.33	11.59	9.75	0.33
25	SW25	0.57	11.43	-1.36	3.23	0.13	26.60	2.24	0.13
26	DW26	1.55	23.98	3.75	-1.95	0.32	10.14	4.25	0.32
27	DW27	1.61	25.75	-1.49	4.15	0.35	21.29	4.07	0.35
28	DW28	1.59	25.00	12.97	2.86	0.33	18.52	4.53	0.33
29	SW29	0.56	11.79	-2.90	1.17	0.13	24.40	3.11	0.13
30	BW30	0.28	5.41	-3.39	2.00	0.06	22.95	3.57	0.06
31	DW31	0.78	13.39	-4.65	1.78	0.15	19.43	3.95	0.15
32	DW32	1.16	15.45	-10.55	1.40	0.19	13.10	12.47	0.19
33	BW33	2.46	41.83	17.78	0.41	0.72	19.35	4.75	0.72
34	DW34	0.65	11.12	-5.33	0.98	0.13	18.92	4.69	0.13
35	BW35	1.44	19.90	-3.16	-0.65	0.25	12.79	10.76	0.25
36	BW 36	0.59	9.20	-10.36	0.71	0.10	13.88	8.11	0.10
37	DW37	0.50	7.98	-7.09	2.62	0.09	17.13	5.75	0.09
38	DW38	0.91	18.40	-1.65	3.55	0.23	25.65	3.13	0.23
39	BW39	0.61	9.49	-7.75	2.40	0.10	16.30	5.75	0.10
40	BW40	1.99	29.62	-3.83	3.37	0.42	17.36	5.88	0.42
41	DW41	1.57	21.52	-7.44	-0.48	0.27	14.54	7.90	0.27
42	BW42	1.36	16.13	-14.37	-0.54	0.19	11.10	13.79	0.19
43	BW 43	1.85	29.42	-4.50	0.83	0.42	16.87	6.55	0.42
44	DW44	1.51	20.69	-6.12	1.04	0.26	15.64	7.83	0.26
45	DW45	0.70	10.29	-7.88	-0.57	0.11	15.90	6.59	0.11
46	DW46	1.80	27.79	18.45	1.03	0.39	16.53	5.29	0.39
47	SW47	0.95	15.99	-3.70	2.85	0.19	20.07	3.38	0.19
48	SW48	1.49	24.64	-3.36	1.04	0.33	19.47	4.50	0.33

49	BW49	1.00	17.90	-5.30	0.20	0.22	18.02	5.71	0.22
50	SW50	1.30	20.16	-7.52	-1.13	0.25	14.62	5.53	0.25
51	BW51	2.28	36.84	-0.01	2.71	0.58	23.16	4.08	0.58
52	SW52	1.04	18.22	-4.22	1.11	0.22	19.56	3.74	0.22
53	BW53	0.69	10.52	-3.81	6.27	0.12	19.09	2.27	0.12
54	DW54	2.03	30.19	-2.37	4.02	0.43	18.91	4.31	0.43
55	DW55	1.91	32.21	-1.35	3.48	0.48	22.12	3.99	0.48
56	BW56	1.60	23.22	-3.73	5.63	0.30	17.83	6.04	0.30
57	BW57	1.10	20.43	-2.93	3.99	0.26	21.91	4.18	0.26
58	DW58	4.54	48.12	-2.32	5.87	0.93	13.93	7.20	0.93
59	DW59	1.72	29.68	-3.23	2.26	0.42	19.37	7.00	0.42
60	BW60	5.19	50.62	-5.77	0.29	1.03	10.73	7.73	1.03
61	DW61	0.95	15.32	-5.66	1.64	0.18	17.68	4.76	0.18
62	DW62	1.19	19.25	-4.36	0.32	0.24	18.67	7.67	0.24
63	DW63	1.48	19.78	-12.20	-4.66	0.25	10.94	6.72	0.25

Conclusion:

The Ujjani reservoir is mainly constructed to cater the requirements of irrigation and domestic purposes. The water from the Ujjani Dam and surrounding region is suitable for irrigation purposes on the basis of SAR, percentage sodium, RSC, RSBC, KI and PI. The water from the dam and surrounding region is getting polluted due to the high content of salts and nitrate. The drainage pattern and permeability affect the concentration of EC and nitrate. The pollutant gets settled in the Ujjani reservoir as the drainage that enters into the Ujjani Dam does not have a steep gradient and this slows down the flow of river water by providing settling time for pollutants.The feeding river carries the load of pollutants from upper part and dumps it into the Ujjani reservoir. The other important contributory factors for nitrate concentration are uncontrolled and excessive irrigation application, animal wastes, use of fertilizers, and greater number of septic tanks.

The drought conditions and fluctuations in water level will escalate this situation to a major extent if proper care is not taken. To reduce the concentration of pollutants, it is advisable to provide common treatment facility to the nearby villages which will to treat the untreated waste. The proper drainage practices and sustainable agriculture will also help to minimize the application of nitrogen-containing fertilizers and its permeability into the aquifer. The drip irrigation will also support to reduce the excessive use of water for irrigation as this is one of the point sources for salts.

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