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Research Article

GEOSPATIAL TECHNOLOGY FOR MAPPING SPATIAL VARIATIONS OF GROUND WATER QUALITY INDEX IN ERANDOL AREA OF JALGAON DISTRICT, MAHARASHTRA STATE, INDIA

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ABSTRACT

In the present investigation, the drinking water quality index of ground water was carried out for 29 ground water samples in different villages of Erandol region, Jalgaon district of the Maharashtra state. Total 29 integrated water samples were collected from different locations and analyzed for water quality parameters viz. pH, Hardness, Dissolved Oxygen, Electric Conductivity, Chlorides, Total Dissolved Solids, Sulphate, Sodium, Calcium, Alkalinity, Nitrates and Fluoride. The geospatial tools like high resolution multispectral remote sensing data (RESOURCESAT-2, LISS IV), GIS software (Arc GIS 10.2) and GPS are used to generate database, sample collections and for mapping spatial variations of different water quality parameters. Ground Water Quality Index mapped by geospatial tools reveals that, the overall each 48 percent of ground water is in excellent and good condition. Whereas, 4% of ground water sources exhibits poor water quality and not suitable for drinking purpose. Out of total samples, fluorides were found beyond the limit in 10% of ground water samples as per BIS standards.

INTRODUCTION

Due to rapid industrialization, the water quality is heavily deteriorating and ultimately it is affecting to the life (Ratnakanth Babu M. J. *et.al.*2011). The quality of urban environment is deteriorating day by day due to increase in the population of urban and industrial areas nearby cities therefore at saturation points cities unable to manage within the increasing pressure on their infrastructure. Surface water and ground water are the major sources of drinking water in urban as well as rural in India. However, uncontrolled extraction without commensurate recharge and leaching of pollutants from pesticides and fertilizer in aquifers has resulted in pollution of ground water supplies. In addition to that, ground water is threatened with pollution from various source viz., domestic wastes, industrial wastes agriculture wastes, run off from urban and agriculture areas. These contaminates can their way into local water bodies and subsequently leads the water quality problems. Ground water can be contaminated when rainfall and surface runoff pass through contaminated soil. Water dissolve many substances can carry particles and microorganism with it into the ground water. Improper Landfills, Mining, application of pesticides and improperly stored chemicals also leads to ground water pollution. Leaking underground storage tanks, improperly installed or failing septic tanks and other surface activities can significantly affects surface as well as ground water quality.

Water quality index is one of the important tools to communicate the quality of water to the anxious people and understand the spatial variation of water quality. It acts as agauge of the quality of water. The main objective of the water quality index (WQI) is to convert complicated water quality data into simple form for the easily usable by the community. Many researchers have studied on water quality by estimating the water quality index to substantiate the variation of water quality (K. Ambiga and R. Anna Durai., 2015, S. Packialakshmi *et.al.*, 2015, Pradeep Kumar Sharma *et.al.*, 2016, Umamaheshwari S., 2016).

The initiation of satellite remote sensing is a timely technological development in view of the serious compression on our natural resources. Remote sensing data provides a wealth of detail information of large area of the earth surface and due to its unique character could be used to access environmental alteration with better accuracy in less time and expense. Geographical Information System has a capability for

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capture, storage, manipulation, analysis and retrieval of multiple layer resource information occurring both in spatial and non-spatial forms (Mishra and Patel, 2001) the GIS technology provides suitable alternatives for proficient supervision of large and intricate database (Anju Panwar *et al.*,2015). Geographic Information System is the computer data base generation, management, analysis and modeling data updating supported system, useful in the earth and environment sciences.

MATERIALS AND METHODS

Study area

Erandol is a small city in Jalgaon district of Maharashtra state, India. It is situated on the banks of Anjani River. Erandol is situated at 20°55′N 75°20′E / 20.92°N 75.33°E. It has an average elevation of 227 meters above the sea level. Geographically Erandol is located at Tapi Basin of the Deccan Plate, between the Satpuda and Ajanta mountain ranges. Anjani river passes through the city The East-West Corridor - Asian Highway 46, which connects Mumbai and Nagpur connects the town to Dhule to the west and Jalgaon to the east.

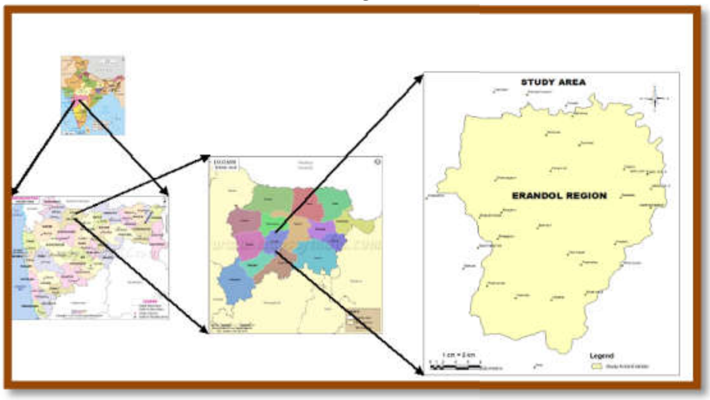

Fig I Study area showing sampling locations in Erandol Region, Maharashtra State, India

Collection of sample and analysis

Collection of total 29 ground water samples from predetermined locations that is, Rural and Suburban areas of Erandol tehsil were collected in pre-cleaned and rinsed polythene bottles with necessary precautions (Brown *et al.* 1974). After collection of the samples, the samples are preserved and shifted to the laboratory for analysis. Physico-chemical analysis was carried out to determine sixteenth different water quality parameters adopting standard methods specified by (APHA,1998) and compared with standard values recommended by Bureau of Indian Standards (BIS, 2012). The water quality data thus obtained is used as database for present study (Table.III).

Table I Ground Water Sampling locations selected under study area.

Sample ID	Village	Latitude	Longitude	Depth	Source
PGW-1	Pimpri Kh	21.01922194	75.3520	25 m	Tubewel
PGW-2	Dharangaon	21.00434222	75.2731	7 m	Dug Well
PGW-3	Nanded	21.14391444	75.2713	46 m	Tubewel
PGW-4	Rameshwaram	21.14026528	75.3186	26 m	Tubewel
PGW-5	Amode	21.12232139	75.3740	17m	Tubewel
PGW-6	Dahidule	21.10612194	75.3830	31 m	Dug Well
PGW-7	Sonwad	21.07640583	75.3453	23 m	Hand pump
PGW-8	Zurkhed	21.0596975	75.3928	21 m	Tubewel
PGW-9	Paldhi	21.02182806	75.4563	23m	Hand pump
PGW-10	Sawada	20.97713417	75.45164389	25 ft	Tubwell
PGW-11	Khadaki	20.90323306	75.44319	35 ft	Dug well
PGW-12	Mhasawad	20.86954556	75.45406889	25 ft	Hand Pump
PGW-13	Bhatkheda	20.82349028	75.40102528	25 ft	Dug well
PGW-14	Nipane	20.81520556	75.35339917	22 ft	Hand Pump
PGW-15	Kasoda	20.818025	75.30189	15 ft	Hand Pump
PGW-16	Pharkande	20.83732694	75.26093639	40 ft	Hand Pump
PGW-17	Bahute	20.86404806	75.226685	25 ft	Dug well
PGW-18	SawkhedeHol	20.89706556	75.24763	60 ft	Dug well
PGW-19	Bhalgaon	20.91186444	75.27660611	35 ft	Tubwell
PGW-20	Erandol	20.929055	75.33321472	20 ft	Dug well
PGW-21	Bhawarkhede	20.94472806	75.24935556	35 ft	Hand Pump
PGW-22	Borgaon	20.95354833	75.28168306	5 ft	Hand Pump
PGW-23	Mukhapat	20.8865	75.376456	21 ft	Dug well
PGW-24	Padmalay	20.870582	75.395175	25 ft	Dug well
PGW-25	Kadholi	20.96144722	75.49448278	22ft	Hand Pump
PGW-26	Katholi	20.9614475	75.49453417	25ft	Tubwell
PGW-27	NMU DW 3	20.99141083	75.49495306	28ft	Dug well
PGW-28	NMU DW 4	21.01458861	75.489775	23ft	Dug well
PGW-29	NMU DW 5	21.01373583	75.48945389	21ft	Dug well

Calculation of Water Quality Index

For calculating WQI we have followed three steps using weighed arithmetic index method (C. R. RAMAKRISHNAIAH *et. al.*, 1972).

In the first step, each of the 11 water quality parameters has been assigned a weight (wi) according to its relative significance in the overall quality of water for drinking purposes (Table II). The maximum weight of 5 has been given to the parameter nitrate and MPN due to its significant role in WQI. Sodium and Calcium which are given the minimum weight of 1 and 2 respectively because it may not be harmful to human health. In the second step, the relative weight (Wi) is computed by using following formula.

$$Wi = wi \frac{wi}{\sum_{i=1}^{n} wi} \quad 1$$

Where, Wi is the relative weight, wi is the weight of each parameter and n is the number of parameters. Calculated relative weight (Wi) values of each parameter are also given in Table.III.

In the third step, a quality rating scale (qi) for each parameter is calculated by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the BIS and the result multiplied by 100.

$$qi = (Ci / Si) \times 100 \quad 2$$

where qi is the quality rating, Ci is the concentration of each chemical parameter in each water sample in mg/L, and Si is the Indian drinking water standard for each chemical parameter in mg/L according to the guidelines of the BIS 10500, 2012.

For computing the WQI, the SI is first determined for each chemical parameter by multiplying quality rating with relative weight, finally the summation of sub-index is used to determine WQI as per the following formula

$$SIi = Wi \ qi \quad 3$$

$$WQI = \sum SIi \quad 4$$

Where, SIi is the sub index of i^{th} parameter; qi is the rating depends on concentration of i^{th} parameter and n is the number of parameters. The computed WQI values are classified into five types, “Excellent water” to “Water, unsuitable for drinking”.

Table II Relative weight of Water Quality parameters

Chemical Parameters	BIS Standards	Weight (w_i)	Relative Weight(W_i)
pH	6.5-8.5	4	0.090909091
Alkalinity	200-600	2	0.045454545
Electrical Conductivity	1-1.5	3	0.068181818
Total hardness (TH)	200-600	2	0.045454545
Sodium(Na)	200	1	0.022727273
Calcium(Ca)	75-200	2	0.045454545
Chloride	250-1000	3	0.068181818
Total dissolved solids	500-2000	4	0.090909091
Fluoride	1-1.5	4	0.090909091
Nitrate	45	5	0.113636364
Sulphate	200-400	4	0.090909091
		$\sum w_i$= 44	$\sum W_i$= 1.00

Data Used

Different data products required for the study include Survey of India toposheets 46O/8, on 1:2,00,000 scale have been referred during interpretation as well as for base map preparation. IRS-P6 LISS IV of 2015 have also been utilized for land use and urban settlement map. The study area was demarcated using Toposheets of 1:2,00,000 by identifying the district boundaries by Scanning, projecting, geo-referencing and digitizing toposheets of the area manually using Arc-GIS. Various land use / land cover features were studied, and a base map was prepared by visual interpretation using toposheets and false colour composite image of LISS IV sensor. Water samples were taken from the area using integrated sampling techniques and the co-ordinates were noted down with the help of GPS (Global Positioning System).

Geo Database

Preparation of spatial database is made up by using various thematic layers like base map of the study area, land use / land cover, drainage network from survey of India toposheets on 1: 2,00,000 scale using Arc-GIS software to obtain baseline data. All maps are digitized to change data into vector format. Landuse / land cover maps are prepared by using Arc-GIS software through supervised classification. The ground truth data has together used with the help of satellite data, GPS (Global Positioning data) and toposheets of survey of India.

Generating water quality map

The matic maps for the WQI and as well as individual water quality parameters of ground water were generated using the addition function available in the ArcGIS software and created a final Water Quality Index map by overlaying these thematic maps which are produced as a result of Inverse Distance Weighted (IDW) interpolations.

RESULTS AND DISCUSSION

pH of most natural water falls within the range of 4 to 9. The majority of waters are slightly basic because of the presence of carbonate and bicarbonates (S.K. Maiti, 2011). In the present study, pH of ground water falls in the range of 7.7 to 10.3. This shows that the groundwater of the study area is mainly alkaline in nature. The minimum pH was observed at Paldhi and Pharkande in north east zone. Whereas, in north west zone 14 sources of ground water pH were observes beyond the limit prescribed by BIS Standards 2012(Fig.II).Dissolved oxygen is one of the most important water quality parameter and it is amount of dissolve oxygen present. The DO levels in the natural water depends on the physical, chemical and biological activities in the water. In the Erandol region DO were found in the range of 3 to 5.8mg/L.

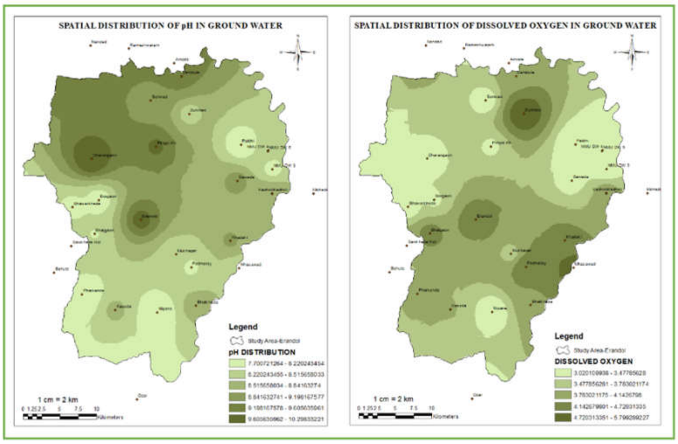

Fig II Showing Spatial distribution of pH and Dissolved oxygen

Pure water is poor conductor of electricity. The higher concentration of electrolyte in water, the more is its electrical conductance. The conductivity gives rapid method to get an idea about dissolved solids in water. The present investigation found maximum conductivity in the south western part of study area(Fig.III), this is due to presence of higher amount of dissolved solids. The maximum permissible limit of EC prescribed by WHO is 1.500 µS/cm at 25^0 c. The major portion of alkalinity in natural water is caused by hydroxide, carbonate and bicarbonate. Alkalinity itself is not harmful to human beings, still the water supplies with less than 100 mg/L are desirable for domestic use. In the study area 13 sources of ground water from north east region were observed higher amount of alkalinity. Whereas, south west and central region shows less amount of alkalinity. All other observations found within limit prescribed by BIS 2012.

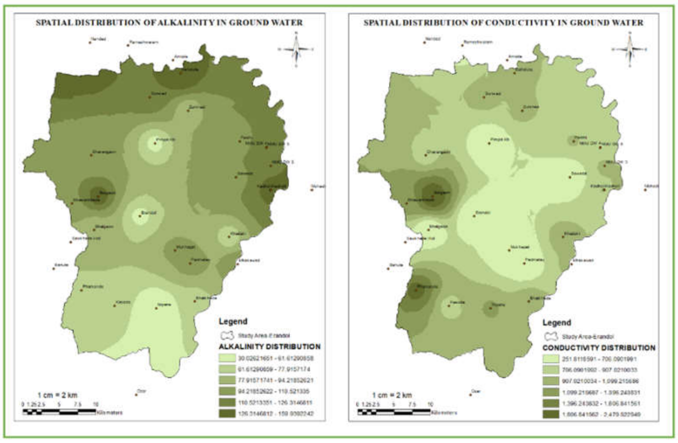

Fig III Showing Spatial distribution of Alkalinity and Electric conductivity

Hardness is the concentration of multivalent metallic cations in the water. Hard water is generally considering to be those water that requires considerable amount of soap to produce foam and that also produce scale in hot water pipes, heaters, boilers and other unit in which the temperature of water is increase. In general, surface waters are softer than the ground water. In the present investigation three sources Bhatkheda, Borgaon and Kadholi in south west region were found higher amount of total hardness(Fig.IV). It is due to presence of higher amount of salts of calcium and magnesium. High content of dissolved solids increases density of water, influences osmoregulation of fresh water organism, reduces solubility of gases as well as utility of water for drinking, irrigation and industrial purpose. The present study reveals that, the dissolved solids present in 14 sources of ground water from the Erandol region were found beyond the acceptable limit prescribed by BIS 2012. The maximum TDS 1720 mg/L was foundat Borgaon in west region. whereas, minimum 70 mg/L TDS observed at Bhalgaon which is in south western part of study area.

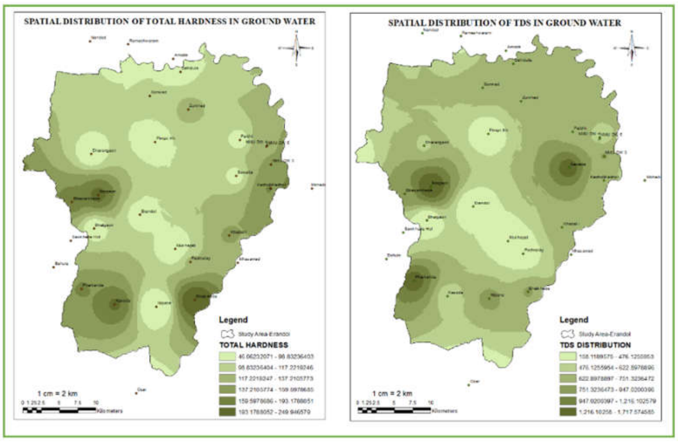

Fig IV Showing Spatial distribution of Total Hardness and Total Dissolved solids (TDS)

Sodium is predominant cation in the study area among calcium and potassium. Its concentration ranges between 35 to 176.6 mg/L with an average value of 86.55 mg/L. according to WHO guidelines the maximum permissible limit is 200 mg/L. in the study area, almost all ground water samples found below maximum permissible limit as far as sodium is concern (Fig.V). Calcium is second most dominant cation and the maximum concentration 267.7 mg/L was observed at Borgaon in west region of Erandol, which is beyond the limit for the drinking purpose prescribed by BIS 2012. All other sources where found within permissible limit.

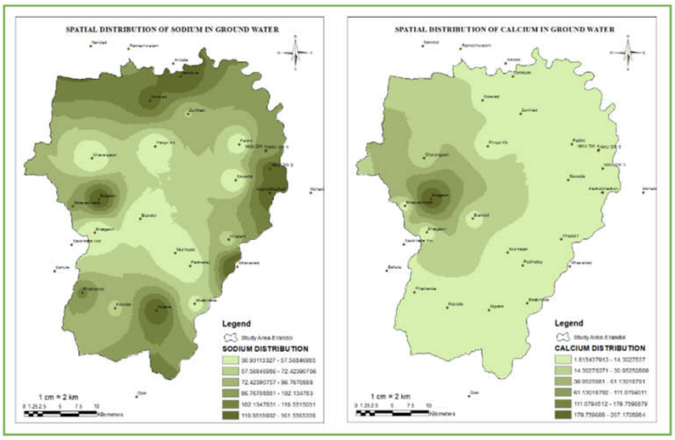

Fig V Showing Spatial distribution of Calcium and Sodium

Chloride is an extensively dispersed element in all types of rocks in one or the other form. Its affinity towards sodium is high. Hence, its concentration is high in ground water. Soil porosity and permeability also has a significant role in building up the chlorides concentration (Chanda D K, 1991). The chloride ion concentration in groundwater of the study area fall within the maximum permissible limit of 250 mg/L (Fig.VI). The maximum concentration of chloride was observed at Farkhande and Borgaon in west region of study area. Fluoride is more common in groundwater then surface. The main sources of fluoride in ground water are different fluoride bearing rocks. A Fluoride concentration of approximately 1.0 mg/L in drinking water effectively reduces dental caries without any harmful effect on health. High fluoride may cause fluorosis. The guideline value of 1.0 mg/L in drinking water has been prescribed by BIS as excessive amount of fluoride causes disfigurement of teeth known as dental fluorosis. In present investigation fluoride was detected in 20 ground water sources. Among the studied sources 3 sites Mukhpat, Kadholi and NMU DW 5 shows more than 1 mg/L of fluoride in the East and central region of the study area.

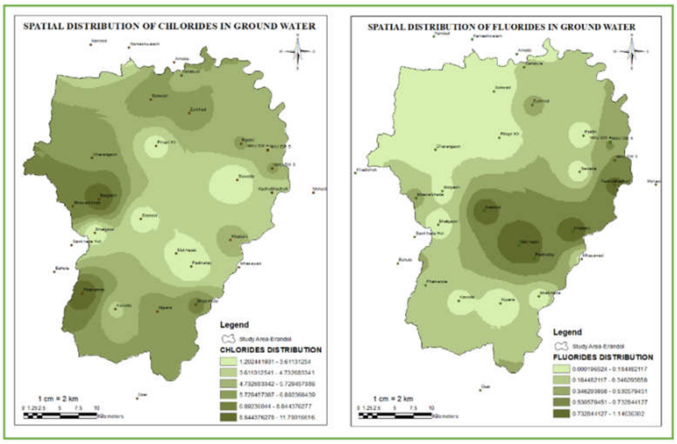

Fig VI Showing Spatial distribution of Chlorides and Fluorides

Nitrate nitrogen is the highest oxidizable form of nitrogen and found in trace quantities in surface water but may attain high levels in some ground water. High concentration in drinking water may cause blue baby disease. In the present investigation, maximum amount of nitrate i.e. 30.1mg/L was observed at Pimpri Kh. Which is located at northern part of Erandol region. Whereas, minimum amount of nitrate i.e. 0.56mg/L was observed at Kadholi which is in the eastern region of Erandol area. Nitrates at all sites were found well below prescribed limits for drinking water. Sulphate is one of the least toxic anions and (WHO, 1984) does recommend guideline value 400mg/L. Water with about 300-400 mg/L of sulphate have a bitter taste and those with 1000mg/L or more of sulphate may cause intestinal disorder. In the study area, sulphate was observed in the range of 38.9mg/L to 177mg/L which is well below the prescribed limit of drinking water. The maximum concentration was observed at Borgaon which is in western part of the study area.

Whereas, minimum concentration was observed at Sawada which is in eastern part of the study area. Water quality maps are useful in assessing the usability of the water for different purposes. Fig. VIII shows spatial distribution of Ground Water

Quality Index in study area. A water quality map is created for each WQI parameter following the classification shown in Table IV. The water quality Index calculated for drinking purpose and it has varied from 32.2 to 100.4. Ground water quality index values shows that water in village Borgaon is unfit for drinking.

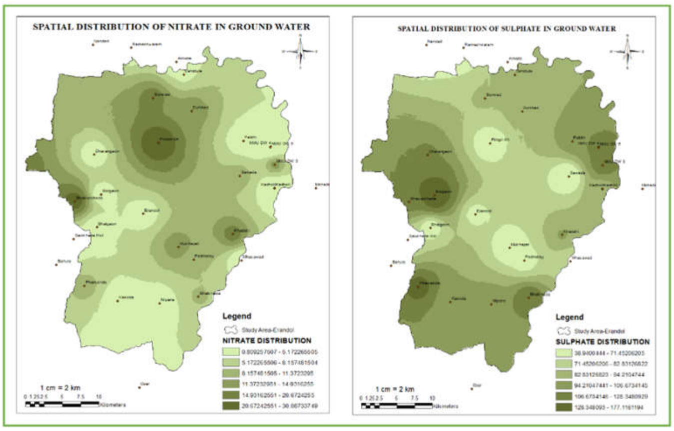

Fig VII Showing Spatial distribution of Nitrate and Sulphate

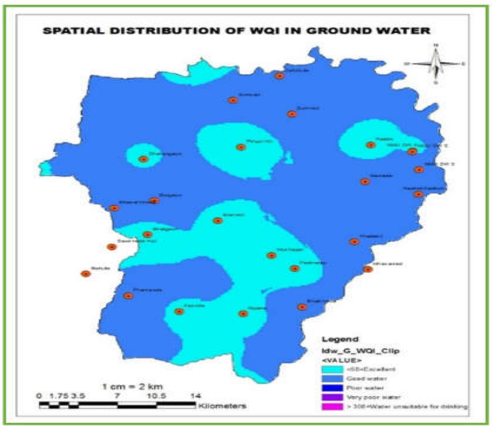

Fig VIII Spatial Distribution of WQI in Ground Water

The rest of the sampling locations have comparatively good quality of water. WQI map is shown in Fig. VIII since water samples were collected from urban and rural areas, the water quality of the samples from urban areas was very poor but away from the urban center water quality was fairly good.

CONCLUSION

The present investigation reveals that, the pH of ground water falls in the range of 7.7 to 10.3. This shows, that the groundwater of the study area is mainly alkaline in nature. the minimum pH was observed at Paldhi and Pharkande in north east zone. Whereas, in north west zone 14 sources of ground water pH were observed beyond the limit. The maximum conductivity was found in the south western part of study area, this is due to presence of highest concentration of dissolved solids. In the study area 13 sources of ground water from North East region were observed highest concentration of alkalinity, whereas, South West and central region shows less amount of alkalinity but, all other observations found within prescribed limit. The maximum amount of hardness was observed at Bhatkheda, Borgaon and Kadholi which is in the South Western region of study area. It is due to presence of higher amount of salts of calcium and magnesium. The dissolved solids present in 14 sources of ground water from the Erandol region were found beyond the acceptable limit. The maximum TDS 1720 mg/L was found at Borgaon in western region of study area whereas, minimum amount i.e.70 mg/L TDS observed at Bhalgaon which is in south western part of study area. The concentration of sodium ranges between 35mg/L to 176.6 mg/L with an average value of 86.55 mg/L. The maximum concentration of calcium i.e. 267.7 mg/L was observed at Borgaon in west region of Erandol, which is beyond the limit for the drinking purpose prescribed by BIS 2012. All other sources of ground water samples were found within the permissible limit. The chloride ion concentration in groundwater of the study area fall within the maximum permissible limit of 250mg/L.

Table III Water Quality Index of Ground Water Samples from PGW-1 to PGW-29

Sr no.	Location	pH	Conductivity µS/cm	Alkalinity	Acidity	TH	DO	Cl	TDS	NO_3	PO_4	SO_4	Na	K	Ca	F	WQI
1	Pimpri Kh	9.7	353	55	40	84	3.4	2.8	219	30.1	0.3	55.2	36.8	1.5	7	BDL	39.6
2	Dharangaon	10.3	802.5	100	65	76	3.2	6.4	605	2.4	0.3	109.4	36.6	8.8	14.4	BDL	47
3	Nanded	9.9	950.8	195	45	106	4.4	2.5	677	10.9	0.5	52.6	172.6	3.3	9.8	0.1694	56.2
4	Rameshwaram	9.6	430.5	105	30	74	3.2	1.9	312	0.8	0.4	47.9	64	2.3	8.3	BDL	35
5	Amode	9.8	1045	125	70	100	3.8	8.0	783	0.8	0.3	96.8	114.4	2.7	10.2	BDL	53.1
6	Dahidule	9.3	951.8	160	115	90	4	4.7	682	4.3	0.4	84.7	160.4	3.1	11.3	0.271	54.3
7	Sonwad	8.8	984.8	125	135	102	3.2	6.6	706	17.5	0.3	84.3	128.8	6.6	13.2	0.0095	53.1
8	Zurkhed	8.3	975.9	80	80	128	5.8	6.8	685	14.0	0.3	87.5	71.4	1.8	4.8	0.4112	58.2
9	Paldhi	7.7	935.2	95	50	84	3.02	6	665	1.6	0.3	102.6	37	1.6	5.1	BDL	44.3
10	Sawada	9.0	251.4	100	40	86	3.2	1.2	1460	10.8	0.3	38.9	30.9	2.2	6.3	BDL	55.6
11	Khadaki	8.9	1078	65	100	140	4.4	5.4	751	17.3	0.3	95.6	65.7	2	6.5	0.9117	63.9
12	Mhasawad	8.2	967.8	110	90	124	5.2	4.6	697	0.7	0.3	71.8	164.2	4.3	12	0.1385	52.6
13	Bhatkheda	8.7	1085	70	70	250	4	7.2	763	8.4	0.2	121.8	52.8	1.7	4	0.1127	57.2
14	Nipane	7.8	1146	30	85	46	3.02	6.8	811	1.7	0.1	106.6	141.7	2.6	8.3	BDL	47.7
15	Kasoda	8.6	836.6	70	40	200	3.8	4.4	551	2.2	0.2	94.7	69.9	1.6	3.3	0.1234	47.4
16	Pharkande	7.7	2050	70	85	164	4	11.8	1430	10.2	0.3	145.5	106	2.2	6	0.2698	76.4
17	Bahute	8.7	487.1	80	50	104	3.02	2.6	329	3.4	0.1	70.7	35	1.1	1.2	0.8006	42.4
18	SawkhedeHol	8.4	510.3	85	75	120	4.2	3.4	358	1.0	0.3	62.3	50.9	2	5.4	0.2592	40
19	Bhalgaon	8.2	324	80	55	70	4.4	2.2	211	1.6	0.2	58.0	30.9	1.5	4.2	BDL	32.2
20	Erandol	9.8	286.1	55	50	82	4.6	2.7	215	2.3	0.1	64.6	38.8	6.8	7.8	0.9089	43.3
21	Bhawarkhede	8.0	1244	110	205	178	3.2	8.6	892	25.3	0.2	112.0	88.4	4.6	7.7	0.4107	64.7
22	Borgaon	7.9	2483	140	145	210	3.4	11.7	1720	1.6	0.2	177.3	146.9	258.5	267.7	0.0892	100.4
23	Mukhapat	8.2	365.2	100	120	60	3.6	3.3	246	14.6	0.2	56.1	35.9	1.8	4.1	1.1468	45.6
24	Padmalay	8.1	410.3	105	105	120	4.63	1.6	276	8.2	0.1	63.3	40.5	1.2	1.8	0.7456	44.6
25	Kadholi	8.6	1438	180	160	268	4	5.8	1060	0.56	0.1	98.4	197.9	3.3	7	0.5846	70.5
26	Kadholi	8.9	368.3	80	65	52	4	1.6	239	2.63	0.1	80.5	62	1.5	2.7	1.002	43.4
27	NMU DW 3	8.0	990.2	125	115	140	3.02	6.1	761	13.0	0.1	125.5	136.8	2.5	5.6	0.5335	58.7
28	NMU DW 4	8.2	603.3	130	130	146	3.02	3.2	452	0.9	0.1	103.3	77.1	2.2	6.1	BDL	41.3
29	NMU DW 5	8..3	831.6	115	140	126	3.02	6.8	728	0.7	0.1	118.9	115.8	2.3	5.5	1.0065	57.5

The maximum concentration of chloride was observed at Farkhande and Borgaon in west region of study area. The fluoride was detected in 20 ground water sources among these studied sources 3 sites i.e. Mukhpat, Kadholi and NMU DW 5 shows more than 1 mg/L of fluoride in the Eastern and central region of the study area.

Table IV Classification of WQI based on value (C. R. RAMAKRISHNAIAH *et. al.*, 1972).

WQI	Water quality	Percentage of Ground water samples
<50	Excellent	48%
50-100	Good water	48%
100-200	Poor water	4%
200-300	Very poor water	0%
>300	Water unsuitable for drinking	0%

The maximum amount of nitrate i.e. 30.1 mg/L was observed at Pimpri Kh. Which is located at Northern part of Erandol region. Whereas, minimum amount of nitrate i.e. 0.56 mg/L was observed at Kadholi which is in the Eastern region of Erandol area. Nitrates at all sites were found well below prescribed limits for drinking water. The sulphate was observed in the range of 38.9 mg/L to 177 mg/L which is well below the prescribed limit of drinking water. The maximum concentration was observed at Borgaon which is in Western part of the study area. Whereas, minimum concentration was observed at Sawada which is in Eastern part of the study area. Most of the study area is covered by agriculture activities and overuse of inorganic fertilizers leads to leaching of nutrients may cause higher amount of nutrient level in the ground water sources. The WQI values of the ground water samples shows that, each 48 percent of groundwater is in excellent and good condition and about 4 percent of total sources were exhibits poor quality of ground water and not suitable for drinking purposes. In the ground water samples, the areas like Borgaon is also showing deterioration in water quality and found that the poor water quality whereas areas like Khadaki, Pharkande, Bhawarkhede and Kadholi have need of special attention before using it for drinking purpose to reside villages.

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