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WATER QUALITY ASSESSMENT APPLYING WATER QUALITY INDEX METHOD IN EARNDOL AREA OF JAGAON DISTRICT, MAHARASHTRA STATE

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ABSTRACT

Water is the most important in influencing the land, regulating the climate and ultimately affects all life forms in the Earth system.Due to rapid industrialization and overuse of chemical fertilizers and pesticides in agriculture are affecting heavy and varied pollution in aquatic environment leading to deterioration of water quality and exhaustion of aquatic life. Consequently, it is essential to the analyze water quality frequently. The present work is aimed to assessthe surface and ground water quality of Erandolarea of Jalgaon District for drinking purpose. The various water quality parameters wereanalyzed using standard methods, these are pH, Electrical Conductivity, Alkalinity, Acidity, Total Hardness, Dissolved Oxygen, Total Dissolved Solids, Fluorides, Chlorides, Nitrate, Phosphate, Sulphate, Sodium, Potassium, Calcium and E. coli. The present investigation revealed that,surface water quality was observed more deteriorated as compared to groundwater. The high WQI values in groundwater samples were principally due to the occurrence of higher values of TDS and E. Coli.

Keywords: Drinking water, Water Quality Index, Erandol Area, Jalgaon

Introduction:

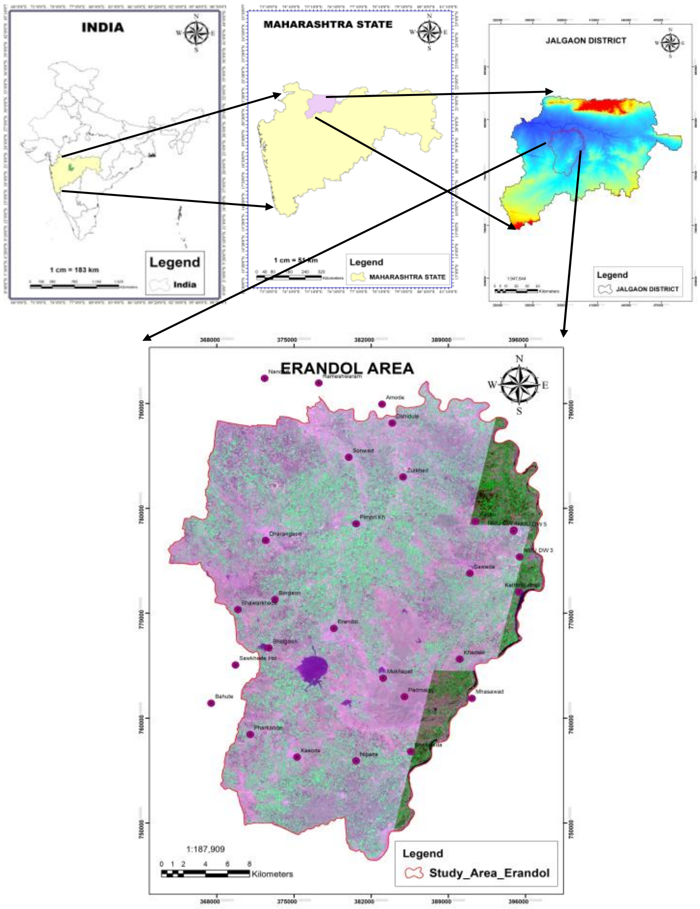
The quality of urban environment is deteriorating day by day due to increase in the population of cities and industrial areas nearby cities therefore at saturation points cities unable to manage within the increasing pressure on their infrastructure. Surface water and ground water are the major sources of drinking water in urban as well as ruler India. Due tounrestraineduse of surface water and extraction of ground water without sufficient recharge and leaching of pollutants from pesticides and fertilizer in aquifers has resulted in pollution of ground as well as surface water supplies(Kumar & Raj, 2018; Sasakova et al., 2018). Water is one of the abundantly presented substances on earth; it is an essential element of all animals and plants and forms about 75 percent of the matter of earth crust(APHA/AWWA/WPCF, 1980). Surface and groundwater are mostly used for domestic and irrigation purposes in this region. Open and tube well water is used for agricultural as well as drinking purposes. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the enhanced pace of industrialization(Okello, Tomasello, Greggio, Wambiji, & Antonellini, 2015).As per WHO, approximately 80% of entirely the diseases in human beings are water born, water related and water based.It is always superior to protect fresh water first rather than recovering on technology to clean up water from contaminated source. Contaminated water is the main cause for the spread of epidemics and chronic illnesses of public. It causes typhoid, jaundice, diarrhea, dysentery, tuberculosis and hepatitis.The consumption of polluted water for irrigation purposes rigorously damages crop and declines grain production(Sahoo, Mahananda, & Seth, 2016).Advancements in the science and technology of water and wastewater treatment, water management and clean water supply, awareness related to water conservation and savings, may definitely improve future clean water inadequacy issue (Boretti & Rosa, 2019; Sharma & Bhattacharya, 2017).The extensive objective of the proposed work is to assess the ground and surface water quality used for agricultural, domestic purpose or for industrial purposes.The WQI provides a single outcome in the form of number which expresses the overall water quality status of a particular water body at a particular period after assessing selected water quality parameters for that particular water body (MPCB, 2018). Water Quality Index is a competent method for evaluating the suitability of water quality for different uses. The assessment of surface and ground water quality can be a complex process undertaking various parameters capable of creating numerous pressures on overall water quality. It is also a very applied and tool for relaying the information on overall quality of water to the layman and concern government, non-government organization local governing bodies (Bhutiani, Khanna, Kulkarni, & Ruhela, 2016). The use of WQI simplifies the reports of results of investigation related to a water body, as it summarizes in a single unitless value, the collective effect of several water quality parameters analyzed. The use of water quality index in estimating the quality of surface water bodies such as rivers and lakes have increased tremendously since the initial WQI established by Horton (1965) and upgraded version by (Brown, McClelland, Deininger, & Tozer, 1970).The Water Quality Index (WQI) is determined consideringseveral biological, physical and chemical water quality parameters that define the various purposes of application of water bodies for human consumption, such as recreation, drinking, industries, agriculture, aquaculture and domestic(Akhtar et al., 2021).

Study Area

The Erandol area is located in Jalgaon district of Maharashtra state has been selected as study areas for the present investigation.It is a small city in Jalgaon district of Maharashtra state, India. Erandol is located at 20°55′N 75°20′E / 20.92°N 75.33°E / 20.92; 75.33. It has an average elevation of 744 feet. Geographically Erandol Situated at Tapi Valley of the Deccan Plate, between the Satpuda Hills and Ajanta Hills. Anjani river passes through the city The East-West Corridor - National Highway 6 or Asian Highway 46, which connects Mumbai and Nagpur connects the town to Dhule to the west and Jalgaon to the east. A major part of the district comes under Tapi basin. It is the key river flowing through the district. For intensive and in-depth study, 48 sampling sites were selected in Erandol area. The site map of the investigation region is depicted in

Figure 1.

Figure 1.Showing study area and sampling locations in Erandol Region, Maharashtra State, India.



Materials and Methods

Collection and analysis of samples

Samples of surface and ground water were collected from predetermined locations from rural and suburban areas selected from the satellite imagery. After collection of the surface and ground samples, these are well-preserved and shifted to the laboratory for quality analysis. Physico-chemical analysis was carried out to determine sixteenth different water quality parameters implementing standard methodsprescribed by (APHA., AWWA., 1998)and outcomes were compared with standard values for drinking water recommended by Bureau of Indian Standards(BIS, 2012). The surface and groundwater quality data thus obtained is used as database for present investigation.

Calculation of Water Quality Index

In the present investigation to calculate WQI, a simple statistical weighed arithmetic index method was adopted which is developed by Ramakrishnaiah CR(Ramakrishnaiah, Sadashivaiah, & Ranganna, 2009). For obtaning WQI values, three steps haveadopted. In the very first step, a weightage (wi) has been allocated to each of the selected parameters according to its relative importance or role in determining the overall quality of water for drinking purposes as per **Table 1.** The highest weight of 5 has been allocated to the parameter MPN and nitrate due to its main importance in water quality assessment. Sodium which is given the minimum weight of 1 by itself may not be detrimental. Furtherin the second step, the relative weight (Wi) is computed by using the following equation:

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i} \qquad 1.$$

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 **Error! Reference source not found.**.In the third step, a quality rating scale (qi) for each parameter is allocated by dividing its concentration in each individually water sample by its respective drinking water standard according to the guidelines laid down in the BIS and lastly result multiplied by 100.

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

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, which is then used to determine the WQI as per the following equation

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

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

SIi is the sub index of i^{th} parameter; qi is the rating based 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 1. Relative weight of water quality parameters.

Water Quality Parameters	BIS Standards	Weight (w_i)	Relative Weight(W_i)
pH	6.5-8.5	4	0.09
Alkalinity	200-600	2	0.05
Electrical Conductivity (EC)	1-1.5	3	0.07
Total hardness (TH)	200-600	2	0.05
Sodium(Na)	200	1	0.03
Calcium(Ca)	75-200	2	0.05
Chloride	250-1000	3	0.07
Total dissolved solids (TDS)	500-2000	4	0.09
Dissolved Oxygen (DO)	6	5	0.11
Fluoride	1-1.5	4	0.09
E.coli	1	5	0.12
Nitrate	45	5	0.12
Sulphate	200-400	4	0.09
		$\sum w_i$= 44	$\sum W_i$= 1.00

Results and Discussions

According to World Health Organization (WHO), inadequate management of urban, industrial and agricultural wastewater means the drinkingwater of hundreds of millions of people is severely contaminated. Natural presence of chemicals pollutants, principally in groundwater, can also be of health significance, including arsenic and fluoride, while other chemicals, such as lead, may be higher in drinking water because of leaching from water supply mechanisms when it is in contact with drinking water.Monitoring water quality is extremely essential for sustaining ecosystem health and the livelihood of the population. It also signifies the health of surface water bodies at particular time (Srivastava et al., 2020).WQI is a mathematical method to determine the overall status of surface and ground water quality at specific times and sites(Akhtar et al., 2021).Descriptive statistics of the concentrations in surface and groundwater quality parameters depicted in

Table *2*and **Table 3**.

Table 2. Descriptive statistics of the concentrations in surface water quality parameters.

Statistical parameters	pH	EC	Alkalinity	Acidity	TH	DO	Cl	TDS	NO_3	PO_4	SO_4	Na	K	Ca	E.coli	F
Min	9.5	118.6	40	40	30.5	3.4	1.3	90	0.1	0.2	61.4	28.8	5.1	12.6	0.0	0.1
Max	11.4	1787	515	265	230	14	16.8	1350	5.9	0.5	206.8	168.4	55.4	57.2	9.0	0.5
Average	10.6	395.9	100	112.4	70.95	5.8	3.4	324.7	0.9	0.3	87.7	67.1	16.9	22.1	2.8	0.2
SD	0.6	387.1	107.3	63.1	49.97	2.5	3.9	314.6	1.3	0.1	34.2	47.9	14.2	11.9	2.6	0.2

All parameters are expressed in mg/L except pH, EC is expressed in µS/cm and E. coliexpressed in MPN/100ml

Table 3. Descriptive statistics of the concentrations in ground water quality parameters.

Statistical parameters	pH	EC	Alkalinity	Acidity	TH	DO	Cl	TDS	NO_3	PO_4	SO_4	Na	K	Ca	E.coli	F
Min	7.7	251.4	30	30	46	3	1.2	211	0.6	0.1	38.9	30.9	1.10	1.2	0.0	0.01
Max	10.3	2483	19	205	268	5.8	11.8	1720	30.1	0.5	177.3	197.9	258.5	267.7	0.0	1.15
Average	8.7	868.5	101.4	88.1	121.7	3.8	5.1	665	7.3	0.3	89.2	86.6	11.6	15.8	0.0	0.5
SD	0.7	509.7	37.1	42.8	55.9	0.7	2.8	383.4	7.9	0.1	31.4	50.7	47.5	48.6	0.0	0.4

All parameters are expressed in mg/L except pH, EC is expressed in µS/cm and E. coli expressed in MPN/100ml

The Surface Water Quality Index (SWQI) calculated for drinking purpose has varied from 31 to 159. Water quality index values depicted that surface water particularly in villageslike Pimpri Kh, and Pharkande, and suburban areas includes Erandol and Dharangaon were unfit for drinking. The rest of the sampling locations showed comparatively good quality of water.The SWQI data showed that the overall 58 percent of water is good and suitable for domestic purpose after applying disinfection process and about 22 percent of each total study area was found to have poor as well as excellent quality. In the ground water samples, the area like Borgaon villagewas showed deterioration in water quality.The overall Ground Water Quality Index (GWQI)datawere depicted that, 4 percent of locationsfalls under poor water category and rest of 48 percent of each are found in excellent as well as good water category. In the surface water sample areas like Pimpri Kh, Pharkande, Erandol and Dharangaon have need of special attention and water should passed through primary treatment prior to usefor domestic purpose.

Table 4.Category of surface and ground water based on calculated WQI values.

WQI	Water quality interpretation	Percentage of Surface water samples	Percentage of Ground water samples
<50	Excellent	22%	48%
50-100	Good water	58%	48%
100-200	Poor water	22%	4%
200-300	Very poor water	0%	0%
>300	Water unsuitablefor drinking	0%	0%

Figure 2.Showing category of surface and ground water based on calculated WQI values.

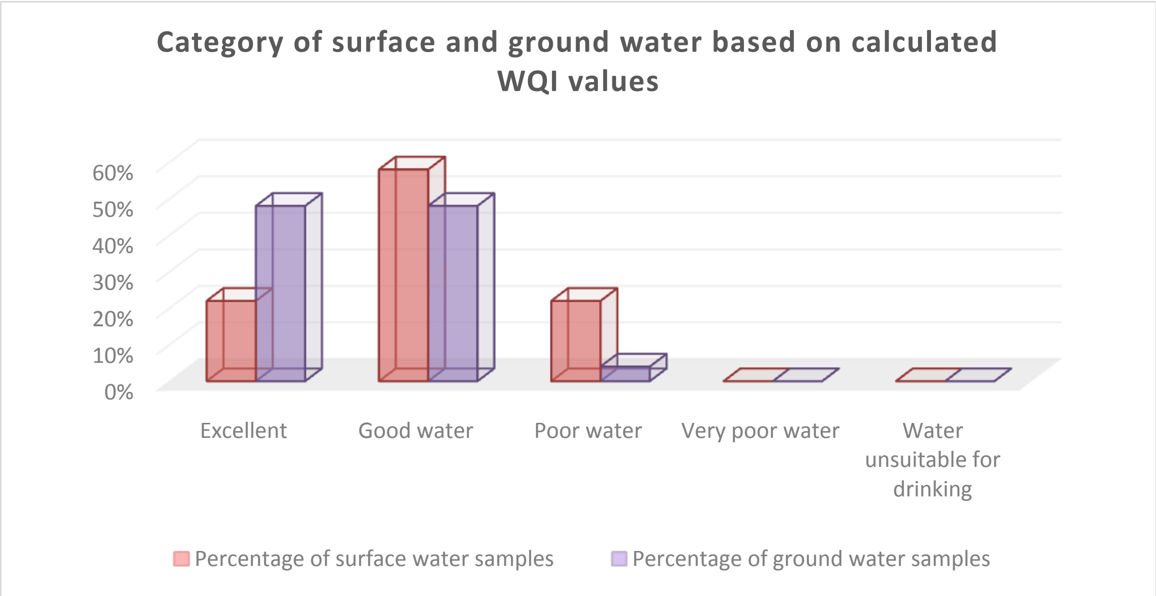


Figure 3. Showing SWQI at different selected sites.

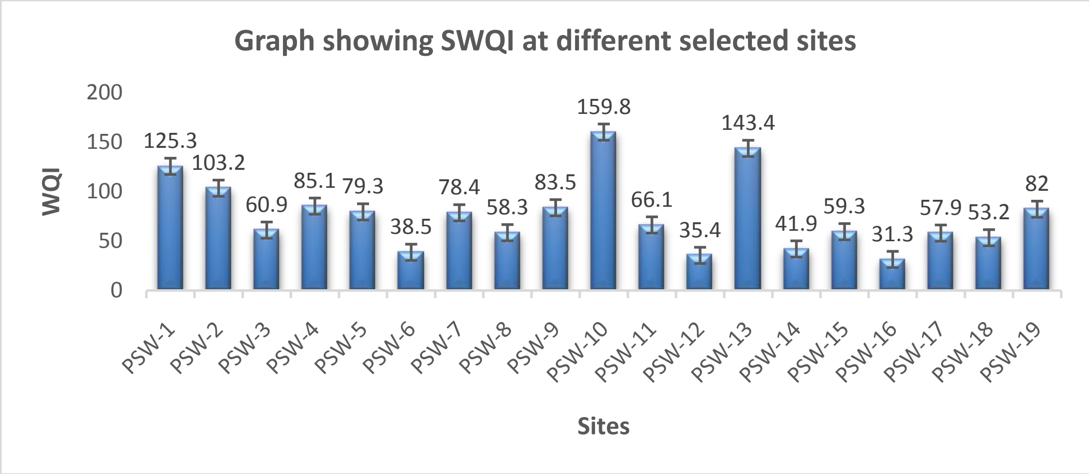
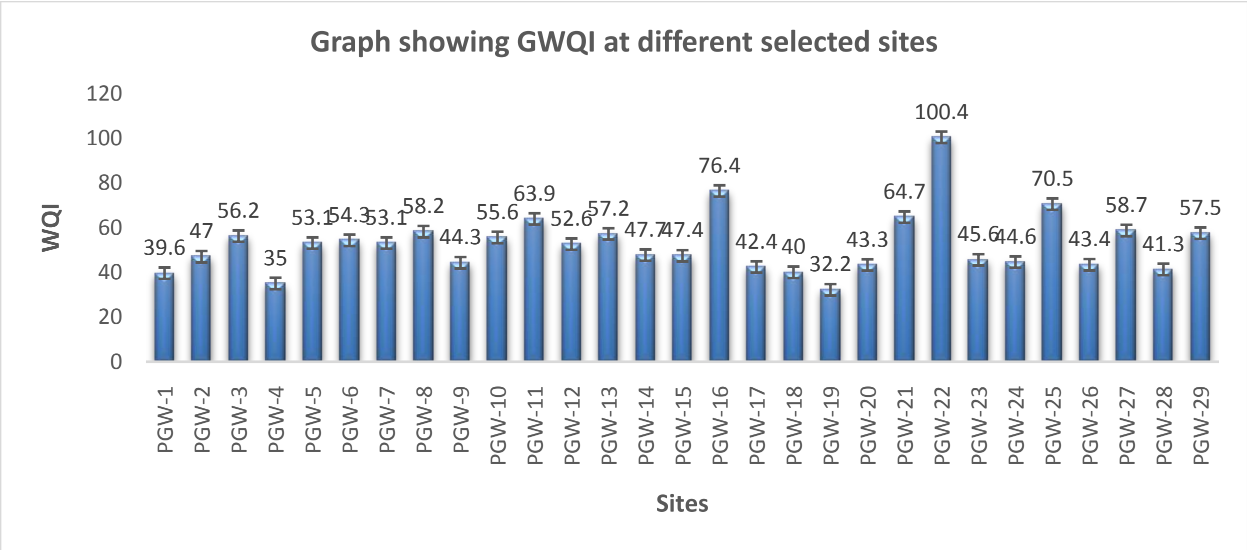


Figure 4. Showing GWQI at different selected sites.



Conclusion

Surface and ground water quality and its suitability for drinking purposes in Erandol area has been estimated. The water quality index data of the present study revealed that majority of the surface and ground water samples fall under goodto excellent category. The surface water quality was observed more deteriorated as compared to groundwater.The high WQI values in groundwater samples were principally due to the occurrence of higher values of TDS and E. Coli. The studies of WQI for both surface and ground water, revealed that only 22% and 4% of sites falls under poor water category and these sources were found unsuitable for drinking purpose. None of the sources of surface as well as ground water showed very poor category as per WQI based classification.Overall analysis outcomes depicted that the agricultural runoff, waste disposal, leaching and traditional methods irrigation are the primarysources of surface and groundwater pollution. Hence, there is anessentialprerequisite of appropriate attention and management of surface and groundwater resources. The application of WQI to evaluate variations in surface and ground water quality was therefore found suitable and effective tool for monitoring and proper management surface and ground water resources.

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