The Pharma Innovation Journal 2023; 12(7): 3352-3357

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(7): 3352-3357

www.thepharmajournal.com
Received: 13-05-2023
Accepted: 20-06-2023

MM Hyalij
Research Scholar, Department of Soil and Water Conservation Engineering, College of Agriculture Engineering and Technology, Dr. BSKKV, Dapoli, Maharashtra, India

HN Bhange
Associate Professor (CAS), Department of Soil and Water Conservation Engineering, College of Agriculture Engineering and Technology, Dr. BSKKV, Dapoli, Maharashtra, India

BL Ayare
Professor and Head, Department of Soil and Water Conservation Engineering, College of Agriculture Engineering and Technology, Dr. BSKKV, Dapoli, Maharashtra, India

ST Pati
Associate Professor, Department of Irrigation and Drainage Engineering, College of Agriculture Engineering and Technology, Dr. BSKKV, Dapoli Maharashtra, India

PR Kolhe
Associate Professor (CAS), Computer Science, Department of Soil and Water Conservation Engineering, College of Agriculture Engineering and Technology, Dr. BSKKV, Dapoli, Maharashtra, India

Corresponding Author:
MM Hyalij
Research Scholar, Department of Soil and Water Conservation Engineering, College of Agriculture Engineering and Technology, Dr. BSKKV, Dapoli, Maharashtra, India

Assessment of water quality index (WQI) for groundwater in North Sindhudurg district

MM Hyalij, HN Bhange, BL Ayare, ST Patil and PR Kolhe

Abstract
One of the crucial natural resources that satisfies the needs for drinking and irrigation is groundwater. The rising requirement for water in irrigation is achived by groundwater resources. Hence, a geo-spatial study was directed for groundwater testing for water quality valuation to regulate the appropriateness of water for irrigation purpose. With the help of GIS tools, the current study was started with the goal of estimating groundwater quality and mapping its spatial distribution for the north Sindhudurg area. In the present study, ground water samples from different location of four tehsils of north Sindhudurg district for five-year period (2016-2020) has been collected from Groundwater Survey and Development Agency (GSDA) Sindhudurg. The Weighted Arithmetic Water Quality Index approach was examined for five years based on ten physicochemical parameters (Total Dissolved Solids, Electrical Conductivity, pH, Calcium, Total Hardness, Sulphate, Sodium, Potassium, Chloride, and Total Alkalinity). The geographic allocation of water quality index maps was created using the IDW interpolation method. Q-GIS software is used to create a map of the water quality index. The analysis of groundwater quality was found that resulted values of water quality index for the all studied five years are comes under 'Good to Excellent' class. This shows that the groundwater in study area is appropriate for irrigational use. Therefore, application of this groundwater for irrigation purpose is not hazardous for soil fertility.

Keywords: water quality index (WQI), inverse distance weightage (IDW) and assessment

Introduction
Groundwater is the water that exists beneath the surface of the Earth in the pore spaces of the soil and in the cracks of the rock formation. It is a reliable source for meeting the requirements for irrigation, drinking and industrial use. It is projected that, around one third of the world's population consumes groundwater for the improvement, industrial and agricultural activities which directly or indirectly disturbs the groundwater superiority (Tatawat and Singh Chandel, 2006; Gupta, 2016) [9, 5].
India is the largest groundwater user, consuming about 230 cubic kilometers of groundwater annually, more than 60% of which is used for irrigated agriculture, and 85% of its drinking water supply depends on groundwater (Pandian and Jayachandran 2014). In Maharashtra, of the total area under irrigation, 2.875 million hectares (71%) of agricultural land is irrigated by groundwater and 11.83 million hectares (29%) by influent or canal irrigation. 85% of the total groundwater used is used for irrigation, 10% for industry and 5% for domestic food. There is a huge use of groundwater in daily routine but now a day's groundwater becomes more pollutant due to naturally occurring chemicals, poor cleanness systems, inappropriate sewage removal, unnecessary usage of fertilizers and pesticides, seepages from industrial releases, over pumping of groundwater.
The term "water quality" generally refers to the physical, chemical, or natural state of water. This may have to do with the suitability of water for specific uses and purposes. The excellence of water is distinguished by a range of physical, chemical and natural parameters, which stand up from a diversity of natural and human impacts. Inverse Distance Weighting (IDW) is a raster interpolation technique present in QGIS software (version 3.10.2). This spatial interpolation technique helps to depict the local mapping of irrigation water quality parameters (Raghav and Singh, 2021) [8].
An irrigation water quality index (IWQI) allows conversion of large data sets describing the appropriateness of irrigation water sources to a single numeric count, thus simplifying the valuation of water quality. The Water Quality Index (WQI) is one of the most proactive tools to provide water quality information to concerned residents and policy creators.

Water Quality Index (WQI) is a measure used to estimate overall water quality based on the values of water quality parameters. This is an assessment that shows the combined impact of various water quality parameters (Amadi *et al.*, 2010) [1].

Groundwater chemistry plays a very significant part for the study of its superiority in the coastal aquifers. In North Sindhudurg district some villages face water shortage during summer months in spite of heavy rainfall. Therefore, all the agricultural as well as domestic and industrial requirement of water are fulfilled by using groundwater. Maharashtra having 720 km long coastal belt is detecting speedy steps in development activities and therefore the available groundwater resources are under constant threat.

Keeping these in view the current study is undertaken to check the assessment of ground water quality for irrigation in north Sindhudurg district encompassing Malvan, Kankavli, Vaibhavwadi and Deogad tehsils.

Materials and Methods

Study Area

Sindhudurg district is situated in the Konkan region of Maharashtra State and encompasses a total area of 5207 square kilometers, out of which north Sindhudurg district covers 2680 sq.km. Sindhudurg district has a sea coast length of 121 km**.** Climatic conditions in the region are strongly influenced by its geographical features. The region falls into the category of 'Guaranteed and Abundant Precipitation zone'. The weather is predominantly damp. The location of the study area can be seen in Fig.1.

Data Procurement

Groundwater quality data of ten parameters namely pH, total dissolved solids, Electrical conductivity, Calcium, Alkalinity, Chloride, Potassium, Sodium, Sulphate and Total Hardness. for five years (2016-2020) period was collected from Groundwater survey and development agency (GSDA), Sindhudurg, Maharashtra for four tehsils namely Malvan, Kankavli, Vaibhavwadi and Deogad.

Software used

In existing study different GIS works were conducted by using Q-GIS 3.18.3 software. Q-GIS is a free opensource software available has been used.

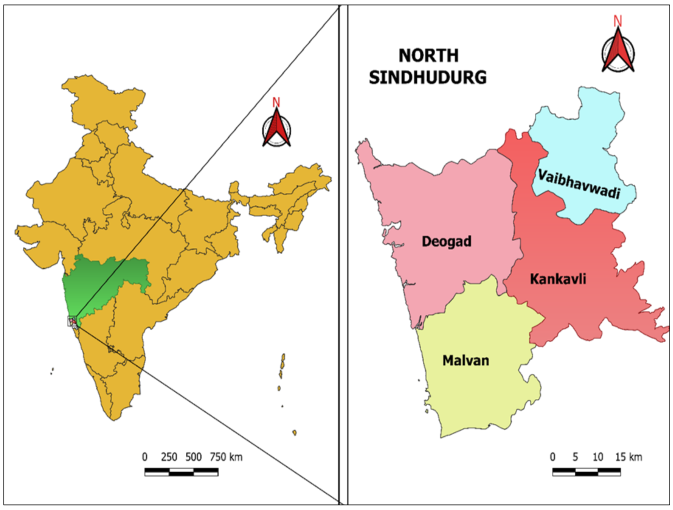

Fig 1: Location map showing four talukas of Study area

Water Quality Index (WQI)

Water quality index (WQI) is calculated to decrease the vast quantity of data on groundwater quality into a single numerical value generally with no dimension in a simple way. The concept of WQI first intended by Horton. For WQI calculation, ten physio-chemical quality parameters have been designated those are pH, total dissolved solids (TDS), Electrical conductivity (EC), Calcium, Alkalinity, Chloride, Potassium, Sodium, Sulphate and Total Hardness (TH). The weighed arithmetic WQI process has been employed for the computation of water quality index for the taken values of water samples for various years.

Water quality index was computed by adopting subsequent process given by (Dharani and Vidya, 2018) to find out appropriateness of ground water for irrigation and drinking purpose. Suppose there n parameters for water quality and quality grade (Q_n) is a number that replicates the comparative value of n^{th} water quality parameter in contaminated water compared to its accepted standard value. Quality grade (Q_n) was computed as follows.

$$Q_n = 100\,\frac{(Vn - V10)}{(Sn - V10)} \qquad (1.1)$$

Where,

Q_n = Quality Grade for the n^{th} parameter

V_n = Actual value of n^{th} water quality parameters

S_n = Standard value of n^{th} water quality parameter

V_{10} = Ideal value (V_{10}= 0 for all the parameters except pH which is 7).

Unit weight (W_n) for n^{th} water quality parameter is inversely proportional to the suggested standard value S_n of the relative parameter.

$$Wn = \frac{K}{S_n} \qquad (1.1)$$

Where,

W_n = Unit weight for n^{th} water quality parameter

S_n = Standard value of n^{th} water quality parameter

K = Constant of Proportionality

The standards suggested by the Indian Council of Medical research (ICMR) and Indian Council of Agricultural Research (ICAR) are considered for quality grade (Q_n) and Unit Weight (W_n) estimation were used in this study.

The complete WQI was computed by collecting the quality grade with the unit weight linear manner and can be provided by the subsequent equation.

$$WQI = \frac{\sum Q_n W_n}{\sum W_n} \qquad (1.3)$$

Where,

Qn = Quality Rating for the n^{th} water quality parameter

Wn = Unit weight for n^{th} water quality parameter

The ranges of WQI, the conforming status of water quality and their probable use are shortened in Table 1. Based on the findings of examining various maps depicting water quality parameters for north Sindhudurg district were prepared in GIS environment using Q-GIS 3.18.3 Software. The entire process for generation of water quality index map is depicted in fig.2.

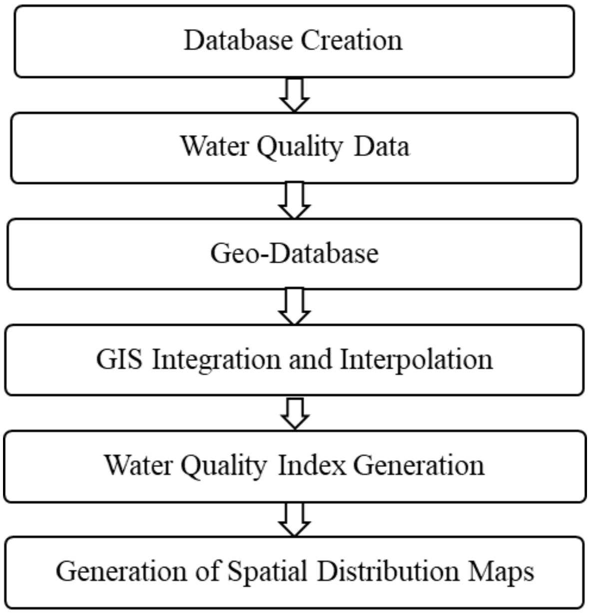

Fig 2: Flow diagram of generation of Water Quality Index (WQI) maps

Table 1: Classification of water quality based on weighted arithmetic WQI method

Water quality index	Water quality status	Possible Uses
25	Excellent	Drinking, Irrigation and Industrial
26-50	Good	Domestic, irrigation and Industrial
51-75	Poor	Irrigation and Industrial
76-100	Very poor	Irrigation
>100	Unsuitable	Restricted use for Irrigation

(Horton, 1965)

Results and Discussion

Water Quality Index (WQI) Map

Water Quality Index (WQI) are important and helpful in assessing the usability of water. It shows the water quality in relation to a numerical index and provides valuable data on the overall excellence of water for irrigation utilities in addition to for water quality management. Water quality index maps of four tehsils for five-year period (2016-20) were created by assigning values to the water quality factors (Table 2). For the present study calculated WQI values are categorized into five categories *viz*, Excellent, Good, poor, Very Poor and Unsuitable. WQI calculated by combining the ten WQI parameters *viz*. EC, TDS, Ca, Cl, SO_4, Total Hardness, pH, Alkalinity, Na and K into the GIS provided the quality of water, whether suitable or unsuitable for irrigation.

Water Quality Index of year 2016-17

The map displaying the water quality index for the study region during the year 2016-17 was shown in Fig.2. The GIS based WQI map analysis indicates that 91.89 percent area falls under excellent category, followed by 7.36% good category. For this year partly area came under poor and very poor quality i.e., 0.51% and 0.13% and 0.11% (2.85 km^2) area had groundwater quality not appropriate for irrigation.

Water Quality Index of year 2017-18

The spatial allocation of the WQI of study area for the year 2017-18 was depicted in Fig.3. WQI map of this year indicates that 1836.11 km^2 (68.49 percent) area having excellent water quality followed by 29.79 percent good category. Groundwater quality which falls under poor, very poor and unsuitable category for irrigation purpose had 1.14 percent, 0.22 and 0.36% area, respectively for this year.

Water Quality Index of year 2018-19

The GIS based WQI map analysis (Fig.4) for the year 2018-19 indicated that 84.93 percent of the area showed an excellent water quality index (0-25). In this year 14.21 percent area had good groundwater quality for irrigation purpose followed by 0.71 percent area under poor groundwater quality, 0.11% area had very poor and very less portion of area i.e., 0.05% area had groundwater quality not fit for irrigation.

Water Quality Index of year 2019-20

The spatial allocation of the WQI for the year 2019-20 was show in Fig.5. This WQI Map of the study area indicates that major portion i.e., 2536.64 km^2 (94.62 percent) area out of total study area (2680.99 km^2) was having excellent (0–25) quality of groundwater. In this year 5.25 percent falls under good under good water quality followed by only 0.13 percent under poor groundwater quality. In this year 99.87 percent area comes under excellent to good groundwater quality.

Water Quality Index of year 2020-21

WQI in the study region spatially distributed map for the year 2020-21 was show in Fig.6. Out of 2680.99 km^2; 81.93 percent (2196.51 km^2) area comes under excellent category, 17.96 percent (481.38 km^2) under good, 0.11 percent (3.07 km^2) under poor category and only 0.015 km^2 area comes under very poor. The results of the current research exposed that overall groundwater was suitable for irrigation use on the basis of water quality index in the north Sindhudurg district. Similar results were also detected and strongly supported by (Bhange *et al*., 2016) [2] and (Bhange *et al*., 2018) [3]. Table 3. displays year wise water quality index categorized classes and its area.

Table 2: Water quality parameters, their standards, and assigned weights

Parameter	Standard, Sn	1/Sn	K	Wn
pH	8.5	0.117647	4.127828	0.485627
EC	2250	0.000444	4.127828	0.001835
TDS	1500	0.000667	4.127828	0.002752
Alkalinity	100	0.01	4.127828	0.041278
Chloride	600	0.001667	4.127828	0.00688
Sulphate	1000	0.001	4.127828	0.004128
TH	300	0.003333	4.127828	0.013759
Ca	400	0.0025	4.127828	0.01032
Na	200	0.005	4.127828	0.020639
K	10	0.1	4.127828	0.412783
	Total	0.242258		1

Table 3: Water quality index categorized classes and its area

Sr. No	Year	Class	Area (Km^2)	Percent
1	2016-17	Excellent	2463.65	91.89
		Good	197.29	7.36
		Poor	13.61	0.51
		Very Poor	3.59	0.13
		Unsuitable	2.86	0.11
2	2017-18	Excellent	1836.11	68.49
		Good	798.77	29.79
		Poor	30.57	1.14
		Very Poor	5.89	0.22
		Unsuitable	9.66	0.36
3	2018-19	Excellent	2276.86	84.93
		Good	380.95	14.21
		Poor	19.10	0.71
		Very Poor	2.88	0.11
		Unsuitable	1.21	0.05
4	2019-20	Excellent	2536.64	94.62
		Good	140.85	5.25
		Poor	3.50	0.13
5	2020-21	Excellent	2196.52	81.93
		Good	481.39	17.96
		Poor	3.08	0.11
		Very Poor	0.02	0.00

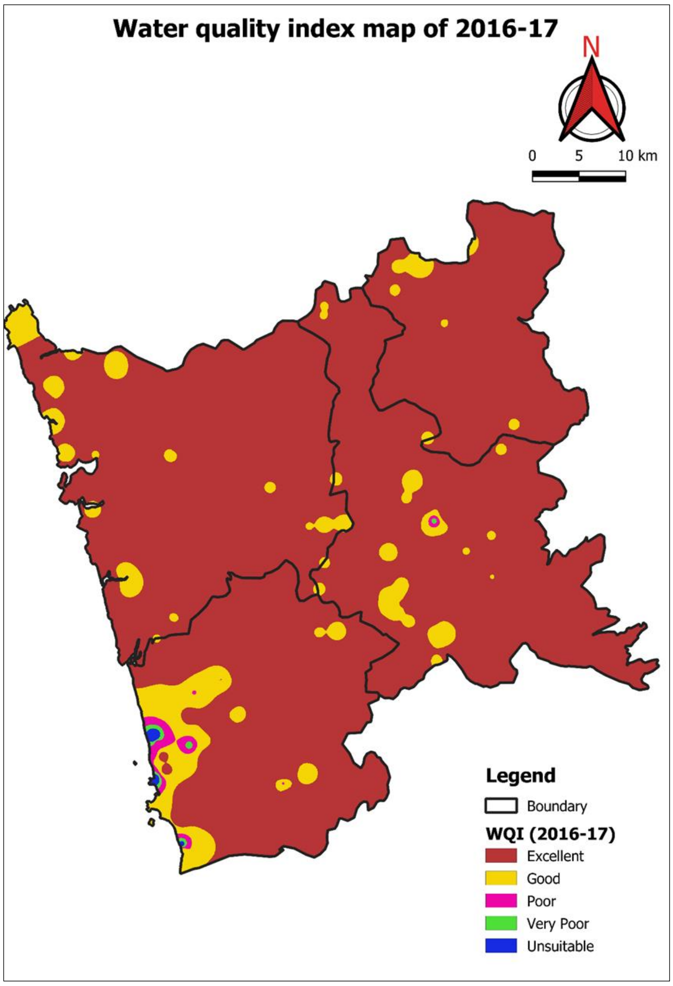

Fig 3: Spatial allocation water quality index map of 2016-17

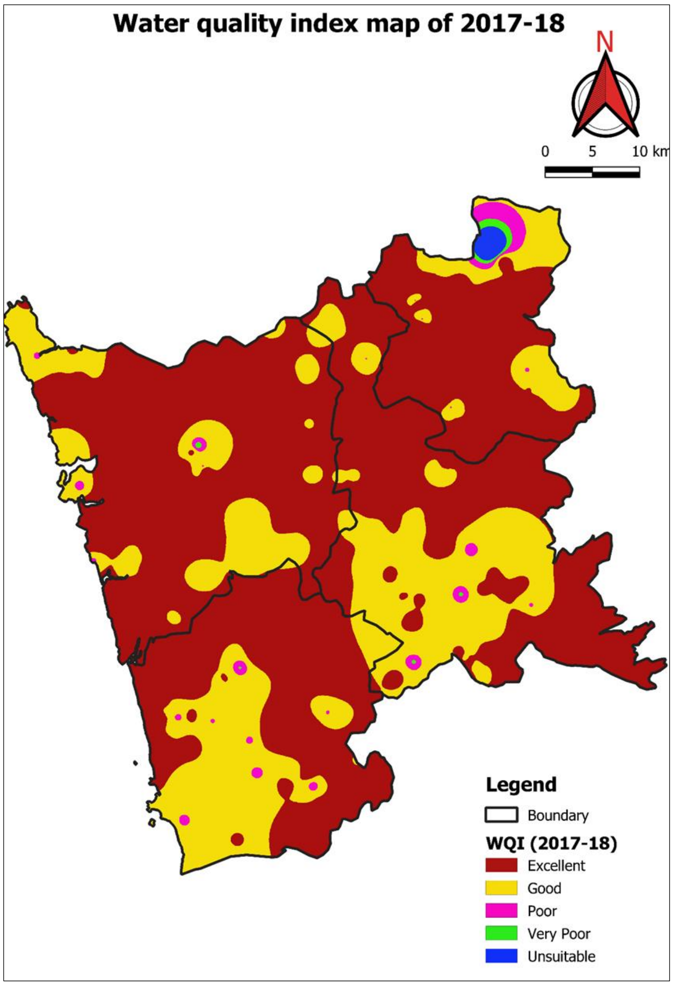

Fig 4: Spatial allocation water quality index map of 2017-18

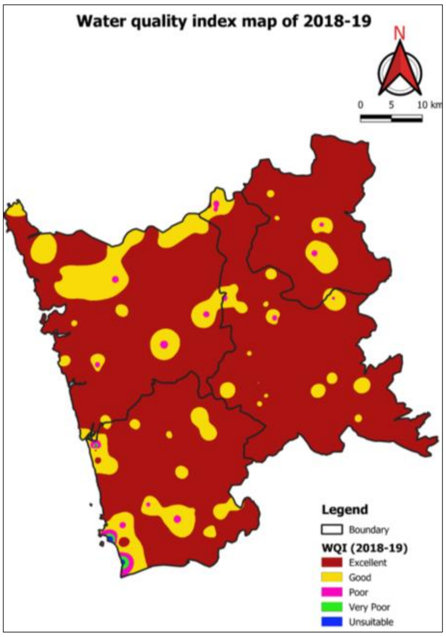

Fig 5: Spatial allocation water quality index map of 2018-19

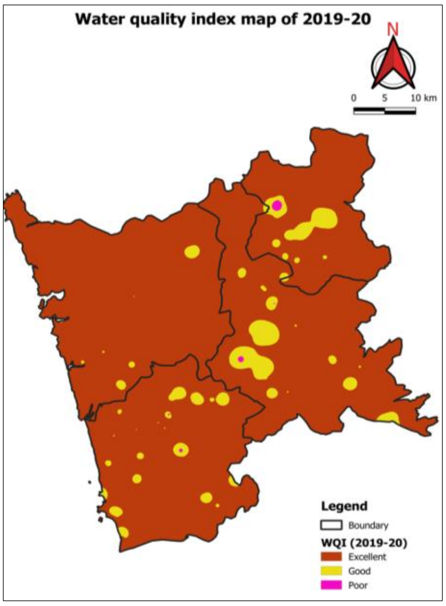

Fig 6: Spatial allocation water quality index map of 2019-20

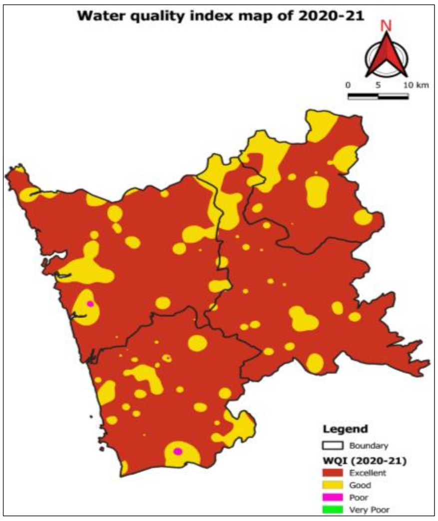

Fig 7: Spatial allocation water quality index map of 2020-21

Summary and Conclusions

Summary

Sindhudurg district is situated in the Konkan region of Maharashtra State and encompasses a total area of 5207 square kilometers, out of which north Sindhudurg district covers 2680 sq.km. Sindhudurg district has a sea coast length of 121 km**.** Climatic conditions in the region are strongly influenced by its geographical features. The region falls into the category of 'Guaranteed and Abundant Precipitation zone'. Total four tehsils of North Sindhudurg district namely Malvan, Kankavli, Vaibhavwadi and Deogad were selected for estimation of groundwater quality. The groundwater quality data from GSDA department was collected for the period of five years from 2016 to 2020.

In accordance with the examination procedure of Water quality index, maps were derived in GIS environment under five major classes. The analysis found that 91.89 percent, 7.36 percent, 0.51 percent, 0.13 percent and 0.11 percent area come under excellent, good, poor, very poor and unsuitable categories respectively for year 2016-17. In the year 2017-18, 68.49 percent, 29.79 percent, 1.14 percent, 0.22 percent and 0.36 percent area come under excellent, good, poor, very poor and unsuitable category. For year 2018-19 the 84.93 percent, 14.21 percent, 0.71 percent, 0.11 percent and 0.05 percent area was found to be under excellent, good, poor, very poor and unsuitable class respectively. For year 2019-20 the 94.62 percent, 5.25 percent and 0.13 percent comes under the excellent, good and poor categories respectively. In the year 2020-21, 81.93 percent, 17.96 percent, 0.11 percent and 0.0006 percent comes under excellent, good, poor and very poor categories. Therefore, total area comes under excellent and good limit.

Conclusions

Using Water quality index technique, the analysis of groundwater quality was revealed that resulted values of water quality index for the all examined five years are falls under either ‘Excellent or Good’ category. This displays that the groundwater in study area is appropriate for irrigational use. Therefore, application of this groundwater for irrigation purpose is not hazardous for soil fertility.

The groundwater was found suitable for irrigation purpose of the entire study area as per irrigation water quality standards. The study will be beneficial to the decision makers and organizers for recovery of groundwater quality nearby as well concerning groundwater quality turn of events. But it is necessity of human to increase responsiveness amongst the individuals to keep the groundwater at their best and clarity levels.

References

1. Amadi AN, Olasehinde PI, Okosun EA, Yisa J. Assessment of the Water Quality Index of Otamiri and Oramiriukwa Rivers. Physics International. 2010;l1(2):116-123.
2. Bhange HN, Singh PK, Purohit RC, Yadav KK, Jain HK, Sudhir J. Assessment of Groundwater quality through GIS for Khed Taluka, Ratnagiri, India. International Research journal of Environment Sciences. 2016;5:8-14.
3. Bhange HN, Singh PK, Ingle PM, Gavit BK. Evaluation of water quality index for ground water in Dapoli, MS, India. Research Journal of Recent Sciences. 2018;7(4):32-35.

4. Dharani PT, Vidya AK. evaluation of water quality index using physicochemical parameters of treated domestic sewage water. Life Science Informatics Publications. 2018;5(2):98-112.
5. Gupta SK. Groundwater quality study in district Dhanbad, Jharkhand, India through is application. International journal of advance research in science and engineering. 2016;3:535-539.
6. Horton RK. An index number system for rating water quality, J Water Pollut Cont. Fed. 1965;37(3):300-305.
7. Pandian M, Jeyachandran N. Groundwater Quality Mapping using Remote Sensing and GIS – A Case Study at Thuraiyur and Uppiliapuram Block, Tiruchirappalli District, Tamilnadu, India. International Journal of Advanced Remote Sensing and GIS. 2014;3:580-591.
8. Raghav A, Singh SK. Drinking water quality evaluation for groundwater of Delhi, India using GIS techniques. Ecology Environment and Conservation. 2021;27(1):359-364.
9. Tatawat RK, Singh Chandel CP. Quality of ground water of Jaipur city, Rajasthan (India) and its suitability for domestic and irrigation purpose. Applied ecology and environmental research. 2006;6:79-88.