International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 10 | Oct 2021 www.irjet.net p-ISSN: 2395-0072

Assessment of Water Quality in Kudal Town of Sindhudurg District (MS-INDIA)

S. D. Disale

Principal, *S. R. M. College, Kudal. Dist. Sindhudurg (MS) (INDIA)*

ABSTRACT: Determination of water quality by calculating water quality index (WQI) is essential for selection of appropriate technique of treatment of water which is used for drinking purpose. WQI is a composite influence of different water quality parameters that helps to express the quality of water in single word. By considering heavy rains and highly porous nature of soil in Kudal town, water samples from four different sources *(viz.* two dug wells, one bore well and one Municipal tap) were analysed for various parameters and WQI index was calculated for these points. The study revealed that the water of dug wells is considerably polluted in rainy season (June to October) due to percolation of precipitated surface water during first monsoon. However, bore-well and Nagar panchayat water were excellent for human consumption due to having proper casing to the bore wells and good filtration plant of Nagar panchayat.

1. INTRODUCTION

Water is one of the most important ecological factors vital for life on this planet. It is obtained from natural resources like rivers or artificial resources like dams, dug wells or bore wells. No doubt, river, lake, glaciers and dams water are the water of precipitation/rains, generally called surface water, whereas dug well and bore well water is the rain water percolated deep in to the earth crust and called ground water. Irrespective of source, ground as well as surface water has been used for drinking and other purposes in various sectors such as industries, agriculture, dairy farming, etc. Sometimes these waters are unfit for drinking due to contamination (Kulkarni, 1990).

Kudal is a small taluka place in Sindhudurg district in Konkan (Maharashtra-India). The population of Kudal town is 16015 as per 2011 census. Kudal town has Nagar Panchayat, the local governing authority, who provides filtered drinking water to the residents through a water distribution system, which fetches water from Karli river. However, majority of the residents have their own small dug wells and/or bore wells. They believe in dug well or bore well water and use it for drinking purpose while Nagar Panchayat water is being used for rest of the purposes.

The ground strata of this region are made up of laterite, which is highly porous stone. As it is a heavy rainfall prone area, with annual rainfall more than 3287 mm, the bore wells and dug wells are flooded with rain water during June to mid of October. Due to this the water quality of Nagar Panchayat water distribution system as well as bore and dug wells declines drastically. As a result, people suffer from various diseases like diarrhea, influenza, jaundice, typhoid, etc. extensive research has been carried out on surface water pollution (Khan and Hussain, 1976; Ghosh and George, 1989; Pandey *et.al*. 1993) and ground water pollution (Ugam Kumari and Dilip Pathak, 1993; Pondhe *et.al*., 1997; Mishra and Patel, 2001and Raje *et.al*, 2016) in various parts of India. The water quality monitoring reports are not available with respect to present study area. Therefore, attempts are made to check the water quality of some selected dug wells and bore wells in the town and determine its potability (fitness for drinking) during monsoon.

2. STUDY AREA

Kudal town is located on Mumbai – Goa highway at 17.9198161 longitude, 17.8346177 latitude and at 698m elevation from mean sea level. The study area has humid climate with annual rain fall of 3287 mm. The geo-strata is made up of laterite stone, which is highly porous along with soil of very low water holding capacity, due to which precipitation water rapidly percolates in soil.

3. MATERIALS AND METHODS

After survey of water sources used by people in Kudal town, four spots were selected for sample collection and marked as point – I through point – IV. Point – I and II are dug well, point – III is bore well and point – IV is Nagar Panchayat tap. Water samples were collected on first Sunday of each month from June to September 2019 in clean plastic containers of 2 L capacity. The physico-chemical parameters *viz.* pH, Turbidity, Electrical Conductivity (EC), Total Hardness in terms of $CaCO_3$, Total Dissolved Solids (TDS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Alkalinity, Calcium and Nitrates were analysed by employing standard procedures (APHA, 1985). While analysing these parameters,

the experiments were triplicated and average readings were used for further analysis and determination of Water Quality Index (WQI) of monsoon period in study area.

4. RESULTS

The values of different parameter studied are presented in table no.1 and water quality indices are depicted in table no. 2, 3, 4, 5 & 6.

4.1. The Water Quality Index (WQI): It was developed by Horton (1965) and later on redeveloped by Brown (1970). Recently many modifications have been considered for WQI (Dvivedi, *et.al.,* (1997) and Bhargava, *et.al.*, (1998). It is defined as the composite influence of different water quality parameters in the quality of water. It is a single number calculated using different water quality parameters and used for overall expression of quality of water in different water bodies used for different purposes (Tunc Dede, *et.al.*, 2013). While tabulating the calculations of WQI, different notations are used. They are enumerated below.

q_n = Quality rating for the n^{th} parameter
S_n = Highest desirable level
V_n = Observed value
W_n = Unit weight for the n^{th} parameter
K = Proportionality constant for a given Point (Water body), calculated as K = 1/k, & k = $\Sigma(1/S_n*Oi)$; where Oi is observed value of a parameter
I_n for pH = 7
I_n for DO = 14.6
I_n for all other parameters =00
WQI = antilog [$\Sigma(W_n*Logq_n)$]
Standard values for pH, Total hardness, TDS and Total Alkalinity are as per ICMR.
Turbidity, COD and Nitrate are as per BIS and EC, BOD and Calcium are as per WHO

Table No. 1. Results of Physico-chemical parameters analysed from four study points during June to September 2019.

Sr. No.	Parameter	Study Points			
		Point - I	Point - II	Point - III	Point - IV
1	pH	6.53	6.48	6.85	7.06
2	Turbidity (NTU)	2.158	2.86	1.36	3.18
3	Ele. Conductivity (S/cm)	188.456	183.240	165.140	138.560
4	Total Hardness (ppm)	109.640	112.520	356.150	164.258
5	TDS (ppm)	685.350	715.450	170.630	580.640
6	BOD (ppm)	0.95	0.15	0.45	0.80
7	COD (ppm)	26.260	29.220	22.340	18.640
8	Total Alkalinity (ppm)	87.260	92.430	130.270	138.280
9	Calcium (ppm)	12.590	12.620	24.340	28.290
10	Nitrates (ppm)	0.057	0.083	0.0270	0.160

Table No. 2. Water Quality Index for Point – I

Sr. No.	Parameter	S_n	$W_n=K/S_n$	V_n	$q_n=(V_n/S_n)*100$	Log q_n	W_n*Logq_n
1	pH	8.5	0.0886	6.53	76.8235	1.8855	0.1671
2	Turbidity	5	0.1506	2.158	43.1600	1.6351	0.2463
3	Ele. Conductivity	300	0.0025	188.456	62.8187	1.7981	0.0045
4	Total Hardness	300	0.0025	109.64	36.5467	1.5628	0.0039
5	TDS	500	0.0015	575.35	115.0700	2.0610	0.0031
6	BOD	1	0.7531	0.95	95.0000	1.9777	1.4894
7	COD	100	0.0075	26.26	26.2600	1.4193	0.0107
8	Total Alkalinity	120	0.0063	87.26	72.7167	1.8616	0.0117
9	Calcium	200	0.0038	12.59	6.2950	0.7990	0.0030

10	Nitrates	20	0.0377	0.057	0.2850	-0.5452	-0.0205
$\Sigma(W_n*Logq_n) = 1.9191$							
WQI = 83.0041							

K = 0.7571 for Point – I

Table No. 3. Water Quality Index for Point – II

Sr. No.	Parameter	S_n	$W_n=K/S_n$	V_n	$q_n=(V_n/S_n)*100$	Log q_n	W_n*Logq_n
1	pH	8.5	0.1166	6.48	76.2353	1.8822	0.2195
2	Turbidity	5	0.1982	2.86	57.2000	1.7574	0.3484
3	Ele. Conductivity	300	0.0033	183.24	61.0800	1.7859	0.0059
4	Total Hardness	300	0.0033	112.52	37.5067	1.5741	0.0052
5	TDS	500	0.0020	715.45	143.0900	2.1556	0.0043
6	BOD	1	0.9912	0.15	15.0000	1.1761	1.1657
7	COD	100	0.0099	29.22	29.2200	1.4657	0.0145
8	Total Alkalinity	120	0.0083	92.43	77.0250	1.8866	0.0156
9	Calcium	200	0.0050	12.62	6.3100	0.8000	0.0040
10	Nitrates	20	0.0496	0.083	0.4150	-0.3820	-0.0189
$\Sigma(W_n*Logq_n) = 1.7641$							
WQI = 58.0898							

K = 0.9912 for Point – II

Table No. 4. Water Quality Index for Point – III

Sr. No.	Parameter	S_n	$W_n=K/S_n$	V_n	$q_n=(V_n/S_n)*100$	Log q_n	W_n*Logq_n
1	pH	8.5	0.0485	6.85	80.5882	1.9063	0.0925
2	Turbidity	5	0.0825	1.36	27.2000	1.4346	0.1183
3	Ele. Conductivity	300	0.0014	165.14	55.0467	1.7407	0.0024
4	Total Hardness	300	0.0014	356.15	118.7167	2.0745	0.0029
5	TDS	500	0.0008	170.63	34.1260	1.5331	0.0013
6	BOD	1	0.4123	0.45	45.0000	1.6532	0.6816
7	COD	100	0.0041	22.34	22.3400	1.3491	0.0056
8	Total Alkalinity	120	0.0034	108.27	90.2250	1.9553	0.0067
9	Calcium	200	0.0021	24.34	12.1700	1.0853	0.0022
10	Nitrates	20	0.0206	0.027	0.1350	-0.8697	-0.0179
$\Sigma(W_n*Logq_n) = 0.8955$							
WQI = 7.8614							

K = 0.4123 for Point – III

Table No. 5. Water Quality Index for Point – IV

Sr. No.	Parameter	S_n	$W_n=K/S_n$	V_n	$q_n=(V_n/S_n)*100$	Log q_n	W_n*Logq_n
1	pH	8.5	0.0150	7.06	83.0588	1.9194	0.0287
2	Turbidity	5	0.0254	3.18	63.6000	1.8035	0.0458
3	Ele. Conductivity	300	0.0004	138.56	46.1867	1.6645	0.0007
4	Total Hardness	300	0.0004	164.258	54.7527	1.7384	0.0007
5	TDS	500	0.0003	580.64	116.1280	2.0649	0.0005
6	BOD	1	0.1271	0.8	80.0000	1.9031	0.2419

7	COD	100	0.0013	18.64	18.6400	1.2704	0.0016
8	Total Alkalinity	120	0.0011	112.28	93.5667	1.9711	0.0021
9	Calcium	200	0.0006	28.29	14.1450	1.1506	0.0007
10	Nitrates	20	0.0064	0.16	0.8000	-0.0969	-0.0006
$\Sigma(W_n*Log q_n) = 0.3222$							
WQI = 2.0999							

K = 0.1271for Point - IV

Table No. 6. Standard Water Quality Indices and WQI of Points Studied.

WQI Range	Status	Point	WQI Value	Status of Water
0 - 25	Excellent	I	83.0041	Poor
25.1 - 50	Good	II	58.0898	Poor
50.1 - 75	Poor	III	7.8614	Excellent
75.1 - 100	Very Poor	IV	2.0999	Excellent
Above 100	Unfit for Drinking	--	--	--

5. DISCUSSION

The pH of water depends on various components dissolved in it. As per BIS standard (BIS, 1992), the desirable limit of pH of potable water ranges between 6.7 to 8.5. beyond these limits, water becomes unfit for drinking (Jayasree, 2002). The data presented in Table no. 1 reveals that the pH of water ranges from 6.48 to 7.02, indicating the fitness for drinking. All water samples are slightly acidic owing to the nature of soil existing in this region.

Turbidity is a measure of determination of amount of suspended particles in water. The desirable limit of turbidity is 5 NTU as per ICMR (1975). The turbidity measured during present study in terms of NTU units ranged from 1.36 to 3.18, which are below highest desirable limit. This indicates that the water in selected water bodies (points) is clear in appearance.

The electrical conductivity is the ability of water to conduct electrons. It depends upon total dissolved solids present in water in ionized state. Generally the pure water is non conductor of electricity, but addition of impurities makes it conduct electricity. Rise in electrical conductivity indicates pollution of water (Mishra and Patel, 2002). During present investigation, electrical conductivity was found to be ranging from 138.560 to 188.456 S/cm. No any water sample exceeded the electrical conductivity beyond 300 S/cm., which is highest desirable limit (WHO, 1994).

The upper limit of total hardness is 300 ppm (ICMR, 1975). The studied water samples showed total hardness (in terms of calcium carbonate) ranging from 109.640 to 356.150 ppm. The water sample at Point-III (Bore well) was found to be more than desired limit, which might be due to percolation of domestic wastes in soil strata and its entry in low lying area (Babar and Kaplay, 1999) or it may be due to demineralization of rock strata (Tiwari, 1999).

The values of total dissolved solids ranged from 170.630 to 715.450 ppm. The TDS at points – I, II and IV crossed the upper desirable limit of 500 ppm, but that of point – III remained well below the limit, indicating the safeness of bore wells as compare to dug wells and open water bodies. Consumption of water with high TDS may leads to health problems like gastro-intestinal disorder (Park & Park, 1980).

The biochemical oxygen demand (BOD) of drinking water is generally less than 1 ppm and water with BOD 3ppm is treated as fair and with doubtful purity when BOD reaches 5ppm (Rao, 1997).during present study, BOD ranged from 0.15 to 0.95, indicating fitness of water for human consumption. No sample exceeded the desirable limit of 1ppm.

The COD values ranged from 18.640 to 29.220 ppm and no water sample showed higher COD than desirable limit of

100 ppm. The desirable limit of total alkalinity is 120ppm. During present study, alkalinity of dug wells was found to be well within the range but, bore well and tap water showed increase in values. This increase might be due to entry of carbonate-bicarbonate containing impurities in respective water bodies (Mishra and Patel, 2002).

Nitrogen is essential component in ecosystem. It is utilized by plants and used for synthesis of nitrogenous molecules, but nitrogen in the form of nitrates is hazardous to animals. Increased use of nitrogen containing fertilizers leads to its accumulation in soil and ultimately in water during rainy season. This nitrate subsequently percolates in water bodies (Zusthi and Khan, 1998). Increase nitrates in potable water leads to diseases like goiter, cancer and methaemoglobinaemia (Manivasakam, 1994). During present investigation, nitrates were reported in all water samples with a range from 12.590 to 28.290 ppm. The nitrates at point – III and IV crossed the higher limit of 20 ppm.

The permissible higher limit of calcium in potable water is 200 ppm as per WHO and 75 ppm as per BIS. The water samples tested showed calcium levels within permissible limits of both BIS as well as WHO. Such lower range of nitrates was also reported by Mishra and Patel (2001); Sukumaran, *et.al*. (2001); Khabade *et.al.* (2002) and Raje *et.al.* (2016).

6. CONCLUSIONS

Although study area is heavy rainfall prone area with highly porous soil strata, water quality at study point – III (bore well) and IV (Nagar Panchayat tap) was excellent for drinking purpose. This could be due to use of proper casing to the bore well and filtration plant of water distribution system of Nagar Panchayat. The water of study point – I and II (dug wells) were of poor quality and that could be due to over flooding of open wells during monsoon.

7. REFERENCES

1) APHA, (1985). Standard methods for the examination of water and waste water (16th Edi.), American Public Health Association, New York, USA.

2) Babar, M. D. and D. R. Kaplay (1999). J. Ecol. Environ. and Con. Vol.5, No.2: pp. 141-143.

3) Bhargava, D. S., Saxena, B. S., and R. W. Diwakar (1998). A study of geo-pollutants in the Godavari river basin in India, Asian J. Environ., Vol. 12: pp. 36 - 59

4) Bureau of Indian Standards (1992). Indian standard for drinking water specification, Bureau of Indian standard, New Delhi BIS- 10500: pp. 2- 4.

5) Brown, R. M., McCleland, N. I., Deinenger, R. A. and R. G. Tozer (1970). Water Quality Index-do we dare?, Water Sewage Works, Vol. 117, No. 10: pp. 339 – 343.

6) Dvivedi, S., Tiwari I. C. and D. S. Bhargava (1997). Water Quality of the river Ganga at Varanasi, Institute of Engineers, Kolkata, Vol. 78: pp. 1 – 4.

7) Ghosh, A. and J. P. George (1989). Studies on the abiotic factors and zooplankton in the polluted urban reservoir: Husain Sagar, Hyderabad: Impact of water quality on embryonic development of fishes. Indian J. Environ. Hlth. Vol. 31: pp. 40-59.

8) Horton, R. K. (1965). An Index Number System for Rating Water Quality. . Water Pollu. Cont. Fed. Vol. 37, No. 3: pp. 300 - 305

9) ICMR, (1975). Manual of standards of quality for drinking water supplies. ICMR, New Delhi. Indian rivers. In Ecology and Pollution of Indian Rivers. (Edi. R. K. Trivedi). Ashish Publishing House, New Delhi: pp. 771-786.

10) Jayasree, J. (2002). Quality of water in Parvathy Puthanal in Thiruvananthapuram. Eco. Env. Cons. Vol. 8, No. 2: pp. 167-170.

11) Khabade, S. K., Mule, M. B. and S. S. Sathe (2002). Studies on phyico-chemical parameters of Lodhe water reservoir from Tasgaon Tehsil (Maharashtra). Indian J. Envron. and Ecoplan. Vol. 6, No. 2: pp. 301-304.

12) Khan, M. A. and A. Husain (1976). Preliminary observation of pollution of Lake Husain Sagar caused by industrial effluents. Indian J. Environ. Hlth. Vol. 18, No. 3: pp. 227- 232.

13) Kulkarni, P. R. (1990). Technological mission and drinking water quality in India. In 22nd Annual Convention IWWA: pp. 28-35.

14) Manivasakam, N. (1994). Physico-chemical examination of water, sewage and Industrial effluents. Pagati Prakashan, Meerut.

15) Mishra, P. C. and R. K. Patel (2001). Study of the pollution load in the drinking water of Rairangpur, a small tribal dominated town in the North Orissa. Indian J. Environ. andEcoplan. Vol. 5, No. 2: pp. 293-298.

16) Mishra, P. C. and R. K. Patel (2002). Study on the water quality of Sundergarh town, a district head quarter of WesternOrissa. Indian J. Environ. and Ecoplan. Vol. 6, No. 1: pp. 84-94.

17) Pandey, A. K., Siddiqi, S. Z. and K. V. Rama Rao (1993). Physic-chemical and biological characteristics of Husain Sagar, an industrially polluted lake, Hyderabad. Proc. Acad. Environ. Biol. Vol. 2, No. 2: pp. 161-167.

18) Park, J. E. and K. Park (1980). Text Book of Preventive and Social Medicine, Bhansidas, Bhanet, Jabalpur.

19) Pondhe, G. M., Pawar, N. J. and Patil, S. F. and A. J. Dhembare (1997). Impact of sugar mills effluent on the quality of ground water. Poll. Res. Vol. 16, No. 3:pp. 191- 195.

20) Raje, G. B., Babar, H. T., Waghmode, S. S. and S. D. Disale (2016). Water Quality Index of Chiplun Town. Asian J. Science and Technology. Vol. 07, Issue, 07: pp.3181-3186

21) Rao, C. S. (1997). Environmental pollution control engineering. New age international publisher Ltd., New Delhi: pp. 294- 330.

22) Sukumaran, G. B., Sivakumar, E. K. T. and R. K. Trivedi (2001). Pollution of ground water around St. Thomas Mount Panchayat Union, Chengalpattu MGR district, Tamilnadu, India. J. Industrial Poll. Control. Vol. 17, No. 2: pp. 225- 238.

23) Tiwari D. R. (1999) Physico-chemical studies of the upper lake water, Bhopal, Madhya Pradesh, India. Poll. Res. Vol. 18(3): pp. 323–326

24) Tunc Dede, O., Telci, I. T. & M. M. Aral (2013). The Use of Water Quality Index Models for the Evaluation of Surface Water Quality: A Case Study for Kirmir Basin, Ankara, Turkey. Water Qual. Expo. Health, Vol. 5: pp. 41–56 https://doi.org/10.1007/s12403-013-0085-3

25) Ugam Kumari Chauhan, and D. Pathak (1993). A study on investigation of contamination potential of ground water of Rewa (MP). Proc. Acad. Environ. Biol. Vol. 2, No. 2: pp. 157-160.

26) WHO (1994). International standards for drinking water (WHO).

27) Zusthi, D. P. and A. V. Khan (1998). Eutrophic gradient in the Dal Lake, Kashmir, India. J. Env. Health. Vol. 30, No. 4: pp. 348-354.