International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Evaluation of Water Quality Indices in Kowndinya Watershed

Munilakshmi N[1], Shanmukha Srinivas G[2]

[1, 2] Department of Civil Engineering, College of Engineering, Sri Venkateswara University, Tirupati, Andhra Pradesh, India
Corresponding author Email: *gssmtech[at]gmail.com*

Abstract: ***A systematic study has been carried out to assess the water quality index of River "Kowndinya" in Chittoor District. water samples collected from eight different locations were analyzed for physico-chemical analysis viz., parameters (Temperature, pH, Dissolved Oxygen, C.O.D., B.O.D., Total Alkalinity, Hardness, Turbidity, Nitrate, Phosphate, Chloride, Sulphate, Acidity, Colour, Total Solids, Total Dissolved Solids, Total Suspended Solids and Most Probable Number) and treatment method for reservoir water was suggested. Each parameter was compared with the standard desirable limit of that parameter in river water with drinking water standards of IS: 10500-2012 and with concrete code of IS: 456-2000. The analytical data of various physical, chemical and biological parameters indicates that some parameters pH, Turbidity and Total solids are found to be in excess than the prescribed limit in some water samples of the study areas. The WQI value indicates that water samples of some sampling stations are quite unfit for drinking purpose because of high value. Suitable suggestions were made to improve the quality of river water.***

Keywords: Water pollution, Kowndinya watershed, physico-chemical analysis, Water quality index

1. Introduction

Water is prime natural resource and precious national asset, forms the chief constituent of eco system. Water resources may be mainly in the form of rivers, lakes, glaciers, rain water, ground water etc. Besides the need of water for drinking, water resource plays vital role in various sector of the economy, such as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries, and other creative activities. The quality and availability of surface water have been deteriorating due to factors like increasing population, industrialization, urbanization etc. Water quality is the main factor controlling health and the state of disease in both animals and humans. Surface Water quality in region is largely deteriorated and it seeks a global concern.

In India it is reported that about 70% of the available water is polluted. The chief source of pollution is identified as sewage constituting 84 to 92 percent of the waste water. Industrial waste water comprised 8 to 16 percent. Water in nature is mostly nearly pure in its evaporation state. The water may acquire impurities at the moment of condensation.

Kowndinya River originates from the Karnataka, from its source to its entry in to the Bay of Bengal. In the present study an attempt has been made to identify good quality of water for different purposes in the kowndinya watershed, Chittoor District. PALAMANERU is located at 13°11'49"N latitude 78°42'33"E longitude. The occurrence of surface water in any area depends partly on the geological and physiological setting and fully on the climatic conditions such as rain fall. Beside low quantum the variability in rainfall distribution is also very high in Palamaneru. After 12 years the river is flowing due to heavy rains occurred in December 2015. The present study was planned systematically to cover entire KOWNDINYA RIVER. As many as 8 salient water locations were identified throughout 7 km stretch. Its upstream side is Samudrala palle and downstream side is Kanumakala palle. Accurate and timely information on the quality of water is necessary to shape a sound public policy and to implement the water quality improvement programmes efficiently. One of the most effective ways to communicate information on water quality trends is with indices.

2. Methodology

Water Quality Index (WQI), a mathematical tool to evaluate all the physico-chemical parameters into single parameter. It is one of the aggregate indices that have been accepted as a rating that reflects the composite influence on the overall quality effectively (APHA 1998). GWQI is computed as follows. Relative weight (Wi) of each quality parameter is computed:

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

where, Wi is the relative weight, w_i is the weight of each parameter and n is the number of parameters. Quality rating scale (q_i) of each parameter is determined by dividing its concentration in each water sample by its respective standard. As per BIS, the values of q_i are computed,

$$q_i = (C_i / S_i) * 100$$

where q_i is the quality rating, C_i is the concentration of each quality parameter in each water sample in mg/l and S_i is the Indian Standard for drinking water of that quality parameter in mg/l. S_i value for each parameter is computed using

$$S_i = W_i * q_i$$

Finally, WQI for each quality parameter is computed as

$$WQI = \sum S_i$$

Based on the value of GWQI, the water may be good (WQI > 100), moderate (100 > WQI > 200) or poor (WQI > 200) in quality.

3. Results and Discussion

The drinking water standards as per IS 10500:2012 for the analysed parameters are as shown in the table 1. The Water Quality Index Level and Water Quality Rating is presented in the table 2. The results obtained from analysis of water samples of river Kowndinya is shown in table 3. The reported values refer to value of water samples collected at different areas along the 7 km stretch of Kowndinya river. The results indicate that the quality of water varies considerably from location to location. A summary of the findings is given below:

Table 1: Drinking Water Standards Values

Parameters	Indian Standards (IS:10500-012)		ICMR	
	Acceptable	Permissible	Acceptable	Permissible
Physical				
Color (Hazen units)	5	15	5	25
Taste and odour	Unobjectionable		Nothing Disagreeable	
Turbidity (NTU)	1	5	5	25
Chemical				
pH	6.5-8.5	No relaxation	7.0-8.5	6.5-9.2
Total dissolved Solids(mg/L)	500	2000		
Total Hardness (mg/L as $CaCO_3$)	200	600	300	600
Calcium(mg/L)	75	200	75	200
Magnesium(mg/L)	30	100	50	150
Copper(mg/L)	0.05	1.5	1.0	3.0
Iron(mg/L)	0.3	No relaxation	0.3	1.0
Manganese(mg/L)	0.1	0.3	0.1	0.5
Chlorides(mg/L)	250	1000	250	1000
Sulphates(mg/L)	200	400	200	400
Nitrate(mg/L)	45	No relaxation	20	50
Fluoride(mg/L)	1.0	1.5	1.0	2.0
Phenolic Substances (mg/L)	0.001	0.002	0.001	0.002
Toxic				
Arsenic(mg/L)	0.05	-	-	0.2
Cadmium(mg/L)	0.01	-	-	0.05
Cyanide(mg/L)	0.05	-	-	0.01
Lead(mg/L)	0.05	-	-	0.1
Selenium(mg/L)	0.01	-	-	0.05
Zinc(mg/L)	5.0	15.0	-	-
Mercury(mg/L)	0.001	-	-	-
Bacteriological	1 coliform per 100mL		1 coliform per 100mL	
Radioactivity				
Alpha Emitters (Bq/l)	-	0.1	-	10^{-9}
Beta Emitters	-	1.0	-	10^{-8}

Table 2: Water Quality Index Level and Water Quality Rating

WQI Level	Water Quality Rating
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very poor
>100	Unfit for drinking purpose.

The value of pH was found to be varying between 8.28-10.66. As per IS:10500-2012 the acceptable and permissible limits of pH for drinking water are 6.5 and 8.5. Samples 1, 7 and 8 have pH values above acceptable limit but below permissible limit, so they are suitable for drinking. The remaining samples have pH values above permissible limit, so it cannot be used for drinking. The values of Color for various samples range between 5 and 10 hazen units. As per IS:10500-2012 the acceptable and permissible limits of Color for drinking water are 5 and 15 Hazen units. Samples 3 and 6 have Color values above acceptable limit but below permissible limit, so they are suitable for drinking if alternative sources are absent. Remaining samples have Color values equals to acceptable limit, so they are suitable for drinking. The Turbidity values of samples varies from 0.4 to 8.6 N.T.U. As per IS:10500-2012 the acceptable and permissible limits of Turbidity for drinking water are 1 and 5 NTU. Samples 1, 4, 5, and 6 have Turbidity values above acceptable limit but below permissible limit, therefore they are suitable for drinking if alternative sources are absent. Samples 2, 7 and 8 have turbidity below acceptable limit, so they are suitable for drinking. Sample 3 has Turbidity value above permissible limit, therefore, it cannot be used for drinking. Total Suspended Solids concentration in the study area ranges between 0 and 300 mg/L. As per IS:10500-2012, for all samples have Total Suspended Solids within the permissible limits, so they are suitable for drinking. The Total Dissolved Solids concentration in the study area ranges between 300 to 900 mg/L. As per IS:10500-2012 the acceptable and permissible limits of Total Dissolved Solids for drinking water are 500 and 2000 mg/L. Samples 3 and 7 have TDS values above acceptable limit but below permissible limit, so they can be used for drinking if alternative sources are absent. Samples 1, 2, 4, 5, 6 and 8 have TDS value below acceptable limit, so they can be used for drinking. The Total Solids concentration in the study area are ranges between 400 to 1100 mg/L. As per IS:10500-2012 the acceptable and permissible limits of pH for drinking water are 500 and 1000 mg/L. Samples 1, 5 and 7 have Total Solids values above

acceptable limit but below permissible limit, so they can be used for drinking if alternative sources are absent. Sample 1 has Total Solids value above permissible limit, so they are not suitable for drinking. Sample 2, 4, 6 and 8 have Total Solids below acceptable limit, so are suitable for drinking. The alkalinity values obtained from the study are between 88 to 300 mg/L as CaCO3. The maximum permissible limit as per IS: 456 – 2000, code of practice for plain and reinforced concrete can be taken as 250 mg/L as CaCO3. The values of alkalinity of sample1 is beyond the permissible limits for construction. High alkalinity of water is harmful for construction and drinking purpose. The presence of alkalinity is due to the presence of bicarbonates and salts of acids such as Borates, Silicates and Phosphates. The high alkalinity is not desirable for potable water. High alkalinity may be reduced by De- Mineralization treatment process. As per IS:10500-2012 the acceptable and permissible limits of Alkalinity for drinking water are 200 and 600 mg/L. Samples 1 and 7 have Alkalinity values above acceptable limit but below permissible limit, so they can be used for drinking if alternative sources are absent. The remaining samples have pH values below acceptable limit, so they are suitable for drinking. The total hardness values of various samples ranges from 58 to 268 mg/L as CaCO3. As per IS:10500-2012 the acceptable and permissible limits of Hardness for drinking water are 300 and 600 mg/L as CaCO3. Samples 1, 2, 3, 4, 5, 6, 7 and 8 have Hardness values below acceptable limit, so they can be used for drinking if alternative sources are absent. Concentrations of chlorides in the water samples in different locations of the study area ranges from 58 mg/L to 320 mg/L. As per IS:10500-2012 the acceptable and permissible limits of Chlorides for drinking water are 250 and 1000 mg/L. Sample 7 has Chlorides value above acceptable limit but below permissible limit, so they can be used for drinking if alternative sources are absent. The remaining samples have Chloride values below acceptable limit, so they can be used for drinking. Acidity concentrations in the water samples analyzed ranges between 0 to 6 mg/L as CaCO3. The permissible limits of acidity for construction purpose should be less than 50 mg/L as CaCO3. All the samples in the study area are within the permissible limits for construction. Samples 1, 2, 3, 4, 5, 6, 7 and 8 have Acidity values below acceptable limit of 50 mg/L, so they are suitable for drinking. Phosphates concentrations in the water samples ranges between 0 to 0.04 mg/L. Nitrates concentrations in the water samples analyzed ranges between 0 to 0.41 mg/L. As per IS:10500-2012 the acceptable and permissible limits of Nitrates for drinking water are 45 mg/L and no relaxation. Samples 1, 2, 3, 4, 5, 6, 7 and 8 have Nitrate values below acceptable limit, so they can be used for drinking. Concentrations of sulphates in the water samples in different locations of the study area ranges from 0 mg/L to 25.5 mg/L. As per IS:10500-2012 the acceptable and permissible limits of Sulphates for drinking water are 200 and 400 mg/L. Samples 1, 2, 3, 4, 5, 6, 7 and 8 have Sulphate values below the acceptable limit, so they can be used for drinking. Concentration of DO in the water samples in different study area ranges from 5.5 mg/L to 7.5 mg/L. The permissible limits of water for the survival of aquatic life is <1mg/L. For the river water the permissible limits of DO for drinking is 6 to 8 mg/L. Samples 1, 2, 3, 4, 5, 6, 7 and 8 have DO >4.5mg/L. So they are suitable for survival of aquatic life and also for drinking. COD concentrations in the water samples analyzed ranges between 12 to 72 mg/L. BOD concentrations in the water samples analyzed ranges between 0.2 to 3.5 mg/L. Most Probable Number is a multiple tube fermentation test which indicates possible pollution of water sample with sewage. As per IS:10500-2012 the permissible limit of bacteriological species for drinking water is 1 coliform per 100 mL. Samples 1, 2, 3, 4, 5 and 6 have more than one 1 coliform per 100 mL which is above permissible limit, so it cannot be used for drinking.

Table 3: Results of Water Quality Analysis of Different samples of KOWNDINYA RIVER

Parameters	Sample 1 Upstream end of river (Samudrala palle-kanumakala palle)	Sample 2 1 km from upstream end of river (Samudrala palle-kanumakala palle)	Sample 3 2km from upstream end of river (Samudrala palle-kanumakala palle)	Sample 4 3 km from upstream end of river (Samudrala palle-kanumakala palle)	Sample 5 4 km from upstream end of river (Samudrala palle-kanumakala palle)	Sample 6 5 km from upstream end of river(0.5 km adjacent to Parag milk foods Ltd.up stream)	Sample7 5.5 km from upstream end of river (0.5 km adjacent Parag milk foods Ltd. downstreamm)	Sample 8 (YSR Reservoir)
pH	8.39	8.80	8.64	10.52	10.66	8.75	8.45	8.28
Dissolved Oxygen(mg/L)	5.5	5.5	7.5	6.5	7.5	7.5	7.0	6.5
COD(mg/L)	40	40	32	48	30	30	40	35
BOD(mg/L)	2.5	3	1.6	3.1	2.0	2.5	4.0	3.5
Turbidity(NTU)	1.8	0.9	8.6	1.7	3.4	1.1	0.4	0.8
Hardness (mg/L as $CaCO_3$)	130	122	152	58	62	156	268	162
Alkalinity (mg/L as $CaCO_3$)	300	184	178	98	88	150	220	150
Acidity (mg/L as $CaCO_3$)	0	0	0	0	0	0	0	6
Sulphates (mg/L)	6	4.5	7	5	6.5	9	25.5	4.5
Color (Hazen units)	5	5	10	5	5	10	5	5
MPN Index (per 100mL)	>8	>8	>8	1.1	<8	<8	<1.1	<1.1
Phosphates (mg/L)	0.03	0.04	0.06	0.02	0.03	0	0	0

Nitrates (mg/L)	0.03	0.05	0	0	0.1	0.1	0	0.41
Chlorides (mg/L)	110	82	110	58	70	80	320	80
Suspended solids (mg/L)	200	0	200	100	300	0	0	0
Dissolved solids (mg/L)	500	400	900	300	400	400	800	500
Total solids (mg/L)	700	400	1100	400	700	400	800	500

Table 4: Drinking Water Quality Standards (Maximum permissible limit) Standards

Parameter	Standard Value (Si)	W =1/S
NO3-	3	0.33
SO4-2	250	0.004
Cl-	250	0.004
TDS	1000	0.001
BOD	6	0.167
COD	10	0.1
Alkalinity	200	0.005

Table 5: Water Quality Index

	Sample 1 At upstream endof River(Samudrala palle-kanumakala palle)	Sample2 1 km from upstream end of River (Samudrala palle-kanumakala palle)	Sample 3 2 km from upstream endof River (Samudrala palle-kanumakala palle)	Sample 4 3 km from upstream end of River (Samudrala palle-kanumakala palle)	Sample 5 4 km from upstream endof River (Samudrala palle-kanumakala palle)	Sample 6 5 km from upstream end of River(0.5 km adjacent toParag milk foods Ltd. Upstream)	Sample 7 5.5 km from upstreamend of River (0.5 km adjacent to Parag milk foods Ltd. downstream)	Sample8 (YSR Reservoir)
WQI	78.62	80.71	60.56	92.84	60.37	62.98	85.15	45.54
GRADE	D	D	C	D	C	C	D	B
Water Quality	Very Poor	Very Poor	Poor	Very poor	Poor	Poor	Very Poor	Good

Samples 7 and 8 has MPN index below the permissible limits and disinfection employing chlorine is suggested before public supply. Water quality index represents the integrated effects of the relevant water quality variables. Table 4 shows drinking water quality standards and unit weights for all the parameters used in calculating WQI. For Kowndinya river water, the rating of WQI of water samples was calculated and represented in table 5. It may be stated that the water quality requirements differ from one age to another and thus any polluted water may be considered suitable for some of the beneficial uses but may remain unsuitable for other purposes.

4. Conclusion

From present investigations concludes that the quality of most of the water samples under study was suitable for drinking purpose in the absence of alternative sources. From WQI values, it is suggested that further improvement is required to treat the Kowndinya water at Palamaneru. It is concluded that reservoir water of Kowndinya river can be used for public supply after giving suitable treatment to it such as disinfection.

References

[1] American Public Health Association (APHA), (1998). Standard method for the examination of water and waste water (20 edition) Washington D.C.

[2] Backman, B., Bodis, D., Lahermo, P., Rapant, S., &Tarvainen, T. (1998). "Application of a groundwater contamination index in Finland and Slovakia". Environmental Geology, 36(1–2),55–64. DOI: 10.1007/s002540050320

[3] BIS (Bureau of Indian Standards) 10500, 1991. Indian standard drinking water- specification, First revision, pp 1-8.

[4] Brown, R. M., McClelland, N. I., Deininger, R. A., &Tozer,R. G. 1970. "A water quality index: Do we dare?" Water & Sewage Works, 117,339–343.

[5] Gupta S, Kumar A, Ojha C.K and Singh G.J, 2004. Environmental Science and Engineering. 46(1): 74-78.

[6] Horton, R. K. (1965). An index number system for rating water quality. Journal-Water Pollution Control Federation. 37: 300-305.

[7] Indian Standard (IS: 10500), (1992). Drinking Water Specification (Reaffirmed 1993).

[8] Khalid, H.L (2011). Evaluation of Groundwater Quality for Drinking Purpose for Tikrit and Samarra Cities using Water Quality Index, European journal of scientific research.58 (4):472-481.

[9] Mishra, P.C. and R.K. Patel, (2001). Study of the pollution load in the drinking water of Rairangpur, a small tribal dominated town of North Orissa. Indian J. Environment and Ecoplanning.5 (2):293-298.

[10] Ramakrishnalah, C.R; Sadashivalah C. and Ranganna G, 2009. Assessment of water quality index for the groundwater in Tumkur Taluk , Karnataka state , India, E Journal of chemistry, 6(2), pp.523-530.

[11] Rao N.S. (1986). Hydrogeology and hydrogeochemistry of VisakhapatanamPh.D Thesis unpublished.

[12] Rizwan R., and Gurdeep S. (2010). Assessment of Ground Water Quality Status by Using Water Quality

Index Method in Orissa, India, World Applied Sciences Journal. 9 (12): 1392-1397.
[13] Saeedi M, AbessiO ,Sharifi F. and Meraji h. (2009). Development of groundwater quality index. DOI: 10.1007/s: 10661-009-0837-5.
[14] Soltan, M. E. (1999). Evaluation of groundwater quality in Dakhla Oasis (Egyptian Western Desert). Environmental Monitoring and Assessment. 57(2): 157–168. DOI: 10.1023/a: 10059-489-3031-6
[15] Stigter, T. Y., Ribeiro, L., &Carvalho Dill, A. M. M. (2006a). Application of a groundwater quality index as an assessment and communication tool in agroenvironmental policies–TwoPortuguese case studies. Journal of Hydrology (Amsterdam). (327): 578–591.
[16] Tiwari, T.N. and M.A. Mishra, 1985. A preliminary assignment of water quality index of major Indian rivers. Indian J. Environmental Protection.5:276-279.
[17] WHO, (1993). Guidelines for drinking water quality (2nd Ed., Vol. 1, pp. 188). Recommendations, Geneva and World Health Organization.