International Journal of Sciences & Applied Research

www.ijsar.in

Assessment of water quality index for Pandu river in Kanpur, UP

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Abstract
Water Quality Index of Pandu river was calculated from ten important estimated physicochemical parameters to assess the quality of water for public consumption and other purpose. Total dissolved solids ranged between 552.8 -623.5 mg/L. The alkaline nature of water indicated by pH values as varied between 8.2 and 8.3. Chloride concentration, below the prescribed limits of WHO, varied between 55.4 – 61.5 mg/L. Estimated phosphate showed maximum value in first year i.e. 1. 74 as compared to second year. Water quality index varied from 359.9 and 405 in respective years, which ascertained deterioration of water quality of Pandu river.

Keywords: Physico-Chemical parameters, Water Quality Index, Pandu river

Introduction
Rivers, lakes, glaciers, rain water, ground water etc are identified as sources of portable water. Major sectors of Indian economy viz agriculture, livestock production, forestry, industrial activities, fisheries etc based on water resources. Increased population, industrialization, urbanization etc had adverse effects as availability as well as water quality has deteriorated badly. The water quality index (WQI) is a mathematical instrument used to converge large parameters of water trais into a single number, which represents the water quality level(4). Horton (1965) defined water Quality Index (WQI) as a reflection of composite influence of individual quality characteristics(8). The weight arithmetic index method (Brown et. al 1972) had utilized for calculating water quality index(2). Weighted arithmetic water quality index classified the water quality according to the degree of purity by using the most commonly measured water quality variables(6). The method has been widely cited in literature and used by the various scientists. This method reflects the composite influence of different parameters and quite useful for communication of overall water quality information to the concerned citizens and policy makers(5). The objective of the present study was the use of the water quality index (WQI) as indicators of the water quality of Pandu river.

Materials and methods
Most important ten parameters were estimated for the calculation of weighted water quality index of Pandu river.

Parameters	Abbreviations	Units	Analytical methods
Temperature	Water temperature	°C	Centigrade thermometer
TH	Total hardness	mg/l	E.D.T.A
pH	Hydrogen Ion Concentration	pH unit	pH meter
DO	Dissolved Oxygen	mg /l	Winkler's Azide modification method
BOD	Bio-Chemical Oxygen Demand	mg /l	Dilution technique and seeding technique
COD	Chemical Oxygen Demand	mg /l	Open reflux method
Cl	Chloride	mg/l	Argentometric method
PO_4	Phosphate	mg/l	Stannous Chloride method
NO_3	Nitrate	mg/l	Phenol - di - sulphuric acid method
NH_4	Ammonia	mg/l	Nesslerization method
SO_4	Sulphate	mg/l	Turbidity method

Samples were collected at critical locations across the passage of Pandu river across Kanpur for continuous two years. WQI has been calculated by using the standards of drinking water quality recommended by the World Health Organization (WHO) Bureau of Indian Standards (BSI) and Indian council for Medical Research (ICMR) (3,7,9).The physico-chemical parameters were determined adopting methods given by APHA (2005)(1).

Water Quality Index (WQI) calculated as follows : $WQI = \sum q_n W_n / \sum W_n$

Let there be `n` water quality parameters and quality rating or sub index (q_n) corresponding to nth parameters is a number reflecting the relative value of this parameters in the polluted water with respective to its standard permissible value. The q_n is calculated using following expression.

$q_n = 100 [(V_n - V_{io}) / (S_n - V_{io})]$

q_n =Quality rating for the nth water quality parameter ; V_n = Estimated value of nth parameters at a given sampling station ;S_n = Standard permissible value of the nth parameters ;V_{io} = Ideal value of nth parameters in pure water. i.e. 7.0 for pH, 14.6 mg/l for DO and 0 for all other parameters and Ideal value of pH is 7.0 where 8.5 is the permissible value of water (i.e. polluted water), therefore, quality for pH is calculated from the following relation.

$q_{pH} = 100 [(V_{pH} - 7) / (8.5 – 7)]$; V_{pH} = observed value of pH.

DO calculation through the water quality rating equation:

$$Q_{DO} = 100 [(V_{DO} – 14.6 / (5 – 14.6)]$$

Calculation of unit weight: $W_n = K / S_n$; W_n = unit weight for the nth parameters, S_n = Standard value of for the nth parameters,

K = constant of proportionality

Results and discussion

Estimated values of various physicochemical parameters for calculation of water quality index are presented in the Table 3. The water quality index varied from 359.9 and 405 in respective years, which indicates deterioration of water quality of Pandu river (11,12).

Table 1: Water quality rating for drinking (Chaterjiee and Raziuddin, 2002) & other purposes.

WQI level	Grading	Water quality rating	Possible water use
0-25	A	Excellent	All purpose like potable, industrial, agricultural
26-50	B	Good	Domestic & Agricultural
51-75	C	Poor	Agricultural & Industrial
76-100	C	Very poor	Agricultural
>100	E	Unfit for drinking	Not of much possible agricultural can be used only after proper treatment

Table 2: Drinking standard recommended by agencies and unit weights.

Parameters	Standard (S_n)	Recommended agency	Unit weight(W_n)
TDS	500	ICMR	0.0037
pH	7-8.5	ICMR/ISI	0.2190
Chlorides	250	ICMR	0.0074
Nitrates	45	ICMR	0.0412
Phosphate	25	ICMR	0.0618
Sulphate	150	ICMR	0.0103
Alkalinity	120	ICMR	0.0155
Hardness	300	WHO	0.0051
BOD	5	ICMR	0.3723
DO	5	ICMR	0.3088

Values are expressed in mg/L

Table 3: Variation in Water quality index for Pandu river.

Pandu	Year 1	Year 2	Standard	Recommended	Unit weight	Year 1		Year 2	
	Observed value	Observed value	(Sn)	agency	(W_n)	Quality rating	W_nq_n	Quality rating	W_nq_n
TDS	552.80	623.50	500	ICMR	0.0037	110.56	0.409	124.70	0.461
pH	8.20	8.30	7-8.5	ICMR/ISI	0.219	80.00	17.520	86.67	18.980
Chlorides	61.54	55.44	250	ICMR	0.0074	24.62	0.182	22.18	0.164
Nitrates	0.83	0.51	45	ICMR	0.0412	1.84	0.076	1.13	0.047
Phosphate	1.74	1.70	25	ICMR	0.0618	6.96	0.430	6.80	0.420
Sulphate	36.53	49.16	150	ICMR	0.0103	24.35	0.251	32.77	0.338
Alkalinity	261.66	280.53	120	ICMR	0.0155	218.05	3.380	233.78	3.624
Hardness	890.94	790.45	300	WHO	0.0051	296.98	1.515	263.48	1.344
BOD	42.40	48.47	5	ICMR	0.3723	848.00	315.710	969.40	360.908
DO	3.18	3.10	5	ICMR	0.3088	118.96	36.734	119.79	36.992
				Total of unit weight =ΣW_n	1.0451		376.21		423.28
Water quality Index WQI =			$\Sigma W_nq_n/\Sigma W_n$				359.97		405.01

The estimated physicochemical parameters varied over the study periods as reflected in table. Total dissolved solids of water body ranged between 552.8 -623.5 mg/L. The higher values of were observed during second year, the higher values might be due to the addition of different nutrients, and agricultural runoff in the main stream(10). The TDS values are more than the prescribed limits of ICMR and ISI i.e. 500mg/l. The pH of the water indicates as an alkaline nature it varies between 8.2 and 8.3. The recommended value of ideal pH by ISI is 6.5 to 8.5 and by ICMR 7.0 - 8.5. Increased trend observed in values of BOD, sulphate, alkalinity and TDS, more over the reverse trend in values of Chloride, nitrates, hardness as reflected in fig. 1.

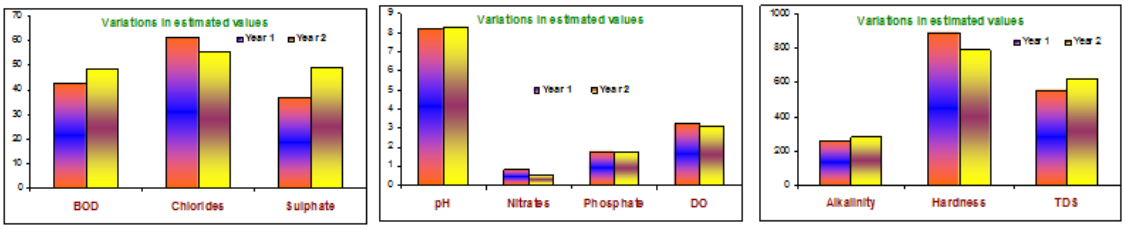

Figure 1: Changes in estimated ten physicochemical parameters.

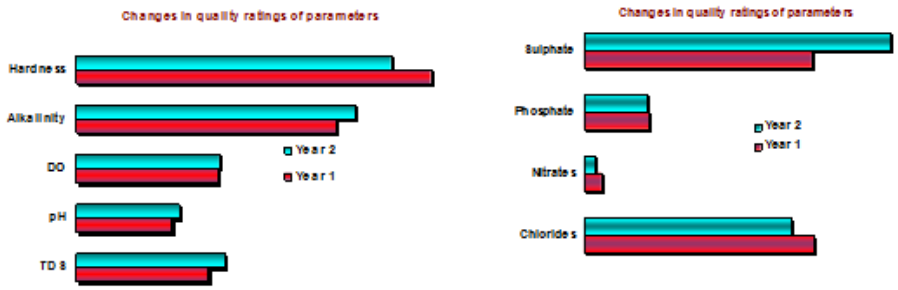

Figure 2: Variations in quality ratings over the years.

Similar observations were recorded for the quality ratings of alkalinity, pH, TDS, sulphate increased over the years while hardness, nitrate, chloride decreased for second year of study (fig 2).

The chloride concentration results in salty taste of water. Some times higher concentration of chlorides is responsible for laxative effect to the human beings. The concentration of chloride varied between 55.4 – 61.5 mg/L which are well below the prescribed limits of WHO. The nitrates are the end product of the decomposition of organic waste present in the fully oxidized water and harmful above 45 mg/L .In the present study nitrate in the surface water are very below the permissible limits.

The estimated phosphate shows that maximum value was in first year i.e. 1. 74 while minimum in second year 1.7 mg/L. These values were very well below the prescribed limits of USPH. The sulphate may have laxative effect if magnesium ion is present at an equivalent concentration. In the present study sulphate concentration is quite high as compared to permissible limits. The value of sulphate concentration ranged within 36.5- 49.2 mg/L.

The alkalinity is not harmful to the human beings within desirable limits for domestic water supply. However the higher values of total alkalinity were observed as varied from 261 – 280 mg/L. The hardness values were recorded as 890 – 790 mg/L, higher value of hardness were observed during first year of study which may be due to the low water level, these values are very high from the desired limits of WHO (< 300mg/L) dissolved oxygen varied from 3.18 – 3.1 mg/L .The BOD values are 42 - 48 mg/L which very high the prescribed limits indicates highly polluted water.

Conclusion

Application of the WQI in the present study gives comparative evaluation of water quality in the different years. The present result shows that WQI in the first year are lesser than latter year due to obvious reasons. WQI ranged between 359 and 405 as ascertained extremely poor quality water, not even suitable for agricultural as well as industrial use. The drinking use is recommended only after through suitable treatment.

Acknowledgments

The authors are grateful to the Principal, Christ College Kanpur India, for providing the all the required facilities to complete the study.

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