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QUALITATIVE ANALYSIS OF SURFACE WATER OF PANCHGANGA RIVER (MS), INDIA

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ABSTRACT

Day by day aquatic ecosystems has put forth challenging environment for florishment of aquatic flora and fauna, due to huge deterioration of water quality. Contamination of water by natural and anthropogenic activities was continued, since beginning of human development. Now days, rendering water quality and pollution of aquatic ecosystems become global concern, which serious issue in front of scientific community. River Panchganga is among the important river in Maharashtra, India. Continuously deteriorating water quality of river Panchganga was monitored in the period of March 2011 to February 2012. During investigation, various physicochemical parameters at different monitoring sites were assessed and used for determination of water quality indexing (WQI) of the river. Average results of the physicochemical parameters and WQI at different monitoring sites indicated the poor water quality of river Panchganga and confirmed need of necessary efforts to overcome the problem of pollution for maintenance of healthy aquatic ecosystems and its balance.

Key words: Water quality index, Surface water, Panchganga river, Physicochemical factors.

INTRODUCTION

Surface water is considered as one of the most vital freshwater source and used for domestic, agricultural and industrial activities all over the world. Amongst total freshwater resources, surface water contributes to the tiny fraction (Anon, 2006). Surface water in the form of ponds, lakes, reservoirs, rivers, streams etc. provides valuable palatable water, which is used for the well being of humanity (Gleick, 1998). Amongst these surface water resources, rivers are immensely important due to their tremendous water holding capacity and large perforated capillary network, which confirms the annual freshwater availability (Jayalakshmi, 2011). Since ancient time rivers plays major role in concretion of biotic community along the river banks, this forms the main basis of topography of the area (Kar, 2008 and Gaikwad, 2014). Along with key role in the hydrological cycle, rivers also form the dwelling places for florishment of aquatic flora and fauna. However, these valued freshwater resources are facing the global problem of deterioration of water quality (Vanek et al., 2005, Vanderlinden et al., 2006 and Conesa et al., 2007). As per present scenario, tremendously increased human population has significantly contributed to the addition of toxicant on large scale, which further depletes the water quality. Diverse kind of contaminants gets added in to these aquatic resources which interfere with the physicochemical properties of the water. Altered physicochemical properties form the burden over the aquatic ecosystem and cause damage to the aquatic biota (Manish and Pavan, 1998 and Samantray, 2009).

In order to overcome the threat of deterioration, periodic monitoring of aquatic resources must be conducted, which helps to keep check on the level of contaminants and to conduct necessary curative measures for the wellbeing of aquatic body (Bellingham, 2012). Water quality index is performance measurement, which aggregates information in to usable form and reflects the composite influence of significant physical, chemical and biological parameters of the water (Landwehr, 1979 and Liou, 2004). House and Newsome (1989), described Water Quality Index as measure of good or bad water quality, which reduces the large quantity data in to single number with simple and reproducible manner. Hence, by keeping in view the importance of Water Quality Index for monitoring of water quality, present investigation was carried out on qualitative assessment of Panchganga river, which helps in analyzing the water quality status of the river.

MATERIAL AND METHODS

Study region:

In order to assess the water quality, Panchganga river, Maharashtra, India was selected as study region. Five monitoring stations viz. Prayag-Chikhali (S_1), Shivaji Bridge (S_2), Rukdi (S_3), Ichalkaranji (S_4) and Narsobawadi (S_5) were selected for sampling along entire flow of river. Their geographical localities were described in the **Fig. No. 1**.

Sampling was conducted monthly during the period of March 2011 to February 2012. Samples were collected at early morning hours, in acid leached polythene bottle. Physical parameters like Temperature and pH were measured in-situ at respective sampling sites. Total Solids (TS) and Total Dissolved Solids (TDS) were determined by Hach's gravimetric method (2012). Whereas chemical parameters like Dissolved Oxygen (DO), free Carbon dioxide (CO_2), Total Hardness (TH), Total Alkalinity (TA), Total Chlorides (TC), Ip (Inorganic phosphate), Nitrates were measured in the laboratory by using standard methods of APHA (2005), Trivedi and Goel (1984).

For assessment of Water Quality Index (WQI) obtained values of physicochemical parameters were compared with drinking water standards of BIS (Bureau of Indian Standards, 2012) as mentioned in the **Table No.1 and 2**. Further water quality indexing was assessed by the method adopted by Chaterjee and Raziudin (2002). Quality rating (q_n) was evaluated by using the mathematical expression;

$$q_n = 100\,(V_n - V_{io}) / (S_n - V_{io})$$

(Let there be 'n' water quality parameters and quality rating (q_n) corresponding to n^{th} parameter is number reflecting the relative value of this parameters in the polluted water with respect to its standard permissible value).

Hence,

q_n = Quality rating of respective physicochemical parameters.

V_n = Value of respective physicochemical parameters.

V_{io}= Ideal value of respective parameters in pure water (i.e. 7 for pH and 14.6 mg/lit for DO. For all other physicochemical parameters it is 0).

S_n = BIS permissible limit for respective physicochemical parameter.

Unit weight (W_n) was estimated by applying formula;

$$W_n = K / S_n$$

Here, K= Constant for proportionality.

Average water quality index was estimated by using equation;

$$\text{Average WQI} = \sum q_n W_n / \sum W_n$$

RESULTS AND DISCUSSION

Water quality is measure of physical and chemical properties of the water, which in turns has its direct influence over the life of aquatic biota. Water quality representing parameters like pH, Temperature, Total Solids, Total Dissolved Solids, Dissolved Oxygen, Free Carbon dioxide, Total Hardness, Total Alkalinity, Total Chlorides, Inorganic phosphate, Nitrates are considered as vital measures for classification of surface water monitoring (Yogendra, 2008). Hence, these physicochemical parameters were assessed during the period of March, 2011 to February 2012, to denote the water quality index of Panchganga river.

Fig. 1: Geographical distribution of the sampling stations from river Panchganga

In the investigations monthly variations of physicochemical variables were assessed along with quality rating parameters. However, noted average physicochemical parameters along with water quality rating unit values.

The pH interferes with the chemical reactions of water and hence considered valued factor for representing water quality (Fakayode, 2005). For sustenance of aquatic biota, pH must be within the range of 6.5 to 8.2 (Wang, 2002). The pH of the Panchganga river showed alkaline nature and recorded in between 7 to 8.5.

The value obtained at site– V showed excess alkaline pH concentration, which may be the result of temperature fluctuation, organic decomposition, higher photosynthetic activities and dilution through surface runoff as stated by Rajasegar (2003) and Swarnalatha (1993). Similarly, temperature also has vital role in the biochemical interactions of the river water (Gangwar, 2012). Temperature of the river varied between 22 to 27°C, which was considered as desirable and favorable for the florishment of aquatic flora and fauna. TS and TDS also plays major role in the maintenance of health of the aquatic ecosystem, as higher TS

values denotes the alarming level of turbidity and excess TDS values are the result of the higher ionic deposition (Singh, 2010). Concentration of TS and TDS ranged between 600 to 850 mg/lit. and 400 to 620 mg/lit. respectively. TS values exceed the miscible limits representing the higher turbidity of the region. Lower values of the TDS denoted the less ionic concentration, which may the result of ample rainfall and surface runoff as previously mentioned by Bhatt et al., (1999).

Table No. 1: BIS drinking water standards along with unit weight

Parameters	Unit	BIS Standards (Sn)	Unit Weight (Wn)
pH		6.5-8.5	0.2190
Temp	Degree Celcius	<40	0.0465
TS	Mg/lit.	500	0.0037
TDS	Mg/lit.	2000	0.0009
DO	Mg/lit.	5-7	0.3723
CO2	Mg/lit.	22	0.0845
TH	Mg/lit. as CaCo3	300	0.0062
TA	Mg/lit.	120	0.0155
TC	Mg/lit.	250	0.0074
Ip	Mg/Ip/ml	45	0.041
Nitrates	Mg/lit.	45	0.041
			$\sum W_n$= 0.838

Table No. 2: Water Quality Index representing water quality status.

Water Quality Index	Water quality status
0 – 25	Excellent water quality
26 – 50	Good water quality
51 – 75	Poor water quality
76 – 100	Very Poor water quality
>100	Unsuitable for drinking

Increased temperature hampers the chemical interactions and reduces the dissolved oxygen concentration from water (Talling, 1957). Values obtained for DO concentration denoted the very little amount of DO as compared to the BIS miscible limit, which may be the result of higher organic activities along with excess biological interaction in the study region. The results obtained complied with the investigations made by Sheikh (2004) on Tansa river. Free carbon dioxide concentration showed exactly reversible trend than that of DO. Though the values obtained were below the BIS limits, CO_2 concentration showed increasing trend from site-I to site- V and reached up to the threshold level of permissible limits, which should be the main cause of worry in near future. Increased concentration of the CO_2 may be the result of deoxygenated water column along with continuously altered temperature range. Total hardness ranged between 100 to 160 mg/lit. as $CaCO_3$, which represented favorable concentration for growth of aquatic biota. Concentration of Total Alkalinity reflected deposition of minerals, carbonates and bicarbonates in to the aquatic body. The value fluctuated between the 210 to 410 mg/lit., which were high above the permissible limits and should be the effect of continuous, heavy deposition of domestic sewage, agricultural runoff along with industrial effluents (Sahni et al., 2011). Total Chloride, Inorganic Phosphate and Nitrates concentrations were ranges between 27 to 62 mg/lit., 0.3 to 1 mg/Ip/ml and 4 to 9 mg/lit. respectively. All these values were within the desired limits confirming the average contamination level of the region. These observations were in conformity with the investigations of Munawar (1970), Shastry (1970) and Sinha (1995).

By considering all these physicochemical parameters, water quality index were evaluated on monthly basis and tabulated in the Table No. 3.

During the entire investigation period WQI fluctuated in between 30 to 129. Site- I was remarked with good water quality, whereas Site-II was noted with poor water quality. Site-III and V were found with very poor water quality, while water quality at site- IV was noted as completely unsuitable for usage **(Fig. 2)**.

Table No. 3: Monthly distribution of water quality index, during the study period

Water Quality Index $WQI = \sum q_n W_n / \sum W_n$	Site- I	Site-II	Site-III	Site-IV	Site-V
Mar	51.84	70.52	39.80	36.87	30.33
Apr	72.13	36.60	30.30	117.40	100.18
May	37.06	102.83	103.87	115.54	78.75
June	39.89	38.81	31.66	106.65	39.64
July	75	76.69	33	102.27	38.97
Aug	73.79	75.52	35.87	102.70	38.03
Sept	38.16	31.65	100.74	108.79	33.73
Oct	32.64	39.19	38.02	106.63	33.60
Nov	39.45	37.91	102.88	97.87	103.26
Dec	30.76	106.18	87.90	116.17	113.53
Jan	32.30	36.28	113.08	128.36	114.54
Feb	36.92	32.93	116.42	124.98	117.44
Mean	40.57	51.38	84.98	112.21	79.16
			Average WQI of the river= 73.66		

Fig. 2 Average WQI of the Panchganga river

In the seasonal variations grossly deteriorated WQI was noted during the months of winter season, whereas moderate or better WQI was observed during rainy season **(Fig. 3)**.

Hence, site- I and II were observed as least polluted zones, while site- III and V were noted as rapidly polluting regions and site- IV was remarked as grossly polluted station.

During the entire investigation period, overall WQI of the Panchganga river ranged between 40 to 120. Average WQI was noted 73.66, which confirmed the poor water quality of the river Panchganga. Similar observations had been made by Das and Acharya (2003) and Naik (2012) while describing the water quality of lotic resources of Cuttack city, India and Mahanadi river Odisha, India respectively. The possible reasons for which were rapidly increased anthropogenic activities that contributed huge dumping of the domestic sewage

Fig. 3: Seasonal variations in the WQI of the Panchganga river

agricultural pesticides, herbicides, weedicides, fertilizers and industrial effluents containing harmful chemicals and heavy metals as previously described by number of researchers while describing the water quality of various aquatic bodies (Shardendu 1988, Ghosh 1989, Venkatewarlu 1993 and Sinha 2014).

Dumping of those contaminants in turns affected the overall health of the river Panchganga and made it less favorable for wellbeing of human and aquatic biota. So, there is need of periodical monitoring to keep check on the level of contaminants. To overcome the problem of poor water quality, necessary measures must be taken with large scale including human awareness activities and prevention of dumping waste, which helps to settle the better water quality and enhances the life of river Panchganga, leading to increase biological productivity and faunal diversity in it.

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