Assessment of Water Quality Index of Indrayani River, Alandi, Pune, Maharashtra

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Abstract— **Present study was intended to calculate Water Quality Index (WQI) of an urban water body, Indrayani River, in order to ascertain the quality of water for public consumption, recreation and other purposes. The sacred river Indrayani has its origin to the kurvande village near lonavala in Maharashtra. Indrayani river faced many difficulties due to increase in industrialization and various other extracurricular activities taking place in and around the holy river and action have been initiated for speedy completion of the same. The aim of the study is to assess water quality and evaluate water quality index of Indrayani River. The present study is step towards investigating water quality status of Indrayani River and suggesting some measures for long term management of desired water quality. During this study seasonal in-situ data and water sample were collected and analysed for total 21 parameters. Water quality index was computed by the National Sanitation Foundation Water Quality Index (NSF-WQI) method which considers physico-chemical and micro biological parameters of water quality. The NSF-WQI ranges from 44 to 62 which is considered as bad to medium.**

Index Terms— **Indrayani River, NSF, Physico-chemical parameters, Water Quality Index**

1) INTRODUCTION

It is well known that clean water is absolutely essential for several purposes for healthy living. Rivers are the most important natural resource for human development but it is being polluted by indiscriminate disposal of sewage, industrial waste and plethora of human activities, which affects its physicochemical and microbiological quality. Increasing problem of deterioration of river water quality, it is necessary to monitoring of water quality to evaluate the production capacity. The water quality monitoring in the area of surface water is performed in order to determine the quality of water. Various parameters are analyzed in the laboratory and some parameters are tested in the field. All these tasks are recorded and utilized for preparing the Report by different agencies, researchers, students in the form of dissertation. These data are considered in order to specify the quality of water at each location. This also helps to determine the pollution level or concentration in each source of water at each location. Observations of respective parameters in view with use of water i.e. for drinking purpose or irrigation purpose, analyzed for each location individually & interpretation of data has done to identify the trend at that location. Also critical parameters are identified at every location. Water Quality Index (WQI) provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of WQI is to turn complex water quality data into information that is understandable and usable by the public. A single number cannot tell the whole story of water quality; there are many other water quality parameters that are not included in the index. However, a WQI based on some very important parameters can provide a simple indicator of water quality. In general, WQI incorporate data from multiple water quality parameters into a mathematical equation that rates the health of a water body with number.

NEED OF WORK

Pune is the second largest city in Maharashtra after Mumbai. Because of education facilities and job opportunities there is an increase in the immigration of people. Since last two decades there is a rise in industrialization. Because of all these factors there is an increase in population. So to fulfill the needs of all clean and treated water should be supply on a large scale. Systematic water quality data would also be of great aid in developing a water quality model which in turn will help in conducting water quality model studies for its sustainable use.

2) MATERIALS AND METHODS

A. STUDY AREA

The Indrayani River originates in Kurvande village near Lonavala, a hill station in the Sahyadri mountain of Maharashtra. Fed by rain, it flows east from there to meet the Bhima River, through the Hindu pilgrimage centers of Dehu and Alandi. It follows a course mostly north of city of Pune. There is a hydroelectric dam called Valvan dam on the Indrayani at Kamshet. The study was carried out covering about 11km stretch of Indrayani river close to the Pune city during period from August 2017 to April 2018 at four location namely Moshi, Alandi Upstream, Alandi Downstream, Charholi covering Rainy, Winter and Summer season. During this study seasonal in-situ data and water sample were collected and analyzed for total 21 parameters.

Table 1 Description of stations

Sr. No	Station	Location	Distance	Latitude	Longitude
1	S1	Moshi	0	18.688	73.846
2	S2	Alandi Upstream	0 to 6 km	18.677	73.889
3	S3	Alandi Downstream	6 to 7 km	18.675	73.896
4	S4	Charholi	7 to 11 km	18.657	73.909

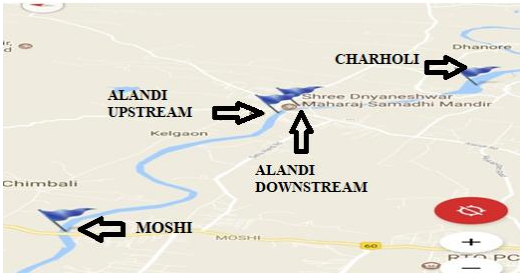

Fig 1 Location of stations

Fig 2 location of Indrayani River

B. FIELD MEASUREMENTS

Water temperature, DO fixation and pH values were measured on the site.

C. LABORATORY ANALYSIS

The following physico-chemical and microbiological parameters were measured in the laboratory:
pH, Temperature, Conductivity, DO, BOD, COD, TDS, Nitrate, Phosphate, Sulphate, Calcium, Magnesium, Chloride, Iron, Silica, Carbonate, Bicarbonate, Turbidity, Fecal Coliform.

3) WATER ANALYSIS METHODS

Methods used for analysis for analysis of different parameters are mentioned in Table 2.

Sr.no	Parameters	Method
1	Temperature	Thermometer
2	pH	pH meter
3	Conductivity	Conductivity Meter
4	DO	Azide Modified Winkler's Method
5	BOD	Azide modification at 20^0C at 5 days
6	COD	COD Digester
7	TDS	Temperature controlled oven
8	Nitrate	Spectrophotometer
9	Phosphate	Spectrophotometer
10	Sulphate	Spectrophotometer
11	Ca Mg	Titration with EDTA
12	Chloride	Titration with AgNO
13	Iron	Spectrophotometer
14	Silica	Spectrophotometer
15	Carbonate	Titration with HCL
16	Bicarbonate	Titration with HCL
18	Turbidity	Turbidity Meter

Introduction to Water Quality Index:

Water quality index provides a single number that expresses overall water quality of certain location based on several water quality parameters. The objective of WQI is to turn complex water quality data into information that is understandable and usable by the public. A single number cannot tell the whole story of water quality. There are many other water quality parameters. In general, water quality indices incorporate data from multiple water quality parameters into mathematical equation that rates the health of a water body with number. Simply WQI is defined as a rating reflecting the composite influence of different water quality parameters. WQI summarizes large amounts of water quality data into simple terms (e.g. excellent, good, bad etc.).

Advantages

1. The proposed methodology was better as statistically weighted averaging was done.
2. The methodology proposed for the selection of variables and weightages can also be used in decision making in other fields of science and technology.

National Sanitation Foundation Method The National Sanitation Foundation, USA developed the Water Quality Index (NSFWQI), a standardized method for comparing the water quality of various water bodies. NSFWQI is one of the most respected and utilized water quality index in the world. Nine water quality parameters were selected for calculating water quality index. These are dissolved oxygen (DO), Fecal Coliform, pH, Biochemical Oxygen Demand (BOD), temperature, total phosphate, nitrate, turbidity and Total Dissolved Solids.

The NSF WQI is expressed mathematically as:

$$\text{NSF WQI} = \sum_{i=1}^{p} Wi \times Ii,$$

Where, Ii = sub index for i th water quality parameter

Wi = weight (in terms of importance1) associated with water quality parameter

p = number of water quality parameters

DO saturation (%) was calculated from website **www.wateronthewb.org**

4) RESULT AND DISCUSSION

Seasonal Results for all Parameters:

Following tables, graphs and observations are made after the sampling of all seasons. For each parameter, graphical representation has shown by station wise.

Table 3 Observations for all parameters in three seasons

	Sampling Season	Rainy Season				Winter Season				Summer Season			
	Date	28/8/2017				9/1/2018				3/4/2018			
	Sampling Stations	1	2	3	4	1	2	3	4	1	2	3	4
Field Observation	Time(am)	9:05	9:50	10:40	11:19	8:27	8:53	9:11	10:03	8:15	8:40	9:05	9:55
	Air temp(°C)	23	25	26	26	14	13	15	15	25.2	25.8	27.5	30
	Water temp(°C)	24	24	24	24	18	18	19	19	25.6	21.5	21.5	24.1
Physical parameter	pH	7.82	7.50	7.79	7.82	7.05	7.25	7.33	7.16	6.75	6.45	6.59	6.79
	EC (µS/cm)	197	187	195.4	219	722	672	712.72	1123	352	551	565	624
	Turbidity (NTU)	37	30	44	30	29.2	20.1	30.3	26.8	17.2	13.7	15.7	15.3
Physico-chemical parameter	DO(mg/lit)	6.74	7.32	10.5	6.605	0	0.40	1.224	0.51	0.8	0	1.6	2.4
	BOD(mg/l)	7.21	5.84	7.23	7.23	15.3	17.3	18.36	17.33	25.7	34.3	38.62	21.476
	COD(mg/l)	16	12	17.6	14.4	27.3	26	27.33	28.66	40	44	52	28
Cations	Na^{+}(mg/lit)	3.5	2.8	3	3.4	14.8	35.5	34.6	17.3	6.2	12.4	18.4	11.8
	k^{+}(mg/lit)	2.1	1.8	1.9	2.2	4.9	3.8	4.2	8.6	2.8	4.2	4.4	6.6
	Ca^{2+}(mg/lit)	22.8	15.6	28.627	20.107	72.1	64.9	72.180	122.7	73.5	87.8	192.4	104.02
	Mg^{2+}(mg/lit)	3.09	7.02	0.413	5.989	29.5	16.4	14.215	40.45	19.6	22.4	21.00	35.002
Anions	CO_3^{--}(mg/lit)	-	-	-	-	-	-	-	-	-	-	-	-
	HCO_3^{-}(mg/lit)	73.6	73.6	81.606	80.670	333	380	328.79	576.6	190	269	276.2	301.20
	Cl^{-}(mg/lit)	8.66	9.30	9.558	10.968	36.1	36.0	33.518	56.22	84.7	91.2	101.3	141.94
	SO_4^{--}(mg/lit)	1.74	1.60	1.909	2.018	18.7	18.3	18.532	23.92	0.89	1.71	1.726	1.807
Nutrients	NO_3^{-}(mg/lit)	6.14	5.01	6.9012	7.9704	0.50	0.58	0.5418	1.026	0.93	1.06	1.199	1.600
	PO_4^{-}(mg/lit)	2.42	1.79	2.018	2.508	1.19	1.27	1.3209	1.601	0.36	0.62	0.792	0.9741
Other	Total Iron(mg/lit)	0.96	1.04	1.07	1.61	3.53	3.27	3.42	5.48	0.29	0.27	0.281	0.273
	Silica(mg/lit)	3.09	3.69	3	3.68	1.34	5.33	1.37	3.75	0.87	0.97	1.01	0.9088
	TS(mg/lit	130	120	130	150	500	480	490	770	230	360	370	410

Table 4 Water Quality corresponding to NSF-WQI

WQI RANGE	**QUALITY**
0-25	Very Poor
25-50	Poor
50-70	Medium
70-90	Good
90-100	Excellent

Table 5 WQI and seasonal results for all locations (Rainy season 2017) (Sampling date- 28/08/17)

Sr no		1	2	3	4	5	6	7	8	9	WQI
Parameters		Water Temp	pH	Turbidity	DO	BOD	TDS	Nitrate	Phosphate	Thermotolerant Coliform	
Sampling Site	Moshi	24	7.82	37	6.75	7.21	130	6.14	2.42	6	62
	Alandi Upstream	24	7.5	30	7.32	5.84	120	5.01	1.79	9	61
	Alandi Downstream	24	7.79	44	10.5	7.23	130	6.9	2.018	6	59
	Charholi	24	7.82	30	6.6	7.23	150	7.97	2.5	6	62

Table 6 WQI and seasonal results for all locations (Winter season 2017-18) (Sampling date- 09/01/18)

Sr no		1	2	3	4	5	6	7	8	9	WQI
Parameters		Water Temp	pH	Turbidity	DO	BOD	TDS	Nitrate	Phosphate	Thermotolerant Coliform	
Sampling Site	Moshi	18	7.05	29.2	0	15.3	500	0.504	1.90	16	45
	Alandi Upstream	18	7.25	20.1	0.4	17.34	480	0.586	1.27	16	46
	Alandi Downstream	19	7.33	30.3	1.22	18.36	490	0.542	1.32	16	46
	Charholi	19	7.16	26.8	0.51	17.33	770	1.027	1.60	16	44

Table 7 WQI and seasonal results for all locations (Summer season 2018) (Sampling date- 03/04/18)

Sr no		1	2	3	4	5	6	7	8	9	WQI
Parameters		Water Temp	pH	Turbidity	DO	BOD	TDS	Nitrate	Phosphate	Thermotolerant Coliform	
Sampling Site	Moshi	25.6	6.75	17.2	0.8	25.76	230	0.933	0.36	16	55
	Alandi Upstream	21.5	6.45	13.7	0	34.32	360	1.066	0.627	16	51
	Alandi Downstream	21.5	6.59	15.7	1.6	38.62	370	1.199	0.793	16	52
	Charholi	24.1	6.79	15.3	2.4	21.47	410	1.600	0.974	16	53

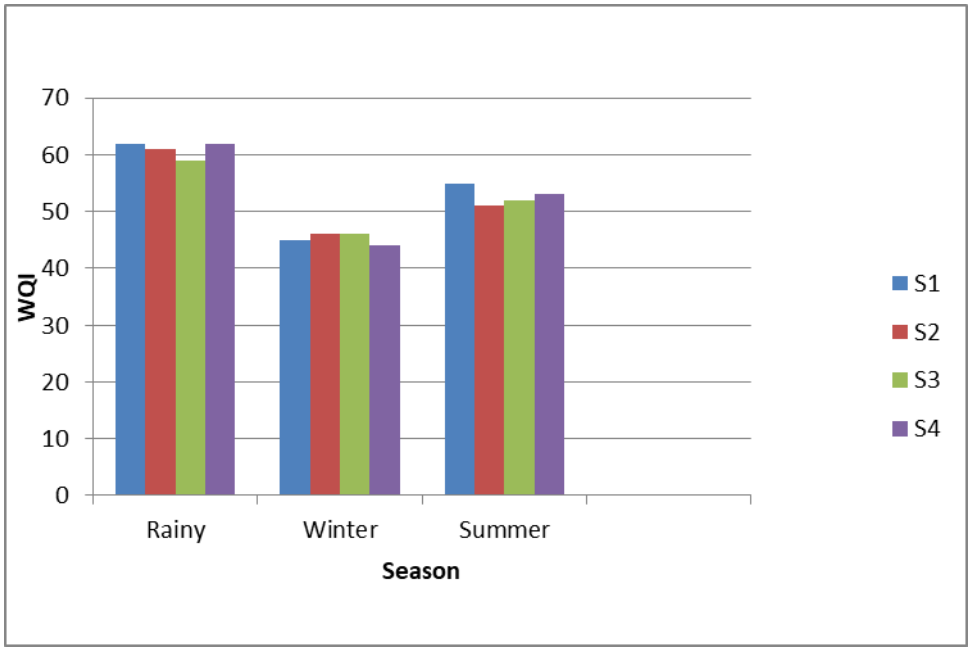

Fig 3 Graph showing seasonal variations of WQI at different stations

During the study, we have observed that the surface temperature of Indrayani River varies between 18 to 25.6. Temperature of water in summer season is comparatively lower than air temperature due to water hyacinth formation at water surface of Indrayani River. pH value is nearly same for all our station. It is slightly basic in rainy season and acidic in summer season. In summer season, due to growth of water hyacinth, solar radiations can't reach water surface lowering the temperature of water. Due to this lowering of water temperature and respiration of plants, DO values in summer season are higher than winter season. In Indrayani River, BOD values ranged from 5.84 to 38.62 mg/L. BOD values increases with season from rainy season to summer season. Maximum value of BOD for Indrayani River occurs in summer season at location Alandi downstream. In Indrayani River, COD value ranges from 12 to 52mg/l. COD values for Indrayani River goes on increasing from rainy season to summer season In summer season, Indrayani River gives higher value than standard limit of COD effluent discharge. WQI for Rainy season was found out to be 61 which is considered as medium. WQI for winter season was found out to be 45 which is considered as poor. WQI for summer season was found out to be 53 which is considered as medium.

5) CONCLUSION

In present investigations attempt has been made to assess the water quality with reference to different parameters such as physical, chemical and microbiological parameters. On the basis of various parameters analyzed in this investigation, it was concluded that the water quality of River Indrayani is unfit for drinking purposes. WQI may be used as indicator to know the health of river. The discharging of domestic and industrial wastewater and also other pilgrim activities were the main factors for contaminating Indrayani stream. Study reveals that water quality index of Indrayani River was found to be in between 44-62 that shows water quality ranging from bad to medium. Water quality in rainy, winter and summer is found to be medium, bad and medium respectively. Hence, there is need for regular monitoring of water quality in order to detect changes in physiochemical parameters of river water at different sites, implementation of remediation measures and public awareness.

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