



RESEARCH ARTICLE

PHYSICO-CHEMICAL ASSESSMENT OF WATER QUALITY OF PAVANA RIVER IN PIMPRI-CHINCHWAD CITY (PUNE) OF MAHARASHTRA STATE (INDIA)

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ABSTRACT

The study was aimed to know water quality from analysis of physico-chemical characteristics of Pavana River, Pune from September 2016 to February 2017. Due to the increase in population and industrialization, there shall be a necessity to understand the present status of Pavana River. Many government bodies do that work but there should be requirement of analysis of river with new methods. The experiment was carried out for three seasons i.e. Monsoon, Post-monsoon and Pre-monsoon. The water sample is collected from river as the depth changes. The physicochemical parameters such as Temperature, pH, DO, COD, BOD, Alkalinity, Total Dissolved solid, Total suspended solids, Total solids, Turbidity has been studied during analysis.

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INTRODUCTION

A. General

Assessment of water resource quality of any region is an important aspect of developmental activities of the region, because rivers, lakes and manmade reservoirs are used for water supply to domestic, industrial, agricultural and fish culture. Good water quality resources depend on large number of physicochemical parameters and the magnitude and source of any pollution load; and to assess that, monitoring of these parameters is essential. Polluted water is the major cause for the spread of many epidemics and some serious diseases like cholera, tuberculosis, typhoid, diarrhea etc. Contamination of drinking water from any source is therefore of primary importance because of the danger and risk of water borne diseases. According to W.H.O, 1998, report there were estimated 4 billion cases of diarrhea and 2.2 million deaths annually. The availability of good quality water is an indispensable feature for preventing disease and improving quality of life. Domestic and industrial wastewater constitute as a constant polluting source, whereas surface runoff is a

seasonal phenomenon mainly controlled by climate. Without adequate quantity and quality of fresh water sustainable development will not be possible. The healthy aquatic ecosystem is dependent on the biological diversity and Physico-Chemical characteristics. The physicochemical properties will also help in the identification of sources of pollution, for conducting further investigations on the eco-biological impacts and also for initiating necessary steps for remedial actions in case of polluted water bodies. In India, many researchers have worked on physicochemical and biological characteristics of reservoirs and rivers. Although statistics vary, the World Health Organization (WHO) reports that approximately 36% of urban and 65% of rural Indian's were without access to safe drinking water. The surface water bodies become the dumping source for industrial effluent and domestic wastes. As a result, the naturally existing dynamic equilibrium among the environmental segments get affected leading to the state of polluted rivers. According to World Health Organization's (WHO) decision, water for the consumers should be free from pathogenic organisms and toxic substances. In spite of vast water resources in lakes and rivers and good monsoon, India faces perennial problems of floods and droughts and high pollution of fresh water resources.

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B.Pavana River

It is a fact that good water quality produces healthier humans than one with poor water quality. Pavana River is life line of Pimpri-Chinchwad city and its water is used for domestic and agriculture purposes. Therefore, effective maintenance of water quality is required through appropriate measurements. Physico-chemical and micro-biological characteristics may describe the quality of water. Therefore, this study was carried out for the actual status of Pavana River from literature survey. In addition, with increasing number of industries and stakeholders of the river, the concern over the quality has also grown up and hence warranted for the present investigation. The Pavana River originates from the Western Ghats, about 6 km South of Lonavala. Flowing eastwards initially, it becomes southbound and passes through the suburbs of Dehu, Chinchwad, Pimpri and Dapodi before it's confluence with the Mula river near Sangvi. An earthfill gravity dam forms the Pavana reservoir. The dam, constructed in 1972, is 1,329 m (4,360 ft.) long and 42.37 m (139 ft.) high, with a gross storage capacity of 30,500 km³.

MATERIALS AND METHODS

In order to analyze the effects of pollution, stretch of the river, starting from Pavana Dam to Dapodi various station points were selected for sampling. Samples must be taken from locations which are representative of the water from sources, treatment plants, storage facilities, distribution network and household connections. Samples were collected for three seasons i.e. Pre-Monsoon, Monsoon & Post-Monsoon. Monsoon sample was collected in first week of September 2016, Post Monsoon sample was collected in first week of November 2016 and Pre-Monsoon sample was collected in first week of February 2017. The samples were of Grab samples & collected in sterilized bottles using standard procedure (APHA 2012). Five samples from each site is collected, two from edge, one from center and two from intermediate of edge and center with measuring depth of each. All other procedure was followed according to APHA (2012). Water sample was collected from 6 stations and they were as following Station 1 (Dapodi), Station 2 (Sangvi), Station 3 (Sudarshan Nagar), Station 4 (Kasarwadi), Station 5 (Pimple Saudagar), Station 6 (Pimpri).

RESULTS AND DISCUSSION

The results which was taking in three seasons i.e. Monsoon, Post-Monsoon, Pre-monsoon season shown in Table1, Table2, Table3 respectively.

1. Temperature:

Surface water temperature was recorded for all 6 stations as well as all samples of the study area during the investigating Physico-Chemical parameters of Pavana River. There was no significant difference between the temperatures of various stations throughout the period of study. In the present investigation, lower water temperature was observed in post-monsoon season of November 2016 i.e. 21.9 and higher temperature was recorded in monsoon season of September 2016 i.e. 27.5. Water temperature was ranging from 21.9 °C to 27.5 °C due to seasonal changes in ambient temperature. Minimum temperature of water was recorded at station 4 (Kasarwadi) and maximum was at sampling station 2 (Sangvi), there is increase in the temperature as compared to the

upstream stations. On the basis of three seasons, an average water temperature was 27.13, 22.32 and 24.53 °C during Monsoon, Post-monsoon and Pre-Monsoon seasons, respectively.

2. Dissolved Oxygen (D.O.):

Dissolved oxygen (DO) is essential to aquatic life and plays an important role in biogeochemical processes in freshwater environments. DO in water come from two sources: atmospheric oxygen and oxygen generated by photosynthetic organisms (algae and aquatic plants). Dissolved Oxygen content of the water varied from 0.09 to 2.89 mg/l, 0.7 to 3.01 mg/l and 0.1 to 1.26 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. It was high during the Post-monsoon season with the maximum at station 1B (Dapodi) i.e. 3.01 mg/l. also the low DO was recorded during the Monsoon season at station 4A (Kasarwadi) i.e. 0.09 mg/l. Average Dissolved Oxygen content of the water samples were 0.57 mg/l, 0.93 mg/l and 0.50 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. The minimum concentration was recorded in Pre-monsoon season in almost all the sites.

3. pH (Hydrogen Ion Concentration):

pH fluctuated between 6.84 to 7.11, 6.83 to 7.05 and 6.75 to 6.99 in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. The seasonal fluctuations of pH were observed at all the sampling stations of the Pavana Rivers. The pH of the river water has remained more or less uniform throughout the study period and did not fluctuate by more than one unit at all stations during the study period. The pH of the surface waters ranges from 6.75 at sampling station 6C (Pimpri) in Pre-monsoon Season to 7.11 at station 1C (Dapodi) in Monsoon season. Lowest value of pH was seen in Pre-Monsoon season. The pH value of water falls between slightly acidic to slightly alkaline in the present study which is well within the permissible limit of pH (6.5-8.5 for multiple uses of water) as prescribe by B.I.S. Average Dissolved Oxygen content of the water samples were 6.98, 6.93 and 6.84 in Monsoon season, Post-monsoon season and Pre-monsoon season respectively.

4. Biochemical Oxygen Demand (B.O.D.):

Biochemical Oxygen demand content of the river water varied from 10 to 170 mg/l, 10 to 70 mg/l and 30 to 80 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. The lowest BOD observed was 10 mg/l at many Station samples in Monsoon and Post-monsoon which indicate a remarkable dilution and dispersion of the pollutants in the river. While, highest BOD was observed was 170 mg/l at Station 6D (Pimpri) in Monsoon season. Station 5 (Pimple Saudagar) sample was follows the second highest BOD in Monsoon season all samples. Average seasonally BOD obtained was 61.67 mg/l, 30.33 mg/l and 51 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. Higher average value during Monsoon season might be due to biological as well as natural oxidation process with increase in temperature.

5. Chemical Oxygen Demand (C.O.D.):

Chemical Oxygen demand content of the river water varied from 16 to 32 mg/l, 28 to 208 mg/l and 56 to 304 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively.

Table 1. Physico-Chemical Characteristics of Pavana River at Various Sampling Station in Monsoon Season in year 2016

Site	Width	Depth	Temperature	PH	DO	BOD	COD	TDS	TSS	TS	Turbidity	Alkalinity
1A	136.5	1.72	27.3	7.1	1.2	10	32	338	23.5	400	4.6	170
1B	136.5	1.71	27.3	7.09	0.83	10	32	360	24.25	334	5.3	170
1C	136.5	1.89	27.3	7.11	2.89	80	32	340	23.75	334	4.2	180
1D	136.5	1.77	27.3	7.1	1.03	50	32	356	24	367	5.8	200
1E	136.5	1.79	27.3	7.04	0.97	10	32	332	22.5	334	5.2	170
2A	51.88	0.19	27.5	6.99	0.09	60	28	346	41.75	400	5.9	190
2B	51.88	0.46	27.4	6.99	0.19	50	28	386	37.5	667	6	220
2C	51.88	0.51	27.3	6.97	0.11	50	28	438	48.5	800	6.6	220
2D	51.88	0.64	27.5	6.99	0.16	50	28	394	42.75	400	5.6	210
2E	51.88	0.23	27.4	6.99	0.18	30	28	414	52.25	634	6.2	220
3A	52.06	0.35	26.9	6.97	0.12	70	32	360	64	367	20.8	200
3B	52.06	1.01	26.9	6.97	0.16	10	32	382	58.5	434	16.4	190
3C	52.06	1.14	26.9	6.93	0.23	40	32	328	61.75	400	19	190
3D	52.06	1.23	26.9	6.95	0.17	30	32	362	57.25	334	22.4	210
3E	52.06	1.2	26.9	6.99	0.12	80	32	388	67.5	400	27.7	180
4A	44.89	1.39	27	7.02	0.09	90	24	392	134.75	533	31.6	210
4B	44.89	1.53	26.9	7	0.1	80	24	360	112.75	667	29.2	210
4C	44.89	1.56	26.9	7.06	0.13	40	24	362	128	433	43.3	200
4D	44.89	1.42	27	7.01	0.11	60	28	384	134.25	467	35.9	200
4E	44.89	1.45	26.9	7.04	0.1	80	24	400	140	567	41.4	210
5A	59.97	0.98	27.1	6.94	0.81	80	16	360	52.5	334	6.2	200
5B	59.97	1.14	27.1	6.95	0.8	120	16	320	48.25	467	9.1	190
5C	59.97	1.25	27.1	6.91	0.87	140	24	332	48	334	8	190
5D	59.97	1.18	27.2	6.98	0.9	100	16	340	51.75	434	8.5	180
5E	59.97	1.09	27.1	6.95	0.82	120	24	374	47.5	467	9.6	190
6A	83.39	1.72	27.1	6.88	0.78	20	20	390	9.25	734	4.4	210
6B	83.39	2.3	27.1	6.89	0.82	10	20	328	10.25	534	3.8	210
6C	83.39	2.61	27.1	6.9	0.81	100	20	240	13	467	6.1	190
6D	83.39	2.59	27.1	6.84	0.8	170	20	590	7.5	800	2.9	190
6E	83.39	1.53	27.1	6.89	0.8	10	20	300	11.75	400	2.7	270
		Min.	26.9	6.84	0.09	10	16	240	7.5	334	2.7	170
		Max.	27.5	7.11	2.89	170	32	590	140	800	43.3	270
		Avg.	27.13	6.98	0.57	61.67	26	366.53	53.30	474.76	13.48	199

Table 2. Physico-Chemical Characteristics of Pavana River At Various Sampling Station in Post-Monsoon Season in year 2016

Site	Width	Depth	Temperature	PH	DO	BOD	COD	TDS	TSS	TS	Turbidity	Alkalinity
1A	136.5	1.72	22.3	7.01	0.6	20	80	300	15	400	4.8	230
1B	136.5	1.71	22.3	7.05	3.01	10	28	320	12.5	367	5.2	230
1C	136.5	1.89	22.4	7	0.17	30	60	300	22.5	400	4.3	240
1D	136.5	1.77	22.3	7.04	0.92	20	44	340	19.5	400	4.9	230
1E	136.5	1.79	22.4	7.05	0.79	20	68	300	20.25	434	4.7	240
2A	51.88	0.19	22.6	6.88	0.81	60	60	340	32	334	5.1	210
2B	51.88	0.46	22.8	6.92	0.8	10	40	340	24.5	400	5.2	200
2C	51.88	0.51	22.8	6.89	0.59	40	64	320	27.5	334	5.6	230
2D	51.88	0.64	22.7	6.91	2.4	20	48	300	7.5	300	5.5	200
2E	51.88	0.23	22.8	6.91	0.62	30	208	340	265	534	5.4	180
3A	52.06	0.35	22	6.96	1.72	10	68	300	45	400	5.5	170
3B	52.06	1.01	22	6.93	0.65	40	80	320	30	334	5.5	240
3C	52.06	1.14	22.2	6.93	0.68	20	72	300	38	400	5.2	190
3D	52.06	1.23	22.1	6.95	0.7	20	80	340	36.25	367	4.9	180
3E	52.06	1.2	22.2	6.95	0.68	30	64	300	41.5	334	5.4	220
4A	44.89	1.39	21.9	7.01	0.8	50	84	520	88.25	600	12	210
4B	44.89	1.53	21.9	7.02	0.81	40	72	480	79.5	567	7.4	220
4C	44.89	1.56	21.9	7.02	0.79	10	80	520	81	567	9.1	220
4D	44.89	1.42	21.9	7.02	0.79	20	80	560	95	634	8	210
4E	44.89	1.45	22	7	0.79	40	88	580	100	634	10	210
5A	59.97	0.98	22.5	6.84	0.92	40	56	520	22.5	600	6.7	230
5B	59.97	1.14	22.5	6.85	0.6	70	56	540	17.5	600	6.8	210
5C	59.97	1.25	22.5	6.83	0.88	50	60	520	19.25	634	7.3	220
5D	59.97	1.18	22.5	6.83	0.81	60	56	500	20.75	567	7.1	210
5E	59.97	1.09	22.5	6.85	0.86	50	60	540	24	634	6.6	210
6A	83.39	1.72	22.4	6.88	0.89	30	56	320	9.5	334	5.7	200
6B	83.39	2.3	22.3	6.88	0.81	10	64	260	5	300	5.8	190
6C	83.39	2.61	22.3	6.89	0.74	10	64	260	5	267	6.5	190
6D	83.39	2.59	22.4	6.89	0.74	30	52	280	7.5	267	5.4	200
6E	83.39	1.53	22.3	6.85	1.5	20	56	300	5	300	5	210
		Min.	21.9	6.83	0.17	10	28	260	5	267	4.3	170
		Max.	22.8	7.05	3.01	70	208	580	265	634	12	240
		Avg.	22.32	6.93	0.929	30.33333	68.26667	382	40.55833	441.4333	6.22	211

Table 3. Physico-Chemical Characteristics of Pavana River at Various Sampling Station in Pre-Monsoon Season in year 2017

Site	Width	Depth	Temprature	PH	DO	BOD	COD	TDS	TSS	TS	Turbidity	Alkalinity
1A	136.5	1.72	24.9	6.8	1.1	30	116	496	2	364	4.5	240
1B	136.5	1.71	24.9	6.84	0.89	30	56	334	2.5	380	4.2	250
1C	136.5	1.89	24.9	6.86	0.23	40	124	248	1.25	394	4.2	250
1D	136.5	1.77	24.8	6.82	0.48	60	120	324	3.1	400	4.6	240
1E	136.5	1.79	24.9	6.84	0.92	40	108	340	2.2	367	4.2	250
2A	51.88	0.19	25.4	6.88	0.59	50	132	284	11.25	500	4.8	230
2B	51.88	0.46	25.3	6.84	0.16	60	124	360	9.5	467	4.6	230
2C	51.88	0.51	25.4	6.81	0.35	50	120	270	7.25	430	5	230
2D	51.88	0.64	25.4	6.87	0.1	80	132	388	8.5	414	4.3	230
2E	51.88	0.23	25.3	6.91	0.68	70	116	372	162.75	550	4.8	250
3A	52.06	0.35	24.3	6.92	0.52	60	140	344	16.75	407	5.6	230
3B	52.06	1.01	24.1	6.86	1.26	40	112	328	7	327	4.5	220
3C	52.06	1.14	24.3	6.83	1.01	30	120	310	5.8	334	4.9	230
3D	52.06	1.23	24.2	6.89	0.81	40	124	332	6.6	400	5.2	230
3E	52.06	1.2	24.3	6.9	0.84	50	120	332	8.5	367	4.7	220
4A	44.89	1.39	24.1	6.93	0.58	30	140	300	40.5	367	5.1	190
4B	44.89	1.53	24.1	6.94	0.61	70	136	324	24.25	367	5.3	200
4C	44.89	1.56	24.1	6.88	0.6	50	140	316	38	334	5.6	210
4D	44.89	1.42	24	6.89	0.51	40	144	310	33.75	324	5.7	200
4E	44.89	1.45	24	6.99	0.4	80	132	320	20.5	364	5.6	220
5A	59.97	0.98	24.4	6.76	0.22	60	120	314	59.5	374	7	230
5B	59.97	1.14	24.5	6.79	0.12	70	128	368	41.25	380	6.9	240
5C	59.97	1.25	24.4	6.8	0.19	60	120	344	47.5	367	6.9	240
5D	59.97	1.18	24.4	6.79	0.23	70	124	338	52	400	7.1	230
5E	59.97	1.09	24.4	6.78	0.23	40	124	324	54.25	334	7.5	240
6A	83.39	1.72	24.3	6.81	0.36	60	120	352	14.5	400	4.6	220
6B	83.39	2.3	24.2	6.77	0.29	30	132	302	16.75	380	4.5	220
6C	83.39	2.61	24.3	6.75	0.16	40	304	352	251.25	514	4.6	220
6D	83.39	2.59	24.3	6.8	0.38	30	108	320	40	354	4.4	220
6E	83.39	1.53	24.2	6.79	0.41	70	64	286	6.5	340	4.4	220
		Min.	24	6.75	0.1	30	56	248	1.25	324	4.2	190
		Max.	25.4	6.99	1.26	80	304	496	251.25	550	7.5	250
		Avg.	24.53	6.84	0.50	51	126.66	331.06	33.18	390	5.17	227.67

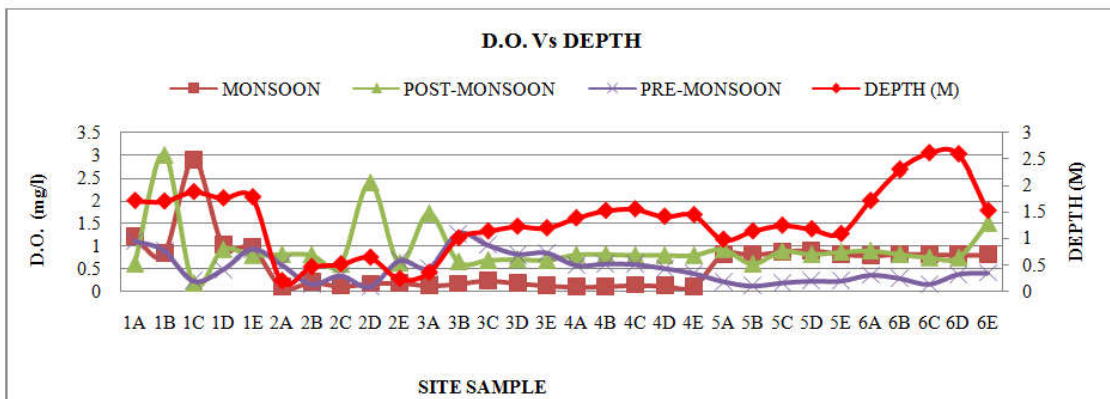


Figure 1. D.O. Vs Depth data of all season

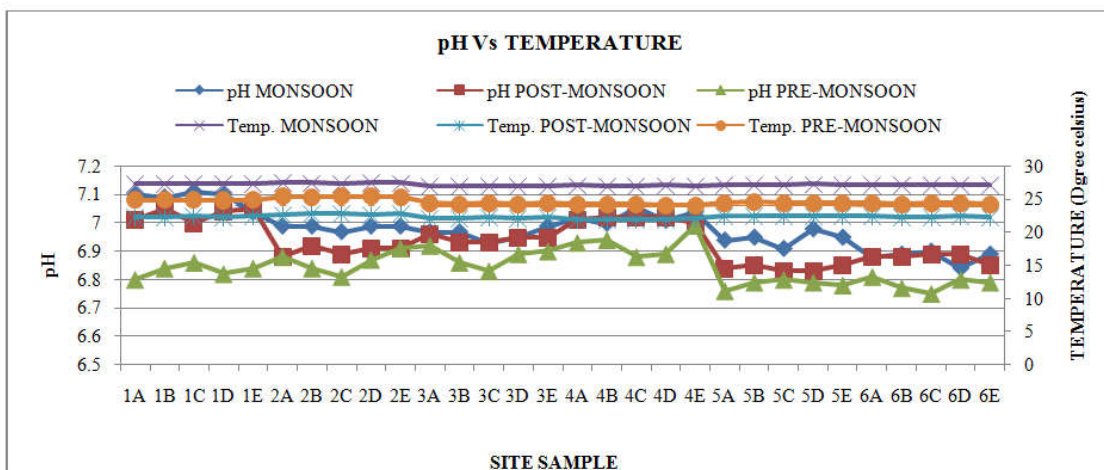


Figure 2. pH Vs Temperature data of all season

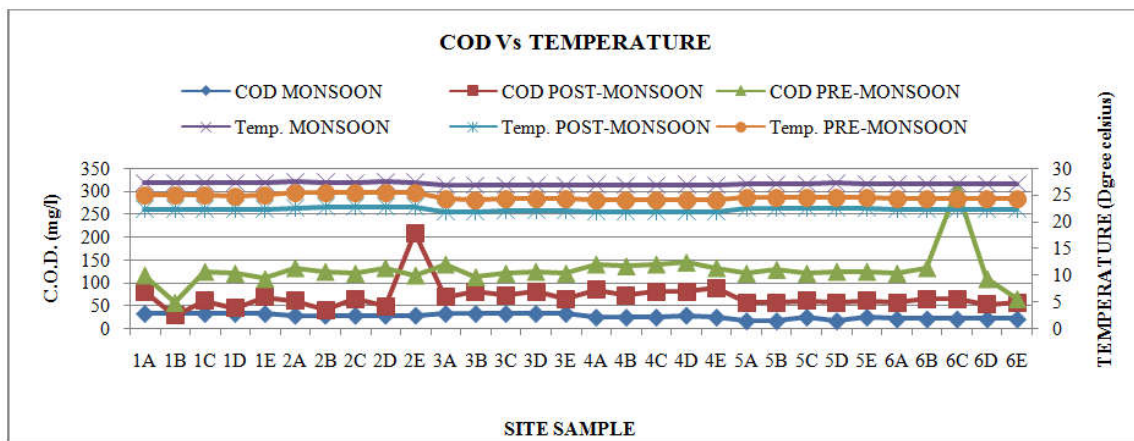


Figure 3. COD Vs Temperature data of all season

This high average value of COD was recorded in Pre-monsoon i.e. 126.67 mg/l followed in Post-monsoon season was 68.26 mg/l and least in Monsoon season 26 mg/l. There is a wide variation in the values of chemical oxygen demand at different sampling station, different samples and between the seasons.

6. Total Dissolved Solids (T.D.S.):

Total Dissolved Solids content of the river water varied from 240 to 590 mg/l, 260 to 580 mg/l and 248 to 496 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. The TDS values ranged from 240 mg/l in Monsoon at station 6C (Pimpri) to 590 mg/l at station 6D (Pimpri) in Monsoon. The seasonal fluctuations in the values of TDS at each season are shown in Tables. The highest seasonal average value of TDS was recorded in Post-monsoon season i.e. 382 mg/l followed in Monsoon season was 366.53 mg/l and least in Pre-monsoon season 331.07 mg/l. The average values were below the limits as the suggested (TDS 500 mg/l).

7. Total Suspended Solids (T.S.S.):

The undissolved matter i.e., silt, clay, organic matter, algae, bacteria and fungi forms TSS. Suspended solids also are seen due to natural process of erosion, sewage and industrial effluents. Total Suspended Solids content of the river water varied from 7.5 to 140 mg/l, 5 to 265 mg/l and 1.25 to 251.25 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. The highest TSS value recorded was 265 mg/l in Post-monsoon at station 2E (Sangvi), while lowest value was 1.25 mg/l at station 1C (Dapodi) in Pre-monsoon. The seasonal fluctuations in the values of TSS at each season are shown in Tables. The highest seasonal average value of TSS was recorded in Monsoon season i.e. 53.308 mg/l followed in Post-monsoon season was 40.55 mg/l and least in Pre-monsoon season 33.82 mg/l.

8. Total Solids (T.S.):

Total Solids content of the river water varied from 334 to 800 mg/l, 267 to 634 mg/l and 324 to 550 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. The highest TS value recorded was 800 mg/l in Monsoon at station 6D (Pimpri), while lowest value was 267 mg/l at station 6C (Pimpri) in Post-monsoon. The seasonal fluctuations in the values of TSS at each season are shown in Tables. The highest seasonal average value of TS was recorded in Monsoon season

i.e. 474.77 mg/l followed in Post-monsoon season was 441.43 mg/l and least in Pre-monsoon season 390 mg/l.

9. Turbidity:

Turbidity is caused by particulate matter in suspension. It is an expression of the optical property of the sample containing insoluble substances which cause the light to scatter. Suspended matter as clay, silt, organic matter and plankton also contribute to turbidity. The seasonal fluctuations in the values of COD at each season are shown in Tables. Turbidity content of the river water varied from 2.7 to 43.3 NTU, 4.3 to 12 NTU and 4.2 to 7.5 NTU in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. High turbidity observed was 43.3 NTU at station 4C (Kasarwadi) while lowest value was 2.7 NTU at site 6E (Pimpri) both in monsoon season. The average seasonally turbidity for the rivers water observed was 13.48 NTU, 6.22 NTU and 5.17 NTU in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. The maximum turbidity observed in Monsoon season was may be due to riverine condition. River water get started turbid after Pre-monsoon season. The turbidity is a striking characteristic to know the physical status of the river.

10. Alkalinity:

Alkalinity is a measure of buffering capacity of water and is caused by calcium carbonate and bicarbonate and also to some extends due to phosphates and organic matter. Therefore, alkalinity analysis helps to know buffering capacity of water to adjust pH. Alkalinity content of the river water varied from 170 to 270 mg/l, 170 to 240 mg/l and 190 to 250 mg/l in Monsoon season, Post-monsoon season and Pre-monsoon season respectively. The maximum concentration of total alkalinity was 270 mg/l recorded in the Monsoon season at sampling station 6E (Pimpri), and minimum value was 170 mg/l in Monsoon and Post-monsoon season at Station 1 (Dapodi) and Station 3 (Sudarshan Nagar) respectively. The seasonal variations of alkalinity are represented in Tables. The higher average values were observed 227.66 mg/l in Pre-monsoon season, Post-monsoon season (211 mg/l) and Monsoon season (199 mg/l). During Pre-monsoon season (summer), increased decomposition of organic matter liberates CO_2 , which in turn, prevents the dissociation of bicarbonates in carbonates, increasing its total alkalinity. The alkalinity values were high at the site due to addition of sewage and organic

matter and bicarbonate show determined relationship with free carbon dioxide.

Conclusion

Based on the study carried out it be concluded that the poor water quality may be due to Civil industrial effluents in case of Pavana River. Dissolved oxygen was found very critical at many places of these rivers and at some places it is below the detectable level causing a threat to aquatic life. High level of BOD and COD confirm excess of this oxygen demanding waste. It is cleared from the present findings that the aquatic environment Pavana river flowing through the Pimpri-Chinchwad city shows increasing load of pollution and lead remedial measure. There is a need to have proper collection and treatment of waste. As also to restore the river in wetland there is a need to regulate the flow and degrade the deposited material.

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