



Studies on physicochemical parameters of Indrayani River, Pune, Maharashtra, India

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Abstract

The Indrayani River is one of the river of Bhima River, originates at Kurvande village near Lonavala, and flows towards east across the north border of city of Pune. The Valvan dam is constructed on Indrayani River for irrigation and hydroelectric power plant. It flows. In the catchment area of Indrayani River, population is rapidly increasing, because of best connectivity of roads and railway transport, many educational hubs and job opportunities. Many villages and four Municipal councils release their untreated sewage wastes into the Indrayani River. At Indori and Dehu collection sites all the physiochemical parameters have high values and this water is not found suitable for drinking and other purposes. The river is becomes eutrophic, at many places water surface is covered with aquatic vegetation such water hyacinth and Vallisneria. Therefore, Indrayani River is getting polluted due of domestic and industrial discharges; there is record of death of fishes, mostly Mahseer.

Keywords: Studies, physicochemical, parameters.

Introduction

The living organism on the earth cannot survive without water, they need water for their existence. The freshwater bodies such river and ponds and streams are become habitat of aquatic fauna. The life on planet needs good quality water for drinking. Human requires good quality water for various purposes such as drinking, agriculture and industries etc. However nowadays, the number of substances such as wastes from various resources being continuously added in water bodies.

These wastes comprising bacteria, viruses, heavy metals, nitrates, phosphates, salts, sewage and detergents are discharged water bodies. These wastes such as sewage, industrial waste water, agricultural runoff and other liquid waste without sufficient treatment are discharged into the water bodies.

These wastes alter the physical and chemical properties of water and make water harmful to human being and for other activities. Today, the major rivers and streams of the world are heavily polluted. The huge population expansion, widespread urbanization, industrialization and agricultural development have led to affect the water quality all over the world¹.

The water is valuable components of origin of life and sustains of life. The water is necessary for whole life processes². There are numerous sources of water contamination, but most of them which are domestic waste, industrial waste, the waste dumped into water by human being, cutting of trees and flooding causes soil deterioration, usage of insecticides and fertilizers in agricultural fields and unprocessed wastes etc. The industrial

wastes containing heavy metal and their by-products discharged into the water bodies without processing and proper treatment, these wastes settle down in water bodies. So the aquatic animals and human being are exposed to these hazardous wastes. These wastes get accumulated in the body of animal like fishes and other aquatic animals and finally in human body as these contaminated fishes were eaten.

These waste materials are so poisonous and can be produce a variety disorders in human body and causes many diseases in human being. The diseases like inflammation, reproductive failure within fertility, immune compromise, respiratory and gastrointestinal disorder, histopathological disorder, cancer and even death. It also causes many infectious diseases such as typhoid and cholera and even many cancers by contaminated water³. The water contaminants can also spread up to dermatitis, renal disease, diarrhea, dementia etc⁴.

As per the report of WHO the 1/6th human population of the world i.e. about 1.1 billion individuals are not getting good quality water for drinking and 2.4 billion people are not having proper sanitation facility. The pollution of water by domestics, industrial and agriculture wastes cause destruction to publichealth and the environment⁵.

The level of water pollution is indicated by factors like pH, temperature, dissolved oxygen, hardness, turbidity, alkalinity, ammonia, chlorides, nitrate and phosphate. As well as the contamination level of a stated water body is indicated by biological oxygen demand (BOD) and chemical oxygen demand (COD)⁶.

The physical and chemical parameters of aquatic body like pH, DO, free and combined CO₂ temperature, alkalinity, chloride, acidity, nitrate, phosphate, transparency, biological and chemical oxygen demand can influence growth, reproduction and development of aquatic animals⁷. The physico-chemical features of the water body will decide the efficiency of aquatic ecosystem⁸.

The eutrophication of ponds is occurred due to discharge of unlimited and unprocessed domestic waste water into the ponds⁹. The discharge of contaminants in the river water affects the DO level, which increase biological oxygen demand and amount of nutrient in the water. This promotes growth of toxic algae in huge quantity and causes to damage aquatic ecosystem¹⁰. The aquatic quality is declined due to increase in acidity, rich in nutrients (nitrate and phosphates) and organic materials, floating solids or contamination with chemicals from industries or agriculture. In such a polluted water aquatic life including fishes may be under pressure and susceptible to various disease¹¹.

The quality of water is depends on biological, chemical and physical substances present in it. The pH, salinity, temperature, dissolved oxygen are chemical and physical factors, which manipulate the aquatic environment. Besides these, acidity, heavy metals, alkalinity, dissolved solids, suspended particles and other pollutants also influence the water quality. The survival of aquatic flora and fauna is depends on all these factors. The condition of water may decline due to slow water flow, domestic and industrial discharges¹².

The water parameters are controlling features for distribution and existence of aquatic organisms in which they happily live. A sudden decrease or rise in these parameters causes adverse impact on normal functioning of body¹³. The poor quality of water may result retarded growth of fauna, low quality food and probable human health threats. The contaminated water can impair growth, development and productivity or even cause death of the cultivated fishes. Accumulation of contaminants in the body of fishes, which may causes threats human health even in low quantities¹⁴.

Today, the fresh water bodies are being polluted due to domestic and industrial discharges, human activities, use of fuel and their products, excess use of fertilizers, misuse and indiscriminating usage of insecticides in farm which cases contamination of aquatic ecosystem. And many water bodies are unfit to aquatic fauna and human being.

Materials and methods

Study area: The Indrayani River is life line of millions of peoples and one of tributaries of Bhima River. It originates at Kurvande village near Lonavala, in the North Western Ghats and flows towards east to meet Bhima River near Tulapur, Pune. The Indrayani River flows through two pilgrimage centres

namely Dehu and Alandi, so it is respected as a sacred river, which related with great Saints such as Saint Tukaram Maharaj and Dnyaneshwar Maharaj. The Valvan dam is constructed on Indrayani River for the purpose of irrigation and hydroelectric power plant. It flows across the north border of city of Pune. In the catchment area of Indrayani River, there are number village, housing complexes, few cities, educational institutes and many industrial areas like MIDC. Since last thirty years industrialization is expanding at fast rate around in the Basin of Indrayani River. Therefore, in this area population is rapidly increasing, because of best connectivity of roads and railway transport, many educational hubs and job opportunities. The local civic bodies such as the Lonavla, Kamshet and Talegaon Municipal councils, the Vadgaon and Dehu Gram Panchayats and many other villages do not have sewages treatment facilities; thus they release their untreated sewage wastes into the Indrayani River. Therefore, Indrayani River is getting polluted due of domestic and industrial discharges, which causes death of fishes, mostly Mahseer.

Sampling stations: We selected four important point of Indrayani river namely- Kalvan dam, Kamshet, Indori and Dehu for the assessment of physicochemical properties of water. For the present investigation, we have examined water samples for a period of one year from September 2018 to June 2019. During July and August this river is flooded with rain water. The four sampling sites were selected for collection of water samples. During early morning the water samples were collected as per APHA¹⁵. All the sampling bottles were disinfected by carefully washing and drying in sunlight and then rinsed with the same water of sampling site before sample collection. These bottles were labelled with dates and collection sites. The water samples were kept in a cool vessel maintaining temperature below 25°C, till the analysis. Water temperature was measured by using a mercury-in-glass thermometer graduated in degree Celsius (0-100°C) at the sampling sites. The pH is measured by pH paper at site and by pH meter in laboratory, dissolved Oxygen (DO) was fixed at the site by adding Maganous Sulphate and Alkaline Iodide and then determined by Wrinkler's method. The remaining parameters such as Free CO₂, Acidity, Alkalinity, BOD, COD, Sulphate, Nitrate, Chloride and Phosphate was estimated by methods given by¹⁶.

Results and discussion

Temperature: The water temperature is significant parameter, which has direct correlation with dissolved oxygen concentration. The oxygen holding capacity of water is inversely proportional to temperature, as temperature of water rises, less oxygen is hold. It results in more respiration rate of living organisms and consumes more oxygen. The rise in temperature and less oxygen content affects the fish spawning; development of aquatic flora and the respiration of aquatic animals in the pond water. The temperature of water of all collecting site is more or less similar.

Table-1: Study of Physicochemical parameters of Indrayani River Collection site Valvan Dam. Samples were collected first week of every month.

Parameters	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June
Temp °c	24	25	26.3	26	27	27	29.2	30	31	31
pH	6.9	6.7	6.7	6.8	6.7	6.8	6.8	6.7	6.8	6.7
Dissolved O ₂	11.12	10.11	10.11	10.11	10.8	10.5	10.23	10.8	10.7	10.5
Free CO ₂	8.8	10.2	9.2	9.4	10.2	10.3	10.12	10.6	10.6	9.8
Acidity	45.3	47.4	46.6	45.6	48.6	44.6	45.6	43.6	45.4	46.2
Alkalinity	18.8	17.9	18.7	19	20.2	19.3	20.6	20	19.6	20.8
Biological Oxygen Demand Mg/litre	1.2	1.1	1.4	1.5	1.3	1.4	1.5	1.4	1.3	1.6
Chemical Oxygen Demand Mg/litre	13	14.1	13.2	14.2	14.5	13.7	14.8	13.3	14.3	13.8
Sulphate Mg/litre	120	121	120	122	123	118	119	121	122	125
Nitrates Mg/litre	21	20.2	21.1	19	20.1	19.8	19.3	20.2	20.3	18.9
Chlorides Mg/litre	30.3	30.8	31	30	32	30.1	30	31	30.9	30.5
Phosphates Mg/litre	18	25	23	30	38	42	36	32	30	29

Table-2: Study of Physicochemical parameters of Indrayani River collection site Kamshet. Samples were collected first week of every month.

Parameters	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June
Temp °c	24.5	26	27	27.2	27.2	29.4	31	30	31	31
pH	6.9	6.7	6.7	6.8	6.7	6.5	6.3	6.5	6.5	6.4
Dissolved O ₂	11.02	8.5	9.25	9.2	9.1	9.5	9.4	8.6	7.9	7.6
Free CO ₂	14.5	14.2	13.8	14.4	13.9	13.5	13.12	13.9	13.8	13.9
Acidity	48.5	49.4	50.6	48.6	50.6	51.8	50.6	51.6	49.4	50.2
Alkalinity	20.6	21.9	23.7	21	20.2	22.3	23.6	22	21.6	20.8
Biological Oxygen Demand Mg/litre	1.9	1.8	2.2	2.5	2.4	2.5	2.1	2.3	2.2	2.2
Chemical Oxygen Demand Mg/litre	20	21.1	19.1	20.2	22.5	21.5	21.2	22.3	21.8	22
Sulphate Mg/litre	170	173	170.4	171	172	170.3	169	168	169.5	172
Nitrates Mg/litre	31.6	30.2	31.3	30.9	31.5	32.1	30.5	30.8	30.1	31.4
Chlorides Mg/litre	105.12	107.65	108.6	104.5	103.32	106.9	103.5	104.7	115.3	108
Phosphates Mg/litre	121	128	125	123	128	120	121	127	122	126

Table-3: Study of Physicochemical parameters of Indrayani River collection site Indori. Samples were collected second week of every month.

Parameters	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June
Temp °C	24.5	25	27	27.2	27	27	29	30	30	31
pH	6.8	6.8	6.6	6.5	6.5	6.7	6.4	6.3	6	6.1
Dissolved O ₂	9.8	8.5	9.25	9.2	7.95	7.8	7.5	6	6.1	5.9
Free CO ₂	13.2	11.36	28.6	35.8	29.9	33.6	33	33.6	32.8	33.9
Acidity	69.5	68.9	66.6	55.7	61.6	69.8	68.6	70.8	69.4	71.3
Alkalinity	30.6	31.9	30.2	31.5	36	28	30.6	31.3	35.6	38.9
Biological Oxygen Demand Mg/litre	2.2	3.3	3.1	3.4	3.8	3.7	3.8	4.1	4.1	4
Chemical Oxygen Demand Mg/litre	18.5	23.1	30.8	26.9	30.1	32.5	32.1	31.9	30.9	32
Sulphate Mg/litre	188.2	180.9	204.8	201.2	228	230	232	231	233.2	230.9
Nitrates Mg/litre	40.8	39.3	40.5	41.7	39.5	42	41	39.8	40.4	39.6
Chlorides Mg/litre	106.32	112.5	113.6	124.7	128.9	136.4	143.8	149.7	152	159.2
Phosphates Mg/litre	132	134	135	138	140	145	142	143	140	146

Table-4: Study of Physicochemical parameters of Indrayani River Collection Site Dehugaon. Samples were collected second week of every month.

Parameters	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June
Temp °c	24.5	26	26	27.2	27	29	30	31	32	31
pH	6.6	6.5	6.5	6.3	6.4	6.5	6.2	6.4	6.1	6
Dissolved O ₂	9.2	8.8	8.25	9.2	8.1	7.5	7.4	6.81	5.82	5.6
Free CO ₂	15.4	15.14	29.46	35.12	36.34	40.26	40.92	42.46	41.8	43.4
Acidity	61.5	62.6	64.2	65.7	70.3	72.6	98.3	100.6	99.3	101.8
Alkalinity	48.7	51.9	50.6	48.6	46	47	28.6	30.3	30	38.4
Biological Oxygen Demand Mg/litre	2.5	3.9	4	4.2	4.3	4.5	4.6	4.4	4.2	4.5
Chemical Oxygen Demand Mg/litre	20.2	27.5	28.6	30.2	41	40.3	39.8	40.2	41.2	42
Sulphate Mg/litre	204.32	216	214.9	225.1	233.8	245	243.7	244	243.7	245.1
Nitrates Mg/litre	40.6	42.3	43.5	44.5	45.8	49	48.6	49.5	49.4	48.6
Chlorides Mg/litre	135.52	130.5	132.2	139.7	140.8	166.9	169.8	170.2	168.4	172.3
Phosphates Mg/litre	130	134	140	145	147	145	152	156	154	159

pH: The quality of water is depends on pH values of that water body. It is one of limiting factor of distribution of aquatic organism; most of them are adapted to an average pH 6.5 to 9.0. As per WHO 1971 the average tolerable limit of pH of the river water is 6.5 (WHO 1971). pH determines the suitability of life. In present investigation pH of water is below 6.4 from March to June at site 3 and 4 may due to more load of organic waste and evaporation, which may affects the life. pH ranging from 4.0-6.5 and 9.0-11.0 can develop stress in aquatic organism particularly in fishes. At pH less than 6.5, the growth of fish is limited, whereas at pH less than 5.0 fish reproductions is ceased and fry can die¹⁷.

Dissolved Oxygen: The amount of dissolved oxygen indicates the capacity of an aquatic ecosystem to sustenance aquatic life. The dissolved oxygen concentration may lower down due to excessive load organic substance, which has negative impact on aquatic ecosystem. During summer, temperature of water is more; the water is unable to combine with oxygen, so oxygen is set free. This free O₂ issued up by oxidation process of organic material, which consumes a part of oxygen and thus declining DO in water. The amount of DO is gradually decreased from collection site Valvan to Dehu. It is noticeably decrease at Indori and Dehu from March to June. In summer season, the values of dissolved were decreased at Indori and Dehu sites, suggesting the more quantity of contaminants at these points.

Carbon dioxide: The Carbon dioxide is a main constituent of aquatic ecosystem. The more amount of free Carbon dioxide has some defined effects on aquatic organisms. The amount CO₂ is gradually increased at Indori and Dehu sites from November to June. It is reported quite higher from February to June at Dehu. It indicates the high amount of organic discharges in river at Dehu. The investigation by Prasannakumari A.A. et al.¹⁸ shown that during summer season at station-C Carbon dioxide is high as 24.3mg/litre, whereas during monsoon season, at station-B CO₂ concentration was minimum (8.3mg/litre). The free CO₂ is as helps to withstand the aquatic environment against speedy alterations in the acidity or alkalinity, which contributes to the fitness of natural water. It forms other compounds in water and also regularises biotic development in aquatic organisms.

Alkalinity: Alkalinity of water describes the buffering abilities; if water has more alkalinity values, it specifies that water body is entropic. This water is not suitable for ecosystem as well as for drinking purposes. In summer season generally decomposition of organic matter is increased, which liberates CO₂ in water. The CO₂ inhibits the detachment of bicarbonates in carbonates, which increase its total alkalinity. The alkalinity is highest in lower part of river i.e. at Indori and Dehu than the upper part of river. Indicating more pollution in lower part of river, where domestic and industrial discharges are more. At the sites, the alkalinity values were high where the domestic sewage and organic matter were deposited. The bicarbonate show firm association with free carbon dioxide¹⁹.

Acidity: Acidity is the assessable capacity of a water or solution to counterbalance the strength of alkalies. It is the totality of acids like strong mineral acids and weak acids existing in sample that contribute to acidity of water. In uncontaminated water, dissolved carbon dioxide (CO₂) is a major acidic component. The acidity is gradually increased at Indori and Dehu site. It is noticed that acidity is much higher from March to June at Dehu, indicates the high level of pollution in river.

BOD: In assessing pollution level in water, Biological Oxygen Demand (BOD) is serve as a important factor. It is used in determining the load of organic substances in aquatic ecosystem. When BOD values of water body are highest it specifies that water body contains more amount of decomposable organic substance and consumption of high quantity of oxygen by heterotrophic biota. BOD level is quite less at Valvan and Kamshet, however BOD level is always high at Indori and Dehu. At Dehu it is much higher than limits of BIS (3mg/lit) and is about 4.0 to 4.6mg/litre from the October onwards. It indicates that river receives heavy load of organic wastes from different sources and this water is not suitable for life. In this investigation, during summer season biological oxygen demand level was more at Indori and Dehu, our findings are in correlated with²⁰.

During summer season BOD values was observed higher might be due to decomposition of organic discharges, accumulation of wastes by artificial activities and reduction in water current. However, during rainy season the BOD values were observed low, this might be due to addition of rain more water in river²¹. Highest BOD value (59mg/litre) was recorded during summer season at station-C. However, the lowest BOD values were noticed during monsoon at all stations in Mula Mutha river⁷.

Chemical Oxygen Demand (COD): The chemical oxygen demand is utilized to measures the amount of chemical waste discharged in water bodies. Organic as well as inorganic wastes are to be evaluated by COD. COD level is quite less at Valvan, however COD values was high at Kamshet, Indori and Dehu sites. At Dehu it is much higher and is above 40mg/litre from the January onwards. In summer season the chemical oxygen demand is more might be due to increase in temperature of water body causes more vaporisation of water; decrease in values of dissolved oxygen, available dissolved oxygen is utilized for decomposition of organic wastes and increase in amount of chemical discharges in river^{20,22}.

Sulphate: The amount of Sulphate at Valvan site is constant throughout year. But from Kamshet it is gradually increased downwards. However at Dehu it becomes the double amount of sulphate of Valvan.

Phosphate: The bottom sediments and decaying of organisms liberate phosphate, which serve as a natural source of Phosphate in aquatic ecosystem. Phosphate stimulates the growth of the phytoplankton and aquatic plants in the water bodies. Besides

these household detergents, domestic sewage, leaking of phosphate fertilizer, these manmade resources also increase level of phosphate. The amount of Phosphate at Valvan site is less and constant throughout year. But from Kamshet it is gradually increased downwards. Though it is at Indori and Dehu it becomes 4 to 5 times more than the amount of phosphate of Valvan.

Nitrates: The amount of Nitrates indicates the level of nutrients in water bodies and it sustenance growth of aquatic vegetation. The high values of Nitrate encourage the more development of algae and other plants. The excess amount of nitrate in drinking water has threat to children and newly born animals, even it may causes death. The amount of Nitrate at Valvan site is less and constant throughout year. But from Kamshet it is gradually increased downwards. However at Dehu it becomes double amount of Nitrate of Valvan.

Chloride: The chlorides generally do not have any detrimental effects on human health. The domestic waste including sewage waste is a source of chloride. The amount of Chloride at Valvan site is constant throughout year, but from Kamshet it is gradually increased downwards. The chloride values were increased from October to June may be due to increase discharge of domestic sewage, evaporation of water and decrease in water level of river.

Conclusion

The Indrayani River is originates at Kurvande village, the Valvan dam is constructed on it immediately about 15km from its origin. Then it starts receiving the wastes from Lonvala Muncipal council, Vadgaon, Kamshet, Talegaon, these wastes includes domestic, sewage and industrial discharges. At collection site Valvan physicochemical parameter values was minimum and acceptable. But as it flows near Lonvala it starts receiving discharges, near Kamshet one tributary join with Indrayani River so water is get diluted. Thereafter it flows through the populated and industrial area Talegaon Municipal council. The domestic wastes and industrial wastes were discharged into river. At Indori and Dehu collection sites all the physiochemical parameters of this river quite high and this water is not found suitable for drinking and other purposes. There is need to improve the quality of water by treating discharges before disposing into Indrayani river.

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