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Comparative Study of Different Oxygen Demands and Dissolved Oxygen

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Abstract: ***Water is the most prestigious gift provide by God on Earth. Now a day's cleanliness of water resources is the most challenging goal for the protection of environment. Monitoring of water quality is required to provide information about load of pollutants on water body. Shortage of water already exists in many regions of the world and it may be due to polluted water. This is the main factor responsible for distribution and population density of both animal and plants. In the present study, water sampling was performed from Bhakra dam reservoir at 31º24'39" N, 76º26'0" E i.e. Gobind sagar reservoir and Sutlej River from twelve different sites between July to December 2016 to study the various physico-chemical properties in three different seasons (Pre-monsoon, monsoon and post-monsoon) by keeping distance ten kilometer between two sampling sites as non-point source. It was clear from the investigation that quality of Sutlej River water changes seasonally. As season changes from pre-monsoon to monsoon, increasing trend was obtained for BOD (biochemical oxygen demand), COD (chemical oxygen demand) and DO (dissolved oxygen). Further change from monsoon to post-monsoon season, BOD and COD shows decreasing trend. While DO shows further increasing trend in post-monsoon season also except B9 sampling site.***

Keywords: Sutlej River; Physico-chemical properties; BOD; COD; DO

1. Introduction

In the developing countries, waste management is very challenging task in environmental concern and behind these are inadequate collection system, lack of knowledge and resources. Ultimately this waste material gets flow to water resources by rain water or by intentional throw into the rivers. Waste water having different chemicals increases the oxygen demand for their decomposition. Chemical oxygen demand (COD) is the requirement of oxygen for the organic compounds and inorganic matter to be oxidized in water while biological oxygen demand (BOD) is the quantity of oxygen required by the organic and inorganic compounds to be oxidized by biological oxidation process. Both of these processes are very useful to assess the water pollution which in turn to control water pollution for management of water resources. In the present scenario, burgeoning development of industries occur which increases the pollution load on water. This ultimately creates health hazards i.e. water related diseases occur in human beings and animals which cause early death of some species [9]. Some biological processes occur continuously within the water bodies and affect the availability of safe water for human consumption [11].

Sutlej is the major river in northern India. It provides water to Punjab, Haryana and Rajasthan for drinking, electricity production and crop irrigation purposes [6]. During its running pathway, Gobind sagar reservoir have Bhakra dam in Bilaspur District of Himachal Pradesh at 31º24′39″ N, 76º26′0″ E. Gobind sagar reservoir is named to provide honour to famous sikh guru Shri Gobind Singh ji and it is famous for their height. Due to which it is known as world's highest gravity dam. Construction work of the dam was started in year 1955 and was completed in approximately seven years. It capacity is approximately 9.34 billion cubic metres water storage which makes it third largest reservoir in India.

But unfortunately water quality of Sutlej River is worsening day by day due to human activities, industrialization and some other factors. Approximately 70% water is polluted in India which can't be used as such without any treatment [5]**.** Various physicochemical properties were studied to assess the water quality as BOD (biochemical oxygen demand), COD (chemical oxygen demand), DO (dissolved oxygen). The data obtained through qualitative analysis would allow the governmental authorities to take decisions on the management and protection of our environmental water.

Figure1 shows the Gobind Sagar and Sutlej River sampling sites of the present study. Four water samples were collected from Gobind Sagar reservoir in which two samples were collected from Bhakra village side named as B1 and B2, while remaining two samples were collected from Raipur madan side. Remaining eight samples were collected from 10 Km apart from each other following the path of the river during pre-monsoon, monsoon and post-monsoon seasons.

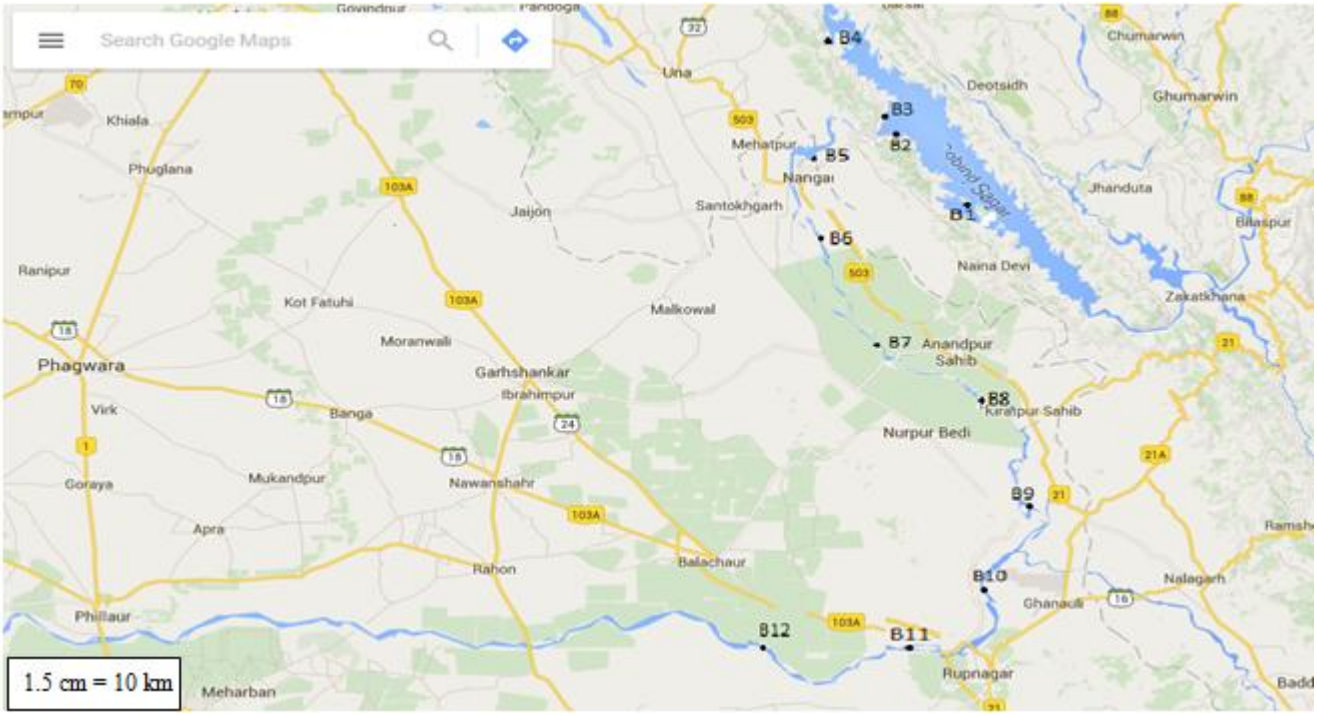

Figure 1: Sampling sites of Gobind Sagar reservoir and Sutlej river where B1, B2, B3, B4 in reservoir, B5 and others 10 Km away from each other along the path of river

2. Materials and Methods

2.1 Sampling and Storage

River and reservoir water samples were collected from twelve different selected sampling sites namely, B1, B2, B3 and B4 in reservoir, in which B2 and B3 are approx 500m away from Bhakra dam while B1 and B4 are 10Km away from previous samples respectively. B5 (about 10 Km downstream from Bhakra dam, Sutlej park nangal), B6 (about 10 Km downstream from B5 site), B7, B8, B9, B10, B11 and B12 by keeping the distance about 10 Km from each other shown in Figure 1. Water samples were collected in sterilized clean high density polythene bottles. These River water samples were then kept in refrigerator.

2.2. Methods of analysis

The methods used for the analysis of mentioned physico-chemical properties are:

2.2.1. Chemical Oxygen demand

Potassium dichromate along with sulphuric acid, silver sulphate and mercuric sulphate results in the oxidation of organic matter and produce carbon dioxide and water. By this oxidation process, some quantity of potassium dichromate was used in the chemical reaction while excess potassium dichromate was determined by titration against mohr salt [$(NH_4)_2Fe\ (SO_4)$] using ferroin indicator. The dichromate consumed by the sample is equivalent to the amount of oxygen required to oxidize the organic matter as per Indian Standards (IS: 3025(Part 58)-2006 [3].

2.2.2. Dissolved oxygen

Dissolved oxygen was determined by Winkler method. Approximately 200 ml water sample was titrated against standard sodium thiosulphate solution in the presence of manganese sulphate and alkaline iodide solution by using starch indicator. The end point was pale blue to colourless as per Indian Standards (IS: 3025(Part 38)-1989 [3]. Volume of sodium thiosulphate used for the titration is equal to the dissolved oxygen present in water.

2.2.3. Biochemical Oxygen demand

Winkler method was used for the determination of DO (dissolved oxygen) both at the start and after incubation at 27ºC±1ºC in incubator as per Indian Standards (IS: 3025(Part 44)-1993 [3]. Difference between DO after incubation and before incubation is equal to the BOD when sample is undiluted.

3. Results & Discussions

The analytical results for chemical oxygen demand, dissolved oxygen and biochemical oxygen demand on different sampling sites are shown in the Table 1 for pre-monsoon, monsoon and post-monsoon seasons. As it is clear from the tabulated data that as the seasons changes, physico-chemical properties of Sutlej river water changes.

Table 1: Variation in Physico-chemical properties on different sampling sites in different seasons

Sr. No.	Sampling Sites	Chemical oxygen demand (mg/l)			Dissolved oxygen (mg/l)			Biochemical oxygen demand (3 days at 27ºC) (mg/l)		
		Pre-monsoon season	Monsoon season	Post-monsoon season	Pre-monsoon season	Monsoon season	Post-monsoon season	Pre-monsoon season	Monsoon season	Post-monsoon season
1	B1	< 1.0	4	< 1.0	6.1	6.5	6.8	< 1.0	1.1	< 1.0
2	B2	< 1.0	4	< 1.0	6.3	6.8	7.1	< 1.0	1.2	< 1.0
3	B3	< 1.0	4	< 1.0	6	6.4	6.9	< 1.0	1.2	< 1.0
4	B4	< 1.0	4	< 1.0	5.6	5.9	6.6	< 1.0	1.1	< 1.0
5	B5	< 1.0	8	4	6.1	6.8	6.8	< 1.0	1.8	1.2
6	B6	< 1.0	8	4	6.8	6.9	7.4	< 1.0	1.8	1.2
7	B7	8	16	8	6.2	6.3	6.8	3	4	3
8	B8	< 1.0	12	8	6.1	6.5	6.8	< 1.0	3.2	2
9	B9	8	16	8	6.2	5.8	7	2	4.1	2.2
10	B10	16	16	8	5.9	6.2	6.8	5	4.1	2.2
11	B11	8	16	8	6.4	6.8	7.3	2	4.1	2.2
12	B12	4	8	4	6.5	6.9	7.3	1	4.1	2.2

3.1. Chemical Oxygen Demand

Chemical oxygen demand (COD) is the amount of oxygen consumed by the organic and inorganic waste present in the water for their decomposition. So COD is the measurement source to find out the amount of organic compounds present in water [6]. Hence it is used as indicator to detect the percentage of organic pollution and deterioration of water quality in water resources caused due to discharge of industrial effluent [8]. Remarkable seasonal variation was found in all samples. The concentration of COD in all the samples was lower in the pre-monsoon season but higher in the rainy season and further decreases in post-monsoon season. This may be due to introduction of chemical waste materials along with microbial contamination in water with rainfall which decreases in post-monsoon season. COD of all water samples lies between less than 1 to 16 mg/l. Acceptable limit of COD is less than 250 mg/l [14].

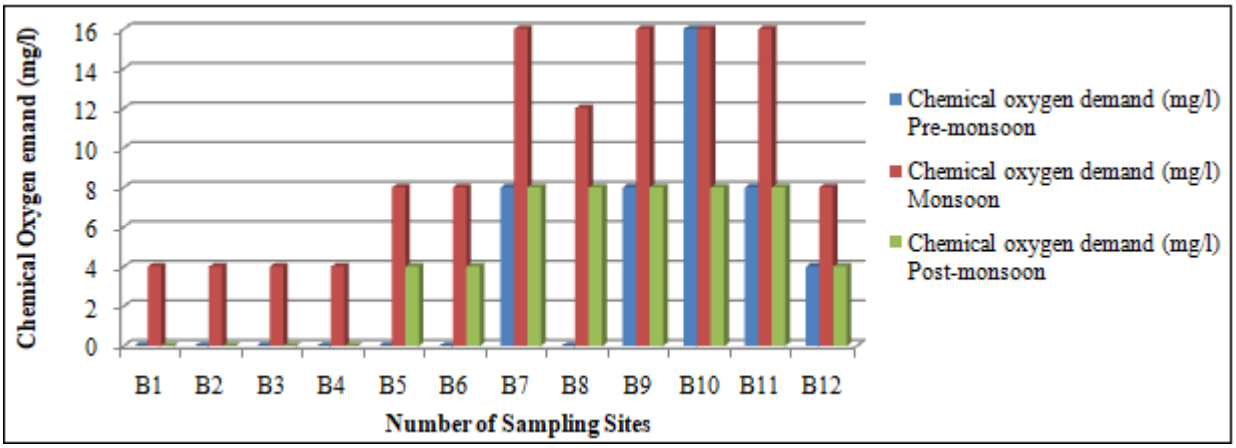

Figure 2: Variation of Chemical Oxygen Demand with respect to various sampling sites along the reservoir and river in different seasons

3.2. Dissolved Oxygen

There is always the solubility of gases in water to some extent. In the same manner oxygen also shows the solubility in water which plays very important role to determine the water quality which makes it the key test to control the water pollution practices. In the fresh water, quantity of dissolved oxygen ranges 14.6mg/l at 0ºC to 7mg/l at 35ºC under one atmosphere of pressure. Some biological and physical processes i.e. decomposition of organic matter, microbial growth and photosynthetic activities occur in water in which consumption and formation of oxygen occurs simultaneously [13] and dissolved oxygen is dependent on these factors. The absorption of oxygen in water from air depends upon temperature of the water and atmosphere, partial pressure of gases, solubility, photosynthetic activity of plants occurring in water etc. [7]. In the present study, concentration of dissolved oxygen was slightly in decreasing trend in monsoon season from pre-monsoon season and further increased in the post-monsoon season. This variation may be attributed due to various factors i.e. high wind velocity joint with rain water increased the concentration of dissolved oxygen in water[4,12]. As the values of BOD and COD elevated, decrease in dissolved oxygen was observed [10]. Further temperature was decreased in December i.e. in the post-monsoon season, solubility of oxygen in water increased, and hence increasing trend of dissolved oxygen was observed.

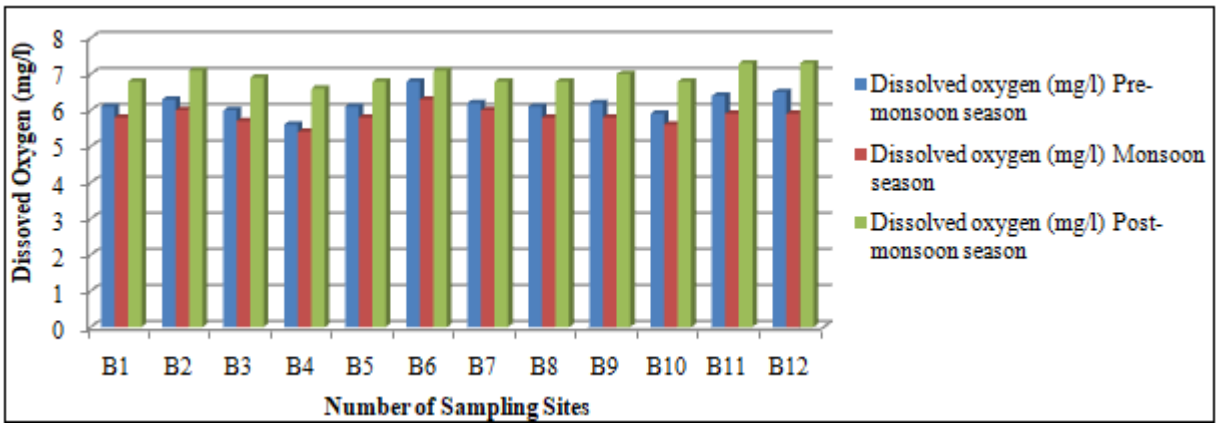

Figure 2: Variation of Dissolved Oxygen with respect to various sampling sites along the reservoir and river in different seasons

3.3. Biochemical Oxygen Demand (BOD)

Some biological organisms are present in water which requires oxygen for their growth which is consumed from the water. The organic materials present in water are biodegraded by microbes by consuming oxygen present in water, which creates oxygen strain in the water and increases the BOD [1]. Hence it is used as parameter to check the organic pollution by measuring the consumed amount of dissolved oxygen by microbial organisms in decomposing the organic matter present in water [2]. The values of BOD in all samples were lower in the pre-monsoon season. This may be due the lower invasion of organic matter and microbial growth but both of these are higher in the rainy season which increases the BOD of water. As rainy season diminished, decreasing trend is observed i.e. in post-monsoon season.

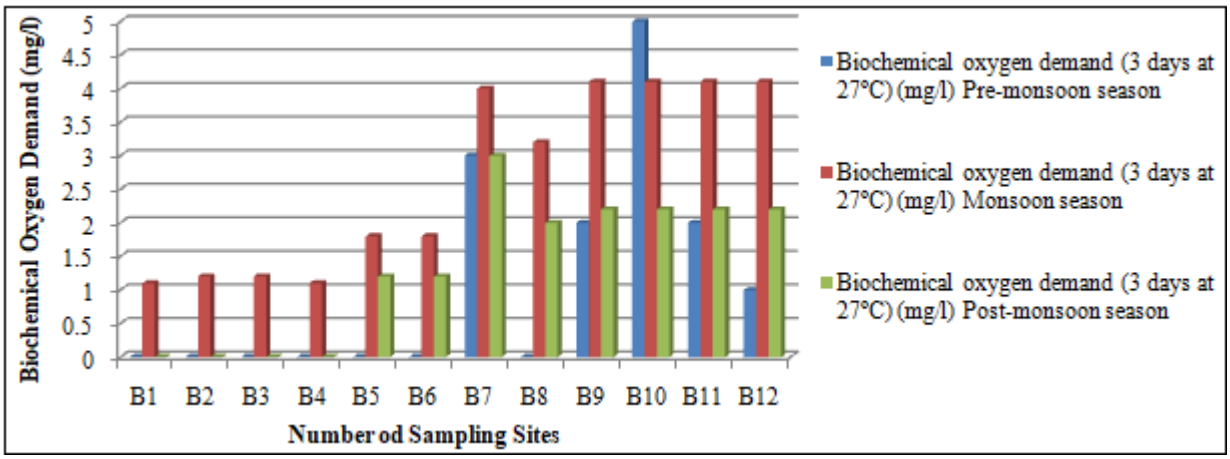

Figure 3: Variation of Chemical Biochemical oxygen Demand with respect to various sampling sites along the reservoir and river in different seasons

4. Conclusion

Present investigation of the above study clearly indicates that BOD (Biochemical oxygen demand), COD (Chemical oxygen demand) and DO (Dissolved oxygen) increases from pre-monsoon to monsoon season. Increase in BOD and COD may be due to the industrial, agricultural and sewage runoff with rain water which increases the oxygen demand for decomposition via chemically or biologically of organic matter present in water. Elevating trend of dissolved oxygen may be due to the increase in wind velocity and speed of water in monsoon season as compared to pre-monsoon season. In post-monsoon season, as influx of rain water having higher concentration of organic matter decreases, BOD and COD also decreases. While concentration of DO showed elevated trend in post-monsoon season also. This may be due to the decrease in temperature of river water. As the temperature of water decreases, solubility of gases increases in water which is clearly observed in DO concentration. It means water quality got improved in post-monsoon season through self purification process with passage of time. Investigative report of this study will be helpful to the government authorities to make the efforts for quality improvement of Sutlej river water by reducing the mixing of agricultural zone water and industrial effluents with surface water of rivers.

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