ANALYSIS

56(297), September, 2020

ISSN 2278–5469 EISSN 2278–5450

DISCOVERY

Limnological study of Dwarkeshwar river water in the downstream at Arambagh, Hooghly district, West Bengal, India

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Article History
Received: 02 July 2020
Reviewed: 03/July/2020 *to* 09/August/2020
Accepted: 10 August 2020
Prepared: 15 August 2020
Published: September 2020

Citation
Nilu Halder. Limnological study of Dwarkeshwar river water in the downstream at Arambagh, Hooghly district, West Bengal, India. *Discovery*, 2020, 56(297), 628-633

ABSTRACT

Water is an important essential element for survive of life and it is directly linked with human civilization and welfare. The present work deals with the analyses of fifteen limnological parameters of water for the assessment of present water quality status of the river Dwarkeshwar in Hooghly district, West Bengal, India from two consecutive years 2009 and 2010.This river is a valuable resource of water for multifaceted purposes to the mankind. Increase of human population activity, urbanization, dumping of domestic sewages at the river shore or in the river and several anthropogenic activities threatening the physico-chemical characteristics of the river water. Still now, dissolved oxygen (DO) content, the most important parameter of river health is good and lied above the permissible limits between 4.0 to 6.0 mg/l prescribed by water quality standard (WHO, 1993) and, water is found to be alkaline

throughout the period of investigations. The total dissolved solids (TDS), chlorides (Cl^-) and sulphates (SO_4^{2-}) were observed comparatively in higher amounts which indicated the presence of sufficient organic substances of animal origin in the river water.

Key Words: Limnological parameters, Dwarkeshwar river, Hooghly, West Bengal, India

1. INTRODUCTION

Water is very important and precious resource for existence of every living organism on this earth. It inhabits a large number of aquatic organisms ranging from microscopic plankton to large aquatic animals and plants (Majumder and Dutta, 2014). Rivers, ponds, lakes and moats are the major different types of aquatic ecosystems that lied in Hooghly district, West Bengal.

Ganga and Dwarkeshwar rivers are the two main lotic water bodies that flow through Hooghly district in West Bengal. Dwarkeshwar river originates from Tilboni hill in Purulia district of West Bengal, India and is an integral part of Damodar basin which is situated on the western part of this district. The river is finally joined with Rupnarayan River at Ghatal. Its length is *Ca* 214 km. It supports fisheries, agriculture, boating, bathing and washing to the local people. It gives shelter to the biological communities. Industrial effluents and domestic wastes are mixed-up in the river water from several polluted source points.

Several authors studied the limnology of different river waters apart from India. Previously, the limnology of Hooghly river water from West Bengal was analyzed (Roy, 1949, 1955). The assessments of limnological characters of the Ganga river water were done time to time by some workers (Lakshminarayana, 1965; Pahwa and Mehrotra 1966; Shukla et al., 1989; Sahu et al., 1994; Singh, 2010; Praveen et al., 2013; Singh et al., 2014).

Few names (Giri et al., 2008; Majumder and Dutta, 2014) may be mentionable who worked on different aspects of ecology on Dwarkeshwar River from West Bengal but taking fifteen limnological parameters from this district is absolutely lacking. Hence the present study was undertaken. This study will reveal physico-chemical characterization of this river water, monthly variation and seasonal changes of physico-chemical properties, present water quality status and pollution level.

2. MATERIALS AND METHODS

Collection of water samples

Water samples were collected from Dwarkeshwar river downstream at Arambagh (22°.88'N and 87°.79'E) in sterilized container (2 liter capacity) between 9.00 am to 11.00 am at regular intervals of one month from January to December of two consecutive years 2009 and 2010 for physico-chemical analyses. The water temperature and pH were determined on the spot at the time of sampling while other parameters were estimated in the laboratory. To determine dissolved oxygen, water samples were fixed at the spot immediately after collection.

Analyses of physico-chemical parameters of water Samples

All the limnological parameters such as dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrate-nitrogen (NO3- N), phosphate (PO_4^{3-}), total suspended solids (TSS), total dissolved solids (TDS), sulphate (SO_4^{2-}), salinity, total alkalinity, total hardness, chlorides (Cl^-) and turbidity were measured according to standard method (APHA, 2005). All the reagents used for the analysis were analytical reagent grade.

3. RESULTS & DISCUSSION

The monthly variations among fifteen different limnological parameters of Dwarkeshwar river water in the downstream at Arambagh site from January to December, 2009 and 2010 were being summarized below in Tables-1 and 2.The temperature data of the river Dwarkeshwar at Arambagh, Hooghly, West Bengal revealed a range of 16.0°C to 31.5°C during 2009 and 17.0°C to 32.0°C during 2010 with the annual mean of water temperature of 25.45°C (SE±1.55) and 26.16°C (SE±1.52) in 2009 and 2010 respectively (Tables-1 and 2). The maximum and minimum temperature in the surface water of the river was recorded during June and December in 2009 and 2010 respectively. The pH value in this river water ranged between 7.2 to 7.9 during 2009 and 7.0 to 7.9 during 2010. The annual mean of pH was recorded as 7.54 (SE± 0.05) in 2009 and 7.47 (SE± 0.07) in 2010 throughout the period of study (Tables- 1 and 2). pH was recorded maximum (7.9) during June in both the year of survey. The minimum value of pH 7.2 in 2009 and 7.0 in 2010 was noted during February. The pattern of pH fluctuation throughout both the years of survey was found to be similar and it was a bimodal distribution pattern. The dissolved oxygen concentration (DO) was in the range of 6.8 to 9.2 mg/1 with an annual mean of

8.3 mg/1(SE±0.21) in 2009. During 2010, the DO value ranged between 6.6 and 9.2 mg/1 with the annual mean value of 8.2 mg/1(SE±0.23) (Tables- 1 and 2). The highest concentration of DO value in the surface layer of Dwarkeshwar river water was observed in the month of October and February of 2009 and 2010 respectively while the lowest concentration during June in both the years. During the period of survey of this river water the range of BOD was from 2.0 to 6.0 mg/1 and 2.1 to 6.2 mg/1 in 2009 and 2010 respectively. The annual mean of BOD value throughout the year of survey in 2009 was 3.50 mg/1(SE±0.31) and in 2010 was 3.60 mg/1 (SE±0.34) (Tables- 1 and 2). The lowest BOD was noted during October in 2009 and February in 2010. On the other hand the highest BOD was recorded in June in both the years (2009 and 2010). The range of COD of river water was ranged from 70.0 to 140.0 mg/1 and 72.0 to 150.0 mg/1 respectively. The annual mean of COD value throughout the year of survey in 2009 was 97.0 mg/1(SE±6.66) and in 2010 was 101.0 mg/1 (SE±7.05) (Tables- 1 and 2). The lowest COD values (70.0 mg/1) and (72.0 mg/1) were recorded during October in 2009 and 2010 respectively. On the other hand, the maximum COD was recorded in June during 2009 and 2010. The pattern of COD fluctuation in the river water was found to be unimodal. The range of NO_3-N in the river was 0.06 to 1.2mg/1 and 0.08 to 1.5mg/1 in 2009 and 2010 respectively. The annual mean value of NO_3-N was 0.46 mg/l (SE±0.12) in 2009 and 0.51 mg/l (SE±0.14) in 2010 (Tables- 1 and 2). Highest values of NO_3-N were found in July during the survey period of 2009 and 2010 while minimum values were found in January in both the years of study. The annual fluctuation pattern of NO_3-N was unimodal. The PO_4^{3-} content in the selected area of Dwarkeshwar river ranged from 0.1 to 1.2mg/1 and 0.15 to 1.4mg/1 in 2009 and 2010 respectively. The annual mean of PO_4^{3-} value were 0.57 mg/l (SE±0.10) in 2009 and 0.67 mg/l (SE±0.12) in 2010 (Tables- 1 and 2). Highest values of phosphate (1.2mg/l and 1.4mg/l) were found in August with the lowest values in February in 2009 and 2010. The annual fluctuation pattern of PO_4^{3-} was unimodal. The concentration of TSS value varied from 28.0 to 72.0mg/1 and 30.0 to 77.0 mg/1 during the years of survey in 2009 and 2010 respectively with a yearly average of 48.75 mg/l (SE±4.52) in 2009 and 50.58 mg/l (SE±4.58) in 2010. The maximum and minimum TSS values were found in July and January of both the years of survey. The pattern of TSS fluctuation in the river water was unimodal with a peak value in July. The range of TDS values was 106.0 to 197.0 mg/1 and 110.0 to 198.0 mg/1 in the years 2009 and 2010 respectively. The annual mean of TDS value was 156.58 mg/l (SE±8.97) in 2009 and 159.08 mg/l (SE±8.91) in 2010. The maximum TDS was found in July while the minimum was recorded in January in both the years 2009 and 2010. The pattern of TDS variation was unimodal. The sulphate concentration in river water ranged from was 8.0 to 16.0 mg/1 and 8.6 to 16.0 mg/1 with the annual mean of 11.23 mg/1(SE±0.73) and 11.71 mg/1 (SE±0.74) in 2009 and 2010 respectively. The maximum sulphate concentration was observed in the month of August with the minimum concentration noted in May of 2009 and 2010 respectively. The range of salinity in the river water ranged from 0.0 to 0.1mg/1 in both the years. The annual mean of salinity was 0.03 mg/1(SE±0.012) in 2009 and 2010 respectively. The maximum salinity was observed in the pre-monsoon season while the minimum concentration of salinity was noted in monsoon and post-monsoon season during both the study years. The salinity fluctuation showed no sharp peak in any of the annual survey. The range of total alkalinity in the river water was 40.0 to 160.0 mg/1 and 50.0 to 162.0 mg/1in the years 2009 and 2010 respectively. The annual mean of total alkalinity recorded was 95.83 mg/l (SE±10.33) and 101.5 mg/l (SE±9.47) of 2009 and 2010 respectively (Tables-1 and 2). The maximum total alkalinity was observed in the month of June while the minimum concentration was noted in the February for both the years of study. The pattern of the total alkalinity fluctuation was bimodal. The concentration of total hardness in river water varied between 62.0 and 162.0 mg/1 and, 64.0 and 164.0 mg/1in the years 2009 and 2010 respectively. The total hardness exhibited a yearly average value of 111.50 mg/l (SE±10.03) and 113.33 mg/l (SE±10.14) in 2009 and 2010 respectively. The maximum total hardness was noticed during May while the minimum concentration was observed during July for both the years of survey. The total hardness value indicated a unimodal fluctuation pattern. The range of chloride concentration varied from 24.0 to 110.0 mg/1 and 30.0 to 112.0 mg/1 in the years 2009 and 2010 respectively. The annual mean of chloride content was 64.16 mg/l (SE±8.55) in 2009 while it was 66.50 mg/l (SE±8.27) in 2010.The maximum chloride content was found in the month of June while the minimum concentration was observed in September for both the years of survey. The pattern of chloride fluctuation was unimodal with a distinct peak in June. The turbidity in Dwarkeshwar river water fluctuated between 14.0 and 34.0 NTU and, 16.0 and 32.0 NTU in the years 2009 and 2010 respectively. The annual average of turbidity value was 22.50 NTU (SE±1.70) and 23.0 NTU (SE±1.46) in 2009 and 2010 respectively (Tables-1 and 2). The maximum turbidity value was recorded in the month of July while the minimum was observed in January for both the years of survey. The pattern of turbidity variation showed a unimodal distribution with a sharp peak in July of both the years of study.

So, from the above discussion it may be concluded that river water was alkaline and total dissolved solids (TDS), chlorides (Cl^-) and, sulphates (SO_4^{2-}) values were quite high which indicated organic pollution of animal origin. Presence of molluscas in river water also supported this argues. While working on hydrobiological status of Kansai and Dwarkeswar river in West Bengal, similar finding was made (Giri et al., 2008). The results of present study on water temperature, pH, DO and total alkalinity analyses were also closely similar with the observation of previous worker (Majumder and Dutta, 2014).

Table 1

Physico-chemical characteristics of the Dwarkeshwar river water (mean ± SE) at Arambagh, Hooghly, West Bengal in 2009

Sl No.	Limnological parameters	Months (Year 2009)											
		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1	Temp. (°C)	18±0.57	20.5±0.57	23.5±1.15	27±1.15	30±1.15	31.5±0.57	31±0.68	31±0.69	29±0.57	26±0.78	22±0.78	16±0.57
2	pH	7.4±0.05	7.2±0.05	7.6±0.11	7.7±0.04	7.8±0.03	7.9±0.04	7.6±0.05	7.5±0.03	7.4±0.04	7.3±0.02	7.6±0.06	7.5±0.04
3	DO (mg/1)	8.8±0.11	9.0±0.57	8.6±0.11	7.6±0.10	7.2±0.23	6.8±0.23	8.6±0.11	8.8±0.11	8.2±0.17	9.2±0.10	8.6±0.05	8.4±0.05
4	BOD (mg/1)	3.0±0.10	2.4±0.11	3.2±0.17	4.0±0.23	5.0±0.23	6.0±0.20	3.2±0.05	2.8±0.06	3.4±0.08	2.0±0.05	3.2±0.23	3.8±0.11
5	COD (mg/1)	90±5.77	100±5.77	110±5.77	120±5.77	130±8.66	140±8.66	80±2.88	90±2.88	80±2.30	70±2.44	80±2.88	74±5.77
6	NO_3-N (mg/1)	0.06±0.02	0.1±0.03	0.15±0.02	0.3±0.05	0.4±0.04	0.87±0.06	1.2±0.07	1.0±0.05	0.8±0.04	0.45±0.06	0.17±0.0.11	0.12±0.04
7	PO_4^{3-} (mg/1)	0.15±0.02	0.1±0.04	0.2±0.05	0.4±0.05	0.6±0.04	0.8±0.06	1.0±0.07	1.2±0.04	1.0±0.02	0.8±0.04	0.4±0.02	0.3±0.02
8	TSS (mg/1)	28±0.57	34±0.68	37±0.68	40±0.78	42±0.78	60±0.68	72±0.89	70±0.69	66±0.44	58±1.15	46±1.11	32±1.01
9	TDS (mg/1)	106±2.30	120±2.30	132±1.15	140±1.15	146±0.89	148±0.78	197±2.30	194±1.15	190±1.01	184±1.11	180±0.89	142±2.30
10	SO_4^{2-} (mg/1)	9±0.11	10±0.10	11±0.13	8.8±0.13	8±0.12	9±0.12	14±0.57	16±0.57	14±0.44	13±0.22	12±0.41	10±0.44
11	Salinity (mg/1)	0±0.0	0.05±0.0	0.05±0.0	0.1±0.01	0.1±0.01	0.1±0.01	0±0.0	0±0.0	0±0.0	0±0.0	0±0.0	0±0.0
12	Total alkalinity (mg/1)	60±3.46	40±3.46	100±3.46	120±2.30	140±2.30	160±2.30	120±3.46	90±1.15	70±1.15	60±1.15	110±2.30	80±3.46
13	Total hardness (mg/1)	110±1.1	118±1.1	136±1.3	154±2.1	162±2.3	158±2.2	62±1.4	68±1.5	78±1.8	92±1.9	96±2.0	104±2.0
14	Chloride (mg/1)	62±0.28	70±0.11	90±0.31	96±0.31	104±0.33	110±0.39	56±0.28	32±0.57	24±0.26	36±0.32	42±0.28	48±0.28
15	Turbidity (NTU)	14±0.28	18±0.30	20±0.32	22±0.34	24±0.36	28±0.38	34±0.57	30±0.57	24±0.33	22±0.3	18±0.32	16±0.3

Table 2

Limnological parameters of the Dwarkeshwar river water (mean ± SE) at Arambagh, Hooghly, West Bengal in 2010

Sl No.	Limnological parameters	Months (Year 2010)											
		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1	Temp (°C)	18.5±0.28	21±0.57	24±1.15	27.5±1.39	30.5±1.39	32±1.01	31±0.44	31.5±0.28	30±0.28	28±0.41	23±1.01	17±1.39
2	pH	7.2±0.04	7.0±0.04	7.5±0.06	7.7±0.05	7.8±0.03	7.9±0.02	7.6±0.06	7.5±0.02	7.4±0.02	7.3±0.02	7.5±0.05	7.3±0.04
3	DO (mg/1)	9.0±0.23	9.2±0.23	8.8±0.24	7.4±0.17	7.0±0.11	6.6±0.05	8.4±0.23	8.6±0.05	8.0±0.11	9.0±0.34	8.4±0.10	8.0±0.10
4	BOD (mg/1)	2.8±0.05	2.1±0.11	3.0±0.23	4.2±0.34	5.2±0.33	6.2±0.46	3.4±0.11	3.0±0.11	3.6±0.10	2.2±0.23	3.6±0.31	4.0±0.08
5	COD (mg/1)	94±2.88	104±3.46	112±3.46	126±3.46	132±4.61	150±8.66	88±3.46	94±3.46	82±4.61	72±2.88	82±5.77	76±3.46
6	NO_3-N (mg/1)	0.08±0.03	0.15±0.0.05	0.2±0.06	0.25±0.05	0.35±0.07	0.82±0.22	1.5±0.34	1.2±0.11	0.85±0.11	0.5±0.06	0.2±0.05	0.1±0.04
7	PO_4^{3-}(mg/1)	0.2±0.06	0.15±0.04	0.25±0.06	0.4±0.07	0.62±0.08	0.84±0.08	1.2±0.10	1.4±0.11	1.2±0.10	1.0±0.09	0.45±0.07	0.36±0.06
8	TSS (mg/1)	30±0.46	35±0.57	39±0.53	42±0.53	44±0.58	55±0.65	77±1.15	73±1.10	68±0.89	60±0.76	49±0.74	35±1.11

9	TDS (mg/1)	110±0.68	122±0.78	134±0.89	142±1.01	148±1.11	150±1.15	198±1.73	196±1.56	193±1.39	189±1.26	181±1.2	146±1.15
10	SO_4^{2-}(mg/1)	10±0.23	11±0.24	12±0.25	9±0.20	8.6±0.11	10±0.22	15±0.57	16±0.78	15±0.53	12±0.44	13±0.48	9±.031
11	Salinity (mg/1)	0±0.0	0.05±0.0	0.05±0.0	0.1±0.01	0.1±0.01	0.1±0.01	0±0.0	0±0.0	0±0.0	0±0.0	0±0.0	0±0.0
12	Total alkalinity (mg/1)	70±4.61	50±1.15	110±5.77	130±4.61	140±3.46	162±5.77	124±3.46	92±2.88	80±2.30	70±2.30	100±4.61	90±3.46
13	Total hardness (mg/1)	114±1.1	122±1.1	138±1.3	156±2.1	164±2.3	158±2.2	64±1.4	68±1.5	76±1.8	94±1.9	98±2.0	108±2.0
14	Chloride (mg/1)	64±2.30	72±2.44	90±2.88	98±1.56	106±1.73	112±1.79	58±1.56	42±1.39	30±1.15	38±1.20	46±1.31	42±1.22
15	Turbidity (NTU)	16±0.28	18±0.30	20±0.32	22±0.34	24±0.36	28±0.38	32±0.57	30±0.57	26±0.33	22±0.3	20±0.32	18±0.3

4. CONCLUSION

The limnological parameters are responsible for bring about changes in the ecological set up of lotic water bodies. The results of limnological study of Dwarkeshwar river water at Arambagh site for two consecutive years 2009 and 2010 revealed that there were significant seasonal variations among some physico-chemical parameters. The important findings of the present study were river water alkaline, moderately hard and nutrient riches. It was also revealed that water was not ideal for direct drinking purposes but useful for domestic utility, agriculture, irrigation and fishery purposes which would offer splendid of services to the society. However, the river was most threatened in terms of water quality degradation and pollution load like any other water bodies. Therefore, it is required proper sustainable management for ecological functioning, set up, productivity and healthy biodiversity.

Acknowledgement

Authors acknowledged here, the published paper retracted from "Spring" journal; because the mentioned journal is discontinue the publication, so we republish the paper with "Discovery" journal.

Funding:

This study has not received any external funding.

Conflict of Interest:

The authors declare that there are no conflicts of interests.

Peer-review:

External peer-review was done through double-blind method.

Data and materials availability:

All data associated with this study are present in the paper.

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