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Assessment of Physico-Chemical Parameters of Himalayan Wetland Deoria Tal

RAMESH C. SHARMA
SHEETAL CHAUDHARY[1]
RAHUL KUMAR
SUSHMA SINGH
VIJAYTA TIWARI
RAMA KUMARI
Department of Environmental Sciences
HNB Garhwal University (A Central University)
Srinagar-Garhwal, Uttarakhand, India
ANITA CHAUHAN
EM Division, ICFRE, Dehradun, India

Abstract:

Physico-chemical parameters play an important role in maintaining the physical, chemical and biological health of wetlands. The present study was conducted to evaluate the physico-chemical parameters (temperature, pH, conductivity, turbidity, dissolved oxygen, free carbon dioxide, biochemical oxygen demand, total dissolved solids, transparency, alkalinity, hardness, calcium, magnesium, chlorides, sulfates, phosphates, nitrates, sodium and potassium) of Himalayan wetland Deoria Tal on a monthly basis from April 2015-March 2016 from four different sites (S_1, S_2, S_3, S_4) and computed seasonally to evaluate the changes in the abiotic profile of the wetland. The quality of water was found good and could be used for human consumption. Keeping in view, the importance of wetlands and their role in global cycles, it is necessary to assess and monitor the quality of water on regular intervals for proper conservation and management.

Key words: physico-chemical, lakes, himalayan, *Mahabharata*, wetland

[1] Corresponding author: sheetal23chaudhary@gmail.com

INTRODUCTION

Wetlands are the most productive ecosystems in the world[1] where terrestrial as well as aquatic habitats meet. They play a crucial role in maintaining various natural cycles as well as support a vast range of biodiversity. Himalayan wetlands act as an important supplier of tangible and intangible services to mankind. They are the source of food, water and habitat for different species occupying the wetland area. Himalayas are the main source of water in the form of rivers, streams, lakes and ponds. Most of the Himalayan people depend on them for drinking, bathing, irrigation, *etc.*

Physico-chemical parameters are the important factors that drive the dynamics and structure of the phytoplankton of any aquatic ecosystem[2]. Seasonal variation in these parameters has a major role in the periodicity, distribution and qualitative and quantitative composition of freshwater biota [3]. Water is needed for life and any change in its quality can deteriorate the health of any ecosystem and hence it is necessary to keep a check on the quality of water for a healthy life. From the past few years, the quality of himalayan wetlands has been disturbed by many anthropogenic activities, especially the tourists and fares organized by the local people. The quality of water influences the productivity of aquatic ecosystem. Maximum productivity depends on the optimal levels of physico-chemical parameters of water [4]. A good amount of work has been done on the limnology of wetlands on a global, national and regional scale[5-21] but there are few scattered reports on some aspects of Garhwal Himalayan lakes [22-23].

MATERIALS AND METHODS

Deoria Tal is a beautiful and scenic freshwater wetland located at an altitude of 2,445 m a.s.l., latitude $30^{0}31'44"$ N and

longitude $79^0$07'48" E. to south east of Ukhimath in the Rudraprayag district of Garhwal Himalaya, India. This wetland is 350 m long and 150 m wide with a catchment and surface area of 5.2 & 1.6 ha respectively. The maximum depth of the wetland is 21 m. The climate remains very cold during the winter with snowfall while in the summer it gets little warm. It is during the monsoon months when a temporary drainage at the southern basin adds water to the wetland. There is no discernible inlet as well as outlet. Natural drains are the main source of water for the wetland. There are a lot of myths related to wetland and the purity of its water. It is believed that *devas* bathe in water and in the epic *Mahabharata*, people believed it is the same place where *Yaksha* asked questions from the *Pandavas*. Fair is being organized every year on Krishna Janamashtami in which huge mass of people gather and do *nagraj* puja.

Four sampling sites (S_1 -$79^0$7'35.5" E, $30^0$31'18.1" N; S_2 -$79^0$7'40.7" E, $30^0$31'20.9" N; S_3- $79^0$7'45.1" E, $30^0$31'22.5" N and S_4 -latitude $79^0$7'43.5" E, $30^0$31'20.1" N) [Fig.1] were identified for analysis of physico-chemical data every month from April 2015- March 2016. Few parameters were analyzed on the site and for the rest of the parameters; samples were transported to the lab for further analysis using the standard methods [24-27].

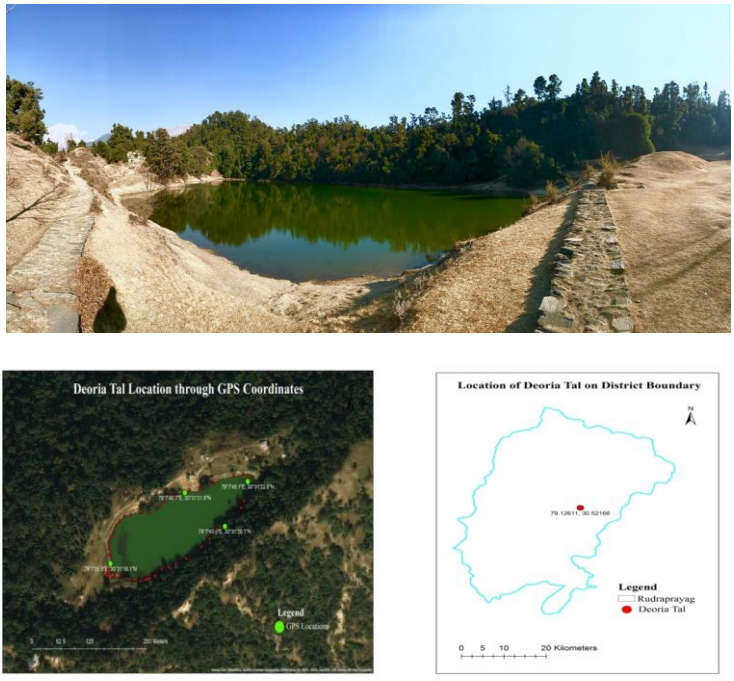

Fig.1. Map of Deoria Tal, India with sampling sites

RESULTS AND DISCUSSION

The study of the physico-chemical profile of water is the basis for limnological study and influences both floral as well as faunal diversity. Physico-chemical parameters are directly or indirectly related to each other in maintaining the healthy environment of the aquatic ecosystem. Seasonal fluctuations in various physico-chemical parameters from four different sites during April 2015-March 2016 are represented in tables 1-4. Air temperature was recorded maximum at S_1 (27.15±1.63^{0}C) in monsoon season and minimum (10.77±4.45^{0}C) at S_4 in winter season. Water temperature was recorded maximum (24.95±1.34^{0}C) at S_1 in monsoon season and minimum (9.83±2.78^{0}C) at S_4 in winter season. The water temperature appertains to the air temperature, as it is a common feature for

water bodies that are shallow at the edge. Majority of biochemical processes are dependent on temperature. pH (Hydrogen ion concentration) was calculated maximum at S_3 and S_4 (6.83±0.03) in summer season and minimum (6.0±0.42) at S_1 in autumn season. pH helps in maintaining various thermo-equilibrium reactions of water and shows that the wetland is slightly acidic. Conductivity was recorded maximum (180±1.41μScm^{-1}) in monsoon season at S_1 and minimum (109.67±12.1μScm^{-1}) in winter season at S_2. This could be related to low TDS in winters that reduce the ionic movement. The same results have been reported from Asan wetland [28]. Turbidity was recorded maximum (3.73±0.35 NTU) at S_3 in the monsoon season and minimum (1.07±0.25 NTU) at S_3 in the spring season. High turbidity in monsoon is due to the addition of sediments from watershed [29]. Dissolved oxygen (D.O.) plays a pivotal role in regulation and survival of aquatic life. It was recorded maximum (7.8±0.4 mg.l^{-1}) in winter season at S_4 and minimum (6.2±0.0 mg.l^{-1}) in monsoon season at S_1 and S_3 both. D.O may change daily and seasonally with a change in temperature shift. Similar findings were observed in the river Song [30]. The concentration of D.O. depends on various factors viz. photosynthesis, temperature, decomposition activities and the aeration level. Free carbon dioxide (CO_2) was found maximum (2.42±0.0 mg.l^{-1}) in monsoon season at S_3 and minimum (1.32±0.0 mg.l^{-1}) in spring season at S_1, S_3 and S_4. It was due to a high rate of decomposition and increased respiratory activities of aquatic flora and fauna [11]. Biochemical Oxygen Demand (BOD) was recorded maximum (0.26±0.0 mg.l^{-1}) and minimum (0.23±0.01 mg.l^{-1}) in monsoon and winter season from all the four sites respectively. Total Dissolved Solids (TDS) was recorded maximum (95±7.07 mg.l^{-1}) at S_4 in monsoon season and minimum (63±5.29 mg.l^{-1}) at S_2 in winter season. Transparency was recorded maximum (109.5±3.54 cm) at S_1 in spring season and minimum (41±1.41 cm) at S_3 in

monsoon season, probably, the rate of decomposition and anthropogenic activities remain less. Alkalinity, hardness, calcium and magnesium was recorded maximum (14.7±0.14 $mg.l^{-1}$; 5.1±0.14 $mg.l^{-1}$; 2.40±0.00 $mg.l^{-1}$; 0.67±0.02 $mg.l^{-1}$) and minimum (13.3±0.14 $mg.l^{-1}$; 4.2±0.14 $mg.l^{-1}$; 1.60±0.00 $mg.l^{-1}$; 0.63±0.00 $mg.l^{-1}$) at all the four sites in monsoon and spring season respectively. Increase in alkalinity during the monsoon is due to heavy rainfall with loaded nutrients [31].Calcium is needed for the metabolism of prokaryotes and higher plants. Calcium and magnesium are present naturally by leaching and by animal wastes anthropogenically. Chlorides were recorded maximum (10.79±0.00 $mg.l^{-1}$) at S_3 in autumn season and minimum (3.83±1.87 $mg.l^{-1}$) at S_2 and S_4 in the summer season. The higher values of chlorides are apparently, due to the fair organized on 15th September every year. A huge mass of people reach the wetland for celebration of *Janamashtami* and put *puja samagri* near the edge of the lake, wash their hands and throw various food items into the water, although it's not allowed. Sulfates were calculated maximum (0.19±0.22 $mg.l^{-1}$) at S_1 in monsoon season and minimum (0.01±0.00 $mg.l^{-1}$) at S_2 in spring season. Sulfate salts are soluble in water and sometimes are not precipitated, therefore present naturally. Phosphates were calculated maximum (0.03±0.00 $mg.l^{-1}$) at S_3 in monsoon season and minimum (0.01±0.01 $mg.l^{-1}$) at all the sites in autumn season. Nitrates were calculated maximum (0.04±0.00 $mg.l^{-1}$) at S_2 in monsoon season and minimum (0.00±0.00 $mg.l^{-1}$) at S_1 and S_2 in spring season. Nitrates, sulfates and phosphates are present in a very small amount round the year because of the organic waste arising anthropogenically. Sodium was recorded maximum (2.25±0.21 ppm) at S_1 in monsoon season and minimum (0.62±0.12 ppm) at S_2 in winter season. Potassium was recorded maximum (0.60±0.08 ppm) at S_4 in monsoon season and minimum (0.29±0.09 ppm) at S_2 in autumn season. The increasing values

of sodium and potassium in the monsoon are due to the weathering of nearby rocks.

Wind and rainfall play a significant role in the cool temperate region of himalayan wetland Deoria Tal. Any change in the physico-chemical parameters are mainly regulated by rainfall, wind pattern and shape of the wetland basin. The higher values of physico-chemical parameters (air & water temperature, conductivity, turbidity, free CO_2, BOD, TDS, alkalinity, hardness, calcium, magnesium, sulfates, nitrates, phosphates, sodium and potassium) in monsoon season were due to the rain that draw ions, litter and sediments to the basin. The lower value in other seasons may be due to the less rainfall and phytoplankton population.

Table 1. Seasonal variations in physico-chemical parameters at sampling station S_1 of Wetland Deoria Tal, Uttarakhand during the period from April 2015 to March 2016

Parameters	Summer	Monsoon	Autumn	Winter	Spring
Air temp (^{0}C)	24.5±1.9	27.15±1.63	22.15±4.03	10.9±4.35	13.15±3.18
Water temp. (^{0}C)	21.87±2.46	24.95±1.34	20±4.24	9.9±2.69	10.6±3.68
pH	6.77±0.06	6.35±0.07	6±0.42	6.5±0.1	6.4±0
Conductivity (µScm^{-1})	134.33±9.29	180±1.41	145±21.21	123±20.66	139±4.24
Turbidity (NTU)	2.53±0.38	3.2±0.28	2.65±0.21	1.5±1.04	1.2±0.14
D.O (mg.l^{-1})	6.87±0.31	6.2±0	7.2±0.85	7.73±0.42	7.3±0.14
Free Co_2 (mg.l^{-1})	2.05±0.13	2.31±0.16	2.2±0	1.61±0.46	1.32±0
B.O.D. (mg.l^{-1})	0.24±0	0.26±0	0.25±0.01	0.23±0.01	0.24±0
TDS (mg.l^{-1})	78±3.61	94±8.49	79±5.66	70.33±6.51	87.5±16.26
Transparency (cm)	60.67±12.34	49.5±0.71	65.5±7.78	102±16.09	109.5±3.54
Alkalinity (mg.l^{-1})	13.73±0.12	14.7±0.14	14.2±0	13.67±0.42	13.3±0.14
Hardness (mg.l^{-1})	4.53±0.12	5.1±0.14	4.7±0.14	4.4±0.2	4.2±0
Calcium (mg.l^{-1})	1.84±0	2.4±0	2±0.23	1.79±0.17	1.6±0
Magnesium (mg.l^{-1})	0.65±0.03	0.67±0.02	0.66±0.02	0.64±0.03	0.63±0
Chlorides (mg.l^{-1})	3.88±1.95	5.18±1.3	10.69±0.15	5.16±1.03	4.97±1
Sulfates (mg.l^{-1})	0.03±0.02	0.19±0.22	0.04±0.06	0.06±0.02	0.06±0.03
Phosphates (mg.l^{-1})	0.01±0	0.02±0	0.01±0.01	0.01±0.01	0.02±0
Nitrates (mg.l^{-1})	0.02±0.01	0.02±0.01	0.01±0	0.02±0.01	0±0
Sodium (mg.l^{-1})	0.95±0.04	2.25±0.21	0.83±0.06	0.66±0.09	0.66±0.11
Potassium (mg.l^{-1})	0.55±0.02	0.48±0.18	0.4±0.02	0.35±0.11	0.31±0.11

Table 2. Seasonal variations in physico-chemical parameters at sampling station S_2 of Wetland Deoria Tal, Uttarakhand during the period from April 2015 to March 2016

Parameters	Summer	Monsoon	Autumn	Winter	Spring
Air temp (^{0}C)	24.47±1.94	27.1±1.56	20.15±1.2	10.9±4.35	13.1±3.11
Water temp. (^{0}C)	21.87±2.46	24.9±1.27	20.5±4.95	9.9±2.69	10.6±3.68
pH	6.77±0.06	6.35±0.07	6.05±0.35	6.5±0.1	6.4±0
Conductivity (μScm^{-1})	131.67±11.24	163.5±6.36	122.5±3.54	109.67±12.1	126.5±3.54
Turbidity (NTU)	2.49±0.27	3.57±0.06	2.62±0.7	0.94±0.23	1.37±0.36
D.O ($mg.l^{-1}$)	7±0.2	6.3±0.14	7.4±0.57	7.67±0.46	7.1±0.42
Free Co_2 ($mg.l^{-1}$)	2.05±0.13	2.31±0.16	2.2±0	1.61±0.46	1.43±0.16
B.O.D. ($mg.l^{-1}$)	0.24±0	0.26±0	0.25±0.01	0.23±0.01	0.24±0
TDS ($mg.l^{-1}$)	75±4.58	88±11.31	81±8.49	63±5.29	67.5±6.36
Transparency (cm)	62.33±9.71	48±1.41	56.5±7.78	95.67±10.07	95±0
Alkalinity ($mg.l^{-1}$)	13.73±0.12	14.7±0.14	14.2±0	13.67±0.42	13.3±0.14
Hardness ($mg.l^{-1}$)	4.53±0.12	5.1±0.14	4.7±0.14	4.4±0.2	4.2±0
Calcium ($mg.l^{-1}$)	1.84±0	2.4±0	2±0.23	1.79±0.17	1.6±0
Magnesium ($mg.l^{-1}$)	0.65±0.03	0.67±0.02	0.66±0.02	0.64±0.03	0.63±0
Chlorides ($mg.l^{-1}$)	3.83±1.87	5.18±1.3	9.3±0.3	5.22±0.92	4.97±1
Sulfates ($mg.l^{-1}$)	0.03±0.01	0.18±0.22	0.05±0.03	0.06±0.02	0.01±0
Phosphates ($mg.l^{-1}$)	0.02±0	0.02±0	0.01±0.01	0.01±0	0.01±0.01
Nitrates ($mg.l^{-1}$)	0.02±0.01	0.04±0	0.01±0.01	0.01±0.01	0±0
Sodium ($mg.l^{-1}$)	0.89±0.02	0.88±0.08	0.81±0.02	0.64±0.08	0.65±0.11
Potassium ($mg.l^{-1}$)	0.57±0.04	0.58±0.01	0.29±0.09	0.33±0.13	0.3±0.11

Table 3. Seasonal variations in physico-chemical parameters at sampling station S_3 of Wetland Deoria Tal, Uttarakhand during the period from April 2015 to March 2016

Parameters	Summer	Monsoon	Autumn	Winter	Spring
Air temp (^{0}C)	24.5±1.9	27.1±1.56	22.15±4.03	10.9±4.35	13.15±3.18
Water temp. (^{0}C)	21.87±2.46	24.9±1.27	20.5±4.95	9.9±2.69	10.6±3.68
pH	6.83±0.06	6.35±0.07	6.05±0.35	6.5±0.1	6.4±0
Conductivity (μScm^{-1})	138.33±12.9	148.5±9.19	140±14.14	126.67±16.56	120.5±31.82
Turbidity (NTU)	2.86±0.67	3.73±0.35	2.7±0.4	1.97±0.12	1.07±0.25
D.O ($mg.l^{-1}$)	6.93±0.23	6.2±0	7.1±0.42	7.67±0.5	7.1±0.42
Free Co_2 ($mg.l^{-1}$)	2.05±0.13	2.42±0	1.98±0.31	1.61±0.46	1.32±0
B.O.D. ($mg.l^{-1}$)	0.24±0	0.26±0	0.25±0.01	0.23±0.01	0.24±0
TDS ($mg.l^{-1}$)	85.33±12.5	86.5±3.54	80±0	80.67±8.02	71±1.41
Transparency (cm)	56.67±12.66	41±1.41	57±4.24	96±4	93.5±4.95
Alkalinity ($mg.l^{-1}$)	13.73±0.12	14.7±0.14	14.2±0	13.67±0.42	13.3±0.14
Hardness ($mg.l^{-1}$)	4.53±0.12	5.1±0.14	4.7±0.14	4.4±0.2	4.2±0
Calcium ($mg.l^{-1}$)	1.84±0	2.4±0	2±0.23	1.79±0.17	1.6±0
Magnesium ($mg.l^{-1}$)	0.65±0.03	0.67±0.02	0.66±0.02	0.64±0.03	0.63±0
Chlorides ($mg.l^{-1}$)	3.88±1.85	5.18±1.3	10.79±0	5.73±0.08	4.97±1
Sulfates ($mg.l^{-1}$)	0.04±0.02	0.05±0.01	0.04±0.01	0.13±0.15	0.03±0.02
Phosphates ($mg.l^{-1}$)	0.02±0	0.03±0	0.01±0.01	0.01±0	0.02±0
Nitrates ($mg.l^{-1}$)	0.02±0.01	0.02±0.01	0.02±0.01	0.01±0.01	0.01±0
Sodium ($mg.l^{-1}$)	0.8±0.12	0.88±0.08	0.83±0.06	0.68±0.06	0.65±0.11
Potassium ($mg.l^{-1}$)	0.58±0.03	0.59±0	0.37±0.01	0.33±0.13	0.31±0.12

Table 4. Seasonal variations in physico-chemical parameters at sampling stations S_4 of Wetland Deoria Tal, Uttarakhand during the period from April 2015 to March 2016

Parameters	Summer	Monsoon	Autumn	Winter	Spring
Air temp (^{0}C)	24.4±1.93	27±1.56	20.1±1.27	10.77±4.45	13.05±3.04
Water temp. (^{0}C)	21.77±2.46	24.9±1.27	20±4.24	9.83±2.78	10.55±3.61
pH	6.83±0.06	6.5±0	6.1±0.42	6.57±0.06	6.45±0.07
Conductivity (μScm^{-1})	130.67±11.24	164.5±28.99	125±21.21	112±25.24	147.5±4.95
Turbidity (NTU)	2.6±0.39	3.73±0.29	3.06±0.07	2.2±0.77	1.9±0.03
D.O ($mg.l^{-1}$)	7.07±0.31	6.5±0.14	7.6±0.57	7.8±0.4	7.1±0.42
Free Co_2 ($mg.l^{-1}$)	1.98±0.22	2.31±0.16	1.98±0.31	1.54±0.38	1.32±0
B.O.D. ($mg.l^{-1}$)	0.24±0	0.26±0	0.25±0.01	0.23±0.01	0.24±0
TDS ($mg.l^{-1}$)	76.67±10.02	95±7.07	83.5±0.71	75.67±7.09	85.5±16.26
Transparency (cm)	61±10.15	47.5±3.54	57.5±10.61	96.33±18.45	100.5±3.54
Alkalinity ($mg.l^{-1}$)	13.73±0.12	14.7±0.14	14.2±0	13.67±0.42	13.3±0.14
Hardness ($mg.l^{-1}$)	4.53±0.12	5.1±0.14	4.7±0.14	4.4±0.2	4.2±0
Calcium ($mg.l^{-1}$)	1.84±0	2.4±0	2±0.23	1.79±0.17	1.6±0
Magnesium ($mg.l^{-1}$)	0.65±0.03	0.67±0.02	0.66±0.02	0.64±0.03	0.63±0
Chlorides ($mg.l^{-1}$)	3.83±1.87	5.18±1.3	9.94±1.21	5.73±0.08	4.97±1
Sulfates ($mg.l^{-1}$)	0.03±0.01	0.04±0.04	0.06±0.06	0.04±0.03	0.03±0.01
Phosphates ($mg.l^{-1}$)	0.02±0	0.02±0	0.01±0.01	0.01±0	0.02±0
Nitrates ($mg.l^{-1}$)	0.02±0.01	0.03±0	0.01±0	0.01±0.01	0.01±0
Sodium ($mg.l^{-1}$)	0.88±0.05	0.88±0.07	0.79±0.04	0.62±0.12	0.65±0.11
Potassium ($mg.l^{-1}$)	0.57±0.03	0.6±0.08	0.37±0.01	0.34±0.14	0.3±0.12

CONCLUSION

The study of physico-chemical parameters of Himalayan wetland Deoria shows that the wetland is slightly acidic and oligotrophic. There is a need of proper planning for its conservation and management.

CONFLICT OF INTEREST

There is no conflict of interest regarding the publication.

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