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A Review Paper on the Water Quality Status of the Bordoibam Wetland with Special Reference to its Avifaunal Diversity

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ABSTRACT: Wetlands are one of the most diverse, productive and a unique ecosystem present on this earth. Wetlands are the transitional area between the terrestrial and aquatic habitats. Bordoibam Bilmukh Bird Sanctuary is a large freshwater wetland that serves as a breeding ground for many important migratory bird species. The present study is a review study which mainly focuses on analytical review on the physico-chemical properties of water of the Bordoibam wetland with special reference to its avifaunal diversity. The various physico-chemical properties of water including water temperature, pH, conductivity, dissolved oxygen (DO), and total dissolved solids (TDS) were analysed and found in a range of pollution indicator index. These databases will also help in future researches to assess the quality of water of the wetland. The study also focused on the variety of bird species found in the wetland along with their local name, English name, scientific name, IUCN status and their feeding habit. At present Bordoibam wetland is a hot area for future research. During the study we have faced problems in collecting data, as there were very less number of papers written and available on the Bordoibam wetland.

Keywords: Bordoibam wetland, Sanctuary, physico-chemical, breeding ground, avifaunal diversity, future research.

INTRODUCTION

At present wetlands are one of the most diverse, productive, richest, and unique ecosystems present on this earth. Wetlands are the meeting point or the transitional area between the terrestrial and aquatic habitats. So, the wetlands harbour a diverse amount of both floral as well as fauna (Choudhury and Saikia 2022); (Singla and Sharma 2019). As the wetlands are very much diverse in nature and due to such reason, they are often referred as the "Kidneys of the landscape" (Mitsch and Gooselink 1986), (Mukherjee and Pal 2021). The Ramsar International Wetland Treaty, which was adopted in 1971 defined wetland as "The area of marsh, fen, peatland, or water, whether natural or artificial, permanent, or temporary, with water that is static or flowing, fresh, brackish, or salt, including areas of marine water the depth of which at low does not exceed beyond 6 meters (Secretariat of the Convention on Biological Diversity, 2015), (Ramsar Convention Secretariat, 2007); (Maltby and Acreman 2011). Many authors have defined wetlands in many ways, but so far, the best definition of wetland was given by Cowardin and Golet. According to them a wetland can be defined as the "Lands transitional between terrestrial and aquatic ecosystems where the water table is usually at or near the surface or the land is covered by shallow water" (Cowardin and Golet 1995). Wetlands not only supports lives of various plants and animals, but it also serves as a major habitat for almost all water birds present worldwide. Various migratory birds also use wetlands for resting, as a breeding ground etc. (Saha, 2021). Moreover, wetlands also provide a livelihood, as well as a source of income for the local communities dwelling nearby it (Choudhury and Saikia 2022). The wetlands also serve as an alternate source for freshwater for all the living organisms, as it helps to replenish ground water aquifers. We all know that one of the most important and cheap natural resource presents on this earth is none other than "water". Water is the most important and primary natural resource which is beneficial for all the living organisms of this planet. So, water from the wetlands have been used to meet various needs like – irrigation, agriculture etc. On the other hand, wetlands also serve many benefits to all the living organisms and provides various ecosystem services. Some ecosystem services provided by the wetlands are – Replenishment of ground water, alternate source for freshwater, fisheries, medicinal plants, water supply, nutrient removal, toxic retention, protection from flood etc. (Secretariat of the Convention on Biological Diversity, 2015); (Turner *et al.,* 2000); (Sharma, 2020). Globally, wetlands cover an area of almost about 12.1 million sq. km which accounts for almost 40.06% of the total ecosystem service values (Costanza *et al.,* 2014). According to Prof. Bhagabati, at present, the wetlands

are considered as the last remains of freshwater bodies on the earth (Prof. Bhagabati, 2010).

India is one of the most mega biodiverse countries in the whole world. Almost about 4 Biodiversity Hotspots out of 36 are present in India only. Almost about 5,55,557 wetlands have been identified in India, which covers an area of around 15.26 M ha, which accounts for around 4.63% of the total geographic area of the country (National Wetland Atlas: India, 2011). In India the count of Ramsar Sites for the year 2021 was 65. Recently on the 75th year of Independence 11 more wetlands have been added to the list of Ramsar sites on 14th August of 2022 thereby increasing the number from 65 to 75. This news was announced by the Union Environment Minister of India, Mr. Bhupender Yadav. The Ramsar Site is a wetland site that is designated to be of international importance under the Ramsar Convention. Wetlands cover around 1-5% of the total area of our country, out of which Inland Wetlands accounts for 69.23% and it covers an area of around 10.56 M ha. On the other hand, Coastal Wetlands accounts for 27.13% and it covers an area of around 4.14 M ha. Moreover, in India the aquatic vegetation accounts for about 9% and 14% of the total wetland area in post-monsoon and pre-monsoon respectively. Among all the 35 States and Union Territories of India, Lakshadweep has maximum geographical area under wetland coverage (~96.12%), which is followed by Andaman & Nicobar Islands (~18.52%). On the other hand, Mizoram accounts for the minimum geographical area under wetland coverage (~0.66%) (National Wetland Atlas: India, 2011).

The state Assam is a constituent unit of the Eastern Himalayan Biodiversity Region, which is one of the "Biodiversity Hotspots" of India. Since, the state is situated in the heart of the river Brahmaputra, so it is one of the most diverse states of the North-eastern region of India and harbours a good number of both flora and fauna (Assam State Biodiversity Board). In Assam wetlands are often referred as "Beels". In Assam wetlands provides various ecosystem services to all the local community people dwelling nearby it (Bhatta *et al.,* 2016). It also serves as an important fishery resource and the local people can use them for income purpose also (Choudhury and Saikia 2022). In Assam almost about 6081 small wetlands have been identified which has been estimated to cover almost about 7,64,372 ha area, which is around 9.74% of the total geographic area of the country. At present the state Assam has been dominated by the "Natural wetlands". Currently, the major wetland types identified in Assam is river/stream which accounts for 84% of the total wetlands of the state and covers around 6,37,164 ha area, followed by lake/pond covering around 51,257 ha area. On the other hand, water logged covers around 14,173 ha area (National Wetland Atlas: Assam, 2011).

Out of all the 23 districts of Assam, the district Dibrugarh has maximum geographical area under wetland coverage, which accounts for nearly around 21.43%. On the other hand, Karbi Anglong has minimum geographical area under wetland coverage, which accounts for only 0.56%. In terms of total wetland area and % of wetland area, Sonitpur is the leading district covering around 83,427 ha area of total wetland and 10.9% wetland area. On the other hand, Hailakandi is the district which covers the minimum wetland area (around 2600 ha) and 0.34% wetland area (National Wetland Atlas: Assam, 2011). Out of all the wetland present in Assam, the "Deep or Beel Wildlife Sanctuary" has been recorded as the largest wetland, covering an area of about 900 ha (Das, 2021).

Table 1: District wise distribution of Wetlands in Assam.

Sr. No.	District's	No. of Wetlands	Total Wetland Area (ha)	% of Total Wetland Area	Geographic area (sq.km)	% of geographic area (ha)
1.	Hailakandi	30	2600	0.34%	1327	1.96%
2.	N.C. Hills	44	6619	0.87%	4888	1.35%
3.	Cachar	46	10419	1.36%	3786	2.75%
4.	Bongaigaon	71	22149	2.90%	2510	8.82%
5.	Dhubri	74	56538	7.40%	2838	19.92%
6.	Karbi Anglong	89	5810	0.76%	10434	0.56%
7.	Karimganj	98	6450	0.84%	1809	3.57%
8.	Goalpara	151	33221	4.35%	1824	18.21%
9.	Kokrajhar	152	24833	3.25%	3129	7.94%
10.	Marigaon	158	28737	3.76%	1704	16.86%
11.	Golaghat	165	43635	5.71%	3502	12.46%
12.	Barpeta	195	59038	7.72%	3245	18.19%
13.	Kamrup	228	43655	5.71%	4345	10.05%
14.	Nagaon	233	35695	4.67%	3831	9.32%
15.	Nalbari	239	20140	2.63%	2257	8.92%
16.	Dhemaji	314	33468	4.38%	3237	10.34%
17.	Jorhat	363	45979	6.02%	2851	16.13%
18.	Darrang	450	48983	6.41%	3481	14.07%
19.	Lakhimpur	458	27307	3.57%	2277	11.99%
20.	Tinsukia	478	40626	5.31%	3790	10.72%
21.	Sibsagar	530	12582	1.65%	2668	4.72%
22.	Dibrugarh	535	72461	9.48%	3381	21.43%
23.	Sonitpur	980	83427	10.91%	5324	15.67%

Total No. of Wetlands: 6081, Total Wetland Area: 764372
(Source: National Wetland Atlas: Assam, 2011).

Das *et al.* (2002) in a study on water quality of ponds and beels of the Guwahati City – 1 revealed marked fluctuations of values of different parameters in all wetlands. The water of Sola beel was found to be extremely polluted as it indicated low level of DO, high load of BOD, COD, carbon dioxide, hardness, chloride, nitrate, phosphate, and ammoniacal nitrogen. Moreover, the water quality of the Silpukhuri, Dighalipukhuri, Jorpukhuri, Deepor Beel indicated marginal pollution load. Moundiotiya *et al.* (2004) carries out a study on the physico-chemical properties of water of the Jamwa Ramgarh wetland. During their study they have observed that thepHranges from 6.8 to 8.5. The EC value remained maximum in summer and minimum in the monsoon season. Likewise, the alkalinity was also maximum in summer and minimum in monsoon. Baruah and Kakoti (2012) carried out a study on the water quality analysis and phytoplankton diversity of Gopeswar temple freshwater pond of Assam. During this study the authors recorded a total of 45 species of phytoplankton which belongs to 6 classes. Out of all the 6 classes, the class "Chlorophyceae" was dominant in the pond with almost 16 species. Moreover, the presence of *M. aeruginosa* significantly indicated towards human generated pollution in the studies pond. An *et al.* (2013) wrote an article on the wetlands of Northeast Asia and High Asia. In this article they mainly focused on the hydrologic alterations of the wetlands, global climate change and various causes behind the degradation of the wetlands. Hazarika (2013) carried out a study on the physico-chemical characteristics of the Satajan wetland with special reference to the fish diversity of the wetland. During this study he found a total of 42 species of fish and the family "Cyprinidae" was recorded as the dominant family and comprised about 30.95% of the total species. He also found a high level of DO level in the water of the studied wetland. A comparative study on four wetlands by Saha (2013) revealed that the WQI, DO, TDS, conductivity varied from wetland to wetland. According to the locations and anthropogenic activity WQI have been observed to have varied more than all the parameters. Barman *et al.* (2015) carried out a study on the seasonal variation of physico-chemical characteristics of the wetlands in West Garo Hills of Meghalaya. During this study they have found that the water of the wetlands was slightly alkaline in nature. Moreover, the DO was found in normal range, BOD was found to be slightly higher than permissible limit. On the other hand, COD and TSS were found beyond the permissible limit. Boruah and Riba (2015) carried out a study on the Bordoibam wetland of Assam. During their observation they have witnessed about 24 species of birds. They have also mentioned that the Bordoibam wetland serves as a breeding ground for some species. Thus, the author suggested that since, the wetland is rich in bio-diversity so priority should be given in terms of conservation and management.

Sonowal and Baruah (2015) carried out a study on certain physico-chemical parameters of Bordoibam wetland. During this study they have observed that all the parameters undertaken by them were found to be normal and suitable for the growth and development of plankton and fishes. On the other hand, since, the buffer zone of the wetlands has been in use by the farmers for cultivation purpose, so the total area of the wetland has been decreasing day by day. Chaudhury and Gupta (2017) attempted to study surface water quality and aquatic insect diversity of the DeeparBeel (Ramsar site), Assam, North-East India. They found an increased dissolved oxygen from site to site. Moreover, conductivity and dissolved solids were also varied in response to different sites of the wetlands. Das (2017) carried out a study on the NDVI and NDWI based change detection analysis of the Bordoibam wetland. During this study they have observed change detection in both NDVI and NDWI maps. They have also observed significant changes in both vegetation and water covered areas of the wetland. Sonowal and Baruah (2017) carried out a study on physicochemical properties of water in Bordoibam-Bilmukh Birds's Sanctuary. During this study they have found a range of pollution indicator index in the waters collected from the wetland. So, they suggested the need of proper measures before the water reaches the pollution zone. Sonowal *et al.* (2018) carries out a study of the phytoplankton diversity along with the physico-chemical characteristics of water in the Bordoibam wetland. During this study they have recorded a total of 33 algal species, they have also found a high level of total coliform than the normal range. Thus, the authors suggested a proper maintenance of the household, agriculture, and industrial wastes in order to retain the pollution free water of the wetland. Bashir *et al.* (2020) carried out a study on the effect of seasonal variations on water quality of Shallabugh wetland. During this study they have found that the values of water temperature, COD, and BOD were recorded to be maximum in summer and minimum in winter. On the other hand, the values of DO and TDS were recorded maximum in winter and minimum in summer.

Kharke and Raut (2020) carried out an experiment on the assessment of water quality index of Godavari River water in Nashik city. During this study they have found that the water of the river is alkaline in nature. They have also found that since the water of the river contains pollutants, so the water showed decreased DO and increased BOD values. Sharma (2020) carried out a study on the floodplain wetlands present in the Upper Brahmaputra Valley. During their study, they have found that though the Fuklai Beel was the smallest, but out of all the 6 studied wetland it was recorded to be in better condition based on landscape assessment. The water quality index (WQI) value and vegetation coverage of the wetland was around 66.6% and 57.3% respectively. Sonowal and Baruah (2020) carried out a study on the water quality status of Bordoibam Bilmukh

wetland. The result of this study indicated a strong correlation between chloride, nitrate, total coliform, and turbidity. On the other hand, no correlations have been observed among conductivity, TDS, DO and total hardness. Aswathy *et al.* (2021) carried out a study on the water quality in a tropical Ramsar wetland of Southern India in the wake of Covid-19. As during the lockdown period water and air quality become better. This study has been done to check the progress of water quality through examining suspended particulate matter using remote sensing data from the wetland. They observed that the SPM values during lockdown was around 8.01mg/L which was lower as compared to pre-lockdown period (10.03mg/L).DO and BOD analysis has been done on a wetland of Goalpara district by Kalita (2021) revealed that the DO level ranges between 7.2-8.7mg/L and was recognised satisfactory. While, the BOD level was found to be highly satisfactory and ranges between 1.3-1.6mg/L. Sharma (2021) attempted to evaluate the fish diversity of the Ramsar wetland sites of Himachal Pradesh in relation to 40°C temperature and observed a total of 44 species of fish in that temperature. Moreover, various threats and conservative measures in the wetlands of the international importance of the state have also been focused during this study. Singh *et al.* (2021) attempted to assess the water quality condition and spatiotemporal patterns in selected wetlands of Punjab, India. The studies groups of wetlands showed similar values of pH, conductivity, TDS, Dissolved oxygen, total alkalinity, chemical oxygen demand etc. Further analysis revealed that all analysed water quality parameters showed temporal patterns in water quality except pH, electrical conductivity, dissolved oxygen, and phosphate content. Bhuyan and Sharma (2022) carried out an experiment on the water quality and change detection of the aquatic vegetation of the Satajan wetland. By comparing the results obtained, the authors concluded that the aquatic vegetations present in the wetland have decreased from 2016 to 2022 by the rate of almost 2.84 acer or 7.84%. Choudhury and Saikia (2022) carried out a study on the physico-chemical properties of various wetlands of Hojai District and their comparative studies. By comparing the results obtained, the authors concluded that out of all the beels studies, the water parameters of Taradubi Beel were most unsuitable for the optimal growth of both the aquatic flora and fauna. Debnath *et al.* (2022) studied the water quality in response to growth and development of *Labeo bata* in the flood-plains of North East India. Khoiyangbam and Chingangbam (2022) studied about the variations of diffusive nitrous oxide emission from fresh-water wetland in Keibul Lamjao National Park of Manipur, Northeast India. In a study by Singh *et al.* (2022) on physico-chemical parameters and wetland water quality assessment by using Shannons entropy revealed that EWQI values were relatively lower sprouting the effects of dilution while, the EHCI values were relatively higher suggesting the entry of heavy metals through leaching and run-off.

*(NDVI- Normalized Difference Vegetation Index, NDWI- Normalized Difference Water Index, COD- Chemical Oxygen Demand, BOD- Biological Oxygen Demand, DO-Dissolved Oxygen, TDS- Total Dissolved Solids, TSS- Total Suspended Solids, WQI- Water Quality Analysis).

MATERIALS AND METHODS

Study Area. Bordoibum Bilmukh Bird Sanctuary is a large freshwater wetland which is located at about 46 kms in the southeast from Dhemaji. The sanctuary is shared between the two districts Dhemaji and Lakhimpur. It is bordered by Arunachal Pradesh in the north, east by Dhemaji and south by Subansiri river. Its latitudinal and longitudinal extension is 27°20'57" N to 94°20'10"E and 27°20'67"N to 94°20'23"E and its altitude is around 91m above the sea level. The map of the study area is shown in Fig. 1.

Fig. 1. Map of the Study Area (Source: Google Earth, Version: 9.175).

It is a magnificent bird sanctuary with several varieties of birds and is also a paradise for bird lovers. The sanctuary covers an area of 11,25 sq. kms and was formed after the great earthquake of 1950 when the Subansiri river changed its course. In this paper the physico-chemical properties of water are being reviewed and analysed with reference to the avifaunal diversity of the wetland.

Objectives of the Study

1) To discuss about the water quality status of the Bordoibam wetland.

2) To know about the avifaunal diversity of the Bordoibam wetland.

Data Collection. This paper is mainly a review paper which is based on secondary sources of data. The secondary data were collected mainly from various

published sources, such as various journals, books, magazines, recently published current affairs and all these were complemented by the invaluable knowledge of the author. This paper mainly highlights about the water quality status of the Bordoibam wetland along with the avifaunal diversity present in the wetland.

RESULTS AND DISCUSSION

From various research analysis on water quality of Bordoibum wetland, the following parameters with slight variations have been observed:

(1) Water temperature. In Sonowal and Baruah (2015) observed that the maximum temperature of the water of core zone of Bordoibum was around 33°C, while that of the buffer zone was around 35°C. Likewise, the minimum water temperature of the core zone was around 17°C, while that of the buffer zone was around 30°C. Similarly, the average water temperature of core and buffer zone was around 26.07°C and 32.67°C respectively. In Sonowal and Baruah (2017) observed that the range of water temperature in the buffer zone and core zone was between 24°C to 33.67°C and 19°C and 30°C respectively. In Sonowal *et al.* (2018) found that in Bordoibambeel minimum and maximum water temperature were 21.4°C and 27.41°C respectively. Winter and monsoon variations have also been observed. In Sonowal *et al.* (2020) observed that in winter minimum water temperature was found to be around 20.12°C and maximum mean water temperature was found to be around 28.23°C in monsoon. Water temperature was comparatively high in the north site of the Bordoibam.

(2) pH: In Sonowal and Baruah (2015) observed the range of mean value of pH to be between 7.16 to 7.76. Average pH of core and buffer zone was around 7.27 and 7.76 respectively. While, the maximum and minimum pH of core zone was around 7.4 and 7.16 respectively, while that of buffer zone was around 7.76 and 7.16 respectively. So, in 2015 the sanctuary water was found to be alkaline, though it does not beer any harmful effect. In Sonowal and Baruah (2017) found the pH range between 6.94 to 8.9 in buffer zone, while in core zone it was around 6.6 to 8.88. Moreover, due to high turbidity low pH was observed during winter season. In Sonowal *et al.* (2018) observed a maximum pH of about 7.33 during monsoon season in the north site of the wetland, while minimum pH of about 6.74 was observed during pre-monsoon season in the south part of the wetland. In Sonowal *et al.* (2020) observed a range of pH between 6.50 to 7.70. The highest pH of about 7.7 was observed in winter, while lowest pH of 6.50 was observed in post monsoon. So, it was observed that during 2020 the water quality of Bordoibam wetland was tolerable to the aquatic organisms.

(3) Dissolved Oxygen (DO): In Sonowal and Baruah (2015) observed that the maximum, minimum and average values of dissolved oxygen (DO) in core zone was around 8.4, 5.4 and 6.97 respectively. Similarly, the maximum, minimum and average values of DO in buffer zone was around 7.8, 6.4 and 7.80 respectively. In Sonowal and Baruah (2017) observed that the range of DO in the core and buffer zone was between 4.1 to 8.4 mg/l and 7.16 to 8.46 mg/l respectively. Moreover, in the core zone the highest and lowest value of DO was recorded during monsoon and winter season respectively. While, in buffer zone the highest and lowest value of DO was observed during monsoon and pre-monsoon respectively. In Sonowal *et al.* (2020) observed the range of DO to be around 7.43 to 8.40 mg/l. The maximum value of DO i.e., 7.48 was observed in the Bordoi Bagan south site, while the minimum value of DO i.e., 7.06 was observed in Bilmukh site. Moreover, in terms of season the maximum value of DO i.e., 8.77 was observed during the monsoon season, while the minimum value of DO i.e., 7.11 was observed during post-monsoon season.

(4) Total Dissolved Solids (TDS): In Sonowal and Baruah (2015) observed that the maximum, minimum and average Total Dissolved Solids (TDS) values of core was around 84.8, 25.4 and 66.28ppm respectively. While the maximum, minimum and average TDS values of buffer was around 89.4, 57.4 and 67.67ppm respectively. In Sonowal and Baruah (2017) observed the range of TDS in the core zone between 57.6 to 164 ppm, while in buffer zone it was around 61.68 to 119.6 ppm. In case of core zone, the lowest and highest TDS was recorded in winter and monsoon respectively, while in buffer the lowest and highest was recorded in monsoon and pre-monsoon respectively. In Sonowal *et al.* (2018) observed the range of TDS was around 161.2 to 325.1 mg/l. The highest TDS value of 325.1 mg/l was observed in the east site during winter season, while the lowest TDS value of 161.2 mg/l was observed in the west site during the winter season. In Sonowal *et al.* (2020) observed the range of TDS between 231.0-312.0mg/l. The maximum value of TDS around 326.20mg/l was observed in Bilmukh site, while the minimum TDS of about 242.0 mg/l was observed in the Tezera Culvert site.

(5) Nitrate (NO_3^-): In Sonowal and Baruah (2015) observed the maximum, minimum and average Nitrate (NO_3^-) values of core zone was around 2.6, 1.6 and 2.00 mg/l respectively. Similarly, in case of buffer zone the maximum, minimum and average values of NO_3^- was around 1.6, 1.2 and 1.37 mg/l respectively. In Sonowal and Baruah (2017) observed the range of nitrate in core zone was between 1.5 to 3.12 mg/l, while in buffer zone it was around 1.58 to 3.24 mg/l. In core zone the highest and the lowest NO_3^- value was during monsoon and winter season respectively. While in case of buffer zone, the highest and lowest NO_3^- value was observed during post-monsoon and monsoon season respectively. In Sonowal *et al.* (2018) found the range of NO_3^- between 0.23 to 1.46 mg/l. The lowest value of NO_3^- i.e., 0.23mg/l was recorded during the monsoon season in the west site. While the highest value of NO_3^- i.e.,

1.46mg/l was recorded during the pre-monsoon season in both east as well as west site. In Sonowal *et al.* (2020) observed the range of NO_3^- between 0.224 to 0.288 mg/l. The maximum NO_3^- value of 0.60mg/l was recorded in the Bordoi Bagan south site, while the minimum NO_3- value of 0.47 was recorded in the Tezera Culvert site.

Sharma (2020) carried out a comparative study on 6 wetlands of Upper Brahmaputra valley including Bordoibam wetland on different parameter revealed some reliable data on the wetland. He observed the pH of the during pre-monsoon and post-monsoon were around 6.21 and 7.59 respectively, while in case of DO it was around 5.1 and 7.72mg/l respectively. Moreover, the TDS value during pre-monsoon and post-monsoon were around 9.1 and 0.1mg/l respectively. The water quality Index (WQI) of about 73.21 was observed with the total quality rating of 440.2624. The study also revealed soil texture and found about 90% sand, 7% silt and 3% clay. The pH of the soil was around 5.8 and a total unit weight of water was around 3.6068.

SUMMARY

From many reviews and research analysis we can summarize that the Bordoibam has an average water temperature of about 33-34°C in core zone and around 32-33°C in buffer zone. While, the average range of pH can be estimated between 6-7.5 and on an average 7-8mg/l DO can be stated from different papers. Likewise, a total average amount of TDS can vary between 58-165ppm in core zone, while in buffer it was between 62-120ppm. Though there was a minimal range of nitrate content present but at present the wetland is free from nitrate population. But, recently in Sharma (2020) has observed a huge mean difference between the TDS values both during pre-monsoon and post-monsoon season.

Das *et al.* (2002) carried out a study on the wetlands of Guwahat-1 and revealed that some of the wetlands were very much polluted. The water of Sola beel was extremely polluted and this was indicated by low DO, high load of BOD, COD, carbon dioxide, hard chloride, nitrate, phosphate etc. Boruah and Riba (2015) carried out a study on the Bordoibam wetland of Assam. Their study mainly focused on the origin, growth, and biodiversity of the wetland as well as the various problems related to the wetland. During their field observation they have witnessed about 24 species of birds. In this paper they have also mentioned that the Bordoibam wetland serves as a breeding ground for some species like the Large whistling duck, purple swamphen, Bronze-winged Jacana, White-breasted waterhen and Watercock. At last, the author suggested that since the wetland is rich in bio-diversity, so, priority should be given in terms of conservation and management. Sonowal and Baruah (2017) carried out a study on physicochemical properties of water in Bordoibam Bilmukh Bird's Sanctuary. During their study they divided the wetland into two zones- one is core zone and the other is buffer zone. The main aim of this study was to analyse the water quality of the wetland. During this study they have found a range of pollution indicator index in the waters collected from the wetland. Thus, the result of the study showed that the study area was a pollution free environment. Sonowal and Baruah (2020) carried out a study on the water quality status of Bordoibam Bilmukh wetland. The result of this study indicated a strong correlation between chloride, nitrate, total coliform, and turbidity. On the other hand, no correlations have been observed among conductivity, TDS, DO and total hardness. The authors also observed a high amount of both coliform and conductivity which indicates towards heavy load of organic matters and ionic substances in the wetland respectively. Sonowal and Baruah (2015) carried out a study on certain physico-chemical parameters of Bordoibam wetland. The authors divided the entire wetland into two zone- Core zone and Buffer zone. During this study they have observed that all the parameters undertaken by them were found to be normal and suitable for the growth and development of phytoplankton and fishes. But, on the other hand, the buffer zone of the wetland has been in use by the farmers for cultivation purpose both in summer as well as in dry seasons. Thus, the total area of the wetland has been decreasing day by day.

Sonowal *et al.* (2018) carried out a study of the phytoplankton diversity along with the physico-chemical characteristics of water in the Bordoibam wetland. During this study they have recorded a total of 33 algal species which can be included into 4 classes i.e., Cyanophyceae, Chlorophyceae, Bacillariophyceae and euglenophyceae. They have also found a high level of total coliform than the normal range, whereas the other parameters were within the pollution level. Sharma (2020) carried out a study on the floodplain wetlands present in the Upper Brahmaputra Valley to know its ecological condition. During their study they found that though Fuklai Beel was the smallest, but out of all the 6 studied wetlands it was in better condition based on landscape assessment. The WQI value of the beel was around 66.6% and vegetation coverage around 57.3%. Bashir *et al.* (2020) carried out a study on the effect of seasonal variations on water quality of Shallabugh wetland. During this study they found that the values of water temperature, COD and BOD were recorded to be maximum in summer and minimum in winter. On the other hand, the values of DO and TDS were recorded maximum in winter and minimum in summer. High values of both BOD and COD indicated towards heavy organic load in the wetland. In this paper the author mentioned about the various anthropogenic activities like- domestic wastes, agricultural runoffs etc. were responsible for the degradation of the water quality of that wetland. Choudhury and Saikia (2022) carried out a study on the physico-chemical properties of various wetlands of Hojai district and their comparative studies. By comparing the results obtained

they found that out of all the beels studies, the water parameters of Taradubibeel was most unsuitable for the optimal growth of both aquatic flora and fauna. Bhuyan and Sharma (2022) carried out an experiment on the water quality and change detection of the aquatic vegetation of the Satajan wetland of Lakhimpur. During the study they have found that the wetland has been dominated mainly by two ions, one was the Mg ion and the other was SO_4 ion. By comparing the results obtained, the authors concluded that the aquatic vegetations present in the wetland have decreased from 2016 to 2022 by the rate of almost 2.84 acer or 7.84%. Kalita (2021) carried out a study on the water quality analysis in the wetlands of Goalpara district of Assam. During this study they found a highly satisfactory result of BOD level which ranges from 1.3-1.6mh/L. While, the result of DO was also found to be satisfactory which ranges from 7.2-7.8mg/L.

Barman *et al.* (2015) carried out a study on the seasonal variation of physico-chemical characteristics of the wetlands in West Garo Hills of Meghalaya. During this study they have found that the wetlands of West Garo Hills were slightly alkaline in nature. Moreover, the DO was found in normal range, BOD was found to be slightly higher than permissible limit. On the other hand, COD and TSS were found beyond the permissible limit. Hazarika (2013) carried out a study on the physico-chemical characteristics of the Satajan wetland with special reference to its fish diversity. During this study he found satisfactory results in all the parameters except the chloride content and the dissolved oxygen (DO) level of the wetland. He also found a total of about 42 species of fish from the wetland and among them the family "Cyprinidae" has been recorded as the dominant family (30.95%). They also mentioned that the presence of chloride and DO indicate towards the contamination of the wetland. Kharke and Raut (2020) carried out an experiment on the assessment of water quality index of Godavari River in Nashik city. During this study they have found that the water of the river was alkaline in nature. They have also found that since the water of the river contained pollutants, so, the water showed decreased DO value, while on the other hand, the value of turbidity and BOD have increased.

Baruah and Kakati (2012) carried out a study on the water quality analysis and phytoplankton diversity of Gopeswar temple freshwater pond of Assam. During this study, a total of 45 species of phytoplankton were recorded which belongs to almost 6 classes- Chlorophyceae, cyanophyceae, Bacillariophyceae, euglenophyceae, chrysophyceae and Dinophyceae. Out of all the 6 classes, the class "Chlorophyceae" has been found to be dominant in the pond with almost 16 species. They have also found that the water of the pond was alkaline in nature. They have not found any significant relation of pH, conductivity, TS, TDS, CO_2, BOD, COD with the algal density. On the other hand, total suspended solids and DO was significantly related with the algal density. Moreover, the presence of *M. aeruginosa* significantly indicated towards the human generated pollution in the studied pond. Moundiotiya *et al.* (2004) carried out a study on the physico-chemical properties of water of the Jamwa Ramgarh wetland. During their study they have observed that the pH ranges from 6.8 to 8.5. The EC values remained maximum in summer and minimum in monsoon. Thus, the authors suggested that if this condition persisted for a long period of time, then the Ramgarh wetland will soon degrade and become inactive.

Table 2: Some species of birds recorded from the Bordoibam wetland.

Sr. No.	Local Name	Common Name	Scientific Name	Family	IUCN Status	Migratory Status	Feeding Habit
1.	Bonkukura	Red Jungle Fowl	*Gallus gallus*	Phasianidae	LC	Resident Bird	Mainly omnivores, mostly feeds worms, grasses, corn, lizards, small snakes etc.
2.	Ronga Muria Bahaituka	Golden-backed Wood Pecker	*Dinopium javanense*	Picidae	LC	Resident Bird	Strict insectivores, mostly feeds on insects, tree crawling invertebrates etc.
3.	Neelkantha	Blue throated Barbet	*Megalaima asiatica*	Megalainidae	LC	Resident Bird	Omnivores, mainly feeds on berries, fruits, termites, insects, figs etc.
4.	Sorali	Lesser Whistling duck	*Dendrocygna javanica*	Anatidae	LC	Show local movements	Mostly omnivores, feeds mainly on grains, aquatic plants, rice, fish, invertebrates etc.
5.	Hanumanta	Stork-billed Kingfisher	*Halycon capensis*	Dacelonidae	LC	Resident Bird	Carnivores, mostly feeds on fish, frogs, crabs, rodents, young birds etc.
6.	Patisogun	White-rumped Vulture	*Gyps bengalensis*	Accipitridae	CR	Resident Bird	Mostly carnivores, mainly feeds on dead cattle and human remains, garbage etc.
7.	PakharaMachruka	Lesser pied	*Cerylerudis*	Cerylidae	LC	Resident	Mostly carnivores,

		Kingfisher				Bird	mainly feed on fish, crustaceans, frogs, amphibians, insects etc.
8.	LakhiFencha	Barn Owl	*Tyto alba*	Tytonidae	LC	Resident Bird	Mostly carnivores, feed mainly on beetles, small mammals, mice, rats etc.
9.	Dawk	White-breasted Waterhen	*Amaurornis phoenicuras*	Pallidae	LC	Resident Bird	Omnivores, mainly feeds on molluscs, small fish, aquatic plants, grass, seeds, insects etc.
10.	Hargila	Greater Adjutant Stork	*Leptoptilos dubius*	Palecanidae	EN	Show local movements	Mostly omnivores, feeds mainly on frogs, large insects, reptiles, rodents etc. They also act as scavengers.
11.	Kamcharai	Purple Moorhen	*Porphyrio porphyrio*	Rallidae	LC	Resident Bird	Omnivores, mostly feeds on rushes, shoots of reeds, eggs, small fish, ducklings etc.
12.	Borisen	Shikra	*Accipiter badius*	Accipitridae	LC	Resident Bird	Mostly carnivores, feeds on insects, birds, frogs, mammals, lizards etc.
13.	KutumCharai	Water Cock	*Gallicrex cinerea*	Rallidae	LC	Resident Bird	Omnivores, feeds on grass, shoots, berries, aquatic insects, molluscs, worms etc.
14.	Pahari Bhatow	Alexandrine Parakeet	*Psittacula eupatria*	Psittacidae	NT	Show local movements	Mainly feeds on seeds, fruits, pollen, buds, nuts, arthropods etc.
15.	Balighora	Red-Wattled Lapwing	*Vanellus indicus*	Charadiidae	LC	Resident Bird	Carnivores, mostly feeds on ants, crickets, grasshoppers, butterflies, insects, beetles etc.
16.	Sorumugi Hanh	Gadwall	*Anas strepera*	Anatidae	LC	Migratory Bird	Basically herbivores, feeds on seeds, weeds, aquatic vegetations, leaves etc., females take aquatic invertebrates during laying period.
17.	Shiva Hanh	Great-Crested Grebe	*Podiceps cristatus*	Podicipedidae	LC	Migratory Bird	Carnivores, mostly feeds on fish, insects, small crustaceans, frogs etc.
18.	Porghuma	Green Imperial Pegion	*Ducula aenea*	Columbidae	NT	Resident Bird	Mainly feeds on fruits, berries, flowers, leaves, figs etc.
19.	Ganga Chiloni	Indian River Tern	*Sterna aurantia*	Laridae	VU	Resident Bird	Mostly carnivores, feeds mainly on fish, aquatic insects, frogs, tadpoles etc.
20.	BamunBogolee	Little Egret	*Egretta garzetta*	Ardeidae	LC	Resident Bird	Carnivores, mainly feeds on small birds, aquatic insects, crustaceans, reptiles etc.
21.	Keteki	Indian Cuckoo	*Cuculus micropterus*	Cuculidae	LC	Resident Bird	Mostly omnivores, feeds mainly on fruits, insects,

							butterflies, grasshoppers etc.
22.	Kakoi-sira	Common Hoopoe	*Upupa epops*	Upupidae	LC	Show local movements	Carnivores, feeds mainly on earwigs, ant lions, bugs, ants, locusts etc.
23.	Maniori	Darter or Snake Bird	*Anhinga melanogaster*	Anhingidae	NT	Slow local movements	Mostly feeds on fish, aquatic insects, molluscs, crustaceans etc.
24.	Pati Kopow	Spotted Dove	*Streptopelia chinensis*	Columbidae	LC	Resident Bird	Mainly feeds on grass, seeds, grains, fallen fruits etc.
25.	Bor-KoliMugi	Ferruginous duck	*Aythya nyroca*	Anatidae	NT	Migratory Bird	Basically omnivores, mainly feeds on aquatic plants, insects, molluscs etc.
26.	Bulbuli	Red-whiskered Bulbul	*Pycnonotus jocosus*	Pycnonotidae	LC	Resident Bird	Mainly omnivores, feeds on berries, figs, nectar, pollen, fruits, spiders, insects etc.
27.	BorChorai	Greater Spotted Eagle	*Aquila clanga*	Accipitridae	VU	Migratory Bird	Carnivores, mostly feeds on birds, snakes, small fish, insects, lizards, mammals etc.
28.	PaniKawri	Little Cormorant	*Phallacrocorax niger*	Phalacrocoracidae	LC	Resident Bird	Piscivorous, mostly feeds on fish, some feed on crustaceans, frogs, tadpoles etc.
29.	Kukura	Pallas Fishing Eagle	*Haliaeetus leucoryphus*	Accipitridae	EN	Migratory Bird	Mostly carnivores, feeds on cherries, fruits, eggs, birds, insects etc.
30.	Satbhani	Jungle Babbler	*Turdoides striatus*	Silvidae	LC	Resident Bird	Basically omnivores, mostly feeds on grains, berries, nectar, insects etc.
31.	BeelTeetor	Swamp Francolin	*Francolinus gularis*	Phasianidae	VU	Resident Bird	Basically herbivores, mainly feeds on leaves, fruits, cereals, bulbs etc.
32.	Kuli	Asian Koel	*Eudynamys scolopaceus*	Cuculidae	LC	Shows local movement	Omnivores, feeds mainly on insects, small mammals, crustaceans, fruits, grains etc.
33.	Bortukula	Lesser Adjutant Stork	*Leptoptilos javanicus*	Ciconiidae	VU	Resident Bird	Carnivores, mostly feeds on reptiles, frogs, large invertebrates, rodents etc.
34.	Ghanchirika	House Sparrow	*Passer domesticus*	Passaridae	LC	Resident Bird	Omnivores, feeds mainly on insects, ants, spiders, wheat, millet, grasshoppers etc.
35.	Moupia	Crimson Sunbird	*Aethopyga siparaja*	Nectarinidae	LC	Resident Bird	Mostly omnivores, feeds mainly on nectars, also feeds on insects, spiders etc.

(Source- Dutta *et al.,* 2011)

CONCLUSIONS

In the context of ecosystem management and observation, the Bordoibam Bilmukh Bird Sanctuary is playing an influential tole. It is very much necessary to take greater steps to conserve the wetland as it is the breeding ground of many migratory bird species. Moreover, the water quality is impactful for ecosystem productivity and aquatic biodiversity. It is in focus that the physicochemical parameters of the water of Bordoibam wetland is in the range in pollution indicator index. Though it is still in check for pollution so, from this point of view necessary and immediate measures

should be taken before reaching pollution zone. At present the Bordoibam wetland is a hot topic for future research.

FUTURE SCOPE

At present the Bordoibam wetland is a hot topic of research for both avifaunal diversity as well as for the water quality analysis. Researchers can go for analysis of the physico-chemical properties of the water of the wetland for more information's about the water quality index so that it would help to conserve the wetland as well as its aquatic biodiversity effectively.

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