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Seasonal Variation of Physico-Chemical characteristics of Wetlands in the West Garo Hill, Meghalaya, India

Barman D.*[1], Roy B[2] and Roy S[3]
[1]Department of Botany, Goalpara College, Assam, INDIA
[2]Department of Chemistry, Goalpara College, Assam, INDIA
[3]Department of Chemistry, Gauhati University, Assam, INDIA

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Abstract

Eleven physico – chemical parameters of wetlands in West Garo Hill, Meghalaya were recorded in different seasons for two years to assess the quality status of water. The parameters were water temperature, pH, electrical conductivity (EC), dissolved oxygen(DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solid (TSS), total dissolved solid (TDS), total hardness, nitrate(NO_3) and phosphate (PO_4). The wetlands of west Garo Hill were found to be highly fluctuates with season. The wetlands did not showed significant difference between the two years. The water showed slightly alkalinity. DO was found normal as prescribed by WHO. COD and TSS were found beyond the permissible limit. The BOD was slightly higher than permissible limit indicates that though the water of wetlands are not polluted at present but it is going to be polluted. Pesticides, chemical fertilizers did not showed affect on water quality.

Keywords: Water quality, West Garo Hill, physico-chemical parameters, seasonal variation.

Introduction

Water is a prerequisite for the existence of life. It is the most limiting factor for many aspects of life such as economic growth, environmental stability, biodiversity conservation, food security and health care. The quality of aquatic environment arises from physical, chemical and biological interactions. Its quality is changing day to day due to continuous circulation, transformation and accumulation of energy and matter through medium of living things and their activities. On the other hand the aquatic body is further upset by human activities, resulting in pollution, algal bloom, fish kill, offensive taste and odor etc.

The quality of water body has direct influence on the type and distribution of aquatic community. Therefore the nature and health of aquatic community is an expression of the quality of water[1]. So, to conserve the aquatic life water quality should be properly maintained and monitored regularly.

According to the mapping of the wetlands using geographic information system (GIS), Meghalaya has 135 wetlands in addition to 167 smaller wetlands while the total wetland area has been estimated at 29,987 hectares. The West Garo Hill has the highest area under wetland followed by the West Khasi Hill. The district is nature's wonderland, blessed with beautiful hills, crystal clear rivers, streams and waterfalls, green virgin forest and a wide variety of flora and fauna. To conserve this aquatic community, monitoring as well as maintaining of water quality is most important. But there is little information is available on the study of water quality particularly its seasonal changing pattern of this area.

The present communication has been considered to study the water quality of wetlands of west Garo Hill, Meghalaya by studying the physico – chemical properties of water and also changing pattern of water quality with seasonal variation.

Material and Methods

Study area: The West Garo Hill occupies the most of the wetlands is located at the westernmost part of Meghalaya. The district is bounded by East Garo Hills on the east, by South Garo Hills on the south- east, Goalpara district of Assam state on the north and north-west and Bangladesh on the south. There are three important mountain ranges namely Tura range, Arbella range and Ranggira range in the districts of Garo Hills. The district is situated between 25°10' and 25°35'N latitudes and 90°15 and 91°-0' E longitude. South-West monsoon and seasonal winds, largely controls the climate of the district. This District with its undulating topography and high intensity of rainfall, suffers acute erosion problem and ecosystem degradation of these wetlands. The problem is further compounded by unscientific agricultural practices such as jhumming/shifting cultivation on steep slopes, rampant deforestation, burning etc., which has resulted in degradation of land and wetlands resource.

Collection of water sample: In the present study, primarily different waterlogged (Water present both wet and dry season) locations were identified. Ten sampling sites were chosen at approximately equal distance from each other. Water Sample from these sites were collected in three seasons viz. summer

(March-Jun), monsoon (July—Sept) and winter (Oct—Feb) for two years. Collections were done during morning hours (8.80 am – 10.30 am). Samples were collected at about 35 cm depth and from the middle of the site and bring to laboratory for analysis. Water temperature, pH, dissolved oxygen (DO) were determined in the field itself.

The water temperature and PH was measured by thermometer and digital pH meter respectively. The conductivity was by systronics conductivity meter. The other physic –chemical properties of water i.e. Total Dissolved Solid (TDS), Total Suspended Solid (TSS), Total hardness, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), nitrate and phosphate were determined seasonally in summer, monsoon and winter according to standard methods (Trivedi and Goel [2], APHA[1]). The data were subjected to statistical analysis using SPSS-16.0

Results and Discussion

The results of physic- chemical characteristics of water with different seasons for two years are presented in Table-1 and table-2.

Water temperature (^{0}C): Water temperature directly related with the growth and distribution of aquatic flora and fauna. Temperature determines the status of oxygen in water body. The average seasonal temperature (20.28^{0}C and 20.05^{0}C) of both the year was same. The water temperature recorded maximum in the summer season followed by monsoon and minimum in winter season in both year (FIG-1 and FIG-2). This investigation is also in close conformity with the finding of Kannan *et al.*[3], Chaturbhuj *et al.*[4], Mishra *et al.*[5] and Arya *et al*[6].

pH: pH determines the acidic and basic characters of water. It is a index of general environmental condition. PH values showed that water is neutral to alkaline ranging from 6.7 to 9.5 (table-2). Sharma *et. al.*[7] states that in India, many small confined water pockets are particularly alkaline in nature. The overall average seasonal means (7.73 and 7.92) of both the year are nearly similar and below the permissible (acidic) limits given by WHO. Table-1 and Table-2 showed the maximum value of pH during summer and minimum in winter season in both years. These findings are not in accordance with Mishra *et al.*[5] and Tara *et al.*[8]

Electrical Conductivity (EC): Electrical conductivity is the ability of water to conduct an electric current. It determines the usefulness of aquatic body as they provide a direct measurement of dissolved ionic matter in the water body. The electrical conductivity was maximum during monsoon followed by summer and minimum in winter season in both the year of investigation (figure-1 and figure-2).

Similar results were recorded by various workers (Dutta and Bhagwati[9], Hulyal and Kaliwal[10], Ramulu and Benarjee[11]). High conductivity in monsoon was due to the run way of domestic product from households, fertilizer and other chemical fertilizer from agricultural land to the wetlands. High conductance leads to salinity problem, eutrophication and finally leads to pollution of water body. But the average seasonal means (1.68 mmohs/cm^2. and 1.76 mmohs/cm$^{2)}$ of both the year was same and below the permissible limit prescribed by WHO[12].

Table-1
Seasonal variation of physico- chemical characters of wetlands in the west Garo Hill, Meghalaya (2012-2013)

Parameter	Summer		Monsoon		Winter		Average seasonal mean	WHO
	Range	mean±SD	Range	mean±SD	Range	mean±SD		
Temp	26.4-28.4	27.33±2.65	20.05-26.40	24.13±4.66	7.91-12.26	9.40±2.1	20.28	
pH	7.6-9.2	8.70±2.36	7.0-7.6	7.40±1.7	6.7-7.3	7.10±1.31	7.73	5-5.9
Cond	1.55-1.81	1.67±0.21	1.33-2.65	1.98±0.21	1.02-1.52	1.39±0.3	1.68	0-1000
DO	5.65-7.94	6.57±2.22	7.43-9.21	8.33±1.66	9.05-11.42	10.44±2.8	8.44	6.2-7
BOD	1.56-2.00	1.93±0.3	1.62-2.80	2.09±0.03	0.21-0.62	0.51±0.06	1.31	01-2
COD	20.44-28.70	25.22±4.66	21.17-28.55	24.05±3.55	18.90-21.46	20.56±2.7	23.27	10
TSS	46.69-51.21	48.96±20.7	59.66-70.94	65.35±24.7	43.67-45.83	44.54±5.6	53.28	50
TDS	668.03-854.69	775.21±222.5	893.10-1034.66-	988.54±243.8	687.24-91.99	754.33±178.9	839.36	1000
TH	172.66-237.33	206.88±98.7	172.51-208.00	183.06±78.00	146.71-74.06	158.75±65.7	182.89	200-600
NO_3^-	1.11-1.47	1.32±0.22	0.35-0.76	0.65±0.11	0.69-1.02	0.87±0.10	0.94	45
PO_4^{3-}	0.032-0.52	0.043±0.005	0.005-0.02	0.022±0.003	0.011-0.024	0.013±0.006	0.025	0.1

SD- Standard deviation, WHO- World Health Organization, All parameters in mg/l except Temp (°C), Conductivity (mmohs/cm)

Table-2
Seasonal variation of physico- chemical characters of wetlands in the west Garo Hill district, Meghalaya (2013-2014)

Parameter	Summer		Monsoon		Winter		Average seasonal mean	WHO
	Range	mean±SD	Range	mean±SD	Range	mean±SD		
Temp	27.1-29.03	28.33±4.32	20.09-24.30	23.13±3.08	8.61-10.23	8.70±2.0	20.05	
pH	7.7-9.5	8.76±1.3	7.1-7.9	7.60±1.6	6.7-7.8	7.40±1.1	7.92	5-5.9
Cond	1.34-1.97	1.78±0.01	1.76-2.65	2.20±0.76	1.11-1.42	1.30±0.21	1.76	0-1000
DO	5.43-7.66	7 .32±1.22	7.58-9.00	8.85±1.96	10.05-13.40	12.54±4.6	9.23	6.2-7
BOD	2.21-2.89	2.65±0.22	1.22-1.40	1.35±0.11	0.21-0.52	0.42±0.04	1.47	01-2
COD	18.12-24.60	20.44±3.65	21.25-27.05	23.66±3.5	18.70-21.06	2 0.12±3.2	21.40	10
TSS	46.76-52.21	50.33±23.11	60.76-70.90	68.25±17.4	41.77-45.63	43.11±17.6	53.89	50
TDS	768.03-814.50	798.77±90.32	1093.40-1334.16-	1323.76±145.6	666.24-851.19	813.07±26.8	978.53	1000
TH	122.66-247.73	145.93±33.21	122.51-211.00	132.77± 29.7	106.61-173.02	121.44±32.4	133.38	200-600
NO_3^-	0.11-1.03	0 .43±0.02	0.05-0.66	0.32±0.04	0.18-1.02	0.22±0.1	0.32	45
PO_4^{3-}	0.012-0.05	0.032±0.001	0.004-0.04	0.03±0.001	0.016-0.024	0.019±0.002	0.08	0.1

SD- Standard deviation, WHO- World Health Organization

Dissolved oxygen (DO): Analysis of DO is a key test in water pollution control and wastewater treatment processes. It is also important in precipitation and dissolution of inorganic substances in water. The range of DO in the present study was from 5.65 mg/l to 11.42 mg/l. The seasonal mean in the 2013-2014 (9.23 mg/l) was higher than 2012-2013 (8.44 mg/l) and was higher than normal permissible limit (6.2-7.00). The DO was higher (10.44 mg/l) in winter season and comparatively lower (8.38 mg/ml) during monsoon and lowest (6.57 mg/l) in the summer (table-1) for the first year. In the next year also showed the same variation as from FIG-II. Results of the present study are similar to those reported by other workers[10,11],[13]. The maximum dissolve oxygen in winter may be due to low atmospheric temperature and minimum dissolve oxygen in summer may be due to high metabolic rate of organisms[14].

Biological Oxygen Demand (BOD): BOD is an indication of the organic load and it is a pollution index especially for water bodies receiving organic effluent. In the present investigation, (table-2) BOD was higher in both the summer (2.65 mg/l) and monsoon (1.35mg/l) season and lowest (0.42 mg/l) in winter season. In the next year (FIG-2) BOD was higher in monsoon followed by summer and lower in winter season. Higher value of BOD in summer and lowest in winter season were also recorded by various workers[15-17]. High BOD during summer and monsoon season may be due to the deposition of organic matter in the monsoon season as well as presence of suitable environment (high temperature) for growth of microbes in the summer season. The average seasonal mean 2012-2013 and 2013-2014 was 1.31 mg/l and 1.47 mg/l respectively. According to Adakola[18] the BOD of water less than 1.00mg/l is unpolluted, more than 1.00 mg/l and less than 9.00mg/l is moderately polluted and higher than 9.00 mg/l is highly polluted. The mean value is slightly higher than 1.00 mg/l indicating that wetlands have unpolluted water.

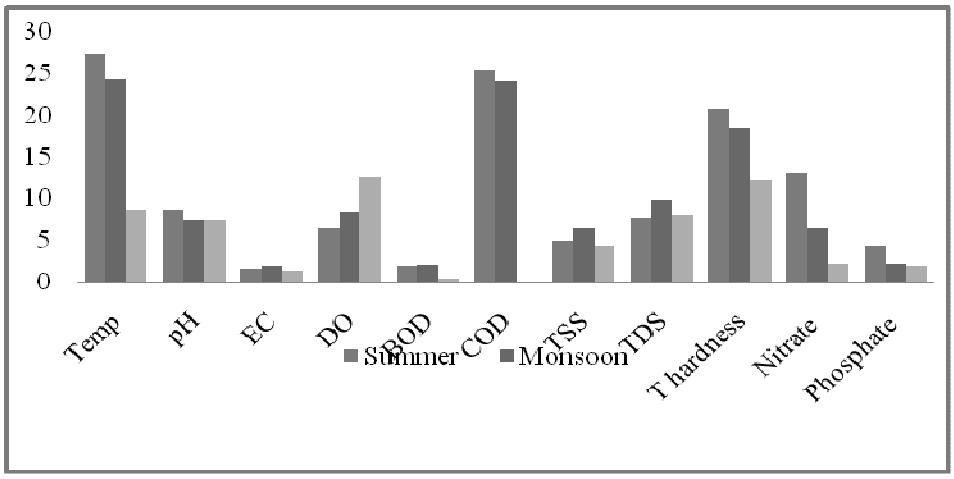

Figure-1
Seasonal variation of physico- chemical characters of wetlands in the west Garo Hill , Meghalaya (2012-2013)

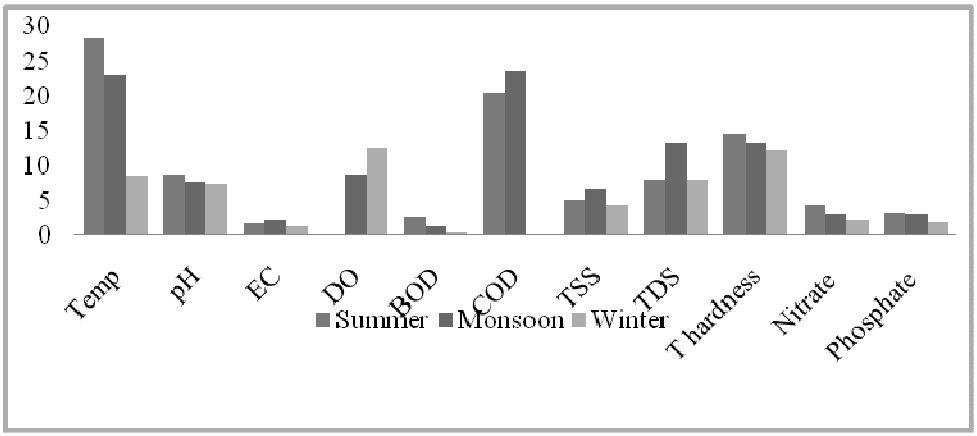

Figure-2
Seasonal variation of physico- chemical characters of wetlands in the west Garo Hill , Meghalaya (2013-2014)

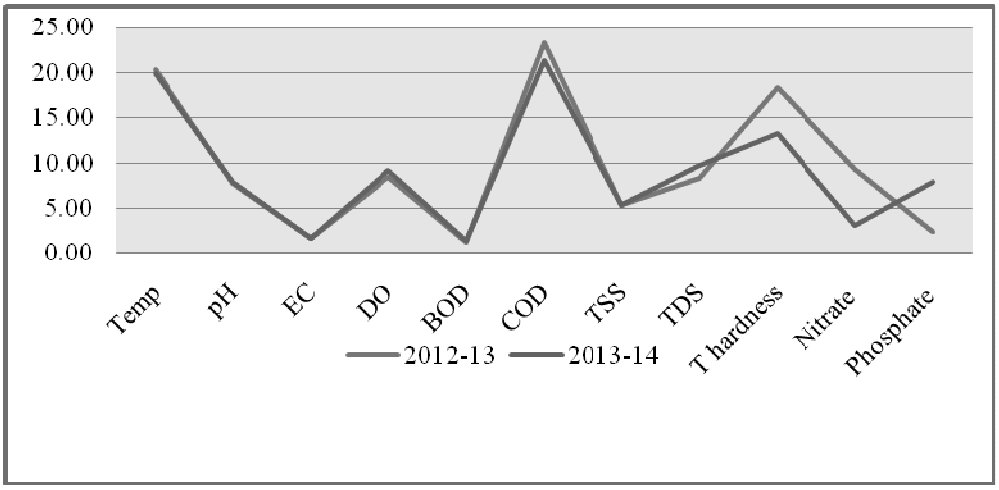

Figure-3
Comparision of Seasonal variation of physico- chemical characters of wetlands in the west Garo Hill Meghalaya in 2012-2013 and 2013-2014

Chemical Oxygen Demand (COD): The COD is useful in studying performance evaluation of wastewater treatment plants and monitoring relatively polluted water bodies. The limitation of the test is its inability to differentiate between the biologically oxidisable and biologically inert material in the water body. The overall seasonal mean both this years are nearly same (23.27 mg/l and 21.40 mg/l) and beyond the permissible limit as prescribed by WHO. In the present study both the year showed seasonal variation. The value of COD was higher (25.22 mg/l) in summer season and lower (20.56 mg/l) during winter season in the first year (2012-2013). In the next year COD was higher in monsoon season than in the summer season (table-2). This result was similar with Abir[15].

Total Dissolved Solid (TDS): Total dissolved solid is the measure of the combined content of all inorganic and organic substances in a water sample. It can pass through a 2 micron filter[2]. High TDS in water body guides eutrophication which finally leads to water pollution. The TDS was recorded maximum (988.54 mg/l) in the monsoon followed by summer (775.21 mg/l) season and minimum (754.33 mg/l) in winter season in the first year of investigation (table-1). In the next year (FIG-III) also showed same variation. According to Verma *et al*.[19] high value of TDS during the monsoon season due to the addition of domestic as well as agricultural product to the water body. The average seasonal mean in the first year (23.27 mg/L) was higher than the next year (21.40mg/l). This mean value was higher than permissible limit.

Total Suspended Solid (TSS): Suspended solids are those portions of total solid that can be retained on a water filter and are capable of setting down. The amount of TDS, 50 mg/l is ascertained as a screening level for potential impairment to water bodies and beyond which is unsuitable for drinking WHO[12]. Average seasonal mean value (53.89mg/l and 53.89 mg/l) of both the year was slightly higher than permissible limit.

In the present finding (table-1) TSS was maximum (65.35 mg/l) in monsoon season followed by summer (48.96 mg/l) and minimum (44.54 mg/l) in winter season in the first year of investigation. In the next year (table-2) also TSS was maximum in monsoon than in the summer and winter. Abir[15], Parikh and Mankodi[20] also found the same results with the present findings.

Total hardness: Total hardness is the sum of calcium (Ca++) and magnesium (Mg++) concentration in the water body. Total hardness above limits (250mg/l) causes encrustation in water supply structure and adverse effect on domestic area (Dhamiji[21], Nagraj *et al*[22]). Total Hardness was found maximum (206.88 mg/l) in the summer and monsoon season and minimum (158.75 mg/l) in winter season (table-1) in the first year. Hulyal and Kaliwal[10] and Gulbhile[23] also found the higher value in summer and lower in winter season. They attributed is to decreases in water volume and increases in rate of evaporation at high temperature. In the next year (table-2) total hardness was found maximum during summer season and minimum in winter season. Various workers[24-27] recorded the maximum hardness during summer and minimum during winter season. The average seasonal mean in the first year (2012-2013) was higher (182.89 mg/l) was higher than the next year (2013-2014). Both the values were below the permissible limit by WHO[12].

Nitrate (NO_3): The most chemically stable form of nitrogen is nitrate. High nitrate concentration can result in excess algal blooms in water body. Nitrates are contributed to fresh water through discharge of sewage, industrial waste and run off fertilizers, decayed vegetables and animal matter from agricultural land. In the present finding average seasonal mean of both the year (0.94 mg/l and 0.32mg/l) was below the permissible limit. The presence of nitrate was maximum (1.32 mg/l) in the summer season and minimum (0.65 mg/l) in monsoon season (table-1). Similar result was also recorded by Yadav[16]. In the next year (figure-2) the nitrate composition showed higher in summer season and minimum in winter season. Pathak and Mankodi[28] and Abir[15] found the high nitrate during the monsoon and minimum during winter season.

Phosphate (PO_4^{---}): Phosphate is the key nutrient also causing eutrophication leading to extensive algal growth. Data from the observation (FIG-3) showed that maximum amount of phosphate present in summer season followed by monsoon season and declined in winter season in both the year. The seasonal mean of both the year (0.025 mg/l and 0.08 mg/l) was below the permissible limit Increase in nutrients during summer is related with the decrease in water level effecting concentration and the release of nutrient during decomposition, which increase with rise in temperature (Chaurasia and doni[29]. However of various workers[10,19,30,31] found maximum phosphate in rainy season and minimum in the winter season.

Conclusion

From the present study it is observed that seasonal variation has highly influenced on the physic-chemical characteristic of water. Data of alkalinity and dissolved oxygen showed the favourable environment of water for aquatic life though it is not useful for drinking purpose. COD and TSS were beyond the permissible limit. It may be due to addition of sewage or other agricultural residues. The current status of wetlands lies below the level of pollution.

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