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Physico-chemical Analysis of the Brahmaputra River in Darrang District, Assam, India

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Abstract: The Brahmaputra River, a fundamental element of the cultural and geographical identity of northeast India, is significant in the Darrang district of Assam, profoundly influencing ecological, agricultural, and socio-economic aspects. Agriculture, which constitutes the main occupation of the majority in the Darrang district, heavily relies on the fertile floodplains of the river, thus rendering it an essential resource for the local population. Furthermore, the Brahmaputra River plays a critical role as a water source for irrigation, particularly during periods of drought, thereby ensuring sustained agricultural productivity. However, the escalating anthropogenic pressures and environmental stressors in recent years have raised concerns regarding the river's health, necessitating a comprehensive evaluation. A thorough assessment of the river's well-being is imperative for the sustainable management of water resources and the preservation of the ecosystem, thereby ensuring benefits for both the local communities and the broader ecosystem. This study was conducted to examine the physico-chemical parameters of the Brahmaputra River, encompassing three distinct sampling sites within the Darrang district. Significant variations were observed across different sampling sites and seasons regarding water temperature, turbidity, conductivity, soil organic carbon content, and nitrogen. Although the pH values remained within acceptable limits, the low total dissolved solids (TDS) values indicated the river's suitability for supporting a healthy fishery. This research revealed substantial spatial and temporal fluctuations in the physicochemical parameters of the Brahmaputra River, which align with common patterns observed in aquatic ecosystems. The findings of this study provided valuable insights into the effective management and conservation of this crucial waterway.

Keywords: Brahmaputra, River, Darrang district, Physico-chemical parameters, Total dissolved solids, Temperature, Turbidity, Conductivity

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Introduction

The Brahmaputra, a prominent river in Asia, has played a significant role in shaping the cultural identity of northeast India and establishing connections between Assam and the rest of the country since ancient times. The Darrang district of Assam, India, particularly recognizes the paramount importance of the Brahmaputra River due to its profound impact on the region's ecological, agricultural, and socio-economic aspects. The majority of the population in the

Darrang district relies on agriculture as their primary occupation, and the river's fertile floodplains support a diverse range of agricultural activities, serving as a crucial resource for the local community. Moreover, the Brahmaputra serves as a vital water source for irrigation purposes, especially during the dry season, thereby ensuring sustainable agricultural productivity. Nevertheless, in recent years, the health of the Brahmaputra River has faced various anthropogenic pressures and environmental stressors, necessitating a comprehensive evaluation of its overall well-being. A thorough understanding of the river's health is imperative for effectively managing water resources and preserving its ecological integrity, which ensures long-term benefits for both local communities and the broader ecosystem. This study was conducted to examine the physico-chemical parameters of the Brahmaputra River, encompassing three distinct sampling sites within the Darrang district.

Materials and Methods

Water samples were collected from Brahmaputra River at three different sampling sites, namely Mangaldai town B1(26.414405,92.061701), Sipajhgar B2 (26.311299,91.945152), and Dhula B3 (26.437898,92.128176) which fall under Darrang district. The samples (water and soil of the river) were collected for two consecutive years (March 2021-March 2023) during four seasons, namely pre-monsoon(PM) (March to May), monsoon (M) (June to August), retreating monsoon (RM) (September to November), and winter (W) (December to February), to cover the variations in physico-chemical parameters. Samples were collected randomly from all sampling sites in the morning of the first week of every month between 7 a.m. and 10 a.m. using Make-Tarson plastic bottles. Parameters such as temperature (WT), turbidity, Conductivity, pH, Total dissolved solids (TDS), Average carbon value of soil, soil pH, and soil N_2 were measured.

Physico-chemical parameters of water:

Temperature (Water): The measurement of water temperature was conducted employing a centigrade thermometer that possessed an accuracy of 0.1°C. After submerging the thermometer in the water for approximately 5 to 7 min, the temperature was documented at the point where the mercury column attained a state of stability.

Conductivity: Conductivity was approximated by utilising a digital apparatus for analyzing water (manufactured by Systronics). In this procedure, water samples were placed within a vessel, the terminals were linked to the power source, and the resulting measurement was documented.

Hydrogen Ion Concentration (pH): The pH of water samples at each sampling site was ascertained through direct measurement utilizing a digital pocket-sized pH meter (Model: HI-96107, HANNA Instrument). Prior to each measurement, the instrument underwent calibration using a standard buffer solution with a pH reading of 7.

Total Dissolved Solids (TDS): The digital water analysis kit (Systronics) approximates the Total Dissolved Solids (TDS). The cell was submersed into a beaker that contained the water sample, and the measurement was documented after the connection of the terminals to the sockets.

Sediment Quality Analysis:

Composite soil samples (sediment) were randomly collected from each survey station within the study period, from 0 to 200 cm in depth. Subsequently, the composite samples were subjected to the removal of identifiable plant debris, followed by the process of desiccation under the cover of shade. Ultimately, the samples were ground into a powdered form using a wooden pestle and mortar so that they could readily traverse through a sieve with a size of 2 mm. These finely powdered samples were then stored in plastic containers for subsequent physical and chemical analysis, adhering to the methodology outlined by Jhingran *et al*. (1969).

Organic Carbon (OC): The methodology employed for determining the amount of organic carbon in the soil sample was the Walkey and Black (1934) procedure, as elucidated by Jackson (1967).

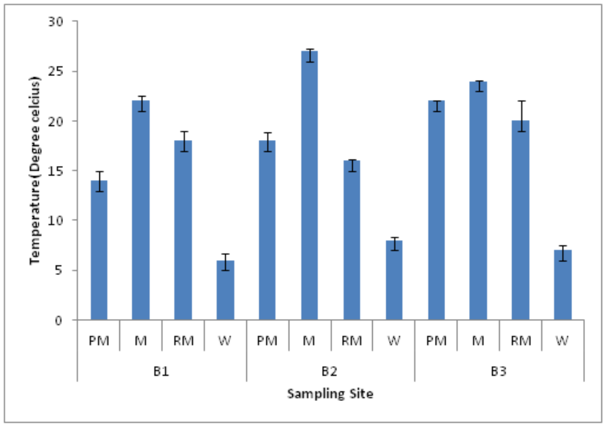

Fig.1: Water temperature during four seasons at the three sampling sites of Brahmaputra river system.

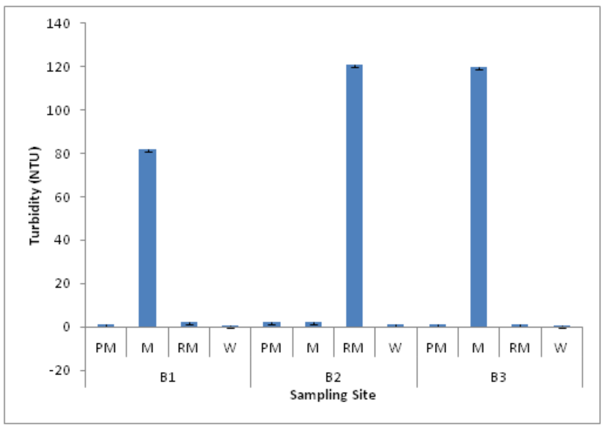

Fig. 2: Seasonal variation in turbidity values at different sampling sites of Brahmaputra river of Darrang District.

Available Nitrogen (N_2): To estimate available nitrogen in the soil, the Kjeldahl method was employed.

Results

Physico-chemical parameters impact the horizontal and vertical migration of aquatic organisms. The presence of these parameters influences the distribution, diversity, and feeding habits of aquatic organisms, such as fish. Consequently, it is crucial to uphold and observe the surrounding environmental parameters to facilitate the favourable growth and development of aquatic flora and fauna.

Temperature (*Water*):

Temperature affects several factors and changes the chemical and physical characteristics of water, making it an essential factor to consider when assessing the quality of the water. Moreover, the temperature of the water can impact the biological activity and metabolic rates of aquatic organisms, which in turn might change the habitats they prefer.

The water temperature was found to fluctuate moderately among all the study sites and ranged from 6.0 ± 2.1°C to 27 ± 0.5°C; highest recorded in monsoon season at B2 and lowest in winter at B1(Fig. 1).

Turbidity:

The measurement of turbidity indicates clearness of the water and amount of much-suspended matter hinders light from passing through it. It

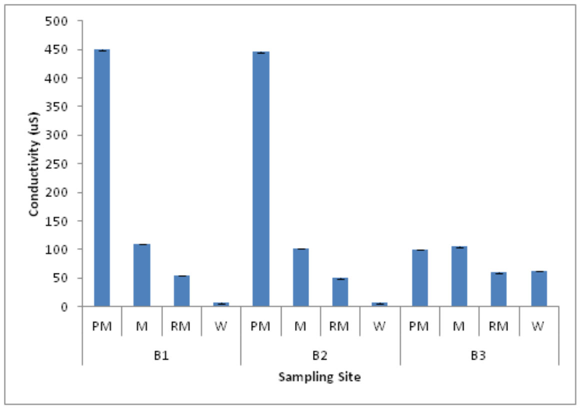

Fig. 3: Seasonal variation in conductivity values at three sampling sites of Brahmaputra river.

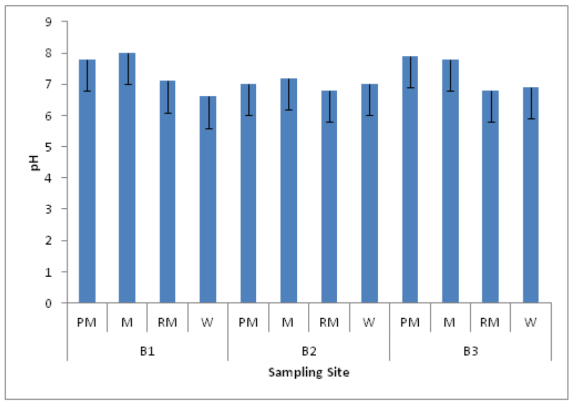

Fig. 4: Seasonal variation in water pH values at different sampling sites of Brahmaputra river.

does not, however, offer a precise assessment of the total amount of suspended elements in water. Although it cannot give an accurate measurement of solids, turbidity is typically employed as an indicator of changes in the concentration of total dissolved solids (TDS) in water.

In the present study, turbidity values ranged from 1 to 121 ± 0.294 NTU (Fig. 2), lowest at B1 and B3 during pre-monsoon and highest at B2 during monsoon season.

Conductivity:

The ability of water to conduct an electrical current is measured by its conductivity. It is a crucial metric for assessing the quality of water. The conductivity decreases with increasing water purity.

On annual average basis, maximum (450± 0.44949 µs) conductivity at site B1 in pre-monsoon and minimum (7 ± 0.816497 µs) at site B2 during winter (Fig. 3) was observed.

Hydrogen Ion Concentration (pH):

The pH scale is used to measure a solution's acidity or alkalinity. It ranges from 0 to 14, with seven being considered neutral. Higher pH values are considered alkaline, whereas lower pH values as acidic. pH is an important consideration when evaluating water quality since it affects aquatic organism growth and reproduction as well as the productivity of the water.

The value of pH was observed within the range of 6.6 ± 0.08165 (winter at B1) and 8 ± 0.08164 (monsoon at B1) (Fig. 4).

Total Dissolved Solids (TDS):

Total dissolved solids (TDS) are the total amount of dissolved organic and inorganic materials in a

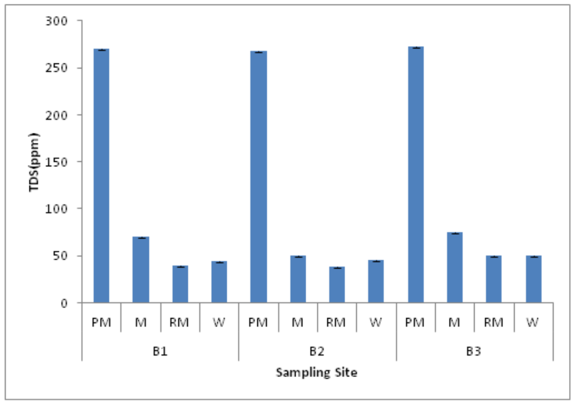

Fig. 5: Seasonal variation in TDS values at different sampling sites of Brahmaputra river.

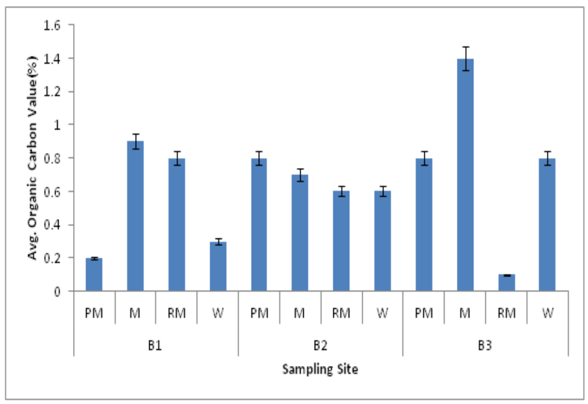

Fig. 6: Average organic carbon values (%) at different sampling sites of Brahmaputra river.

liquid, including suspended molecules, ions, and micro granules. TDS and salinity are almost the same in clean water. Nevertheless, cells may contract in water with a high TDS concentration, which could impact an organism's ability to move through the water column and cause it to float or sink outside its normal range.

Values of TDS were found to fluctuate between 40 ± 0.08165 ppm (B1) and 272 ± 0.0816 ppm (B3) during retreating monsoon and pre-monsoon, respectively (Fig. 5)

Sediment Quality:

Average organic carbon values:

The carbon in soil organic matter (SOM) is called organic carbon. It is essential to the health of the soil because it serves as a nutrient reservoir that increases water penetration into the soil while lowering surface crusting and compaction.

During the investigation period, the data recorded for organic carbon varied from 0.1% ± 0.0182 in retreating monsoon at B3 to 1.4% ± 0.1825 in monsoon season at B3 (Fig. 6).

Soil pH:

The term "soil pH" describes acidic or alkaline nature of the soil. It is an important parameter that influences many different chemical processes in the soil. It is well known that this variable in soils can be used to determine the chemical composition of the soil solution.

The soil pH of the river recorded maximum 8 ± 0.9165 in monsoon season at B2 and minimum 6.8 ± 0.08165 in winter season at B3 (Fig. 7).

Soil Nitrogen (N_2):

Along with trace levels of ammonia and nitrate, organic matter makes up the majority of the nitrogen found in soil. Available nitrogen is the

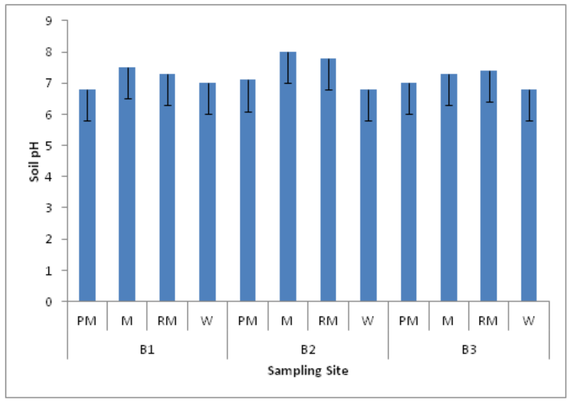

Fig. 7: Seasonal variation in soil pH values at different sampling sites of Brahmaputra river.

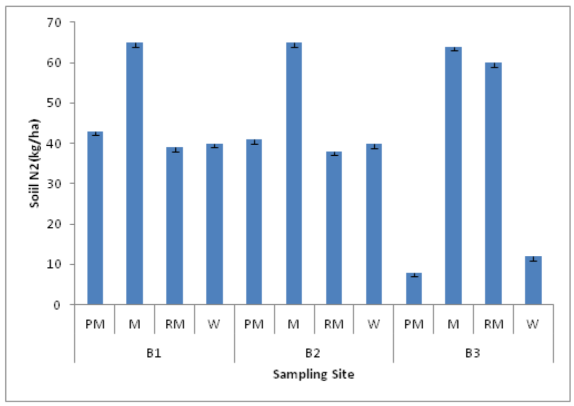

Fig. 8: Seasonal variation of soil nitrogen at different sampling sites of Brahmaputra river.

nitrogen in the soil that is available to plants. Environment-related variables like rainfall and temperature have an impact on the amount of nitrogen that is readily available in the soil.

The present study recorded a maximum of 65 ± 0.244949 Kg ha^{-1} nitrogen in monsoon at all the site and a minimum of 012± 0.0816 Kg ha^{-1} during the winter season at site B3 (Fig. 8).

Discussion

It was discovered that B2 had the highest temperature recorded, whereas B1 had the lowest. This could be because B1 is situated higher than B2. Sharma *et al.* (2016) found a similar pattern of temperature fluctuation in a Garhwal headwater stream. It is noteworthy that Laal *et al.* (1988) and Nath (2001) have found that seasonal variations in water temperature are a regular occurrence in aquatic ecosystems..

Turbidity levels ranged from 1 to 121 ± 0.294 NTU, with the lowest values observed at B1 and B3 during pre-monsoon, and the highest at B2 during the monsoon season. Conductivity showed a maximum of 450± 0.44949 µs at site B1 in pre-monsoon and a minimum of 7 ± 0.816497 µs at site B2 during winter. The pH values ranged between 6.6 ± 0.08165 (winter at B1) and 8 ± 0.081649658 (monsoon at B1). TDS levels fluctuated between 40 ± 0.08165 ppm (B1) and 272 ± 0.08164 ppm (B3) during retreating monsoon and pre-monsoon, respectively. Organic carbon content varied from 0.1 ± 0.01825% in retreating monsoon at B3 to 1.4% ± 0.18257 in monsoon season at B3. Soil pH recorded its highest (8 ± 0.9165) in the monsoon season at B2, and its lowest (6.8 ± 0.08165) in the winter season at B3. Nitrogen content displayed a maximum of 65 ± 0.244949 Kg ha^{-1} in monsoon at all sites and a minimum of 012± 0.08165 Kg ha^{-1} during the winter season at site B3. According to Gupta *et al.*

(2006), the ideal nitrogen content in soil should range from 272–544 kg ha^{-1}. However, the present study recorded nitrogen values that ranged from a maximum of 65 ± 0.244949 Kg ha^{-1} to a minimum of 012± 0.08165 Kg ha^{-1}. The lower values of nitrogen could be due to the low concentration of organic carbon, which contains nitrogen and nitrogen-fixing microorganisms in the soil, as suggested by Talukdar (2016).

The Brahmaputra River's physico-chemical characteristics in the Darrang district of Assam show notable seasonal and geographical fluctuations. The experiment's results are relatively similar to observations of other researchers-- Das (2013), Singh *et al.* (1999), and Banerjee *et al.* (1998).

Conclusion

The examined factors included water temperature, turbidity, conductivity, and soil organic carbon content. Of these, nitrogen showed notable differences between sampling sites and seasons. The total dissolved solids (TDS) levels were low, and the pH values were within the allowable range, suggesting that the river water is ideal for maintaining a robust fishery.

Significant temporal and spatial changes in the physico-chemical characteristics of the Brahmaputra River were shown by the investigation, which is typical of aquatic ecosystems. The investigation's findings may offer insightful information for the Brahmaputra River's preservation and management.

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