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Seasonal variation of water quality parameters of river Dikhow in Nagaland and Assam

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Abstract
Dikhow River is one of the largest tributaries of the Brahmaputra river basin originating from Yezami village near Zunheboto town of Nagaland. It debouches into the mighty river Brahmaputra river at Dikhowmukh, Sivasagar district, Asam covering a length of 255.8 km contributing 0.7% runoff**.** The geographical area of the Dikhow catchment is approximately 3100 km^2, covering 85% of Nagaland, 10% of Assam and 5% of Arunachal Pradesh. The study area of the entire river stretch was divided into 6 stations whose elevation ranged from 90.83 msl to 669.9 msl (3 in Nagaland and 3 in Assam). These stations were selected to study the hydro-biological profile of the river stretch, its pollution status and fish diversity from January 2019 to February 2020. The important physico-chemical water quality parameters of the river in these stations like Dissolved Oxygen (5.2-10.1 mg/L), pH (7.0-8.2), Turbidity (3.8-143.8 NTU), Total Hardness (24.02-121.01 mg/L), Total alkalinity (33-89 mg/L), etc. were found to be ambient for the survival of aquatic fauna in some parts in some period of the year.

Keywords: Dikhow, environmental health, physical parameter, chemical parameter

Introduction
Water is a vital natural resource, it has many fascinating properties that are essential to life, covering three-fourths of the surface of the Earth. Clean water is important for everyone's social, environmental and economic well-being. Geologically, economically, socially and spiritually, the rivers are of considerable significance. While they contain just around 0.0001 % of the world 's overall water content at any given moment, rivers are critical water and nutrients carriers of every part of the planet. They are critical components of the hydrological cycle and function as surface water drainage channels (Longchar *et al*., 2018) [8]. The rivers of the planet drain almost 75 per cent of the land surface of the earth. The river ecology is formed through the interaction of river biota and its hydrogeochemical environment. It is defined by the continual transfer of various items, such as organic matter and nutrients, from the drainage basin to the river and downstream with the running water. River environments are adaptive to the natural hydrological regime and many components of these systems depend on flooding to share resources, nutrients, sediments and living organisms, not just with water (Acreman, 2000).

Dikhow River is one of the largest tributaries of the Brahmaputra river basin originating from Yezami village near Zunheboto town of Nagaland. It debouches into the mighty river Brahmaputra river at Dikhowmukh, Sivasagar district, Asam covering a length of 255.8 km contributing 0.7% runoff**.** The geographical area of the Dikhow catchment is approximately 3100 km^2, covering 85% of Nagaland, 10% of Assam and 5% of Arunachal Pradesh. River Dikhu 's major tributaries are Yangyu and Nanung in the Tuensang and Mokokchung district. The Dikhu River is not only a popular tourist attraction but also an important source of people's livelihood. The Dikhu River is a lifeline for millions of people in Assam and Nagaland.

A river's water content is the composition of many interrelated compounds, which are subject to local and temporal fluctuations and are often influenced by the water flow amount. Surface water resources are more vulnerable to contamination than groundwater (Ogubanjo and Rolajo, 2004) [11], especially in developing countries where heavy industrialisation, increasing urbanisation and adaptation to new agricultural practices play an important role in raising

living standards but at the same time cause serious harm to the environment (Mulk *et al*., 2015) [10], and declining quality of life for many people (Pearce and Turner, 1990) [12]. The current study is the first recorded of river Dikhow's physico-chemical water quality parameter of the entire stretch.

Materials and Methods

Study Area

The present study comprises of 6 sampling stations divided into 2 sectors hill and plain with 3 station in the hills of Nagaland 3 station in the plains of Assam. The details of the stations are as follows-

Station 1 - Longsa	26°15′17.95"N 94°31′42.63"E	Elevation – 667m msl.
Station 2 - Dikhu Village	26°17′46.33"N 94°35′29.09"E	Elevation-559 m msl
Station 3 - Changtongya	26°29′51.62"N 94°41′38.78"E	Elevation-322 m msl
Station 4 - Nazira	26°55′31.64"N 94°45′21.98"E	Elevation-98 m msl.
Station 5 - Sivsagar Town	26°58′33.08."N 94°37′50.78"E	Elevation-96 m msl.
Station 6 - Dikhow Mukh	27°00′00.40"N 94°28′06.03"E	Elevation- 90 m msl.

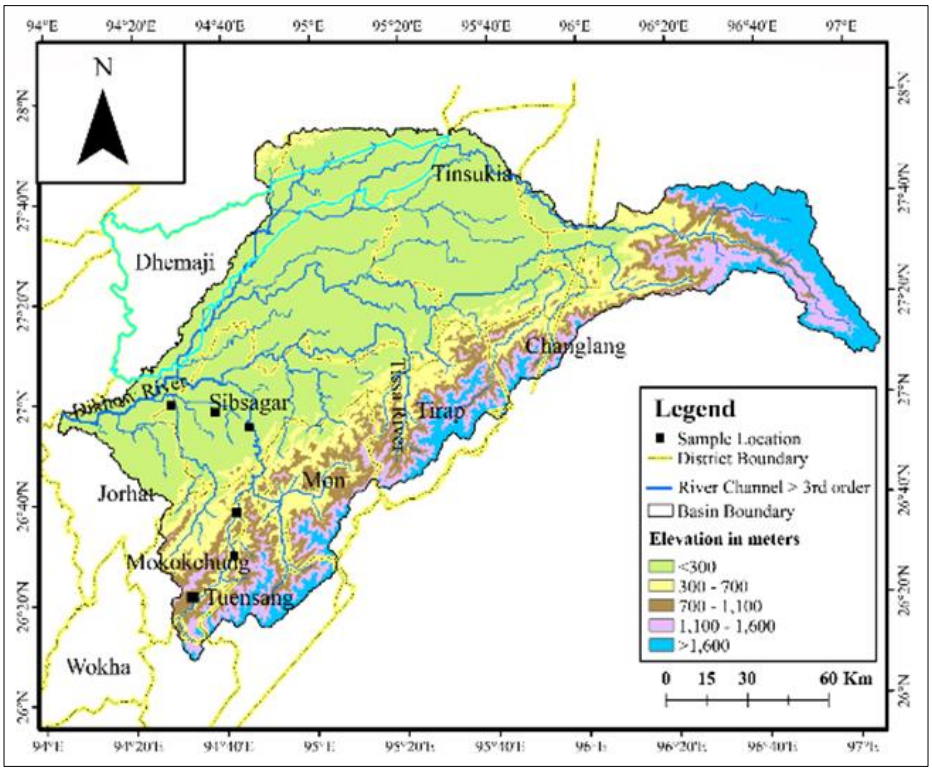

Fig. 1: GIS map of the study area along with stations

Sampling was carried out on a monthly interval from February 2019 to February 2020. The area of study and limnological data are Indicated on the Map (Figure 1). Assessment of water's physico-chemical parameters was carried out by adopting the methodology of APHA (1985).

Results and Discussion

Seasonal variations of Physico-Chemical of water

The monthly variation of water quality parameters among different stations are given below in Figure 2.

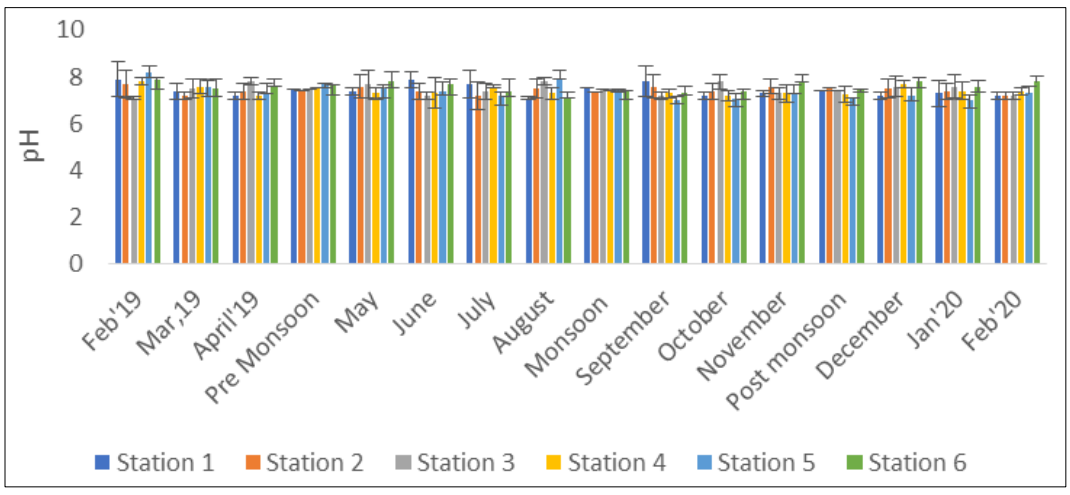

Fig. 2a: Periodical Variation pH in River Dikhow.

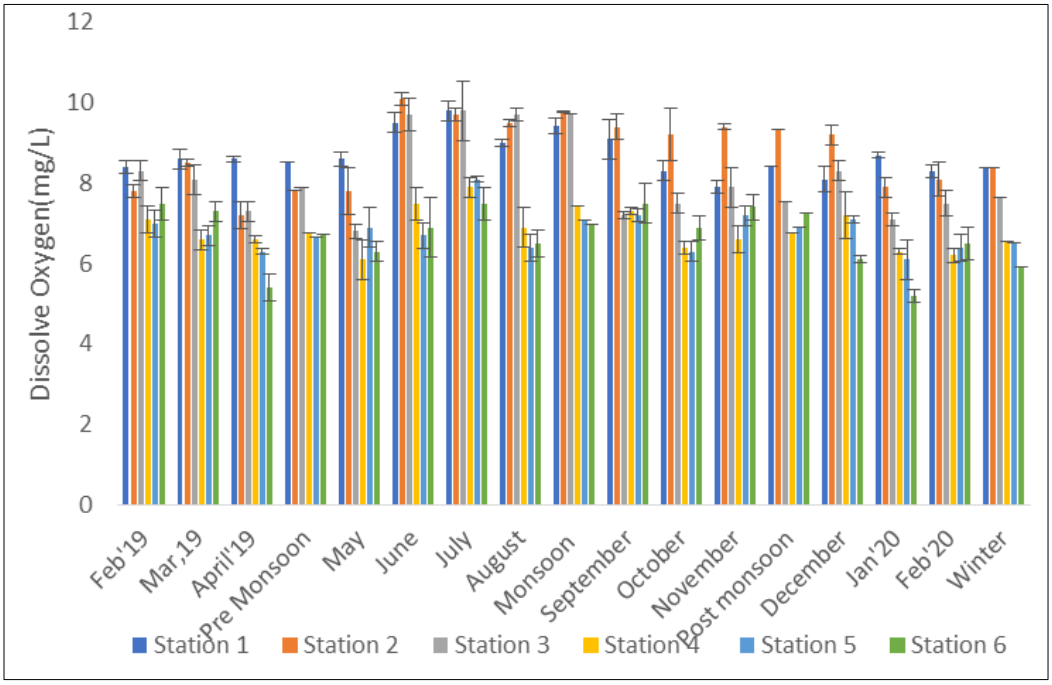

Fig. 2b: Periodical Variation Dissolve Oxygen in River Dikhow.

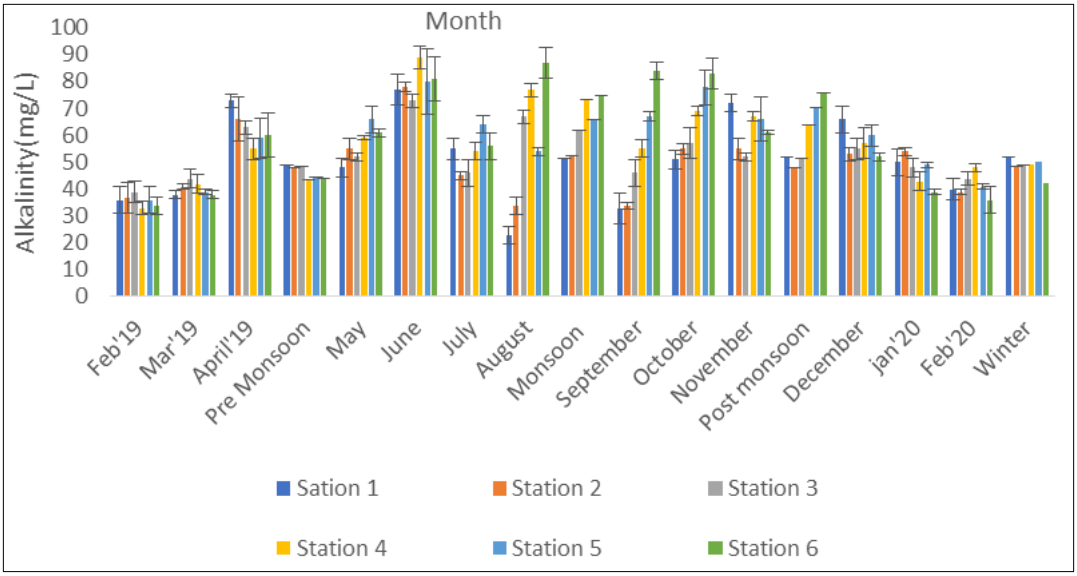

Fig. 2c: Periodical Variation of Total Alkalinity in River Dikhow

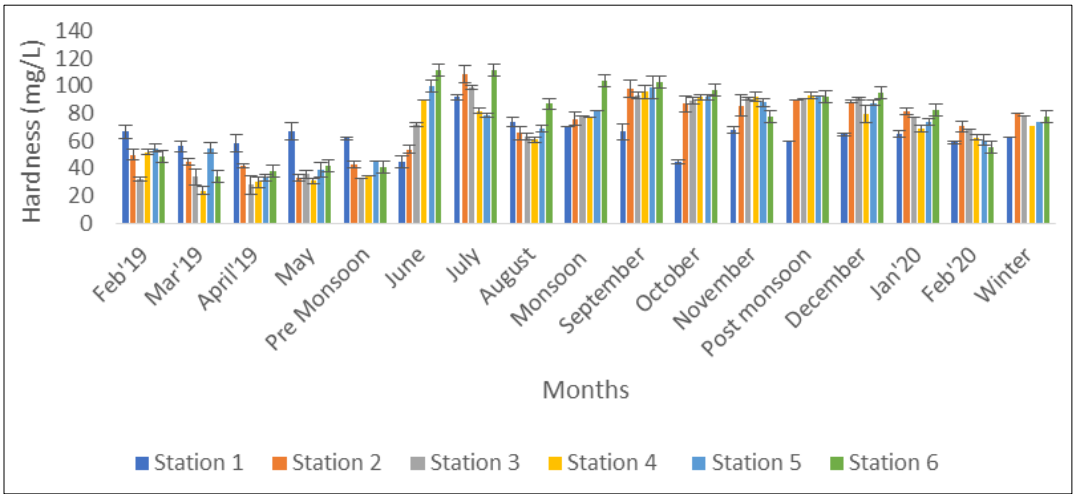

Fig. 2d: Periodical Variation of Total Hardness in River Dikhow.

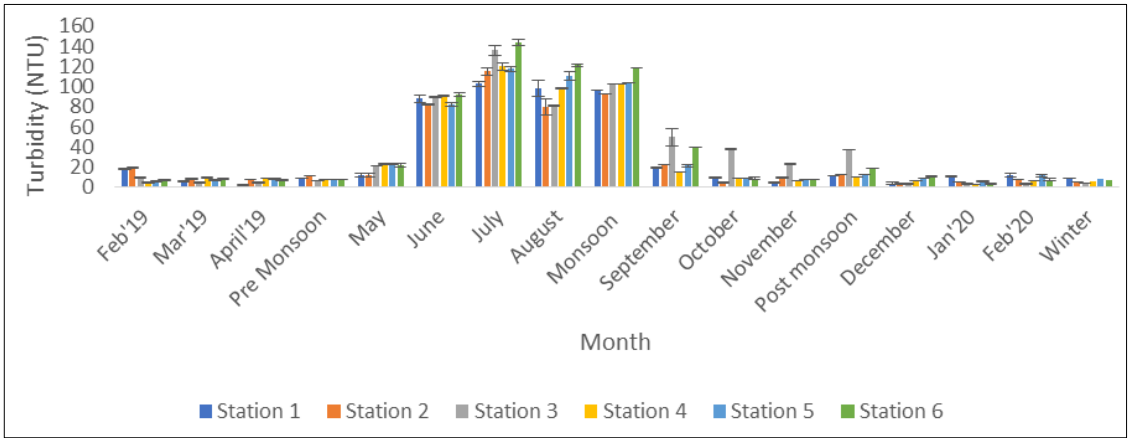

Fig. 2e: Periodical Variation of Turbidity in River Dikhow

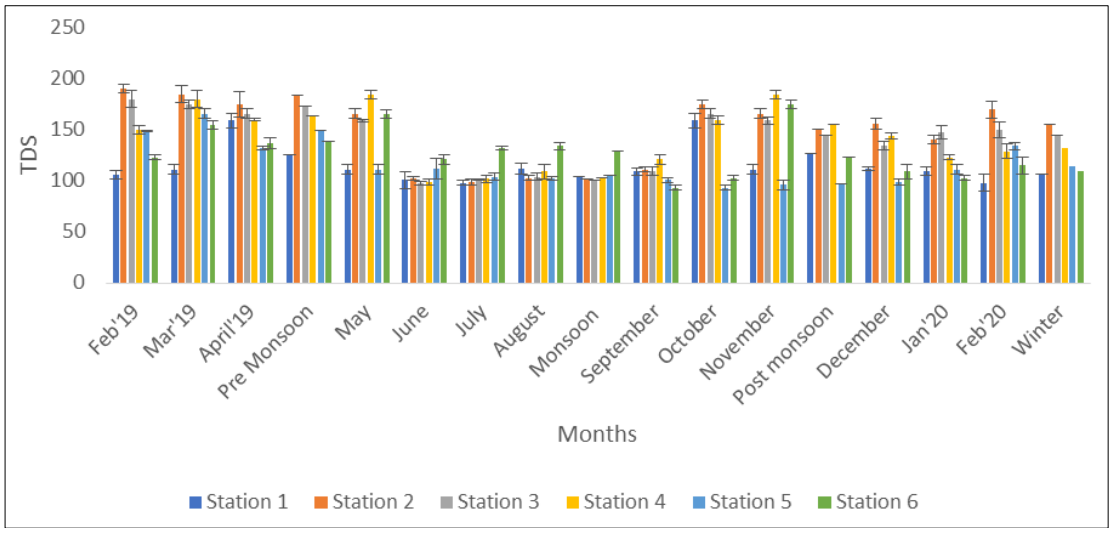

Fig. 2f: Periodical Variation of Total Dissolve Solid in River Dikhow

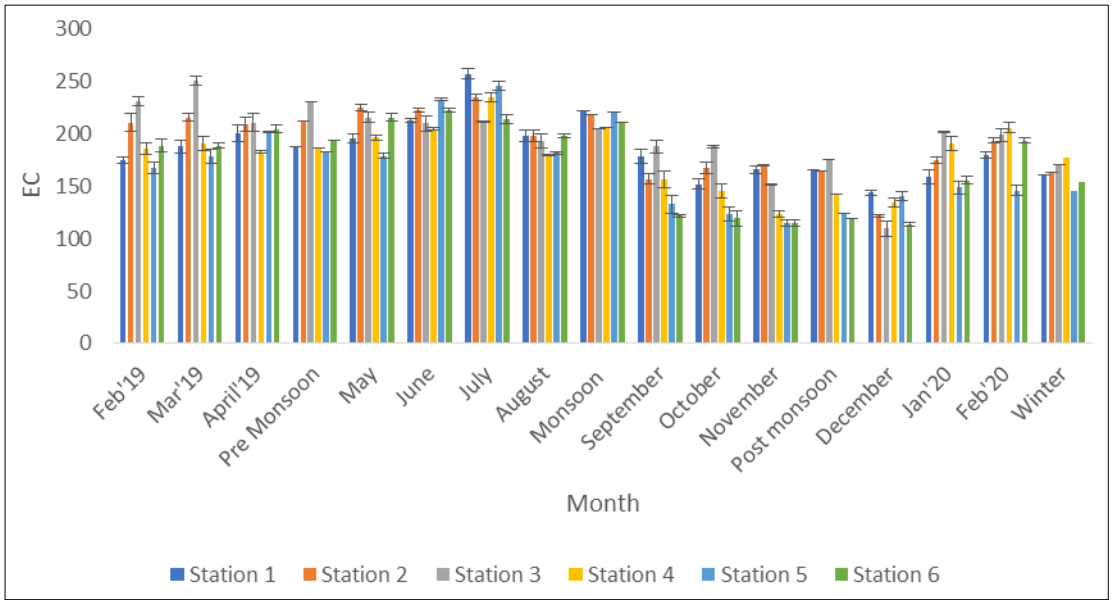

Fig. 2g: Periodical Variation of Electric Conductivity in River Dikhow

pH value expresses the intensity of the acidic or basic characters of water. The average pH values (Fig 2a) for pre-monsoon, monsoon, post monsoon and winter was found to be 7.55 ± 0.09, 7.4 ± 0.06, 7.3±0.1 and 7.8 ± 0.8 respectively which was found to be ambient for survival of fish fauna. The pH of the river is congenial (6.5-9) for fish culture as suggested by Boyd and Tucker 1998 [4].

The amount of oxygen which is dissolved in a water body is known as dissolved oxygen (DO). Generally, fish feed best, grow fastest and are healthiest when DO concentrations are above 5 mg/L. The mean DO values (Figure 2b) ranged from minimum 7.23 mg/L (±0.95) during winter season to a maximum 8.4 mg/L (±1.25) during monsoon. In the present study, DO was found to be lowest in winter but increased

steadily and reached its maximum in summer. Das *et al*. (2015) [5] reported that long day photosynthesis expands which increases DO in summer. The percentage of soluble gases in water is also influenced by bright sunlight in the summer. The concentration of dissolved oxygen (DO) is directly related to the speed of flow (Marques *et al*. 2003). The range of Dissolve oxygen in the river is ambient for survival of fishes as suggested by Boyd and Tucker 1998 [4].

Turbidity is the presence or absence of clay silt, dissolved organic and inorganic matter, turbid water received from the catchment area, plankton and other microscopic organisms. Observed turbidity value (Fig 2e) of Dikhow river ranged between 7.3-11.9 NTU, 92.5-103.6 NTU, 10.4-18.8 NTU and 3.67-9.1 NTU during pre-monsoon, monsoon, post monsoon and winter respectively. Maximum value of turbidity was observed during monsoon season. Which may be due to number of reasons like excess sediments carried by runoff from the catchment areas, high water current eroded the bank of the river, suspended matter and dissolved particles. The turbidity of the river fluctuates below and above the congenial limit 20-39 NTU (Abbasi, 1998) [1] which we can say that river may not be congeal for fish growth all through the year.

Total Alkalinity is a measure of the concentration of ions in water that would react to neutralize hydrogen ions. The mean concentration of alkalinity in water samples (Figure 2c) of Dikhow river was observed to be 46.2 ± 2.32, 63.33 ± 9.07, 60±10.43 and 48.55 ± 2.98 during pre-monsoon, monsoon post monsoon and winter season. The alkalinity range is suitable for fish growth as suggested by Boyd and Tucker 1998 [4].

Total Hardness is related to the soap precipitation capability of the water. Divalent metallic cations such as calcium, magnesium, strontium, ferrous ions and manganese ions induce hardness. (Abbasi, 1998) [1]. Mean values of total hardness (Figure 2d) was maximum during post monsoon (86.8 ± 12) and minimum during pre-monsoon (42.9 ± 9.6) and the values were within the standard limit of 300 mg/L as per BIS. The hardness of water is not a pollution indicator parameter but indicates water quality mainly in terms of Ca^{2+} and Mg^{2+}. Water with less than 75 mg/L of $CaCO_3$ is considered soft and above 75 mg/L of $CaCO_3$ as hard (Sawyer, 1960). Total hardness is found to be minimum during monsoon season which may be assumed that in the absence of free carbon dioxide some of the half-bound carbon (HCO_3) gets channelized in to bound form (CO_3), thus resulting in low bicarbonate values. The hardness value indicate it is suitable for fish growth as per Santhosh and Singh, 2007 [13].

Electrical Conductivity (EC) is a measure of the ability of water sample to carry current. Factors like temperature, ionic mobility and ionic valences influences the electrical conductivity (Abbasi, 1998) [1]. Observed EC values (Fig 2g) for the water samples of Dikhow river in the studied area ranged between 182-230 µS/cm (±17.04), 204-221.66 µS/cm (±6.79),118-175 µS/cm (±21.7) and 144.00-176.33 µS/cm (±10.) during pre-monsoon, monsoon, post monsoon and winter season respectively, which is under the standard limit of ICMR (300 µS/cm). The increased in EC values of water indicates that there is a source of dissolved ions in the vicinity. Higher the value of dissolved solids, greater the number of ions in water. Increasing levels of conductivity is the products of decomposition and mineralization of organic materials. The EC of the river Dikhow is within the range of 76-474 µS/cm as suggested by Hem, 1992 [6] which is under desirable limits.

Total Dissolved Solids (TDS) is the concentration of dissolved particles present in a water sample and BIS desirable limit for TDS is 500 mg/L. TDS values (Fig 2f) are within the desirable limit of BIS with a mean value of 155.5 mg/L (±20.05) during pre-monsoon, 107.39 mg/L (±9.80) during monsoon and 132.9 mg/L (±20.02) during post monsoon and 127.0 mg/L (18.3) winter season. Increased sediment load from catchment such as farm fields and mixing of effluents released from nearby collieries with river water induced high TDS values during monsoon. With the increasing temperature during monsoon months, organic matter mineralized faster which leads to increase in TDS values. TDS of the river is ambient for freshwater biota as it is below 400 mg/L describe by Boyd and Tucker 1998 [4].

Conclusion

Variation of surface water physico-chemical parameter is season and altitude specific. It can be seen in the current study the parameters shift with altitude. The current study showed us an inverse trend in the variation of Dissolved oxygen in the river seasonally. It also highlights high turbidity resulting during flood season and high anthropogenic activity like mining. The river is fairly untouched from hydrological data point of view even though it is relatively significant as millions of people depend upon it. The current study bridges the data gap of hydrological information of entire stretch of the river and also leaves apparent scope for futures studies related to aquatic environment, hydrobiology and biodiversity.

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