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Assessing the impact of Hydroelectric Power Project on the water quality of Serlui River in Kolasib district, Mizoram, North-East India

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Abstract

Water quality is an important factor for estimating the suitability of water for domestic purposes. The present study was carried out to analyze the impact of hydroelectric project construction on the water quality of Serlui river in Kolasib district, Mizoram. All together, three sampling sites were selected along river from upstream to downstream in vicinity of the hydroelectric power project. The parameters such as Temperature, pH, Electrical Conductivity(EC), Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) were studied seasonally (pre-monsoon, monsoon and post-monsoon seasons) for one year (i.e., from March2015 to February2016). The findings reveal that the temperature ranged from 23.9˚C (Site 1) to 33.8˚C (Site 3) during monsoon, pH from 6.2 (Site 3 during monsoon) to 7.5 (Site 2 during post-monsoon), EC from 94.3µS (Site 1 during post-monsoon season)to 141.5µS (Site 3 during monsoon season), DO content from 6.2mgL^{-1}(Site 3 during Post monsoon) to 7.5mgL^{-1}(Site 2 during pre-monsoon and post-monsoon season) and BOD content from 0.8mgL^{-1}(Site 1 and Site 2) to 1.9mgL^{-1}(Site 3 during post-monsoon season). The results indicate that all the values fall within the permissible limit of water quality laid down by various scientific agencies like B.I.S, U.S.P.H, and W.H.O. Significant increase in temperature, EC and BOD from Site 1 to Site 3 showed effect of hydroelectric power project on the water quality of the river which may be due to the direct discharge of treated water into the river system after power generation, and sewage containing more organic matter.

Keywords: Hydroelectric power project, Physico-chemical parameters, Serlui river, Water quality.

Introduction

Water is one of the vital element for survival of life. Better quality of water is described by its physical, chemical and biological characteristics. Due to increased human population, industrialization, use of fertilizers in agriculture and many man-made activities, majorities of surface water bodies are getting polluted with time scale. Water quality refers to the chemical, physical, biological, and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and/or to any human need or purpose. Almost 70% of the water in India has become polluted due to the discharge of domestic sewage and industrial effluents into natural water bodies, such as rivers, streams as well as lakes[1].

The world faces a great challenge to supply the energy needs of a growing population. Hydropower is one of a number of options for meeting this challenge but the improper management of water systems may cause serious problems in availability and quality of water[2].

Despite the fact that, the Northeastern region harbors colossal water assets, the ongoing efforts to harness this cosmic hydropower potential through a series of dams has posed an unparalleled threat to the water, social and ecological security of the region. Hydropower dams involve the setting up of large infrastructure, which in turn leads deterioration of water quality resulting into nuisance in aquatic environment.So far no systematic study was undertaken to critically assess the water quality of River Serlui flowing through a major district of Kolasib selected in the present work.Therefore, the present study was aimed to analyze the physico-chemical characteristics of river water collected from selected sites using standard methods. The cause-effect analysis was computed by taking a comparative account of information procured.

Materials and Methods

Description of Study area and collection of water sample: The Serlui B Hydroelectric Power Project is located in the Kolasib district of Mizoram, India. The dam is a 51 meters (167 ft) earth-fill embankment dam with a length of 293 meters (961ft) [3]. The dam creates a reservoir catchment area of 53 square kilometers with life storage capacity of 453.59 cubic million and the installed hydrocapacity is 12MW[3]. The catchment area is 397 square kilometers with an annual rainfall of 3028.6mm[3]. A total of three study sites were selected along the river Serlui in vicinity of Hydro Power Project. The description of study sites is as follows.

Site 1: This site is situated at upstream, before Hydro Power Project, and treated as a reference (Control) site.

Site 2: This is diversion inlet site.
Site 3: This is diversion outlet site.

Collection of water samples: For assessing the physico-chemical characteristics, the water samples were selected from selected sites on monthly interval (in triplicate) for one year (March 2015 to February 2016).The findings were computed seasonally i.e., pre-monsoon (March to June), monsoon (July to October) and post-monsoon (November to February) seasons.Wide mouth bottles were used to collect the samples with necessary precautions. The samples were stored in 4˚C for further analysis.

Analytical methods: Analysis of various water quality parameters was carried out for temperature, pH, Electrical Conductivity (EC), Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) using methods as outlined in`Standard methods for examination of water and waste water` as prescribed by APHA[4] and compared with standards given by WHO (2004)[5], BIS (1983)[6] and USPH (1962)[7].

The temperature, pH and conductivity were determined at the place of collection and for analysis of Dissolved Oxygen content, water samples were fixed immediately after collection.

Results and Discussion

The graphical representation for water quality attributes of Serlui river at three different sites during pre-monsoon, monsoon and post-monsoon are presented in Figure 1 to 5, respectively.

Temperature: Water temperature represents one of the most important biophysical characteristics of surface water quality as it is an important factor which affects DO and most of biological and biochemical processes[8-9]. The average temperature ranged from 23.9˚C to 29.4˚C at Site1, 27.4˚C to 33.4˚C at Site 2 and 27.1˚C to 33.8˚C at Site 3. The average temperature was found to be higher during monsoon seasons and lower during post-monsoon. The variation in water temperature depends on season, geographical location, ambient air temperature and chemical reaction in water body[10].

In the present study, it was found that there is a significant increase in the temperature of the water from Site 1 to 3, which maybe due to the release of treated water after power generation directly into the river from the dam. High temperature during monsoon season maybe due to the discharge of organic matters through surface runoff and subsequently microbial decomposition which results into increase in water temperature[11-13].

pH: The pH is an important indicator of water quality as all chemical and biological reactions are governed by pH. The measurement of the pH of water is required to determine the corrosiveness of the water. The present investigation depicts that the average pH ranged from 6.8 to 7.4 at Site 1, 6.5 to 7.5 at Site 2 and 6.2 to 6.6 at Site 3. The pH values were found to be slightly acidic during the monsoon season at all the three sites, this may be attributed to the high rate of decomposition of organic matter which results into the release of humic acid. pH values recorded were within the prescribed limit given by scientific agencies (Table-1).

Electrical Conductivity (EC): Electrical conductivity (EC) is a measure of the capacity of water to conduct an electrical current, and it depends on the concentration of ions and intensity of nutrients. In present investigation, the average EC ranged from 94.3µS to 127.3µS at Site 1, from 95.0µS to 129.0µS at Site 2 and from 114.3µS to 141.5µS at Site 3.

The Site 3 showed higher EC value, which maybe due to the high degree of ionic state. Higher EC during monsoon season and lower during post- monsoon season might be the high concentration of dissolved solids and presence of inorganic material followed by low ionic state[11-15]. EC values recorded were within the prescribed limit given by scientific agencies (Table-1).

Dissolved Oxygen: Dissolved Oxygen (DO) is the concentration of dissolved oxygen in water and is necessary for the support of oxygen-demanding aquatic organisms. DO is an important parameter for water purity. During the present investigation, it was found that the average values of DO ranged from 6.8mgL^{-1} to 7.4 mgL^{-1} at Site 1, from 6.5mgL^{-1} to 7.5 mgL^{-1} at Site 2 and 6.2mgL^{-1} to 6.7 mgL^{-1} at Site 3. The variation in DO at Site 3 maybe due to the consumption of DO in the oxidation of organic matter from the waste discharged at the downstream of the dam indicating a high pollution load. Lower dissolved oxygen content during monsoon could be due to the increased process of microbial decomposition of organic matter[16-18].DO values recorded were within the prescribed limit given by scientific agencies (Table-1).

Biological Oxygen Demand (BOD): Biological Oxygen Demand (BOD) is a chemical procedure for determining the amount of Dissolved Oxygen needed by aerobic biological organisms in water body for decomposition of organic matter. In the present study, BOD content of water ranged from 0.8 to 1.4mgL^{-1} at Site 1, from 0.8 to 1.6 mgL^{-1} at Site 2 and from 1.5 to 1.9 mgL^{-1} at Site 3.

The increase in BOD content at Site 3 maybe due to the discharge of waste water from the dam outlet into the river. The average value of BOD recorded were found to be higher in monsoon, which may be due to the acidification of water by elevated metabolic activities of microorganisms present in the water and a decline in the average value of BOD during post-monsoon could be due to low rate of decomposition of organic matter[16,18]. BOD values recorded were within the prescribed limit given by scientific agencies (Table-1).

Table-1
Water quality standards given by various scientific agencies and comparison of results

Parameters	Standards				Range of water quality characteristics during study period
	USPH	WHO	BIS	ICMR	
Temperature (˚C)	-	-	-	-	23.9˚C to 33.8˚C
pH	6-8.5	6.5-8.5	6.5-8.5	7-8.5	6.2 to 7.5
EC (µS)	300	-	-	-	94.3 µS to 141.5 µS
DO (mgL^{-1})	>4	-	>5	-	6.2 mgL^{-1} to 7.5 mgL^{-1}
BOD (mgL^{-1})	+	-	<3	-	0.8 mgL^{-1} to 1.9 mgL^{-1}

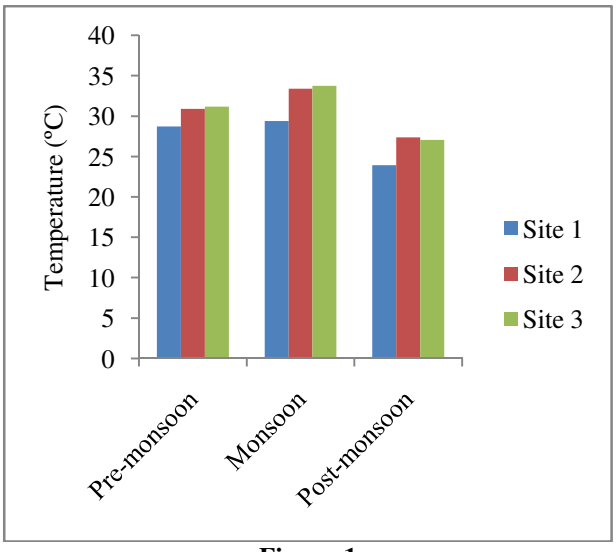

Figure-1
Seasonal variation in temperature of water at selected study sites

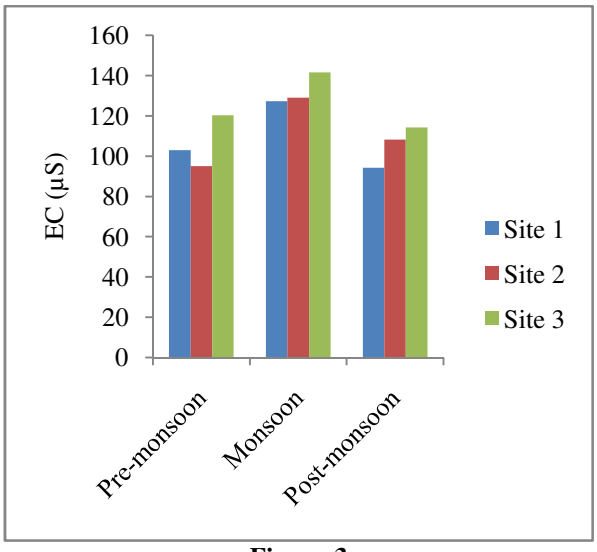

Figure-3
Seasonal variation in EC of water at selected study sites

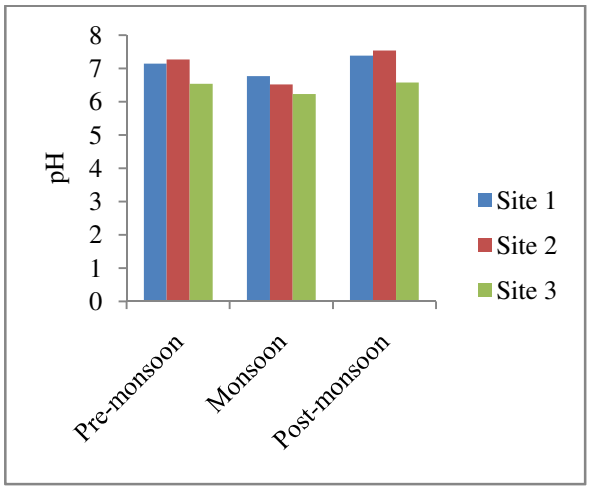

Figure-2
Seasonal variation in pH of water at selected study sites

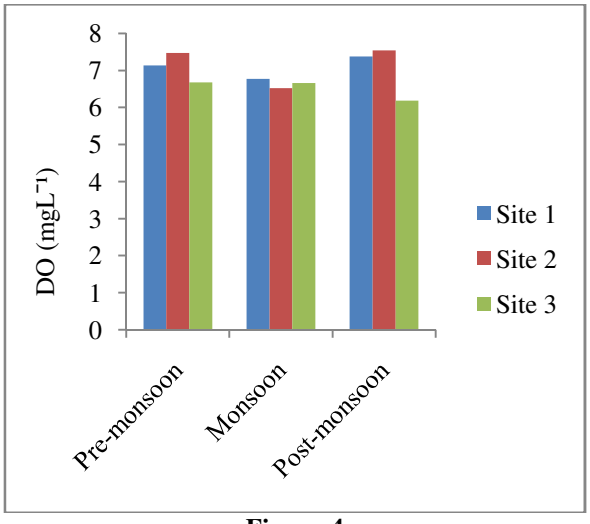

Figure-4
Seasonal variation in DO of water at selected study sites

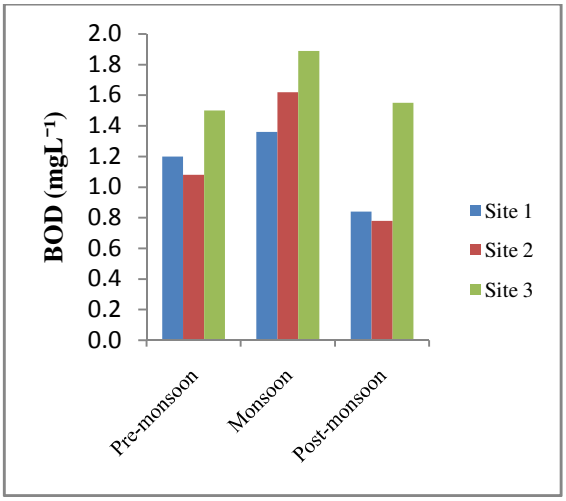

Figure-5
Seasonal variation in BOD of water at selected study sites

Conclusion

As people in surrounding use water of river Serlui for drinking purpose without any treatment, thus, the present study was conducted to assess impact of Hydroelectric Power Project on water quality of Serlui river in Kolasib district of Mizoram, India. The findings reveal that intensity of pollutant was increased from Site I (upstream- control site) to Site 3 (downstream) of river. However, most of parameters showed the values within the prescribed limit in each season given by scientific agencies.

The pH of the water at Site 3(diversion outlet) was found to be slightly acidic and a sudden increase in the values of Temperature, Conductivity and Biological Oxygen Demand from the upstream of the river towards the downstream was observed whereas, lower Dissolved Oxygen content was recorded at the downstream of the river, which maybe due to the discharge of treated water after power generation directly into the river system and sewage containing more organic matter. Even though all the parameters are within the permissible limit of standard, there is an ample scope of appropriate management measure, as long term utilization of such water may lead to adverse effects on human beings as well aquatic life. The findings of present study may be a base line for further studies on maintenance of water quality of river Serlui, through formulating appropriate management strategies.

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