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Assessment of the Chemical Characteristics of River Serlui-A in Aizawl, Mizoram, North East, India

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ABSTRACT

The present study was carried out to assess the chemical characteristics of river Serlui-A in Aizawl, Mizoram, at monthly intervals for a period of two years, i.e. from October 2016 to September 2018. The results are presented on seasonal basis i.e. pre-monsoon (February-May), monsoon (June-September) and post-monsoon (October-January) seasons. For detailed investigation, 4 sampling sites were selected and water samples were collected at monthly interval. The findings on various water quality attributes with value range in parentheses are as- pH (6.1-7.9), dissolved oxygen (5 to 7.9 mgL^{-1}),biological oxygen demand (1.1 to 3.8 mgL^{-1}), chloride (5.2 to 47.5 $CaCO_3$ mgL^{-1}), total alkalinity (25.6 to 186 mgL^{-1}) and total hardness (18 to 181 $CaCO_3$ mgL^{-1}). The findings were compared with the standards given by several scientific agencies for potable water . The pH, DO, chloride, total alkalinity and total hardness were within the prescribed limit, however, BOD was beyond the limit. The data were subjected to correlation coefficient among different variables using SPSS version 16.0 software to check the validity and significance of the result.

Keywords Biological oxygen demand, Chemical characteristics, Serlui-A, Dissolved oxygen, Total hardness.

INTRODUCTION

The hydrosphere consists of the gaseous, liquid and solid water of the earth. The ocean has a volume of around 1.3 billion km^3 and comprises 97.40% of the earth's water. The remaining water-about 36 million km^3 is contained in several freshwater compartments of the hydrosphere. The largest portion of the Earth's freshwater is mainly unavailable for direct use by mankind, because it is bound in ice or occurs as deep groundwater. The amount of freshwater available for human use at any particular time is shallow groundwater and water in lakes, manmade reservoirs, rivers and other streams- about 4.6 million km^3 or 12% of the freshwater in the hydrosphere (Boyd 2015). A water resource (rain, river, sea and ground water) is one of the major components of environmental resources that are under threat either from over exploitation or pollution, exacerbated by human

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activities on the earth's surface (Efe 2002). Water pollution in India has now reached a critical point. A study conducted by the scientists of National Environmental Engineering Research Institute (NEERI), Nagpur revealed that nearly 70% of water in India is polluted. Large number of rivers has been studied regarding their pollution status like Yamuna, Okhla, Ganga, Mahanadi (Dwivedi and Dwivedi 2010). The quality of water generally is defined in terms of its physical, chemical and biological parameters (Ketata Mouna et al. 2011).

MATERIALS AND METHODS

The study area and study site: Mizoram lies between $21^0$56'N – $24^0$31' N latitudes and 92-16' E – $93^0$26´E longitudes and sandwiched between Bangladesh and Myanmer. Its location is of strategic significance geographically and politically. The Tropic of Cancer, (23^03^0'N latitude) cuts across the region in Aizawl district at the southern periphery of Aizawl traversing places like Champhai, Chhawrtui, Darlung and Phuldungsei. This imaginary line divides the region into two almost equal parts. Mizoram has a total geographical area of 21,087 square kilometers (Pachuau 2009). The capital of Mizoram is Aizawl. It is the largest city and is located north of the Tropic of Cancer in the northern part of Mizoram. It is situated on a ridge 1,132 m above sea level, with the Tlawng river valley to its west and the Tuirial river valley to its east.

Serlui-A river is approximately 7-8 kilometers long and it flows from Lungleng village towards Maubawk where it merges with river Tlawng. This river is being used to generate 1 MW Serlui-A hydroelectric power station. This river is a major tributary of the Tlawng river.

For detailed investigation following study sites along river Serlui-A were taken into consideration for water quality analysis.

Site 1 : Was selected at the source in Lungleng village and considered as control/reference site to compare results from other sites selected towards downstream of river. Site 2 : Was selected just before hydroelectric power station. Site 3 : Was selected just after hydroelectric power station. Site 4 : Was selected at the point where Serlui-A river merges with river Tlawng.

Analytical method

The water samples were collected from selected sites on monthly interval (in triplicates) for two years (October 2016-September 2018). Wide mouth bottles were used to collect the samples with necessary precautions. The water samples were analyzed for various chemical characteristics namely, pH, dissolved oxygen, biological oxygen demand, chloride, total alkalinity and total hardness. The methods as outlined in the Standard Methods for Examination of Water and Wastewater (APHA 2005) and Handbooks of methods in environmental studies, water and waste water analysis were followed (Maiti 2001). The analysis for the temperature, pH and EC were determined at the place of collection and for analysis of Dissolved Oxygen content, the water samples were fixed immediately after collection. The saples were then stored in 4^0C for a period of maximum 48 h for further analysis.

Statistical method

All the data obtained were subjected to statistical analysis. To check the significant relationship among all the chemical parameters (significance level 0.05), the correlation coefficient (r) was calculated using the computer software SPSS 16.0. The findings on water quality attributes were expressed as average mean values for two years data (October 2016 to September 2018).

RESULTS AND DISCUSSION

pH

During 2016-17, the water pH ranged from 7.1 at Site 1 in post-monsoon season to 7.9 at Site III in pre-monsoon and Site IV in post-monsoon, pre-monsoon and monsoon season. Subsequently, during 2017-2018 values were between 6.1 (Site 1 in pre-monsoon season) and 7.7 (Site IV in post-monsoon season).

Table 1. Range of river water quality in light of standards given by various scientific agencies .

Parameter	Water quality standards BIS	ICMR	USPH	WHO	Range of water quality characterist-ics during 2016-2018
pH (nano mole L^{-1})	6.5-8.5	7-8.5	6-8.5	6.5-8.5	6.1-7.9
DO (mg L^{-1})	>5	-	>4	-	5-7.9
BOD (mg L^{-1})	<3	-	-	-	0.6-3.8
Chloride (mg L^{-1} $CaCO_3$)	250	200-1000	250	200	5.2-47.5
Total alkalinity (mg L^{-1} $CaCO_3$)	200	120	-	-	25.6-186
Total hardness (mg L^{-1} $CaCO_3$)	-	300	500	-	18-181

Overall findings state range of pH as 6.1 to 7.9 (Table 1). The pH depicts that the water was found to be slightly acidic in pre-monsoon season (Fig. 1). The findings of the present study are in conformity with the works of Suravi et al. (2013). A highly positive and significant correlation was observed between pH and total hardness (r=0.978, p<0.05) (Table 2).

DO

During 2016-17, the DO content of water ranged from 5 mgL^{-1} at Site III in pre-monsoon season to 7.9 mgL^{-1} at Site 1 in post-monsoon. Subsequently, during 2017-2018 values were between 5.9 mgL^{-1}

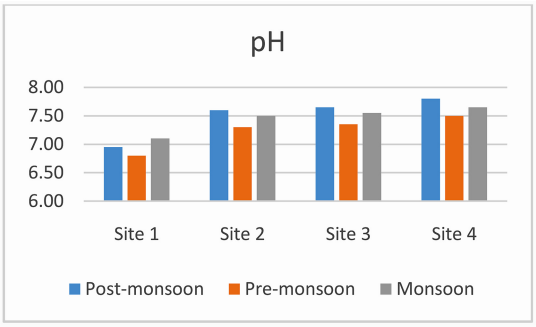

Fig. 1. Seasonal variation in pH values at selected sites.

(Site II in post-monsoon season) and 7.8 mgL^{-1} (Site 1 in monsoon season). Overall findings state range of DO as 5 mgL^{-1} to 7.9 mgL^{-1} (Table 1).The DO content was found to be low in the pre-monsoon (Fig. 2). Similar findings were made by Suravi et al. (2013). Low DO may be due to the increase rate of respiration of biological organisms and organic decomposition. A highly negative and significant correlation was established between DO and BOD (r= -0.989, p<0.05), DO and chloride (r = -0.980, p< 0.05), DO and total alkalinity (r = -0.990, p<0.01) (Table 2).

Biological oxygen demand

During 2016-17, the BOD content of water ranged from 1.6 mgL^{-1} at Site 1 in post-monsoon season to

Table 2. Correlation coefficient (r) between the water quality attributes for two years average data. * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

		Correlations pH	DO	BOD	Chloride	Total alkalinity	Total hardness
pH	Pearson correlation	1	-0.885	0.87	0.909	0.92	0.978*
	Sig. (2-tailed)		0.115	0.13	0.091	0.08	0.022
DO	Pearson correlation	-0.885	1	-0.989*	-0.980*	-0.990**	-0.94
	Sig. (2-tailed)	0.115		0.011	0.02	0.01	0.06
BOD	Pearson correlation	0.87	-0.989*	1	0.941	0.963*	0.906
	Sig. (2-tailed)	0.13	0.011		0.059	0.037	0.094
Chloride	Pearson correlation	0.909	-0.98*	0.941	1	0.997**	0.973*
	Sig. (2-tailed)	0.091	0.02	0.059		0.003	0.027
Total alkalinity	Pearson correlation	0.92	-0.990**	963*	997**	1	0.974*
	Sig. (2-tailed)	0.08	0.91	0.037	0.003		0.026
Total hardness	Pearson correlation	0.978*	-0.94	0.906	0.973*	0.974*	1
	Sig. (2-tailed)	0.022	0.06	0.094	0.027	0.026	

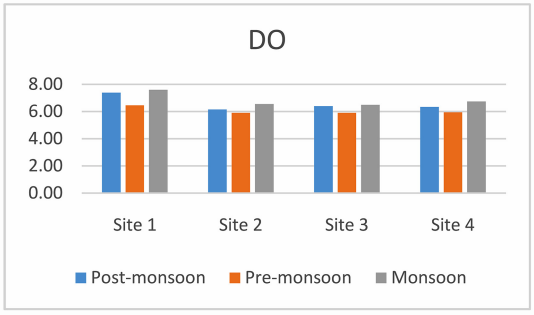

Fig. 2. Seasonal variation in DO values at selected sites.

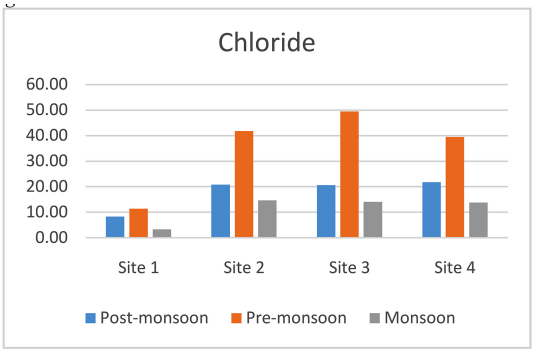

Fig. 4. Seasonal variation in chloride values at selected sites.

3.8 mgL^{-1} at Site II in monsoon season. Subsequently, during 2017-2018 values were between 1.1 mgL^{-1} (Site 1 in post-monsoon and pre-monsoon season) and 2.6 mgL^{-1} (Site II and Site III monsoon season). The BOD content of water ranged from 1.1 mgL^{-1} -3.8 mgL^{-1} (Table 1). The value was observed to be higher in monsoon season due to the metabolic activity of microorganisms leading to acidification of waters (Fig. 3). A similar finding was made by Sunar and Mishra (2016), Lalparmawii and Mishra (2012). A highly positive and significant correlation was observed between BOD and total alkalinity ($r=0.963$, $p<0.05$) and a highly negative and significant correlation was established between BOD and DO ($r= -0.989$, $p<0.05$) (Table 2).

Chloride

During 2016-17, the chloride content of water ranged from 1.3 mgL^{-1} $CaCO_3$ at Site I in monsoon season to 63 mgL^{-1} $CaCO_3$ at Site III in pre-monsoon. Subsequently, during 2017-2018 values were between 5.2 mgL^{-1} $CaCO_5$ (Site I in monsoon season) and 36 mgL^{-1} $CaCO_3$ (Site II, III and IV In pre-monsoon season). Overall findings state range of chloride as 1.3 mgL^{-1} $CaCO_3$ to 63 mgL^{-1} $CaCO_3$ (Table 1). A lower value for chloride content was observed during monsoon season and higher value during pre-monsoon season (Fig. 4). Lower value may be due to increased amount of water while higher value may be attributed to less amount of water as well as the release of domestic sewage. Zafar and Sultana (2008), Singh and Gupta (2010) recorded similar observation. A highly positive and significant correlation was observed between chloride and total alkalinity ($r =997$, $p>0.01$), chloride and total hardness ($r=0.973$, $p>0.05$) and a highly negative and significant correlation was observed between chloride and DO ($r = -0.980$, $p>0.05$) (Table 2).

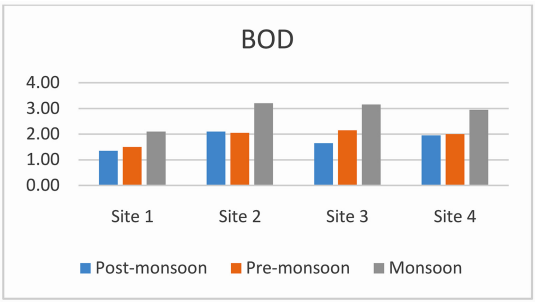

Fig. 3. Seasonal variation in BOD values at selected sites.

Total alkalinity

During 2016-17, the total alkalinity of water ranged from 25.6 mg L^{-1} $CaCO_3$ at Site I in post monsoon season to 200 mgL^{-1} $CaCO_3$ at Site II in monsoon season. Subsequently, during 2017-2018 values were between 54 mgL^{-1} $CaCO_3$ (Site I in pre-monsoon season) and 139 mgL^{-1} $CaCO_3$ (Site III in monsoon season). Overall findings state range of total alkalinity as 25.6 mgL^{-1} $CaCO_3$ to 200 mgL^{-1} $CaCO_3$ (Table 1). Alkalinity is a measure of buffering capacity of the water. It is generally imparted by the salts of carbonates, bicarbonates, phosphate, nitrates borax,

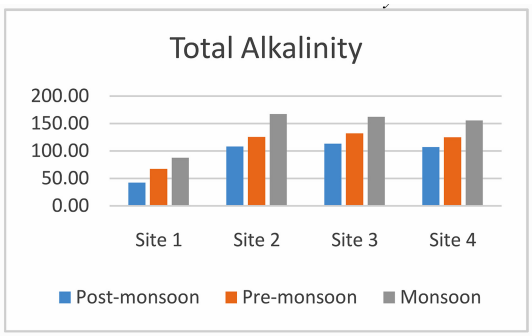

Fig. 5. Seasonal variation in total alkalinity values at selected sites.

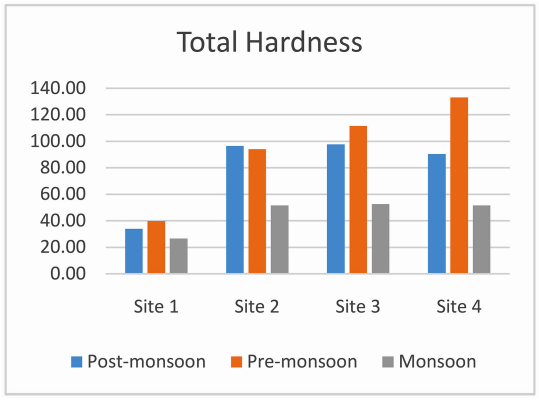

Fig. 6. Seasonal variation in total hardness values at selected sites.

silicates together with the hydroxyl ions in a free states. In the present study the total alkalinity was lowest during monsoon season and highest during the post-monsoon season (Fig. 5). During decomposition of dead plants and living organisms CO is released which results in the addition of the carbonate and bicarbonate, this might be one of the reason for increase in alkalinity value (Verma 2012). AncyMol and Shaji (2016), Sahoo et al. (2016) also observed a similar trend. A highly positive and significant correlation was observed between total alkalinity and BOD ($r=0.963$, $p<0.05$), total alkalinity and chloride ($r = 0.997$, $p<0.01$), total alkalinity and total hardness ($r=0.974$, $p<0.05$) and a highly negative and significant correlation was observed between total alkalinity and DO ($r= -0.990$, $p<0.01$) (Table 2).

Total hardness

During 2016-17, the total hardness of water ranged from 18 mgL^{-1} $CaCO_3$ at Site I in monsoon season to 181 mgL^{-1} $CaCO_3$ at Site IV in pre-monsoon season. Subsequently, during 2017-2018 values were between 28.3 mgL^{-1} $CaCO_3$ (Site I in post-monsoon season) and 86 mgL^{-1} $CaCO_3$ (Site III in pre-monsoon season). Overall findings state range of total hardness as 18 mgL^{-1} $CaCO_3$ to 181 $mgL^{-1}CaCO_3$ (Table 1). Total hardness is due to the presence of calcium and magnesium salt. The total hardness value was found to be highest during pre-monsoon season as compared to post monsoon and monsoon season (Fig. 6). Zafar and Sultana (2008), Singh and Gupta (2010) made similar observations. A highly positive and significant correlation was observed between total hardness and pH ($r=0.978$, $p<0.05$), total hardness and chloride ($r=0.973$, $p<0.05$), total hardness and total alkalinity ($r=0.974$, $p<0.05$) (Table 2).

CONCLUSION

The finding of the present study are compared with the standards for drinking water given by different scientific agencies like BIS (2010), ICMR (1996), USPH (1962),and WHO (2004). It was found that all values except BOD were within the permissible limits given by different agencies. The findings of the present study on the chemical characteristics of water are in conformity with the earlier works. The high BOD content at some sites could be attributed due to discharge of domestic sewage containing waste of organic origin. The water is contaminated mainly by the disposal of wastes in the river, throwing of garbage by people who visit the river for recreational purpose and also sometimes due to the washing of blankets.

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