Physical characteristics of public drinking water in Aizawl city, Mizoram, India

Z. R. Thasangzuala, B. P. Mishra

***Abstract*— The present study deals with the physical properties of 8different sources of public drinking water (3 handpumptubewells, 3 spring fountains, 2 river sources) in Aizawl city, Mizoram, India, for a period of 2 (two) years,i.e. from June, 2012 to May, 2014. From the study it was observed that turbidity ranged from 0.19 NTU - 11.42 NTU; total dissolved solids from 20.2 mg/L- 402 mg/L; electrical conductance from 40.4 µS - 793 µS.The surface spring water showed higher values for TDS and EC, followed by underground water and treated water. On the other hand, turbidity values were normally higher in tubewell water. Statistically there was a positive, direct and significant relationship between total dissolved solids and electrical conductance.**

***Index Terms*— Physical characteristics, Total dissolved solids, Electrical conductance, Turbidity, Water qualitystandards,PHEDepartment.**

I. INTRODUCTION

Water is very essential element for living organisms and amounting to about 80% of total body weight. The alteration in physical attributes of water may lead to adverse effects on productivity of water body and nuisance in the aquatic environment. In a study on seasonal variations inphysico-chemical characteristics in water resources quality in Western Niger Delta region, Nigeria (Efe*et al.,* 2005), the overall implications called for urgent water resources management strategy in the area in order to circumvent the fast deteriorating water resources quality, which may pose associated health risk and environmental hazards. Anthropogenic activities had marked affect on the physico-chemical characteristics of water (Gasim *etal.*, 2007).Multivariate statistical techniques to identify the source of pollution and assessment of surface water quality undertaken by Hossain*et al.*, (2013) showed that surface water quality was highly influenced by ionic groups of salts, soil erosion and agricultural runoff, organic and nutrient pollutions from domestic wastewater, industrial sewage and wastewater treatment plants. A study on seasonal variations in different physico-chemical characteristics of river Yamuna water quality in proposed Lakhwar Hydropower Project influence area (Singh *etal.*, 2008), stated the higher concentration of certain pollutants probably due to road construction near the river; and high population density contributed more towards presence of fecal coliform. Johnson *et.al.*, (2010) studied degradation of the quality of water during monsoon and the related out-break of water-borne diseases, and observed that during the monsoon, the water quality degraded due to the addition of physical, chemical and microbial contaminants.Lalchhingpuii (2011) studied status of water quality of Tlawng river in the vicinity of Aizawl city, Mizoram, and reported that Tlawng river near upstream was least polluted, and intensity of pollutants was increased due course of travel of river, and more pollution stress was observed at sites after meeting point with tributaries; and the treated water supplied to Aizawl city by Public Health Engineering Department, Government of Mizoram (by drawing raw water from Tlawng river near the study sites) also contained traces of pollutants but was cleaner than Tlawng river water. Lalparmawii (2012) carried out a study on analysis of water quality and biomonitoring of Tuirial river in vicinity of the Hydel Project in Mizoram and found that total dissolved solids was higher during rainy and autumn seasons ascribing the excess surface runoff containing organic and inorganic impurities; and she also observed that electrical conductance values increased during winter season which might be due to low flow rate of water contributing to the subsequent increase in dissolved solids and low values of electrical conductance during rainy season might be due to dilution of river water through runoff. Lalzahawmi Chenkual (2012) studiedphysico-chemical properties of Chite stream, Aizawl, Mizoram, and reported that electrical conductance ranging from 377 µS – 418 µS; total dissolved solids from 4.3 mg/L – 10 mg/L.A study on the groundwater quality in and around Tanning Industry, Tiruchirappali, India (Raja *et al.*, 2009) reported that the groundwater not suitable for drinking purpose because of leaching of pollutants. Mishra *et al.*, (2013) carried out a study on assessment of water quality index of the municipal filtered water in Shivpuri town, Madhya Pradesh, India, and opined that the filtered water needs proper treatment before consumption and also needed to be protected from the perils of contamination.

Mizoramis a hilly area and receives monsoon rain from May to September and the average rainfall density is 255 cm per year. The main sources of potable water are river water, groundwater and spring water. Most of the water consumed in Mizoram is untreated raw water obtained from one or more sources mentioned above. Treated water is available for small section of the society only, and that also only in the state capital Aizawl and a few other towns.

Therefore, in view of the above, the present study was carried out for 2 successive years from June, 2012 to May, 2014 to assess the physical quality of potable water in Aizawl city.

II. STUDY AREA AND STUDY SITES

Aizawl is the capital of the Mizoram state, and coversan area of 3576 sq.km (23.73^{o}E latitude and 92.72^{o}N longitude).

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The city is only about 100 years old and it is situated on the top of a ridge running in the north-south direction. The average altitude of Aizawl city is 1132 meter from mean sea level and the population of the city is 4,04,054 (male – 2,01,072; female – 2,02,982) by 2011 Census. It is the political, administration, educational, commercial, cultural and social centre of the State.

A total of 8 study sites were selected for detailed investigation. The study sites comprised of 3 handpump tubewells one each from Zuangtui, Ramhlun South, Bethlehem veng areas; 3 tuikhurs/natural spring sources each from Zemabawk, Hunthar, Tlangmuan Damveng areas;2 treated water supply sources from both the Greater Aizawl Water Supply Pumping Scheme Phase - I and Phase - II which drew raw water from river Tlawng, and then after giving conventional treatment viz. aeration, coagulant aided sedimentation, filtration, disinfection by chlorination, thus delivered to a common reservoir at Tuikhuahtlang, Aizawl for public supply through piped water distribution network.The detailed account of study sites is given in Table 1.

Table 1- Detailed account of study sites.

Sl No	Site symbol	Type of Water Source	Location	Major Source of Pollution
1	T1	Spring source	Zemabawk	Sewage and detergents
2	T2	Spring source	Hunthar	Sewage, detergents, dust from nearby road traffic
3	T3	Spring source	Tlangnuam	Detergents, dust from nearby road traffic
4	H1	Hand pump tubewell	Zuangtui	Sewage
5	H2	Hand pump tubewell	Ramhlun	Sewage
6	H3	Hand pump tubewell	Bethlehem	Sewage
7	P1	River water after treatment	Tuikhuahtlang	Municipal, domestic, agricultural and animal wastes
8	P2	River water after treatment	Tuikhuahtlang	Municipal, domestic, agricultural and animal wastes

III. MATERIALS AND METHOD

Water samples were collected at monthly intervalin triplicates from each sampling sitefor a period of two years (i.e. from June, 2012 to May, 2014) for analysis of physical characteristics of water namely, turbidity, total dissolved solids and electrical conductance using EUTECH instruments of State Referral Institute, Public Health Engineering Department, Government of Mizoram. The methods as prescribed in the standard methods for examination of water and wastewater (APHA, 2005) were also referred.

IV. RESULTS AND DISCUSSION

1) Total Dissolved Solids

Total amount of dissolved solids in water consist mainly of inorganic salts, small amount of organic matter, and dissolved gases. During the study, it was found that surface spring sources contain higher TDS, followed by underground water and treated water.The minimum and maximum TDS values were 20.2 mg/L from site P1 during July, 2012 and 402 mg/L during May, 2014 at site T1, respectively (Fig. 1). The site having most consistent TDS was site H1 with minimum standard deviation of TDS as 4.90 in mg/L; while the site giving most varying TDS concentration was site T1 showing maximum standard deviation of TDS as 44.34 in mg/L.

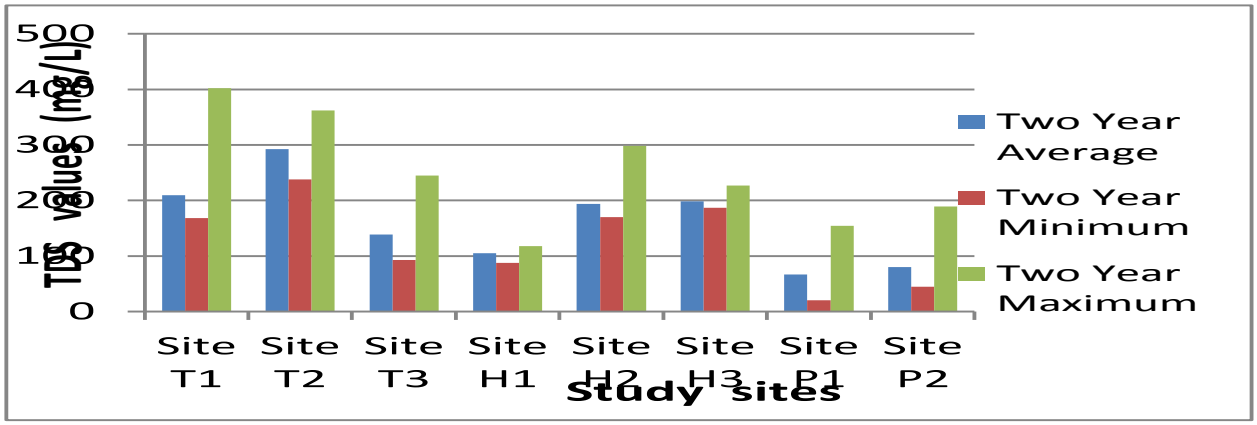

Figure 1 :Mean, minimum and maximum TDS values for two years

As shown in Figure 2, seasonal TDS values were found to be higher in pre-monsoon season, followed by winter, monsoon and post monsoon seasons. The higher TDS values during pre-monsoon and winter may be due to minimal water availability in the sources, leading to high concentration of inorganic salts andorganic matters,on the contrary more runoff during monsoon and post monsoon contributed to less concentration of dissolved solids causing low TDS, due to dilution of water.The results of the present investigation are in conformity with the work of Patka *et al.*, (1997), Tiwari (2005), Mishra (2009), Singh *et al.*, (2010), Lalchhingpuii (2011).

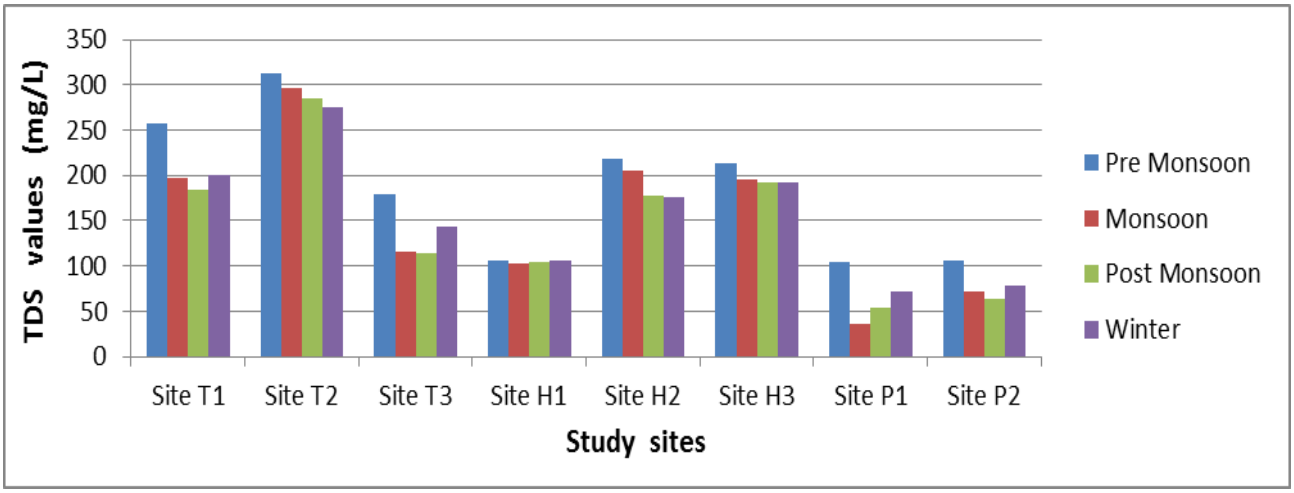

Figure 2 :Seasonal variation in TDS values for two years average data

2) Electrical Conductance

Electrical conductance is a measure of the capacity of water to conduct an electrical current, and is a function of the types and quantities of dissolved substances in water. The findings revealed that treated water exhibited minimum EC while surface spring sources were having higher EC values. The minimum and maximum EC values obtained were 40.4 µS in July, 2012 at site P1 and 793 µS in may, 2014 at site T1, respectively (Fig. 3).The minimum standard deviation of EC observed was 10.54 µS belonging to site H1 which showed that this particular source was having most consistent EC; while the maximum standard deviation of EC was 90.17 µS at site T3 showing that the EC of this source was exhibiting most varying performance.

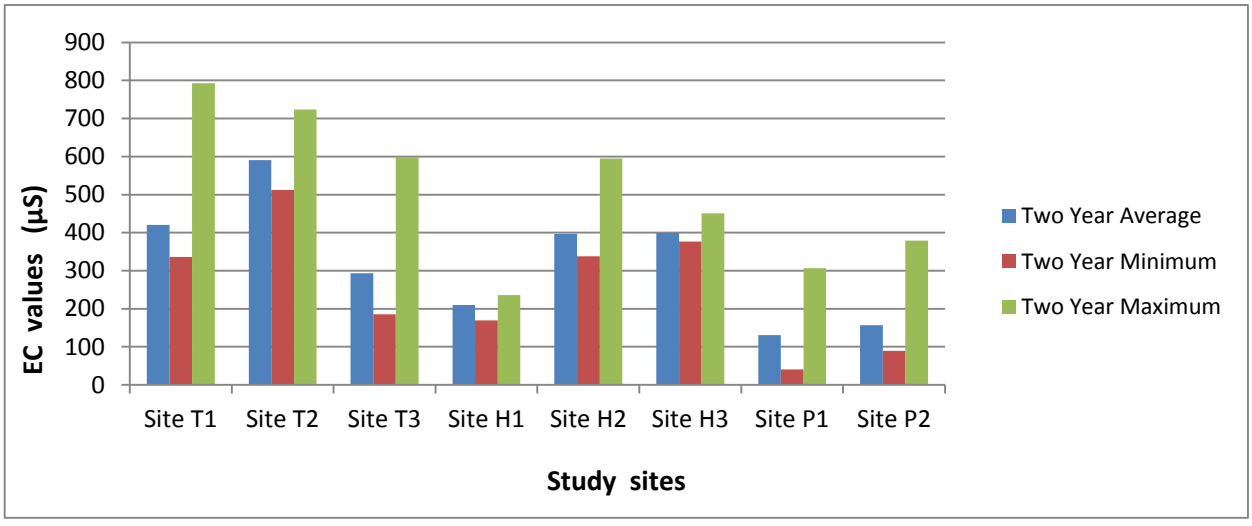

Figure 3 :Mean, minimum and maximum EC values for 2 years

The seasonal EC values were found to be higher in pre-monsoon season followed by winter and becoming least in monsoon and postmonsoon seasons. Decrease in water availability in the sources during pre-monsoon and winter seasons causing high concentration of ions dissociated from salts, bases and acids seemed to result in high EC, while low values of EC in monsoon and post monsoon may be due to high water level (Fig. 4). The findings of present study are in conformity with the work of Shukla*et al*., (1992), Deshmuk*et al.*, (2004), Mishra (2009), Lalparmawii (2012).

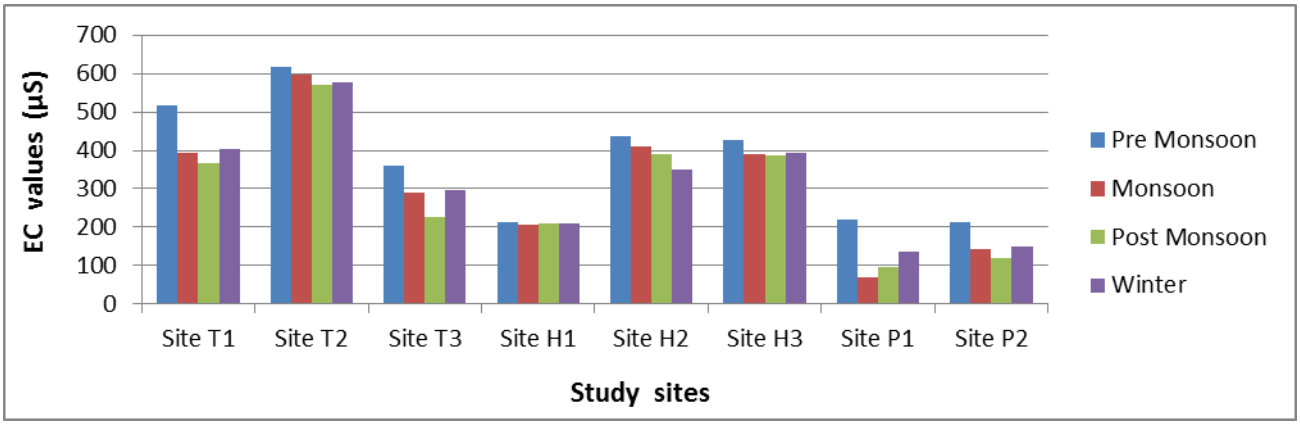

Figure 4 :Seasonal variation in EC values for two years average data

3) Turbidity

Turbidity of water depends on concentration of suspended matter such as clay, silt or some other finely divided organic materials present in water. The results on turbidity in water given in Figure 5 showed that the minimum and maximum turbidity were 0.19 NTU during August, 2012 at site H1 and 11.42 NTU during May, 2014 at site H2, respectively (Fig. 5). The site with minimum standard deviation of turbidity was H1 with 0.38 NTU which showed that this particular source was having most consistent turbidity; while the maximum standard deviation of turbidities was 3.1 NTU at site H2 showing that the turbidities of this source was exhibiting most varying performance.

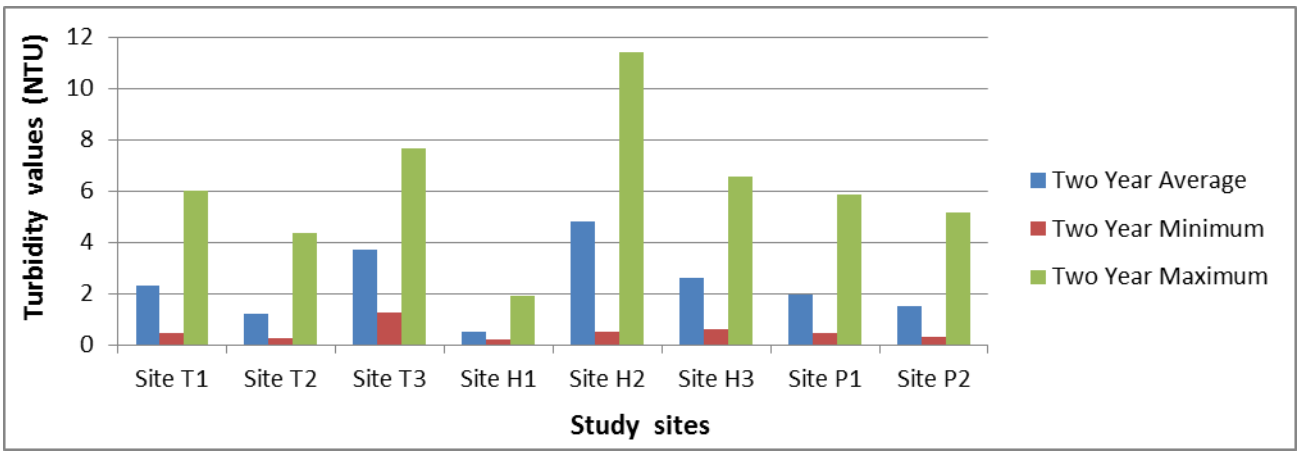

Figure 5 : Mean, minimum and maximum Turbidity values for two years

As seen in Figure 6, the seasonal variation in turbidity was observed higher during monsoon and post monsoon seasons and low values were noticed during pre-monsoon and winter seasons, except for site T3 having highest turbidities during pre monsoon as water was low. During winter season, it was noticed that the yield of site H2 was so less that people did not use the handpump tube well and because of this the water was highly turbid during this period. High turbidity during monsoon and post monsoon period may be due to increased sediment load in the river sources as well as due to rise of groundwater level, resulting into higher seepage velocity of groundwater entering into the spring fountains and tubewells which caused excessive suspended solid load, and vice versa during pre-monsoon and winter seasons.

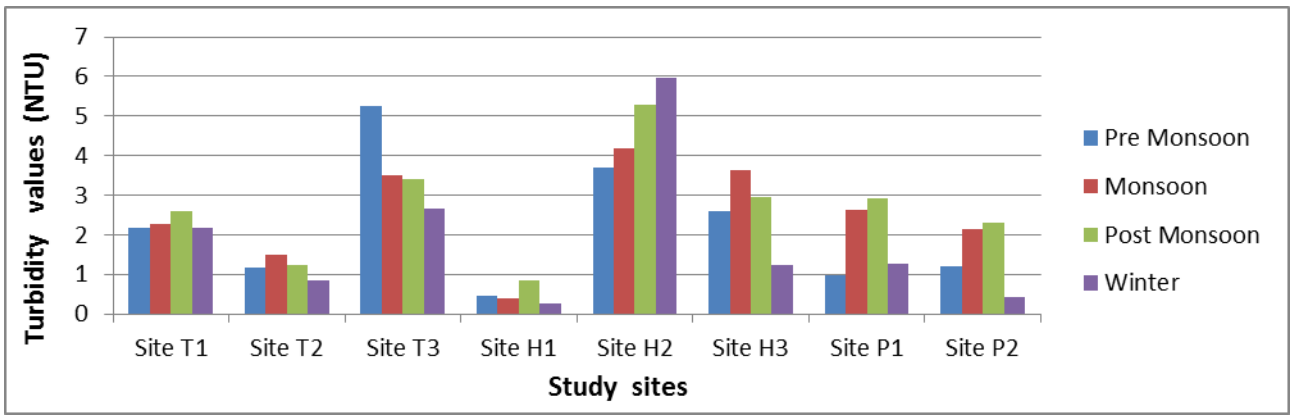

Figure 6 :Seasonal variation in Turbidity values for two years average data

V. CONCLUSIONS

The results obtained from the present study are compared with the standards for drinking water given by various scientific agencies like WHO Standard (2008),USPH (1962), ICMR (1996) and BIS (2003). It is found thatthe maximum electrical conductance values of all sites, excluding site H1, were above maximum permissible limits; and the minimum electrical conductance of site T1, T2, H2, H3 for two consecutive years were still above permissible limits. High electrical conductance may be because of pollution of the water sources from sewage and detergents to which they are freely exposed. Regarding total dissolved solids, the results obtained from all sites were well within permissible limits.In case of turbidity, two years average values for all sites were within permissible limits while maximum turbidity of only site H2 exceeded the limit during May, 2014.It is recommended that the water be treated properly before supply for drinking purpose.

The interrelationship between turbidity and total dissolved solids, turbidity and electrical conductance as well as total dissolved solids and electrical conductance are calculated to determine the relationship between the physical characteristics studied so far. On the other hand, strong interdependency between total dissolved solids and electrical conductance was established which shows that the two parameters are directly proportional.

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