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Short Note

Assessment of Water Pollution through Its Electrical Conductivity and pH Measurement

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Abstract: The studies related to water pollution assessment has rarely been done for Mizoram, the remotest north-eastern state of India. In this hilly state, only 60% people of the state have the access to safe drinking water, in spite of high annual rainfall. The main sources of drinking water for the people in Mizoram are through streams, tap water, rain water and river water. In the present investigation, an attempt has been made to assess the pollution of water obtained from different sources for thirty samples. The electrical conductivity and pH values of the collected samples have been measured at room temperature and analyzed. It has been found that the amount of pollution is highest in the stream water which is located in the vicinity of the drainage and garbage disposal point, while the fresh rain water has been found to be more polluted than stored rain water and the quality of tap water is even better than stored rain water. The measured pH values of various water samples also provide information about the acidic or basic character of water samples.

Key words: Water pollution, electrical conductivity, pH value.

Introduction

Pollution is defined as an unfavourable alteration of the environment from the effects of changes in energy patterns, radiation level, physical or chemical constitution or the abundance of organism. Pollutants are generated by the natural sources as well as by human activity. Some pollutants are natural while others are largely human in origin. Environmental pollutants can affect men, animals, plants or materials causing injury to health or reduction in the growth of plants. Their effect may be local or global (Khopkar, 2005; Meenakshi, 2006).

The water pollution may be defined as the contamination from a foreign substance either from natural or from human activities that cause harmful effects on all the living organisms, including plants, animals and human beings. Out of the number of synthesized organic chemicals (approx. two million), one third of the total production of these find their way into the environment. Many substances are altered readily to the extent that they lose their original structure entity, but the metabolites so formed are either non-degradable or slowly degradable. As an example, the so-called bio-degradable detergents yield refractory degradation intermediates that may persist much longer than the parent compound. Some of the more refractory substances (some hydrocarbons and chlorinated hydrocarbons) detected in the water may also typically occur in ground water and drinking water (Werner et al., 1981; Wilderer, 2007; Tiwari, 2007; Tiwari, 2004).

In the context of state of Mizoram, which receives huge rainfall of about 2500 mm annually, only 60% of the people have access to drinking water. Although the contribution of industrial waste to water pollution is the lowest due to absence of any big industry in the state, but the various sources of pollutants that affect the drinking water are through drainage, garbage, landslides and agricultural run-off. Harvested rain water also gets polluted due to air pollutants because of increased number of vehicles in the capital which contribute to the smoke in the air in this hilly state. During the month of Feb.-March the amount of smoke reaches to the alarming level due to traditional agricultural practice of Jhoom Burning. Another cause of water pollution is that most of the villages in Mizoram are fitted with antiquated treatment plants or septic tanks. Due to the presence of sludge or sediments in the sewage water, they reduce the sunlight penetration when mixed with fresh water affecting aquatic life as well (Subramanian, 2005; Subramanian, 2004; Silva et al., 2004; Schwarbe, 2002).

According to W.H.O. stipulation, the quantum of world's water supply is: ocean water 97.3%, ice cap glaciers 2.1%, ground water 0.3%, fresh surface water 0.009%, fresh saline water 0.008%, surface stream 0.001%, sub-surface soil 0.005%, atmosphere 0.001%. Water has excellent characteristics such as good solvent properties, high dielectric constant and surface tension. It has transparent appearance, maximum density at 4 degree Celsius, high heat of evaporation with higher heat of fusion of ice and higher heat capacity (Meenakshi, 2006).

Acidity/Alkalinity (pH Value)

pH is a measure of the concentration of free hydrogen ions in solution. It is expressed on a logarithmic scale (1-14). Values at the low (1-7) end of the pH scale represent extreme to low acidity, while values at the high (7-14) end of the pH scale are a measure of low to extreme alkalinity; 7 in the middle of the scale indicates a neutral solution. If pH paper or meter is not working properly, we should try it by adding some salt to our sample in order to get a better result. The same rule applies for the pH measurement of rainfall or snowfall for atmosphere measurements.

Electrical Conductivity or Salinity

Salinity describes the salt concentration in water. It is usually measured as electrical conductivity of water in micro siemens per centimetre (μS/cm, sometimes referred to as EC units). Electrical conductivity is an appropriate indicator of salinity, as it is proportional to the concentration of total dissolved salts and is easily measured in the field or by later laboratory analysis. Salinity is also sometimes measured directly (as is the case of Western Australia) as total dissolved solids (Soil Water Monitoring, 2005; Ng et al., 2006; Juang et al., 2007; Appendix, 2005). In other words, the conductance is the measure of concentration of mineral constituents present in water. The conductance is the reciprocal of resistance, which is measured usually between two electrodes kept at one centimetre apart with an area of cross section of 1 sq. cm. The value of conductance depends upon the presence of the total concentration of ions. It also checks the quality of distilled water. The average value of the conductance should be less than 2 μohms for distilled water.

The conductivity is the numerical index of ability of an aqueous solution to carry an electric current. Such ability of carrying an electric current by the aqueous solution depends upon the presence of ions in the sample of water as well as on their total concentration, mobility, valence and temperature. The values that are used to assess the degree of mineralization, variation in dissolved mineral levels or estimate total dissolved solids. Since the conductivity depends upon temperature, the temperature must be kept fixed. KCl is used as the standard during such measurements.

Various methods have been adopted to assess the pollution of water (Soil Water Monitoring, 2005; Sayer, 2005). Present study is an attempt to show that electrical conductivity values of water samples indicate the extent of pollution in them and the measurement of electrical conductivity values may be explored as a reliable, faster and useful method for the quick assessment of water pollution (Khopkar, 2005; Meenakshi, 2006; Subramanian, 2005; Tiwari, 2007).

Experimental

The water samples were collected from different locations in the Southern part of Aizawl, the capital city of Mizoram in the month of June 2007. The water samples were from various sources such as rain, tap, and streams. While collecting the samples, necessary precautions were taken into account in order to get them in natural form. The containers used were well cleaned and dried. All measurements were done at room temperature (25°C). The measurements of Electrical Conductivity and pH were done by using the Equiptronics make instruments; Auto Temperature Conductivity meter (cell constant=1.01) and Auto Temperature pH meter (model EQ-611) respectively. Before taking the observations, the EC electrode was properly washed with dilute HCl and the reading was set to 1, while the pH meter was set to the values 4 and 7 appropriately before taking the observations. These instruments were borrowed from the Department of Chemistry, Mizoram University. The recoded values of various water samples were analyzed and conclusions were drawn.

Results and Discussion

Table 1 gives electrical conductivity and pH values for 30 water samples collected from various places in the southern part of Aizawl, the capital city of Mizoram.

Table 1: Electrical conductivity and pH values in different water samples

Sr. No.	*Sample number*	*Nature of sample*	*Electrical conductivity (in μ mohs)*	*pH value*
1	01	Stream surface water	598.0	6.23
2	02	Stream water below 10 cm. of surface	600.0	6.36
3	03	Stream water	142.6	7.35
4	04	Stored rain-water	183.0	6.77
5	05	Fresh rain-water	905.0	6.98
6	06	Tap water	219.0	6.76
7	07	Stream water	380.0	7.70
8	08	Stream water	360.0	6.36
9	09	Stream water	630.0	5.84
10	10	Stream water	120.0	6.74
11	11	Stream water	670.0	5.79
12	12	Stream water	870.0	5.49
13	13	Stream water	720.0	5.66
14	14	Stream water	860.0	5.47
15	15	Stream water	340.0	5.38
16	16	Stream water	250.0	6.51
17	17	Stream water	220.0	7.37
18	18	Stream water	1110.0	5.03
19	19	Stream water	830.0	5.63
20	20	Stream water	820.0	5.55
21	21	Stream water	110.0	6.78
22	22	Stream water	460.0	6.16
23	23	Stream water	150.0	6.96
24	24	Stream water	130.0	6.74
25	25	Stream water	350.0	6.35
26	26	Stream water	450.0	6.37
27	27	Stream water	230.0	6.76
28	28	Stream water	400.0	6.46
29	29	Stream water	230.0	6.57
30	30	Stream water	90.0	6.81

Figure 1 shows that the water sample number 18 possesses highest peak, which indicates that the sample is containing large concentration of salt. The electrical conductivity is an appropriate indicator of salinity because the EC is proportional to the concentration of total dissolved solids (TDS). This means that sample contains large amount of ions due to which its EC value is the highest amongst all the samples. This may be due to the presence of big drainage and garbage disposal point nearby this stream, which contributes largely for its increased level of pollution.

Figure 1 also shows that the sample no. 30 collected from stream water possesses the lowest value of electrical conductivity. This indicates that the sample contains smallest amount of salt amongst all the thirty samples. Thus we can say that this water sample is least polluted. It is important to mention that this water source is situated in a neat and clean place with no drainage and garbage disposal point nearby.

In Figure 1, a sharp rise in the curve between the samples 4 and 5, the stored rain water and the fresh rain water respectively, indicates that EC value for the sample 5 is very large as compared to sample 4, although both are the samples of rain water. This huge gap in the EC value may be due to the presence of air pollutants dissolved in the fresh rain water sample, unlike in the stored rain water. The later may be due to precipitation of most of the ionic impurities during storage.

Figure 1 also shows that for the samples 9, 11, 12, 13, 14, 19 and 20, the EC values are more or less similar, which indicates the presence of high salt concentration or highly saline water. The reason for this may be due to presence of drainage in the vicinity of these water sources. The samples 12, 14, 19 and 20 indicate higher pollution level as compared to the samples 9, 11 and 13. This may be due to the presence of polluting agencies through which rain water passes to reach the water source.

In Figure 1, the samples 1 and 2 show straight line curve parallel to X-axis. This is because both the samples have been collected from the same source but the sample 2 has been collected into 10 cm deeper from the surface and the EC value for this sample is greater by two units only. However this source of water is also having drainage very close to it, which may be the main cause of high value of EC.

Figure 1 also shows that the sample no. 6 collected from the tap seems to be more polluted than many other samples collected from streams. However this may also be due to presence of certain cleaning agents utilized for the purification of water by the supply department.

Figure 1 depicts that the samples 3 and 10 show smaller peaks as compared to that for the samples 7, 8, 15, 16 and 17. This indicates that more ionic impurities are

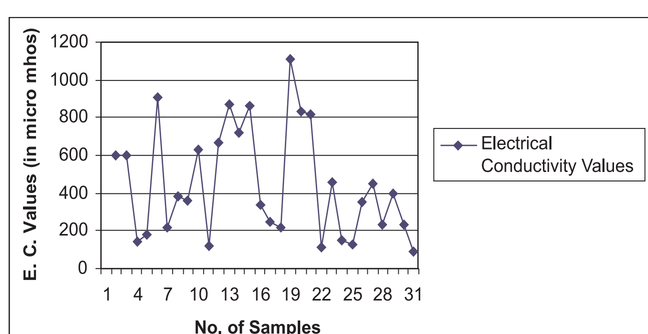

Figure 1: Variation of Electrical Conductivity values for various samples of water.

present in the water sources from which the samples 7, 8, 15, 16 and 17 are collected, while the ionic content and hence the EC value is less for the water sources from which the samples 3 and 10 are collected, indicating that the extent of pollution in case of samples 3 and 7 are less than that for the remaining samples. The reason for high pollution is the receipt of pollutants from drainage in the vicinity and agricultural run-off in to the water sources.

Figure 1 also describes that the samples 22, 25, 26, 27, 28 and 29 show larger peaks as compared to those in case of the samples 21, 23 and 24. This indicates that the former samples possess high ionic content as compared to the latter samples indicating towards the extent of pollution. The high ionic content in a large number of water sources may be due to inadequate blocking facilities in the vicinity of sources for garbage, drain substances and other unwanted things from entering into it.

Figure 2 shows the variation of pH values for various water samples. The highest peak refers to the sample 7, which indicates that water is alkaline, but to a lower extent. This may be due to presence of pollutants in the water. It also gives interesting information for the sample 18; it indicates minima of Figure 1 and maxima of the Figure 2. Thus the sample 18 possesses the lowest value of pH and the highest value of EC amongst all the 30 samples. This shows that water source is extremely acidic with large amount of ionic impurities.

Figure 2 also depicts that for the samples 1, 2, 3, 6, 8, 10, 16 and 21 to 30, the variations in the curve is more or less very small and the nature of this group of samples possess low acidity. The nature of the sample 30, however, is very close to the neutral type of water. The samples 9, 11 to 15, 19 and 20 show similar character and are extremely acidic. The water samples 4 and 5, collected from fresh rain water and the stored rain water do not show any remarkable difference in their pH values unlike their EC values.

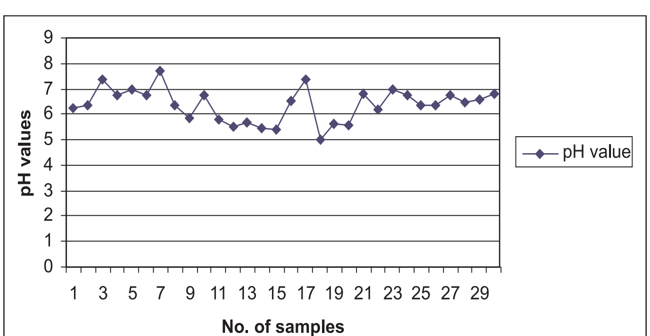

Figure 2: Variations in pH values for various samples of water.

Conclusions

From the observation results and discussions the following conclusions were drawn:

(a) The EC values for the samples collected from the sources having drainage and garbage point in its vicinity are very high indicating the presence of ionic contents in the form of pollution, while EC values are very low for the samples collected from the sources with clean surroundings. Also the EC value for the fresh rain water has been found to be much larger as compared to that of stored rain water indicating the presence of large dissolved ionic contents in the fresh rain water. Thus the Electrical Conductivity values are the indicators of the extent of pollution in various samples and hence may be explored as a reliable, faster and useful method for the assessment of water pollution.

(b) Most of the samples are found to show extreme to low acidic nature. Few samples are found to show low alkaline nature. Thus pH values are also helpful in assessing the water pollution.

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