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Rainwater Quality Analysis in Selected Areas of Eastern and Northeastern India

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***Abstract*—Rainwater is an important source of fresh water especially for those who live in rural areas, where water use is limited due to scarcity or where surface and underground water quality is poor. The growing trend of industrialization has marked impact on the atmospheric chemistry around the globe. Such impacts are also predicted for developing countries like India. Rainwater quality analysis is, therefore, carried out to understand the problems of rainwater contamination with various pollutants. In the present study rainwater quality has been monitored at six different sites in Eastern and Northeastern India (i.e. Irongmara, Kolkata, Kharagpur, Dolaigaon, Bongaigaon, BGR Township) with respect to their physico-chemical parameters. The samples were collected using PVC bottles and the parameters measured were pH, electrical conductivity (EC) and nitrate. The mean pH value of the rainwater obtained was 5.91±0.49 during the sampling period. The mean conductivity value of the rainwater during the study period was 24.25±9.35. The values of pH in rainwater samples were relatively within the World Health Organization (WHO) standard for drinking water. The study revealed that the precipitation tends to be slightly acidic in nature with a mean pH value of 5.91.It is also observed that rainwater contamination may not be restricted to industrial areas alone but vehicular emission may also contribute significantly in certain areas.**

***Keywords*— rainwater quality, physico-chemical parameters, industrial areas, Eastern and Northeastern India.**

I. Introduction

Water is the elixir of life. Mankind relies on a small percentage of crucial water resources available in the seas, rivers, springs and lakes. Water is one of the most valuable resources that is widely distributed all over the world and is available to mankind for sustenance and survival. Due to rapid industrialization and urbanization the entire world including India is presently suffering from shortage of drinking water. In this framework, the analysis of alternative water resources, such as rainwater, is becoming increasingly popular as a sustainable source of water with a reduced impact on the environment. Rainwater is the purest form of water until it is contaminated by the atmospheric pollution. The composition of rainwater varies from site to site and region to region due to influence of local sources. A good knowledge of the chemical qualities of rainwater through regular physico-chemical analysis is necessary so that rainwater can be used as an alternative source of water in future. In order to cope with the water scarcity rainwater quality analysis is needed in order to use rainwater as an alternative water supply for human consumption. Hence this study intends to examine the quality of rainwater

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from some selected industrialized and rural areas of Eastern and Northeastern India.

II. Materials and Methods

A. Location and Description Of Sampling Sites

India is geographically located at 28°36.8′ N and 77°12.5′ E in the northern hemisphere of the globe. Rainwater samples were collected from six sites. Four sites were from different parts of Assam and two from West Bengal. Four sites of Assam were Irongmara, Dolaigaon, Bongaigaon and Bongaigaon Refinery Township (BGR Township) and two sites of West Bengal were Kolkata and Kharagpur.

B. Sample Collection and Analysis

Samples of rainwater were collected from six different sites which include Kolkata, Kharagpur, Bongaigaon, Dolaigaon, BGR Township and Irongmara. Care was taken to ensure that samples were representative of water to be examined and that no accidental contamination occurs during sampling. Samples were collected in clean plastic containers by placing the container on a raised platform in an open environment in the ground or on the roof of a building in order to ensure that the water has no contact with any object before getting into the container. Sample collection equipment used were washed with 10% HCL and then thoroughly rinsed with distilled water prior to the sample collection. The collectors were deployed just before the onset of rainfall and were withdrawn immediately after they were filled up or when the rain ceased. Immediately after collection the samples were filtered using Whatman filter papers. This portion was used for pH, EC and other chemical analysis. pH and electrical conductivity (EC) were measured immediately on arrival of the samples in the laboratory. pH measurements were performed using calibrated pH meter (ESICO Model 1013), while conductivity was measured with a Conductivity Meter (ESICO Model 1601). The nitrate estimation was done with the help of UV/VIS Spectrophotometer Model 1371.The pH meter and the conductivity meter were calibrated before and after each measurement. Statistical analysis was done using SPSS 20.

III. Results and Discussion

The mean pH of rainwater varied between 5.35 and 6.77 (Fig. 1) the values being the highest at Kolkata (6.77) and lowest at Dolaigaon (5.35). The average pH of rainwater obtained is found to be slightly acidic value 5.91±0.49 during the sampling period. The analytical results show that pH of rainwater ranged between 5.35 to 6.77 indicating acidic to alkaline nature of rainwater as compared to the reference level of 5.6 (Charlson and Rodhe, 1982). The pH range is comparable with that reported in earlier studies for Mumbai (Naik et al. 2002). Thus, the alkaline pH of the samples is not because of the lack of acidification, but due to the neutralization caused by different cations. The higher pH of rainwater at Kolkata may be attributed to heavy vehicular traffic in the metro cities. The higher pH at Bongaigaon, Dolaigaon, BGR Township, Kolkata and Kharagpur also signifies the anthropogenic

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contribution from fossil fuel burning, industrial and vehicular emission at these places. The study area fall under residential area and has narrow roads on which vehicular traffic activity takes place. In India, the reported pH values of rainwater varies from 6 to 7.5, which is higher as compared to reference pH of rainwater (5.6) (Safai et al. 2004; Ali et al. 2004; Mouli et al. 2005; Kulshrestha et al. 2005). Table-1 compared the pH of rainwater of the sampling sites to some other selected Indian cities. The pH of the present study areas is lower than the Indian average (6.5) and the other cities like Agra, Goa, Sinhagad,, Pune, Ahmedabad, Lucknow, Hyderabad and Bhubaneshwar except Kolkata and is higher than the reported pH of Bangalore, Korba, Kalyan and Chembur The higher pH of rainwater at Kolkata, Kharagpur, Delhi, Agra and other parts of India are due to high loading of alkaline rich atmospheric suspended particulate. From Fig.3 it is seen that during the sampling period 2011-2012 pH value of individual rainfall event is found to be highest at Kolkata and lowest at Dolaigaon in case of both 2011 and 2012. The mean conductivity value of the rainwater during the study period was 26.96±12.19. Fig. 2 shows that conductivity of direct collection rainwater samples is observed to be highest at Kolkata and it is found to be least at Kharagpur. This is likely to be due to the entry of more cations and anions into the atmosphere of industrially developed areas like Kolkata. It has been observed from Fig.4 that during the sampling period 2011 and 2012 highest conductivity value is found at Kolkata whereas in both 2011 and 2012 conductivity value is found to be lowest at Kharagpur. Table- 2 indicates that nitrate concentration in rainwater (direct collection) is found to be highest at Kharagpur (1.65 mg l^{-1}) and lowest at Bongaigaon (0.77 mg l^{-1}).

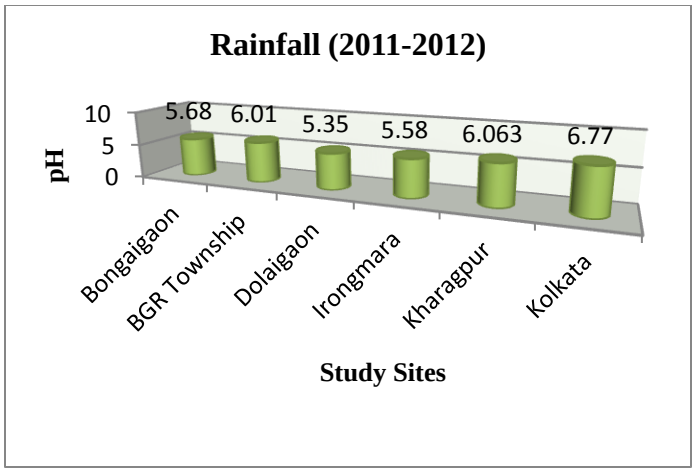

Figure 1. Variation in mean pH in rainfall events between different sites during 2011-2012

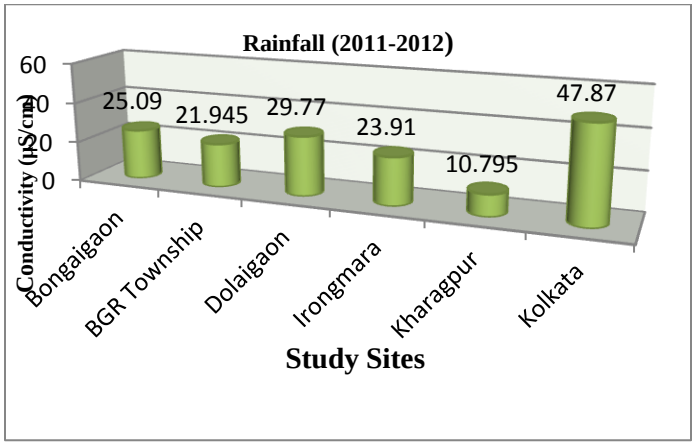

Figure 2. Variation in mean Electrical Conductivity in rainfall events between different sites during 2011-2012

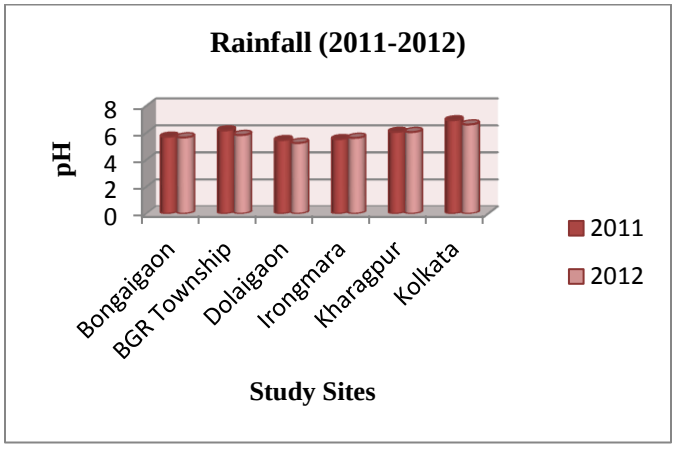

Figure 3. Annual variation in pH in rainfall events in different sites during 2011-2012

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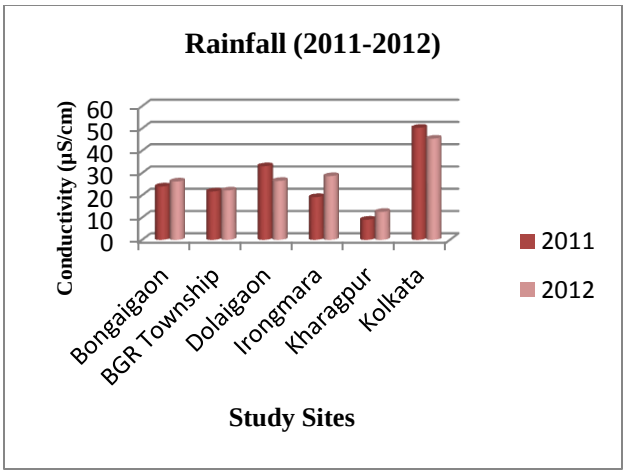

Figure 4. Annual variation in Electrical Conductivity in rainfall events in different sites during 2011-2012

Table-1: Comparison of pH of rainwater of the sampling sites during 2011-2012 with some other selected sites of India

Site	pH	Reference
Bongaigaon	5.68	Present study
Dolaigaon	5.35	Present study
BGR Township	6.01	Present study
Kolkata	6.77	Present study
Kharagpur	6.06	Present study
Irongmara	5.58	Present study
Delhi	5.7	Ravichandran and Padmanamurty (1994)
Ahmedabad	6.7	Rastogi and Sarin (2005)
Dyalbagh (Agra)	7.01	Kumar *et al*. (2002)
Gopalpura (Agra)	6.5	Satsangi *et al*. (1998)
Lucknow	6.5	Khare *et al*. (2004)
Korba	4.8	Chandravanshi *et al*. (1997)
Pune	6.1	Pillai *et al*. 2001
Hyderabad	6.1	Kulshrestha *et al*. (2003)
Bangalore	4.82	Shivashankara *et al*. (1999)
Bhubaneswar	6.2	Das *et al*. (2005)
Goa	6.3	Parashar *et al*. (2001)
Kalyan	5.7	Khemani *et al*. (1989)
Kalyan	5.28	Naik *et al*. (2002)
Colaba	6.4	Naik *et al*. (2002)
Alibag	6.74	Naik *et al*. (2002)
Chembur	4.8	Khemani *et al*. (1989)
Dhanbad	5.3	Singh et al. (2006)
Asansol	6.08	Banerjee (2008)

Table-2: Nitrate concentration of rainwater collected from some selected sites of Eastern and Northeastern India

Site	Mean Concentration in mg l^{-1} (range)	S.D.
Bongaigaon	0.77 (0.085-2.06)	1.114123123
Dolaigaon	1.18 (0.3-2.84)	1.43308525
BGR Township	1.17 (0.36-2.8)	1.408734657
Kolkata	1.20 (0.92-1.71)	0.439810565
Kharagpur	1.65 (0.34-2.96)	1.852619767
Irongmara	1.223333333 (0.15-2.36)	1.106360399

IV. Conclusion

Since most of the places are industrial areas except Irongmara which is a rural area this shows that the rainwater from the industrial areas is contaminated by the emission of the industries and the possible emissions from automobiles. These observations may be due to the interaction between the rainwater and the effluents released from the industries. It is also observed that rainwater contamination may not be restricted to industrial areas alone but vehicular emission may also be responsible for this contamination as seen in the results.

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