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Surface Water Acidification due to Vehicular Industrial and Anthropogenic Activity: Bhubaneswar City—A Case Study

B.B. Kar* and R.P. Biswal
KIIT University, Bhubaneswar
✉ karpublications@gmail.com

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Abstract: This paper presents the seasonal analysis reports of the chemistry of rainwater, surface water and fog of Bhubaneswar city for three years, i.e., July 2008 to June 2011. In this study 838 rain water samples, 342 fog samples and 658 surface water samples have been collected from twelve different areas such as, Acharya Vihar, Saheed Nagar, Bapuji Nagar, Forest Park, Nalco Chhak, Sailashree Vihar, Patia, Chandaka Forest range, Baramunda, Khandagiri, Palaspalli and Kausalyaganga.The present study reports about the occurrence of acid rain, formation of fog and smog and their rate of contamination to the surface water changing its pH and nutrient content. The water sample collected from Acharya Vihar, Bapuji Nagar and Kausalyaganga area were found to be highly acidic in nature (pH < 5.2). It has been observed that pH of the rain water varies within the range of 4.3 to 5.0 and fog water sample in the range of 4.2 to 4.8 respectively. It has been found that the water sample obtained from other areas are slightly acidic in nature where the pH of the surface water remains in the range of 5.5 to 5.8. It has been observed that the water sample in high acidic area is found to be more loaded with heavy metal in comparison to the water obtained from low acidic area. A correlation has been established by the critical analysis of both the water samples (atmospheric and surface).

Key words: Acidification, physico-chemical properties, fog sample, rainwater, surface water, contamination.

Introduction

Acid precipitation and acidic rain has brought a classified threat to all developing and developed countries. So far work has been limited to certain parameters and the major effect of this acidification on the ecosystem has not yet been studied extensively (Akande et al., 2013; Alexander and Jones, 2001; CEH/BGS, 2012; Kendon et al., 2013; Marsh et al., 1994; Marsh et al., 2007). The influence of the atmospheric phenomenon on the surface water quality hasn't been carried out systematically (Perry and Hollis, 2005; Rodda, and Marsh, 2011; Tabony, 1977). In the present study, an attempt has been made to monitor the effect of acidic rain and fog on the surface water ecology of Bhubaneswar city.

Materials

Rainwater and fog water were collected eventually during the sample period July 2008 to June 2011. For collection of rainwater, a sampling international specifications (WHO GAW No. 85) and the procedure was followed as below:

The fog water sample were collected with the help of standard fog collectors(SFC). For the collection of fog

*Corresponding Author

water SFCs have been set from November to February for the consecutive years. The duration of collection was evening 6 pm to next morning 6 am (12 hrs) completely.

The surface water has been collected from rivers, ponds and reservoirs for all four seasons. The sample analysis was carried out using chemical of analaRGrade. The pH, conductivity and water temperature have been studied using water analysis kit. Concentration of ions such as Cl, F, I, NO_3, SO_4 and NH_4 were determined using UV-visible spectrophotometer. The analysis of other cations has been done using AAS and mercury has been analysed with the help of ICP technique.

Result and Discussions

The chemical composition, nutrients, water temperature, pH and conductivity of the rain water, fog water and surface water have been represented in Tables 1, 2 and 3 respectively. The comparative data between low acidic water and high acidic water have been presented in Table 4.

Table 1: Chemical composition of rain water

Chemical composition	*% present*
Cd	1.04
Pb	0.84
Hg	0.14
Zn	0.38
Al	1.77
Fe	2.08
Ca	0.12
Mg	0.20
Na	0.8

Temperature = 25°C, pH = 4.8, Conductivity = 276 gm/cm^3

Table 2: Chemical composition of fog water

Chemical composition	*% present*
Cd	0.98
Pb	0.92
Hg	0.20
Zn	0.42
Al	3.06
Fe	4.05
Ca	0.42
Mg	0.32
Na	0.7

pH = 4.3, Temperature = 20°C, Conductivity = 540 gm/cm^3

Table 3: Chemical composition of surface water

Chemical composition	*% present*
Cd	1.88
Pb	0.92
Hg	0.37
Zn	1.09
Al	6.32
Fe	14.73
Ca	10.36
Mg	4.77
Na	2.64

pH = 5.8, Temperature = 30°C, Conductivity = 874gm/cm^3

Table 4: The comparative data between low acidic water and high acidic rain water

Area under study	*pH*
Nalco Chhak	4.8
Saheed Nagar	4.9
Baramunda	5.7
Khandagiri	5.3
Palaspalli	4.9
Chandaka forest	6.4
Sailashree Vihar	6.2
Kausalyaganga	6.2
Patia	6.5

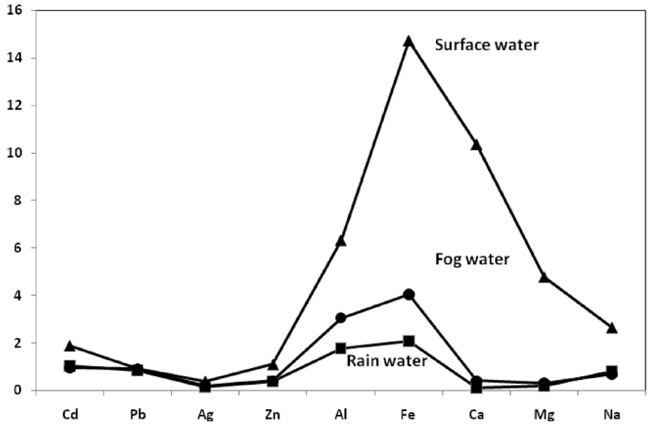

Figure 1: Comparison of data between rain water, fog water and surface water

Acidification of Atmospheric Water Sources

From the study it has appeared that about 48% of rain water and fog water samples are acidic with pH < 6.0 out of which about 29.5% samples showed pH ≤ 5.3 which is very low in comparison to natural rain water and fog. The decrease in the pH value indicates the presence of acid contaminants in the atmosphere. The water samples show the natural values as well as

alkalinity, that happens due to the neutralization of acidic water because of the presence of atmospheric particulate matter, dust particles etc. The study revealed that due to the presence of high concentration of dust particle in less quantity of water sample, the pH of the water samples become neutral. It has been observed that the initial rain water is highly acidic which slowly gets decreased due to washing of dust particles.

It has also been observed that pH of the fog water collected during the winter season maintains a continuous trend and the fog samples obtained after rainfall are found to be more acidic in nature due to removal of dust pollutants. The sample obtained from Acharya Vihar area is found to be more acidic i.e. 4.3 as compared to the sample obtained in Chandaka Forest range which may be attributed to the presence of dense vegetation in Chandaka area that consists of dusty atmosphere which makes the water sample almost neutral ~6.6.

Acidification of the Surface Water Bodies

Due to the increase in acidity, the nutrients present in the soil get leached out along with the rain water which in turn increases the acidification of the surface water. In the post-monsoon season, the concentration of the metal ions increases drastically which is attributed to the lack of natural neutralization.This trend is maintained till the permission period when there is no natural dilution taking place in the water bodies. Due to various anthropogenic sources, there is continuous increase in metal ion accumulation in the surface water. The water samples obtained from Nalco Chhak, Saheed Nagar, Baramunda, Khandagiri and Palaspalli are found to be in the pH range of 4.2 to 4.7 whereas the samples from Chandaka forest range, Forest park, Sailashree Vihar, Kausalyaganga, Patia etc. were found to be neutral. A comparison data between rain water, fog water and surface water is represented in Figure 1. It indicates that traffic and vehicular pollution play a vital role to contribute the acidification of rain water.

Though there are free radicals present in the wind sources to make the water medium alkaline, the leaching out of the nutrient to the water medium helps to neutralize the surface water. SO_X and NO_X are considered to be the vital pollutants to particulate in the acidification of surface water.

Conclusion

The present study concluded that acidification of the atmospheric water is mostly affected due to the presence of two major pollutants, SO_X and NO_X. The atmospheric water gets contaminated with the dust and particulate matter which in due course contaminate the surface water. In Bhubaneswar city the average acidification of fog water is in the range of 4.5 to 4.9 whereas the rain water is in the range of 4.2 to 5.1.

The accumulation of SO_X and NO_X in the atmosphere contributes to formation of H_2SO_4 and HNO_3 which in turn must be mixing with the rain water to cause acid rain. The presence of metal concentration in acidic water is found to be more which is due to the leaching of the metal values from the soil to the water sources.

The study revealed that the metal accumulation becomes more in monsoon and gradually lowers down in the monsoon season. The entire work concludes that due to increase in vehicular pollution and anthropogenic activities in the city, the water sources become contaminated which leads to surface water acidification. In addition to the above phenomenon, release of gaseous pollutants such as SO_x and NO_x leads to acid rain.

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