CHEMICAL COMPOSITION OF RAINWATER IN SOUTH BANGALORE, KARNATAKA

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ABSTRACT

Physicochemical analysis of rainwater collected from 14 Stations of Bangalore South was carried out during the month of May, June and July 2008. The pH was ranging from 5.2 to 7.2 Minimum and maximum concentrations of major anions SO_4^{2-}, Cl^- , NO_3^- and NH_4^+ were 0.9 & 22.22, 0.12 & 72.14, 0.11 & 33.43 and 0.5 &1.89 mg/L. The minimum and maximum concentrations of major cations (Ca^{2+}, Na^+, K^+ and Mg^{2+}) were 1.72 & 33.9 , 1.1 & 45.37 ,5.46 & 29.45,and 3.52 &-39.67 mg/L. The obtained data shows the order of different ionic species contributing to acidic and alkaline depositions in rain water of fourteen stations of South Bangalore are $Cl^- >> SO_4^{2-} > NO_3^-$ and $Na^+ > Ca^{2+} > Mg^{2+} > K^+ > NH^{4+}$.

Keywords: Rainwater; acidity; alkalinity; South Bangalore.

INTRODUCTION

The total amount of water available on earth has been estimated at 1.4 billion cubic kilometers, enough to cover the planet with a layer of about 3-km deep. About 95% of the earth's water is in the oceans, which is unfit for human consumption and other use because of its high salt content; about 4% is locked in the polar ice caps; and the remaining 1% constitutes all the fresh water in hydrological cycle including ground water reserves. Only 0.1% is available in as fresh water in rivers, lakes, and streams, which is suitable for human consumption. This highlights the significance of the need to preserve our fresh water resources. The annual precipitation of rainfall over India is 400 million-hectare meters. The surface water resources carry 17,68,000 million cubic meters out of which only 50% can be put to beneficial uses. In addition, the ground water potential of 4,22,900 million cubic meters is available for utilization and about 1,00,000 million cubic meters is being exploited at present. Indian rivers have been classified into fourteen major, forty-four medium, and fifty-five minor & desert river basins. The major river basins cover 83% of the total drainage basin and contribute to 85% of the total surface flow whereas medium and minor river basins share 8% and 8% respectively of the total surface flow. But, the major problem is the quality of surface water in majority of the locations, which is affected by pollutants from various sources such as domestic waste discharges, industrial waste disposal, and other human activities like bathing, washing and swimming etc.

Water is an inorganic component, which covers about ¾th of the earth's surface, but only 3

Percent of it is available to man for use. The remaining 97 percent of water found in oceans is full of soluble salts, being unfit for human use and consumption. Rainwater is free source of nearly pure water. The natural chemical composition of the atmosphere is affected by human activities. Pollutant emissions are mainly produced by chemical industrial processes, fuel combustion from automobiles, and anthropogenic activities. Most of the pollutants are transported by winds from the industrial localities and national highways. Anthropogenic emissions result in the presence of polluting compounds in the environment. In high populated cities, gas and particulate matter, thoroughly distributed in the atmosphere. Although their natural concentrations rarely reach harmful levels, they can be dangerous to human health and to the environment at high concentrations. Pollutants can be deposited from the

atmosphere on to the surface of earth in wet and dry forms. The pluvial precipitation is an important mechanism by which many natural and anthropogenic compounds are removed from the atmosphere.[1, 2]

Bangalore a fast growing metropolis, the garden city is the capital of the southern Indian state of Karnataka. Situated at about 1000 meters above sea level, it is known for its salubrious climate where temperatures remain moderate through out the year. The maximum temperature in July is around 32^0C and the minimum around 22^0C. It is connected by air, rail and road to all major cities of the country and has direct international connections to many cities worldwide. Hosur Road is the part of National Highway which connects the city of Bangalore and the **Tamil Nadu** border town of **Hosur**. It is a four-lane highway which also has service lanes on either side at the busier parts. Apart from being a part of the **National Highway**, the road is also significant because it houses many industrial and IT business houses. The famous IT industrial park **Electronics City** is also located in Hosur Road. Owing to the large number of offices and its use as major truck route, the road is chocked during most part of the day. In recent years, the main highway connecting Electronics City with Bangalore has seen a large increase in vehicular traffic, causing traffic jams at several road junctions. Currently, major infrastructure improvements are taking place including widening of the road and the building of a 9 kilometer elevated highway. It promises to reduce and redistribute the traffic for a smoother flow. The highway, Hosur road also has some buildings of some major IT players like BOSCH, Sasken, Convergys etc, along with showrooms of major auto manufacturers like Toyota etc. Air pollution in Bangalore city is undoubtedly the exhaust emission from vehicular traffic[1]. Inadequate public transport system has led to an increase in the use of personalized vehicles, Congested traffic, poor road conditions and outdated automotive technology add to the increase in vehicular emissions. Large quantities of pollutants have continuously been introduced into ecosystems as a consequence of urbanization and industrial processes.[3]

EXPERIMENTAL

Sampling sites were Koramangala, Agara Lake, Madiwala, St. John's Hospital, Bomannahalli, Begur Road, Sharjapur, Sharjapur , H.S.R Layout, Singasandra, Hosa Road, Central prison, Electronic city, Anekal and Attibele. Rainwater samples were collected manually, on individual events basis, in clean polyethylene bottles using glass funnels. All samples were filtered and refrigerated at 4ºC until all chemical parameters measured and ionic components determined. pH was measured using a standard pH-meter . Sulphate was determined turbidimetrically. The sulphate ions in the rainwater samples was precipitated by solid barium choride in the presence of glycerol to stabilize the suspension (barium sulphate). Chloride ion was determined by the silver chloride method. Nitrate was determined colorimetrically. Ammonium was measured by Nessler's method. Analysis for calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^+) was performed using a Perking Elmer Atomic Absorption Spectrophotometer .[4,5,7]

RESULTS AND DISCUSSION

Pollutant emissions are mainly produced by chemical industrial processes, fuel combustion from automobiles, and anthropogenic activities. Most of the pollutants are transported by winds from the industrial localities and national highway. The minimum pH value was measured in rainwater in month of May. The pH level are some what acidic, the range of pH was 5.5 to 6.7 in all the stations .In June and July pH range was 6.3 to 7.2. With regard to soluble sulphate in rainwater, average concentrations are reported in Table-1 and Figure-1. Minimum and maximum concentrations were 1.24 & 22.22 in May, 1.1 & 20.38 in June and in July 0.9 & 16.3mg/L. Sulphate concentrations in rainwater reflect the co-emission of its precursor in great amounts into the atmosphere. Sulphur-rich fuels could be the most important source of these emissions. The concentrations of chloride, Nitrate and Ammonium varied considerably and there was a wide spectrum of results. The Minimum and maximum concentrations for chloride were(0.12&72.14 in May, 0.12 & 65.45 in June and in July 0.9 & 45.32 mg/L), for nitrate (0.13 & 33.43 in May ,0.11 & 4.99 in June and in July ND & 3.34 mg/L) and for ammonium were (0.7&1.85 in May 0.5 & 1.89 in June and in July ND & 1.54 mg/L).

The concentration of sulphate, Chloride , Nitrate and Ammonium in 14 stations of Bangalore South ranged from 1- 16 % (Max in Bomannahalli, Begur Road and H.S.R Layout , 15-16 %), 0- 68 % (Max

in Madivala 68 %), 0- 31 % (Max. in Koramangala, 31 %) 2- 15 % (Max. in Begur Road & Electronic city, 15 %).

Among the metal ions detected, the following are known by their neutralising effect on precipitation acidity Ca^{2+}, Na^{+}, K^{+} and Mg^{2+} were detected in all stations. The minimum and maximum concentrations for Magnesium were (4.50 &-39.67 in May, 4.30 & 33.95 in June and in July 3.52& 25.38 mg/L), Calcium(2.23& 33.9 in May, 2.10 & 30.27 in June and in July 1.72 to 25.67 mg/L), Sodium(1.72 & 45.37 in May, 1.30 & 43.45 in June and in July 1.1 & 25.69 mg/L) and for Potassium (6.56 & 29.45 in May, 6.20 & 21.69 in June and in July 5.46& 20.23 mg/L).

The concentration of metal ions (, Na^{+}, Ca^{2+}, K^{+} and Mg^{2+}) in various stations of Bangalore south - Sodium 1- 13 % (Max. in Bomannahalli, Electronic city & Anekal 13 %), Calcium 1- 15 % (Max. in Bomannahalli, Begur Road & Electronic city , 15%) , Potassium 3- 13 % (Max. in Bomannahalli, Begur Road, Electronic city & Attibele , 12-13 %) and for magnesium 2- 18 % (Max. In Bomannahalli, Begur Road, Electronic city & Attibele (Heavy Traffic Areas) , 13-18 %). This variation might be due to change concentration at the end of the stage of atmospheric aerosol removal. Sodium have been found to be emitted into the atmosphere from fossil fuel combustion .On the other hand, the presence of Ca^{2+}, Na^{+} and Mg^{2+} reflects the amount of dust soil particles, and lime from various industries, large-scale biomass burning being blown into the atmosphere by the wind action.[6,8&9] This particulate matter settles during dry fall, and it is rapidly washed out by the early stage of rainfall. The obtained data shows the order of for different ionic species contributing to acidic and alkaline depositions in rain water are $Cl^{-} > > SO_4^{2-} > NO_3^{-}$ and $Na^{+} > Ca^{2+} > Mg^{2+} > K^{+} > NH^{4+}$.

CONCLUSIONS

Among the metal ions detected, the following are known by their neutralising effect on Precipitation acidity Ca^{2+}, Na^{+}, K^{+} and Mg^{2+} were detected in all stations. All the detected elements are characteristic of suspended solid pollutants of anthropogenic origin. Monthly average values have undergon a drop after first stages of the rainfall from the month of May to July may be due to the changes in atmospheric and environmental conditions of heavy traffic and the industrial areas.

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Table-1: Physico- chemical Analysis of Rain water in Bangalore South

Sl No.	Sampling sites	pH			SO_4^{2-} mg/L			Cl^- mg/L			NO_3^- mg/L			NH^{4+} mg/L		
		May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1	**Koramangala**	5.6	6.3	7.2	1.24	1.1	0.9	0.12	0.12	0.12	33.43	0.11	0.9	0.95	0.5	-
2	**Agara Lake**	5.5	6.3	7.0	1.25	1.1	0.9	0.12	0.12	0.12	7.88	0.11	0.9	0.31	0.5	-
3	**Madiwala**	5.7	6.5	7.5	5.88	4.38	3.45	72.14	65.45	45.32	5.99	4.99	3.34	1.85	1.76	1.54
4	**St. John's hospital**	6.2	6.3	7.0	1.28	1.1	0.9	0.12	0.12	0.12	5.84	0.11	0.9	0.64	0.5	-
5	**Bomannahalli**	6.2	6.5	7.2	24.17	20.38	16.34	3.7	2.34	1.56	0.5	0.5	-	2.1	1.86	1.47
6	**Begur Road**	6.7	6.7	7.0	24.05	20.00	16.45	9.6	8.23	5.43	0.4	-	-	3.2	1.89	1.50
7	**Sharjapur**	5.6	6.3	7.0	1.26	1.1	0.95	0.12	0.12	0.12	9.01	0.11	0.9	0.7	0.5	-
8	**H.S.R Layout**	5.5	6.3	7.0	24.17	21.10	10.9	3.7	0.12	0.12	0.13	0.11	0.9	0.7	0.5	-
9	**Singasandra**	6.5	7.2	7.2	16.88	10.45	2.33	9.6	7.56	5.40	9.01	0.11	0.9	2.1	1.86	1.47
10	**Hosa Road**	6.7	7.2	7.4	12.23	10.45	8.64	2.9	1.65	1.54	0.5	0.5	-	0.95	0.5	-
11	**Central prison**	6.7	7.2	7.4	22.22	17.56	10.53	1.4	1.32	1.12	5.64	4.43	0.9	3.2	1.89	1.50
12	**Electronic CIty**	5.9	6.8	7.9	13.60	12.45	10.53	5.6	4.59	3.34	4.74	3.55	2.56	1.75	1.46	1.23
13	**Anekal**	5.5	6.3	7.0	5.12	1.1	0.9	0.64	0.12	0.12	0.13	0.11	0.9	0.7	0.5	-
14	**Attibele**	5.5	6.3	7.0	15.7	1.1	0.9	3.97	0.12	0.12	0.13	0.11	0.9	0.7	0.5	-

Table –2: Analysis of metal ions in rainwater from May-July 2008, Bangalore South

Sl No.	Sampling sites	Ca^{2+} mg/L			Na^+ mg/L			K^+ mg/L			Mg^{2+} mg/L		
		May	June	July	May	June	July	May	June	July	May	June	July
1	**Koramangala**	2.23	2.10	1.78	1.78	1.3	1.1	6.73	6.20	5.46	4.50	4.30	3.52
2	**Agara Lake.**	6.88	6.54	5.43	3.54	3.26	1.29	10.23	9.54	6.29	9.47	9.43	6.36
3	**Madiwala**	29.23	20.98	18.7	33.52	25.59	20.43	17.23	12.47	9.48	9.45	8.38	6.23
4	**St. John's Hospital**	2.10	2.15	1.59	1.78	1.43	1.62	6.56	6.25	5.67	4.88	4.47	3.67
5	**Bomannahalli**	33.9	30.27	25.67	45.37	41.4	23.43	19.61	21.69	20.23	39.67	33.9	21.23
6	**Begur Road**	31.92	25.63	20.35	43.51	43.43	25.67	29.34	21.69	17.62	12.67	33.9	25.34

7	**Sharjapur**	6.23	6.44	5.87	3.21	3.12	1.46	10.45	9.66	6.41	9.65	9.26	6.75
8	**H.S.R Layout**	3.33	3.10	2.68	2.48	3.45	1.45	7.43	6.98	5.76	5.45	4.94	3.84
9	**Singasandra**	29.56	20.34	18.15	33.37	25.47	20.82	17.46	12.53	9.13	9.00	8.41	6.47
10	**Hosa Road**	29.23	20.98	18.7	33.52	25.59	20.43	17.23	12.47	9.48	9.45	8.38	6.23
11	**Central prison**	6.56	6.23	5.10	3.36	3.42	1.16	10.18	9.26	6.24	9.39	9.52	6.41
12	**Electronic city**	33.9	30.27	25.67	45.37	41.4	23.43	19.61	21.69	20.23	39.67	33.9	21.23
13	**Anekal**	2.24	2.15	1.72	1.72	1.38	1.19	6.76	6.26	5.49	4.51	4.31	3.53
14	**Attibele**	31.88	25.49	20.65	43.56	43.45	25.69	29.45	21.51	17.52	12.62	33.95	25.38

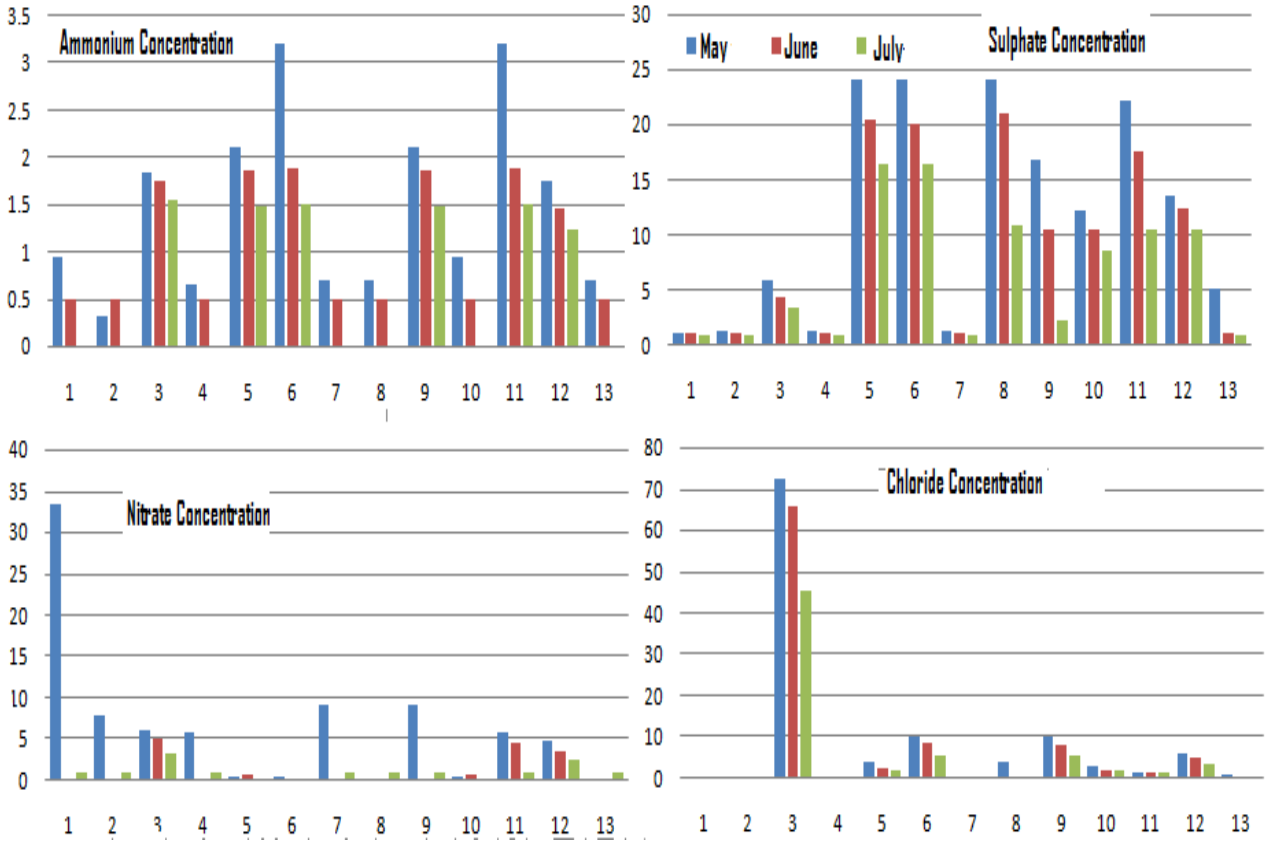
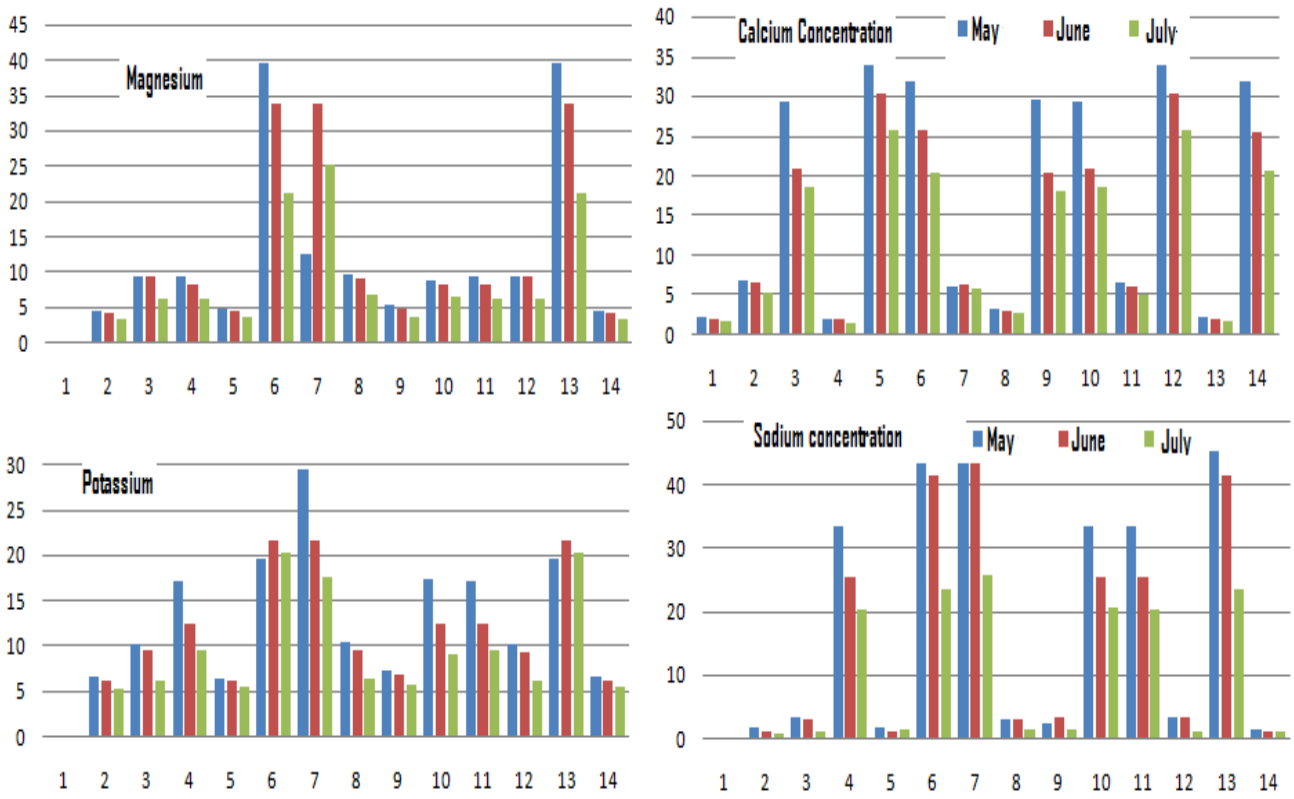


Fig.-1: Physico-chemical analysis of rain water in various sites of Bangalore south



1.Koramangala,2. Agara Lake ,3. Madiwala ,4. St. John's Hospital, 4. Bomannahalli, 5.Begur Road,6. Sharjapur, 7. H.S.R Layout, 8.Singasandra,9. Hosa Road, 10.Central prison, 12.Electronic city, 13. Anekal and 14.Attibele

Fig.-2: Nutrient analysis of rain water in various sites of Bangalore south

(Received: 7 November 2008 Accepted: 14 November 2008 RJC-277)

I would feel more optimistic about a bright future for man if he spent less time proving that he can outwit Nature and more time tasting her sweetness and respecting her seniority.

—Elwyn Brooks White, *Essays of E.B. White*, 1977