

Physicochemical Assessment of Rainwater of Karachi, Pakistan

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Abstract:

Local precipitation (rain) is a good source of surface water and could be a safe source of drinking water if it is free from contaminants. Many Asian countries do not have access to safe drinking water, so they have no alternative but to use water from contaminated sources that poses a health hazard. In the present study, thirty five rainwater samples were collected in Karachi, Pakistan during monsoon season of year 2007. The pH, electrical conductivity, total dissolved solids, dissolved oxygen and hardness were immediately monitored after sample collections and their other physicochemical parameter were analyzed in order to distinguish safe source of drinking water. The presented data is a first report to put forward possible sources of NH₄,

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Na, K, Mg, Ca, F, Cl, NO₃, CO₃²⁻ and SO₄²⁻ concentrations in rainwater of Karachi city, Sindh, Pakistan. All samples were completely free from fluoride contamination while the concentration of chloride and sulfate was in range of 15.11-125 mg/l and 10.02-72.02 mg/l indicate their presence from air pollution. Moreover, the study showed that the rainwater can be harvested to extend potable and non-potable water supplies in this city.

Key words: Air pollution, Air Quality, Drinking Water, Environmental Assessment, Monsoon, Potable, Precipitation, Rainwater Harvesting.

Introduction

Pakistan is located between 24° and 37° N and 61° and 75° E. Most part of the country receives low rainfall and high solar radiation. Northern areas receive more than 500 mm rain fall annually. The annual rain fall in Sindh is 60 % (FAO 1987). Most of the rangelands of Pakistan are in arid and semi-arid zones characterized by low precipitation and extremes of temperature and low humidity (Climate data Karachi, 2010). Karachi is the metropolitan city of Pakistan and it is also situated in Sindh. Climate of Karachi is arid with annual rainfall of 250 mm occur in monsoon season from July to August (Umrani *et al.* 1996). Pollution is increasing due to anthropogenic and agricultural activities, fast urbanization, rapid industrial development, poor sanitation system and unhygienic practices by general public. Chemical composition of rainwater is influenced by the contents of the atmosphere through which it falls. Precipitation is also a path way for removing gases and particles from the atmosphere. During removal process oxides of sulphur and nitrogen incorporated into rainwater which are chemically converted into sulphuric and nitric acid (Suresh *et al.* 2006; Khan *et al.* 2005). The scavenging of the atmospheric pollutants affects the chemical composition and pH of rainwater. The acidity value depends upon the neutralization produced by certain rainwater components such as NH₃, CaCO₃ and hydroxide. Low pH rain

and atmospheric aerosols are considered to be typical environmental pollution affecting human health, acidification of lake and soil, deterioration of monuments and natural equilibrium (Aohan *et al.* 2005; Omer 2005).

The quality of rainwater depends upon the variation in rainwater composition. It varies from place to place and season to season due to climate, topography, location of sampling site and natural and anthropogenic sources etc. This study was intended to understand the effect of natural and anthropogenic effect on the quality of rainwater. In order to estimate the effect of pollution in air we analyzed rainwater samples collected from eighteen towns Karachi, Pakistan.

Material and Methods

Sample collection

Rainwater samples were collected from eighteen different towns of Karachi, Pakistan in the Monsoon season of 2007 in clean buckets (fig. 1).

Sample storage

Water samples were transferred to the polypropylene bottles that were pre rinsed with deionized water. A total of thirty three samples were collected and their pH, EC, DO, TDS and hardness were measured immediately after sample collection. Each sample was filtered through 0.25 μm filter paper (Millipore, USA) and divided into two portions. One part was stored under refrigeration for anion analysis and other portion was acidified with HNO_3 (Merck) for cation analysis.

Instrumentation

The major cations were measured by Perkin-Elmer atomic absorption spectrophotometer (AAAnalyst 700). Anions were analyzed by ion chromatography (Metrohm 761 Compact IC with suppressed module, equipped with an anion-separator

column (Dual 2). pH, EC, DO and NH_4 was analyzed by multi parameter ion analyzer (HANNA Instrument).

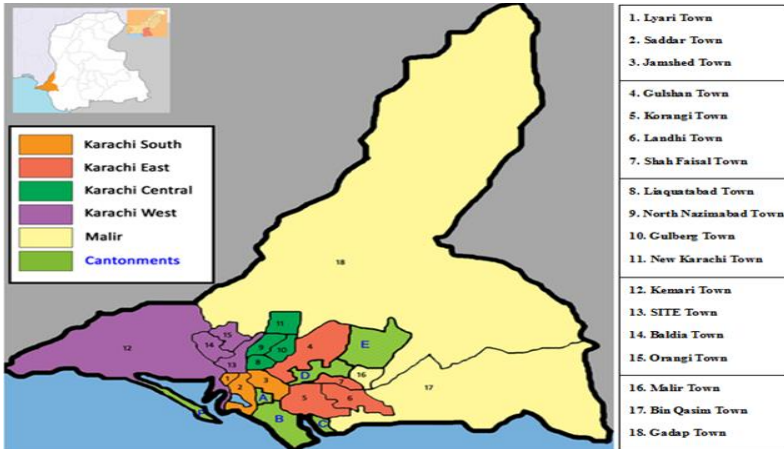


Fig. 1. Map of Karachi, Pakistan indicating sampling locations.

Results and Discussion

Rainwater is one of a major source of drinking water on this planet. It collects in rivers, lakes, streams, dams, etc. It is also seep through the ground and recharges the ground water table that supplies drinking water to wells and boreholes.

The research is conducted to monitor the quality of rainwater in Karachi, Pakistan in order to find the extent of air pollution and to find considerable scope for the collection and storage of rainwater when it falls, in spite of its huge losses occur due to evaporation, transpiration and contamination by natural and anthropogenic pollutions.

pH

The pH value of rainwater samples ranged between 5.91-7.68 the rainwater sample obtained from saddar has a slightly acidic pH whereas Korangi Industrial Area is slightly basic. A significant change is not observed in rainwater samples. The range of pH in rainwater is in permissible limit of WHO (World Health Organization) standard of water use for drinking purpose.

Electrical conductivity (EC)

The value of EC ranged from 0.03-0.17 m.S. The rainwater samples collected from North Nazimabad and PCSIR has a lowest EC value whereas Korangi industrial area has highest EC value in rainwater samples.

Total dissolved solids (TDS)

The highest value of TDS was found in Korangi industrial area i.e. 127 mg/l and lowest value was found in North Nazimabad town, Sakhi Hassan sample i.e. 26 mg/l.

Dissolved oxygen (DO)

The value of dissolved oxygen ranged from 6.9-7.8 mg/l. Lowest value was obtained in Orangi town sample and highest value was obtained in PCSIR and Liaquatabad samples.

Hardness

Lowest value of hardness was obtained in Gulshan-e-Hadid sample i.e. 19.80 mg/l and highest in Golimar sample i.e. 73 mg/l.

Ammonium

The value of NH_4 ranged in between 10.94 to 154.40 mg/l. The lowest value was found in Karachi University sample whereas highest value was found in North Karachi sample.

Sodium

Highest value was found in Saddar sample i.e. 116.20 mg/l where as lowest value was found in Garden West sample with concentration of 5.515 mg/l.

Potassium

Highest value was found in North Karachi sample and lowest value was found in Khokrapar sample.

Magnesium

The highest concentration of Mg was obtained is 121.03 mg/l which was found in Malir Hault sample and lowest value was obtained in Liaquatabad sample i.e. 11.02 mg/l.

Calcium

The concentration of calcium in rainwater sample is ranged from 12.00 to 134.30 mg/l. The highest value of calcium was found in Malir Hault sample of Malir town and the lowest concentration of calcium was obtained in sample collected from Cantonment area of Defence.

Chloride

The value ranged between 15.11-125 mg/l. Lowest value was obtained in PCSIR while highest value was obtained in Korangi industrial area.

Fluoride

All samples were completely free from fluoride.

Nitrate

Lowest value was found in Gulistan-e-Jauhar sample i.e. 9.82 mg/l and highest in Saddar sample i.e. 72.0 mg/l.

Carbonate

The concentration of carbonate ranged between 13.23-62.03 mg/l. Lowest value was obtained in New Karachi while highest value was obtained in Khokrapar sample.

Sulfate

The value ranged between 10.02-72.02 mg/l. Lowest value was obtained in New Karachi while highest value was obtained in Khokrapar sample.

Table: 1. Physicochemical assessment of rainwater samples collected from eighteen towns of Karachi, Pakistan

Shah Faisal Town	Gulshan-e-Iqbal Town	Jamshed Town	Saddar Town	Lyari Town	Orangi Town	Baldia Town	SITE Town	Areas/ Parameters	
								Keamari Town	Keamari SherShah Colony
Drigh Colony Green Town Colony Gate	PCSIR Karachi University Gulshan-e- Jauhar Colony	PECHS	Saddar Garden West Defence	Bihar Colony	Mohammad Nagar	Saeedabad Muhajir Camp	Pak Colony Banaras Colony	Keamari SherShah Colony	
6.81, 6.86 6.42	6.75, 6.11 6.38, 6.50	7.12	5.91, 6.55 6.60	7.32	6.2	6.3 6.3	6.5 6.4	7.1 7.0	pH
0.04, 0.08 0.08	0.06, 0.03 0.15, 0.06	0.13	0.076, 0.16 0.04	0.12	0.09	0.05 0.05	0.10 0.09	0.07 0.06	EC (m.S)
38.0, 50.3 64.0	50.3, 27.0 106, 70.0	103	60.3, 112 69.0	115	72.00	60.30 59.32	72.00 73.00	99.08 95.26	TDS (mg/l)
7.6, 7.3 6.7	7.1, 7.8 7.2, 7.2	7.0	7.2, 6.9 7.3	7.0	6.8	7.2 7.2	7.0 7.1	7.1 7.1	DO (mg/l)
32.70, 31.50 22.30	40.3, 29.42 70.0, 59.20	65.0	57.5, 57.9 52.0	70.0	59.0	62.0 59.0	69.0 70.0	72.0 71.0	Hardness (mg/l)
24.25, 22.62 22.30	10.94, 98.25 68.02, 45.02	65.03	56.44, 50.10 42.36	46.52	25.98	15.15 16.25	52.90 50.30	25.03 22.39	NH ₄ (mg/l)
40.25, 21.16 19.26	50.25, 32.05 25.36, 19.40	26.50	116.2, 5.515 9.600	99.09	41.02	55.92 52.31	85.30 82.32	95.34 85.32	Na (mg/l)
4.00, 6.71 5.02	2.69, 1.99 6.90, 7.25	6.11	7.20, 2.50 7.00	6.20	5.80	2.58 2.96	5.83 5.23	6.32 6.21	K (mg/l)
25.03, 78.40 55.02	47.02, 22.30 14.00, 12.00	29.32	36.50, 26.32 14.00	52.58	15.0	19.02 21.03	25.32 22.53	38.21 32.01	Mg (mg/l)
43.00, 62.50 60.23	83.90, 35.20 32.03, 19.00	49.34	89.50, 52.36 12.00	92.72	19.0	16.52 21.22	22.51 22.01	95.32 90.25	Ca (mg/L)
30.60, 32.30 29.32	43.00, 15.11 19.24, 74.00	25.31	112, 23.7 32.0	102	50.0	65.11 62.13	85.35 82.36	75.82 72.03	Cl ⁻ (mg/l)
22.03, 11.25 25.26	17.60, 10.02 9.82, 42.01	28.36	72.00, 19.02 30.01	35.31	25.02	29.15 25.99	42.03 40.21	59.32 52.32	NO ₃ ⁻ (mg/l)
20.01, 19.25 26.32	52.03, 42.05 32.02, 22.52	49.35	41.84, 25.06 26.02	52.15	32.56	22.39 23.52	32.02 30.25	59.32 55.96	CO ₃ ⁻² (mg/l)
52.03, 15.40 24.11	28.40, 20.02 20.00, 13.00	32.52	70.40, 21.42 42.60	32.25	15.20	31.01 28.59	19.36 20.96	60.23 58.72	SO ₄ ⁻² (mg/l)

WHO Standard	Gadap Town	Binqasim Town	Malir Town	Liaquatabad Town	Gulberg Town	New Karachi Town	North Nazimabad Town	Korangi Town	Landhi Town
	Gadap	Gulshan-e-Hadid	Malir Hault Kausar Town Malir City Khokrapar	Liaquatabad Golimar	Ancholi	New Karachi	Sakhi Hassan	Korangi Industrial Area	Dawood Chowrangi
6.5-8.5	6.92	6.34	6.87, 6.29 6.30, 6.70, 6.37	6.04 7.39	6.52	6.03	6.07	7.68	7.32
*NULL	0.04	0.05	0.08, 0.09 0.09, 0.08, 0.05	0.04 0.11	0.05	0.09	0.03	0.17	0.12
500	89.0	44.0	62.0, 65.0 63.0, 60.0, 67.0	39.0 88.0	85.0	76.0	26.0	127	120
*NULL	7.6	7.2	7.0, 7.2 6.9, 7.0, 7.0	7.8 6.9	7.4	7.2	7.0	7.1	7.3
0-75	65.0	19.80	41.9, 44.0 44.0, 38.0, 50.7	40.35 73.0	35.0	51.0	24.8	65.0	69.0
*NULL	85.11	52.02	44.32, 82.31 62.02, 58.25, 50.02	58.25 40.11	65.21	154.40	21.52	42.02	102.5
200	55.38	25.23	12.39, 20.02 15.02, 14.22, 15.00	46.00 11.90	85.56	52.03	54.80	25.40	65.92
*NULL	5.50	3.02	2.99, 2.50 3.89, 6.99, 0.39	5.28 5.20	6.30	7.71	4.02	0.601	6.32
50	45.21	29.25	58.11, 121.03 44.25, 61.00, 24.00	11.02 21.00	21.03	26.40	15.24	15.00	59.21
200	62.02	32.58	47.02, 134.3 56.85, 47.25, 22.00	33.01 22.00	52.11	25.02	22.03	21.00	85.32
250	25.31	26.25	52.30, 49.01 15.21, 49.99, 16.23	25.03 45.00	39.23	47.0	51.0	125	25.29
45	25.82	15.24	23.25, 32.01 35.02, 25.82, 47.25	12.58 20.01	31.03	22.03	21.02	72.02	19.52
*NULL	45.34	15.02	30.21, 32.02 32.25, 30.25, 13.23	25.09 58.57	21.39	62.03	30.89	18.25	39.25
250	22.90	49.02	30.25, 21.00 24.02, 17.02, 10.02	15.03 19.25	19.25	72.02	13.02	65.6	42.39

*NLL – No Limit Listed

All the estimated physicochemical parameters of the investigated rainwater samples are within the standard limits of drinking water given by World Health Organization (Table 1).

Conclusion

The quality of rainwater can be easily used as a tool for the assessment of air pollution. In this study a good number of samples were collected and their major physicochemical parameters were determined. All the samples meet the quality of WHO drinking water standards and are free from considerable pollution. Therefore, we propose from the study that the rainwater can be collected and stored for potable and non-potable purposes in Karachi, Pakistan.

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