Hinthada University Research Journal, Vol. 3, No. 1, 2011

Study on the Physicochemical Properties of Rain Water from Hinthada University Campus

Sandar Moe Aung [1] and Aye Aye Myint [2]

Abstract

Rain water is the purest form of natural water. However, it is contaminated by the polluted atmosphere and contains suspended organic and inorganic impurities. The rapid industrial growth in some countries of East Asia causes increasing use of fossil fuel that emits acid gases such as CO_2, SO_2, NO, HNO_3 and H_2SO_4 vapor to the atmosphere. Acid depositions can produce various effects on environment and living creatures. Therefore, to monitor the total amount of acid deposition is quite important. In this research, some physicochemical properties of rain water from Hinthada University Campus such as pH, Electrical Conductivity(EC), Total Dissolved Solids (TDS), Chloride (Cl^-), Sulphate (SO_4^{2-}), Nitrates (NO_3^-), Sodium (Na^+) , Potassium (K^+), Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) were determined by different method. It was observed that pH values of rain water were found to be in the range of 4.8 and 6.2. However, other chemical participate such as EC values of rain water were found to be in the range of 10 and 30 µS/ cm. TDS values of rain water were found to be in the range of 10 and 20 ppm. Chloride values of rain water were found to be in the range of 144 and 355 ppm. Sulphate values of rain water were found to be in the range of 0.08 and 2.92 ppm. Nitrate values of rain water were found to be in the range of 0.14 and 0.89 ppm. The content of sodium, potassium, calcium and magnesium were (5.873, 1.268, 2.198 and 1.566) ppm, respectively. It was anticipated that rain water on Hinthada University Campus is slightly acidic. However, rain water from Hinthada University Campus do not hazard for people who live in Hinthada District.

Key words : Rain water, physicochemical properties, acid deposition, pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS)

Introduction

Acid deposition

"Acid rain" is a broad term used to describe several ways that acids fall out of the atmosphere. A more precise term is "Acid Deposition" (Schwartz, 1989). Acid rain is measured using a scale called "pH". The lower a substance's pH is the more acidic it is. Pure water has a pH of 7. Normal rain is slightly acidic. It has a pH of about 5.6 (Daifullah & Shakour, 2003). Generally, Acid rain is the word used for describing rainfall that has a pH level of less than 5.6. The pH value of rain water represents the concentration of the free hydrogen ions (ENEAT, 2004; Aung aung, 2006).

Acid rain formation

The rapid industrial growth in some countries of East Asia causes increasing use of fossil fuel that emits acid gases such as CO_2, SO_2, NO, HNO_3 and H_2SO_4 vapor to the atmosphere (Toshichi, 1996). This and other human activities such as increasing use of fertilizers in agriculture eventually will acidify the earth with acid deposition. However, information on the present status of acid deposition in the region is very sketchy. Therefore, it will be very difficult to formulate a sound and concrete strategy to mitigate the problem of acid deposition in the region. Since the deposition is also known to be trans-boundary, cooperation among the countries in the region is imperative. Acid deposition is two forms, dry and wet deposition.

One process is wet deposition when acids are taken by cloud waters and fall down onto land and waters with rain, snow or fog. The large amount of dissolved acids causes the strong acidity of precipitation known as "Acid Rain".

[1] Demonstrator, Department of Chemistry, University of Yangon

[2] Professor and Head, Dr., Department of Chemistry, Hinthada University

By another process called dry deposition, airborne acids are removed from the air during fine and cloudy days. They pass through air to the ground and deposit on waters, grasses, trees or buildings, and even inside human respiratory systems.

Acid depositions can produce the various effects on environment and living creatures such as trees or fish by increasing acidity in soil, lake water, etc. Therefore, to monitor the total amounts of acid deposition is quite important along with pH of rain water (Kolthoff & Stenger, 1947, Zeng & Hopke, 1989).

Definition of content elements

pH

pH is a general measure of the acidity or alkalinity of a water sample. The symbol pH stands for potential for hydrogen. The pH of water, on a scale of 0 to 14 is a measure of the $[H^+]$. Water contains both hydrogen ions and hydroxide ions. Pure distilled water contains neutral (pH 7), neither basic nor acidic. Rain water is acidic with pH less than 7 and it is basic with a pH greater than 7. Stream water usually ranges from pH 6.5 - 8.5. Rain water by contrast is naturally acidic at about 5.6.

Electrical Conductivity (EC)

Electrical Conductivity is a measure of conductance of water and is the capacity of water to conduct electricity current. It is due to presence of free ions produced by the dissolution of mineral salts. Conductivity of water increases with increase in temperature and it is proportional to the concentration of the dissolved salts. Conductivity water used for analysis purpose should not be less than 2.

Total Dissolved Solids (TDS)

Rivers have solids particles in them called dissolved and suspended solids. The total dissolved solids test measures the amount of particles dissolved in rain water. The TDS ranges from 20 to 2000 mg/L or pert per million in rivers and may be higher in groundwater. High levels in drinking water may cause objectionable tastes. The quantity of TDS in water including the precipitation, rainwater is almost pure with less than 10 ppm. The major dissolved substances found in water can cause the positively charged ions of sodium, calcium, magnesium, potassium and iron and the negatively charged ions of chloride, bicarbonate and sulphate.

Chloride (Cl^-)

Chlorides are binary compounds of chlorine. A chloride is made of chlorine chemically combined with a metal. It is formed naturally when hydrochloric acid reacts with any metal in the water. Chloride is common in areas with limestone deposits but it is not found in most other soils, rocks or minerals. The presence of chloride, when it does not occur naturally, indicates possible water pollution. Other sources of chloride are septic tank effluent, animal waste and potash fertilizer. High levels of chloride kill plants and wildlife.

Sulphate (SO_4^{2-})

Industries and utilities, that burn coal, release sulphur compounds into the atmosphere into the environmental to become a part of the acid rain problem (Thomas & Cotton, 1954). Dissolved sulphate can be converted to hydrogen sulphide. Dissolved sulphate can combine with calcium to form scale heaters and boilers (Rossum & Villarruz, 1961).

Nitrates (NO_3^-)

Nitrogen is known to be an important plant nutrient, thus, it is used as fertilizer and it is found in high concentrations in agricultural runoff. Nitrogen is contributed to eutrophication of lakes and streams. Nitrates values of rain water were found to be in the range of 0.01 ppm to 3 ppm. An elevated concentration 0.1 mg/L is indicative of the influence of man such as the use of nitrate fertilizer, septic tank failure and the vulnerability of the aquifer by surface drainage.

Aim and Objective

Aim

To determine the some physicochemical properties of rain water from Hinthada University Campus

Objectives

1. To collect rain water samples in Hinthada University Campus from August, 2009 to October, 2010.
2. To study the physicochemical properties of rain water from Hinthada University Campus such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Chloride (Cl^-), Sulphate (SO_4^{2-}), Nitrates (NO_3^-), Sodium (Na^+), Potassium (K^+), Calcium (Ca^{2+}) and Magnesium (Mg^{2+}).

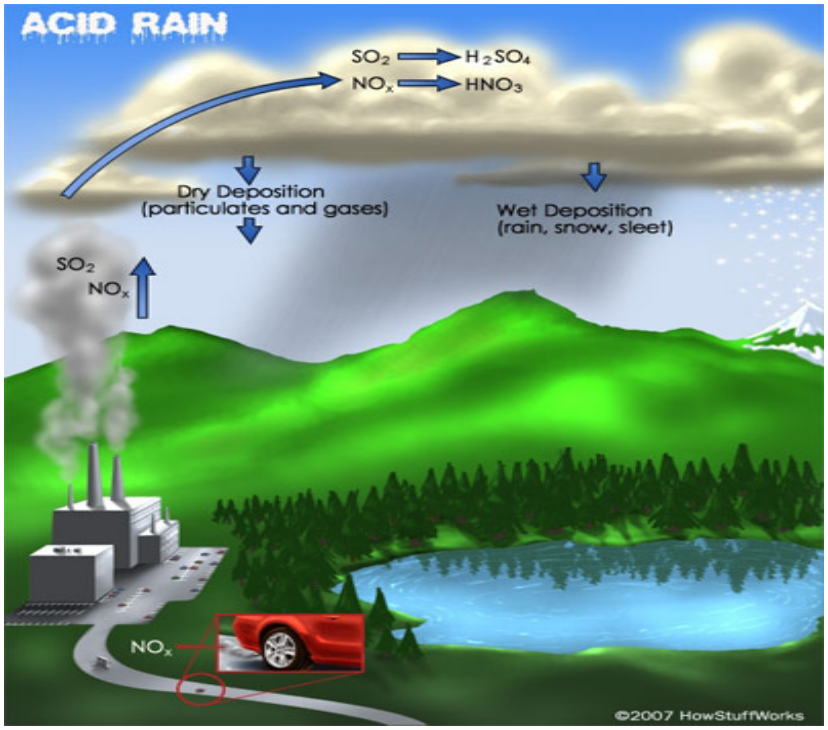

Figure 1 Formation of acid rain

Experimental Section

In this research, to study the physicochemical properties of rain water from Hinthada University Campus such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS),

Chloride (Cl^-), Sulphate (SO_4^{2-}), Nitrates (NO_3^-) were determined from August, 2009 to October 2010.

Determination of pH

pH meter (HANNA instrument) was used to the determination of pH in rain water samples by pH electrode and standard solution pH 7 was adjusted. Then samples were determined.

Determination of Total Dissolved Solids (TDS)

Total Dissolved Solid meter (HANNA instrument) was used to the determination of TDS in rain water samples. The TDS electrode was switched on and standard solution 1382 ppm was adjusted. Then samples were determined.

Determination of Electrical Conductivity (EC)

EC meter (HANNA instrument) was used to the determination of EC in rain water samples. The EC electrode was switched on and standard solution 1413µS/cm was adjusted. Then samples were determined.

Determination of Sulphate (SO_4^{2-})

Sample 10 mL was filled in test tube. One Sulphate Turb tablet was added in test tube, crushed and mixed to dissolve. A cloudy solution indicates the presence of sulphate. It was allowed to stand for 5 minutes. Wavelength 520 nm was selected on UV-visible Spectrophotometer.

Determination of Nitrate (NO_3^-)

Sample 20 mL was filled in Nitratest tube. One level spoonful of Nitratest powder was added. Then the tube was shaking well for one minute. Nitratest tube was allowed to stand for about one minute and gently invert to three or four times to aid flocculation. Nitratest tube was allowed to stand for 2 minutes to ensure complete settlement. Screw cap was removed and wipe around the top of the tube with a clean tissue. The clear solution was decants into a round test tube, filling to the 10 mL mark. One Nitricol tablet was added, cursed and mixed to dissolve. It took for 10 minutes to allow full color development. The wavelength of the spectrophotometer was set up to 570 nm.

Determination of Chloride (Cl^-)

Sample 10 mL was filled in test tube. One Acidifying tablet was added, crushed and mixed to dissolve. One chloridol tablet was added; test tube was allowed to stand for 2 minutes, crushed any remaining particles and mixed to dissolve. A cloudy solution indicates the presence of chloride. Wavelength 520 nm was selected on spectrophotometer. Use the light shield while taking readings.

Table 1 The effects of an acidified ecosystem on the natural environment

As water pH approaches	Effects
6.0	- crustaceans, insects, and some plankton species begin to disappear.
5.0	- the progressive loss of some fish populations is likely, with the more highly valued species being generally the least tolerant of acidity. - major changes in the makeup of the plankton community occur. - the water is largely devoid of fish
less than 5.0	- terrestrial animals, dependent on aquatic ecosystems, are affected. - waterfowl, for example, depend on aquatic organisms for nourishment and nutrients. - as these food sources are reduced or eliminated, the quality of habitat declines and the reproductive success of birds is affected.

Table 2 Elements, their acceptable level and hazard of human health

Contaminant	Maximum Acceptable level	Common Sources	Health Effects
pH	6.5-7.5	Natural environment	Damage of forest, building and human skin
Total Dissolve Solid	10 (ppm)	Erosion of naturally occurring mineral deposits	Gastrointestinal irritation in some individuals
Nitrate	10 (ppm)	Animal waste, fertilizer, natural deposits, septic tanks	Methemoglobulinemia (blue baby syndrome)
Calcium	1 (ppm)	Dairy products, beans, leafy vegetables	Rickets, osteomalacia
Manganese	1 (ppm)	Natural deposits	Staining of laundry, plumbing
Potassium	1 (ppm)	Vegetable, fruit ,nuts	Illness, injury, diuretic therapy, muscular weakness, paralysis, mental confusion

Results and Discussion

Rain water sample from Hinthada University Campus, Hinthada Township, Ayeyarwady Region in Myanmar was collected to study for physicochemical parameters, inorganic constituents and metals from August, 2009 to October, 2010. pH value in rain water samples is found to be 4.8 to 6.2. Therefore, samples are called “slightly acid rain”. Hence, the following results were determined.

Table 3 Metal (Na^+, Mg^{2+}, K^+ and Ca^{2+}) contents of rain water samples from Hinthada University Campus (2009-2010)

DATE	Na^+ (ppm)	Mg^{2+} (ppm)	K^+ (ppm)	Ca^{2+} (ppm)
24.5.10	2.733	0.896	0.559	1.269
9.6.10	3.033	0.638	0.481	0.669
14.6.10	**3.096**	**1.566**	**1.268**	**2.198**
31.7.10	1.512	1.041	1.057	1.574
12.8.10	0.968	0.214	0.117	0.471
17.9.10	5.873	1.342	0.378	1.969
8.10.10	4.077	0.944	0.157	1.904

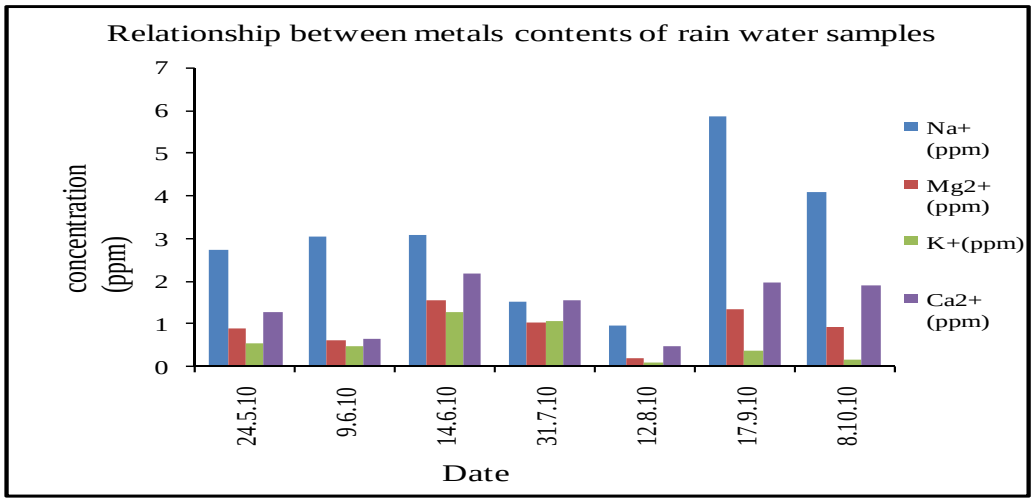

Figure 2 Relation between metal contents of rain water samples from Hinthada University Campus

Table 4 Relation between pH and Rainfall from Hinthada University Campus

Date	pH	Rainfall (mm)
24.8.09	6.2	12
29.9.09	5.3	12
24.5.10	5.6	18
25.5.10	5.6	14
9.6.10	5.4	28
14.6.10	5.7	20
31.7.10	5.6	40
12.8.10	5.2	33
17.9.10	4.9	10
8.10.10	4.8	9

Figure 3 Relation between pH and Rainfall from Hinthada University Campus

Table 5 Some physicochemical properties of rain water samples from Hinthada University Campus

Date	pH	Rainfall (mm)	TDS (ppm)	Cl^- (ppm)	EC (µS/cm)	SO_4^{2-} (ppm)	NO_3^- (ppm)
24.8.09	6.2	12	0	144	10	2.12	0.89
29.9.09	5.3	12	0	162	20	0.92	0.14
24.5.10	5.6	18	0	155	10	2.76	0.14
25.5.10	5.6	14	0	100	0	2.00	0.63
9.6.10	5.4	28	0	112	10	2.92	0.17
14.6.10	5.7	20	10	150	20	2.72	0.31
31.7.10	5.6	40	0	151	10	2.68	0.17
12.8.10	5.2	33	0	155	0	0.72	0.18
17.9.10	4.9	10	20	150	30	2.28	0.17
8.10.10	4.8	9	0	155	10	0.08	0.76

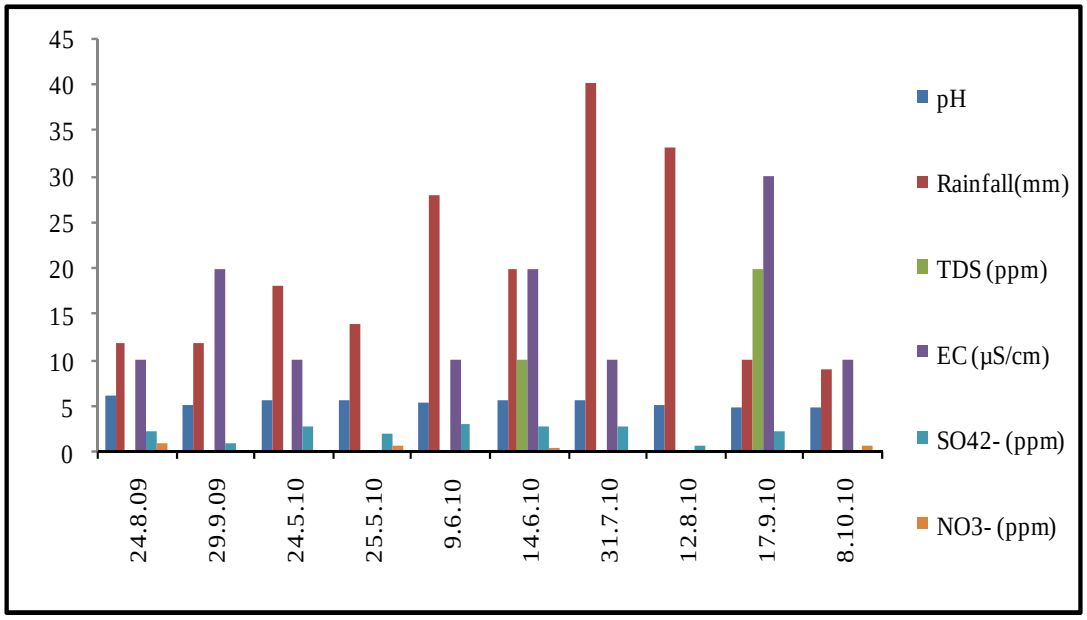

Figure 4 Some physicochemical properties of rain water samples

Table 6 Some parameters of water quality of rain water from Hinthada University Campus

No.	Elements	Normal Values	24.8.09	29.9.09	24.5.10	25.5.10
1	pH	6.5-7.2	6.2	5.3	5.6	5.6
2	Iron	0.3-1.0 (ppm)	0.045	0.11	0.65	0.165
3	Chloride	250 (ppm)	144	152	162	355
4	Chlorine	> 2 (ppm)	0.01	0.05	0.01	0.03
5	Alkalinity	> 20 (ppm)	35	45	39	35
6	Total Hardness	0-60 (ppm)	0	0	65	0
7	Ammonia	0.02 (ppm)	0	0	50	0.06
8	Nitrite	< 0.5 (ppm)	0	0	0.94	0.56
9	Nitrate	<0.01- 3 (ppm)	0.89	0.14	0.14	0.63
10	Fluoride	0.7- 1.7(ppm)	1.10	0.40	1.50	1.50
11	Sulphate	> 1 (ppm)	2.12	0.92	2.76	2.00

Table 7 Relationship between Hinthada,Yangon and Sittway of pH range

Date	Hinthada	Yangon	Sittway
24.8.09	6.2	6.3	6
29.9.09	5.3	5.6	5.5
24.5.10	5.6	4.3	5.3
9.6.10	5.4	4.5	4.8
31.7.10	5.6	5.1	4.8
12.8.10	5.2	4.9	5.1
17.9.10	4.9	5.1	5.4
8.10.10	4.8	4.7	5.5

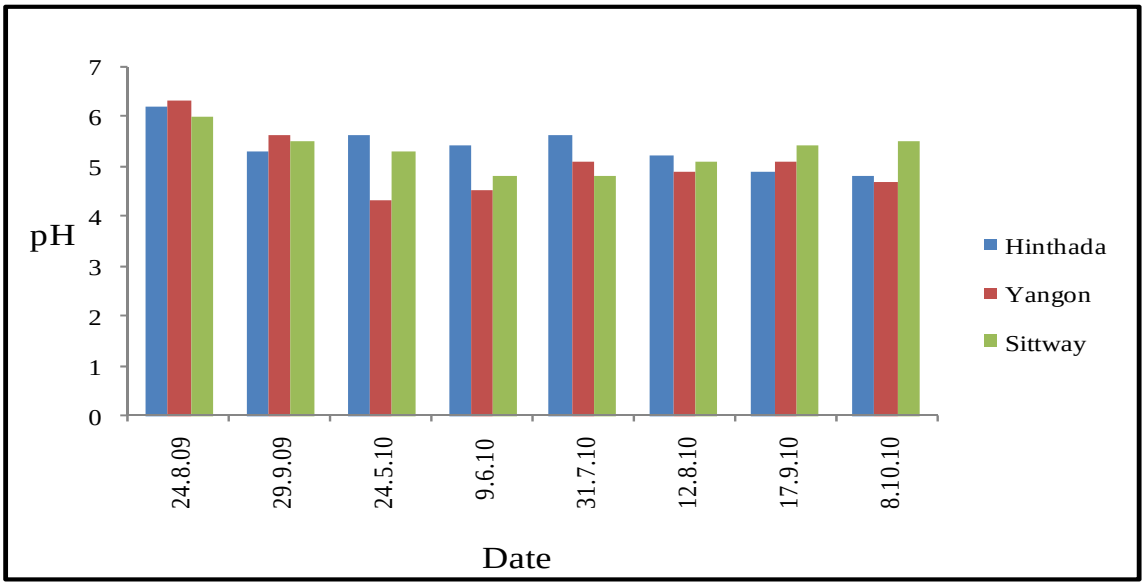

Figure 5 pH range compared in Hinthada, Yangon and Sittway

Conclusion

In this research, some physicochemical properties of rain water from Hinthada University Campus were investigated. It was observed that rain water samples of Hinthada University Campus were slightly acidic; their pH values were observed that between 4.8 and 6.2. The pH range of the rain water samples in Hinthada University Campus was higher than that of the other stations in Myanmar. Other physicochemical properties such as EC values 10 - 30 µS/ cm, TDS values 10-20 ppm, Chloride values 144-355 ppm, Sulphate values 0.08-2.92 ppm and Nitrate values 0.14-0.89 ppm were observed. The maximum values of Sodium, Potassium, Calcium and Magnesium were 5.873, 1.268, 2.198 and 1.566 ppm, respectively. It was anticipated that rain water on Hinthada University Campus is slightly acidic. Therefore, rain water in Hinthada University Campus does not hazard people live.

Acknowledgements

We wish to cover my sincere acknowledgements to Dr. Tin Tun Myint, Acting Rector, Hinthada University, Dr. San Lin, Pro-Rector, Hinthada University, for their permission to conduct this research work.

We also owed my deepest and heartfelt thanks to our colleagues, Department of Chemistry, Hinthada University, for their encouragement throughout my research work.

References

Aung Maung, (2006), "Myanmar's Environmental Status and its Concern over Acid-Deposition", Conference paper Submitted to Advisory Group Meeting of the Acid Deposition Monitoring Network in East Asia (EANET), Pathumtham, Bangkok, Department of Meteorology and Hydrology, Yangon, Myanmar

Daifullah, A.A.M., and Shakour, A.A., (2003), "Chemical Composition of Rainwater in EGYPT", Dokki, Giza, Egypt, 32-43

Daniel Beysens, (2009), "Dew and Rain Water Collection in South Croatia", *International Journal of Environmental Science and Engineering*, **1**, 64-70

EANET (2004), "Acid Deposition Monitoring Network in East Asia" *Journal of EANET*, **1,** 1-10

Kolthoff, I.M., and Stenger, V.A., (1947), "Volumetric Analysis", 2nd ed., Interscience Publishers, New York, 242-245

Rodhe, H., and Herrera, R., (1988), "Effects of Acid Deposition on Tropical Aquatic Ecosystems", John Wiley & Sons Ltd., North America, 141-166

Rossum, J.R., and Villarruz, P., (1961), "Suggested Methods for Turbidimetric Determination of Sulphate in Water", *J., Amer., Water Works Assoc.*, **53,** 873-890

Schwartz, S.E., (1989), "Acid Deposition; Unraveling a Regional Phenomenon", *Science,* **243**, 753 – 763

Scientific Advisory Group Meeting of Acid Deposition Monitoring Network in East Asia (2000), "Technical Documents for Wet Deposition Monitoring in East Asia", Tokyo, Japan, 1-67

Thomas, J.F., and Cotton, J.E., (1954), "A Turbidimetric Sulphate Determination", *Water Sewage Works*, **101,** 462- 480

Toshichi, O., (1996), "Acid Rain, Multiple Effects and Influences on Ecosystem", ADORC (Japan Global fund project), r*esearch journal*, **2**, 1-30

Zeng,Y., and Hopke,P.K., (1989), "A Study of the Sources of Acid Precipitation in Ontario", A*tmospheric* E*nvironment*, **23(7)**, 1499-1509

Online Materials

1. http://www.ei-cornell.edu/watersheds/ Acid Rain Experiments.pdf
2. http: //www. scar.utoronto.ca /~ weather/maryp/Effects/fish.html
3. http://www.ec.gc.ca/acidrain/acidwater.html
4. http://www.epa-gov/airmarkets/acidrain/experiments/exp7-html
5. http://www.unep.ch/ozone/ratif-html
6. http://www.cdphe.state.co.us/sdphereg.asp#wqreg.html
7. http://www.ga.water.usgs.gov/edu/acidrain.html
8. http://www.epa.gov/airmarkets/acidrain/index.html