AGROENVIRON 2000

2nd International Symposium on New Technologies for Environmental Monitoring and Agro-Applications

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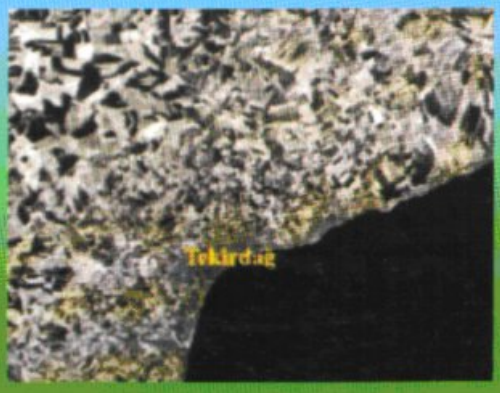

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VARIATION OF ACID PRECIPITATION AND ITS EFFECT ON BELGRAD FOREST IN ISTANBUL

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ABSTRACT

The air pollution is one of the most serious environmental problems of the world. It can cause acid precipitation, which destroys stoma and cell walls of vegetation. Especially, the vegetation is very important in cities. Therefore, the Belgrad Forest plays an essential role for people who live in Istanbul. In this study, the variation of pH, conductivity and SO_4^{-2} concentration of precipitation are analyzed from November 1997 to June 1998 with respect to duration and direction of rain at two stations samples in Istanbul, which were recorded at Maslak Campus of Istanbul Technical University (ITUCM), the urban area, and Forest Research Area of Istanbul University Faculty of Forestry at Bahçeköy (IUFFB). For this purpose, recording the precipitation period using a specially designed system the samples were collected. As a result, the concentration of SO_4^{-2}, pH and conductivity are measured much higher compared to measurements made at the other countries of the world. On the other hand, the yellow points are observed on pine needles in ITUCM because of the accumulation of acid fog and dew. It is found that the acid precipitations always come from west-northwest direction.

KEY WORDS: Acid rain, Ions, pH, Neutralization.

1. INTRODUCTION

Air pollution has important impact considering the urban and suburban areas. One of the air pollution effects is acid precipitation, which causes environmental problems in urban areas and rural areas due to mezo scale transport. One hand, air pollution can cause respiratory problems, leading to increased sickness absenteeism, increased use of health care services and even premature mortality. On the other hand, acidic deposition affects forest, metal structures and lakes. That's why; air pollution is under intensive discussion in all of the world (Adriano and Johnson, 1989; Bayçu, 1997; Şen, 1998). The aim of many studies on air pollution is to reduce the effect of pollutions. For example sulphur dioxide and lead emissions have been reduced since 1975 (Acid News, 1995; Cehak, 1986; Charles, 1995)

Another important target is the prevention of climate change. The international community is agreed that the increasing concentration of greenhouse gases in the atmosphere has led to an increase in the global temperature. The greenhouse problem surpasses all other air quality problems (Calvert, 1984; Carlson and Haines, 1989). Across Europe, strategies are being developed to reduce acidification and photochemical air pollution. An air emission ceiling for each country in the European Union is being agreed. In the area of climate change, there is good co-operation between the United States, The Netherlands and other EU Members States in the ongoing global negotiations (Cowling, 1982; Durham, 1990; Gatz, 1991).

It is very important for ecosystem the chemical composition of precipitation. Since 1970, it has been studying the effects of acidity in precipitation on ecosystem. Acid rain can cause by dry and wet deposition for damaging agricultural crops and forest. Dry and wet deposition of chemical spices at the surfaces provide one hand a natural sink for atmospheric trace substances, on the other hand a source of nutrients for the biological systems (Al Momani et al., 1998; Kantarcı and Karaöz, 1998). Moreover high acid concentration in precipitation can affect and increase the solubility and the availability of trace metal (Heck et al., 1986). The sulfur accumulation in Austrian pine needles in the ITU campus and in the Belgrad forest research and some yellow points are observed on pine needles in research area of Istanbul Technical University Maslak Campus (Öztürk, 1998).

The water quality influences the growth of plants. It is affected by chemistry of rainfall. For this reason, several studies on chemistry of precipitation were carried out in different countries.

The aim of this study is to estimate the chemical composition of precipitation, the source of air pollutants, and the determination of the effects of the acidity of precipitation on ecosystem in urban and in forest areas.

2. MATERIALS AND METHODS

The rain samples taken from ITÜ Maslak Campus, the urban area, and Forest Research Area of IÜ Faculty of Forestry at Bahçeköy were analyzed. After the initiation of precipitation, the samples were collected by recording the precipitation period using a specially designed system. According to this system, the rainfall was collected in the six collecting bottles with 10 min. interval.
The pH values and electric conductivity were measured just after the collections. The chemical analyses of rain samples were made at the Environmental Engineering laboratory of Middle East Technical University. Here, the analyses were carried out by the following methods: SO_4^{2-} ions by a Varian Model 2010 ion chromatography.
In order to determine the origin of rain, the trajectories of cyclones were analyzed. During the analyses of trajectories the synoptic maps (surface, 850 mb, 700 mb, 500 mb level charts), radio sounding and satellite picture were simultaneously used. In addition, time variant cross section analyses were carried out to determine third dimension for the trajectories. Hence, the error stemming from the level variations of the rain clouds were eliminated. In trajectory analysis rain samples were grouped in eight different directions having 45° of intervals.

3. RESULTS AND DISCUSSION

Precipitation samples collected at two stations in Istanbul from November 1997 to Jun 1998 were analyzed to asses the chemical composition of rainwater and its changes with time and directions. The results are evaluated separately with respect to duration and direction. The results include the Weibull, log-normal and exponential distributions. During the six-month period, 89 rainy days were observed. After the grouping the statistics are obtained as follows: 31 % of rain came from west-southwest, 24 % from north-northwest, 19 % from north-northeast, 16 % from west-northwest, 9 % from south-southwest and 1 % from south-southeast intervals. It is found that the precipitation samples having low pH values came from west-northwest, west-southwest and south-southwest directions.
As seen in Figure 1, the precipitations are acidic from January to March during the measuring period. During the rest of the months pH values are higher than 5.6. The samples with high electrical conductivity came from south-southwest, west-southwest and north-northwest directions. Figure 2 shows the variation of measured electrical conductivity values. High content of SO_4^{2-} ions came from south-southwest directions. Comparison of samples of the first ten minutes with the samples of 10-20 minutes indicated that, during the first ten minutes there is a considerable washing out of pollutants in the atmosphere.

Hata! Bağlantı geçersiz.
Figure 1. pH values in observations period in Istanbul.

Hata! Bağlantı geçersiz.
Figure 2. Conductivity values in observations period in Istanbul.

Observations and the measurements indicate that there are high SO_4^{2-} concentrations in Istanbul precipitation (Fig. 3). High SO_4^{2-} concentrations are neutralized by alkaline resulting in low average acidity. Comparison with the several cities around the world leaded to the fact that there are higher ion concentrations in Istanbul's precipitation. The results obtained with this originally designed system are going to form a database for new studies and will open new horizons.

Hata! Bağlantı geçersiz.
Figure 3. SO_4^{2-} concentration values during observation period in Istanbul.

The major ion concentration are high but also pH values are high this is neutralizes probably due to the presence of the $CaCO_3$. Indeed calcium is absent from west region of Istanbul. Table 1 shows the comparison of measured ion concentrations of the present study and elsewhere. Table 1 indicates high ion concentrations in Istanbul region from the other locations.

Table 1. Main ions concentrations in various stations in the world (μeq/l).

Station	Period	pH	H^+	Cond.	SO_4^{2-}	NO_3^-	Cl^-	Mg^{2+}	Ca^{2+}	Na^+	K^+	NH_4^+
ITÜMK[1]	Oct. 1997-May 1998	6,34	0,54	121	468	100	160	101	1887	215	30	170
IÜOFAO[1]	Oct. 1997-May 1998	6,28	1,8	-	549	93	160	236	1041	200	16	82
Antalya[2]	Jan. 1992-Dec. 1992	5,17	6,76		66	70	390	94	140	450	121	50
Ankara[3]	Sep. 1989-May 1990	6,1	3,7		150	62		-	210	21	19	12
Izmir[4]		5,64	2,33		66	23	117					22
Bahçelievler[5]	Jan. 1996-Nov. 1996	6,5			712	140			188			
Florya[5]	Jan. 1996-Nov. 1997	6,1			397	445			150			
Göztepe[5]	Jan. 1996-Nov.1998	6,3			281	511			251			
Colmar[6], France	Sep. 1991-Mar. 1992	5,7	10	60	147	78	167	16	166	70	83	140
Netherlands[7]		4,1	79		140	47	313	90	60	290	28	78
Albany[8], New York		4,09	81		68	45	8	3	10	5	6	17
Ontario[9], Canada		4,28	53		64	11	5	3	13	3	1	17
Matsue[10], Japan		4,72	19,1		165	16,9			28,3	130		19,5
Chorgcing[11], China		4,44	36,3		165	18	23	18	42	45	23	64

([1]Toros, 2000, [2]Al-Momani and et al., 1995b, [3] Tuncel and Ungör, 1996, [4] Al-Momani and et al., 1995a, [5]Gülsoy and et al.,1997, [6]Sanusi et al.,1986, [7]Schuurkes and et al., 1988, [8]Khwaja and Husain 1990, [9] Zeng and Hopke 1989, [10]Amaguchi and et al. 1991, [11]Zhao et al., 1988)

4. CONCLUSIONS

The pH, electricity conductivity and SO_4 concentrations are measured in two locations in Istanbul. Moreover, the effects of the chemical composition of precipitation on the leaves are analyzed and observed by this study. Consequently, results of this research are as follows:

- The average pH values are always higher than 5.6, which is the critical limit for acidity.
- During the measuring season, 23 % of all precipitation is acidic.
- Some yellow points are observed on pine needles in research area of Istanbul Technical University Maslak Campus.
- The chemistry of precipitations has to be measured continuously and a measuring network system must be built in Turkey.
- The chemistry of rainfall must be measured above and below the canopy at the same time with the same level meteorological measurements. The relationships between the meteorological parameters and pollutant must be studied.
- Observations and the measurements indicate that there are high anion and cation concentrations in Istanbul precipitation. High SO_4^{2-} concentrations are neutralized by alkaline resulting in low average acidity. Comparison with the several cities around the world leaded to the fact that there are higher ion concentrations in Istanbul's precipitation. The results obtained with this originally designed system are going to form a database for new studies and will open new horizons.
- The pH values of precipitations in ITUCM and IUFFB are minimum 4.64 and 4.99, maximum 7.42 and 7.57 respectively. The frequency distribution of pH values histograms is estimated about 7.
- The neutralized effects of some ions in precipitations are maximum from west-northwest. The main reason of neutralization of precipitation can be caused by geological structure of the research area.

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