APPROPRIATE ENVIRONMENTAL AND SOLID WASTE MANAGEMENT AND TECHNOLOGIES FOR DEVELOPING COUNTRIES

VOLUME 5

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Günay Kocasoy
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International Solid Waste Association
BOĞAZİÇİ UNIVERSITY

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MONITORING OF ACID RAIN AND DROUGHT OVER THE THRACE REGION OF TURKEY

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ABSTRACT

In the last decades, different types of natural disasters have occurred all over the world. Most of them are originated from extreme atmospheric conditions, such as drought, acid rain, flood, hail, forest fire, etc. These conditions are evaluated by some scientists as a result of the climate change. For this purpose, a research project has been proposed to analyse the different effects of the meteorological conditions in Thrace region. In this study, a special designed rain gage system was used to collect the rainwater samples for detailed examination of the rain water chemistry of four locations, namely Kırklareli, Tekirdağ, Orhaniye/Edirne and İstanbul in the Thrace region. Beside this, monthly average precipitation was used to determine the drought levels for 31 locations in the region by two different drought indexes. The precipitation regime for the same locations was determined by using trend, principal components and harmonic analysis.

KEYWORDS

Precipitation chemistry; acid rain; drought; rain regime.

INTRODUCTION

One of the important environmental problems in the world is the global warming and its impacts on the ecosystem. Most countries have some responsibilities for the present situation. The increments of greenhouse gas concentration cause changes in our climate. Both hemispheres are not going to be affected equally from the climate change. There is no limitation to those gases so that the life in all countries is under the direct or indirect effects of them. In recent years, some needful steps are taken to reduce the pollutant emissions at the global scale. Because of the aforementioned reasons, a lot of scientists have focused to predict the climatic change and to estimate their effects on our life by using General Circulation Models (GCMs). According to some GCM scenarios, while temperatures will increase, amount of rainfall will decrease and soil water contents will change within the next 100 years for regions with semi arid conditions like Turkey (IPCC, 1998).

Since the beginning of the industrial revolution, atmospheric concentrations of green house gases (especially CO_2 amounts) have increased steadily. These increases have enhanced the heat-trapping capability of the earth's atmosphere. As a result, global mean surface temperatures have been increased since the late 19th century. The increment of the global temperature in the atmosphere causes to rise the sea level. Beside this, precipitation and evapotranspiration patterns will also change. Furthermore, affected regional climate could alter crop yields and water quality due to the variation of the precipitation chemistry. It could also affect ecosystems to a grade degree. For this reason, many studies have been performed to estimate the effects and the sources of air pollution (Fujita et al., 2000; Lee et al., 2000; Zhao et al., 1988). Additionally, several studies have been conducted on chemical composition of precipitation (Toros et al., 2000; Kaya and Tuncel, 1997). On the other hand, the ion concentrations of natural rainwater can vary with the time and duration of precipitation.

Primary result of the global warming may be drought for semi-arid countries like Turkey. Any lack of rainfall will have some economic, social and environmental impacts. That's why, any kind of drought may adversely affect agriculture and related areas. Analysis of the rainfall potential and variation of the Thrace region is very important, because this area plays a vital role on the agricultural and industrial economy of Turkey. In the world, drought is monitored sensitively on semi-arid areas to estimate the reason of possible agricultural yield decreases. This information is very needful for planning of future (Şaylan et. al., 2001).

By evaluation the aforementioned considerations, goals of this study are selected as follows:

- Measuring the chemical composition of rainwater
- Estimation of precipitation regime
- Calculation of drought indexes.

EXPERIMENT AREA AND MEASUREMENTS

Data from the chemical composition of rainwater are measured and collected by special designed rainwater collectors. These collectors have been established in

- Istanbul, at the Maslak Campus of Istanbul Technical University.
- Kırklareli, at the field of Kırklareli Atatürk Rural Research Institute.
- Tekirdağ, at the research area of Agricultural Ministry Wine Research Institute.
- Edirne, at the research farm of Kırklareli Atatürk Rural Research Institute in Orhaniye/Keşan.

In addition to the station data, the precipitation data of 31 meteorological stations in Thrace region have been collected. Figure 1 shows the locations of these stations on the map of Turkey. Figures 2 a,b,c,d,e show the installed measuring systems in Istanbul, Kırklareli, Tekirdağ and Orhaniye/Edirne, respectively.

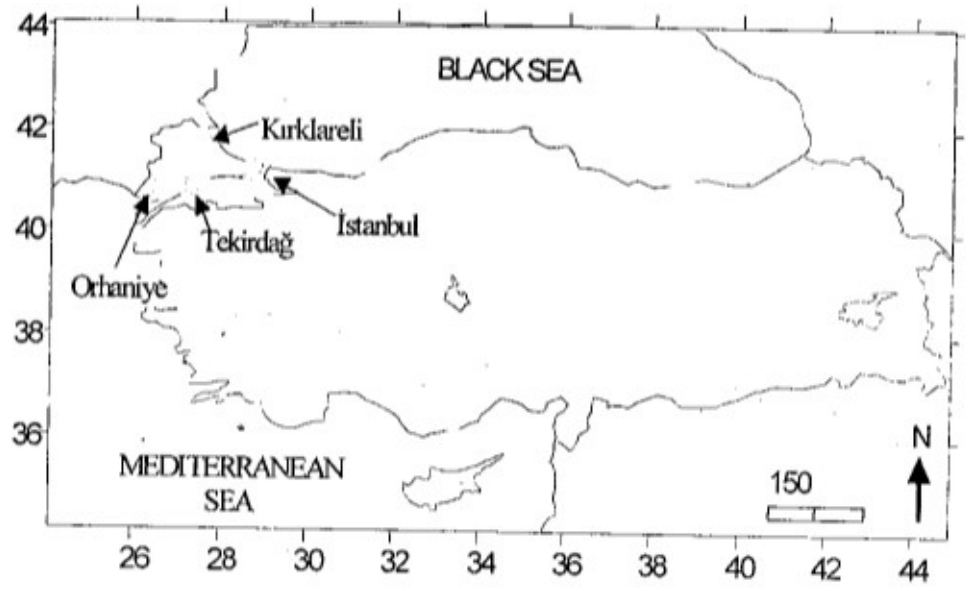

Figure 1. The locations of the measurement systems.

In this study, the following measuring systems and methods have been used:

- Rainwater samples are collected by using a specially designed system during the monitoring period (Şaylan et. al., 2001). The system consists of a rain gauge (TE 525 Tipping Bucket), a data-logger (CR10x, CR23x Campbell), five solenoid valves and polyethylene storage bottles (PE). According to this system, the rainfall is collected in the six collecting bottles with 10-min. interval.
- Rainwater collector system is used in Istanbul, which collects from 0 to 60 minutes rainfall samples for 5 different bottles with a CR10x data logger. Meanwhile, additional meteorological data have been collected by an automatic weather station.
- Rainwater collector system is used in Kırklareli, which collects the desired rainwater samples sequentially. No data logger has been used in this system.
- A CR23x data logger and an additional NO_2 analyser are used in Tekirdağ, which samples were measured in this station by using rainwater collector system.
- Finally, an automatic system has been established in Orhaniye/Keşan (the same system as in Istanbul).
- Meteorological maps and remote sensing data have been used to estimate the possible source of the air pollution in this region.
- Soil water contents from 4 stations are measured every 15-days in different depths of soil.

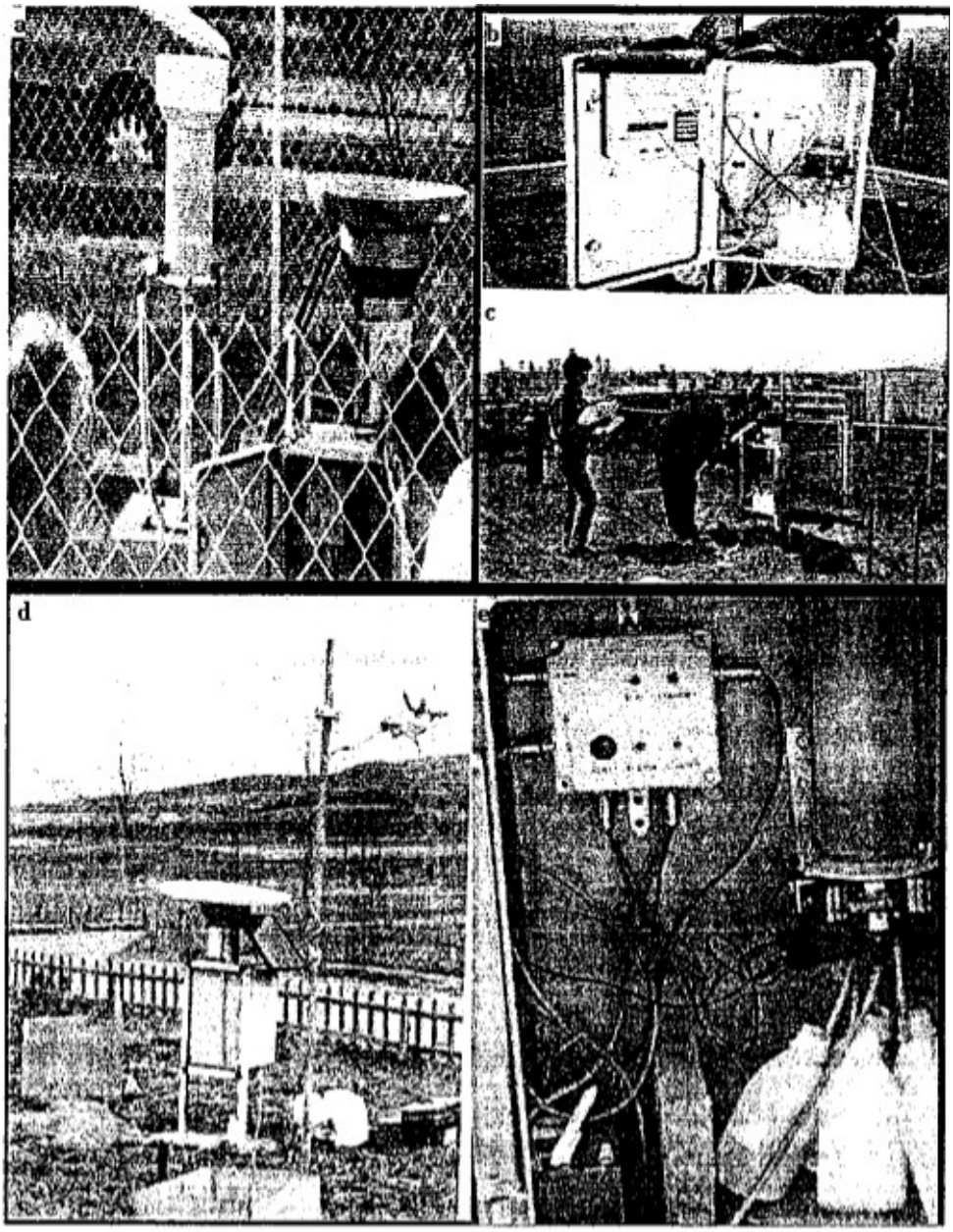

Figure 2. Measuring systems in the Thrace region a) Kırklareli b) Tekirdağ c) İstanbul d) Orhaniye/Edirne e) Specially designed rainwater collector (Şaylan et. al., 2001).

The methods can be summarised as follows:

- Estimation of precipitation regime: Principal component, harmonic and trend analyses.
- Analysis of the precipitation chemistry: pH, EC, anions (SO_4^{2-}, NO_3^- and Cl^-) and cations (Na^+, Mg^{2+}, K^+, and Ca^{2+}).
- Determination of the drought level: Percent of precipitation and standardised precipitation indexes.

RESULTS AND DISCUSSION

This project is the first experimental project related with this topic in Thrace region of Turkey. On the other hand, the sequential samples of rainwater were analysed for the first time through so long time period in this region.

For this reason, the results will be very useful and needful for this research area. In this project, it has been cooperated with Kırklareli Atatürk Research Institute.

In addition to the aforementioned goals, meteorological maps and remote sensing data have been used to estimate the possible source of the air pollution in this region. Furthermore, pH, EC, anions (SO_4^{2-}, NO_3^- and Cl^-) and cations (Na^+, Mg^{2+}, K^+, and Ca^{2+}) of collected rainwater samples are being analysed. The back trajectory analysis has performed by using meteorological maps.

This project is still going on and will be finished at the end of 2002. The following figures give the basic results of the analysis. All of the results are going to be evaluated after the measurements were completed.

The following figures are given in order to make basic interpretations of the numerical data that were handled above.

The total precipitation amount of Kırklareli is 218 mm between 10 October 2000 and 13 May 2001 (Figure 3). Figure 4 shows that the variation of daily average pH values in Kırklareli from 12.11.2000 to 27.04.2001.

As seen in Figure 4, pH values are over 5.6 except one day. On the other hand, Figure 5 gives the first result of the harmonic analysis for Thrace region.

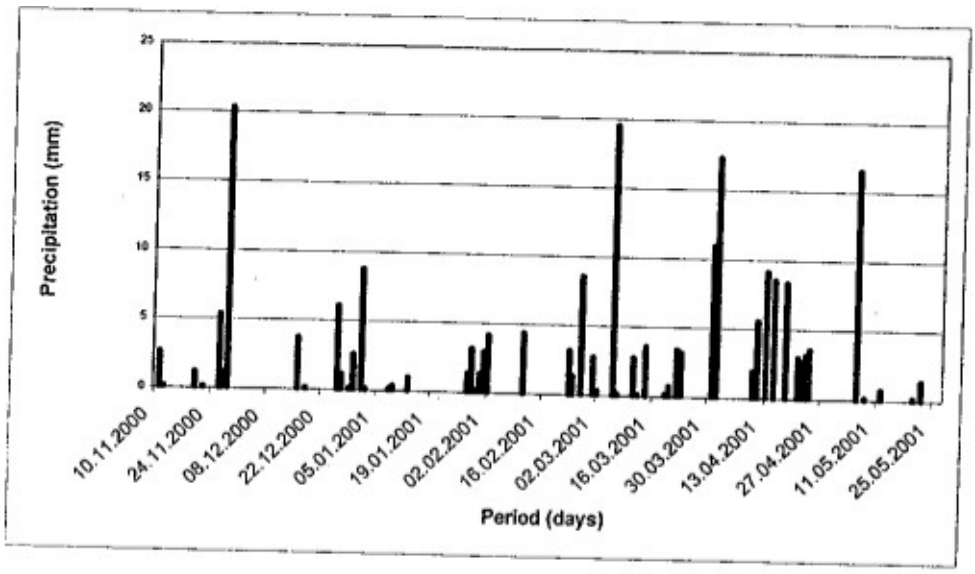

Figure 3. Variation of precipitation amounts in Kırklareli (Şaylan et. al., 2001).

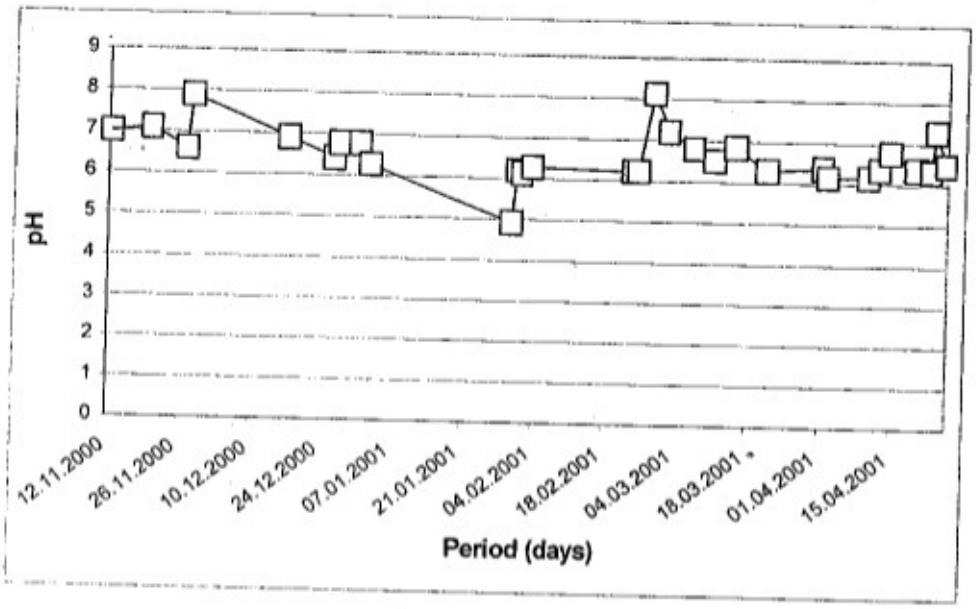

Figure 4. Variation of pH values in Kırklareli (Şaylan et. al., 2001).

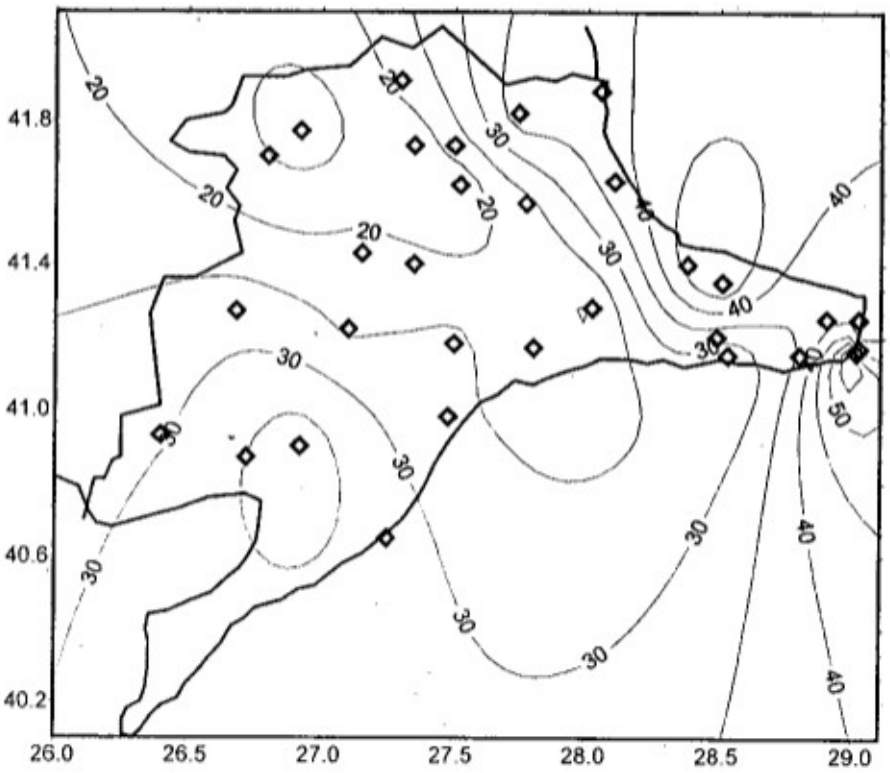

Figure 5. Results of harmonic analysis on precipitation data for the Thrace Region.

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REFERENCES

Fujita S. I., A. Takahashi, H. H. Weng, L. F. Huang, H. K. Kim, C. K. Li, F. T. C. Huang and F. T. Jeng, "Precipitation chemistry in East Asia", *Atmospheric Environment* Vol. 34, pp. 525-537, 2000.

IPCC, The Regional Impacts of Climate Change; An Assessment of Vulnerability, A Special Report of IPCC Working Group II, Cambridge University Press, 1998.

Kaya G. and G. Tuncel G., "Trace Element and Major Ion Composition of Wet and Dry Deposition in Ankara, Turkey". *Atmospheric Environment* Vol. 31, 3985-3998, 1997.

Lee B. K., S. E. Hong and D. S. Lee, "Chemical Composition of Precipitation and Wet Deposition of Major Ions on the Korean Peninsula", *Atmospheric Environment* Vol. 34, pp. 563-575, 2000.

Şaylan, L., O. Şen, M. Kadıoğlu, K. Koçak, H. Toros, B. Çaldağ, F. Bakanoğulları, F. Avşar and Ş. Akbay, Determination of Drought, Acid rain and Precipitation regime in the Thrace Region. İ.T.Ü. Research Found Project, I. Project Report, Istanbul, 2001 (in Turkish).

Toros H., Acid rain sources and effects in Istanbul. Ph.D., Dissertation, Istanbul Technical University, Department of Meteorology, Istanbul, pp. 97, 2000.

Zhao D., Xiang J., Xu Y., Chan W. H., "Acid Rain in Southwestern China", *Atmospheric Environment* Vol. 22, pp. 349-358, 1998.