The Effects of the Air Pollution Observed in Winter with Regard to Water and Soil Resources in Erzurum Site

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Abstract: On Erzurum site, usage of fossil fuels for artificial heating causes atmospheric pollution and especially by means of precipitation it plays an important role on pollution of soil and water sources. This study has planned to indicate the dimension of precipitation transmissions. In this study, the concentration values of SO_2 and PM before and after precipitation through 2003-2008 winter seasons were analysed. It appoints a negative relationship between SO_2 and PM concentrations with winter precipitation; and their correlation coefficients are -0.138 and -0.150 respectively. In order to examine the effects of precipitation on reducing of SO_2 and PM concentrations, t-paired tests were performed. It adjusts that, precipitation affect reducement of SO2 and PM concentrations with $p<0.01$ significance level. As a consequence, it indicates that the polluted air can affect the east side of Erzurum plain and Sakalıkesik plain negatively in Erzurum where winters are long and tough.

Keywords: air pollution, water, soil, Erzurum

Introduction

Air pollution means exceeding the normal limit of foreign substances in the air by means of density and abundance which can cause material damages and also affect health of livings negatively. (Güler and Vaizoğlu 2006). World Health Organisation (WHO) defines air pollution as existing of sand, dust, ash, fume, fog, smoke, steam, gas, scent, which can damage humans, plants and animals and also affect lifestyles excessively, around surrounding atmosphere in quantity, characteristics and in time (WHO 2000).

As being most common possible contaminating elements, NO_x and SO_2 complete their enchaining reactions by constitution of nitric acid (HNO3) and sulphuric acid (H_2SO_4), as a result of gas cycle after oscillation to atmosphere and finally, they fall down to soil surface as acid rains (Al-Khashman 2009).

The detrimental effect of PM changes due to physical and chemical contents. Also merging with humidity in the atmosphere, PM converts into acid and it composes acid damage. By including heavy metals such as Ni and Cd, PM makes toxic effect on livings by meddling into soil and water (Başar et al. 2005; Cole et al. 2005; Turalıoğlu 2005; Dietz et al. 2007; Beyhun et al. 2008; Der Duh et al. 2008;).

The contaminating elements in the air can move quickly and horizontally via airflows along cities, countries and even continents (Kurita et al. 1985; Jaffe et al. 1999; Givati and Rosenfeld 2004). After carried in the atmosphere, the contaminators fall on soil, water, buildings etc by a range of process like decantation, dilution and chemical reactions.

Atmospheric deposition velocity values can be different according to deposit surfaces or meteorological parameters. Wet deposition occurs by any hydrometeor effect and dry deposition occurs without this effect, only the effect of gravity is efficient. In wet deposition, a mechanism which on the one hand with contraction by water drops (rainout) and on the other hand sweeping with drops (washout) which are on the ground cause alienation of PM and other gases from atmosphere. Thus, plant, water and earth surfaces become polluted. In this way it causes, livings, microorganisms on or in the polluted surfaces and the insects like birds, bees and snails which are fed with pollens, to die in masses from time to time.

The polluted water which fall on earth combine with surface water by the help of floodwater or combine with groundwater with the substances in the soil (Güler ve Çobanoğlu 1994). During the way to ground, according to the kind of geologic formation and deepness, it is exposed to filtration process and it feeds wells, lakes, rivers and seas which are located in the region where geological formation is saturated. To sum up, like other contaminators, the final place of air contaminators is water so water is exposed to pollution more than any others easily and quickly.

As a result of falling of acid and other substances which constitute acid with rains, remains H^+ ion in the soil. Being replaced by these ions, the ions like Ca^{++}, Mg^{++}, Na^+, K^+ and NH^+ leave their place on the soil surface and move to soil solution (Güler ve Çobanoğlu 1997).

Although there is not intensive industrialisation in Erzurum, the increasing number of vehicles, cement and sugar factories form some part of air pollution source. The main reason for air pollution in Erzurum is the usage of fossil fuels for heating (Turalıoğlu et al. 2005; Beyhun et al. 2008). Despite the usage of natural gas since 2004 partially, using of poor quality coal is still a big problem. As a result of the wind which blows south and west directions, carries the polluted air to the eastside of Erzurum and Sakalıkesik plains.

This study took place in order to indicate the important effects of the convection of air pollution parametres SO_2 and PM and their negative effects on soil and water sources during the years between 2003 and 2008 in Erzurum.

Material and Method

Erzurum, located in the Eastern Anatolia is situated on a plateau surrounded by high mountains at north (Gavur-Dumlu mountains, 3200m), south (Dumanlı-Plandöken mountains, 3125m) and east (Eğerlidağ, 2974m). The height of this plateau is 1950m above the sea level and the city population is about 450000 (Fig. 1).

The risky places which are located in the is a north and east of city centre in terms of exposure to air pollution, Erzurum and Sakalıkesik plains have altitude 1850m and 1750m respectively, it means that lower than city centre.

Erzurum is located in the terrestrial climatic zone as a result mean daily temperature is 5.9°C, coldest month is January with -8.7°C and the hottest month is August with 19.5°C. Average annual precipitation is 447mm; at most in May with 73.1mm, at least in August with 18.7mm. 43.78% of average annual precipitation takes place in October-March period. The highest relative humidity values take place in December and January with 76% and lowest values accrue in August with 47% and average annual relative humidity is 64%. In the research area wind speed is 2.6 m/s. Some meteorological parameters of study area are given in Table 1.

In this study SO_2 and PM values, which are the factors of air pollution take place between 2003-2004 and 2007-2008 winter seasons, have been analysed with wet days and precipitation amounts together. The data were obtained from General Directorate of Meteorology. SO_2 and PM values were evaluated in 12 different regions (Fig. 1) twice a day, in the morning (08.00-09.00) and in the evening (16.00-17.00) and in this way average daily values were obtained. SO_2 and PM values were observed in October-January winter season between 2003-2004 and for the other years, values were observed in October-March winter season because of legislative changes.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Ave. Temp. (°C)	-8.7	-7.2	-2.6	5.2	10.7	14.4	19.3	19.5	14.9	8.3	1.4	-5.1
Min. Temp. (°C)	-36.0	-37.0	-32.2	-18.5	-7.0	-3.2	-1.8	-1.1	-6.8	-12.0	-28.0	-35.0
Relative Hum. (%)	76	75	74	65	61	56	50	47	50	61	72	76
Precipitation (mm)	24.7	28.9	35.2	53.3	73.1	52.0	29.2	18.7	25.0	47.5	36.8	22.6

Average wet day	11.5	11.1	12.3	13.3	15.8	11.1	6.6	4.8	5.0	9.2	9.5	10.6
Days with snow cover	29.4	26.5	21.5	4.0	0.2	-	-	-	0	0.9	6.4	23.2
Ave. wind speed (m/s)	2.4	2.5	2.5	3.1	3.2	3.2	3.6	3.3	2.6	2.5	2.4	2.0
Prevailing wind direction	E	ENE	ENE	SSW	WSW	ENE	ENE	ENE	ENE	WSW	WSW	ENE

Table 1. Some meteorological parameters of study area

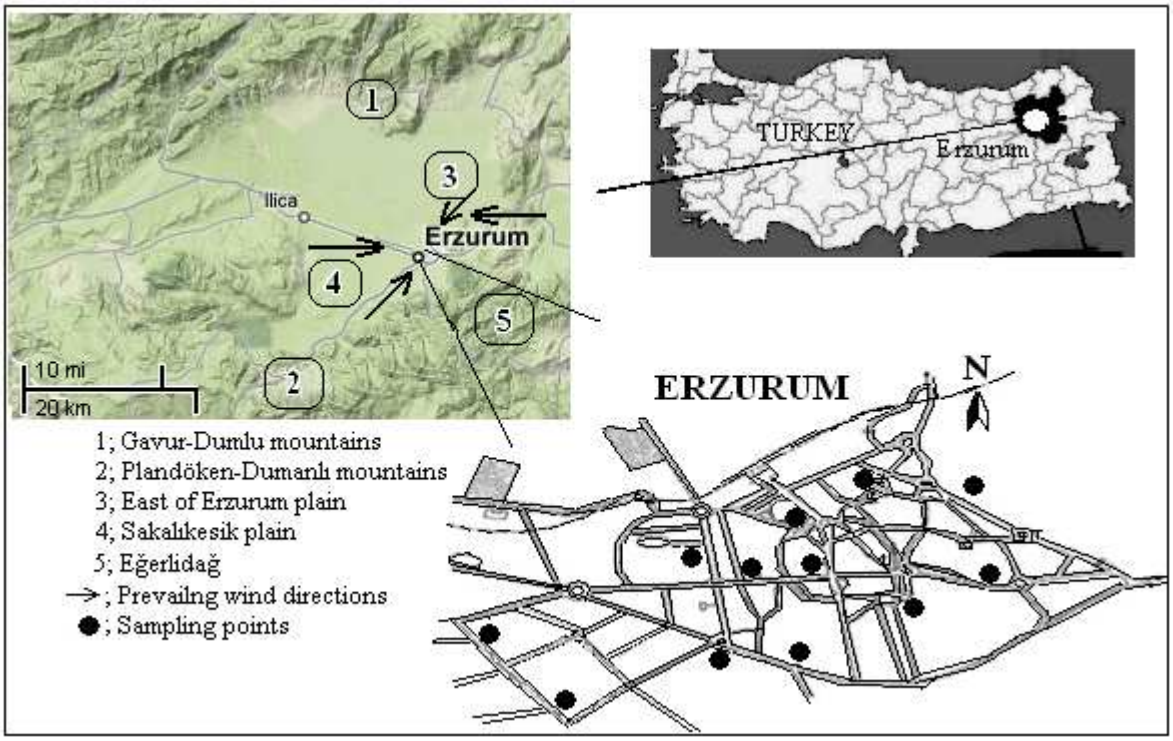
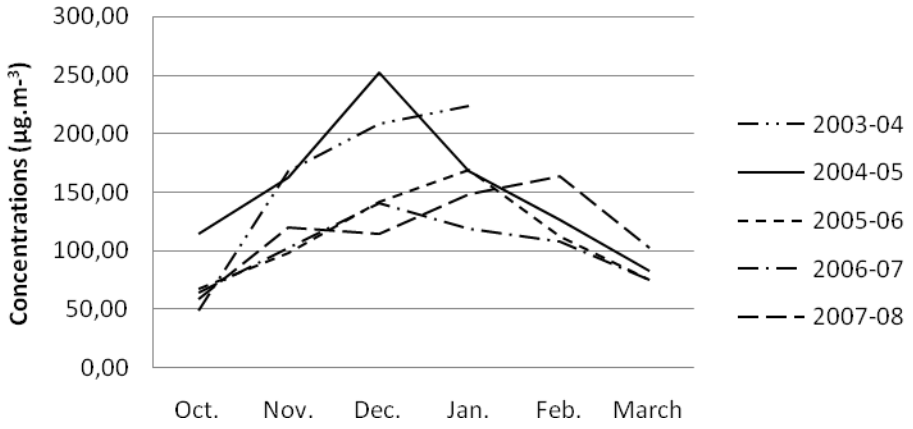


Figure 1. Map of the study area

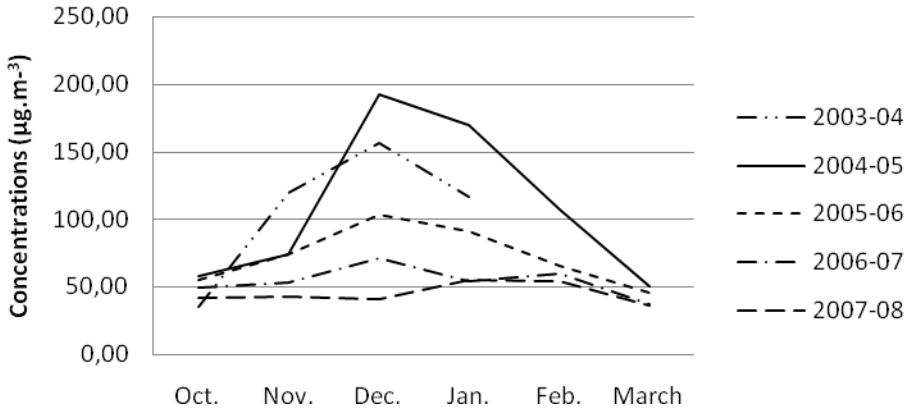
In order to determine the relationship between SO_2 and PM concentrations with precipitation amounts, regression tests and Pearson correlation tests were performed by using the program SPSS 15.0. Also in order to indicate the effects of precipitation on daily SO_2 and PM concentrations, t-paired methods were applied.

Results and Discussion

In Erzurum between the years 2003-2008 winter seasons, monthly average of SO_2 and PM concentrations are shown in Figure 2.



(a)



(b)

Figure 2. The change of SO_2 (a) and PM (b) concentrations in winter periods of 2003-2008.

As shown in the figure, the peak time for SO_2 and PM concentration values is 2004-2005 winter season and the values are minimum in 2007-2008 winter season. Generally, the highest levels take place in December and secondly in January. This study shows parallelism with the studies took place in 1995-2002 by Turalıoğlu et al. (2005) and in 2003-2006 by Beyhun et al. (2008). Because of artificial heating needs continue till mid-May, the SO_2 and PM concentration values are lower in October than March. As shown in the Figure, air pollution shows roll-off rate from the year 2003 to 2008. The main reason of this decline is the increase of using natural gas for heating. Beyhun et al. (2008) claims that the lowest pollution took place in 2006 between the years 2003-2006 because natural gas usage began that year.

Average annual precipitation is 2.38mm, maximum precipitation level is 38.3mm and minimum level is 0.1 mm during the observed years. Pearson correlation analysis shows a negative relationship between precipitation amounts and SO_2 and PM concentrations. It designates coefficients between precipitation amounts and SO_2 concentration as ρ=-0.138 and between precipitation amounts and PM concentration as ρ=-0.150 under $p<0.01$ significance level. Turalıoğlu et al. (2005) defines this relationship as ρ=-0.137 for SO_2 and ρ=0.075 for PM. Regression analysis shows equations dependently to precipitation (P) as;

SO_2=109.996-1.863P and
PM=59.901-1.602P.

In order to examine the effects of precipitation on SO_2 and PM concentrations, the concentration values of before and after precipitation were analysed by paired-t test. Results of evaluation are shown at Table 2.

There has not been any study on the chemical content of winter precipitation in Erzurum. On the other hand, it is determined by Turalıoğlu et al. (2008) during a study around Erzurum, that measured PM includes Si, Ca, Al, Fe, S, K elements with high levels. The other studies throughout the world indicates that for places having combustion sourced air pollution, by wet deposition Mg and Na anions and cations fall to the rural and urban areas (Lee et al. 2000, Flues et al. 2002; Der Duh et al. 2008). For the period between March 13 and June

29 2002, maximum 299.1 μeq/l and 67.4 μeq/l SO_4 and NO_3 anions respectively were measured in precipitation (Bayraktar et al. 2004).

	SO_2	PM
n_i	344	349
$\bar{D}$	+18.1824	+10.3953
$S_{\bar{D}}^2 = \frac{\sum_{i=1}^{n}(D_i - \bar{D})}{n-1}$	3333.818	2376.443
$S_{\bar{D}} = \left(\frac{S_{\bar{D}}^2}{n}\right)^{1/2}$	3.113	2.609
$t_h = \frac{\bar{D}}{S_{\bar{D}}}$	5.841	3.984
t_c	2.568	2.568
p<0.01, null hypothesis (H_0); μ_b-μ_a=0 and alternative hypothesis (H_1); μ_b-μ_a>0 *		
*Since the expectation of precipitation will reduce the SO_2 and PM concentrations, one-tailed alternative hypothesis was set up.		
$t_c < t_h$; Therefore, it was rejected the null hypothesis of no difference.		

Table 2. The results of paired t-test

The east of Erzurum plain and Sakalıkesik plain are located near settlement premises, so because of winds, air pollutants were carried and with winter rains considerable amount of air pollutants blend in with soil and water sources. As a result of this fact, earth can be directly affected chemically and physically or underground and surface water sources can be polluted by runoff or drain away from soil.

Conclusion

Around Erzurum area, a fuel for artificial heating is used till mid-May. The air pollutants are carried eastern Erzurum plain during April, October and September and to Sakalıkesik plain during December, January, February and March. The entrained pollutants which fall on soil by deposition are an important subject statistically. The researches for air pollution effects directly and indirectly on agriculture should concentrate on production costs, market values and social effects apart from the environmental impact analysis.

In Erzurum, the first reason of air pollution is the usage of fossil fuels for heating. That's why in order to decrease the air pollution level, "Turkish Air Quality Protection Regulation" should be implemented effectively and for artificial heating natural gas or other sources which are not harmful to environment should be used widespread.

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