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STATISTICAL ANALYSIS OF METEOROLOGICAL FACTORS AND AIR POLLUTION AT WINTER MONTHS IN ELAZIĞ, TURKEY

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Abstract: In the present study, relationship between monitored air pollutant concentrations such as SO_2 and the total suspended particles (TSP) data and meteorological factors such as wind speed, temperature, relative humidity and atmospheric pressure was investigated in months of October, November, December, January, February, and March during the period of three years (2003, 2004 and 2005) for Elazığ city. According to the results of linear and non-linear regression analysis, it was found that there is a moderate and weak level of relation between the air pollutant concentrations and the meteorological factors in Elazığ city.

Keywords: Sulphur dioxide; total suspended particles (TSP); meteorological parameters; statistical analysis; Elazığ; Turkey; winter months

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INTRODUCTION

The air pollution in urban areas has different characteristics on account of the changing meteorological factors depending on the geographical and topographical peculiarities of the urban area. The level of the air pollution concentrations is correlated with the combination of the various meteorological factors. For that reason, the air pollution concentrations and meteorological data should be evaluated statistically in order to correlate them (Demirci & Cuhadaroglu, 2000).

Given a set of observations from air monitoring and meteorological stations, calculating statistical relationships among the variables is possible by using some statistical techniques such as regression analysis. Some statistical models establish how close relationships are between concentration estimates and values actually measured under similar circumstances. Effects of all factors that determine atmospheric pollutant concentrations are implicitly accounted for in the air quality data used to develop and optimize the models. These models also have low development cost and resource requirements (Turalıoglu *et al.* 2005).

There are some studies in the literature which investigate the air pollution in some big cities in the world such as Paris (Escourou, 1990), Ravenna (Tribassi *et al.*, 1990) and Shangai (Chao, 1990). Also, characterization of the concentration and distribution of urban submicron PM_1 aerosol particles at the city of Kaohsiung were investigated by (Lin & Lee, 2004). (Cuhadaroglu & Demirci, 1997) performed a study to show the influence of some meteorological factors on air pollution in Trabzon city in Turkey. They used SPSS code to make statistical analyses and obtained correlations for SO_2 and particle concentrations between meteorological factors. Their results indicated that there is a moderate and weak level of relation between the SO_2 level and the meteorological factors in Trabzon city. In their other study (Demirci & Cuhadaroglu, 2000), they considered wind circulation and air pollution by taking into account wind directions with the same statistical code. They found that there is a weak relationship between wind speeds blowing from different directions and pollutant concentrations. Also, they suggested that the newly constructed residential blocks should be divided by the main roads and streets on directions of WNW-ESE and SSW-NNE in the urban. In the study presented by (Bridgman *et al.*, 2002), the relationship of SO_2 concentrations to six major meteorological parameters has been investigated. Results found that SO_2 concentrations strongly related to colder temperature, higher relative humidity and lower wind speed. For prediction of SO_2 and smoke concentrations of Kayseri-Turkey, multiple regression equations including meteorological parameters and previous day's pollutant concentrations have been used by (Kartal & Ozer, 1998). The changes of air quality in Erzurum-Turkey and the correlation of SO_2 and TSP pollution in Erzurum city with meteorological parameters such as wind speed, temperature, atmospheric pressure, precipitation, and relative humidity were researched by the (Turalıoglu *et al.*, 2005). Ensar *et al.* (2003) statistically analyzed the relationship between outdoor air quality data and meteorological factors, such as wind speed, rainfall, temperature, sunshine hours and relative humidity using the code SPSS. Latini *et al.* (2002) investigated the effects of meteorological conditions on the urban and suburban air pollution. Ezzatian (2007) studied the effect of meteorological parameters on Esfahan Air Quality Index by Isfahan Meteorological Weather Station, Environmental Organization Stations. Yordanov (1977) performed statistical processing of air pollution data in the planetary boundary layer in terms of meteorological conditions. Ando *et al.* (2000) proposed models for the enforcement of the air quality standards in both urban and industrial areas.

In recent years, due to the rapid increase in population density, building density and energy consumption, the outdoor air quality has deteriorated in the crowded urban areas of Turkey. Elazığ city, which is located in the east Anatolia region of Turkey, is also influenced by air pollutants. The correlation of SO_2 and TSP pollution in Elazığ city with meteorological parameters such as wind speed, temperature, atmospheric pressure, solar radiation, and relative humidity were researched by the (Akpinar *et al.*, 2006, Akpinar *et al.*, 2008). Akpinar *et al.* (2006) investigated the relationship between air pollution concentrations and meteorological data such as wind speed, temperature, relative humidity and atmospheric pressure for Elazığ at winter, autumn and spring seasons. The mentioned study has contained analysis for only two years (2003–2004) but it is actually not enough for these kinds of studies.

In the study, analysis was made to season of autumn, spring and winter. During autumn and spring seasons, investigation of effects of meteorological variables on the air pollutants are not necessarily, since they were at low levels in the warm periods. Moreover all heaters are active in winter season at full capacity. Akpinar *et al.* (2008) examined relationship between monitored air pollutant concentrations such as SO_2 and the total suspended particles (TSP) data and meteorological factors such as wind speed, temperature, relative humidity, sun intensity and atmospheric pressure was investigated for all month in winter seasons during the period of three years (2003, 2004 and 2005) for Elazığ city.

The main purpose of the present study is to obtain relationship between air pollution concentrations and meteorological data such as wind speed, temperature, city. The characteristics of topographic, climatic and air quality of Elazığ city were presented first, then the relationship of SO_2 and TSP concentrations with the combination of meteorological parameters for each of months at winter seasons of the 2003–2005 was investigated.

MATERIAL AND METHODS

Features of study area

Elazığ city (longitude; 40º 21’ and 38º 30’, latitude; 38º 17’ and 39º 11’) is situated in north part of Euphrates River of east Anatolia region of Turkey. The area of Elazığ city is 9.281 km^2 which is equivalent to 0.12 percent of Turkey. Height above sea level is 1067 m. It is a peninsula due to dams in its boundaries such as Keban, Kralkizi, Karakaya and Özlüce. Elazığ city has a typical highland climate, in that it is generally cold in winter and hot in summer and there are considerable temperature differences between day and night. Location of Elazığ city can be shown from **Fig. 1**.

The wind speed, outside temperature, relative humidity and atmospheric pressure were the measured meteorological parameters of this research. The measurements have been carried out by conventional meteorological instruments at the station located in the east of the Elazığ city by the Turkish Meteorological State Department (TMSD). **Figure 2** shows the monthly average wind speed, temperature, relative humidity and atmospheric pressure values in the years of 2003, 2004 and 2005. It can be seen from the figure that the values are very close to each other for both years. As it was shown from **Fig. 2**, for Elazığ city, the annual average temperature is about 13ºC, the annual average wind speed is about 2.5 m/s, the annual average relative humidity is about 54% and the annual average atmospheric pressure is about 902 mbar.

The Elazığ city needs at least six months of artificial heating. As no important industrial company as a point source of air pollution exists in the city, the major source of air pollution is heating. Sugar and cement factories, the most important point sources near the city, are far away from city center, about 15 km and 2 km, respectively.

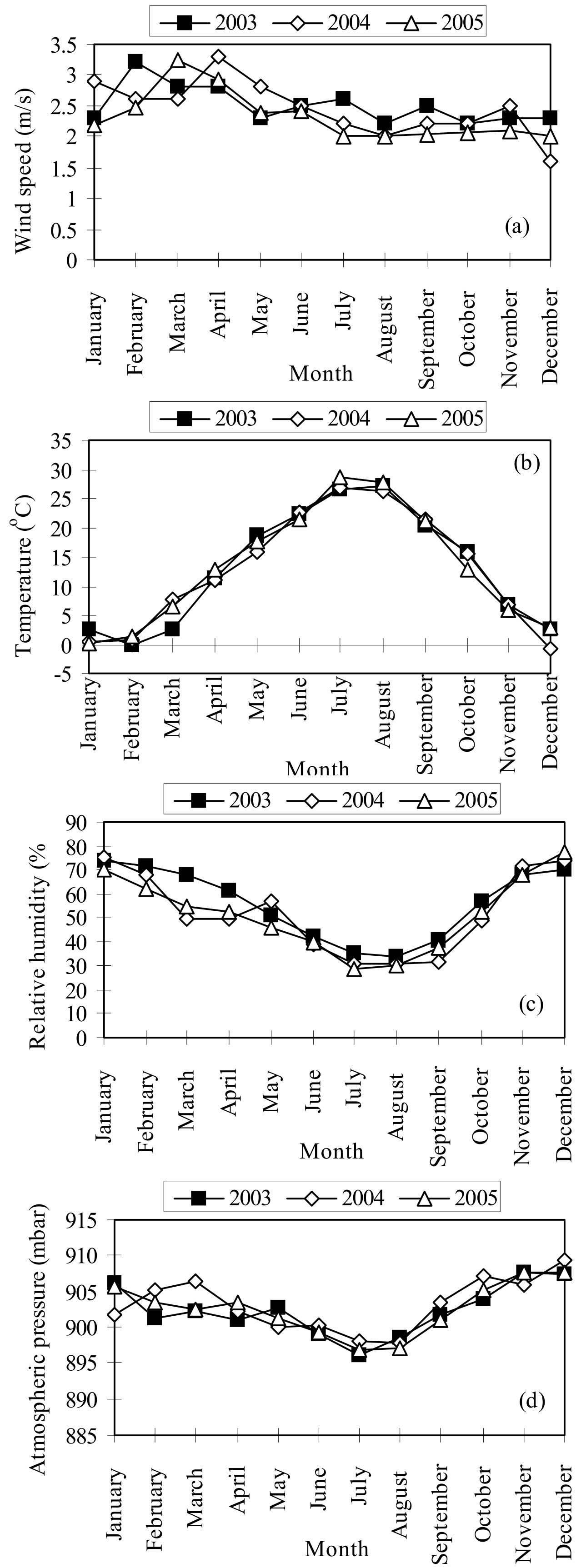

Fig. 2 Some meteorological data ((a) mean of wind speed, (b) temperature, (c) relative humidity and (d) atmospheric

SO_2 and total suspended particles (TSP) concentrations measurements

The Environmental and Forestry State Department have been doing sulphur dioxide and particle concentrations measurements at two stations in centrum of the Elazığ city. Measurements were made with neutralization titration for SO_2 and with refractometric evaluations for 24 h integrated dust filter samples in accordance with WHO recommended measurement methods (Elbir, 2000). The daily average values of SO_2 and total suspended particles (TSP) concentrations in the city were calculated by using arithmetic averages of the data obtained from the two stations. The air pollution data used in the study were obtained from the Environmental and Forestry State Department and Turkish Statistical Institution (2003-2004-2005).

DATA ANALYSIS

Regression analysis is used to find the relationship between variables and to obtain the best available prediction equation for the model chosen. If the number of independent variables more than one, multiple linear regression analysis is used and a general regression equation, which has five independent variables, can be expressed as:

$$Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + e \qquad (1)$$

where a is the constant of regression and b is the coefficient of regression. The values of the constant and the coefficients are determined using the least-squares method which minimizes the error, appearing as e in the above regression equation. The significance level of the constant and coefficients are statistically tested using the T and Z distribution. A generally used measure of the goodness of fit of a linear model is R^2, sometimes called the coefficient of determination. The coefficient of determination is that proportion of the total variability in the dependent variable that is accounted for by the regression equation and expressed as:

$$R^2 = 1 - \frac{\sum \left(Y_{pre,i} - \bar{Y}\right)^2}{\sum \left(Y_{obs,i} - \bar{Y}\right)^2} \qquad (2)$$

where $Y_{pre,i}$ is the value of Y predicted by the regression line, $Y_{obs,i}$ is the value of Y observed, and $\bar{Y}$ is the mean value of the Y_i.

A value of $R^2 = 1$ indicates that the fitted equation accounts for all the variability of the values of the dependent variables in the sample data. At the other extreme, $R^2 = 0$ indicates that the regression equation explains none of the variability. It is assumed that a high R^2 assures a statistically significant regression equation and that a low R^2 proves the opposite (Turalıoglu *et al*., 2005, Norusis, 1990).

In the present study, a stepwise regression model was used. Stepwise regression of independent variables is basically a combination of backward and forward procedures in essence and is probably the most commonly used method. After the first variable is entered, stepwise selection differs from forward selection: the first variable is examined to see whether it should be removed according to the removal criterion as in backward elimination. In the next step, variables not included in the equation are examined for removal. Variables are removed until none of the remaining variables meet the removal criterion. Variable selection terminates when no more variables meet entry and removal criteria. As well as establishing the correlations between pollutant concentrations and meteorological parameters by **Eq. (1)**, the equation expressed as:

$$Y = f(X_1),$$
$$Y = f(X_2),\ \dots,\ Y = f(X_2, X_3),\ \dots,$$
$$Y = f(X_1, X_2, X_3, X_4, X_5) \qquad (2)$$

has also been analyzed separately and the independent variables which have small values of R^2 have been eliminated. Using the remaining variables, equations having one, two, three or four variables are developed.

In addition to R^2, the various statistical parameters such as; mean bias error (MBE) and root mean square error (RMSE) were used to determine the quality of the fit. These parameters can be calculated as follows:

$$MBE = \frac{1}{N}\sum_{i=1}^{n}\left(Y_{pre,i} - Y_{obs,i}\right) \qquad (3)$$

$$RMSE = \left[\frac{1}{N}\sum_{i=1}^{n}\left(Y_{pre,i} - Y_{obs,i}\right)^2\right]^{1/2} \qquad (4)$$

N is the number of observations.

SO_2 and particle concentrations data together with meteorological parameters such as wind speed, temperature, relative humidity and atmospheric pressure, were analyzed by multiple linear regression using the SPSS programme. SO_2 and total suspended particles (TSP) concentrations were considered as dependent variables while meteorological parameters such as temperature, wind speed, relative humidity and atmospheric pressure were considered as independent variables.

RESULTS AND DISCUSSION

The monthly averages of SO_2 and TSP values in 2003–2005 are graphed in **Figs 3a** and **3b** to see the monthly

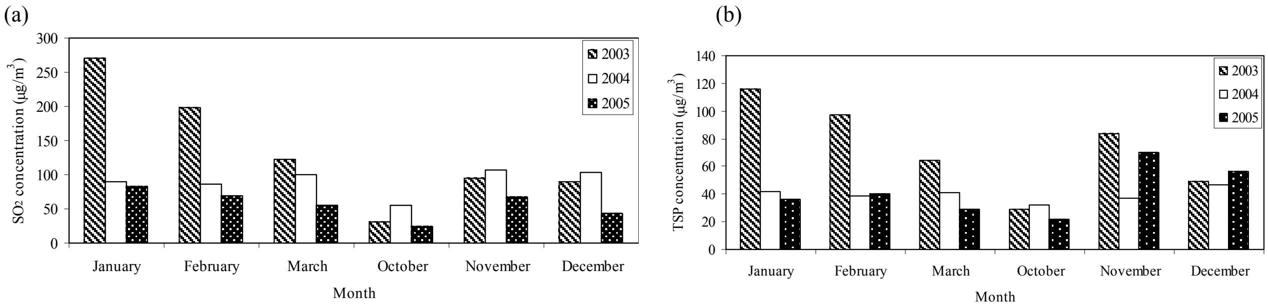

Fig. 3 Monthly average (a) SO_2 and (b) TSP (total suspended particles) concentrations values in 2003–2005 winter seasons.

trends in concentrations. As seen from **Fig. 3**, the maximum SO_2 and TSP values are in January-February months, which are the coldest months of the year in Elazığ city. However, **Table 1** shows means and standard deviations of SO_2 and TSP concentrations and meteorological parameters in months of October, November, December, January, February, and March during the period of tree years (2003, 2004 and 2005). **Figures 4(a-c)** and **5(a-c)** are presented to show variations of wind speed with SO_2 and TSP concentrations, respectively. Data belongs to months of October, November, December, January, February, and March of 2003–2005 years. It can be seen from the figures that both SO_2 and TSP concentrations are slightly decreased with increasing wind speed. This situation shows that when wind speed is high, pollutants dilute by dispersion, because the volume and dilution of the polluted air are controlled by wind speed and its directions.

Table 1. The means and standart deviations of SO_2 and TSP concentrations and meteorological parameters in 2003–2005 winter seasons

	Mean	Standart deviation	*N*
	2003		
SO_2 concentration, µg/m^3	134.044	88.899	182
TSP concentration, µg/m^3	67.961	36.857	182
Wind speed, m/s	2.522	1.493	182
Temperature, °C	5.118	6.295	182
Relative humidty ratio, %	67.986	12.864	182
Atmospheric pressure , mbar	904.85	5.684	182
	2004		
SO_2 concentration, µg/m^3	94.098	37.609	183
TSP concentration, µg/m^3	39.890	20.577	183
Wind speed, m/s	2.401	1.490	183
Temperature, °C	5.137	6.796	183
Relative humidty ratio, %	64.318	16.053	183
Atmospheric pressure , mbar	905.982	5.295	183
	2005		
SO_2 concentration, µg/m^3	57.318	28.115	182
TSP concentration, µg/m^3	41.890	25.291	182
Wind speed, m/s	2.338	1.337	182
Temperature, °C	5.024	5.420	182
Relative humidty ratio, %	64.187	14.294	182
Atmospheric pressure , mbar	905.311	5.214	182

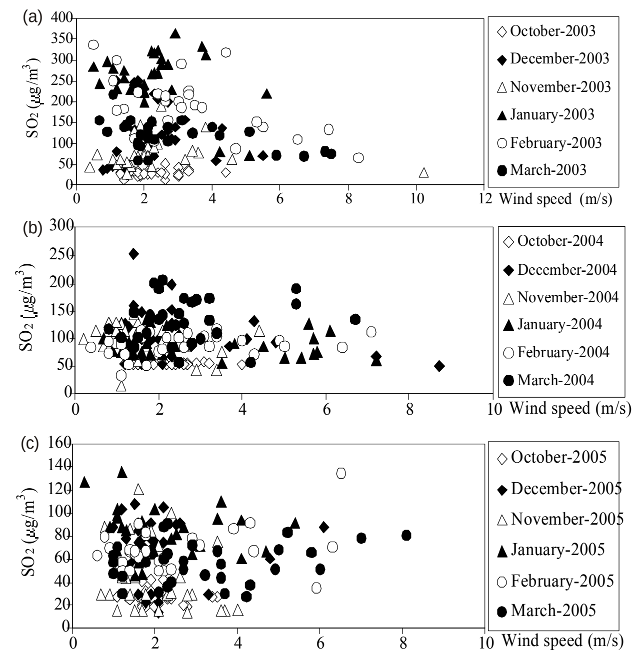

Fig. 4 SO_2 concentrations versus wind speed in 2003–2005 winter seasons.

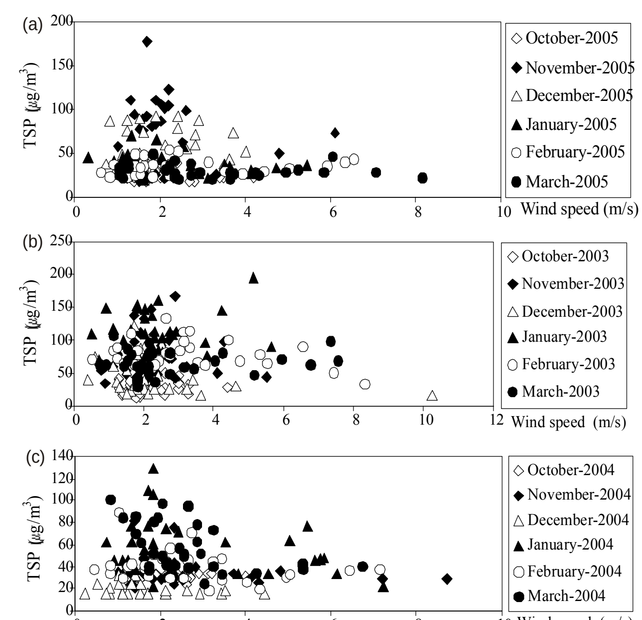

Fig. 5 TSP (total suspended particles) concentrations versus wind speed in 2003–2005 winter seasons.

When two figures (**Figs 4** and **5**) are compared, it is seen that wind speed is more effective on SO_2 concentration than that of TSP concentration. Effects of variations of mean temperature on SO_2 and TSP concentrations are presented in **Figs 6(a–c)** and **7(a–c)**, respectively. Data consist of the same effect as wind speed on SO_2 and TSP concentrations that both SO_2 and TSP concentrations are decreased with increasing temperature. Maximum values of SO_2 and TSP concentrations are obtained around the 0°C of air temperature. Consumption of fuel depends on the air temperature and it is not the primary parameter that affects the diffusion conditions of pollution. Thus, temperature is considered a pollution control parameter (Kartal & Ozer, 1998). Variations of relative humidity with SO_2 and TSP concentrations are shown in **Figs 8(a–c)** and **9(a–c)**, respectively. On the contrary of wind speed and temperature, which was plotted in **Figs 4–7**, SO_2 and TSP concentrations are increased with increasing relative humidity. Relative humidty should also be inversely related to pollutant concentrations since it controls the rate of absorbtion of pollutants (Kartal & Ozer, 1998). Variations of SO_2 and TSP concentrations with atmospheric pressure are plotted in **Figs 10(a–c)** and **11(a–c)**, respectively.

(a)

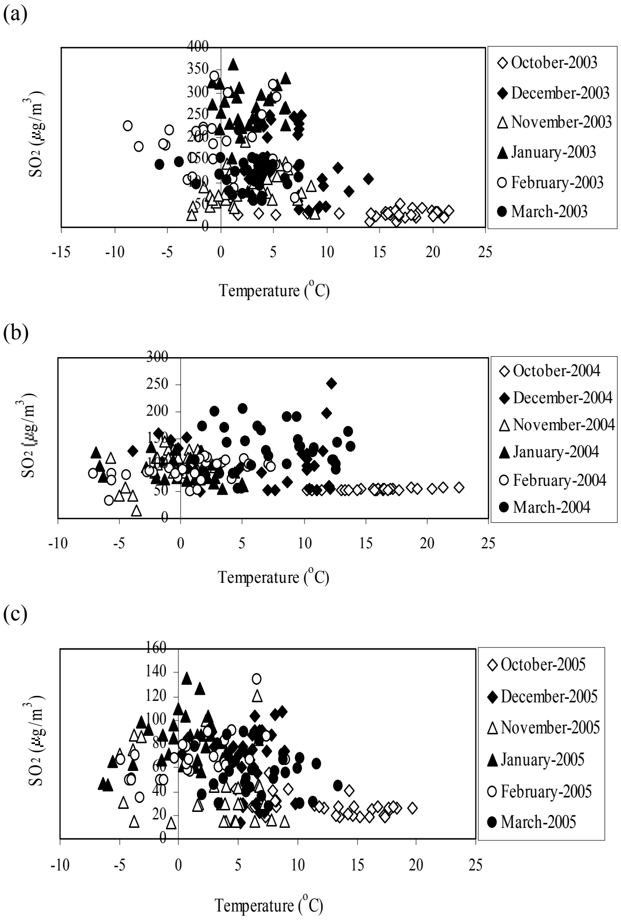

Fig. 6 SO_2 concentrations versus temperature in 2003–2005 winter

(a)

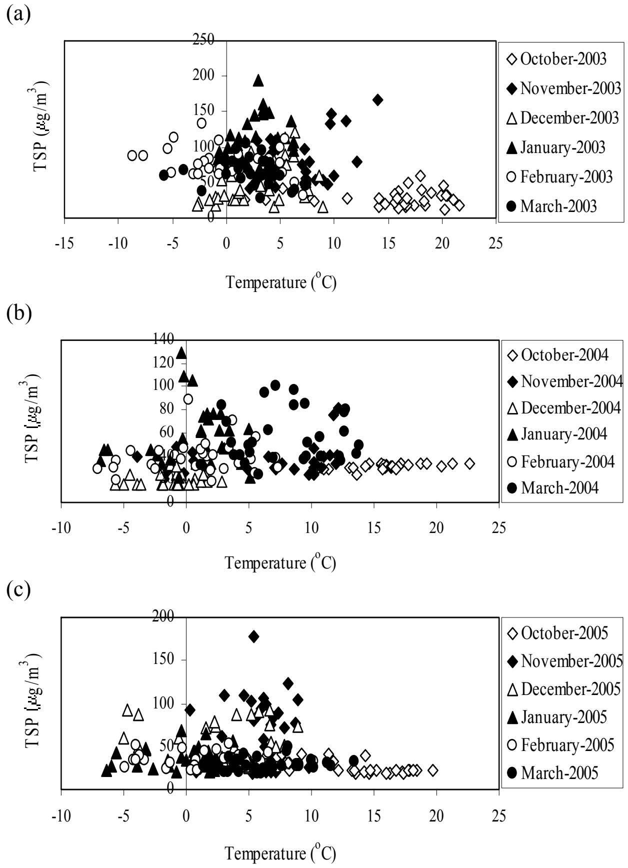

Fig. 7 TSP (total suspended particles) concentrations versus temperature in 2003–2005 winter seasons.

(a)

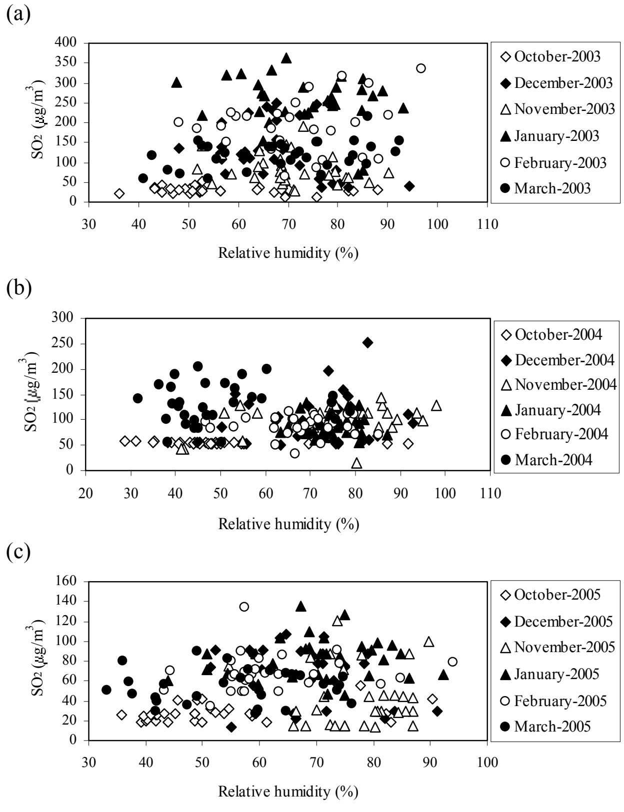

Fig. 8 SO_2 concentrations versus relative humidity in 2003–2005

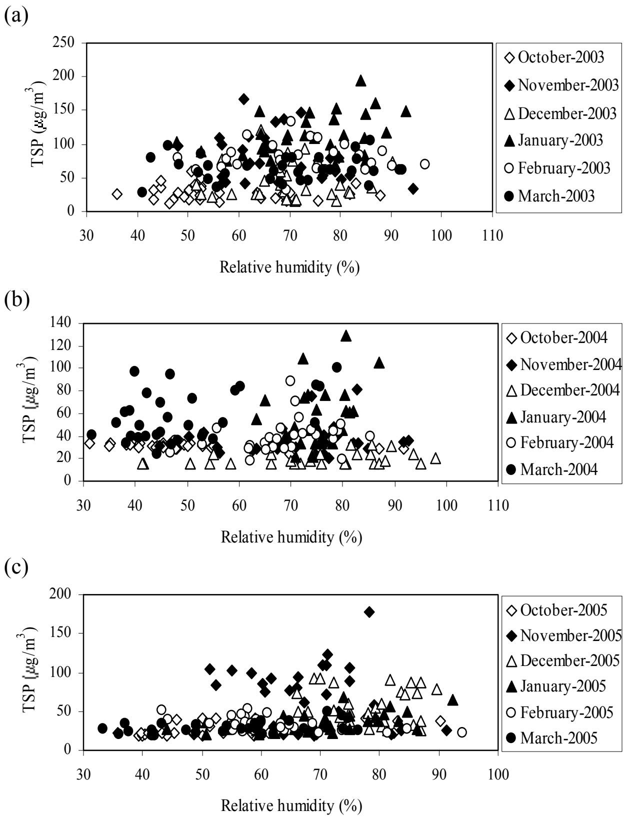

Fig. 9 TSP (total suspended particles) concentrations versus relative humidity in 2003–2005 winter seasons.

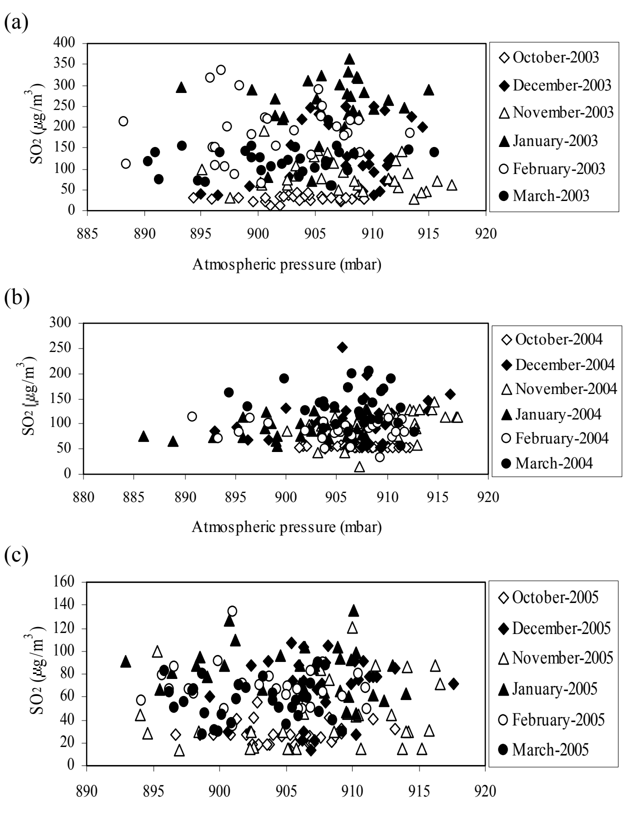

Fig. 10 SO_2 concentrations versus atmospheric pressure in 2003–

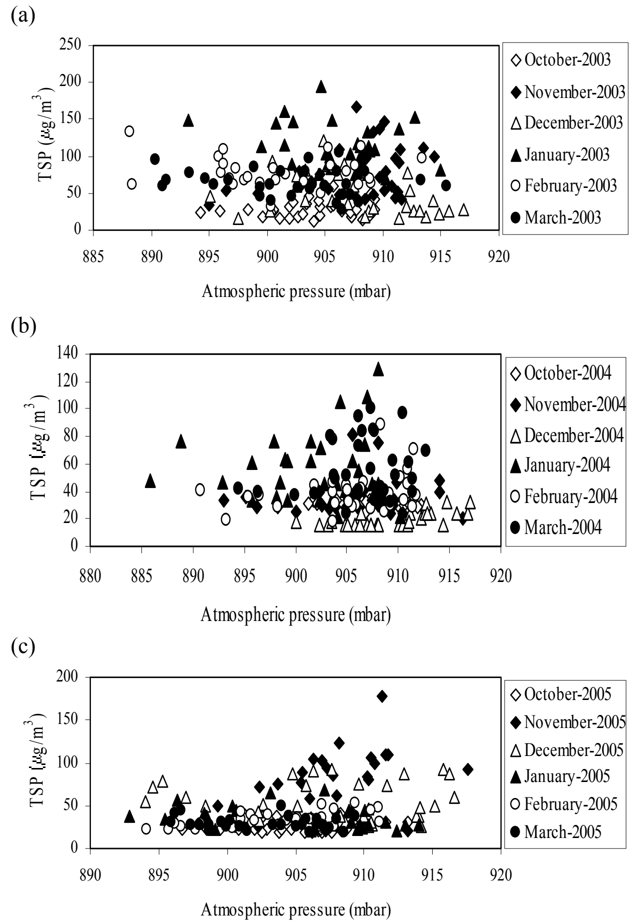

Fig. 11 TSP (total suspended particles) concentrations versus atmospheric pressure in 2003–2005 winter seasons.

These figures show that SO_2 and TSP concentrations are slightly increased with increasing atmospheric pressure. However, atmospheric pressure is more effective parameter on SO_2 concentration than on TSP concentration.

The regression equations between meteorological parameters (temperature, wind speed, relative humidity and atmospheric pressure) and SO_2 and TSP concentrations and the correlation coefficients were defined separately for 2003–2005 years, by linear regression analysis. The correlations (R) between daily average SO_2, TSP concentrations and daily average meteorological parameters are shown in **Table 2**. As seen in **Table 2**, the correlation of SO_2 with meteorological parameters is very similar to the relation of TSP with meteorological parameters. It is shown from **Table 2** that there is a weaker correlation between the pollutants concentrations and meteorological parameters.

The relationship between SO_2 and TSP and meteorological parameters (temperature, wind speed, relative humidity and atmospheric pressure) in September - October - November - December - January - February - March - April of 2003–2004 years

Table 2. The correlations coefficients and the regression equations between various meteorological parameters for SO_2 and total suspended particles (TSP)

Pollutants		R
	2003	
SO_2	= 148.16-5.5957*[WS]	0.0088
	= 8.6261+ 1.8447*[RH]	0.0713
	= 168.38-6.7092*[T]	0.2258
	= 537.16+ 0.7418*[P]	0.0022
Total Suspended Particles (TSP)	= 68.397-0.1724*[WS]	5E-05
	= 15.765 + 0.7677*[RH]	0.0718
	= 78.128-1.9864*[T]	0.1151
	= 125.52+0.0636*[P]	1E-04
	2004	
SO_2	= 95.317-0.5076*[WS]	0.0004
	= 78.551+0.2417*[RH]	0.0106
	= 99.693-1.089*[T]	0.0387
	= - 482.07+ 0.636*[P]	0.008
Total Suspended Particles (TSP)	= 41.407-0.6313*[WS]	0.0021
	= 36.536 + 0.0522*[RH]	0.0017
	= 39.228-0.1291*[T]	0.0018
	= 446.93+0.4493*[P]	0.0134
	2005	
SO_2	= 55.065-0.9638*[WS]	0.0021
	= 37.188+ 0.3136*[RH]	0.0254
	= 67.868-2.0997*[T]	0.1639
	= - 0.1484+ 0.0635*[P]	0.0001
Total Suspended Particles (TSP)	= 46.798-2.099*[WS]	0.0123
	= 7.5517+0.535*[RH]	0.0914
	= 45.176-0.6541*[T]	0.0197
	= - 1060.6+1.2178*[P]	0.0631

was investigated by stepwise multiple linear regression analysis. The correlations (R) between daily average SO_2, TSP concentrations and daily average meteorological parameters are shown in **Table 3**. It is shown from **Table 3** that there is a weaker and moderate correlation between the pollutants concentrations and meteorological parameters.

In this study, the resulting equations are consistent that all of meteorological parameters for 2003, 2004 and 2005 years were investigated using non-linear regression analysis. Correlations are given with statistical parameters, as follows:

For 2003 year

SO_2= -143.510-4.1434*[WS] -6.2312*[T]+ 0.5930*[RH]+ 0.3089*[P], R=0.60997, MBE=2.806, RMSE=37.86 (5)

TSP= -37.3234+0.8893*[WS] - 1.5918*[T]+ 0.50006*[RH]+ 0.0853*[P], R=0.50236, MBE=0.941, RMSE=12.70 (6)

For 2004 year

SO_2= -719.017+1.4873*[WS] -1.0077*[T]+ 0.08237*[RH]+ 0.89342*[P], R=0.42259, MBE=0.841, RMSE=11.35 (7)

TSP= 737.5768 - 2.0849*[WS]+ 0.1860*[T]+ 0.03964*[RH] -0.7684*[P], R=0.41344, MBE=0.275, RMSE=3.71 (8)

For 2005 year

SO_2= 351.1286+0.7563*[WS] - 2.1831*[T] - 0.0141*[RH] - 0.3133*[P], R=0.51258, MBE=0.589, RMSE=7.95 (9)

TSP= -1491.15+2.1592*[WS]+ 0.3605*[T]+ 0.6692*[RH]+ 1.6383*[P] R=0.51916, MBE=0.71, RMSE=9.59 (10)

Considering **Eqs 5–10**, measured SO_2 and TSP values were compared with calculated ones. **Figures 12, 13** and **14** show the predicted and measured values of SO_2 and TSP.

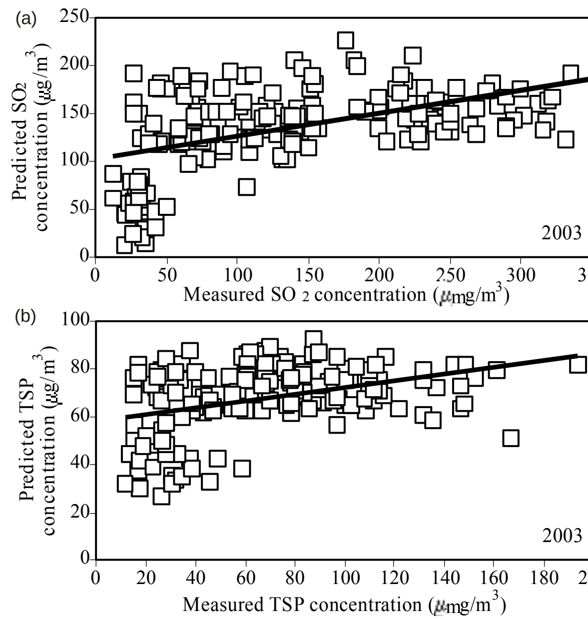

Fig. 12 Measured and predicted concentrations (a) SO_2 value according to **Eq. (3)** and (b) TSP value according to **Eq. (4)** for 2003 year.

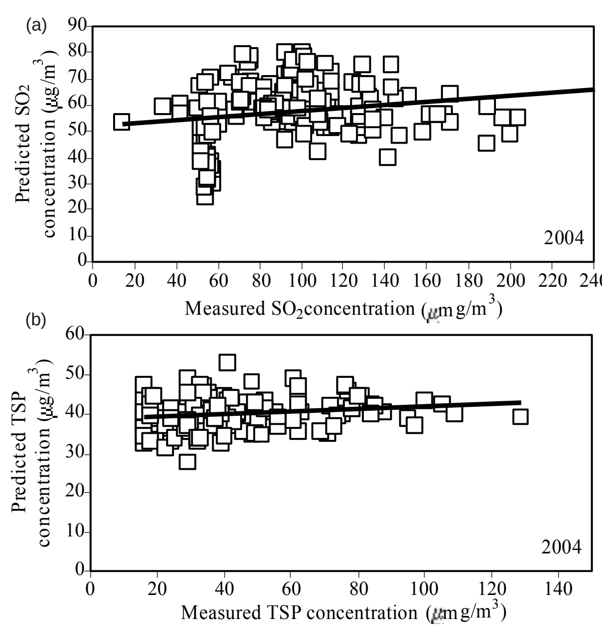

Fig. 13 Measured and predicted concentrations (a) SO_2 value according to **Eq. (5)** and (b) TSP value according to **Eq. (6)** for 2004 year.

Table 3. The relationship between SO_2 and TSP and meteorological parameters (temperature, wind speed, relative humidity and atmospheric pressure) in September-October-November-December-January-February-March of 2003–2004 years

	Pollutants	R
October 2003	SO_2= -283.356-0.00420*[WS] -0.296*[T] -0.207*[RH]+ 0.364*[P]	0.3991
November 2003	SO_2= 737.139-20.113*[WS] -4.304*[T] -2.718*[RH] -0.379*[P]	0.4017
December 2003	SO_2=1641.939-9.379*[WS]+ 4.399*[T] -1.314*[RH] -1.604*[P]	0.5211
January 2003	SO_2= -2028.58-18.958*[WS]+ 2.9158*[T] -1.937*[RH]+ 2.715*[P]	0.4646
February 2003	SO_2= -2367.40-27.573*[WS]+7.032*[T]+ 0.509*[RH]+ 2.896*[P]	0.6635
March 2003	SO_2= 268.965-7.406*[WS] -1.609*[T]+ 0.469*[RH] - 0.175*[P]	0.5291
October 2004	SO_2= 132.543 - 0.524*[WS]+ 0.304*[T] - 0.0364*[RH] -0.0885*[P]	0.8156
November 2004	SO_2=-994.370-4.991*[WS] -2.186*[T]+0.649380*[RH]+ 1.190*[P]	0.4699
December 2004	SO_2= -2160.58-4.640*[WS]+ 6.0005*[T] -0.0183*[RH]+ 2.501*[P]	0.6240
January 2004	SO_2= -624.039+3.449*[WS] - 3.709*[T]+ 0.513*[RH]+ 0.738*[P]	0.4721
February 2004	SO_2= 343.607+2.902*[WS]+ 2.504*[T]+ 0.0991*[RH]+ 0.0991*[P]	0.5796
March 2004	SO_2= 3418.418-3.607*[WS] -1.840*[T] -0.0901*[RH] -3.595*[P]	0.2844
October 2005	SO_2= 84.856-1.387*[WS] -0.860*[T]+ 0.0392*[RH] -0.0501*[P]	0.5006
November 2005	SO_2= -1550.76+1.766*[WS]+ 1.169*[T] -0.574*[RH]+ 1.814*[P]	0.4214
December 2005	SO_2= 276.162-8.026*[WS] -1.619*[T] -0.186*[RH] - 0.217*[P]	0.4126
January 2005	SO_2= 503.6877-4.274*[WS]+ 2.943*[T]+ 0.227*[RH] -0.472*[P]	0.4769
February 2005	SO_2=-1641.91+6.103*[WS]+ 2.583*[T]+ 0.883*[RH]+ 1.811*[P]	0.7031
March 2005	SO_2=-403.395+2.634*[WS] -0.597*[T]+ 0.0511*[RH]+ 0.5006*[P]	0.3888
October 2003	TSP= -457.231+1.531*[WS]-0.522*[T]-0.193*[RH]+0.553*[P]	0.3574
November 2003	TSP= -915.893-10.206*[WS]+ 7.625*[T] -2.288*[RH]+ 1.234*[P]	0.6730
December 2003	TSP= 1532.714-10.925*[WS]+ 4.3476*[T] -0.317*[RH] -1.597*[P]	0.6612
January 2003	TSP= 2212.970+4.187*[WS]+ 3.567*[T]+ 1.099*[RH] -2.427*[P]	0.6220
February 2003	TSP= 534.595-3.080*[WS] -0.554*[T] -0.208*[RH] -0.477*[P]	0.4598
March 2003	TSP= 1082.204+0.238*[WS] -2.587*[T]+ 0.0943*[RH] -1.129*[P]	0.4327
October 2004	TSP= 224.728-0.606*[WS]+ 0.126*[T] -0.0706*[RH]-0.210*[P]	0.7333
November 2004	TSP= -118.940-0.629*[WS] +0.562*[T]+ 0.137*[RH]+ 0.158*[P]	0.4222
December 2004	TSP= -642.549+0.138*[WS] -0.0088*[T]+0.0777*[RH]+ 0.721*[P]	0.6887
January 2004	TSP= 522.649-6.526*[WS]+ 2.560*[T]+ 1.123*[RH] -0.591*[P]	0.5012
February 2004	TSP= -551.446-0.605*[WS]+ 0.398*[T]+ 0.378*[RH]+ 0.625*[P]	0.4105
March 2004	TSP= -236.296-6.034*[WS]+ 0.0748*[T]+ 0.671*[RH]+0.3033*[P]	0.5970
October 2005	TSP= -277.393-0.429*[WS] -0.652*[T]+ 0.174*[RH]+ 0.335*[P]	0.6285
November 2005	TSP= -6704.42+6.796*[WS]+ 7.319*[T]+ 0.0147*[RH]+ 7.399*[P]	0.5151
December 2005	TSP= 123.343+3.596*[WS]-0.847*[T]+ 0.406*[RH] -0.114*[P]	0.3011
January 2005	TSP= 310.142-1.805*[WS]+ 1.079*[T]+ 0.603*[RH] -0.345*[P] R=	0.6462
February 2005	TSP= -1001.09+1.086*[WS]+ 0.263*[T] -0.129*[RH]+ 1.151*[P]	0.7149
March 2005	TSP= -385.039+0.406*[WS]+ 0.552*[T]+ 0.287*[RH]+ 0.436*[P]	0.4898

CONCLUSIONS

Impacts of meteorological factors on air pollutant concentrations were evaluated for Elazığ, Turkey during the winter seasons of 2003–2005 years, using a statistical code. During the summer seasons, the effects of meteorological variables on the air polluants were not investigated, since they were at low levels in the warm periods. As a general result, SO_2 and total suspended particles (TSP) were weakly decreased with decreasing wind speed and temperature. However, it was weakly increased with increasing relative humidity and atmospheric pressure. Because SO_2 and TSP concentrations were decreased with increasing wind speed and circulation of air flow. Also, atmospheric pressure was increased with the cooling of air since density of air was increased. Finally, the results from this study show that there were no strong relationships between the meteorological parameters and the ground level air pollutant concentrations in centrum of Elazıg city within the terms statistically analyzed. In order to predict the SO_2 and TSP concentrations with regard to meteorological parameters, statistical models were developed for each month. The correlation coefficients of the statistical model of SO_2 and TSP including meteorological parameters changed between 0.2844 and 0.8156, and 0.3011 and 0.7333, respectively. However, the statistical models of SO_2 and TSP including all of meteorological parameters were investigated for each year. The correlation coefficients of these models showed changing between 0.41344 and 0.60997.

These equations can be employed for a wide variety of purposes, for example, when data were lacking because of instrument failure or other reasons. By inserting forecasted values of the meteorological parameters into the multiple regression equations, future prediction of air pollution concentrations may be performed in the Elazığ, Turkey.

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NOMENCLATURE

P	atmospheric pressure (mbar)
RH	relative humidity (%)
T	temperature (^oC)
WS	wind speed (m/s)