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Modeling of sulfur dioxide emissions in Ahvaz City, southwest of Iran during 2013

Gh.Goudarzi[1,2], S. Geravandi[3,4], K. Ahmadi Angali[1,5], A. K. Neisi[1,6], A. R. Yari[7], S. Dobaradaran[8], B. Ghalani[9], B. Hashemzadeh[10], M. J. Mohammadi*[4,11,12]

1. *Environmental Technologies Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

2. *Air Pollution and Respiratory Diseases Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

3. *Department of Nursery, Islamic Azad University, Tehran Medical Sciences Branch, Tehran, Iran*

4. *Razi Teaching Hospital, Clinical Research Development Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

5. *Department of Biostatistics, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

6. *Department of Environmental Health Engineering, School of Public Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

7. *Research Center for Environmental Pollutants, Qom University of Medical Sciences, Qom, Iran.*

8. *Department of Environmental Health Engineering, Faculty of Health & the Persian Gulf Marine Biotechnology Research Center, the Persian Gulf Research Center, Bushehr University of Medical Sciences, Bushehr, Iran.*

9. *Industrial Engineering, Orientation System Efficiency, Manager of NIDC, Ahvaz, Iran*

10. *Department of Environmental Health, Khoy School of Nursing, Urmia University of Medical Sciences, Urmia, Iran*

11. *Department of Environmental Health Engineering, School of Public Health & Environmental Technologies Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

12. *Abadan School of Medical Sciences, Abadan, Iran*

** Corresponding author's E-mail: javad.sam200@gmail.com*

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ABSTRACT

Sulfur dioxide has two important sources in the atmosphere and this is why most of scientists believe in a geographic split in the globe. Power plants, major emitter of SO_2, are located in north hemisphere such as in Russia, China, Canada and the USA. In south hemisphere, phytoplankton produces a massive amount of dimethyl sulfide (DMS) and dimethyl disulfide (DMDS). Then these types of reduced products dissociate in the atmosphere and convert into SO_2. It is a colorless gas which is released from burning coal, high sulfur coal and diesel fuel. The sulfur dioxide emissions from transportation systems, steel, oil and other industries are major concerns of air pollution in Ahvaz city, Iran. The main objective of this study was to determine the behavior of data over the time in a specific statistical model framework and compare through intended one to implement the Box-Jenkins method to make time series models in Ahvaz (located in Southwestern Iran), during 2013. Data of sulfur dioxide from four monitoring stations were collected at the first step and processed by Excel software; finally, the model of sulfur dioxide dispersion were evaluated. Time series analysis showed that air pollutants were associated with one step delay of sulfur dioxide and two steps delay of moving average. The finding of this study showed that the average concentration of sulfur dioxide in winter was higher than in summer. According to the results of this study, distribution of sulfur dioxide data has a correlated structure over the time; therefore the time series model is an appropriate model to explain the behavior of sulfur dioxide over the time.

Keywords: Sulfur dioxide, Emissions, Time series analysis, Iran.

INTRODUCTION

Many investigations have conducted to estimate the number of cases in terms of mortality and morbidity attributed to air pollutants such as sulfur dioxide, nitrogen dioxide, ozone, PM_{10} and carbon monoxide (Samet *et al.* 2000; Pope III & Dockery 2006; Goudarzi *et al.* 2012 ; Soleimani *et al.* 2013; Su *et al.* 2016; Neisi *et al.* 2016).

Epidemiological studies showed that air pollution is responsible for damaging to human health such as increasing death rates. It may reduce the quality of life and welfare too (Hoseinishokooh 2008; Goudarzi *et al.* 2014b; Mastaneh & Mouseli 2013; Ehsan & Kianmehr 2013; Dobaradaran *et al.* 2016). Sulfur dioxide is originated from biogenic sources such as volcanoes and anthropogenic sources such as industrial processes.

Coal and petroleum with high percentages of sulfur in the process of combustion, generate sulfur dioxide. Sulfur dioxide is a colorless gas with a pungent odor; it can irritate eye, respiratory and nasopharynx systems (Törnqvist *et al.* 2007; Ehsan & Kianmehr 2013; Rahila & Siddiqui 2014; Sepideh *et al*. 2014 Zallaghi *et al.* 2014). Ahvaz city has been well known due to industries as well as environmental pollution over the time (Goudarzi *et al.* 2014a,b).

Time series and case–crossover analyses are the most common methods which have been used to estimate the short-term effects of air pollution on health (Fung *et al.* 2003; Schwartz 2004).

There have been numerous community time series studies about the effect of air pollution on mortality (Smith 1989;Schwartz & Zanobetti 2000;Dominici *et al.* 2002).

Development and use of statistical and other quantitative methods in the environmental sciences have been a major communication between environmental scientists and statisticians (Herzberg & Frew 2003).

The common descriptive statistical approach used for air quality measurement and modeling is rather limited as a method to understand the behavior and variability of air quality (Modarres & Dehkordi 2005; Masoudi 2014). Time series analysis is a useful tool for better understanding of cause and effect relationship in environmental pollution (Schwartz & Marcus 1990).

The main aim of time series analysis is to describe the movement history of a particular variable in over the time.

Many authors have tried to detect changing behavior of air pollution through over the time, using different techniques (Hies *et al.* 2000).

Many others have tried to relate air pollution to human health through time series analysis (Gouveia & Fletcher 2000; Saffarinia & Odat 2008). Nowadays time series models are depriving in environmental research works.

Time series models have two advantages in comparison with other methods such as regression and polynomial regression.

Firstly, each value is a model about the past events or past stochastic terms (chocks), so interpretations and monitoring of air characteristics are so easy through these models. The second is forecasting or estimation of values in future; means to predict the future values based on the past values and stochastic structure governed on data.

Also, studies of the health effects of air pollution on mortality and morbidity in China have mostly been conducted in Beijing, Shanghai, Shenyang, Wuhan, and Taiyuan.

Air pollution is predominant among environmental concerns in Ahvaz, Iran.

In this research, we are intended to implement the Box-Jenkins method to make time series models on sulfur dioxide data in Ahvaz. In such context, the aim of this study was planned and carried out to assess the modeling of sulfur dioxide dispersion in the air of Ahvaz (located in southwestern part of Iran) during 2013.

MATERIALS AND METHODS

Methods

The time series analysis, using MINITAB ver. 16 statistical software packages were used in this ecological and retrospective study. As we mentioned, the time series data consist of the sequential data points taken at equal increments over the time.

A broad class of time series model is ARMA (p, q), combined two models AR (Auto Regressive), MA (Moving Average); therefore, ARMA is autoregressive and moving average together. Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) are two important and useful instruments to identify q and p, respectively. The order of time series model (Box-Jenkins steps) was used to make the model consisted three steps.

The first is, identification of p and q. The second one is, estimation of parameters and the third is, verification of the model adequacy (Lee 2002; Goudarzi *et al.* 2014c).

Since the design of the model's default is carried out by the World Health Organization in Eastern Mediterranean region, so we can generalize it for Ahvaz city. Sulfur dioxide data were taken from Ahvaz Department of Environment (ADoE). Sampling was performed for 24 hours in four stations. In this study, 35040 (24 × 365 × 4) samples of Ahvaz air were taken for sulfur dioxide during 2013. Raw air quality monitoring data were in a Microsoft Office Excel spread sheet. These data were in volumetric base (PPM). Stations were "Downtown", "Old School of Public Health", "Bureau of Meteorology" and "Head office of ADoE". In order to do the analysis, first of all, the basic time series models were analysed, using MINITAB software.

Description of study area

Ahvaz, the capital of Khuzestan Province of Iran, with one million people approximately, an area of 8152 km², is located at 48° to 49°29′ east of Greenwich meridian and 31° 45′ north of the equator (Goudarzi *et al.* 2015; Geravandi *et al.* 2015b; Mohammadi *et al.* 2015; Geravandi *et al.* 2015a). Air pollution data particularly sulfur dioxide was collected from ADoE. Air quality monitoring stations were located in "Naderi", "Behdasht Ghadim", "Havashenasi" and "Mohitzist". The areas of study and air quality monitoring stations in Ahvaz are illustrated in Fig. 1.

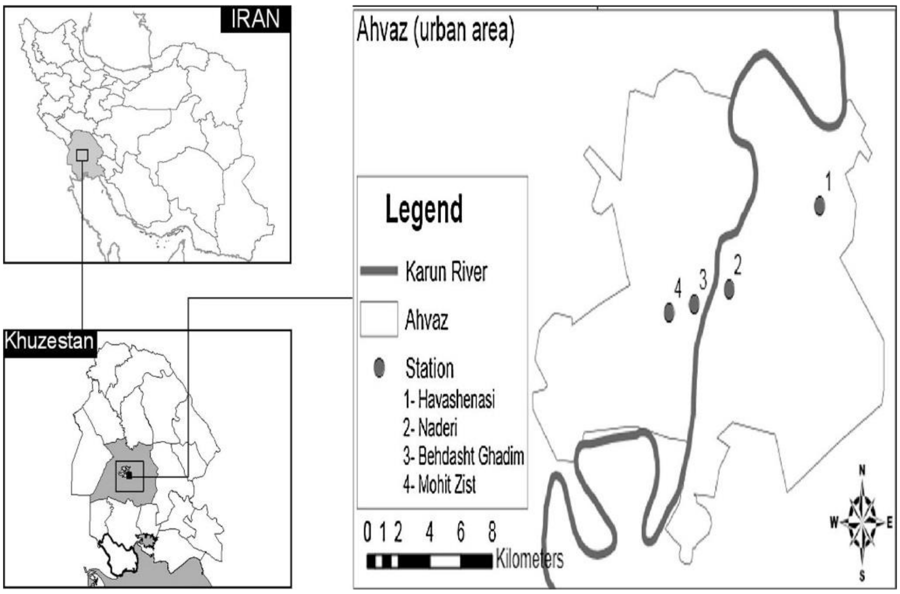

Fig 1. The study location and sampling station in Khuzestan Province (Ahvaz), southwest of Iran.

RESULTS

Time series plot (TSP), which is the first step in time series analysis, should be depicted. A preliminary concept of the behavior of data is given by time series plot in Fig. 2. It shows the TSP of sulfur dioxide concentration over the time. There is no increasing or decreasing pattern over the time so data have stochastic behavior through time. Therefore, it is assumed that the difference between low and high concentration is large, resulting in the largest skewers and variation in all examined air pollutants.

As illustrated in this Fig., the average concentration of sulfur dioxide in winter was higher than in summer; indicating more fuel usage due to the abundance of industries and lower maximum mixing depth in the atmosphere during winter. In addition, low-sulfur diesel is not used in industries and transportation systems.

Bear in mind, sulfur content of diesel in Iran is about 7000 ppm and this is why the Department of Environment (DoE) has prevented commuting cars which have been using this type of diesel.

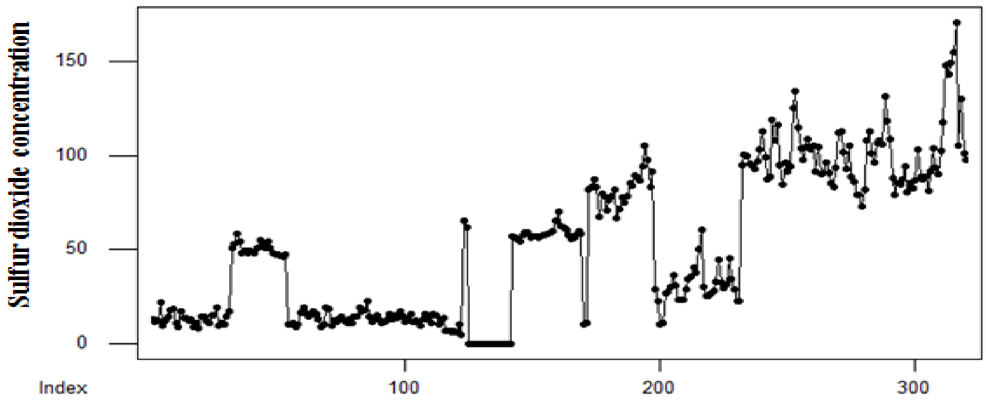

Fig 2. Time series plot of sulfur dioxide concentration.

Figs. 3 and 4 suggested the order of model. Both figures suggest p = 1, q = 2, on first five lag of partial correlations showed significance Correlation except the second lag (Fig. 4) and autocorrelation had decay pattern indicated no moving average term in model (Fig. 3).

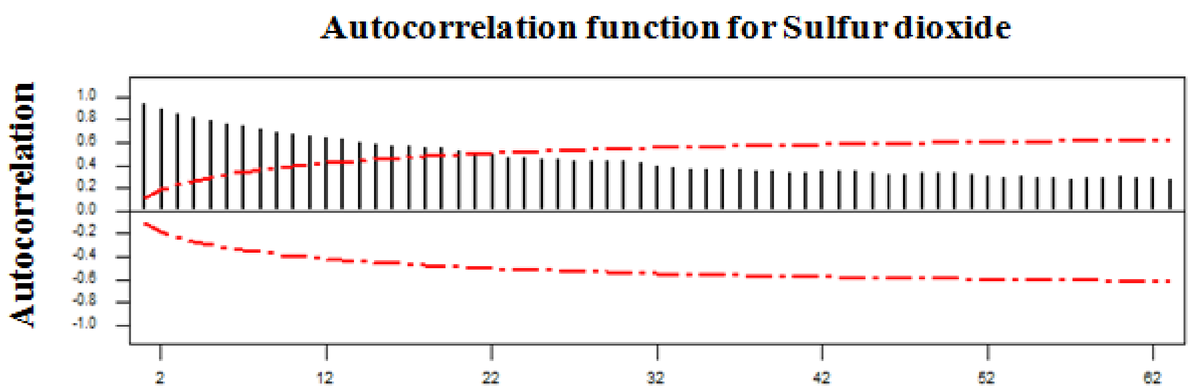

Fig 3. Time series autocorrelation for sulfur dioxide concentration.

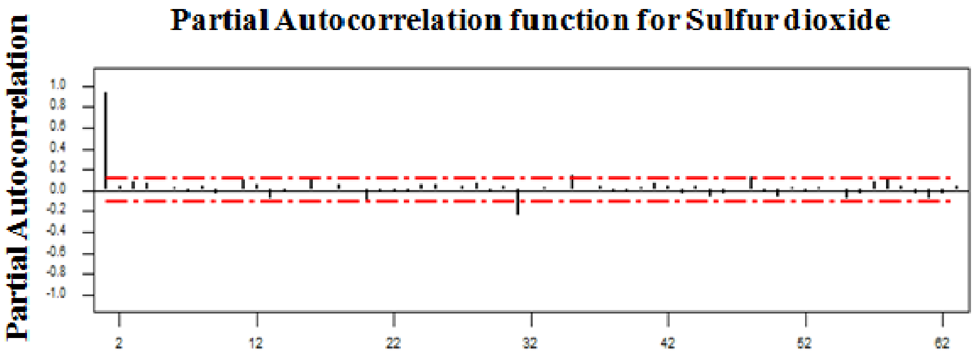

Fig 4. Time series partial autocorrelation function for sulfur dioxide concentration.

We carried out ARMA (1, 3) or AR (1); the estimation of parameters are given in Table 1. MINITAB result shows that the coefficients of first order of autoregressive is significant (p-value > 0.05); therefore, we select its term. Furthermore, Ljung –Box results are given for both models which are in turn.

It suggests no any seasonal pattern in models. The final model is given as follows:

$$SO_{2_t} = 1.12 + 0.98 SO_{2_{t-1}} + a_t - 0.095 a_{t-1} - 0.16 a_{t-2} \quad (1)$$

Where at~N (0, 159.4), N stand for normal distribution.

Table 1. Time series table of sulfur dioxide concentration.

Type	Coef	SE Coef	T	P
AR 1	0.9792	0.0145	67.68	0.000
MA 1	0.0945	0.0583	1.62	0.106
MA 2	0.1582	0.0591	2.68	0.008
Constant	1.1183	0.4893	2.29	0.023
Mean	53.79	23.53		
	Number of observations:			320
Residuals	**SS = 50202.5 (backforecasts excluded)**			
	MS = 159.4		**DF = 315**	
Modified	Box-Pierce	(Ljung-Box)	Chi-Square	statistic
Lag	12	24	36	48
Chi-Square	6.8	19.0	50.1	61.4
DF	7	19	31	43
P-Value	0.445	0.455	0.017	0.034

AR: Auto Regressive
MA: Moving Average

DISCUSSION

Ahvaz is located in an arid area in southwest of Iran with long and hot summertime. Keep in mind, high density of industries (steel, oil and gas) makes Ahvaz as one of the most important emitter. Daily air pollution time series analysis of Ahvaz city was performed in this study. Time series analysis which let us compare many pollutants with different levels and units indicates various health adverse periods from the beginning of the year to the end. It was also shown that most daily air pollution time series have high persistence of air pollution conditions through time. The influence of weather conditions like rainfall, air moisture and wind velocity-direction on the air pollution temporal dynamics are also very important in the air pollution management and control which will be ongoing author's task to investigate. The air pollution prediction and forecasting is another important aspect which has already been extensively analyzed worldwide. Models which can perfect fit the data may completely fail to predict (also known as over fitting). Although the time series analyses explain the historic air pollution data very well, it maybe produces very poor prediction results. Atkinson *et al.* (2014) studied the epidemiological time series studies of $PM_{2.5}$ and daily mortality and hospital admissions: a systematic review and meta-analysis. Their findings showed that a 10 µg.m^{-3} increase in $PM_{2.5}$ concentration was related to a 1.04% increase in risk of death (Atkinson *et al*. 2014). Annual air pollution time series analysis of Al-Hashimeya area has been performed (Saffarinia & Odat 2008). It has shown different temporal behavior of different air pollutants. This different time behavior is not only the reason of correlation of different pollutants with each other, but the seasonal variation on increasing or decreasing air pollutants as well. It was also shown that most annual air pollution time series have high persistence of air pollution conditions through time. This persistence is not only harmful for public health but also makes the air pollution management and control very demanding. The best fitted model of sulfur dioxide concentration at 95% CIs were given for the current ARMA (6, 6) (Saffarinia & Odat 2008). The results of this study showed that the best fitted model of current was ARMA (1, 3) that relatively lower because of different SO_2 concentration in Ahvaz city. In another study Hosseinpoor *et al.* (2005) conducted a work to find the relation between hospitalizations due to angina pectoris exposed to air pollution with used time-series study. The results of this study showed that there was a significant association between the SO_2 level and the number of daily admission due to angina pectoris (Hosseinpoor *et al.* 2005). Based on the results of our study, there was a significant association between the SO_2 level and human health. Su *et al.* (2016) observed in their study the adverse effects of fine particulate air pollution on cardiovascular hospital emergency room visits obtained from time-series study (PDL model) in Beijing, China. Also, in our study, health endpoints was associated with low concentration of measured SO_2 in Ahvaz by time-series study (ARMA model).

CONCLUSIONS

This study was the first report of modeling of sulfur dioxide emissions in Ahvaz city, southwest of Iran. Statistical model is an applicable method to evaluate the behavior of pollutant and its dispersion. Time series plot of SO_2 showed some anomalies in trend of winter and summer, so that, the concentration of sulfur dioxide in winter was higher and implied to inversion condition as well as more usage of high sulfur diesel. In this study, data showed that the sulfur dioxide has a correlated structure over the time. ARMA model showed that the sulfur dioxide at each time can be estimated based on the previous value AR (1) and the second last value of MA (2). The MA term express some stochastic factor occurred at the previous steps which were not determined exactly but their effects were estimated by the MA. Moreover, the sulfur dioxide could be forecast through the time series model that creates constructive tools for monitoring and managing of sulfur dioxide. The major limitations of this study were shortcoming in databases and the lack of temporal behavior parameters of SO_2. We recommend further studies to evaluate the model of emissions and a method to evaluate the behavior of sulfur dioxide in all megacities of Iran.

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REFERENCES

Atkinson, R, Kang, S, Anderson, H, Mills, I & Walton, H 2014, Epidemiological time series studies of $PM_{2.5}$ and daily mortality and hospital admissions: a systematic review and meta-analysis. *Thorax*, thoraxjnl-2013-204492.

Dobaradaran S, Geravandi S, Goudarzi G, Idani E, Salmanzadeh S, Soltani F & Mohammadi, MJ 2016, Determination of cardiovascular and respiratory diseases caused by PM_{10} exposure in Bushehr. *Journal of Mazandaran University of Medical Sciences,* 26: 42–52.

Dominici, F, Mcdermott, A, Zeger, SL & Samet, JM 2002, on the use of generalized additive models in time-series studies of air pollution and health. *American Journal of Epidemiology,* 156: 193-203.

Ehsan, S & Kianmehr, M 2013, Effect of black surfaces to increase the average surface temperature of the earth: A global warning! *Caspian Journal of Environmental Sciences,* 11: 19-27.

Fung, KY, Krewski, D, Chen, Y, Burnett, R & Cakmak, S 2003, Comparison of time series and case-crossover analyses of air pollution and hospital admission data. *International Journal of Epidemiology,* 32: 1064-1070.

Geravandi, S, Goudarzi, G, Mohammadi, MJ, Taghavirad, SS & Salmanzadeh, S 2015a, Sulfur and Nitrogen Dioxide Exposure and the Incidence of Health Endpoints in Ahvaz, Iran. *Health Scope,* 4 e24318.

Geravandi, S, Takdastan, A, Zallaghi, E, Niri, MV, Mohammadi, MJ, Saki, H & Naiemabadi, A 2015b, Noise Pollution and Health Effects. *Jundishapur Journal of Health Sciences,* 7, e25357.

Goudarzi, G, Geravandi, S, Foruozandeh, H, Babaei, AA, Alavi, N, Niri, MV, Khodayar, MJ, Salmanzadeh, S & Mohammadi, MJ 2015, Cardiovascular and respiratory mortality attributed to ground-level ozone in Ahvaz, Iran. *Environmental Monitoring and Assessment,* 187: 1-9.

Goudarzi, G, Geravandi, S, Javad Mohammadi, M, Ghomaishi, A & Salmanzadeh, S 2014a, Cardiovascular death, respiratory mortality and hospital admissions respiratory disease related to PM_{10} exposure in Ahvaz, Iran. *Iranian Journal of Health, Safety and Environment,* 1: 159-165.

Goudarzi, G, Geravandi, S, Vosoughi, M, Javad Mohammadi, M & Sadat Taghavirad, S 2014b, Cardiovascular deaths related to carbon monoxide exposure in Ahvaz, Iran. *Iranian Journal of Health, Safety and Environment,* 1: 126-131.

Goudarzi, G, Mohammadi, MJ, Angali, KA, Neisi, AK, Babaei, AA, Mohammadi, B, Soleimani, Z & Geravandi, S 2012, Estimation of health effects attributed to NO_2 exposure using AirQ model. *Archives of Hygiene Sciences,* 1: 59-66.

Goudarzi, G, Shirmardi, M, Khodarahmi, F, Hashemi-Shahraki, A, Alavi, N, Ankali, K, Babaei, A, Soleimani, Z & Marzouni, M 2014c, Particulate matter and bacteria characteristics of the Middle East Dust (MED) storms over Ahvaz, Iran. *Aerobiologia,* 30: 345-356.

Gouveia, N & Fletcher, T 2000, Time series analysis of air pollution and mortality: effects by cause, age and socioeconomic status. *Journal of Epidemiology and Community Health,* 54: 750-755.

Herzberg, AM & Frew, L 2003, Can public policy be influenced? *Environmetrics,* 14: 1-10.

Hies, T, Treffeisen, R, Sebald, L & Reimer, E 2000, Spectral analysis of air pollutants. Part 1: Elemental carbon time series. *Atmospheric Environment,* 34: 3495-3502.

Hoseinishokooh, S 2008, *Evaluation of Hospital Preparation under Iran University of Medical Sciences to earthquake*. MSc. Thesis, Health Services Management degree, School of Public Health Tehran University of Medical Sciences.

Hosseinpoor, AR, Forouzanfar, MH, Yunesian, M, Asghari, F, Naieni, KH & Farhood, D 2005, Air pollution and hospitalization due to angina pectoris in Tehran, Iran: A time-series study. *Environmental Research,* 99: 126-131.

Lee, CK, 2002, Multifractal characteristics in air pollutant concentration time series. *Water, Air, and Soil Pollution,* 135: 389-409.

Masoudi, M 2014, Status and prediction of ozone as an air pollutant in Ahvaz City, Iran. *Caspian Journal of Environmental Sciences,* 12: 215-224.

Mastaneh, Z & Mouseli, L 2013, Capabilities and limitations of crisis management in the Teaching Hospitals of Hormozgan University of Medical Sciences, 2010. *Scientific Research and Essays,* 8: 1196-1202.

Modarres, R & Dehkordi, AK 2005, Daily air pollution time series analysis of Isfahan City. *International Journal of Environmental Science & Technology,* 2: 259-267.

Mohammadi, MJ, Godini, H, Khak, MT, Daryanoosh, SM, Dobaradaran, S & Goudarzi, G 2015, An association between air quality and COPD in Ahvaz, Iran. J*undishapur Journal of Chronic Disease Care,* 4: e26621.

Neisi, A, Goudarzi, G, Babaei, A, Vosoughi, M, Hashemzadeh, B, Naimabadi A, Mohammadi, MJ 2016, Study of heavy metal levels in indoor dust and their health risk assessment in children of Ahvaz city, Iran. *Toxin Reviews,* 35:16–23

Pope III, CA & Dockery, DW 2006, Health effects of fine particulate air pollution: lines that connect. J*ournal of the Air & Waste Management Association,* 56: 709-742.

Rahila, R & Siddiqui, M 2014, Review on effects of particulates; sulfur dioxide and nitrogen dioxide on human health. *International Research Journal of Environmental Sciences,* 3: 70-73.

Saffarinia, G & Odat, S 2008, Time series analysis of air pollution in Al-Hashimeya Town Zarqa, Jordan. *Jordan Journal of Earth and Environmental Sciences*, 1: 63-72.

Samet, J, Dominici, F, Zeger, S, Schwartz, J & Dockery, D 2000, The national morbidity, mortality, and air pollution study. Part I: Methods and methodologic issues. Research report, Health Effects Institute, 5-14; discussion 75-84.

Schwartz, J 2004, The effects of particulate air pollution on daily deaths: a multi-city case crossover analysis. *Occupational and Environmental Medicine,* 61: 956-961.

Schwartz, J & Marcus, A 1990, Mortality and air pollution in London: a time series analysis. *American Journal of Epidemiology,* 131: 185-194.

Schwartz, J & Zanobetti, A 2000, Using meta-smoothing to estimate dose-response trends across multiple studies, with application to air pollution and daily death. *Epidemiology,* 11: 666-672.

Sepideh, ST, Hassan, D & Mohammadi, MJ 2014, The a study on concentration of betx vapors during winter in the department of ports and shipping located in one of the southern cities of iran. *International Journal of Current Life Sciences,* 4: 5416-5420.

Smith, RL 1989, Extreme value analysis of environmental time series: an application to trend detection in ground-level ozone. *Statistical Science,* 4: 367-377.

Soleimani, Z, Goudarzi, G, Naddafi, K, Sadeghinejad, B, Latifi, S, Parhizgari, N, Alavi, N, Babaei, A, Akhoond, M, Khaefi, M, Rad, H, Mohammadi, M & Shahsavani, A 2013, Determination of culturable indoor airborne fungi during normal and dust event days in Ahvaz, Iran. *Aerobiologia,* 29: 279-290.

Su, C, Breitner, S, Schneider, A, Liu, L, Franck, U, Peters, A & Pan, X 2016, Short-term effects of fine particulate air pollution on cardiovascular hospital emergency room visits: A time-series study in Beijing, China. *International Archives of Occupational and Environmental Health,* 89: 641-657.

Törnqvist, H, Mills, NL, Gonzalez, M, Miller, MR, Robinson, SD, Megson, IL, Macnee, W, Donaldson, K, Söderberg, S, Newby, D E, Sandström, T & Blomberg, A 2007, Persistent edothelial dysfunction in humans after diesel exhaust inhalation. *American Journal of Respiratory and Critical Care Medicine,* 176: 395-400.

Zallaghi, E, Goudarzi, G, Geravandi, S & Mohammadi, MJ 2014, Epidemiological indexes attributed to particulates with Less than 10 micrometers in the air of Ahvaz City during 2010 to 2013. *Health Scope,* 3, e22276.

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غ. گودرزی[۱]، س. گراوندی[۲]، ک. احمدی انگالی[۱]، ع. نیسی[۱]، الف. یاری[۳]، س. دوبرادران[۴]، ب. قلانی[۱]، ب. هاشم زاده[۵]، م. محمدی[۱*]

۱- مرکز تحقیقات و فناوری های زیست محیطی، دانشگاه علوم پزشکی جندی شاپور، اهواز، ایران

۲- گروه پرستاری داخلی جراحی، دانشکده پرستاری، دانشگاه آزاد اسلامی واحد علوم پزشکی تهران، تهران، ایران

۳- گروه مهندسی بهداشت محیط، عضو مرکز تحقیقات آلاینده های محیطی، دانشگاه علوم پزشکی قم، قم، ایران

۴- گروه مهندسی بهداشت محیط، عضو هیئت علمی علوم پزشکی بوشهر، بوشهر، ایران

۵- گروه مهندسی بهداشت محیط، دانشکده پرستاری خوی، دانشگاه علوم پزشکی ارومیه، ایران

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چکیده

دی اکسید گوگرد دو منبع مهم در جو دارد و بسیاری از دانشمندان به توزیع جغرافیایی دی اکسید گوگرد در جهان با توجه به این باور اعتقاد دارند. نیروگاه های برق واقع شده در نیمکره شمالی از جمله روسیه، چین، کانادا و ایالات متحده منتشر کننده بخش عمده دی اکسید گوگرد در جهان هستند. در نیم کره جنوبی، فیتوپلانکتون ها مقدار قابل توجهی از دی متیل سولفید و دی سولفید دی متیل را تولید می‌کنند. سپس این نوع از محصولات در جو زمین واکنش داده و به دی اکسید گوگرد تبدیل می‌شوند. دی اکسید گوگرد، گازی است بی‌رنگ که از سوزاندن زغال سنگ، زغال سنگ حاوی مقادیرگوگرد بالا و سوخت دیزل منتشر می‌شود. انتشار دی اکسید گوگرد از سیستم حمل و نقل، فولاد، نفت و صنایع دیگر از جمله مهم‌ترین تهدیدات در رابطه با آلاینده‌های هوا در شهر اهواز هستند. هدف اصلی این مطالعه، تعیین الگوی انتشار داده‌ها در طول زمان مد نظر در چارچوب مدل آماری خاص در نظر گرفته شده و مقایسه از طریق پیاده‌سازی روش باکس-جنکینز برای ایجاد مدل‌های سری زمانی در اهواز (واقع در جنوب غربی ایران)، در طول سال ۱۳۹۲ بود. داده‌های مورد نیاز به صورت خام از چهار ایستگاه پایش آلاینده‌های هوا اداره کل حفاظت محیط زیست گردآوری شد. در مرحله اول این داده‌ها توسط نرم افزار EXCEL پردازش شد و در نهایت داده های پردازش شده به وسیله مدل‌های سری زمانی بررسی شد. نتایج تجزیه و تحلیل سری‌های زمانی نشان داد که آلاینده مدنظر با یک درجه تاخیر و دو درجه تاخیر حرکت متوسط در مدل فیت شده ARMA بود. یافته‌های این مطالعه نشان داد که میانگین غلظت دی اکسید گوگرد در فصل زمستان بیشتر از تابستان بود. با توجه به نتایج حاصل از این مطالعه، انتشار و پخش دی اکسید گوگرد دارای یک ساختار هم‌بسته در طول زمان بود، بنابراین مدل سری زمانی یک مدل مناسب برای توضیح رفتار انتشار دی اکسید گوگرد در طول زمان است.

* مولف مسئول