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Effects of Air Pollutants from Al-Dura Power plant in the Surrounding Area South Baghdad

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Abstract: Thermal power stations are one of the main pollution sources in Baghdad that release many toxic substances in the environment and cause toxic effects on public health. Three selected sites were selected with gradual distances from Al-Daura thermal power station within (0.5 Km (st. 1), 1 Km (st. 2) and 2 Km (st. 3), respectively) according to the direction of downwind of site. In addition, one of unpolluted site was chosen for comparison as a control site around 4 Km upwind from Al-Daura thermal power station. The samples were taken for two seasons,winter 2014 and spring 2015; the first season was in December 2014 and the second season was in March 2015. The concentrations of some pollutants that originated from Al-Daura thermal power station as air pollutants were measured. The results of air analysis showed high concentrations of Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Hydrogen Sulfide (H_2S) and volatile organic components (VOCs) in all three sites in comparison with control site, and the higher values for SO_2, NO_2 and H_2S were shown in site 3; while the concentrations of VOC were higher in site 2. There are no significant differences in concentrations between the air pollutants in the two seasons, except for SO_2, which were increased in the first season than in the second season.

Keywords*: Air pollution , power station*

Introduction

The thermal power stations are the most popular power stations due to its high production and it's depending on fossil fuel or their derivatives as a main fuel, so it's classified as a high pollution project. Their most emissions are nitrogen oxides (NO_x), sulphur dioxide (SO_2), unburned hydrocarbons, particulate matter (PM), volatile organic compounds (VOCs), greenhouse gases and heavy metals (Singh *et al*., 2010; Kumar *et al.,*2013).

Due to the very high content of sulphur in heavy fuel oil, it can be expected that sulphurous emissions from the power stations will be high. This may lead to serious environmental impacts because of that SO_2 is one of the most common and harmful air pollutants. It is formed when high sulfur content materials are burning such as crude oil. It dissolves easily in water, and when is emitted from a smokestack it dissolves into water vapour to form acid. From an environmental perspective, SO_2 is particularly damaging due to its role in forming acid rain which damages trees and crops and makes soils, lakes and streams acidic which in turn can kill off organisms in those water bodies.

Nitrogen oxides (NOx) are a group of highly reactive gases that can be generated by burning fossil fuels. So, thermal power stations are one of the largest sources of nitrogen oxide pollution. Combustion of fuels at high temperatures converts the elemental nitrogen in the air and fuel to NOx. After combustion and release, NOx and their by-products enter the environment, which can affect the human health and the environment (Gauderman *et al*., 2000; USEPA, 2001).

Hydrogen sulfide **(**H_2S) is a colorless and flammable gas. Its smell is distinctive of rotten eggs or the obnoxious odor of a blocked sewer. H_2S is the sulfur analog of water molecule and can be oxidized by a series of reactions to form SO_2, sulfates, such as sulfuric acid and elemental sulfur. H_2S has long been known for its toxic properties (Eghbal, *et al.,* 2004; Truong *et al.,* 2006; Wang, 2012).

Volatile organic compounds (VOCs) mean all the organic compounds of anthropogenic nature, other than methane, that could be participating in atmospheric photochemical oxidants by reactions with nitrogen oxides in the presence of sunlight, and whose composition makes it possible for them to evaporate under normal atmospheric conditions of temperature and pressure (Ciaparra *et al.,* 2009).

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The aim of the present study is to determine the levels of some pollutants in the surrounding areas of Al-Daurah thermal power station such as(SO_2, NO_2, H_2S and VOC).

Materials and methods

Study area:

Three sites with gradual distances from Al-Daurah thermal power station south of Baghdad within (0.5, 1 and 2 Km) were selected for sampling. These selections were, according to the direction of the wind of the site, which are confirmed as polluted locations by Sahieb *et al*. (2013) and Lafta *et al*. (2014). In addition, one of unpolluted site was chosen for comparison as a control around 4 Km upwind from Al-Daurah thermal power station. All samples were collected for two seasons, winter 2014 and spring 2015; the 1st season was in December 2014 and the 2nd was in March 2015 (Figure 1)

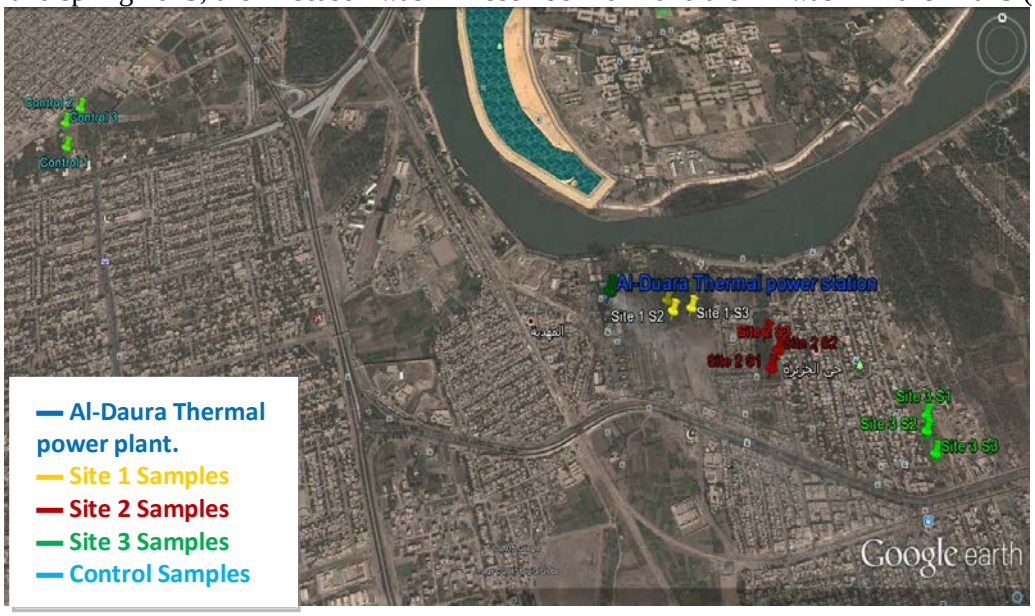

Figure 1:The study area of Al-Daurah thermal power station with sampling stations

Sampling collection:

Air samples for all three contaminated sites and control were collected using three NOVA 600 Series devices to measure the SO_2, NO_2 and H_2S gas concentrations, and one devise of MiniRAE3000 to measure VOCs concentrations for all sites. The devices were turned on for one hour from 9:00 am the readings were recorded automatically every minute, then devices were connected to a computer with software (Omega) equipped with these devices and the averages of readings were taken.

Statistical Analysis

The statistical analysis system-SAS (2012) was used for evaluation of the effect different factors (site and season) in study of parameters. Least significant difference-LSD test was used to compare between mean values at 0.05 levels.

Results and Discussion

The data obtained from this research, as shown in Tables 1, 2, 3, 4 and 5, included the measurements of the concentrations of SO_2, NO_2, H_2S and VOCs.

SO_2 concentrations

The results in Table 1 show that the mean concentrations of SO_2 in season 1 (0.355 ± 0.04 ppm) were significantly higher than in season 2 (0.328 ± 0.042 ppm.). Also, a high significant increase in the concentration of SO_2 has been recorded on site 3 when compared with site 1 and control site, in the same time there is no significant difference in the concentration of SO_2 between site 2 and 3. There was a significant difference in the interaction (sites and seasons) and was the highest in the site 3 of season 1, whereas, the lowest was in the control site in season 2. The concentrations of SO_2 in all three sites for two seasons were higher than the value of proposed national limit for air quality of the Iraqi Ministry of Environment (0.15 ppm) for one hour exposure (Lafta *et al.*, 2014).

Table 1. Concentrations of SO_2 (ppm) (Mean ± SE) in the air of study sites for the two seasons

Site	Season		Mean ± SE
	1 December 2014	2 March 2015	
Control	0.127 ± 0.002	0.115 ± 0.001	0.121 ± 0.002 C
1 (0.5 Km distance)	0.351 ± 0.004	0.313 ± 0.002	0.332 ± 0.008 B
2 (1 Km distance)	0.463 ± 0.013	0.427 ± 0.007	0.445 ± 0.008 A
3 (2 Km distance)	0.479 ± 0.005	0.460 ± 0.003	0.469 ± 0.004 A
Mean ± SE	0.355 ± 0.04 A	0.328 ± 0.042 B	---
LSD value: Site: 0.062 *, Season: 0.004 *, Interaction of Site × Season: 0.106 *			
(P>0.05) N.S: Not significant			

NO_2concentrations

The results in table 2 illustrate that there was no significant difference in the mean concentration of NO_2 in the two seasons. The highest concentration of NO_2 was in site 3 with a significant difference from other sites. The higher interaction value with a significant difference was in site 3 season 1 that was 0.682 ± 0.033 ppm, while the lowest interaction value was in the control site in season 2 that was 0.171 ± 0.002 ppm.

The concentrations of NO_2 in all three sites for two seasons were higher from the value of proposed national limit that has been recorded for NO_2 as 0.25 ppm for one hour exposure (Lafta *et al.,* 2014).

Table 2. Concentrations of NO_2 (ppm) (Mean ± SE) in the air of study sites for the two seasons

Site	Season		Mean ± SE
	1 December 2014	2 March 2015	
Control	0.200 ± 0.004	0.171 ± 0.002	0.185 ± 0.006 D
1 (0.5 Km distance)	0.403 ± 0.007	0.391 ± 0.005	0.397 ± 0.002 C
2 (1 Km distance)	0.601 ± 0.013	0.587 ± 0.004	0.594 ± 0.003 B
3 (2 Km distance)	0.682 ± 0.033	0.665 ± 0.014	0.673 ± 0.003 A
Mean ± SE	0.471 ± 0.05 A	0.453 ± 0.06 A	----
LSD value: Site: 0.104 *, Season: N.S, Interaction of Site × Season: 0.074 *			
(P>0.05) N.S: Not significant			

H_2S concentrations

The results in table 3 show that there was no significant difference in the mean concentrations of H_2S between the two seasons. Whilst, they show significant differences in the concentrations of H_2S from all three sites when compared with the control site, the concentration of H_2S in site 3 was 1.147 ± 0.002 ppm, higher than all other sites. The higher interaction value with a significant difference was recorded during season 1 at site 3, while the lowest value was in season 2 at the control site.

Noted that the H_2S did not have a limit for air quality because it's a dangerous gas and it's not supposed to be existed in the ambient air (Lafta *et al.,* 2014).

Table 3. Concentrations of H_2S (ppm) (Mean ± SE) in the air of study sites for the two seasons

Site	Season		Mean ± SE
	1 December 2014	2 March 2015	
Control	0.42 ± 0.007	0.35 ± 0.004	0.385 ± 0.015 C
1 (0.5 Km distance)	0.991 ± 0.036	0.950 ± 0.172	0.97 ± 0.009 B
2 (1 Km distance)	1.045 ± 0.110	1.028 ± 0.089	1.036 ± 0.004 B
3 (2 Km distance)	1.153 ± 0.083	1.141 ± 0.066	1.147 ± 0.002 A
Mean ± SE	0.902 ± 0.08 A	0.867 ± 0.09 A	---
*LSD value: Site: 0.104 * , Season: N.S, Interaction of Site × Season: 0.018**			
(P>0.05) N.S: Not significant			

VOCs concentration

There was no significant difference has been recorded in the concentrations of VOCs between season 1 and 2 (that were 0.252± 0.03 and 0.271 ± 0.03 ppm, respectively)(table 4).While, the concentrations of VOCs in all three sites were significantly higher when compared with the control site. The interactions of VOCs concentrations in season 2 at site 2 were higher for all others.

The concentrations of VOCs in site 2 and 3 for two seasons were higher than the proposed national limit for VOCs that is 0.24 ppm (Lafta *et al.*, 2014).

Table 4. Concentrations of VOC (ppm) (Mean ± SE) in the air of study sites for the two seasons

Site	Season		Mean ± SE
	1 December 2014	2 March 2015	
Control	0.076 ± 0.003	0.081 ± 0.007	0.078 ± 0.001 B
1 (0.5 Km distance)	0.260 ± 0.009	0.292 ± 0.005	0.276 ± 0.007 A
2 (1 Km distance)	0.355 ± 0.005	0.381 ± 0.024	0.368 ± 0.005 A
3 (2 Km distance)	0.318 ± 0.015	0.331 ± 0.038	0.324 ± 0.002 A
Mean ± SE	0.252 ± 0.03 A	0.271 ± 0.03 A	---

*LSD value: Site: 0.183 *, Season: N.S, Interaction of Site × Season: 0.310**
(P>0.05) N.S: Not significant

The results in tables 2,3 and 4 showed that the higher values of the concentrations of SO_2, NO_2 and H_2S in the farthest site (site 3) more than other sites for two seasons. These results were emphasized by Gaussian-plume type model for predicting the concentrations downwind of a pollutant source. This model demonstrated that the gaseous emissions spread for long distances from their sources depending on many factors, such as the state of the atmosphere, terrain, emission characteristics and thermodynamic effects (Wang, 2012).

Also, the results suggested that in addition to the pollution coming from the power station, there are other effects on site 3 like vehicles exhaust and emissions from diesel generators that have been spread near to site 3. Interference of these pollution sources may be another reason for these high concentrations, but the most source effect was from the power station emissions from the combustion of HFO from thermal power stations. While the concentrations of VOCs were higher in site 2 due to the heavy weight of VOCs that may exist in the nearest places to their source from Al-Daura thermal power station. Intergovernmental Panel on Climate Change (IPCC) (2013) stated that VOCs abundances are generally concentrated very near their sources. The distribution of SO_2, NO_2, H_2S and VOC in all sites and control site is shown in figure 2.

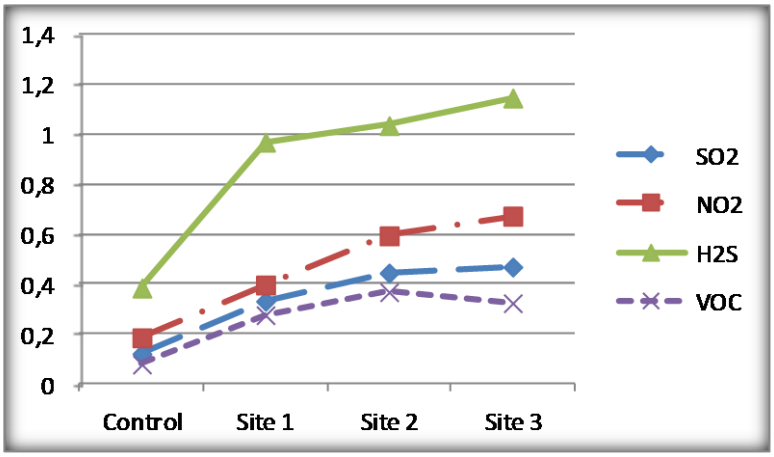

Figure 2. Distribution of air pollutants in all three sites.

Njoroge and UNEP, (2007) demonstrated that the distribution of the pollutants that release to the air for a long distance from their sources and their deposition onto the soil, water and plants depending on their density.

According to the report of the Iraqi Ministry of Environment about the air pollution from Al-Daurah thermal power station in 2014, it is demonstrated that there were high concentrations of air pollutants (SO_2 = 0.448; NO_2 = 0.663; H_2S = 0.971 and VOCs = 0.169 ppm) (Lafta *et al.*, 2014), in a site close to site 3 and these results correspond with the results of the current study.

In this study, there were no significant differences between the concentrations of air pollutants in two seasons except for SO_2 that were increased in season 1 more than season 2 with a significant difference (Table 2). At the same time there was a slight increase in the concentrations of NO_2 and H_2S noted in season 1 than season 2 (Table 3 and 4), while the concentrations of VOCs were increased significantly in season 2 than season 1 (Table 5).

The explanations of these results is matched with that of Lafta *et al.*, (2014) who reported that these differences may be caused by the differences of the amount and intensity of emissions that are launched by Al-Daurah thermal power station during the working hours which may increase at certain times according to the electrical load as well as the climatic factors (wind, humidity, temperature and rain) (Table 1).

Intergovernmental Panel on Climate Change (IPCC) (2013), mentioned that the climatic factors have influential and powerful impacts on the concentrations of gaseous pollutants in ambient air. Where, the wind speed decreases the ratio of the concentrations of gaseous pollutants in ambient air, thereby reduce its impact. The temperature has varying effects depending on the type of contaminants. Thus, it contributes to increase the concentration of a particular pollutant in the air while working to reduce another one. For example, the high air temperature is working on increasing the concentrations of VOCs and ground ozone gas in the summer season, while, it was observed that the atmospheric SO_2 and NO_2 gases were in the highest concentrations in the winter season and the lower concentrations in the summer season. Humidity factor may have more effect (to increase or to decrease) on the concentrations of atmospheric SO_2, and $NO_2$where it works on decreasing the spread of the gases in the ambient air. While constant rainfall is a great factor in the reduction of atmospheric SO_2, NO_2 gas concentrations which results in the transformation of these gases to H_2SO_4 and HNO_3 constituting the acid rains.

References

Ciaparra D, Aries E, Booth M, Anderson DR, Almeida SM, Harrad SC (2009) Characterization of volatile organic compounds and polycyclic aromatic hydrocarbons in the ambient air of steelworks. Atmospheric Environment,**43**, 2070–2079.

Eghbal, M. A., Pennefather, P. S., and O'Brien, P. J. (2004). H_2S cytotoxicity mechanism involves reactive oxygen species formation and mitochondrial depolarization. Journal of Toxicology, **203**:69−76.

Gauderman WJ, McConnell R, Gilliland F, London S, Thomas D, Avol E, (2000). Association between air pollution and lung function growth in Southern California children. American Journal of Respiratory and Critical Care Medicine, **162**, 1-8.

(IPCC) Intergovernmental Panel on Climate Change, (2013). "Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change". Cambridge University Press, United Kingdom and New York, NY, USA, pp. 1535.

Kumar, S.; Katoria, D. and Sehgal, D. (2013). Environmental impact assessment of thermal power plant for sustainable development. International Journal of Environmental Engineering and Management, **4**, 567-572.

Lafta, A.; Johi, H.; Kazar, A. and Abood, S. (2014). A study on the Impact of Al-Daura power station emissions on neighboring areas.(Study report). Ministry of Environment/ Directory of Environmental Protection and Enhancement in the Middle Region/ Directory of Baghdad Environment / Branch of Monitoring Air Quality and Noise. Iraq (In Arabic). (Unpublished report).

Njoroge, G. and UNEP (2007). Environmental Pollution and Impact of Public Health. Implication of the Dandora Municipal Dumping Site in Nairobi, Kenya.

Singh, R.; Singh, R. K.; Gupta, N. C. and Guha, B. K. (2010). Assessment of heavy metals in fly ash and groundwater –a case study of NTPC Badarpur thermal power plant Delhi, India. *Poll Res.*, **29**, 685-689.

Sahieb. B. H.; Ghalib. M. S.; Hasin, S. K. and Ishaq, A. (2013). The effect of residual heavy Metals originated from electric power station on internal and surrounded soils on polluted site. (Study report). Ministry of Environment/ Directory of Environmental Protection and Enhancement in the Middle Region/ Directory of Baghdad Environment / Branch of Agriculture Pesticides.Iraq (In Arabic). (unpublished report).

Statistical Analysis System (SAS) (2012) User's Guide Statistical. Version 9.1th ed. SAS. Inc. Cary. N. C. USA.

(USEPA) United States Environmental Protection Agency, (2001). How Ground-level Ozone Affects the Way We Live and Breathe. Office of Air and Radiation.

Truong DH, Eghbal MA, Hindmarsh, W, Roth SH, O'Brien, PJ, (2006). Molecular mechanisms of hydrogen sulfide toxicity. Journal of Drug Metabolism Reviews, **38**:733-744

Wang R, (2012) Physiological implications of hydrogen sulfide: a whiff exploration that blossomed. *Physiol. Rev*., **92**, 791–896.