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Procedia Economics and Finance 24 (2015) 409 – 418

Procedia
Economics and Finance

www.elsevier.com/locate/procedia

International Conference on Applied Economics, ICOAE 2015, 2-4 July 2015, Kazan, Russia

Economic Modeling of the Regional Polices to Combat Dust Phenomenon by Using Game Theory

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Abstract

In recent years, dust phenomenon as an environmental externality has affected Iran and other Middle East countries. The major parts of dust which has polluted Iran's atmosphere, mainly comes from Iraq. This dust phenomenon has also had a lot of economic and social damages for these two countries.

The main aim of this study is to analyse the advantages of cooperation between Iran and Iraq against this phenomenon. The significant damage of this phenomenon has been estimated on health and hygiene, transportation and agriculture sections. The expenditure in contrast with this problem has also been calculated in the crucial zone of creation dust.

According to the estimation of this study, total damages of dust for Iran and Iraq are 1043.5 and 1404 million dollars, respectively. While the cost of solving this problem is about 2425.7 million dollars. By applying cooperative games theory, the cooperation between Iran and Iraq to combat dust phenomenon has been analysed. Net benefits of these two countries has been calculated in two cooperation games and their characteristic functions has been derived. Then by using Shapley solution, outcome benefits have been distributed between these two countries. The results suggest that the net benefits of two countries will increase if they associate with each other. In the meantime, based on the results of coalition, a fairly allocation has also been used for costs which has been utilized against dust phenomenon between Iran and Iraq. So these two countries should spend 1442.6 and 1082.1 million dollars to conquer this phenomenon, respectively.

The managers of Iranian environmental protection organization should have more effective cooperation with Iraq to resolve dust problem by using diplomatic means and provide parts of its cost by side payments.

Keywords: *Dust, Game Theory, Cooperative Games, Shapley Value, Iran, Iraq.*

Selection and/or peer-review under responsibility of the Organizing Committee of ICOAE 2015.

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Selection and/or peer-review under responsibility of the Organizing Committee of ICOAE 2015.
doi:10.1016/S2212-5671(15)00697-8

1. Introduction

The dust phenomenon is one of the most important world challenges especially in arid and semiarid areas such as Middle East. In recent years this phenomenon affected some countries such as Iran and Iraq. Because of various factors such as inappropriate utilization of water and soil resources, consecutive wars occurring, vegetation destruction and marshes drying along with natural events and climate changes, dust phenomenon has been intensified in the Middle East region. In the western of Iran, dust storms occurrence with foreign origin has extremely increased and made social, economic and environmental problems during last years. Health trouble is one of the most important effect of dust phenomenon affecting of the people of society. Particles connection can causes cardiovascular disease such as heart attacks and infarct (EPA[5], 2009). These particles lead to blood clotting in vessels (Pope, et al, 2006).

Dust causes respiratory disease like Asthma such that the regions which have affected dust storms like the Middle East and Caribbean have the highest prevalence of asthma among the world (EPA, 2009; Griffin, 2007). In addition, it can lead to epidemic diseases such as meningitis and valley fever (Sultan, et al, 2005: MMWR[6], 2003). Therefore the exposure of these particles cause early death in short time and especially in long time (EPA, 2009).

In addition, because of troubles made from visibility reduction, the dust phenomenon mainly lead to road, air and rail transportation disturbaces. Visibility reduction increases road accident and consequently causes many bodily and financial damages (Ekhtesasi and Sepehr, 2009). For instance, dust storms in Beiging[7] increased road accidents from 20 to 30 percent compared to normal conditions (Ai and Polenske, 2008). Also, the total travelling time and costs for drivers, passengers and road-based public transport increases when visibility limitation causes the potential reduction in travelling speed or cancellation (Tozer, et al, 2013).

Dust storms has a major effect on air transportation services and airports closure so the airlines are forced to divert, delay or cancel flights. These practices have extra costs of fuel and labor required to align passengers (Tozer, et al, 2013).

Dust storms cause environmental damages both at their site of origin and downwind. Where the dust arises from the damage is caused by the loss of top soil, resulting in the reduction of soil carbon and organic matter (Leys, 2002). Dust and windblown sand can also cause burying vegetation and damaging infrastructure such as fencing and irrigation facilities (Huszar and Piper, 1986; Bennel, *et al*, 2007).

Dust deposition on the surface of leaves blocks their stoma and thus the mechanism of gas exchange, evaporation, transpiration and photosynthesis is faced with the problem (Mehravaran, 1999) and thereby reduces the plant defense power against pests. This can stop the growth of plants and decrease agricultural production by about 30% (Ye, *et al*, 2003). In addition, the deposition of dust on the soil surface, will change the soil structure and reduce the infiltration rate, leading to the degradation of the soil (Migahid, *et al*, 1995).

Other than direct losses that followed, Dust phenomenon cause indirect harmful damages in varied different sectors, such as closure of schools, offices and economic centers, impairment of television signals, climate change and the loss of water resources, poverty growth and its social consequences, forced migrations.

Given the political and social consequences of dust phenomenon in the Middle East, and its problems in human health and living creatures, investigating of the issues has become a necessity for the region. Thus, if estimating of the losses of dust phenomenon will be determined, a measure for the solution of this phenomenon will be determined for societies and countries authorities as well. On the other hand, cooperation of countries involved in

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[5]. US Environmental Protection Agency

this phenomenon is necessary due to trans boundary property of its externality. The game theory is a useful method for the analysis of these issues.

In this study, first of all the amount of dust phenomenon damages in Iran and Iraq as well as the cost of conquering this phenomenon will be estimated. Then by applying cooperative games theory and considering Iran and Iraq countries as players, environmental and economic aspects of dust phenomenon in both cooperation and noncooperation solutions will be presented.

2. The Literature survey

This section reviews the studies related to the topic of the paper. So given the breadth of the subject, the review of these studies will present in two separate categories: the studies surveyed and assessed the damages of dust phenomenon in the first and applied game theory to resolving international issues as trans boundary pollution in the second.

2.1. A review of studies on the dust phenomenon

Williams and Young (1999) calculated annual wind erosion damages using Benefit Transfer Method (BTM) in Australia. In this study the sectors of health, flights, car accidents and road maintenance sections have been chosen. The total amount of damages in the case of low, medium and high were estimated 11, 23 and 55 million in Australian dollars, respectively.

Kang et al (2004) estimated socio-economic costs of dust storms in South Korea, by assuming an average of 14 dusty days per year. They firstly calculated the socio-economic cost per person about $ 29.51 and then multiplied this number by the total population of South Korea and modified it with a discount rate of 7.5 percent. Thus, the total socio-economic damages are estimated in amount of $ 5921 million per year.

Miri *et al* (2009) investigated the damages of dust storms in the Sistan region. They completed questionnaires among the local people. They also reviewed the relevant organizations reports, so the damages have been estimated about $125 million, during the years 2000 to 2004.

Tozer and Leys (2013) estimated the economic effects of a large dust storm called Red Dawn occurred in the state of New South Wales in Australia on 23 September 2009. By applying Benefit Transfer Method (BTM) and using previous related studies, they calculated the damage cost of the dust storm in transportation, commercial activities, cleaning and closure of schools and businesses. The damages have been estimated about $ 299 million totally. It is mentioned that they didn't consider the estimating health damage due to its intangible effects and lack of information.

2.2. A review of studies on the application of game theory in environmental pollution

Kaitala, *et al* (1992) analyzed acid rain issue as a trans boundary air pollution in framework of a dynamic game between Finland and the Soviet Union. In this research is assumed that the countries are going to maximizing the net benefits from pollution control as measured by the impacts on the values of forest growth net of the abatement costs**.** The cooperative and no cooperative solution have been compared to assess the benefits of bilateral cooperation. The results show that cooperation is beneficial to Finland, but not to the Soviet Union. Consequently, Finland has to offer financial compensation to its neighbor to encourage investment in environmental protection.

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[6]. Morbidity, Mortality Weekly Report
[7]. The capital of china

Halkos and Hutton (1993) calculated the potential benefits from cooperation of some Western European countries to prevent the acid rain phenomenon. The cost of removing sulfur dioxide emission in the electricity generation process is defined as the cost of reducing pollution. The results showed that acid rain damages are much lower while the countries cooperate together.

Botteon and Carraro (2001) by considering a model with five asymmetric regions including: 1. Japan; 2. USA and Canada; 3. Europe Union; 4. Eastern Europe and Russia; 5. India and China; as players to survey an international environmental agreement in game theory framework. To allocate the cost of pollution emission reduction among players, the study used the Nash bargaining and Shapley solutions. The results show that, using the Shapley solution with transfer payments, creating an incentive for further cooperation.

3. Methods and the procedures of the calculation

As mentioned earlier, dust phenomenon causes many damages that it is difficult to estimate all of the relevant costs. So, based on the viewpoints of environmental experts, the most important damages were identified. Then by taking into consideration the findings of previous studies, the damages will be estimated. Accordingly, the damages caused by dust phenomenon in health, transportation (road and air) and agriculture (cultivation and gardening) is estimated.

It is worth noting that, although the pollution of dust phenomenon in Iran sometimes goes to the central regions of the country, in the provinces of West and South West of the country due to greater intensity and frequency of this phenomenon, pollutants caused further damages. Accordingly, on the basis of consultation with environmental experts, the provices of Khuzestan, Kermanshah, Ilam, Kurdistan, Lorestan and Bushehr were selected as the most influenced regions to estimate the damage. In the case of Iraq, almost all regions of the country is affected by dust phenomenon. Thus, the dust phenomenon costs of the entire country of Iraq will be calculated.

Concentration, persistence and number of dusty days, are the main factors that affect the amount of dust phenomenon damages. However, based on consultation with environmental experts, dusty days will be considered as influential factor on the amount of damage in this study.

In addition, in this research, in order to be comparable and addable the findings with other researchers the calculated values are expressed in 2013 prices and based on US dollar. So, after calculating the damages in each section and convert them into dollars (if needed), then by using equation (1) the values will be calculated in 2013 prices:

$$\boldsymbol{V_{2013}} = \sum_{t=t.}^{2013} \boldsymbol{D_t}.(1+\boldsymbol{i})^{\boldsymbol{t}} \qquad (1)$$

In the above equation, $\boldsymbol{V_{2013}}$ is the value of losses in the year 2013, *t.* is the initial year (the year that the amounts transferred to this study), D_t. is the Losses in t. year and *i* is the rate of inflation.

To estimate the amount of damages in the health sector, the study will be used the study of Miri, *et al* (2009) that have estimated the damages of dust storms in the Sistan region during the period 2000 to 2005. Thus, the amount of damages determined by Miri, *et al* (2009), based on per capita and dusty days of Sistan region will be considered, then the values according to equation (2) will be transferred to the regions under study.

$$\text{Health Cost} = \text{(Health Damages Caused by Dust Storms per Person per Dusty Day)} \times \text{(Dusty Days Number)} \times \text{(Population)} \qquad (2)$$

In this study, the damages in transportation system in both road and air part will be estimated separately. First in the road transportation sector by using Miri, at al (2009) and applying equation (3), the damages of accident cars

will be calculated. In the equation (3), road trips number as a factor in the number of accidents have been considered.

The Damages in the Road Transportation Section	=	(Damage Caused by Accidents per Trip per Dusty Days)	X	(Dusty Days Number)	(Trips Number)	(3)

In the air transportation sector, Miri, *at al* (2005) calculated the damages caused by the cancellation and delay of flights in dusty days in the Sistan region. So by using this study and based on equation (4), the damages of air transportation in the regions studied will be estimated. The number of air flights has been considered as the main factor in cancellation and delay of flights.

The Damages in the Air Transportation Section=	=	(Damage Caused by Cancellation and Delay per Flight per Dusty Days)	(Dusty Days Number)	(Flights Number)	(4)

Due to the special conditions of each region climate, agricultural products are different. In addition, different types of agricultural products in the region has not been distributed uniformly. Therefore, the value agricultural products is different depending on the amount of each type of product in each region. For this reason, Benefit Transfer Method (BTM) has limitations in estimating the amount of agricultural damages.

Proportional to the value of the products of each region, the method will be used to estimate the damages of agricultural sector. Ai and Polenske (2008) study stated that the dust particles in China has caused reduction of agricultural products to 30%. Ye, *et al* (2003) also acknowledged that the deposition of dust reduces agricultural production about 30%. Hence, according to the studies mentioning, a 30% decrease in agricultural production due to dust phenomenon, will be considered for calculating the damages.

Thus, to calculate the depreciation of agriculture production (cultivation and gardening), first, it is necessary to estimate the value of all products with the assumption of not happening dust phenomenon and then calculate the reduction amount of them (namely 30%) based on the value estimated at first (Khaleghi, 2010)

$$V_{estimate} = V_{real} + \%30\ X\ V_{estimate} \rightarrow V_{estimate} = \frac{V_{real}}{\%70} \quad (5)$$

Where $\mathbf{V_{estimate}}$ is the estimated products value with the assumption of not happening dust phenomenon and $\mathbf{V_{real}}$ is the real products value in the condition of dust phenomenon happening.

Therefore, the cost of damages in agriculture section will be estimated by the following equation**:**

$$\text{The damages cost in agriculture section} = (30\%)\ \text{X}\ V_{estimate} \quad (6)$$

4. Research Calculation and Model Estimation

4.1. The Amount of Damage Cost of Dust Phenomenon in Iran and Iraq

By using the equations from (2) to (6) the amount of dust phenomenon damages in Iran and Iraq will be calculated. Then by applying equation (1) the values will be expressed in 2013 prices. The results of calculations of Iran and Iraq are presented in Tables 1 and 2 respectively.

Table 1. The amount of damage caused by the dust phenomenon in Iran

Section	Damage (million dollar-prices of 2013)
Health	306.5
Transportation	66.6
Agriculture	670.4
Total	1043.5

Source: research Calculations

4.2. Estimation of Combating Cost

According to studies conducted by the Iran Meteorological Organization, 6 region of dust phenomenon happening have been detected. The area of these six regions located in Iraq is 6654 square kilometers (about 665,400 hectares) approximately.

On the other hand, based on the calculation of the Iran Forests and rangelands office, mulching cost along with trees planting and based on the number of years of their useful durability has been estimated to amount of 2524.7 million dollars per hectare, annually.

4.3. Cost and Benefit Allocation between Iran and Iraq

To evaluate the contribution of each country for combating dust phenomenon, a basic assumption will be considered: If the two countries combat with dust phenomenon, all of the losses will be prevented.

So, the net benefit gained from the coalition will be calculated:

$$\boldsymbol{NB\{\emptyset\} = 0}$$

$$\boldsymbol{NB\{Iran\} = TB\{Iran\} - TC\{Iran\} = 1.43.5 - 2524.7 = -1481.2}$$

$$\boldsymbol{NB\{Iraq\} = TB\{Iraq\} - TC\{Iraq\} = 1404 - 2524.7 = -1120.7}$$

$$\boldsymbol{NB\{Iran, Iraq\} = TB\{Iran, Iraq\} - TC\{Iran, Iraq\} = TB\{Iran\} + TB\{\ Iraq\} - TC\{Iran, Iraq\}}$$
$$\boldsymbol{= 1404 + 1043.5 - 2524.7 = -77.2}$$

Where TB is total benefit gained from dust phenomenon conquer, TC is the total cost to combat it and NB is net benefit.

Table 2. The amount of damage caused by the dust phenomenon in Iraq

Section	Damage (million dollar-prices of 2013)
Health	615.7
Transportation	52.6
Agriculture	735.7
Total	1404

Source: research Calculations

Characteristic function of the game is as follows:

$\boldsymbol{V}\{\emptyset\} = 0$

$\boldsymbol{V}\{\boldsymbol{Iran}\} = \boldsymbol{NB}\{\boldsymbol{Iran}\} - \boldsymbol{NB}\{\emptyset\} = \mathbf{-1481.2}$

$\boldsymbol{V}\{\boldsymbol{Iraq}\} = \boldsymbol{NB}\{\boldsymbol{Iraq}\} - \boldsymbol{NB}\{\emptyset\} = \mathbf{-1120.7}$

$\boldsymbol{V}\{\boldsymbol{Iran, Iraq}\} = \boldsymbol{NB}\{\boldsymbol{Iran, Iraq}\} - (\boldsymbol{NB}\{\boldsymbol{Iran}\} + \boldsymbol{NB}\{\boldsymbol{Iraq}\}) = \mathbf{-77.2} - (\mathbf{-1481.2 - 1120.7}) = \mathbf{2524.7}$

By using Shapley value, net benefits will be allocated between two players (Iran and Iraq). Shapley values were calculated and presented in Tables 3 and 4 for Iran and Iraq respectively.

Table 3. Shapley value calculation for Iran

Coalition with Iran	$\lvert S \rvert$	$[V(S) - V(S - \{i\})]$	$\frac{(\lvert S \rvert - 1)!\,(n - \lvert S \rvert)!}{n!}$	$\frac{(\lvert S \rvert - 1)!(n - \lvert S \rvert)!}{n!}[V(S) - V(S - i]$
{Iran}	1	V({Iran})-V({∅})=1481.2	$\frac{(1-1)!(2-1)!}{2!}=\frac{1}{2}$	$\left(\frac{1}{2}\right)(-1481.2) = -740.6$
{Iran, Iraq}	2	V({Iran},{Iraq})-V({Iraq})=3645.4	$\frac{(2-1)!(2-2)!}{2!}=\frac{1}{2}$	$(\frac{1}{2})(3645.4) = 1822.7$
$\varphi_{\text{Iran}}(V)$	–	–	–	1082.1

Source: research Calculations

Table 4. Shapley value calculation for Iraq

Coalition with Iraq	$\|S\|$	$[V(S)-V(S-\{i\})]$	$\frac{(\|S\|-1)!\,(n-\|S\|)!}{n!}$	$\frac{(\|S\|-1)!(n-\|S\|)!}{n!}[V(S)-V(S-\{i\})]$
{Iran}	1	V({Iran})-V({∅})=-1120.7	$\frac{(1-1)!(2-1)!}{2!}=\frac{1}{2}$	$\left(\frac{1}{2}\right)(-1120.7)=-560.35$
{Iran, Iraq}	2	V({Iran},{Iraq})-V({Iraq})=4005.9	$\frac{(2-1)!(2-2)!}{2!}=\frac{1}{2}$	$(\frac{1}{2})(4005.9)=2002.95$
$\varphi_{\text{Iraq}}(V)$	–	–	–	1442.6

Source: research Calculations

Thus, the Shapley value function of the game is φ (V) = (1082.1,1442.6) which shows the allocation of the net profit gained from the coalition, between the two countries. The following equations determine the share of each country cost payment:

$$\boldsymbol{X_{Iran} = 2524.7 - 1082.1 = 1442.6}$$

$$\boldsymbol{X_{Iraq} = 2524.7 - 1442.6 = 1082.1}$$

Therefore, based on the results of the above calculations, Iran and Iraq have to undertake 1442.6 and 1082.1 million dollars, respectively.

5. Summary, Conclusions and Suggestions

In this paper by describing the problem of dust phenomenon and its consequences, the economic analysis of certain theoretical framework was presented to deal with this phenomenon in the interaction with the neighbors. According to calculations performed in the study, the total annual cost of Iran and Iraq are 1043.5 and 1404 million dollars respectively. Mulching cost of the main centers of dust is 2524.7 million dollars per year.

Using the theory of cooperative games, net benefits in terms of cooperation and non-cooperation between the two countries were calculated and compared**.** The results show that if the two countries are working together to combat with the phenomenon, their combined net profit increased in amount of 2524.7 million dollars. Then, by using Shapley solution the net benefit which has increased was allocated between the two countries. Accordingly, Iran's and Iraq's increased net benefit are 1082.1 and 1442.6 million dollars. Thus, the cost that each country should be undertaken to deal with the phenomenon was calculated; Iran and Iraq should be undertake 1442.6 and 1082.1

million dollars respectively. Because of 1481.2 against 1120.7 million dollars net losses when the two countries not cooperate together to conquer dust phenomenon, share of Iran is more than Iraq.

Therefore, based on the results, Iran and Iraq could cooperate to combat the phenomenon in order to increase their net benefits. In other words, cooperative strategy chosen by the two countries caused to gain more net benefit to them. Shapley solution with transfer payments, increases the incentive of cooperation between the two countries to combat with the dust phenomenon in the condition of cooperation.

Therefor Iran can provide a portion of combatting cost in the territory of Iraq with the different methods such as side payments. Further research suggestions are as follows:

- in the future studies one can consider the other countries of the Middle East which deal with dust phenomenon and a game with more than two players.

- Given the close relationship between the water resources and the occurrence of dust phenomenon, entering the region international waters into the game theory analysis, could be another topic of future research.

References

Ai, N., and K. R. Polenske (2008). "Socio-Economic Impact Analysis of Yellow Dust Storms: An Approach and Case Study for Beijing". Economic Systems Research, N. 20, PP. 187–203.

Benchekroun, H., Taherkhani, F. (2013). "Adaptation and the Allocation of Pollution Reduction Costs", Department of Economics, CIREQ, McGill University.

Bennell, M. R., Leys, J. F. and Cleugh, H. A. (2007). "Sand-Blasting Damage of Narrow-leaf lupin (Lupinus angustifolius L.): a Field Wind Tunnel Simulation". Australian Journal of Soil Research 45, 119–128.

Botteon, M. and C. Carraro, 2001. "Environmental Coalitions With Heterogenous Countries: Burden Sharing and Carbon Leakage. in A. Ulph (ed.) Environmental Policy, International Agreements, and International Trade, New York, Oxford University Press, 38-65.

Ekhtesasi, M.R. and A. Sepehr (2009). "Investigation of Wind Erosion Process for Estimation, Prevention, and Control of DSS in Yazd–Ardakan plain", Environmental Monitoring and Assessment, 159 (1-4), PP. 267–280.

Griffin DW. (2007). "Atmospheric Movement of Microorganisms in Clouds of Desert Dust and Implications for Human Health", Clinical Microbiology Reviews, 20 (3), PP. 459-577.

Groothuis, P. A. (2005). "Benefit Transfer: A Comparison of Approaches" Growth and Change 36(4), PP. 551-564.

Halkos, G. and Hutton, J. (1993). "Acid Rain Games in Europe, Discussion Papers in Economics", University of York, UK, No. 93-12.

Huszar, P. C. and S. L. Piper (1986). "Estimating the Off-Site Costs of Wind Erosion in New Mexico", Journal of Soil and Water Conservation, 41, PP. 414–416.

Jeong, Dai-Yeun (2008). "Socio-Economic Costs from Yellow Dust Damages in South Korea", Korean Social Science Journal, N. 2, PP. 1-29.

Kaitala, V., Pohjola, M. and Tahvonen, O. (1992). "Transboundary Air Pollution and Soil Acidification: A Dynamic Analysis of an Acid Rain Game between Finland and the USSR", Environmental and Resource Economics. N.2, pp. 161- 181.

Leys, J. (2002). "Erosion by Wind, Effects on Soil Quality and Productivity", Encyclopaedia of Soil Science. (Ed. R. Lal.), PP. 499–502.

Migahid, M. and M. El-Darier (1995). "Effect of Cement Dust on Three Halopytic Species of the Mediterranean Salt Marshes in Egypt", Journal of Arid Environment, 30(3), PP. 361-366.

Miri, A., Ahmadi, H. Ekhtesasi, M.R., Panjekeh, N.Ghanbari A. (2009). "Environmental and socio-economic impacts of dust storms in Sistan Region, Iran", International Journal of Environmental Studies, Vol. 66, No. 3, PP. 343–355.

Morbidity, Mortality Weekly Report (MMWR), (2003). "Increase in coccidioidomycosis - Arizona, 1998–2001", Centers for Disease Control and Prevention (CDC), 52(6), PP. 109-112.

Petrosjan, L., and G. Zaccour, 2003. "Time-consistent Shapley Value Allocation of Pollution Cost Reduction", Journal of Economic Dynamics and Control, vol. 27, PP. 381-398.

Pope, C. Arden, Joseph B. Muhlestein, Heidi T., Dal G. Renlund, Jeffrey L. Anderson, Benjamin D. Horne (2006). "Ischemic Heart Disease Events Triggered by Short-Term Exposure to Fine Particulate Air Pollution", Circulation, N. 23, PP. 2443-2448.

Sultan, B., Labadi, K., Guegan, J-F. and Janicot, S. (2005). "Climate Drives the Meningitis Epidemics Onset in West Africa", PLOS Medicine 2(1), PP. 43-49.

Tozer, P. and J. Leys (2013). "Dust Storms – What Do They Really Cost?", The Rangeland Journal, N. 35, PP. 131-142.

U.S. Environmental Protection Agency (2009). "Integrated Science Assessment for Particulate Matter", December. EPA 600/R-08/139F.

Williams, P. and M. Young (1999). "Costing Dust: How Much Does Wind Erosion Cost the People of South Australia", CSIRO Land and Water, Policy and Economic Research Unit: Adelaide.

Ye, B., Ji, X. and H. Yang (2003). "Concentration and Chemical Composition of $PM_{2.5}$ in Shanghai For a 1-year Period", Atmospheric Environment, 37(4): 449-510.