Original Research Paper

Quantitative Analysis of the Pb Concentration in Dust Fall in Zahedan in the Winter of 2014

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Abstract: Dust is considered as one of the atmospheric phenomena that inappropriately influences the environment. Falling dust contains particles with the size of 100 microns or less, which falls from atmosphere on the surface of the earth. This study aimed at determining the Pb concentration in falling dust samples in order to investigate the urban pollution caused by this element. To investigate the quantitative changes in falling dust lead and its spatial analysis, sampling was performed using 30 sediment traps for 3 months in the winter of 2014. These traps were installed in 30 stations on the roofs of some buildings in Zahedan which were about 1.5 meters high. As the results indicated the Cumulative average of lead concentration was 97.32±5.4 mg/kg in the winter. Correspondingly, scrutinizing lead zoning map revealed that the lowest lead level was measured at the Azadegan station in the winter, whilst the Behdasht station received the highest lead level.

Keywords: Dust Fall, Heavy Metals, Pollution, Cumulative Average

Introduction

Rapid urbanization and constant demand for infrastructure development in urban areas have led to disruptions and consequently to a major reduction in the quality of urban environments (Joshi *et al.*, 2009). Dust is commonly a mixture of solid or soluble particles or both suspended in the air (Sheikhi *et al.*, 2010). Recently, two methods named theoretical calculation and laboratory measurements have been used for measuring falling dust (Azimzadeh *et al.*, 2010). In the laboratory method, samplers and MDCO (Marble Dust Collectors) are used to collect horizontal and vertical dust. The MDCO was designed by Ganer in 1975. This trap consists of a plastic container and one or two rows of glass arches that can be installed on the ground or attached to a vertical base. The plastic containers can be used for different purposes, among which circular dishes are better than rectangular ones, since the effects of wind direction on rectangular dishes are more obvious. The diameter of the spheres used is 1.6 centimeters (Jia and Huang, 2008). Dust storm phenomenon is pinpointed as a dire issue in various regions of the world including Iran (Akbari *et al.*, 2012). While most dust exists in the atmosphere originally comes from fine particles, which are more prevalent in arid and semi-arid regions of the world. In fact, the dust generation can be a response to the change in land cover, in which the role of human activities along with the normal situation of the geographical environment cannot be ignored. Raeispour (2007) Recently, an increase in dust level has caused serious problems, especially in areas close to the arid regions. Nakano *et al.* (2004) arid and semi-arid Asian areas are the most significant hotbeds of dust in the world. Among the dust-affected areas, the Middle East is one of the world's most polluted places located in hot and arid desert belt and is truly fragile (Lashkari and Keykhosravi, 2007). Studies related

to the frequency of dusty days in the country indicated that the central holes in Iran have experienced the highest number of dusty days (Alijani, 1997). Most of the dust source areas are in the Middle East and Southwest Asia, the Arabian Peninsula and the surrounding deserts, which are active during a period of April to July (Goossens and Rajot, 2008). Dust is one of the atmospheric phenomena causing inappropriate environmental outcomes. Dust causes climate change on a global and local scale and also leads to changes in biological, geological and chemical cycle and also in human environment. Mineral particles generated by dust can influence cloud composition, cloud characteristics and atmospheric deposition. Atmospheric dust pollution inhibits sunshine penetration and can result in reduction of agricultural products up to 5-30% (Shahsavani, 2010). Since, dust transmission rout is broad; this phenomenon can also change soil and its biological trends (Goudie, 2009). Dust consists of a mixture of solid and soluble particles or both suspended in the air which are able to steadily stay suspended for a long time and can even move many kilometers away from their original source. These particles along with some evacuated mineral particles can increase the concentration of some other pollutants including heavy metals having harmful influence on human and other creatures (Sheikhi *et al.*, 2010). Human activities cause an inclination in the level of heavy metals in the environment (Pourali and Taghizadeh, 2011). Dust plays a focal role in the transmission of environmental pollutants (Csavina *et al.*, 2012). Pb is one of the heavy metals entering the environment in various ways by human (Hosseini *et al.*, 2013). In recent years, due to the elimination of lead from petrol, its entry into the urban environment has decreased significantly, but the accumulation of its previous uses has remained in the environment (Moayedi *et al.*, 2007). The lead half-life in blood, soft tissue and bone tissue is 2-4 weeks, 4 weeks and 27.5 years, respectively (Karimpour, 1993). Increasing the concentration of lead in air dust increases the concentration of lead in children's blood. If infants were exposed to more than 10 µg of lead per day, their IQs will be decreased dramatically (Lanphear and Roghmann, 1997). Numerous diseases can be mentioned caused by lead poisoning including anemia, nephropathy, neuropathy, psychiatric disorders and excessive hypertension (Samara and Voutsa, 2005). Many studies have been conducted on the concentration of lead in particulate particles in different parts of the world. Moreno-Grau *et al.* (2002) calculated the maximum concentration of lead to be 1000 mg. kg in the city of Cartag. Salamatian (2013) calculated the

maximum amount of lead in the falling dust of Isfahan to be 4.07 mg .kg in winter. Focused on a study in Cordoba province in central Argentina investigating the concentration average, rate of precipitation of heavy metals and rare elements in the falling dust, as well as the study of its relation with the surface soil and the amount of these elements in wheat grains and have identified the origin of these elements.

Materials and Methods

Introducing the Study Area

The present study is conducted in Zahedan, with an area of about 557 square kilometers and a population of 574000 people. It is known to be 1385 m high from sea level and is between geographical latitudes of 605125 eastern longitudes and 293045 northern latitudes. According to the obtained meteorological data, the annual rainfall mean is 72 mm, the maximum of annual temperature average is 42.5°C and the minimum of annual temperature average is –12.6°C.

Falling Dust Sampling and Determining it's Lead

Systematic random sampling method was used to determine the sampling regions. Consequently, 30 stations were selected in the city. In order to investigate falling dust, a Marble Dust Collector (MDCO) was used. This sampler was placed at a height of 1.5 m above the roof where sampling was carried out for three months from December 2014 to February 2014. At the end of each month, trapped dust was carefully collected from the MDCO. A total of 90 dust samples were taken from 30 stations in the city. At the same time as each sample was taken, the geographic coordinates of each point were written down using GPS in the UTM system. During this 3-month period, trapped dust in MDCO was carefully collected on a monthly basis and weighed accurately using a scale of 0.001 g. The samples were analyzed using ISO11466. Extraction was performed to determine the concentration of heavy metals using nitric acid and hydrochloric acid (Black, 1965). To measure lead concentration in dust samples, the atomic absorption spectrometry of the Analytic jena-350 flame model was used. Descriptive statistics parameters including mean, maximum, minimum, elongation and skewness of total lead metal concentration were obtained by SPSS V. 16 software. The data were normalized by Kolmogorov-Smironov test. Having prepared the information file from the lead metal variables, the statistical indices of the classical lead data were analyzed and Arc GIS 9.3 software input file was provided. To investigate spatial and frequency distribution of Pb in the city considering obtained results from different stations, zoning map of study area was provided by Kriging method using Arc GIS 9.3 software (Fig. 1).
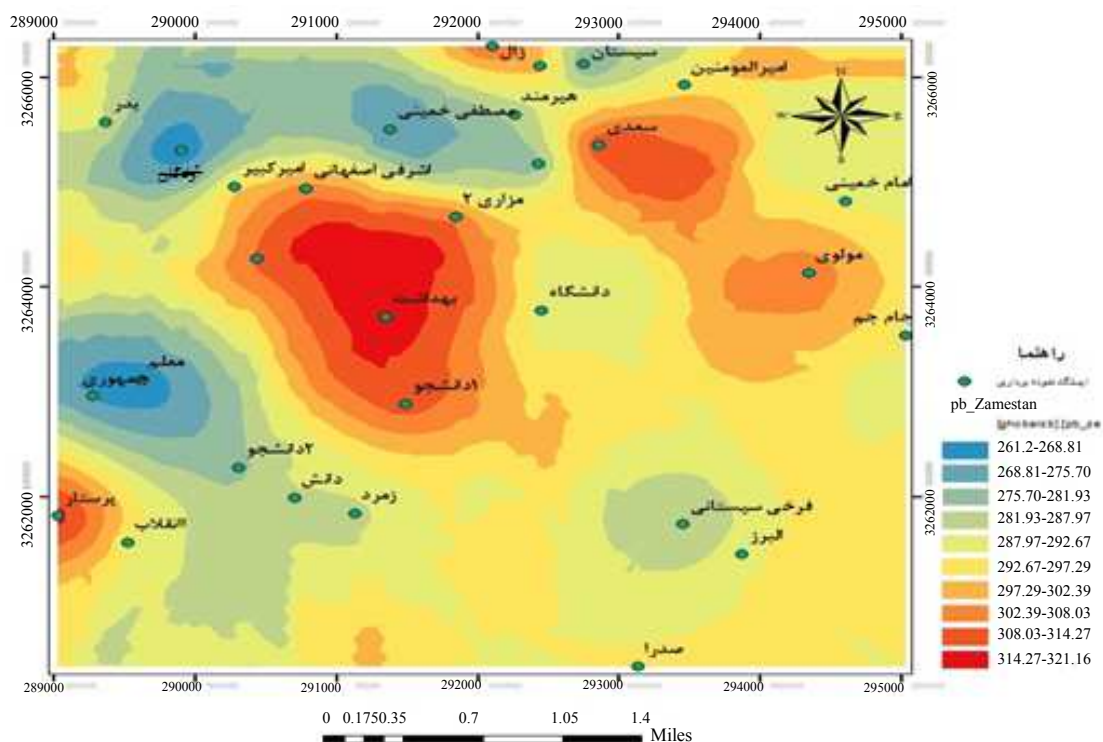
Fig. 1: Zoning map of Pb metal of dust falling in the winter 2014

Table 1: Indices and the environmental potential level of heavy metallic pollutants (Salamatian, 2013; Saeedi *et al.*, 2012; Wei *et al.*, 2010)

Qualitative class of pollution	Pollution index (PI)	The environmental risk level of each metal	Ecological risk (Er)
Low	PI<1	Low risk	Er<40
Medium	1<PI≤ 3	Medium risk	40<Er≤ 80
High	PI≥3	Significant risk	80<Er≤ 160
-	-	High risk Very high danger	160<Er≤ 320Er≥ 320

Pollution Index Calculation

In environmental studies especially when the geochemical distribution of elements in the environment is the result of a combination of human and natural factors, changes in trends should be evaluated using pollution indices

Pollution Index (PI)

To determine soil contamination to heavy metals, the contamination factor was used. Based on this factor, the amount of heavy metals is measured relative to its natural value and the amount of soil pollution is calculated as:

$$PI = Cn / Bn \qquad (1)$$

The ecological risk (Er) for each element is also calcula- ted according to the following formula:

$$Er = Tr.PI \qquad (2)$$

where, *Cn* is the concentration of metal in each sample and *Bn* is the standard value of this metal in the soil and the *Tr* is the factor of the toxic reaction. According to Hecanson's suggestion, the value of *Tr* for lead metal is 5 (Akbari *et al.*, 2012). Table 1 depicted how these indices are categorized.

Results

The Amount of Lead Metal in Dust Fall

Table 2 depicted descriptive statistics of lead metal and Table 3 demonstrated the index of pollution and ecological risk associated with lead metal in winter.

Table 2 descriptive statistics of lead between different months of the winter 2014, season shows that the highest concentration of lead in February, with an average 75.24±13.82 mg. kg and the lowest level in January, with an average 1.03±7.66 mg. kg.

Table 2: Descriptive statistics of lead metal in different months in winter (mg. kg)

	Arithmetic mean (mg.kg)	St.d	Min	Max	Skewness	Kutosis	k-s
Junary	1.03	7.66	90.00	118.25	0.06	-0.61	0.95
February	75.24	13.82	50.20	99.90	-0.07	-0.88	0.91
March	1.12	10.49	102.85	148.75	1.80	3.67	0.15

Table 3: Lead pollutant indices of falling dust in the winter of 2014 (mg. kg)

Cumulative average of Pb metal in winter 2014	Pollution index in winter 2014	Ecological risk in winter 2014
97.32	1.20	6

Also, according to the results of Kolmogorov-Smirnov test (column 8 of Table 2), p-value data of lead metal in winter months was more than 0.05, so the data have normal statistical distribution. Table 2 also shows that the maximum measured value of lead with 148.75 mg. kg for the Behdasht station is in March 2014. The minimum amount of lead measured at Mostafa-Khomeini station in February is 50.20 mg. kg.

Also, according to Table 3, the results indicated that the average lead concentration in winter was 97.32±5.40 mg. kg, which was the highest concentration related to the Behdasht station with the value of 107.05 mg. kg and the lowest measured value the Azadegan station was 87.07 mg. kg.

As the results of the Table 3 indicated, the amount of PI in winter is more than one; therefore it is classified in the medium level of pollution. The ecological risk index is less than 40 in the winter (Er = 6), so the lead metal in winter 2014 shows a low environmental risk.

The zoning map of the region demonstrated the distribution and frequency of lead in the falling dust of the whole area of Zahedan that the lowest level of lead were measured at the Azadegan, Moallem and Jomhuri stations, whilst Behdasht station experienced the highest level of the lead metal (Fig. 1).

Discussion

As mentioned above, in most cities in arid and semi-arid regions, the main cause of air pollution is haze. Lead is one of the most harmful heavy metals for human health. In a study conducted by Shi *et al.* (2010), they examined the urban and suburban areas of Shanghai. The findings showed that all heavy metals other than arsenic were found to be more than the original source and the origin of copper, zinc, nickel, cadmium, lead and chromium was in urban, transportation areas and for coal mercury. In the suburbs, the source of lead, arsenic and cadmium is from traffic jams, nickel and chromium from the industry and mercury is originating from household waste. In this vein, Qingjie *et al.* (2008) used the ecological risk indices, cumulative contamination and the level of promoted contamination to calculate heavy metal contamination in Bijing Parks of China. The findings indicated that most of the soils in the park are non-polluted or have low pollution. Feng *et al.* (2008)

studied the dust of Jinan City in northern China. Samples were analyzed to study copper, lead, zinc and cadmium. The results showed that all four elements had a significant accumulation in dust particles of this city and their concentrations were more than the basic. The results of this study indicated that the concentration of lead in Zahedan city dust exceeds measured values in Yazd and in Behbahan (Akbari *et al.*, 2012). The results of zoning of the lead of falling dust showed that the highest concentration of lead was related to Salamat station and the lowest concentration was related to Azadegan station. Studies have shown that the main source of lead released is from vehicle fuel. Hence, high vehicle traffic can be a factor in increasing the concentration of heavy metals.

Conclusion

Comparing the obtained results of lead level in this study with other studies in other cities requires knowing about extraction and the method of extraction of heavy metals. In this study, the amount of heavy metal in the falling dust was investigated, it is suggested to study the amount of other heavy metals such as Zn, Ni, Cu and etc in the dust of Zahedan. Getting advantages of such studies, we can obtain information on the contamination and environmental hazards of these elements and we can also determine the source of the production and dissemination of these elements and examine methods of control, reduction and prevention of the resulting effects. Also, the amount of exposure of citizens to these elements can be taken into consideration and by comparing the results with research carried out in other border cities of the country, the process of transmission of these elements can be reached.

Acknowledgement

Funding Information

Author's Contributions

Sara Abdollahi, Akram Karimi, Vijay P. Singh and Saeid Eslamian: Write manuscript.

Meysam Madadi and Kaveh Ostad-Ali-Askari: Write manuscript and revise it.

Ethics

In this article, all ethical principles related to scientific-research articles such as: validity and authenticity, originality, data collection in a standard manner, integrity and accuracy of research and ... are observed.

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