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Heavy metal contamination in street precipitated dust in Tabriz City, Iran and its ecological risk

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ABSTRACT

Dusts are suspended particulate matters in the air, which are created from different terrestrial and human made sources. Over time, they re-precipitate on surfaces given their size and density. Forty-nine samples of street dusts were collected from the sideways of several main streets from the city center, the Tabriz South passenger terminal, and one sample was collected from the yard inside Tabriz University in the summer and under dry climate conditions. Further, the concentration of iron, manganese, zinc, lead, nickel, chromium, copper, lithium, and cadmium metals was measured in them. The possible sources of contaminants were identified using correlation analysis, cluster analysis, Pearson correlation coefficient, and principal component analysis. In addition, using enrichment factor (EF), the effect of human activities on the concentration of heavy metals was assessed. The results indicated high concentrations of cadmium, lead, copper, zinc, iron, chromium, and nickel compared to the mean concentration of these metals in the Earth's crust. The maximum concentration of copper, lead, chromium, nickel, zinc, and iron was related to Kasaey Expressway, which is one of the most crowded expressways of Tabriz. Analysis of the results indicated that contamination can be due to different human activities including heavy traffic of vehicles, combustion of fossil fuels, additives added to vehicles' fuels, corrosion of metal surfaces of automobiles, and corrosion of construction materials. The enrichment factor values of copper, cadmium, lead, and zinc showed extremely high enrichment, with human origin. The calculations related to the ecological risk were also performed using Hankinson method. All of the studied points show very high ecological risk.

KEY WORDS: STREET DUSTS, HEAVY METALS, ECOLOGICAL RISK, ENRICHMENT FACTOR, TABRIZ

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INTRODUCTION

The growth of population, industries, and vehicles has increased the extent of pollution across cities especially Metropolitan cities. Therefore, recently evaluation of the quality of street dusts as pollution sources has attracted a great deal of attention. The heavy metals in street dusts are one of the major pollutants of urban environment, which can be due to heavy traffic, industries, wear of buildings, wear of rubber and peace is used in vehicles, mineral activities, and combustion of fossil fuels, (Jiries, 2003; Al-Khashman, 2007, Manasreh, 2010 Mukati, 2017).

Over the past few years, large amounts of atmospheric dusts have entered cities including Tabriz through the country's boundaries. Although there is controversy over their accurate origin, it is stated that their main sources are the deserts of the neighboring countries. In any case, significant amounts of them precipitate on the surfaces of urban regions as dust. Combustion of fossil fuels also produces some amount of heavy metals including nickel), chromium, lead, and manganese. These pollutants have aggregation and carcinogenic properties, and can develop various health and environmental problems. Furthermore, exposure to them can bring about low intelligence, kidney problems, and for long-term exposure, it can cause death. Street dusts containing heavy metals can also enter the children's body through hands and mouth (Watt, et al., 1993, Jiries, 2003, Balarak, 2017).

Recently, various studies have been conducted about the concentration and distribution of heavy metals, some of which has been performed in developed countries. In Turkey, Sezgin et al selected one of the expressways of this country to take samples from soil and street dusts. The sampling was performed from both sides of this Expressway and the tunnel. Analysis of the results indicated that the mean lead concentration in the street dusts was 9-11 times as large as its concentration in the soil. Regarding copper and cadmium, the mean concentration of this pollutant in street dusts was twice as large as their concentration in soil. This number is around 9-12 times for zinc.Nickel also indicates a concentration higher than the concentration in the soil. Next, the sources of emission of these metals are attributed to industries and vehicle traffic (Sezgin, et al., 2003).

In another study, conducted in Lebanon by Jiries, the sampling regions were categorized into four regions including city center, tunnels, indoor parking lots for vehicles, and residential areas. The maximum level of heavy metals was observed in the tunnels, while the minimum concentration existed in the residential areas. Thereafter, based on the results, it was found that there is a high correlation between lead and cadmium. Therefore, it can be stated that these pollutants have a common emission source, (Jiries, 2003).

In a number of studies, sources of emission of heavy metals in the soil and street dusts have been examined using cluster analysis and principal component analysis. In 1997, De Miguel used cluster analysis of Method Ward as well as two-dimensional principle component analysis. He considered three sources of vehicle traffic, building construction, and natural resources among the factors for emission of 25 types of rare metals in street dusts in Oslo and Madrid (Miguel et al., 1997). Ordonez et al detected the source for emission of 27 different metals in the studied dusts samples using SPSS and cluster analysis as human sources, natural sources, or a combination of them (Ordonez et al., 2003).

Considering the intensified level of air pollution and suspended particles in recent years in Tabriz, as well as entrance of large dust masses in the past two years along with the adverse effects of polluted dusts on citizens' health and environment, the concentration of heavy metals in this populated city should be investigated. In the present study, the concentration of copper, cadmium, chromium, nickel, manganese, zinc, iron, lithium, and lead present in street dusts of Tabriz was examined to identify the sources of production and the ecological risk resulting from these pollutants was measured, and finally analyzed.

MATERIAL AND METHODS

Tabriz is a metropolitan city in the Northwest of Iran and is the capital of East Azerbaijan province. In 2016, Tabriz population has been around 1558693 people. This city is the largest economic pole of the north west of Iran, and is considered the administrative, communication, trade, political, industrial, cultural, and military center of this region.In recent years, the number of residents and in turn industries in vehicles in this city has increased considerably, such that today Tabriz is considered one of the most polluted cities of the world. Tabriz climate is warm and dry, and precipitation usually occurs during fall and winter. For this reason, sampling was performed in the dry season of summer and in August, when precipitation is minimum. The sampling distribution is as follows:

Ten samples were collected from Imam Khomeini, Azadi streets as well as Kasaei Expressway. Five samples were taken from Shotorbanan and 17 Shahrivar streets, 14 were collected from the southern passenger terminal, and finally one sample was taken from Tabriz University. The sampling from street and expressways was performed to emphasize their vehicles and heavy traffic as one of the most important environmental polluting sources. The sampling was performed using a sweep and blower taken from the margin of curbs at both sides of the streets, as well as margin of curbs and the walls of the passenger terminal. The samples were then kept inside special bags and transferred to the laboratory at a temperature less than 4°C. To ensure absence of measurement errors and calculate the concentrations and based on the typical method of these studies, the samples were experimented at room temperature (less than 40°C) until reaching a constant dry weight. Thereafter, they were passed through seeves with 10, 35, 60, and 230 scores.

RESULTS AND DISCUSSION

The granulation results of some of the samples have been presented in Table 1. The particles with a diameter of less than 63 micron (the diameter of the sieve pore with score 230), which are easily scattered in the air and become suspended and are more probable to enter the respiratory system and develop risk to the human health as per the method of Zhou et al., (2003) were investigated.

To measure the concentration of heavy metals, acid digestion was performed using HCl, nitric acid, and perchloric gram. The concentration of heavy metals was measured by atomic absorption device (210 VGP). For all of the analyses, the control samples and per each 10 samples, one duplicate sample underwent acid digestion and was analyzed alongside other samples.The error of the experiments was less than 6%. Cluster analysis and principal component analysis were employed using MVSP and SPSS 18.0 software applications to identify the possible sources of metals in street dusts, while enrichment factor (EF) was utilized to investigate the possible effects of human activities on their concentration (Wei et al., 2010). The EF of a metal is obtained by the following relation:

Where, In Eq. (1), [C_x/Cref] *sample* represents the ratio of the intended concentration to the reference metal in the studied sample and [C_x/Cref] *background* shows the ratio of the intended metal to the reference metal as the background values. Five different groups of EF values are defined for analyzing the obtained values, as shown in Table 2 (Yongming, et al., 2006).

To obtain the ecological risk of heavy metals, the following relation was used (Hakanson, 1980):

Where, in Eq. 2, C_s is the concentration of the sampled metal and C_n shows the background values of the metals. E_r denotes the ecological risk of each element and RI reveals the ecological risk of the sum of the elements. Hakanson (1980) has presented T_r value (which is the toxicity index of heavy metals) as 30, 5, 5, 2, and 1 for cadmium, copper, lead, chromium, and zinc, respectively. To analyze the obtained values, four different groups are defined, as presented in Table 3.

The maximum, minimum, mean, and standard deviation values of the concentration of different metals across the 50 studied samples are presented in Table 3.

The maximum concentration of copper, lead, chromium, nickel, zinc, and iron is related to the sampling points in Kasaei Expressway, which is one of the most crowded expressways of Tabriz. Based on this point, it

Table 1. The mass percentage of particles across different sizes of the dusts samples and some of the studied stations

Sample number \ Particle Diameter (mm)	0-0/063	0/063-0/25	0/25-0/5	0/5-2
1	%12/6	%43/06	%23/06	%20/63
5	%1/72	%21/41	%39/53	%34/85
9	%8/53	%45/35	%29/6	%15/87
11	%10/58	%62/62	%19/26	%7/49
21	%16/87	%38/17	%34/46	%9/86
23	%9/26	%30/69	%20/92	%38/85
26	%2/6	%23/45	%22/26	%50/43
31	%7/92	%71/28	%15/65	%4/76
33	%17/85	%43/22	%16/68	%21/26
40	%4/31	%51/81	%28/78	%14/32
44	%14/38	%39/38	%20/8	%24/34
48	%10/4	%33/22	%26/96	%28/65

Table 2. Different groups of the range of changes in the EF	
EF values	**extent of enrichment**
Low enrichment	2> EF
Medium enrichment	2≤ EF <5
High enrichment	5≤ EF <20
Very high enrichment	20 ≤ EF <40
Extremely high enrichment	EF≥40

Table 3. The groups of the range of changes in RI and ecological risk value	
Ecological risk value	**RI value**
Low ecological risk	150> RI
Medium ecological risk	150≤ RI <300
Considerable ecological risk	300≤ RI <600
Very high ecological risk	RI ≥ 600

can be stated that the possible origin of these metals includes the sources related to the extensive commuting of vehicles. However, cadmium, manganese, and lithium have different emission sources.

To investigate whether the concentration of the contaminant is measured in this study reveals large values or not, Table 4 compares the different heavy metals studied around the world and in this research. Compared to other cities, especially the cities belonging to developed countries, the concentration of cadmium, manganese, zinc, iron, and lithium reveals larger values. Cadmium and zinc metals show far higher concentration compared to the rest of the points, increasing the concern over the high level of these pollutants in the street dusts of Tabriz. Lead and copper, which are also among the main pollutants on the environment, except for a few cases, have concentrations higher than those around the globe.

Furthermore, except for nickel, chromium, and lithium, other elements have significantly larger concentrations than the mean concentration in the Earth's crust. Considering these three metals, one cannot say that as they have lower values compared to the mean earth crust level, they originate from the nature. This is because according to Table 4, the values of these three pollutants in other cities are also lower than the mean value of the Earth's crust. Since Iran is not considered an industrial country when compared to Canada, England, and Spain, and Table 4 has presented the data of populated cities including London, the high level of some of the pollutants in street dusts of Tabriz is serious and it is possibly due to other sources apart from the natural sources.

One of the sources for emission can be considered the fuel used in the vehicles of Tabriz, which considering its unsuitable quality, it may show larger values for hazardous pollutants in Tabriz compared to industrial and populated cities of the world. Corrosion of the body of vehicles, different metal surfaces across the city, as well as the tiny particles of rubber and brake pad of the vehicles are also other sources for entrance of these metals as particulate matters in the urban environment.

IDENTIFYING THE POSSIBLE SOURCES

Enrichment factor (EF)

To identify the natural or non-natural sources of the pollutants measured in the study, various analyses have been used. EF values can be used to understand whether the sources of emission of heavy metals are natural or human-made. As shown in the formula related to EF calculation, a value called background values required. Across different studies, the values calculated for heavy metals from previous studies are chosen as the background value (Manasreh, 2010; Zheng, et al., 2010).

In some of the studies, concentration of heavy metals in the Earth's crust has also been used as background values (Tokalioglu, et al., 2003; Kartal, et al., 2006). Therefore, as measuring the concentration of heavy

Table 3. There values of the mean, minimum, and maximum concentration and standard deviation of the studied cases (n=50)				
Element	**Mean**	**Minimum**	**Maximum**	**standard deviation**
copper	223	57/56	779/35	54/56
cadmium	10/12	10/1	12/09	0/65
lead	253/6	63/65	765/8	12/23
chromium	34/5	15/25	57/09	85/32
nickel	33/2	13/55	73/95	444/52
manganese	1211/3	699/25	2322/65	10/98
zinc	865/8	400/34	1934/18	1/65
iron (%)	7/9	2/68	8/69	3/98
lithium	9/8	4/54	17/87	2/55

Table 4. The mean concentration of heavy metals present in street dusts of Tabriz and other parts of the world (ppm)

Heavy metals / City	Diameter of particles (mμ)	Copper	Cadmium	Lead	Nicole	Chromium	Manganese	Zinc	Iron	lithium
Tabriz (this study)	<64	224	10/5	255/4	56/36	33/3	1212/2	863/6	48725/6	9/3
Oman (Jordan) Jiries (2003)	<200	249/6	1/1	976	16/27	18/33	144/6	410	5370/6	1/72
Birmingham (England) Charlesworth, et al	<63	466/9	1/6	48	41/1			534		
Kuala Lumpur (Malaysia)Ramlan and Badri (1989)	<63	35/5	2/9	2466			153	344	1790	
London (England) Schwar, et al (1998)	<500	155	3/5	1030				680	26000	
Mutah (Jordan) Manasreh (2010)	<63	69	1/3	143	1/7		136	132	5362	
Madrid (Spain) De Miguel, et al(1997)	<100	188		1927	44	61	362	476	19300	
Otawa (Canada) Rasmuseen, et al (2000)	100-250	188	0/6	68	19	59	534	184	25660	9
Kawala (Greece) Christoforidis and Stamatis (2009)	<63	172/4	0/2	386/9	67/9	232/4		354/8		
The mean concentration of heavy metals in the Earth's crust Karbassi, et al. (2005) & Niencheski, et al. (2002)	--------	50	0/2	14	80	100	950	75	41000	20

metals present in street dusts of Tabriz is performed for the first time in this study, due to unavailability of previous information and not developing and presenting the background concentration values of elements for different regions of the world by the relevant organs (while these values have been prepared and presented by many countries) (Jien, et al., 2011; Wei, et al., 2010), the mean values present in the Earth's crust have been used as the background concentration of metals.

According to Relation 1, in addition to the background values, some other values are required as the reference metal. Typically, the metal chosen as the reference metal has the minimum correlation coefficient with other heavy metals, and it mostly originates from natural sources. In this study, to select the reference metal in calculations related to the EF, correlation coefficients of heavy metals with each other were calculated and presented in Table 5. The correlation coefficients in this table are Pierson coefficients.

As can be observed in Table 5, manganese, lithium, and cadmium metals do not have a considerable correlation with other metals. In most cases, however, they show negative correlation coefficients with other pollutants. Therefore, they have different possible emission sources from other pollutants. Cadmium is found in trace amounts in the Earth's crust and typically human activities cause elevated concentration of this pollutant in the water, soil, and air.

There are also some studies in which lithium have been used as the reference metal for normalizing the calculations (Niencheski, et al., 2002; Loring, 1991). Therefore, lithium concentration was used for reference values. Using the concentration of the studied heavy metals across the 50 sampling stations, their mean concentration in the Earth's crust in Table 4 and Relation 1, EF related to each metal was calculated and presented in Table 6.

The metals with maximum EF of over 10 may mostly be due to human activities (Yongming et al., 2006). In any case, the high values of this factor represent enrich-

Table 5. The correlation coefficient values of heavy metals with each other									
	Copper	**Cadmium**	**Lead**	**Chromium**	**nickel**	**Manganese**	**Zinc**	**Iron**	**lithium**
Copper	1/000								
Cadmium	-0/124	1/000							
Lead	0/778	-0/260	1/000						
Chromium	0/653	-0/309	0/675	1/000					
nickel	0/645	-0/351	0/534	0/782	1/000				
Manganese	-0/231	0/211	-0/156	-0/259	-0/401	1/000			
Zinc	0/678	0/129	0/529	0/427	0/342	0/237	1/000		
Iron	0/873	-0/335	0/746	0/709	0/667	-0/117	0/589	1/000	
lithium	-0/167	-0/239	-0/272	-0/007	0/185	0/338	-0/119	-0/154	1/000

ment and possible risks of metals. Accordingly, based on the obtained results, it can be said that copper, cadmium, lead, and zinc are probably a result of human activities. At least it can be stated there is a high risk factor for the human health with exposed to these dusts.

As can be seen in Table 6, it is observed that cadmium shows a large enrichment factor. As the reference concentration of this metal is very low (0.2), thus cadmium is possibly due to human activities and could be the riskiest metal among the studied metals here in the urban dusts of Tabriz. The same situation applies to lead.In calculating enrichment factor which lithium as the reference metal, the EF of nickel and chromium is close to 2, and thus they can be partly due to human activities. In this state, the mean EF of iron and manganese is larger than 2, thus showing a medium enrichment level. To identify the human or natural origin of the studied elements, principal component analysis and cluster analysis have been used, and the results were then compared.

Cluster analysis and Pearson correlation coefficient

To identify the possible emission sources of pollutants, Pearson correlation coefficient was calculated using MVSP software, with the calculation results presented in Table 5. Based on the table, copper, chromium, lead, nickel, zinc, and iron have high correlation coefficients. Therefore, they share common possible emission sources. Lithium has the largest correlation coefficient with manganese. As can be observed, cadmium does not have a considerable correlation coefficient with other pollutants, suggesting a different emission source. To enhance the accuracy of the results, the dendrogram related to these calculations which shows the Pearson correlation coefficient of pollutants with each other can be observed in Fig. 2. Based on this figure, the emission sources can be categorized into three main groups A, B, and C. copper, iron, chromium, and metal lie in Cluster A, with a correlation coefficient of larger than 0.6. Therefore, they may share a common emission source. Zinc, with also a correlation coefficient of larger than 0.5, joins these metals and has almost the same emission source.

Fig. 2. The dendrogram for cluster analysis of the pollutants present in street dusts (source: MVSP software)

Considering the components constituting this cluster, nickel, chromium, iron, lead, and copper may have different emission sources including combustion of fossil

Table 6. The spectrum of the EF values obtained considering lithium as the reference metal across the samples					
EF values / Heavy metals	**Mean**	**Minimum**	**Maximum**	**Standard deviation**	**median**
Cadmium	42/45	61/29	309/42	48/45	117/01
Proper	7/09	2/32	50/25	7/07	7/49
Chromium	0/39	0/5	1/92	0/35	0/65
Iron	1/25	0/89	7/99	1/22	2/43
Nickel	0/62	0/35	3/25	0/59	0/82
Lead	31/04	8/21	188/34	32/02	31/15
Zinc	12/15	12/17	64/68	12/99	23/35
Manganese	0/95	1/22	4/55	0/96	2/79

Table 7. The matrix of the rotational components of the pollutants present in the street dusts of Tabriz

Heavy metal	Factor 1	Factor 2	Factor 3
Copper	0.915	-0.232	-0.065
Cadmium	-0.202	-0.292	0.705
Lead	0.826	-0.214	-0.122
Chromium	0.800	0.081	-0.381
nickel	0.721	0.092	-0.533
Manganese	-0.005	0.558	0.124
Zinc	0.791	-0.006	0.462
Iron	0.916	-0.147	-0.153
lithium	-0.045	0.890	-0.138

fuels, sources originating from iron alloys (corrosion) and possibly earth sources containing iron element to some extent. As nickel exists in heavy fossil fuels as well as gas oil, it is also possible that some of the elements of this cluster may have originated from combustion of heavier fuels and other heavy hydrocarbons sources such as bitumen for covering the passages.

In the second main branch lies only cadmium. Considering the close-to-zero correlation coefficient it has with Group C, and negative coefficient in conjunction with Group C it has with Group A, its source of emission in street dusts is different from the source of other pollutants. Manganese and lithium are in the branch C, showing a negative and close-to-zero correlation coefficient with other pollutants in other branches.It can be stated that the main source of emission of lithium is the nature. However, regarding manganese, as it has a far larger concentration than the mean concentration in the Earth's crust, in addition to natural origin and local soils, it may also have human sources, which are clearly different from the sources of other heavy metal studied here.

Principal component analysis (PCA)

Using PCA and SPSS 18.0, the accuracy of the results obtained from the previous analyses was examined. The principal factors extracted with a characteristic value of over 0.7 were chosen, with Table 7 revealing the values of the matrix containing the rotational components of these factors. As can be observed, three main factors were obtained from PCA.

The main factors larger than 0.5 in each group of Table 7 have been shown. Copper, lead, chromium, nickel, iron, and zinc have considerable back is larger than 0.7, and thus they share the same emission source, which are human sources. As could be predicted, manganese and lithium in the second group with the factors larger than 0.5 are linked to each other and share the same emission source, which are probably natural sources.

With negative factors values or the very low values it shows with other substances, cadmium has lied in the third group and has a different source compared to other pollutants. Therefore, it can be stated that factors 1 and 3 indicate different human sources, but factor 2 represents natural emission sources.

The three different analysis used for identifying the emission sources of the pollutants presented almost the same results. Therefore, the different sources of production of these pollutants can be categorized into the three following groups:

Group I: copper, lead, chromium, nickel, zinc, and iron lie in this group. These pollutants are most probably due to human activities. Studies have shown that the main sources of emission of lead in street dusts include additives added to vehicle fuels. Chromium, copper, and zinc originated from wear of the alloys used in vehicles as well as other services and metal materials. Iron is also used in coverage of vehicles. Therefore, the wear of

Table 8.

metals / Sampling regions	Zinc	Chromium	Lead	Cadmium	copper	RI	Ecological risk
Kasaei Expressway	15.1	0.91	180.1	1602.55	41.55	1938.1	Very high
Imam Khomeini Street	10.32	0.78	85.5	1697.17	27.51	1718.95	Very high
Azadi Street	10.5	0.61	58.95	1718.5	16.25	1705.8	Very high
Shotorbanan Street	10.1	0.59	75.58	1605	17.45	1706.05	Very high
17 Shahrivar	5.39	0.48	39.02	1748	5.89	1796.4	Very high
Southern passenger terminal	11.09	0.69	100.15	1713	24.91	1848.89	Very high
Tabriz University	12.65	0.53	18.71	1602.34	18.81	1698.96	Very high

the cover used in vehicles can enhance the concentration of this element in street dusts. Industrial activities could also be considered sources for emission of these elements in street dusts. However, as the sampling was performed on Regis inside the city and the margin of streets, where no factory or a special industry existed around the streets, the main source can be considered wear of pieces used in vehicles. Combustion of fossil fuels and the oils used in vehicles are among the main sources of producing nickel. The maximum concentration of the pollutants in this group belongs to Kasaei Expressway, which is more crowded than other regions. Therefore, the high rate of vehicle traffic is the main source for emission of these pollutants.

Group II: cadmium is used in producing batteries, plastic, and construction materials. In this study, administrative and residential buildings were abundant around the streets. Therefore, wear of tires and battery of vehicles as well as construction materials seems to be the main source of cadmium emission. In any case, combustive origin for cadmium is unlikely, but its human origin in the city and considering the illusion intensity is evident.

Group III: manganese and lithium like in this group. Regarding the considerable correlation lithium has with manganese and considering the relatively high concentration of manganese in dusts, it seems that it is the origin of some part of manganese present in the dusts of natural sources containing lithium (such as the regional soil), and the origin of some part of it includes human sources dissimilar to the sources of other metals.

Ecological risk

To investigate the ecological risk of the sampling stations, E_r and RI values were calculated by Relation 2, with the results presented in Table 8.

All of the sampling stations indicate high ecological risk. The maximum ecological risk is associated with Kasaei Expressway, which is one of the most crowded expressways of Tabriz. The minimum risk also belongs to the dusts inside Tabriz University. Considering the minor commute of vehicles in this point, the large space of the University, the extent of the green space, and the distance between the sampling point and the peripheral lines of the University and its surrounding streets in relation to the other sampling points, the obtained results seem to be absolutely logical. Furthermore, although Tabriz University is not considered a crowded region for vehicles, this point of sampling also shows a high ecological risk. Possibly, blow of wind causes displacement of polluted dusts of streets around the University, thereby elevating its ecological risk. The mean RI across the sampling points of the south of Tabriz indicates that the ecological risk and concentration of pollutants in this part of Tabriz are high and serious.

CONCLUSION

In this study, the concentration of nine heavy metals was measured across 50 samples of street dusts in Tabriz city. Furthermore, calculation of ecological risk resulting from emission and identification of different sources of heavy metals in street dusts were performed. Based on the calculations and the analyses, three main sources including high traffic of vehicles (the pieces used in vehicles and combustion of fossil fuels), the pieces used in buildings, and natural sources are among the factors for emission of heavy metals in street dusts. Using the calculations related to the ecological risk, all of the stations indicated high risk. Therefore, the health risks of exposure, inhalation, and possible swallowing of particulate matters of these dusts across Tabriz regions are very high. Thus, more detailed studies are required to investigate the effects and risks resulting from this issue across Tabriz.

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