An Investigation on Soil Lead Pollution due to Vehicle Traffic in Ghamishlu Refuge

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Abstract
Lead as non-essential metal, is known the source of toxicity and impacts on the environment and humans. The goal of recent paper is to determine the Pb concentration of road and road margin dust of Ghamishlu wildlife refuge in Isfahan province with an area about 120,000 hectares surrounded by four main roads. Traffic load in the southern freeway have been reported as about 3600-19000 cars/day. 12 road dust and 72 soil samples (0-5 cm in depth) were collected from transects of the road in distances of 3, 20 and 50m. The sample Lead was extracted according to ISO11466 international standard procedure and analyzed with flame AAS. Pb concentrations of road dust were measured in range of 800.17±109.28 and 582.28±71.28 mg/kg for area with heavy and low traffic load, respectively. In addition, The result of ANOVA shows there is significant difference between Pb concentration of area with high and low traffic loads (P=0.005). The rate of mean Pb concentrations of the high to low traffic loads was calculated about 1.37, 1.97, 1.42 and 1.40 for distance of 3, 20 and 50m from the road, respectively. The results shows vehicle transit is the main source of road Pb pollution in the road and its margins. The results indicate Pb concentration decreases significantly with increasing distance from road center. The results show significant difference between road dust and 20m distance from road margin and lead concentration doesn't change significantly far away 20m from road center. Two indices entitled Index of Geo-accumulation and Pollution Index were applied for classifying pollution in recent study. The result of lead road dust indices detects high intensity pollution, and the soil in three meter distance of road margin has non to moderate pollution. I_{poll} detects significant difference compared with I_{geo} in margins (P=0.00). More than 22.4% of studied points have high anthropogenic pollution values (at about 75 to 100% of total concentration).

Introduction
Fuel combustion is the major source of environmental pollution. Motor vehicles release trace elements and heavy metals in urban areas. Lead **as** solid particles exits from exhaust and other parts of the vehicles and settles on the road and margins. Lead is an unessential metal which has the most damaging effects such as renal and liver disorders, anemia, men and women infertility, diminished learning abilities, hyperactivity and aggressive behavior of children. Goal of the present paper is to determine the Pb concentration of road and road margin of Ghamishlu refuge in Isfahan province.

Materials and methods
Study area
Ghamishlu wildlife refuge is located in 45km far from eastern north of Isfahan. .Ghamishlu with an area of about 120,000 ha surrounded with four main roads including Isfahan-Tehran highway in the east, Najafabad–Tiran in the south, Dehagh - Alavijeh in the west and Alavijeh industrial park in the north of Ghamishlu refuge.

Fig. 1. Location of Ghamishlu wildlife refuge

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Research Method

Soil samples were taken from 12 linear cross sections with three point samples perpendicular to the road. 12 road dust and 72 soil samples (0-5 cm in depth) were collected from cross sections, perpendicular to the road in distance of 3, 20 and 50m. The samples were prepared to be analyzed by International Standard ISO 11466. At first, approximately 3 g of sieved and oven- dried soil sample was weighted and was added to the nearest 0.001 g of the subsample into the 250 ml reaction vessel moistened with about 0.5 ml to 1.0 ml of water and 21 ml of hydrochloric acid followed by 7 ml of nitric acid drop by drop while mixing, if necessary, to reduce foaming. The absorption vessel and condenser were connected to the reaction vessel allowed to stand for 16 h at room temperature to allow for slow oxidation of the organic matter in the soil. Lead concentration was measured with Atomic Absorption Spectrophotometry, model *Analytic jena-350*. Data was analyzed with SPSS 16. Lead concentration of road and margin with low and heavy traffic were compared with ANOVA method. Geo-accumulation index (I_{geo}) and pollution Index (I_{poll}) were calculated (equation 1 and 2) to show the pollution intensity (Muller, 1979).

$$I_{pou} = \log_2\left(\frac{C_n}{B_n}\right) \qquad (1)$$

$$I_{geo} = \log_2\left(\frac{C_n}{1.5B_n}\right) \qquad (2)$$

Where, Igeo is geoaccumulation index, Cn is measured lead concentration (mg/kg), Bn is Background lead concentration due to geogenesis.

Results

-Comparison of Pb concentration between heavy and low traffic flow

Pb concentration was measured in range of 800.17±109.28 and 582.28±71.28 mg/kg for heavy and low traffic flow, respectively. The result of ANOVA shows the significant difference between Pb concentration of the road with heavy and low traffic flow (P= 0.005). Mean Pb concentration is high in point samples no 1, 2, 7, 8, 9, 10, 11 and 12 in heavy traffic flow of Isfahan-Tehran highway and Tiran-Najafabad and low in point samples of 3, 4, 5 and 6 which were sampled in low density traffic roads (Fig. 1). Generally, pb concentration in dust and margin of heavy traffic roads is higher than that of lower density ones.

-Comparison between road dust and marginal soil

Comparing Pb concentration of dust and marginal soil detects significant difference by applying Kruskal-Wallis analysis method (P=0.029). Table 1 shows descriptive statistics of Pb concentration of the road dust and soil of road margin. There isn't significant difference between on-site and off-site of marginal soil (3, 29, and 50 m) of Ghamishlu wildlife refuge. The result shows that Pb concentration decreases significantly with increase of distance from road center to margin sampling points.

Table 1. comparison of the Pb concentration range of samples

Sample	No of sample	Pb concentration (mg/kg)		
Dust (total)	12	720.21±139.59[a]†	908.58	519.28
3m road margin	23	109.28±68.14[b]	326.00	59.26
20m road margin	24	84.37±49.67[c]	284.57	47.53
50m road margin	24	82.75±53.54[c]	314.87	47.60

† The same letter means no significant difference.

Index of Geo-accumulation

The least measured pb concentration (47.53 mg/kg) was considered as the background lead concentration due to geogenesis. Analyzing the index indicates that road dust is classified as highly polluted and 3-meter marginal soil is classified as not polluted to semi polluted (Figure 2). Of course, with increase distance from the road, I_{geo} decreases significantly.

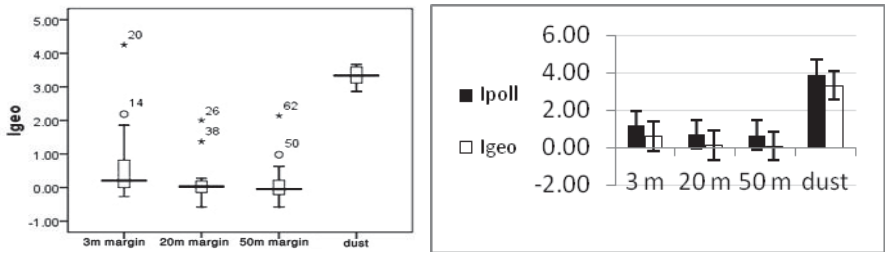

Fig 2. I_{geo} and I_{poll} range in road dust and margin

According to Fig.2, anthropogenic pollution is classified at least one class higher than geogenesis pollution. 3-meter, 20-m and 50-m marginal soils are classified as moderat, not to moderate polluted and not polluted, respectively.

Ipoll

The results showed that manmade pollution of lead contamination in 22.4% of the points allocated to 75-100% of the pollution (Fig.3).

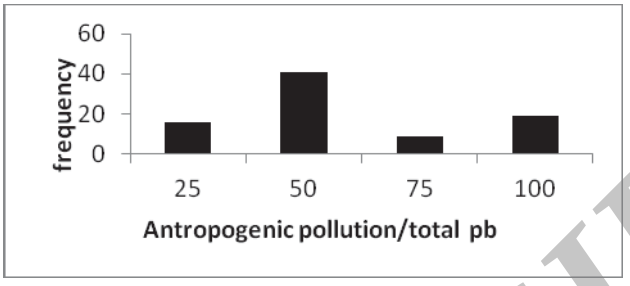

Fig 3. Manmade pollution relative abundance of toal lead contamination

Discussion and conclusion

The lead resulted from fuel consumption is the main source of environmental pollution. Lead as solid particles exits from exhaust and other parts of the vehicles and settles on the road and margins. The study area is surrounded by four main roads. Isfahan-Tehran and Najafabad-Tiran roads have heavy traffic and it is lower in Dehagh-Alavijeh and the north road traffic density. Measuring lead in the present study indicates the role of traffic in increasing the amount of lead in Ghamishlu area. The mean ratio of pb concentration of the road dust in heavy and low traffic roads in 3, 20, and 50 meters are 1.37, 1.97, 1.42, and 1.40 respectively. That's why traffic is considered as the major source of lead in the area. Road is considered as the basic source of emission to the surrounding environment and its pollution is up to 7 times as much as the margins. The results are in line with the results from Ordons, Rahmani, and Kheiri comparing pb concentration in road dust and also in margins and significant reduction of concentration show the same result.

The results indicate the significant effect of the road to 20 meter distance on the margins while the results for 20 and 50 -meter distances are not significant that approve the results from Taebi and Rahmani. Two indices entitled Igeo and PI were applied for classifying pollution in recent study. Because of the similarity of mathematical basic formulas of the two indices, their classifications aren't different. The Igeo is very efficient as the criteria for classifying the lead pollution in soil and dust of the margins. In this case, road dust is classified as high class and after that, 3-meter margin is classified as medium and 20-meter and 50- meter margins are not polluted to semi polluted. This results are in line with the results from Feiz. We hope that the amount of lead will be reduced in the margins of the roads regarding that using lead -free fuel has been preferred in Iran Environmental Protection Organization as well as changes in political.

Keyword: dust, geo-accumulation index, Ghamishlu refuge, lead, pollution index.