Summer 2020, Vol 10 (2): 167-179 J. Adv. Appl. Geol. OPEN ACCESS

The concentration and health risk assessment of potentially toxic elements in agricultural soils of the Aleshtar plain, Lorestan Province

Leila Sheikhi[1], Giti Forghani Tehrani[1*]

1- Department of Geology, Faculty of Earth Sciences, Shahrood University of Technology, Shahrood, Iran

Keywords: Toxic Elements, Risk, Soil, Aleshtar

1-Introduction

The pollution of soils with the potentially toxic element is a worldwide problem. Potentially toxic elements presented in the soils can enter to other compartments of the ecosystems and thereby, lead to health problems in organisms (Rocco et al., 2016; Hasan et al., 2018). Some potentially toxic elements, e.g. Cr, Pb, Cd, Hg, As and Sb, present naturally in the environment, however, when their concentration increases, they can be harmful for the environment (Cai et al., 2019; Muhammad et al., 2019). In recent decades, anthropogenic sources including agricultural and industrial activities as well as urban development lead to the increase of the concentration of toxic elements in the environment (Karimi et al., 2017; Cai et al., 2019). The application of fertilizers, pesticides and herbicides during the agricultural activity is one of the most important sources of potentially toxic elements in the environment; therefore, in the agricultural fields the concentration of these pollutants in the soil can be higher than the natural background values (Nash et al., 2003; Atafar et al., 2010; Karimi et al., 2017; Hasan et al., 2018). Thus, in agricultural soils there is a serious health risk imposed by toxic elements because of the accumulation of these pollutants in the food chain (Walter et al, 2002; Rocco et al., 2016).
Aleshtar plain is an important agricultural field in Lorestan Province. The aim of the present study is to investigate the concentration of the potentially toxic elements in agricultural soils, to determine the source of the pollutants, and to assess the health risk imposed by toxic elements.

2-Methodology

In order to study the intensity of the soil contamination with potentially toxic elements and to assess the health risk of the Aleshtar plain, 18top soil samples were collected in the study area. The soil samples were air-dried at room temperature and then they were passed through a 2 mm stainless steel sieve. The sieved samples were stored in polyethylene bags prior to laboratory analysis. The total concentrations of elements were measured by ICP-OES instrument after digesting by strong acids. The physic-chemical properties of the soil samples (including pH, organic matter, carbonate, and soils texture) were determined using the standard methods. In order to assess the pollution of the soils, the geochemical indices (enrichment factor, geomagnetic factor, single factor pollution index, Nemerow integrated pollution index, combined pollution index, pollution load index, potential ecological risk index) were calculated. Health risk assessment was conducted using the protocol of USEPA (1989).

3- Results and discussion

The pH of the samples varies between 6.9 and 7.5% (average value of 7.2 %) which is compatible with the high content of calcium carbonate in samples. The amount of organic matter varies in the range of 2.7-9.3% (average value of 6%). The high content of organic matter in the studied soils is due to the application of manure in the agricultural fields. The calcium carbonate amount of the studied soils is in the range of 5 to 39% (average value of 21%). The relatively high content of calcium carbonate is probably due to the extensive application of lime as

* Corresponding author: forghani@shahroodut.ac.ir
DOI: 10.22055/AAG.2019.29590.1988
Received 2019-05-18
Accepted 2019-11-05

a soil amendment, as well as the geology of the study area. The presence of calcium carbonate and organic matter in soils can lead to decrease of the metal availability and mobility. Based on the total concentration values, the average concentrations of Ni, Pb, As, Zn, Cu, Co, Cr, Ag, Sc, Mo, U, Th and Sb in the studied soils are 117.9, 18.4, 14, 84.4, 37.1, 19.7, 155.7, 0.4, 13.5, 0.8, 8.5, 11, and 4.1 mg/kg, respectively. The average concentrations of Cd, As, Sb, Zn, Ni, Fe, Mn, Cr, Ag, Co, Th and U are higher than the world's soil average composition (Kabata-Pendias, 2011), while the concentrations of As, Zn and Sb in all samples are higher than their values in the World's soil average composition. The calculation of the geochemical indices indicates that the studied soils are significantly contaminated with Sb and As. Health risk assessment indicates that the hazard quotient for As via ingestion pathway for children is higher than 1; therefore, there are adverse non-carcinogenic health effects of arsenic for this age group. The results show that there is a carcinogenic risk imposed by arsenic via ingestion pathway for both adult and children age groups. Cr is carcinogenic for children via dermal contact and ingestion; whereas it is carcinogenic for adults through ingestion. The intake of Ni via ingestion by adults and via dermal contact by children can be associated with carcinogenic risk. The results indicated that Cd is carcinogenic for children through the ingestion route.

4-Conclusion

The aim of this study is to study the contamination of the agricultural soils in the Aleshtar Plain, and to assess the probable environmental health risk imposed by potentially toxic element via ingestion, inhalation, and dermal contact routes. The obtained results in this study show that the agricultural activity has considerably increased the concentration of potentially toxic elements in the Aleshtar agricultural soils. On the basis of the geochemical indices values, the soils of the study area are polluted with respect to As, Sb, Cr, and Ni. Environmental health risk assessment shows that the presence of As, Cr, Ni, and Cd in soils of the study area can lead to the carcinogenic and non-carcinogenic effects in both adults and children. Regarding the probable negative effects of metal accumulation on public health status, the management of agricultural practice in the study area is of crucial importance.

References

Atafar, Z., Mesdaghinia, A., Nouri, J., Homaee, M., Yunesian, M., Ahmadimoghaddam, M., Mahvi, A.M., 2010. Effect of fertilizer application on soil heavy metal concentration. Environmental Monitoring and Assessment 160, 83–89.

Cai, L.M., Wang, Q.Sh., Wen, H.H, Luo, J., Wang, Sh., 2019. Heavy metals in agricultural soils from a typical township in Guangdong Province, China: Occurrences and spatial distribution. Ecotoxicology and Environmental Safety 168, 184–191.

Hasan, M., Kausar, D., Akhter, G., Shah, M.H., 2018. Evaluation of the mobility and pollution index of selected essential/toxic metals in paddy soil by sequential extraction method. Ecotoxicology and Environmental Safety 147, 283-291.

Karimi, A., Haghnia, G.H., Safari, T., Hadadian, H., 2017. Lithogenic and anthropogenic pollution assessment of Ni, Zn and Pb in surface soils of Mashhad plain, northeastern Iran. Catena 157, 151-162.

Muhammad, S., Ullah, R., Jadoon, I.A.K., 2019. Heavy metals contamination in soil and food and their evaluation for risk assessment in the Zhob and Loralai valleys, Baluchistan province, Pakistan. Microchemical Journal 149, 1-7.

Nash, D., Halliwell, D., Hannah, M., Clemow, L.,Webb, B., 2003. Phosphorus and selected metals mobilized from two commercial fertilizers into overland flow during border irrigation. Nutrient Cycling in Agroecosystems 67, 255–264.

Rocco, C., Duro, I., Di, R.S., Fagnano, M., Fiorentino, N., Vetromile, A., Adamo, P. 2016. Composite vs. discrete soil sampling in assessing soil pollution of agricultural sites affected by solid waste disposal. Journal of Geochemical Exploration 170, 30-38.

USEPA, 1989. Risk assessment guidance for superfund volume I human health evaluation manual (Part A). Office of Emergency and Remedial Response. U.S, Environmental Protection Agency Washington, 20450. EPA/540/1-89/002.

Walter, I., Martı´nez, F., Alonso, L., de Gracia, J., Cuevas, G., 2002, Extractable soil heavy metals following the cessation of biosolids application to agricultural soil. Environmental Pollution 117, 315–321.