



APPLICATION OF TWO DIFFERENT HEALTH RISK ASSESSMENT APPROACHES TO DETECT SOIL POTENTIALLY TOXIC ELEMENT INDUCED RISK

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1. Introduction

Soils of urbanized and mining areas succeeded the main geochemical features of parent materials, as well as accumulate potentially toxic elements (PTE) from different anthropogenic sources. The latter resulted in the change of soil chemical composition and high level of PTE which may have negative reflection on people's health. In this study 207 soil samples (Fig.1) were collected from the entire territory of the city of Alaverdi hosting Alaverdi copper smelter. After the determination of Fe, Ba, Mn, Co, V, Pb, Zn, Cu, Cr, As and Mo concentrations by XRF the established data set was subjected for the PTE induced health risk assessment. In this study two commonly used health risk assessment approaches - Summary pollution index (Zc) [1-3] and Hazard Index (HI, US EPA) [4] were used to assess human health risk posed by the content of studied PTE in soil of Alaverdi city.

2. Materials and methods

Soil sampling

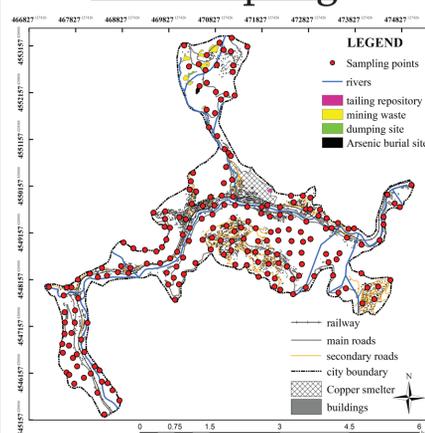


Fig.1. The spatial distribution of sampling points in Alaverdi

Chemical analysis



Health risk assessment

Summary pollution index (Zc)

$$K_{ci} = C_i/C_{i\text{back}},$$
$$Z_c = \sum_{i=1}^n K_{ci}^{-1}$$

US EPA

$$CDI_{\text{children/adults}} = (C \times EF \times ED \times IRS \times CF \times RBA) / (AT \times BW),$$
$$HQ^i = CDI / RfD^i,$$
$$HI = \sum_{i=1}^n HQ^i.$$

3. Results

The result showed that the detected concentrations are mainly the result of superposition of PTE contents introduced into the environment from natural mineralization processes and Alaverdi copper smelter related activities. The health risk assessment showed that the Zc values (Fig.2) belonging to the extremely hazardous level has point-like shape and are surrounded by the hazardous and moderately hazardous levels, respectively. Summary pollution index showed that approximately 53 % of the city territory including the residential part is under the risk suggesting the increase in the overall incidence of diseases among frequently ill individuals, functional disorders of the vascular system and children with chronic diseases [1]. The US EPA method were in line with the results of the Zc and indicated that the observed contents of elements are posing non-carcinogenic risk to adult (Fig.3) mainly near the copper smelter. In the case of children (Fig.4) single-element non-carcinogenic risk values greater than 1 were detected for As, Fe, Co, Cu, Mn, Pb and Mo in 122, 95, 86, 10, 10, 9 and 6 samples out of 207 soil samples and the mean HQ values decrease in the following order: $As_{(2.41)} > Fe_{(1.14)} > Co_{(1.09)} > Mn_{(0.61)} > Pb_{(0.41)} > Cu_{(0.32)} > V_{(0.19)} > Mo_{(0.11)} > Cr_{(0.05)} > Ba_{(0.03)} > Zn_{(0.02)}$. The multi-elemental non-carcinogenic risk observed in the entire territory of the city indicating an adverse health effect to children. The results of this study suggesting the need of immediate risk reduction measures with special attention to arsenic.

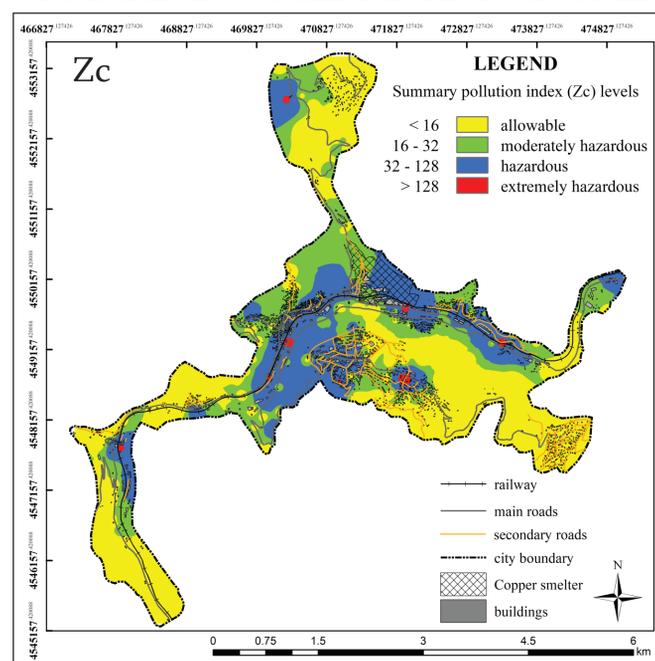


Fig.2. The spatial distribution of Zc risk levels in Alaverdi

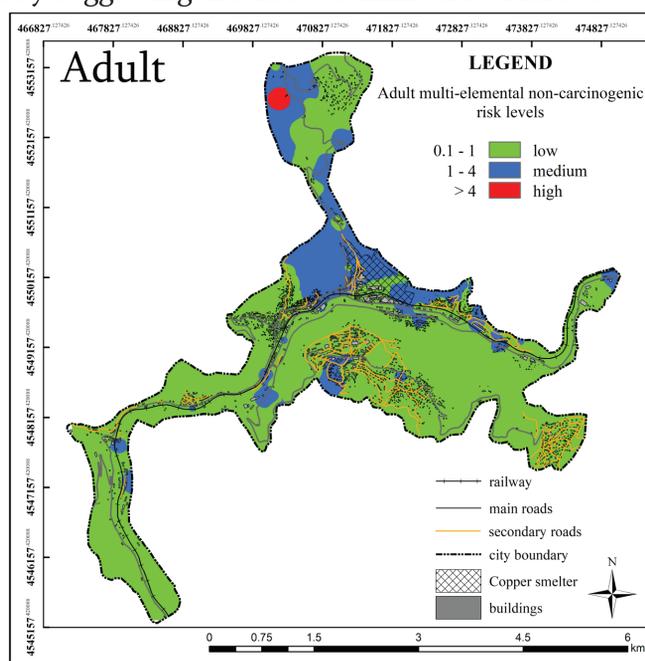


Fig.3. The spatial distribution of adult's multi-elemental non-carcinogenic risk in Alaverdi

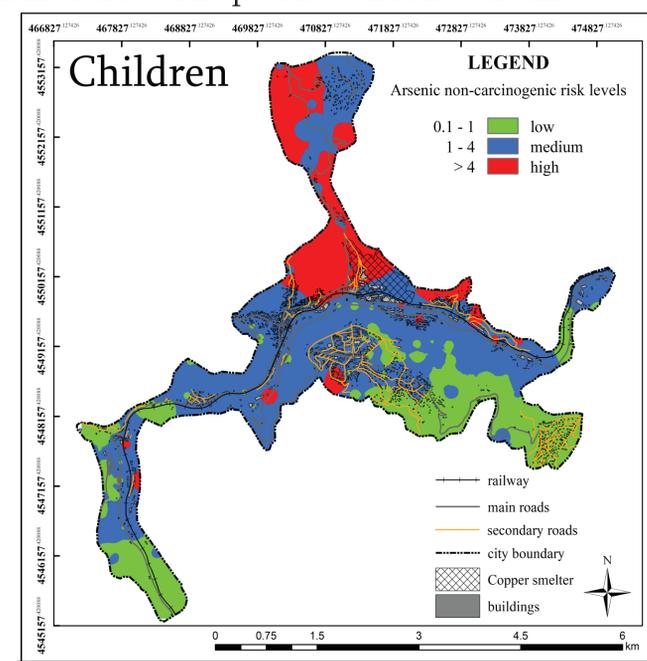


Fig.4. The spatial distribution of children non-carcinogenic risk posed by As contents in soil of Alaverdi

4. Conclusions

1. Detected health risk is conditioned by the superposition of PTE natural and manmade contents.
2. Applied risk assessment approaches provide analogous results.
3. The highest non-carcinogenic risk to children's health observed for arsenic contents.

5. References

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