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Distribution of Chemical Elements In Urban Sediments in Slovenia (Extended Abstract)

The goal of the study work was to assess the distribution of chemical elements in anthropogenic urban sediments (street sediment, house and attic dust) in Slovenia, and to define them with respect to geology.

Distributions of 27 chemical elements (Al, Ca, Fe, K, Mg, Na, P, Ti, Ba, Cd, Co, Cr, Cu, La, Mn, Nb, Ni, Pb, Sc, Sn, Sr, Th, V, Y, Zn, Zr and Hg) were estimated, essential geochemical association established and their areal distribution in urban sediments across the countryside and six larger towns in Slovenia determined.

The geochemical properties of urban sediments were compared to those of sampled natural materials - soils and overbank sediments - and evaluated in terms of their elemental contents and elemental associations. As based on comparisons of urban and natural sampled materials with the factor analysis, in Slovenia five geochemical patterns of elemental distributions were established.

The first group comprises Al, Fe, K, Ti, La, Mn, Nb, Sc, Th, V and Y. The Slovenian averages of these elements in house and attic dust are much lower than in soil and overbank sediment. In the countryside, these elements have a similar distribution in overbank sediment, in house and attic dust. The highest elemental values occur in the NE of Slovenia. With respect to lithology, the highest medians of Al and V were found in house and attic dust in the area of igneous and metamorphic rocks (Pohorje) and molasse-type deposits of the Pannonian Basin, and the lowest in the W, in areas of outcropping flysch and carbonate rocks (fig. 1a - 1d).

The contents of these elements in attic and house dust in towns oscillate around the Slovenian averages. The highest values of Al, K, Fe, Ti, Mn, La, Nb, Sc, Th and V occur in the urban area of Maribor which supports the hypothesis of association of these elements with weathering of igneous and metamorphic rocks. High values of Fe, Mn and Nb in the Jesenice area seem to be influenced by the metallurgy. The principal source of these elements is most likely the weathering of rocks

The second group associating Cd, Cu, Pb, Sn, Zn and Hg represents the anthropogenically introduced chemical elements. For Slovenia, the averages in attic and house dust are for factors higher than in soil and overbank sediment. Most striking is the similarity of areal distribution of these elements in the countryside between the attic dust and overbank sediment. High values mainly of Cd, Pb and Zn in Lower Styria are ascribed to the influence of Mežica mines and smelter, and of the Celje zinc smelter. High Hg in the west in all sample media is a consequence of centuries of operation of the Idrija mercury mining smelting, and of military activities during the first World War (fig. 2a - 2d).

In towns, the contents of Cd, Cu, Pb, Sn, Zn and Hg in all analysed materials are for factors higher than the Slovenian averages. Interesting exceptions are the mercury means in house and attic dust of towns that are lower than the Slovenian averages. Very high contents of Cd, Cd, Cu, Pb, Sn and Zn in all sampled materials are characteristic for the town of Celje which should be explained by operation of the Celje zinc smelter. High mercury in Koper might be the result of deposition of high Hg in the sediment of the Soca river to the Gulf of Trieste. The contents of Cd, Cu, Pb, Sn, Zn and Hg in urban sediments vary much within the settlements, and Cd, Cu, Pb, Sn, Zn and Hg in attic dust display also significant regional trends.

The third group comprises Cr and Ni. Their highest contents among all sampled materials were found in house dust. Cr and Ni, and in part also Sn and Zn are the chemical elements most typical for households. In the countryside, they are influenced by natural (high contents in the flysch areas in SW and crystalline rocks in NE) and anthropogenic factors (high values in Upper Carniola, as a result of metallurgy in Jesenice).

Similarly as Cr and Ni are associated to towns also Mn, Fe, Nb and Co. Their high values are localized mainly to the iron metallurgy centre of Jesenice. Characteristic for distributions of these elements are insignificant differences of contents between various sampled materials within the settlements in contrast to higher differences between the settlements.

The fourth group unites Na, Ba and Sr. Typical are the highest contents in house dust, and very small variance of contents with sampled materials. The contents seem to be dependent upon the amount of plagioclases in samples. In the countryside Na, Ba and Sr are almost equally distributed among house and attic dust, and overbank sediment. The highest contents were found in NE Slovenia. Na, Ba and Sr especially in attic dust reflect well the regional geochemical trends. Significant differences within the settlements are attributed to household activities. With respect to lithology the highest elemental contents were found in house and attic dust in regions of igneous and metamorphic rocks (Pohorje), and their lowest contents on carbonate rocks.

In towns, a similar association consisting of Na, Ba and La was established. High values in the Maribor area are attributed mainly to geogenic causes. The highest differences were found between the sampled materials and between towns.

The fifth group combines Ca and Mg, the elements typical of carbonate rocks. In the countryside, their lowest contents were detected in soil, and the highest in overbank sediment. As the source for these elements in attic and house dust the decomposition of construction materials is suspected. In towns high Ca and Mg were found in street sediment, owing to sanding the streets in wintertime.

An alarming fact are the very high contents of Cd, Cu, Pb, Zn, Sn and Hg in house dust. They exceed much their levels in natural sediments. The urban sediments, especially the house dust, are substances to which the humans are incessantly exposed. Dust particles containing heavy metals enter human organism through swallowing or inhaling, and they accumulate in it. Several authors established significant associations between the heavy metal contents in house dust, and concentrations in body liquids (blood, urine). There of direct hazards to population in Slovenia may be derived. High contents of heavy metals in urban dust are potentially dangerous especially to children. Small infants are the most endangered group because of their higher intake of dust than for adults, and owing to their higher sensitivity to the influence of heavy metal.

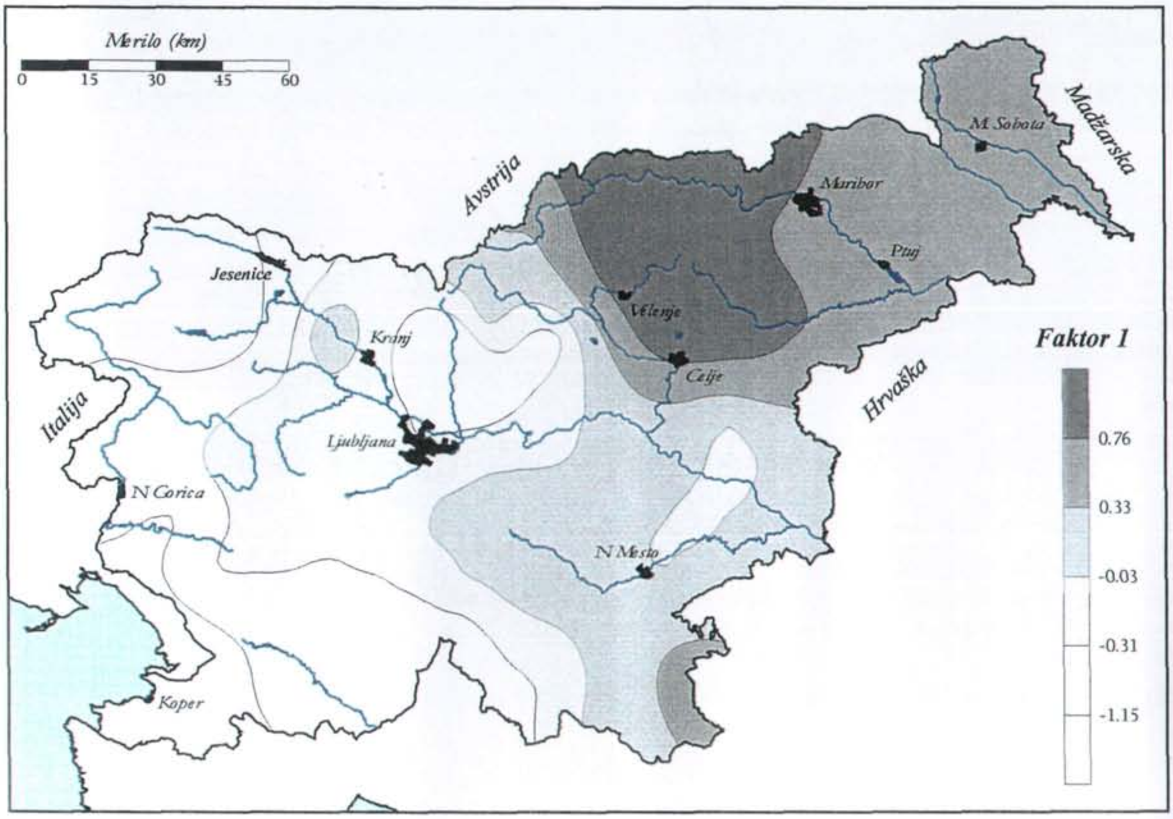

Fig. 1a: Distribution of factor 1 (Al, K, Ti Sc, Y, V, Th, Fe, Nb, -Ca and -Cu) in attic dust

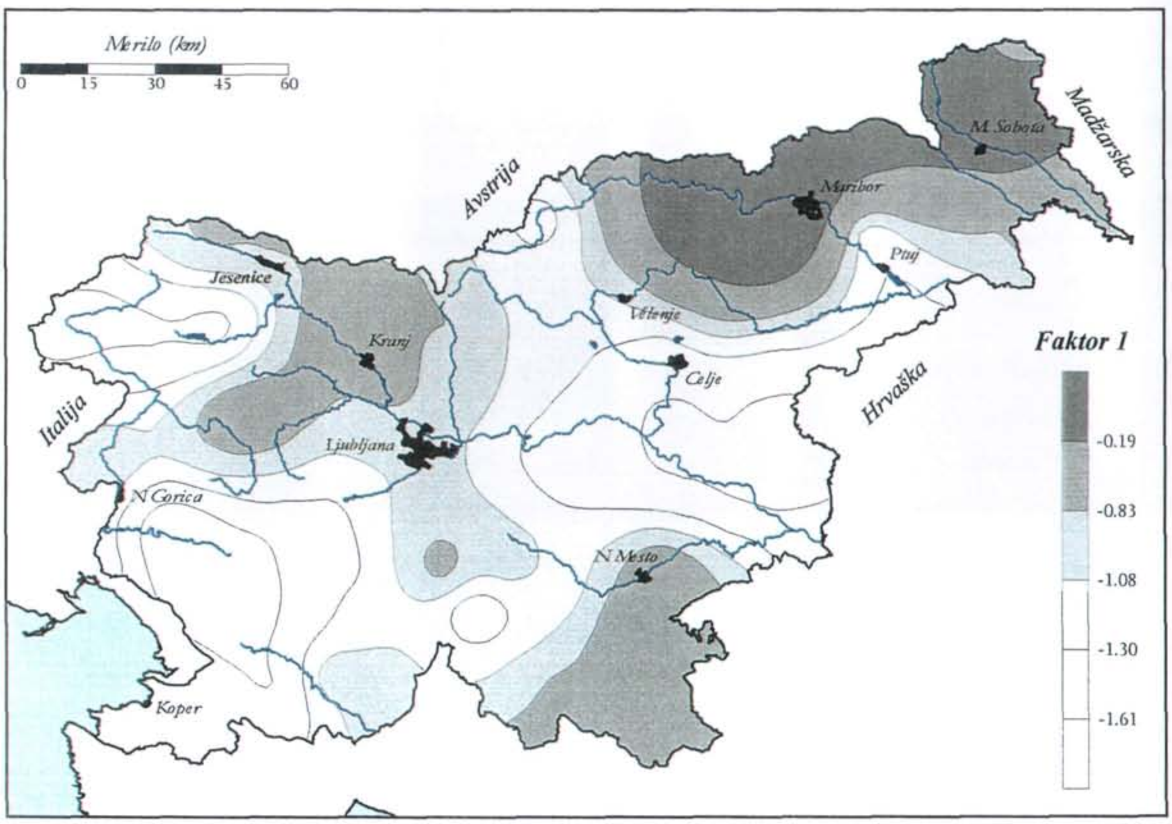

Fig. 1b: Distribution of factor 1 (Al, K, Ti Sc, Y, V, Th, Fe, Nb, -Ca and -Cu) in household vacuum cleaner dust

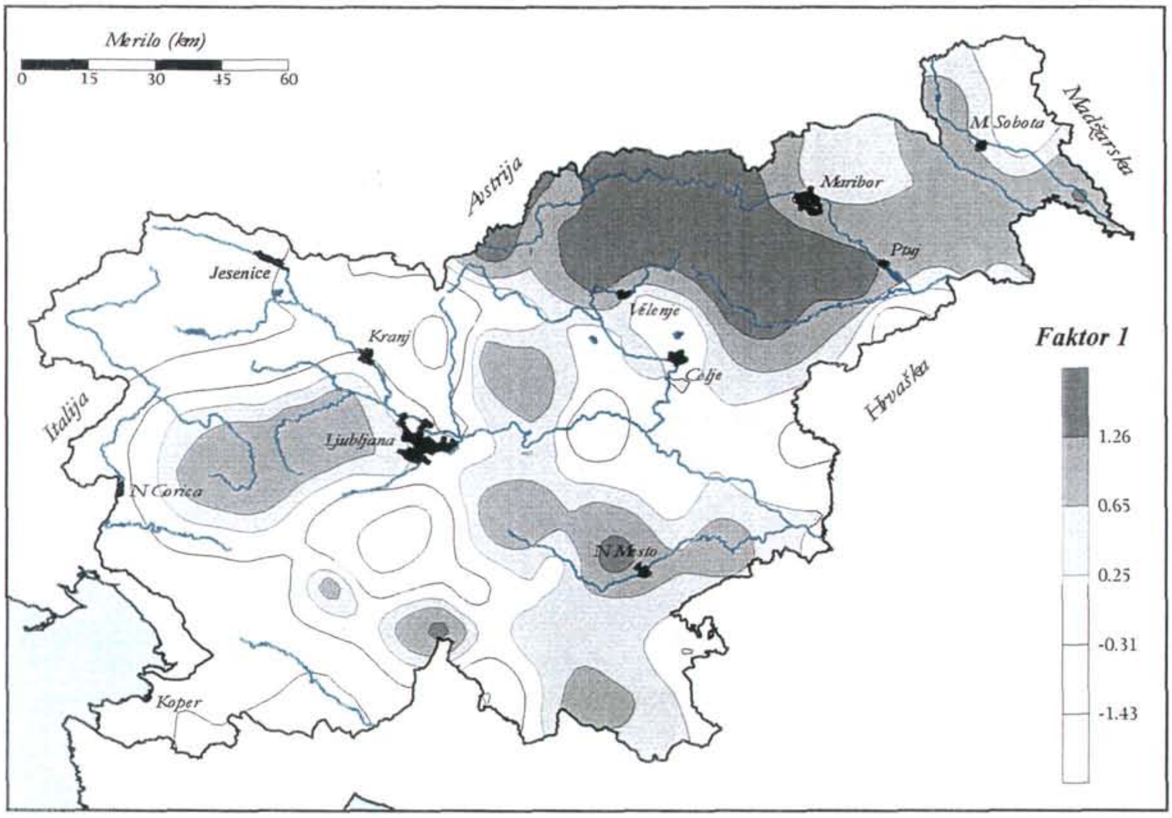

Fig. 1c: Distribution of factor 1 (Al, K, Ti Sc, Y, V, Th, Fe, Nb, -Ca and -Cu) in overbank sediment

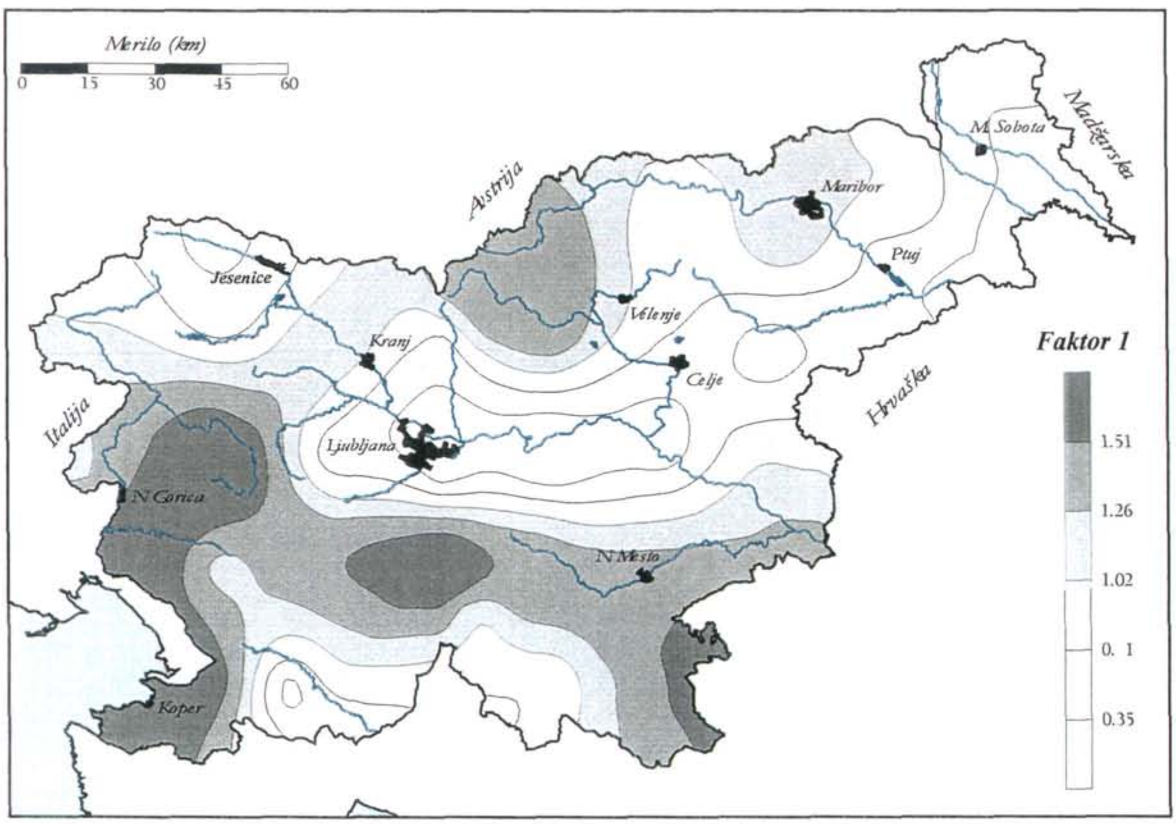

Fig. 1d: Distribution of factor 1 (Al, K, Ti Sc, Y, V, Th, Fe, Nb, -Ca and -Cu) in soil

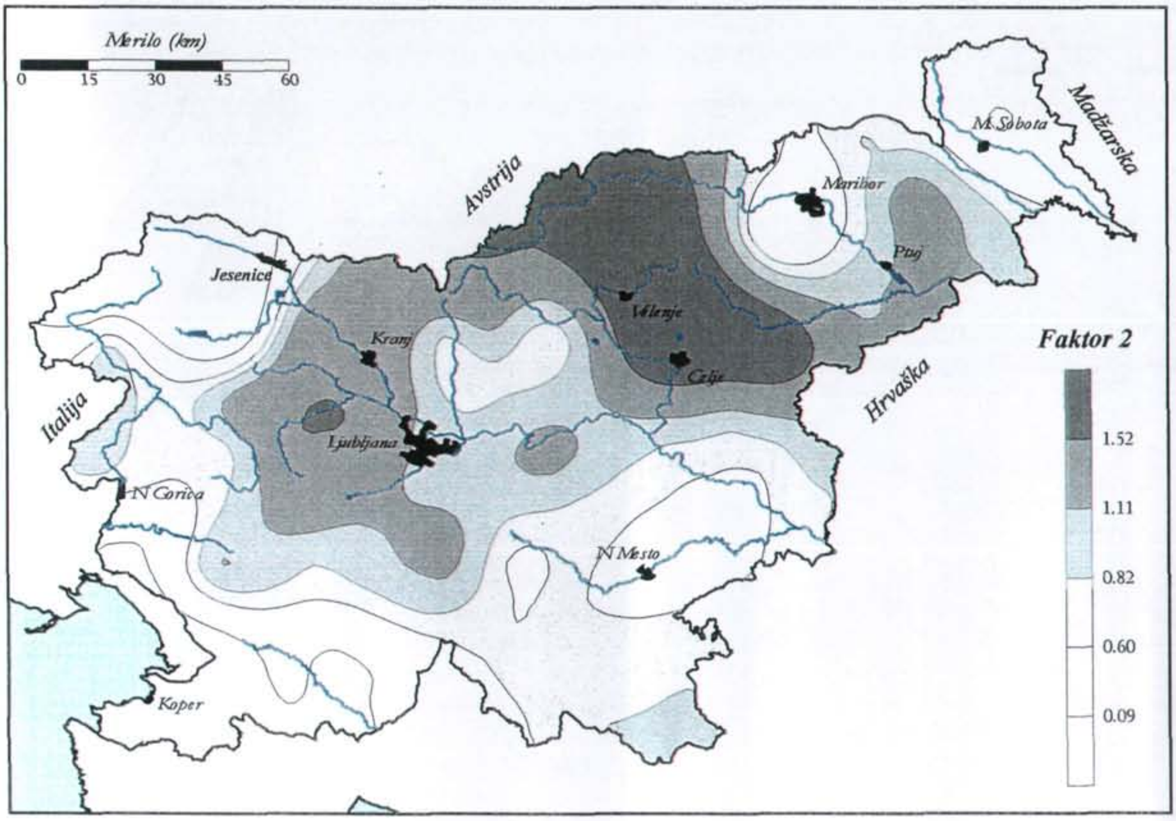

Fig. 2a: Distribution of factor 2 (Cd, Cu, Pb, Sn, Zn, Hg and -Sc) in attic dust

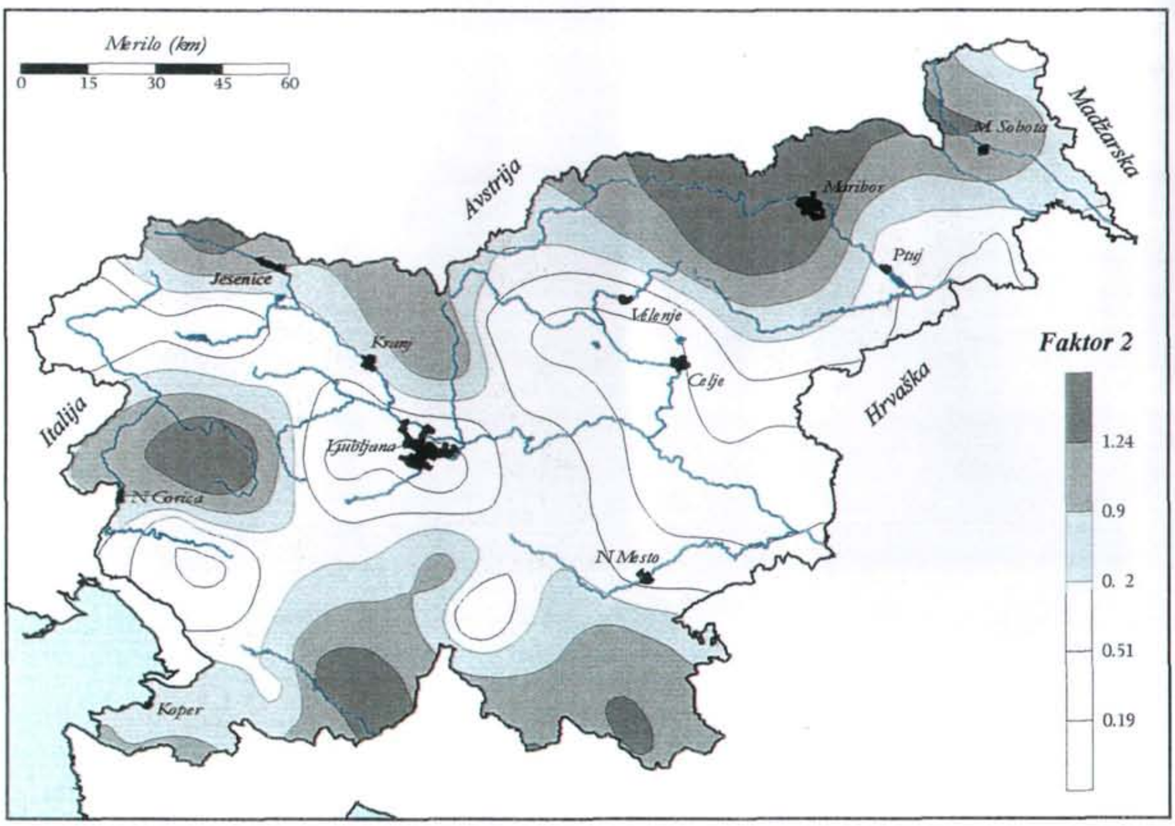

Fig. 2b: Distribution of factor 2 (Cd, Cu, Pb, Sn, Zn, Hg and -Sc) in household vacuum cleaner dust

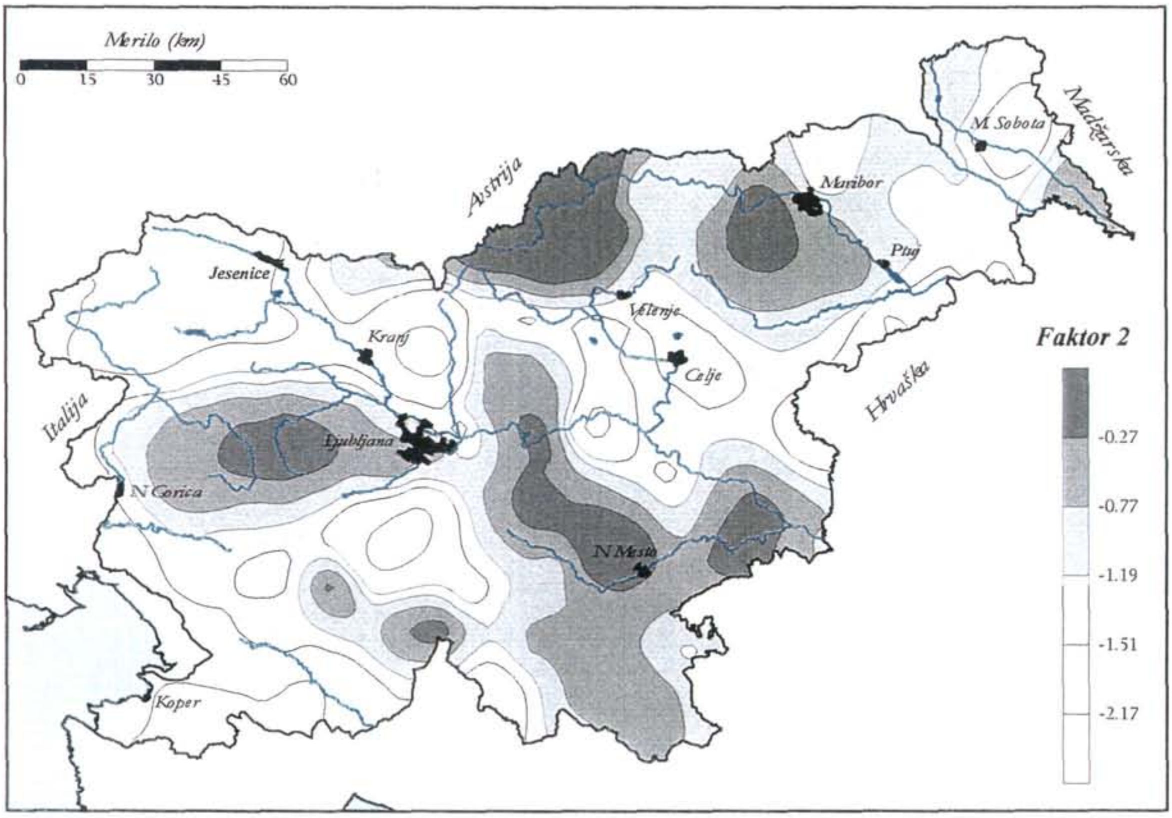

Fig. 2c: Distribution of factor 2 (Cd, Cu, Pb, Sn, Zn, Hg and -Sc) in overbank sediment

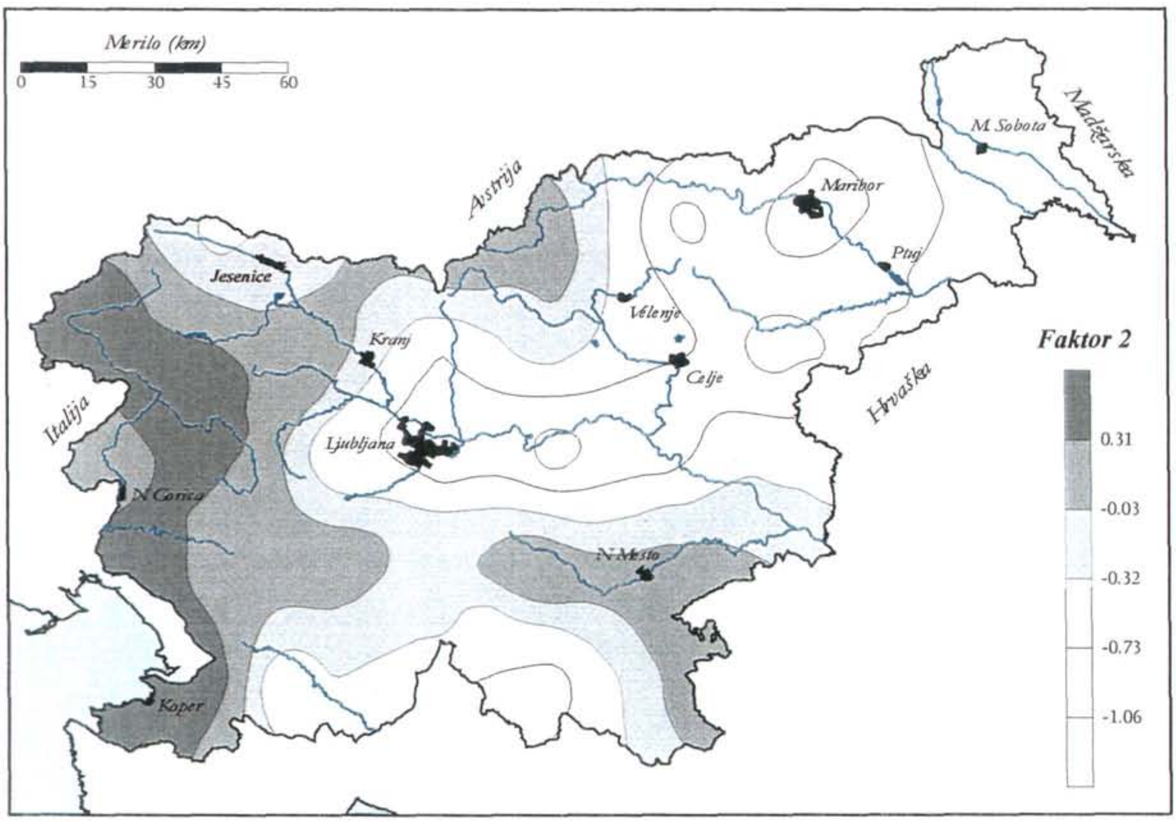

Fig. 2d: Distribution of factor 2 (Cd, Cu, Pb, Sn, Zn, Hg and -Sc) in soil