Spatial variation of ^{137}Cs activity concentration in urban environment using attic dust samples from city of Salgótarján in northern part of Hungary

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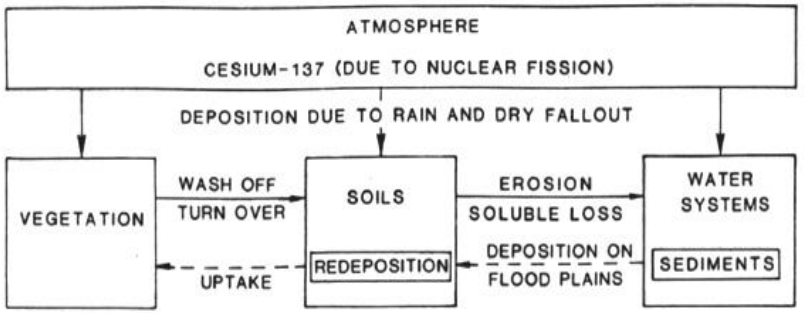
Introduction

The ^{137}Cs ($T_{1/2}$ =30) is a principal radioisotope introduced into the environment through the atmospheric bomb tests (from 50s to 60s) and the major nuclear accidents (Chernobyl, 1986 and Fukushima, 2011). From atmosphere, ^{137}Cs adsorbs to precipitation and returns to lithosphere by wet and dry deposition as radioactive fallout component (Fig 1).

The attached particles could have reached houses (e.g. through open windows, and vents etc.) and deposited inside resulting in the exposition of the habitants to ^{137}Cs. In areas that are not accessible for a regular cleaning (e.g., attics) physical state and chemical composition of attic dusts remain constant in time.

Fig 1. Diagram of the Cs-137 cycle on the landscape (Ritchie and Mchenry, 1990)



The aim of study was using undisturbed attic dust samples as past record of anthropogenic pollution, due to this elucidating the pathways of radioactive contamination in the urban environment.

Study area

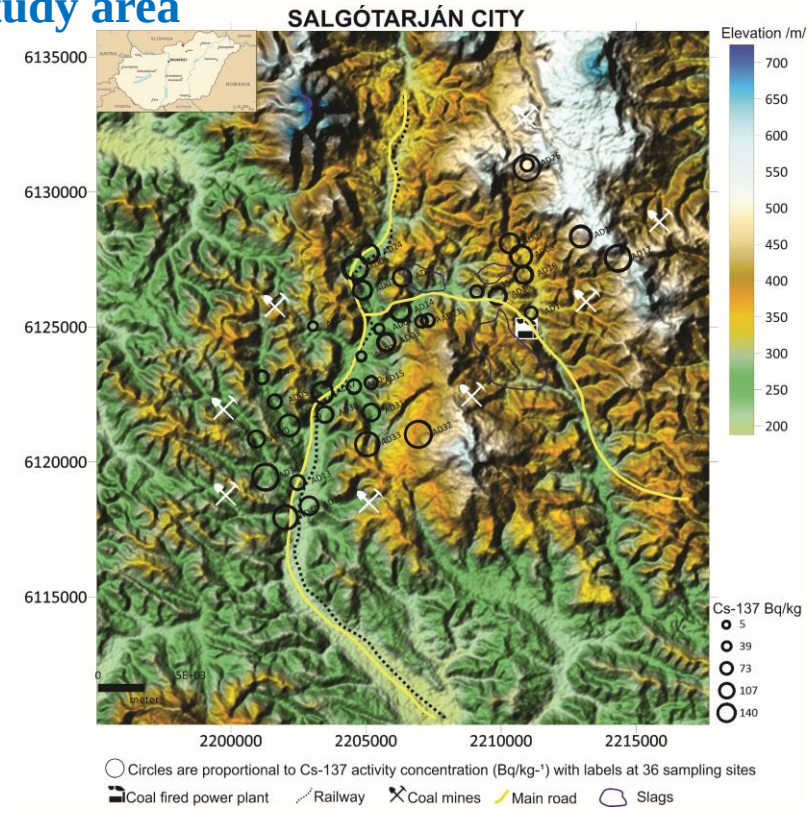


Figure 2. Salgótarján study area. Topographic shaded relief model with elevation above sea level in meters showed. The circles are proportional to the Cs-137 activity concentration (Bq/kg-1) at 36 sampling sites.

Sampling

Field work (Euro Geo Survey international urban geochemical sampling *(Demetriades and Brike, 2015)*

The sampling protocol following *Völgyesi et al., (2014)*

- 36 attic samples collected
- Undisturbed attic dust samples homogenized <0.125 mm
- Cs-137 were determined using a well-type HPGe detector placed in a low-background iron chamber at the laboratory of the, Hungarian Center for Energy Research.

Results

- The obtained ^{137}Cs activity concentration ranged from 4.34 ± 0.27 Bq/kg to 140.74 ± 1.66 Bq/kg, with mean value is a 73.32 ± 1.58 Bq/kg
- The significant correlation (r=0.5, p<0.05) were found between Cs-137 activity concentration versus elevation (m) in studied area.
- The houses built between 1945-1989 generally display higher activity concentration than younger houses.

Spatial variation of Cs-137 (Bq/kg)

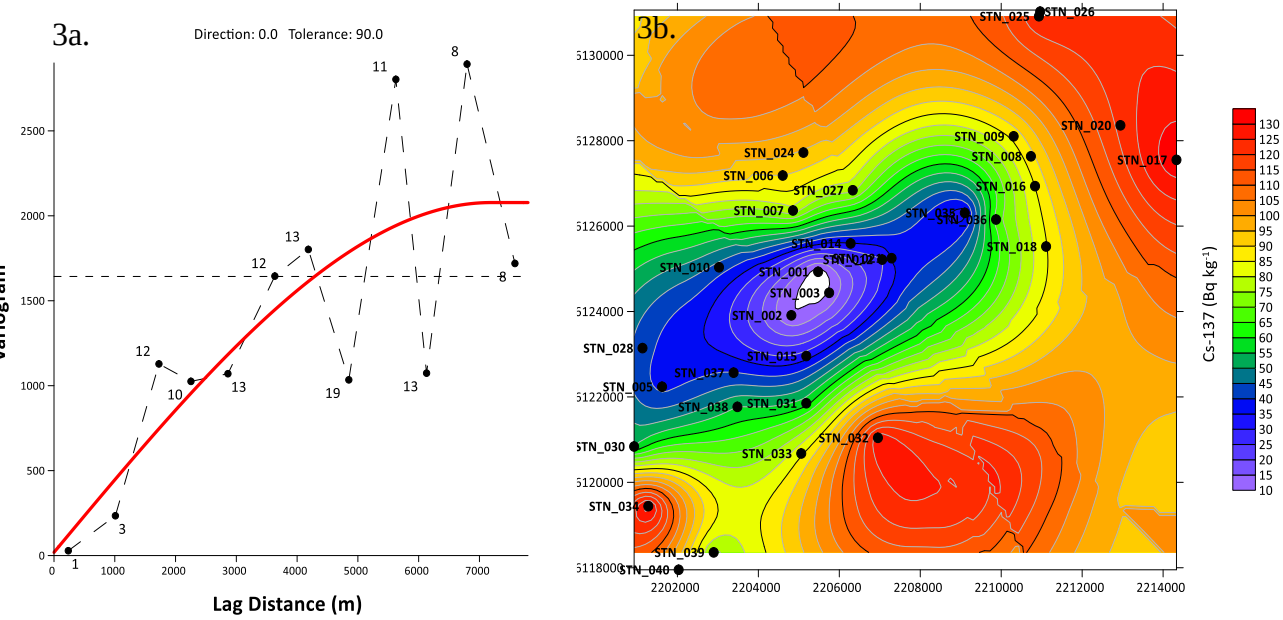


Fig. 3a. The empirical (black dashed line with dots) calculate with the Matheron-type equation and fitted spherical theoretical semivariogram (Red line) derived from Cs-137 activity values. Model parameters: sill C_0=0.19; C_0+C=2078; a=7.2 km; r^2=0.6. Values of the empirical semivariogram (black dots) represent the data pairs within a given distance (bin width was 650 m) behind the semivariograms. The dashed line indicates the variance. 3b. Kriged map of the Cs-137 activity from the study area. Interpolation was done with ordinary point kriging using the obtained spherical variogram model.

A theoretical semivariogram was developed to determine the spatial dependence of Cs-137 on city scale. Empirical variogram was obtained, a best-fit (r^2=0.6) spherical model was determined (Fig. 3).

Summary

Undisturbed attic dust can be effective environmental samples for monitoring historical fallouts of production from early nuclear weapon testing and nuclear catastrophe(s).
Elevated activity concentration of Cs-137 distribution strongly influenced by local physical conditions (topography and meteorology).

THANK YOU FOR YOUR ATTENTION!

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