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Anthropogenic and geogenic radionuclides content in an undisturbed Slovenian forest soil

Jankong P (1), Mabit L (1), Toloza A (1), and Zupanc V (2)

(1) IAEA/FAO, Soil Science Unit, FAO/IAEA Agriculture & Biotechnology Laboratory, IAEA Laboratories Seibersdorf, Austria (P.Jankong@iaea.org / +431-2600-28222), (2) Department of Agronomy, Biotechnical Faculty, University of Ljubljana, Slovenia.

The measurements of natural background radiation and anthropogenic radionuclides in terrestrial environment, especially in soil, have been carried out in many countries for several decades to establish base line data of radiation level. So far, the knowledge of radionuclides concentration levels in Slovenia is limited to a few investigations and the use of anthropogenic 137Cs radionuclide has not yet been used as soil landscape tracer in Slovenia.

Therefore, the purposes of this study were: (i) to collect the inventory information of naturally occurring isotope (40K, 226Ra, 232Th, 235U and 238U) and man-made radionuclides (137Cs) as well as their depth/vertical distribution in soil; (ii) to complete radio-ecological survey information in Slovenia and provide information regarding the external dose-rate based on the depth distributions of the gamma emitters in the soil of the study area; and (iii) to establish a reference inventory value of 137Cs fallout in order to prepare for a future investigation to test 137Cs as soil tracer under Slovenian agro-environment.

To estimate the natural level of radioactivity and the initial fallout of 137Cs, twenty soil profiles (0-40cm) divided into four increments of 10 cm were collected in an undisturbed forest located in East Slovenia in Šalamenci close to the Hungarian and Austrian borders at the beginning of the Pannonian plains.
Depending on the depth increment, the average activity concentration of 137Cs, 40K, 226Ra, 232Th, 235U and 238U were found to be respectively from 0.47 $\pm$ 0.27 to 70 $\pm$ 33 Bq kg-1, from 535 $\pm$ 16 to 703 $\pm$ 20 Bq kg-1, from 51 $\pm$ 3 to 49 $\pm$ 2 Bq kg-1, from 54 $\pm$ 6 to 62 $\pm$ 4 Bq kg-1, from 7.8 $\pm$ 0.8 to 8.1 $\pm$ 0.3 Bq kg-1and from 58 $\pm$ 22 to 68 $\pm$ 27 Bq kg-1. On average the top soil mass activity of 40K is 7 to 8 times higher than that of 137Cs and the depth distribution of this isotope, instead of showing a constant amount along the soil profile, presents an increase with depth. The external gamma dose rate of the top soil (79 $\pm$ 3 nGy h-1) is higher than the world average of 57 nGy h-1 reported by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

In complement to this local radio-ecological survey, as erosion studies in Slovenia have been only implemented using conventional techniques since the beginning of the 1960s, this study through the assessment of the initial 137Cs fallout in this undisturbed forest is also a first preliminary step in investigating soil redistribution using nuclear technique that can complement previous investigation using conventional erosion and sedimentation measurement.
In this forest 137Cs, as expected in an undisturbed reference site, showed an exponential decreased with depth. 98 % of 137Cs is concentrated in the first 20 cm of the soil and the activity in the 30-40 cm layer was below the detection limit. For future investigation to assess the erosion and sedimentation processes of agricultural fields in the neighbourhood using the 137Cs approach, the base-line level of 137Cs was established at 7316 $\pm$ 2525 Bq m-2 with a coefficient of variation of 34 %.

Keywords: Anthropogenic and geogenic radionuclides; 137Cs; 40K; 226Ra; 232Th; 235U; 238U; external gamma dose rate, erosion.