CHANGES OF RADIOECOLOGICAL STATE IN LITHUANIA AFTER AN ACCIDENT IN THE CHERNOBYL NPP

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Abstract: The subsequences of Chernobyl NPP accident were perceptible in Lithuania. Therefore the aim of present work was to evaluate changes of radioecological state of plants and soil of their habitats during 1993–2007 in Lithuania regions (Ignalina, Varena and Plunge) because of the Chernobyl NPP accident contaminated with Cs-137, Cs-134 and Sr-90. During investigated period, decrease in Cs-137 activity in soil was observed only in Plunge region in 2007. Cs-134 activity in soil of all investigated regions was detected only in 1996 and 1997. Sr-90 activity in soil significantly decreased also only in Plunge region over 1996–1997, and later it hardly changed. Cs-137 activity in plants substantally decreased in all investigated regions: in Varena over 1993–1994, Ignalina over 1994–1995 and Plunge over 1994–1997, however, at later period it changed a little. Cs-134 activity in plants of all investigated regions decreased over 1994–1997 and from 1998–1999 it was under minimal detectable level. Sr-90 activity in plants of Ignalina, Varena and Punge regions decreased over 1993–1995 and later it changed not much. Data reveal that after the Chernobyl NPP accident significant autoreabilitation processes took place in plants of contaminated areas of Lithuania over 1993–1998, while from 1999 these processes apparently slowed down. Autoreabilitation processes rate in plants were different in Lithuanian regions: in Plunge it was slower than in Varena or Ignalina. Differences may be influenced by particular soil characteristics, as well as other ecological conditions. Whereas autoreabilitation processes in the soil were hardly noticeable.

Keywords: radioecological pollution, autoreabilitation, Chernobyl NPP

Introduction

The radioecological pollution caused by Chernobyl NPP (CNPP) accident was perceptible in the Lithuania. Therefore, the long-term investigations of radionuclides distribution in the environment are essential for determining the areas of enlarged radioecological pollution, as well as for estimation of autorehabilitation processes of territories contaminated by radionuclides.

Soil is a critical component in the terrestrial ecosystem predetermining the intensity of radionuclides migration in the environment. Plants also play an important role in the processes of radionuclides migration in the terrestrial ecosystem. However, no direct correlation between the radionuclides specific activity in soil and their accumulation in plants was observed (Shestopalov *et al*., 2001). After penetrating the soil radionuclides can be involved in the processes of biological metabolism occurring in system soil–plant and via food chains migrate into higher trophic levels (Dusauskiene-Duz & Marciulioniene, 2004). Therefore investigations of both plants and soil are relevant concerning the contamination of terrestrial ecosystem with radionuclides.

The aim of present work was to evaluate changes of radioecological state of plants and soil of their habitats during 1993–2007 in Lithuania regions (Ignalina, Varena and Plunge) because of the CNPP accident contaminated with Cs-137, Cs-134 and Sr-90.

Materials and methods

The samples of plants and soil were collected at background monitoring stations of the regions (Plunge, Varena and Ignalina) of Lithuania during the period 1993–2007 (Fig. 1). 11 plants species were used in the investigation: *Hylocomium splendens* (Hedw.)

Shimp, *Pteridium aquilinum* (L.) Kuhn, *Dryopteris filix-mas* (L.) Schott, *Vaccinium myrtillus* L., *Calamagrostis arundinacea* (L.) Roth., *Sphagnum* sp., *Calluna vulgaris* (L.) Hull, *Calla palustris* L., *Ledum palustre* L., *Hypericum perforatum* L. and *Dactylis glomerata* L. All the samples were dried up to dry air weight (d. w.) and incinerated at the temperature of 430°C–610°C.

Figure 1. Stations of background monitoring of the Lithuanian regions (Plunge, Varena, Ignalina)

Cs-137 and Cs-134 specific activity in plants and soil samples was measured using the high purity germanium detector, with relative efficiency of 30% and energy resolution of 1.72 keV at 1333 keV (Gudelis *et al.*, 2000; Luksiene *et al.*, 2006). Carbonate (Sokolova, 1971), oxalic (Pimpl, 1996), and radiochemical methods (Suomela, 1993) were used for determination of Sr-90 specific activity in samples. Till 2001, Sr-90 measure was based on its daughter product Y-90 by low background radiometer UMF-1500M, with efficiency of measurement – 17 %. From 2002, Sr-90 balanced with Y-90 was measured by liquid scintillation spectrometer Tricarb 3170TR/SL, efficiency of measurement – 39 %.

Results and discussion

During investigated period, the highest Cs-137 specific activity in the soil was determined in Plunge region, with the highest average value 340 Bq kg^{-1} d. w. in 1997 (Fig. 2). From 1996 to 2002 Cs-137 specific activity in soil of Plunge region not changed much, while in 2007 the decrease of Cs-137 specific activity in soil was observed. The highest average value of Cs-137 specific activity in soil of Varena region was determined in 1996 (103 Bq kg^{-1} d. w.) and in soil of Ignalina region in 1997 (115 Bq kg^{-1} d. w.) (Fig. 2). However, significant decline of Cs-137 specific activity in soil of these regions was not indicated. Cs-134 specific activity in soil of all investigated regions was detected only in 1996 and 1997. Sr-90 specific activity in soil significantly decreased also only in Plunge region over 1996–1997 (with highest value 82 Bq kg^{-1} d. w. in 1996), and later it hardly changed, while in other investigated regions Sr-90 specific activity in soil changed not much during all investigated period (Fig. 2). The decrease of Cs-137 and Sr-90 specific activity in the soil of Plunge region might be influenced by several processes and factors, such as mechanical soil composition, ionic capacity and moisture of soil, low additional penetrating of radionuclides into the soil,

due to global fallout, decay of radionuclides, their migration to the deeper soil levels or uptake by plants.

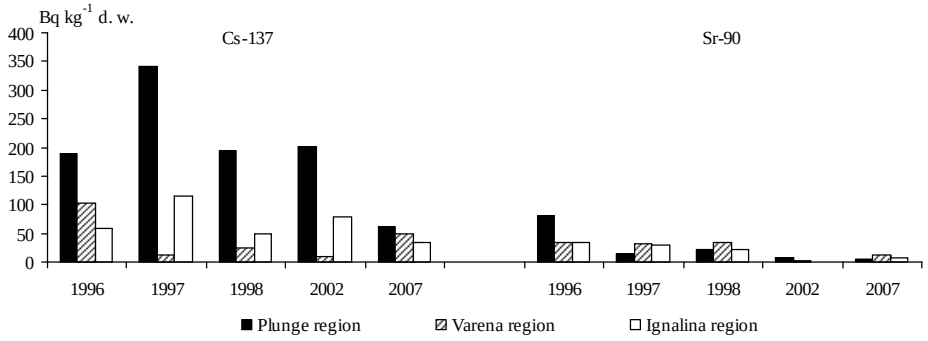

Figure 2. Average values of Cs-137 and Sr-90 specific activity (Bq kg^{-1} d. w.) in soil at background monitoring stations in the Ignalina, Varena, and Plunge regions

Average values of Cs-137, Cs-134 and Sr-90 specific activity in plants of all investigated regions varied in quite wide range. The highest specific activity of both Cs-137 and Sr-90 in the investigated plants was determined in *Pteridium aquilinum*.
The highest average value of Cs-137 specific activity in plants of Varena region was determined in 1993 (226 Bq kg^{-1} d. w.) and in plants of Plunge and Ignalina regions in 1994 (227 and 92 Bq kg^{-1} d. w., respectively) (Fig. 3). Cs-137 specific activity in plants substantially decreased in all investigated regions: in Varena over 1993–1994, Ignalina over 1994–1995 and Plunge over 1994–1997. At later period Cs-137 specific activity in plants of Plunge and Ignalina regions changed a little, while this radionuclide specific activity in plants of Varena region decreased yet more over 1998–2002 (Fig. 3).

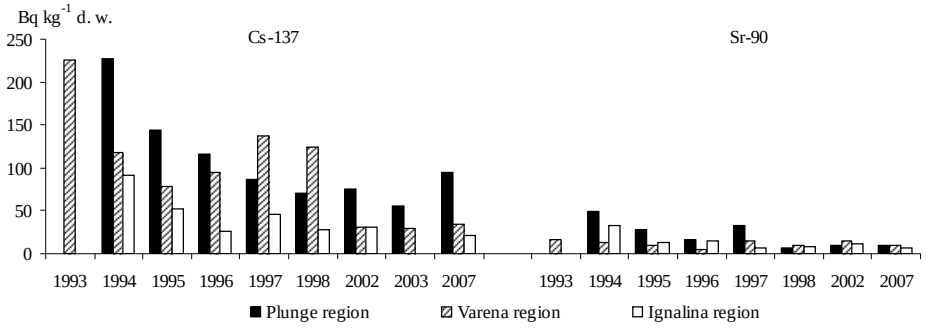

Figure 3. Average values of Cs-137 and Sr-90 specific activity (Bq kg^{-1} d. w.) in plants at background monitoring stations in the Ignalina, Varena, and Plunge regions

Cs-134 specific activity in plants of all investigated regions decreased over 1994–1997. Cs-134 specific activity in plants of Plunge and Ignalina regions from 1998, as well as from 1999 in Varena region was under minimal detectable level.

The highest average value of Sr-90 specific activity in plants of Varena region was determined in 1993 (17 Bq kg^{-1} d. w.) and in plants of Plunge and Ignalina regions in 1994 (49 and 33 Bq kg^{-1} d. w., respectively) (Fig. 3). Average values of Sr-90 specific activity in plants of Varena region was diminishing very slightly over 1993–1994, while in plants of Plunge and Ignalina regions diminishing was stronger and took place over 1994–1995. From 1995 to 2007 average values of Sr-90 specific activity in plants of investigated Lithuanian regions changed not much (Fig. 3). The decrease of investigated radionuclides specific activity in plants might be relevant to above mentioned characteristics of the soil, because plants major part of radionuclides absorb from it, as well as to characteristics of the plants: such as, distribution of plants rootage zone in the soil, different mineral nutrition and metabolism of plants or competitive relationships between plants. Sr-90 specific activity in plants of investigated regions decreased slower than specific activity of Cs-137 or Cs-134. That might be related with Sr-90 and Cs-137 migration differences in system soil–plant. Cs-137 characterizes by long deposition period in soil, whereas major part of Sr-90 is in the exchangeable form because of weak fixation in the soil (Shestopalov *et al*., 2001).

Conclusions

Data reveal that autoreabilitation processes in the soil of Varena and Ignalina regions were hardly noticeable, as distinct from most contaminated Plunge region. But even here autoreabilitation processes in the soil were much slower than that in the plants.
However, after the CNPP accident significant autoreabilitation processes took place in plants of contaminated areas of Lithuania over 1993–1998, while from 1999 these processes apparently slowed down. Autoreabilitation processes rate in plants were different in Lithuanian regions: in Plunge it was slower than in Varena or Ignalina. Differences may be influenced by particular soil characteristics, as well as other ecological conditions.

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