THE MEASUREMENT OF Cs-137 IN LATVIAN FOREST LITTER

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Abstract: The investigation evaluates the role of forest growth, in dissipation in the territory the radionuclide Cs-137 accumulating in the soil of Latvia forests after the Chernobyl accident. The comparison of the concentration of Cs-137 in the upper layer of the soil was carried out in the pine, spruce and birch forests, and outside forest territories as well in Rucava (influence zone of the Chernobyl accident) and in Taurene (nonpolluted zone). Within limits of the same pine forest in Rucava the concentration of Cs-137 fluctuates within limits of 108-724 Bq/kg, in the spruce forest 205-2270 Bq/kg, outside forest territory 15-30 Bq/kg. In Taurene the fluctuation of these indices is in the pine forest 42-157 Bq/kg, in the spruce forest - 19-133 Bq/kg, outside forest territory - 3-19 Bq/kg. These data confirm the great role of the coniferous forests in both the adsorption of Cs-137 from the air, and its redistribution within borders of the forest.

1. Introduction

The accident of Chernobyl Nuclear Power Plant changed the radiological situation acutely in many countries. Some countries were touched only a bit, but in others it became a national disaster. Nevertheless in these countries which were subdued to relatively small radioactive pollution it is necessary to do research work as regard pollution and its influence on the environment.

After the decay of the short- and medium-lived radionuclides, the radioactivity background due to that is mainly created by radionuclide Cs-137. Without the data about the pollution the knowledge is necessary about its vertical distribution in the soil, its mobility, its ability to accumulate in plants and living organisms. For our study of the radioactive pollution we chose litter. This choice was made because the greatest accumulation of the products of nuclear fission from atmosphere is observed in forest /1/. In their paper the authors /2/ explored some Latvian forest reserves and stated that before Chernobyl accident the concentration of Sr-90 and Cs-137 was between 37 to 370 Bq/kg in the needles of pines and soil. Partial results (autumn 1991) of a large survey of radioactive contamination in Polish forests, predominantly coniferous, are presented in the paper /3/. In paper /4/ experimental data on the content of radioactive nuclides of Cs in individual components of Lithuanian pine biogeocenosis after the Chernobyl accident are presented.

The aim of the study was to obtain data about the migration, accumulation, and distribution of the Cs-137 contamination in Latvian forest territories. It was important to investigate experimentally:

- the depth of the Cs-137 migration within 8 years after the Chernobyl accident
- the pollution level in specific regions
- whether the pollution level differs depending on various tree stands
- relation between the number of samples analyzed and the level of credibility of the obtained results (at various levels of probability)

The special attention should be paid to the investigation of the pollution levels in the forest in relation to various tree stands. The regions with the different level of the radioactive pollution were selected: at Rucava in South-western Kurzeme which was passed over by the tail of the radioactive cloud of Chernobyl and Taurene in Vidzeme, outside the area influenced by Chernobyl.

2. Materials and methods

The samples were collected in the summer of 1994 and 1995. For the investigation of the accumulation of Cs-137 in the forest litter the samples of the acknowledged standard size, that is, of 5 cm thick layer were gathered. The migration of Cs-137 was acquired at various depths (5 levels: from 0 to 25 cm).

The size of the sample areas was 50x50 m. The samples in both different areas of the investigation were gathered choosing stands:

- of the similar age, and height, etc
- growing in the similar type of soil
- of the level area

The samples were dried and homogenized in the "runner mill". The measurements of the radioactivity of Cs-137 were performed, using the semiconductor gamma-spectrometer with 70 cm^3 HPGe detector. The background of the radioactivity was minimized by using the 80 mm thick shield of lead and copper plate. The samples were measured in the Marineli vessel at the top of the detector, the volume of the sample was 1 liter. The certified standard of Cs-137 with the activity of 1040 Bq was used in the process. The measurement time was selected for the statistical error of results. It didn't exceeded 3-5%.

3. Results and discussion

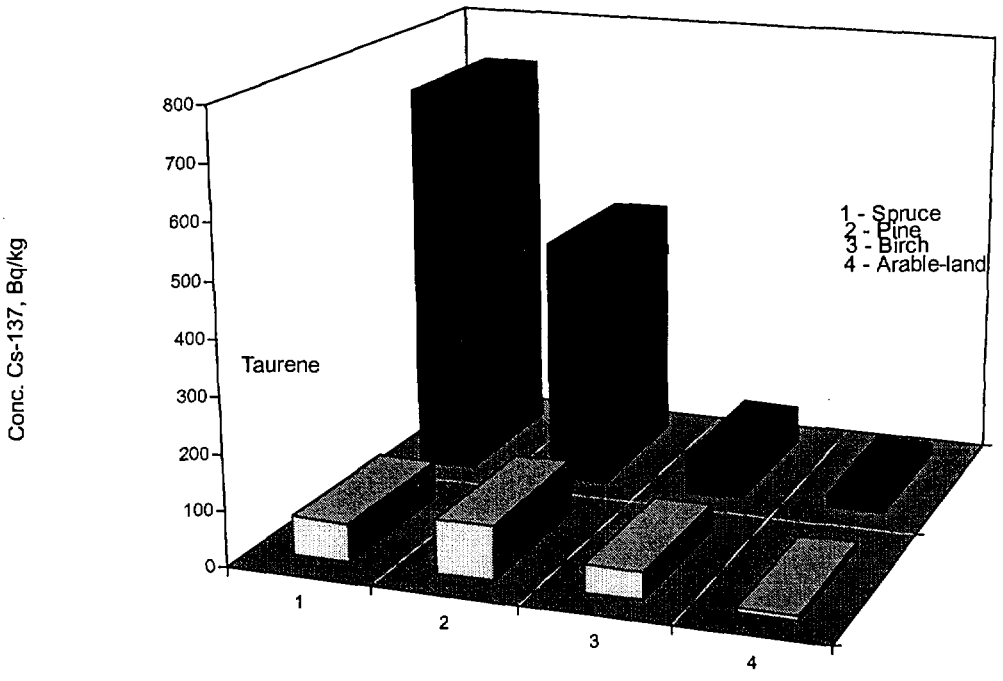
Experimentally estimating the migration of Cs-137 in the forest soil up to 25 cm depth, it was established that even after 8 years the Chernobyl accident up to 96% of Cs-137 is concentrated in the upper 5 cm layer. It confirms other author's /5/ data that 90-95% of Cs-137 is located in the soil in fixed (insoluble) condition and its migration takes place very slowly.

The results shows that the correlation between the relative quantity of Cs-137 in forest litter and the relative quantity of needles there is the linear one. It enables us to conclude that in thicker forests more polluted place with Cs-137 could be found.

In the forests of Taurene (in the nonpolluted zone by the Chernobyl accident) the concentration of Cs-137 in all forests, regardless of their structure, is significantly higher than in the clearing outside the forest (Fig.1).

The mean concentration of Cs-137 of Taurene's forest is 79 Bq/kg; but in volume of soil- 57 Bq/l. Outside the forest territories they are respectively 9 Bq/kg and 13 Bq/l. The highest variations of Cs-137 are in the spruce forest - 19-133 Bq/kg; the variations of the concentration of Cs-137 in the pine and the birch forests does not exceed these limits. Significantly different indices are in the forests influenced by the Chernobyl accident of Rucava (Fig.1).

Fig.1. Content of Cs-137 in the forest litter, Bq/kg



The highest content of Cs-137 is established in the spruce forest; the mean values are 813 Bq/kg or 342 Bq/l. There are large differences in Cs-137 concentration in the same forest. The results obtained in two separate spots within 10 m distance one from another differ more than ten times: 205 and 2268 Bq/kg (Tab.1).

Table 1. Content of Cs-137 in the forest litter, Bq/kg

Area	*Pine*	*Spruce*	*Birch*	*Arable land*
Rucava	110-720 446	810-2270 718	43-130 69	15-30 23
Taurene	42-160 97	19-130 69	37-79 48	4-20 9
Q(R)/Q(T)	4.6	10.4	1.4	2.5

A little lower amplitude of the fluctuation occurs in the pine forest: the concentration of Cs-137 in the samples analyzed are within limits from 108 to 724 Bq/kg. The mean value are 446 Bq/kg or 196 Bq/l, that is significantly lower than in the spruce forest.

The lowest concentration of Cs-137 is in the birch forest: in average 71 Bq/kg or 79 Bq/l. These indices do not differ significantly from the indices in the Taurene birch forest that was not influenced by the Chernobyl accident. It confirms the large abilities of adsorption of the crowns of the coniferous trees. It is useful to remember that during the Chernobyl accident the birch trees didn't have leaves yet, therefore their ability of adsorption was low.

In the territories outside the forest near Rucava the content of Cs-137 in the soil is in average 23 Bq/kg or 31 Bq/l, that is, approximately three times less than the content of radiocaesium in the birch forest, 20 times less than in the pine, and 40 times less than in the spruce forest.

Alongside with the adsorption qualities of the forest these data illustrate also a very important feature of the method, namely, in order the results obtained could characterize the average level of the pollution in the chosen forest. The method allows one to compare pollution in different areas. The special attention should be paid to the number of gathered samples of the soil.

There exists a real probability (approximately 12%) that in the accidentally collected sample of the forest soil the concentration of Cs-137 in the nonpolluted pine forest of Taurene could be higher than in the pine forest of Rucava influenced by the Chernobyl accident.

Taking into account the fact that the radioactive pollution gets into the soil mainly with litters of the coniferous and foliage trees and in the areas with a larger amount of litter in the upper layer of the soil is looser than in the areas with the thinner layer of litter, the credibility of the average data in relation to the chosen measurements Bq/kg or Bq/l could be questioned.

Our material confirms that in the outside of the forest territories where the coefficient of the variations of the density of the soil (g/cm^3) V is small (7-8%) the fluctuation of quantities of the radioactive Cs-137 are of the same kind, regardless the use of the measurements either of volume or of weight: in Rucava V is 18% and 21%, in Taurene V is 44% and 45%. The different coefficients of the variations V are in the forests. For instance, In the spruce forest in Rucava Bq/l - V=53% and Bq/kg - V=72%.

4. Conclusion

- The pollution of Cs-137 gets into the soil with litters and 95% of the pollution accumulates within upper layer of 0-5 cm with rather different density, that in our samples fluctuated within limits from 0.328 to 1.308 g/m^3.
- The average indices of the radioactive pollution in the pine forest of Rucava are 4.6 time higher than in the forest of Taurene (446 and 97 Bq/kg); in the spruce forest this difference reaches 11.7 times (813 and 69 Bq/kg); in outside of the forest territory 2.6 times (23 and 9 Bq/kg). In a view of the

fact that during the Chernobyl accident, the birch trees were not in leaf yet, the proportion of the soil pollution in the birch forest is only 1.5.

- Because of the mosaic-like structure of the radioactive pollution of the soil to obtain the average sample (in our case) confidence level 0.90 in the pine forest the 20 sample taking spots are necessary; in the spruce forest they are 50, in the birch forest and outside of the forest territory - 10 sample taking spots are necessary.

5. References

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