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Cs-137 K-39 Distribution and Cycling in some Forest Ecosystems 25 Years after the Chernobyl Accident

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Many radioecological research conducted in forest ecosystems after the Chernobyl Accident suggest that Cs-137 distribution in the forest stand and tree components changes with the time. Downward Cs-137 fluxes were shown to prevail during first several years after the accident. It was supposed that with the course of time, the parameters of Cs-137 migration and cycling in the forests would be similar to the corresponding parameters of K-39 that is a chemical analog of Cs-137. However, our later studies showed that in the forest ecosystems on chernozem and grey forest soils (Tula Oblast of Russian Federation, 400-500 km from the ChNPP), annual return of Cs-137 to the soil with litterfall still increased its root uptake by a factor of 2-5, while the K-39 cycle was in steady state. It suggests that Cs-137 cycling parameters in these ecosystems is different from the potassium cycling even a while after the fallout.

In 2008-2013 a similar study was conducted in pine and birch forests located some 100 km from the ChNPP, in Bryans Oblast of Russian Federation where the composition and physico-chemical properties of the initial fallout were similar to that in the 30-km zone of exclusion. In 2008, Cs-137 deposition in the pine and birch ecosystems was 11000 and 6000 Kbq/m2, respectively. Cs-137 content in different tree parts varied from 4 to 38 Kbq/kg, and in the pine forest decreased in the following rank: yang needles > internal bark > twigs (under 1 cm in diameter) > external bark > large brunches (over 1 cm in diameter) > wood. In the birch forest, the Cs-137 content in the tree parts decreased in the following rank: leaves > twigs > internal bark > large branches> external bark > wood. The K-39 content in the tree parts varies from 0.01% to 1 % and is ranked as above, i.e. similar to Cs-137. The average coefficient of correlation between K-39 and Cs-137 in the tree components is 0.85, at P=0.95.

In the investigated ecosystems, the total mass (activity) of potassium and Cs-137 accumulated in the above-ground tree components depends on the total biomass as well as the elements concentration in each tree component; the largest proportion of both elements is attributed to wood, while minimum amount is contained in the external bark. At the same time, both Cs-137 and K-39 accumulated in the annual tree increment are mainly attributed to young assimilative organs (leaves and young needles).

In the pine ecosystem, the proportion of both Cs-137 and potassium that returns annually to the soil with litterfall is about 45% of the total element amount in the tree stand, which is about 47% of the annual element accumulation in the phytomass. In the birch ecosystem, Cs-137 return to the soil is 49% and exceeds that of K-39 40%. In both ecosystems, the assimilative organs (leaves and needles) make the most significant contribution to annual return of Cs-137. Thus, the parameters of biological cycle of K-39 ? Cs-137 in the investigated ecosystems are comparable, as forecasted. It can be concluded that the annual cycles of K-39 and Cs-137 in these ecosystems are in a quasi steady state, and only a small proportion of these elements is retained annually in the forest stand compared to their annual return to the soil.