New data on the character of $^{137}$Cs lateral and vertical migration in soil-litter-moss cover within undisturbed elementary landscape geochemical systems on the test site in the Chernobyl abandoned zone, Russia

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A study of $^{137}$Cs distribution in two new landscape cross-sections characterizing the ELGS system (top-slope-closing depression) in the “Vyshkov-2” test site located in the Chernobyl abandoned zone, the Bryansk region, Russia, has been performed in 2020. The test site (70×100 m) is located on the Iput’ river terrace in a pine forest characterized by undisturbed soil-plant cover. The soil cover is presented by sod-podzolic sandy illuvial-ferruginous soils. The initial level of $^{137}$Cs contamination of the area varied from 1480 kBq/m$^2$ to 1850 kBq/m$^2$. Cs-137 activity was measured in the soil, moss and litter cover along two parallel (the distance was 5 m) cross-sections with 1 m step. Moisture content was also determined in the studied objects to roughly assess the influence of water regime on radiocaesium migration. Surface $^{137}$Cs activity was measured in field conditions by adapted gamma-spectrometer Violinist-III. Cs-137 content in the soil and plant samples was determined in laboratory conditions by Canberra gamma-spectrometer with HPGe detector.

Analysis of the obtained data showed that a major part of $^{137}$Cs is now fixed in the soil layer 2-10 cm deep while the highest specific activity of radiocaesium is found at a depth of 2-8 cm that can be explained mainly by the burial of the initially contaminated layer under the annual leaf fall.

Along the first cross-section we observed positive correlation between $^{137}$Cs surface activity and the content radiocaesium in the top soil layer 0-2 cm ($r_{0.05}=0.643$, n=15). Cs-137 activity in the moss samples correlated with the radionuclide activity in soil samples 4-6 cm deep ($r_{0.05}=0.627$; n=15). In the moss samples the highest correlation was observed between the green and rhizoid moss parts ($r_{0.01}=0.704$, n=60). Correlation between radiocaesium activity of the green part of mosses and the underlain litter samples was lower, but also significant ($r_{0.01}=0.612$, n=60). Values of $^{137}$Cs activity in the rhizoid part of moss and in litter were also positively linked, but to a lower degree ($r_{0.01}=0.402$, n=60).

Along the second cross-section correlation between $^{137}$Cs surface activity and the content radiocaesium in the top soil layer 0-2 cm equaled to $r_{0.05}=0.507$ (n=7). Radiocaesium content in moss samples (green, rhizoid parts) and litter was higher correlated with $^{137}$Cs content in soil layer 2-4 cm ($r_{0.05}=0.640$; 0.410; 0.460, n=7). Similar to the first cross-section the highest correlation was...
observed between the green and rhizoid parts of moss ($r_{0.01}=0.780$, $n=39$). Relation between $^{137}$Cs activity in green part of moss and litter samples appeared smaller than along the first cross-section but still significant ($r_{0.01}=0.419$, $n=39$) while that between the rhizoid part of moss and litter was higher ($r_{0.01}=0.509$, $n=39$).

Performed study showed that in the studied objects $^{137}$Cs secondary migration has a specifically stable character which may be related to spatial peculiarities of radionuclide migration in soil-plant cover controlled by water regime in the ELGS system. In our opinion this may form a characteristic cyclic variation of $^{137}$Cs activity observed along cross-sections of ELGS.

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