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Patterns and dynamics of Cs-137 soil contamination on the plot scale of the Bryansk Region (Russia): the role of processes, connectivity

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Character of surface and subsurface water flow was studied using 137Cs as a marker on a forest plot with a size of 50x70 m in the western part of the Bryansk Region, situated in the lower part of a slope that has a southern exposition and is drained by a stream. The range of altitudinal levels of plot amounts to 152,68-154,68 m. The plot was surveyed with a terrain contour level equalling to 20 sm. The data of the survey were used to make a digital elevation model (DEM). The plot has a undulated relief with a general surface slope in southern and southeast directions, with some depressions ranging from dozens of centimeters to several meters and 20-40 cm deep, in which groundwater comes up straight to the surface in spring.
137Cs distribution was investigated using field radiometry survey by different steps: 10m for the total plot, and 2 m for the two local plots with the size of 10x10 m, and 0,5 m step for a subplot with the size of 3x4 m. The total quantity of measuring points was more than 200. For the total plot 137Cs mean value was 950 kBq/m2, min – 463 kBq/m2 and max- 1706 kBq/m2. Local plot in the depression, was characterized by the following levels of the 137Cs pollution: mean, max and min value accordingly were equal 682, 1280, 281 kBq/m2. At the initial period of the accident at the Chernobyl NPP (April-May 1986) the quantity of 137Cs water soluble form could reach 50%, therefore 137Cs could have been carried out because of a surface and subsurface water flow.
The dependence of 137Cs distribution on microrelief has been examined. Values of Laplace operator obtained for a detailed (step of 0,1 m, Laplace1) and a generalized grid (step 0,25 m, Laplace2), as well as altitude were regarded as parameters which control 137Cs redistribution. Negative Laplacian corresponds to wash-out zones (convex microrelief) while positive Laplacian corresponds to accumulation zones (concave microrelief). To determine the relation of 137Cs distribution to the mentioned relief parameters, general additive models were used. According to results of modeling using a detailed and a generalized grid it has been found (Linnik, Saveliev et.al., 2007), that in accumulation zones (depressions) 137Cs deposit was lower when Laplace operator was positive (Laplace1>0=915 kBq/m2; Laplace2>0=921 kBq/m2) than in wash-out zones, singled out by negative values of Laplace operator (Laplace1<0=978 kBq/m2; Laplace2<0=979 kBq/m2). The inversion effect revealed in 137Cs deposit distribution could not be accounted for be processes of surface 137Cs wash-off as the chain of depressions was isolated. We found that connectivity of subsurface moving soil moisture saturation was made up by a number of small and shallow channels, covered by litter, they served as 137Cs travel paths at the period of spring wetting in April-May 1986. The total 137Cs output in soluble form from this plot calculated for the two models was 5,9% and 6,4%.

References:
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