Vertical profiles of Cs-137 in soil of the Matua Island (the Central Kuril Islands, Russia) in 2017

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The 2011 Fukushima-Daiichi nuclear power plant (FDNNP) accident resulted in the atmospheric releases of large quantities of man-made radionuclides. According to [1], Matua Island, located at a distance of more than 1000 km from FDNPP, was also subjected to minor radioactive contamination. Matua Island, 52.6 sq.km, a recent volcano with the highest point of 1446 m a.s.l. is located in the center of the Kuril Islands Arc. Volcanic soils are formed on stratified gravelly-stony tephra more than 60 cm thick, underlain by thin layers of volcanic slags. The latest catastrophic eruption which changed the landscape of the island occurred in 2009.

Studies of the vertical distribution of the Cs-137 in soils were carried out on four landscape catenas. The length of the catenas from the sea shore deep into the island ranged from 700 m (maximum height a.s.l. 70 m) to 3.3 km (height a.s.l. 450 m).

Soil core samples were taken in summer 2017 at a depth of tephra, which was located at a depth of 10 to 25 cm. Soil was sliced into separate layers with a step of 2 to 5 cm.

The measurement activity concentrations of the Cs-137 in the soil samples were carried out on a low-background gamma spectrometer Canberra Industries. The counting time was fixed not less than 24 h to ensure that the statistical measurement error is small.

Cs-134, the "Fukushima" fallout marker, due to the decay, was not detected. Therefore, it is difficult to accurately assess the Cs-137 contribution from the FDNNP accident from a global fallout.

The vertical distribution of Cs-137 is characterized by extreme heterogeneity, which reflects both the primary fallout conditions and the landscape conditions of the likely lateral redistribution. For catena 1 with a length of 1 km and an altitude of 400 m, the number of pickets (P0, P1, etc. – the numbering of pickets goes downhill), the specific activity of Cs-137 (Bq/kg) and the depth of the layer (cm) are given as follows: P0 - 27 Bq/kg (2-4 cm); P1 - 64 Bq/kg (6-8 cm); P2 – 70 Bq/kg (8-10 cm); P3 - 53 Bq/kg (4-6 cm); P4 - 15 Bq/kg (0-5 cm). Similar spatial heterogeneity of the specific activity of Cs-137 and its depth penetration was also found for catena 3 with a length of 1250 m and a height of 75 m (the numbering of pickets goes up the slope): P1-137 Bq/kg (17-20 cm); P2-76 Bq/kg (0-5 cm); P3 - 35 Bq/kg (0-4 cm); P4 - 43 Bq/kg (3-6 cm); P6 – 24 Bq/kg (5-10 cm).
The distribution of Cs-137 in individual soil layers was used to evaluate the empirically found shapes of the vertical profiles of radionuclide concentration. Cs-137 is believed here to be a very valuable tracer that can be used to test variability of vertical geochemical migration in Matua landscapes.
