RADIONUCLIDES MIGRATION IN SOILS OF DNIPRO' RESERVOIRS COAST

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Abstract

The migration of radionuclide (^{137}Cs), dropped out after Chernobyl accident on a surface of soils in Kyiv and Kaniv reservoirs area, to a great extent depends on properties of soils. In out previous publications the influence of soil acidity neutralization on radionuclide mobility in waterlogged soils was shown. At the same time there was insufficiently proved a judgment about partial radionuclide accumulation in a capillary fringe of waterlogged soils. The new data confirm this conclusion.

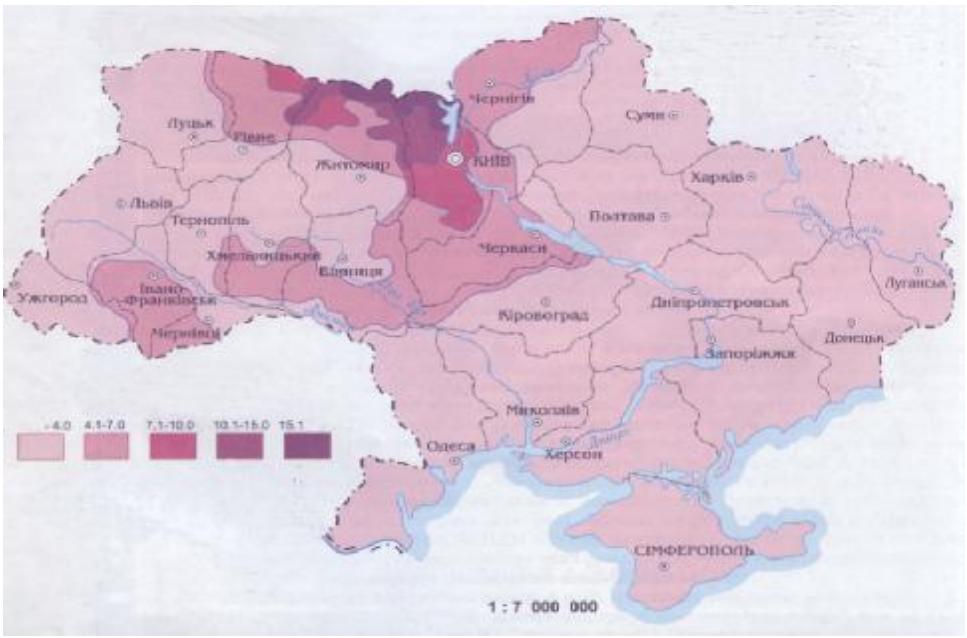
The cases of deeper (till 40-50 cm) radionuclide penetration downwards on a profile of hydromorphic soils are marked at very close ground water level. Research of swampy organic (peat) soils on the left bank of Kaniv reservoir (in the Trubizh river valley) has shown essentially large radionuclide mobility in comparison with the published data. It can be caused by an alkaline reaction of soils. The cases of radioactive pollution of reclaimed hydromorphic soils are revealed also in connection with reclamation agents (phosphor-gypsum) and fertilizers application. The especial attention is deserved with a problem of probable destruction (abolition) of the Kyiv reservoir, in the bowl of which the huge amount of radionuclide in bottom sediments is saved. Inevitable after a water descent the water and wind erosion of bottom sediments will involve radioactive elements in an active circulation in landscapes and in the next reservoirs (Kaniv and others) pollution.

Introduction

After Chernobyl accident the radionuclide pollution of the territory along the Kyiv reservoir coast is predominantly 1-5 and 5-10 Ci/km^2, and along the Kaniv reservoir coast – 1-5 Ci/km^2 or less (Figure 1).

Radionuclides that had fallen on the surface of coastal soils migrate now into soils profiles, in water and deposits of those reservoirs. Some peculiarities of such migration were investigated before (1-3). However, new feature of radionuclide penetration into soil profiles was revealed, and we need to confirm it.

Figure 1. Radionuclide pollution in Ukraine after Chernobyl accident



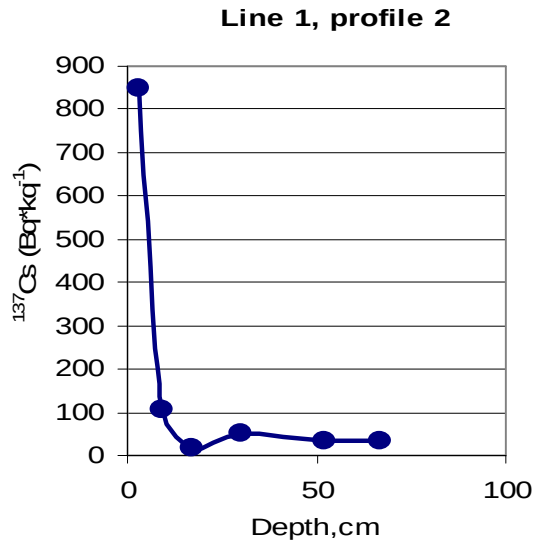
Methods

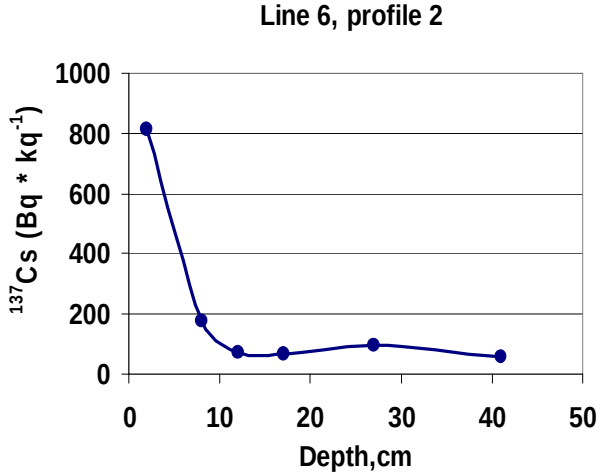
Activity of ^{137}Cs we determined in soil samples on the Universal Radiometer RUB-06-01 at Radiobiology Department of National Agricultural University under Dr. I.N.Gudkov supervision. Soil samples we took on the experimental sites on the coast of Kyiv and Kaniv reservoirs, which are shown in (1-3).

Results

We investigated a radionuclide migration in soils of both low (waterlogged) and high coastal plain. In 1986-2002 in the region of Kyiv reservoir ^{137}Cs have penetrated to the depth 15-25 cm, depending on soil type, organic matter content, soil texture, etc. The majority of the radionuclide was accumulated in a forest litter and a sod as well in the surface 7-10 cm layer of soil (1400-1800 Bq/kg). About one-tenth of the initial amount of pollutants has penetrated 15-20 cm deep, and even lees – 20-25 cm. A rate of radionuclide penetration into soddy-podzolic waterlogged soils depends on soil reaction (acidity) as well (1-3). At the same time we have revealed a slight accumulation of radionuclide (^{137}Cs) in a capillary fringe of the waterlogged soils. Such process take place with the seepage of water from a reservoir to the adjacent territory and afterwards radionuclide migrate (rise) to the lower horizons of the soils (Figure 2).

Figure 2. Radionuclide (^{137}Cs) in soils on the Kyiv reservoir coast (line 1 and 6)





To confirm this process we continued the investigation on the coast of Kyiv reservoir near village of Kozarovychi (Table 1, line 3-v). In both soil profiles we see a slight radionuclide accumulation above the groundwater level.

Table 1. ^{137}Cs activity in waterlogged soils on right bank of Kiev Reservoir, line 3-v (v. Kozarovychi)

Place of samples and data	Depth of samples, cm	^{137}Cs specific activity, Bq/kg
P-1, line 3-v, 05-10-2002	0-4	212
	4-8	254
	8-12	238
	12-17	233
	17-22	230
	22-27	146
	30-50	166
	70-100	145
	100-125	160
	125-150	134
	150-175 (above GWT)	180
P-3, line 3-v, 05-10-2002	0-5	232
	5-10	220
	10-15	240
	15-20	271
	20-25	165
	25-30	151
	30-55	118
	55-65	142
	65-89	152
	89-125	126
	125-150	96
	150-175	55
	175-200 (above GWT)	105

In hydromorphic soils on the coast of Kaniv reservoir radionuclide penetrate much deeper – to 40-50 cm, sometime – to 50-100 cm, and there is a second maximum of the radionuclide in the capillary fringe of soil profile. In order to research this peculiarity more reliably we investigated a radionuclide migration in reclaimed hydromorphic (swampy and peat) and semi-hydromorphic soils in the Trubizh river basin. The results (Table 2) confirm our preliminary conclusion.

Table 2. ^{137}Cs activity in hydromorphic organic (peat) and semi-hydromorphic mineral (meadow- chernozemik) soils on the coast of Kaniv reservoir (river Trubizh basin),

Place of sampling and data	Depth of samples, cm	^{137}Cs specific activity, Bq/kg
P-1, st. Zavorychi, Swampy peat soil, 25-05-2002	0-5	262
	10-15	252
	20-25	88
	50-60	98
	90-95 (above GWT)	96
P-9, v. Prystromy, Swampy peat soil, 20-05-2002	0-5	231
	5-10	347
	10-15	68
	15-20	454
	20-25 (above GWT)	449
Meadow-chernozemik soil, ameliorated with chemicals (gypsum) and drainage	0-5	151
	5-10	113
	10-15	276

v. Lyubertsi, experimental plot, 20-05-2002	15-20	184
	20-25	147
	25-30	157
Meadow-chernozemik soil, v. Lyubertsi, field, 20-05-2002	0-5	134
	5-10	93
	10-15	136
	15-20	147
	20-25	113
	25-30	146

Very important problem arise here because of some scientists recommendation to destroy the Kyiv reservoir. A role played by the Kyiv reservoir and its coastal soils in retention of nuclear pollutants and reduction n of nuclear waste pollution along the entire series (cascade) reservoirs on the Dnipro river is very great. Major part of radionuclides which migrated into Kyiv reservoir was bound by the bottom sediments and this prevented a dangerous pollution of the downstream and the Black Sea. In the case of the reservoir destruction a strong pollution of the environment is possible here because of polluted bottom deposits erosion .

Conclusions

Radionuclide penetration to the depth 15-25 cm into the profiles of soddy-podzolic soils of the Kyiv and Kaniv reservoirs coast takes place under an influence of atmospheric precipitation and depend on the soil type, organic matter content, soil acidity, texture, etc. At the same time a slight accumulation of nuclear wastes is detected in a capillary fringe of the waterlogged soils.

The radionuclide mobility in hydromorphic soils, especially in swampy and peat soils, is much more. Radionuclide penetration here reaches 40-50 cm, some time – 50-100 cm, and there is a second maximum in the capillary fringe (above the ground water level). It can be caused by alkaline reaction of soils and availability of soluble organic substances in soil profile. The depending of reclaimed soils radioactive pollution from reclamation agents (phosphor-gypsum) and fertilizers application was revealed as well.

Probable destruction (abolition) of the Kyiv reservoir, which was recommended by some scientists, is a very dangerous action. In the bowl of this reservoir the huge amount of radionuclide in bottom sediments was accumulated. So, inevitable in this case water and wind erosion of the bottom sediments will involve radioactive elements in active circulation in landscapes and in the next reservoirs pollution.

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