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Efficiency of natural self-purification of ecosystems vs. countermeasures applied at the East-Ural Radioactive Trace (EURT)

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As a result of the radiation accident in 1957 at the Production Association "Mayak" (Russia, the Urals) a fast area (23000 km2), later named the East-Ural radioactive trace, was contaminated. Accidental emission presented by the long-living radionuclides was found to be dominated by Sr-90. In 1967 the EURT area was subjected to a secondary contamination resulting from radioactive sediments transport by wind from "Mayak" technological reservoir, Karachay Lake. Currently, the stock of Sr-90, Cs-137 and Pu-239,240 in the EURT's soil cover consist of 640•10 12 Bq. This study is aimed to compare an efficiency of the countermeasures adopted at the EURT and natural processes responsible for self-purification of contaminated ecosystems. With concern to the principle of ranging the contaminated areas two zones were established: impact and buffer ones. The impact zone is situated near the accident epicenter, i.e. within 2-30 km from of the Trace central axis. After accident this zone was removed from agricultural utilization. The buffer zone has permanent anthropogenic pressure.

The native, undisturbed during the reclamation operations, flow adjacent of landscape sites were chosen within the impact and buffer zones. They included of a watershed area and bank area of the lakes. The impact zone demonstrated the lowest concentration of the radionuclides around the frequently flooded lake shore. Absence of anthropogenic pressure, the high density of the plant cover and deficit of the soil moisture in summer time are the main reasons for decreasing the intensity of the water runoff from watershed. As a result the self-purification processes are dominated around the shoreline soils. The buffer zone is characterized by an opposite regularity appeared in increasing of the Sr-90 content in the soils of the lake shore. In this case, the intensive agricultural utilization of the flat watersheds leads to increase of erosion and degradation processes and, as consequently, to the accumulation of the radionuclides within bank area of the lakes. Analysis of the radionuclides depth distribution in the soil profiles across the watershed area showed about 80-87% of Sr-90 and Cs-137 in account to their total contents are retained in the upper humus layer (0-30 cm). The radionuclides are distributed more or less evenly in the soils of accumulative plots of landscape.

Some countermeasures were taken around the EURT's territory in order to create relatively safe conditions for human habitation, to reduce the background radiation and intake of the radionuclides in the herbaceous plants. One of them is undercutting contaminated layer for a depth of the soil profile. The success of this measure was provided by heavy-loam of the soil texture. Last research of these plots has shown the maximum contamination is still shifted out of the root layer. As a result the first link of the food chain presented by herbaceous vegetation showed significantly lower level of the radionuclides accumulation in comparison to the non reclaimed areas. Another countermeasure connected with removal and disposal of the soil surface layer was used in the resettled villages. In this case, the stock of radionuclides in the soil was shown to be twice lower comparing to the contiguous non reclaimed areas. This fact particularly indicates positive changes occurred in ecosystems around the resettled villages. Thus, the countermeasures developed around the EURT should be considered as successful and effective for achievement of the main task focused on complex improvement of the radiation conditions across the EURT. These countermeasures will be effective in other contaminated areas having the similar characteristics of the soils, landscapes and climate.