Geographic Assistance of Decontamination Strategy Elaboration

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Those who elaborates the strategy of decontamination of vast territorics is to take into consideration the heterogeneity of such elements of landscape as relief, lithology, humidity and types of soils and, vegetation, both on local and regional level. Geographic assistance includes 1) evaluation of efficacy of decontamination technologies in different natural conditions, 2) identification of areas of their effective application and definition of ecological damage, 3) estimation of balances of the radionuclides in the landscapes to create background of the decontamination strategy.

1. Introduction

Geographical assistance is directed to take in consideration of heterogeneity of environmental conditions which determine the efficacy and the ecological consequences of the technologies of decontamination and elaboration of decontamination strategy.

2. Obtained results

2.1. Field trials and evaluation of decontamination technologies

Geographic assistance of experimental trials and of decontamination technologies evaluation includes identification and characterisation of testing plots, evaluation of efficacy of decontamination technologies in different natural conditions and definition of ecological damage.

The program of field trials and ecological evaluation of the decontamination technologies includes identification and characterisation of testing plots, evaluation of efficacy in different natural conditions and definition of ecological damage. Soils, surface deposits, relief and vegetation cover of field experimental plots were identified, and efficacy of the technologies depending of natural conditions was evaluated. Thus the areals of most effective expected application of the technologies tested were defined.

On the basis of geosystem analysis of the field trial results special map shoving the application areals of turfcutter soil decontamination technology, urban decontamination technologies and rotating brush removal of the forest litter is prepared for the evacuation zone of Chernobyl NPP. The map shows natural units (areals) with certain combinations of relief, lithology, soil and vegetation conditions, which are supposed as areals where

effectiveness of decontamination by the technologies mentioned will correspond to results discovered during experimental field trials.

Best natural conditions for application of turfcutter technology are obtained in non-ploughed grasslands with thick turf layer and composed mineral or organic soil horizon of high and intermediate humidity. Among them gleic soddy-podzolic, soddy and alluvial loamy and sandy-loamy soils, covered with meadows or long-fallow grass vegetation and especially drained organic (peat bog) soils of flood plains and lowered river terraces. Good results of this technology are corresponding to semi-gleic and non-gleic soddy and soddy-podzolic sandy-loamy soils. Damage of the ecosystems is minimal because of fast vegetative selfrestoration of ground cover.

At the same time results of the turfcutter technology on poor, dry sandy podzolic and soddy soils with sparse grass cover and thin mat are not very good: turf mat can't be rolled. Simultaneously areals of some special types of forests, swamps and sandy areas, which are shown on the map, can't be decontaminated using a technology evaluated in the frame of ECP-4.

2.2. Evaluation and mapping of local balances of the radionuclides

Any decontamination strategy for large territories has to take into consideration the direction and intensity of natural processes of migration of the radionuclides which influence the formation of their regional and local balances and therefore self-decontamination (or self-contamination) of the natural areals. Processes of redistribution of the radionuclides vary depending of such stable components of landscape as relief, lithology and soils, and variable ones as vegetation cover. Areals with negative, neutral, or positive balances of the radionuclides are defined on the maps.

The balance of radionuclides in the landscapes reflects the ability of the natural systems to "evacuate" the pollutants. It can be negative, positive or neutral. Landscapes which occupy high levels of relief, normally are characterised with negative balance. They are geochemically autonomous, and their balance depends only of the intensity of natural evacuation of the pollutants. The landscapes with positive balance (depressions, valleys etc.) are under geochemical influence of surrounding territories, which belong to the same watershed basin.

Attention should be taken also on tendencies and intensity of natural evolution and self-restoration of the landscapes in Chernobyl zone which started after the evacuation of population and sufficient modification and limitation of human activity. It caused intensive development of plant succession processes which modify initial ploughed lands, meadows and cultivated forests into relatively stable forest ecosystems according to edaphical conditions of territory. Self-restoration of vegetation, accumulation of phytomass, deconsolidation and self-restoration of soils decrease washing-off and increase infiltration.

Maps of local balances of Cs-137 in ecosystems of Chernobyl zone are created by overlaying the map of natural landscapes and maps of vegetation successions. Maps were elaborated by computer using PC View Color and Adoba Photoshop 2,5 softwares.

Long-term balance of Cs-137 was evaluate taking into account the direction and velocity of the plant successions and landscape selfrestoration processes which are obtained in evacuation zone. According to our elaborated succession model, this processes, in

collaboration with human activity, shall create dense forest cover at present long fallow grasslands, dry meadows territories and settlements during 50-80 years.

Influence of vegetation on washing-off balance of the radionuclide is expected semi-homogenous for the territory of evacuation zone after restoration of the forest cover. Expected long-term changes of spatial structure of balance of Cs-137 in landscapes of the territory shall be connected with decreasing of role of washing-off processes as result of fixation of the soil surface by forest vegetation. Proportion of areals of Chernobyl zone with different balances in the short- and long-term aspects is presented on the Figure 1.

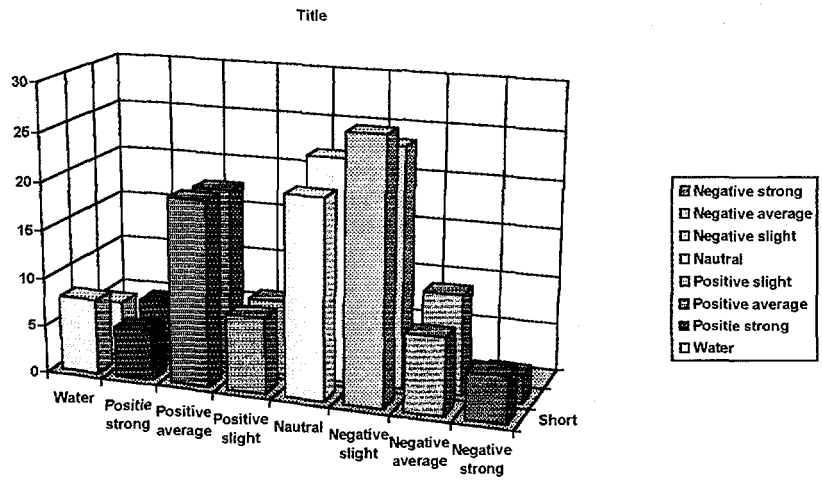

Fig. 1. Landscape areals (% of territory) with negative, neutral and positive short-term (up to 50 years after the accident) and long-term (more than 50 years) balances of Cs-137

The figure shows that evolution of the situation is under influence of natural landscapes restoration. Areals with **strong negative balance** which cover 4,7% of territory for sort-term evaluation decrease to 2,8% for long-term one. **Average negative balance** of Cs-137 is expected for 7,9% of the territory in short-term aspect and for 10,4% in long-term. **Slight negative balance** is expected for 27,1% of territory in short-term evaluation and for 24,7% - in long-term. Generally landscapes with negative short-term balance of the radionuclide occupy about 39,7% of estimated territory, and with long-term - 37,9%. It means that more than one third part of Chernobyl zone proclives to lose Cs-137 by washing-off.

Neutral balance is expected for territories of the river terraces, which are characterised with sandy deposits, flat or hillock surfaces and very few washing off. Together with water surfaces and industrial areas, neutral balance areals cover 20,6% of the territory for short-term evaluation and 23,1% for long-term one. The increasing of this category and decreasing of **water surface** from 7,9% to 5,9% in future is connected mainly with future drainage of cooling pond of NPP and annexation of its territory to ones with neutral balance.

Areals of **positive balance** of Cs-137 are identified in Chernobyl accident zone with closed depressions, watershed catchments, elements of erosional network and rear lowered parts of river terraces and flood plains. **Positive short-term balance** of the radionuclide is expected for 32,3% of territory of 30-km zone, and long-term one - for 33,1%. Landscapes with **strong positive balance** cover about 5,2% in short-term evaluation, and about 6,4% - in long-term one. Expected increasing of this category and corresponding decreasing of category of **average positive balance** from 19,2 to 18,9% from short-term to long-term evaluation can be explained by intensive restoration of the forest vegetation during future 30-50 years.

Thus, territory of 30-km zone of Chernobyl NPP is divided in three approximately equal parts. One of them is self-decontaminating. Radionuclides are directed from here to second third by natural processes of washing-of. The last third does not participate this processes. Countermeasures can be planned for the last one without taking into consideration processes of self-decontamination. The estimations presented here are in good correspondence with field radiogeochemical experimental data.

The proposed above evaluation is qualitative one. Using experimental data its quantitative interpretation can be made. The physical decay of the radionuclides is also to be taken into account.

3. Discussion

Maps of short-term and long-term balances of radionuclides 1) show localisation of places, 2) explain the factors of their concentration and therefore stability of the radioecological situation in 30-km zone of Chernobyl NPP, 3) reflect the increasing of this processes in time. This conclusion combined to prepared maps can be used as background for evaluation of intensity and direction of processes of natural redistribution of the radionuclides. Also it can be used for elaboration of general conception of decontamination strategy and for preparation of decisions related to application of the countermeasures.

Depending of the development of natural processes, long-term rehabilitation strategy can be recommended for application at landscapes with positive long-term balance of the radionuclides. These landscapes can be proposed also as depositories for radioactive soil material generated from the application of countermeasures.

Moreover, evaluation of long-term efficasy of the decontamination technologies has to take into consideration both regional (local) balances of radionuclides, and intensity of natural processes of self-decontamination, especially for the zones of negative balance.

On the stage of elaboration of spatial aspects of decontamination strategies the maps of balance of the radionuclides in the natural landscapes can be useful to determine places of recommended soil (litter) removal and their relocation. One of possible strategies can be based on artificial relocation of the radionuclides to the zones of natural accumulation.

In addition to well known economical and dosimetrical criteria of cost-benefit analysis, some ecological criteria are to be considered. First one is to evaluate the cost of ecological consequences of decontamination, if damage of the ecosystems takes place. Second one is to extend the analysis of cost-benefit proportions for the period of total restoration (artificial or natural) of initial landscapes and ecosystem conditions.