

Tatjana Myshlion

Belarus
Research Institute of Radiology
16 Fedyuninsky str.- Gome 246000
Belarus

Problems of the agricultural use flood-plain landscapes of byelorussian polesye, contaminated by radionuclides (with the example of the river sozh flood-plain)

There is explored geochemical allocation of ^{137}Cs and ^{90}Sr in a river valley Sozh for the definition of possible ways of optimization use of agricultural landscapes in flood-plain landscapes.

Introduction

The accident on Chernobyl NPP was by the reason of contamination of territory Byelorussian Polesye by long-lived radionuclides. During 16 years the natural vegetation flood-plain landscapes develops in conditions of an increased background radiation. Most biologically dangerous radionuclides now are ^{137}Cs and ^{90}Sr . They have a major half-life period (30 and 28,5 years) and high biogeochemical migration in system water - ground - plant [1]. The landscape approach to analysis of an ecological situation, forecast of change and development of the propositions on of optimization is determined by that the formation of a field of pollution both at a stage of primarily falling of radionuclides, and during their secondary redistribution occurs immediately in a landscape and under influence of the natural factors. The question on agricultural use of flood-plain landscapes is important. As in territory of three areas, contaminated by radionuclides (Gomel, Brest, Mogilyov), of a flood-plain meadow are by an essential source of grassy forages for cattle. In Republic Belarus about 245 thousand hectares alluvial soil have contamination density of ^{137}Cs more than 37 kBq/m² [4]. Are polluted with radionuclides the flood-plain of the rivers Pripyat, Sozh, Dnieper, Goryn, Ubort, Iput, Berezina and others.

In this work investigate a landscape - geochemical distribution of ^{137}Cs and ^{90}Sr in valley river Sozh for the subsequent determination of the possible ways optimization use of the agricultural landscapes in limits flood-plain. One of primal problems of investigation - on the basis of geochemical structure flood-plain landscape to mark out geochemical barriers, which accumulating chemical elements, including radionuclides and to exclude this areas of flood-plain from agricultural use.

The geochemical barriers are section of sharp changing of a geochemical situation, which one results in precipitation of migrating chemical elements [2]. The barriers can be mechanical, biogeochemical and physicochemical.

The mechanical barriers are created as a result of changing of loose soil with dense.

The biogeochemical barriers characterize ability of alive organisms to retain chemical elements during a long time.

The excretion of physicochemical barriers is based on changing of physical and chemical requirements of migration. Distinguish more than 10 views on this type of barriers. But in flood-plain landscapes most wide-spread neutral and sorption. Neutral, or calcium, the barrier is formed at presence of carbonate rocks and stop migration of strontium, calcium and iron.

The sorption barrier is expressed in landscapes with high keeping in ground of colloid particles (humus, clay). It can precipitate practically all elements meeting in a solution in the ionic form [3].

Objects and methods investigation

The object for the investigation was flood-plain of river Sozh near village Novoselki and Raduga Gomel region. It is the most polluted site of the river. The level of pollution ^{137}Cs varies from 185 up to 2220 kBq/m², ^{90}Sr up to 111 kBq/m². The investigations were carried out in 2000 - 2002 years.

The agrochemical indexes are determined in soil samples of the upper horizons of soil on the working standard procedures. ^{137}Cs specific concentration in soil samples, vegetation

and samples of water were measured using spectrometric complexes Canberra and Oxford. Measurement error was not higher than 15%. The results of measurements were statistically processed using dispersion analysis built in software (Excel 7.0). Radiochemical output of ⁹⁰Sr was carried out using standart tehnique with final measurements on alpha&beta counter "Canberra – 2400".

By results of definition of the content ¹³⁷Cs and ⁹⁰Sr coefficient of accumulation is counted: $Ka = (\text{concentration } ^{137}\text{Cs or } ^{90}\text{Sr in plants, Aq/kg}) / (\text{concentration } ^{137}\text{Cs or } ^{90}\text{Sr in soil, Aq/kg})$.

Results and discussion

The accumulation of radionuclides by vegetation of a water-meadow depends on many factors. Main of which are a type of ground and level of natural fertility, view of vegetative association, requirements of humidifying etc. The soil and vegetative integument of a flood-plain is rather manifold and depends on character of a relief and part of a flood-plain.

In the flood-plain landscape is separable flood-plain at bed (sandbank and swell at bed), central flood-plain, flood-plain at terrace and first terrace over flood-plain.

On the flood-plain at terrace, former river-bed and sometimes on depressings of the central flood-plain there are peat soils; first terrace over flood-plain has of sod-podzol soils; on the flood-plain at bed and central flood-plain is sod - gleyey and gley soils. The sandbank is occupied of the willow bush. The swell at bed has a higher relief and is occupied of the motley grass -cereal association. The rises of the central flood-plain are occupied in water-meadow, with motley grass - cereal -leguminous association.

The depressed of central flood-plain is introduced motley grass - sedge association. The flood-plain at terrace has a depressed relief, is characterized motley grass - horse-tail - sedge association and willow - alder bush.

The natural vegetation first terrace over flood-plain is introduced motley grass - cereal association. The investigations have shown, that ⁹⁰Sr in comparison with ¹³⁷Cs migrate into plants more intensively. The differences in Ka reach 4 – 47 times (fiig.1).

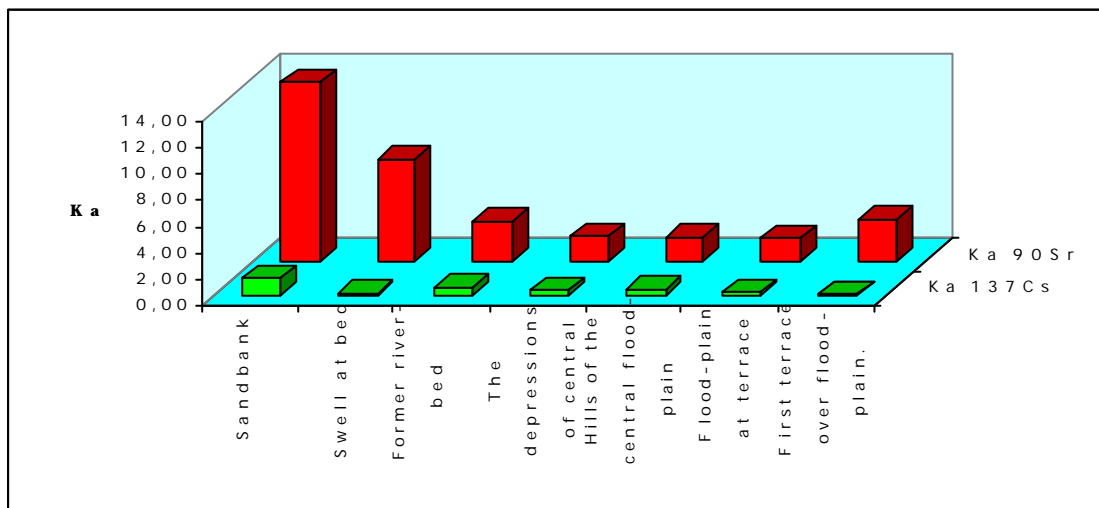


Fig. 1. The distribution of coefficient accumulation of ¹³⁷Cs and ⁹⁰Sr in flood-plain landscape on river Sozh (average measures for 2000-2002 years of investigation).

It is explained by a various degree of their fastening in ground. And also differences of chemical composition of a grass, grow on various parts of flood-plain and with selective ability of plants. Plants, which one absorb a lot of calcium, absorb more ⁹⁰Sr, than plant by poor calcium.

Most of all ⁹⁰Sr accumulate leguminous vegetative associations, it is less cereals and sedge. Plants, which one contain more potassium, accumulate ¹³⁷Cs more.

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On diminution of the content ^{137}N s in vegetative associations of a flood-plain landscape it is possible to construct the following series: sedges < cereals < leguminous.

On a degree of diminution of entering ^{90}Sr they dispose in the following order: leguminous < cereals < sedges.

There are registered the higher concentrations ^{137}Cs on a mechanical geochemical barrier in flood-plain landscapes on the border between sandbank and swell at bed; on biogeochemical and sorption barriers on former river-bed and biogeochemical barrier on flood-plain at terrace (Fig.2).

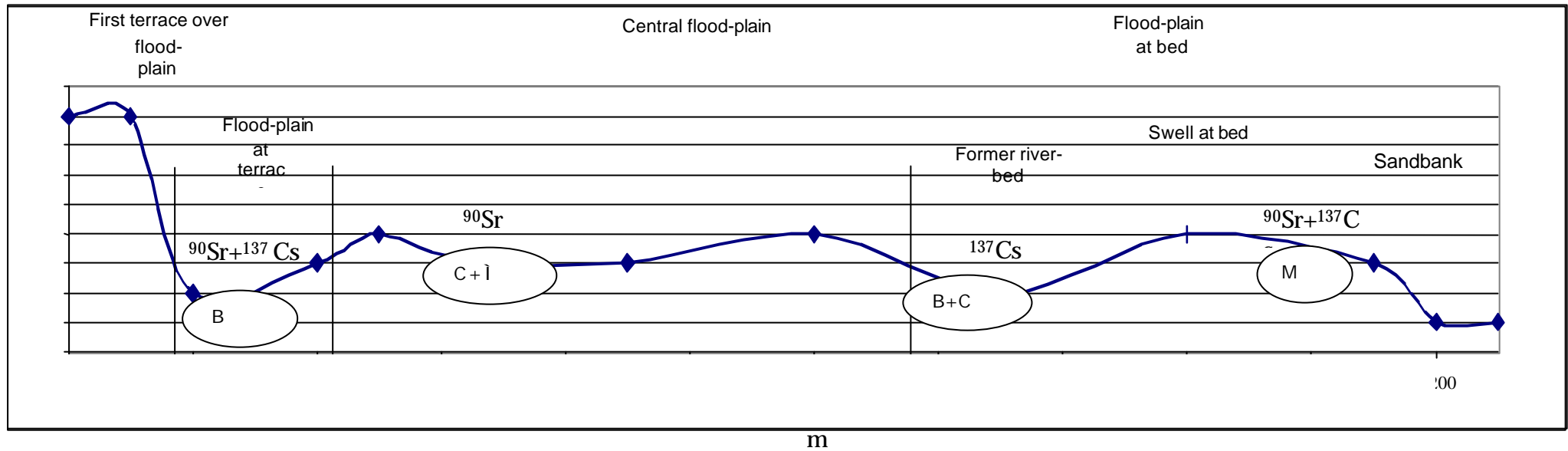
^{90}Sr is accumulated mainly on a mechanical geochemical barrier on the border between sandbank and swell at bed; on sorption and mechanical barriers on the border between high and low parts of the central flood-plain and sorption barrier on flood-plain at terrace (Fig.2).

The ways of optimization of use pasturable and hayland, polluted by radionuclides are offered by eduction of geochemical barriers (sites with higher concentrations ^{137}Cs and ^{90}Sr on account of some geochemical property this territory) in flood-plain and exception this sites from agricultural use. It can low entry the radionuclides in fodder for animal on 38-40%.

And also we elaborated the recommendation on optimal to use for each facies of the flood-plain landscape for decrease of entering of radionuclides in forages for animal with calculation of spatio-temporal differentiation of allocation of radionuclides (the differences in accumulation herbage in hay harvest and after-grass).

This recommendation can be used for natural pasturable and hayland in flood-plain landscape in the absence there of economic opportunities for counter-measure, directional on improvement fodder grounds.

On flood-plain, used, as the haymaking, where is used in basic central flood-plain because of the peak productivity, is recommended to use only high sites. It is necessary to do only first hay harvest (June), because the after-grass (July, August) accumulate considerable quantity ^{137}Cs .



M – Mechanical barrier
B – Biogeochemical barrier
C – Sorption barrier

Fig. 2. Geochemical barriers of a geomorphological profile flood-lands landscape.

Flood-plain at terrace is necessary to exclude from use over of waterlogged, overgrown with shrubs and predominance on sedge associations, not suitable for forages of cattle.

On Sandbank can not be used because of strong overgrown with shrubs, and Swell at bed can be used only for first hay harvest (June).

If depressions of central flood-plain is not waterlogged and vegetative integument has not less than 45-50 % of valuable fodder grasses (cereal and leguminous) in depending on the content of radionuclides in a grass the opportunity of use for production of forages is determined:

- The content ^{137}Cs in green mass of grass up to 165 Bq/kg, ^{90}Sr up to 37 Bq/kg (hay: ^{137}Cs up to 1300 Bq/kg, ^{90}Sr up to 260 Bq/kg) - the forages are usable without restrictions;
- The content in green mass of grass ^{137}Cs up to 600 Bq/kg, ^{90}Sr up to 185 Bq/kg (hay: ^{137}Cs up to 1850 Bq/kg, ^{90}Sr up to 1300 Bq/kg) the forages are suitable for deriving milk for obligatory processing on sour cream and oil;
- The content in green mass of grass ^{137}Cs no more than 240 Bq/kg (hay: ^{137}Cs up to 1300 Bq/kg) – this forages is possible to use for fattening of cattle at a final stage.
- The content in green mass of grass ^{137}Cs more than 600 Bq/kg, ^{90}Sr more than 185 Bq/kg (hay: ^{137}Cs more than 1850 Bq/kg, ^{90}Sr more than 1300 Bq/kg) the forages are unsuitable for agricultural use without application of land treatment [4].

At prevalence sedge associations, which are characterized by increased accumulation of radiocaesium in comparison with other associations at a level of pollution ^{137}Cs 1300-1850 Bq/kg it is possible to use as silage for fattening of cattle at a final stage.

At use flood-plain of a landscape as a pasture, on central flood-plain it is recommended pasture only on rise sites, restricting access of cattle to depressions by an establishment of fences. The optimum quantity to pasture no more than two times and only during a beginning vegetation

It is possible to use depressions central flood-plain, on conditions that of the content of valuable forages and levels of pollution mentioned above for fattening young cattle (calves).

The flood-plain at bed is recommended to use only during a beginning of vegetation (June), because is observed increase of the specific activity in August, is especial on swell at bed.

Flood-plain at terrace is necessary to exclude from use as pasture over of waterlogged, overgrown with shrubs and predominance on sedge f associations, not suitable for forages of cattle.

Use of the this recommendation in region, polluted ^{137}Cs and ^{90}Sr will help to lower transition of radionuclides in forages for animal and, accordingly, internal dose exposure to radiation on the population, because milk and meat are one of basic dose-forming of stuffs.

References

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