

ECOLOGO-RADIOLOGICAL STUDY AREA AT BRYANSK REGION (RUSSIA)

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ABSTRACT

This article describes an ecologo-radiological study area established by the Russian Scientific Research Institute for Civil Defence and Emergencies in radiocontaminated territory (Bryansk region, Russia). The data on radionuclide contamination for experimental sites located under different soil and landscape conditions is given. The major kinds of scientific, research-and-practical as well as international activity that are put into practice at the study area are discussed. A brief review of some investigations and international programs which were carried out at the ecologo-radiological study area is given.

KEYWORDS

Ecologo-radiological study area, experimental site, inhabited locality under control, radiocontamination, contamination density, radionuclide, migration.

The ecologo-radiological study area has been established by the Russian Scientific Research Institute for Civil Defence and Emergencies (RSRICDE) and officially approved by a Decree of Administration (Bryansk region) to carry out scientific and practical works for the solution of various problems related to surmounting the consequences of the Chernobyl disaster and other radiation accidents. The study area is located in a radiocontaminated territory (Bryansk region). Its boundaries are restricted by 52.20° n.lat. in the south, 52° e.long. in the east as well as by the Russian frontier in the west and in the north. The study area is an inalienable territorial part of the region, the territory being under the management of the local services, organizations and production units where experiments may be carried out.

At present the ecologo-radiological study area consists of a combination of experimental sites as well as several inhabited localities under control that are situated at the radiocontaminated territory, the territory being used for different production purposes. This territory includes all zones of radiocontamination within the limits of the most typical soil-and-landscape conditions as well as a complex of entities for laboratory and everyday (service) use. In Figure 1 given below the arrangement of the experimental sites constituting the study area is shown.

Investigations of radiocontamination at these experimental sites have demonstrated that the total contamination density by radionuclides ranges from 250 kBq/m² to 2260 kBq/m², the contribution of

Ru 106, Sb 125, Cs 134, Cs 137 radionuclides being, on average, 0.04%, 0.51%, 1.75%. 97.7%, respectively. The radioactive contamination at the experimental sites has been formed basically as a result of the fallout from condensation forms. The contribution of fuel component to the activity is small, for instance, 1.0-1.3% for Cs137. The values of contamination density with strontium and plutonium radionuclides are 7.5 kBq/m^2 - 25.8 kBq/m^2 and 0.1 kBq/m^2 - 0.4 kBq/m^2 , respectively. In Table 1 given below the average values of contamination density at 19 experimental sites are given. All data is presented for 01.01.97.

An experimental site represents a typical portion of territory to be investigated, of about $100\times 100\text{ m}$ area which occupies one element of the relief mesoform (for instance, hillside) or a portion of field or forest which affords uniformity in landscape-and-geochemical conditions and radionuclide composition throughout its extent.

An inhabited locality under control represents an area where a population lives constantly and where socio-economic and medico-demographical conditions are typical of radiocontaminated territory.

The complex of entities for laboratory and everyday (service) use is situated within the territory as well as within the buildings of the Novozybkov branch of the Russian Research Institute for Fertilizers and Agricultural Soil Science (RRIFASS). It consists of:

- laboratory base including chemical, spectrometrical, radiochemical, sample preparation, data acquisition and processing laboratories equipped with up-to-date analytical instruments;
- entities of everyday (service) use that represent buildings where conferences and seminars are held as well as buildings for specialists' reception, accomodation and dining;
- cars.

The operation of the study area attempts to solve the following groups of problems:

Scientific-research problems:

- investigation of radionuclide transformation, migration and forms of presence in different environmental media, including burials of radioactive wastes.
- elaboration and verification of models of radionuclide behaviour in different environmental media;
- verification of coefficients of radionuclide transfer in the following systems: "soil-plant", "soil-forest products" as well as verification of resuspension coefficients under different meteorological conditions and during agricultural operations;
- efficiency evaluation of diverse protective and restoration measures;
- study of dynamics of variations in a radiation-hygienic situation;
- creation of a large-scale geoinformation system.



Fig. 1 Arrangement of the experimental sites (numbered) constituting the study area.
Average values of contamination density at the experimental sites.

Table 1

Site number	Average value of contamination density, kBq/m ²			
	Ru 106	Sb 125	Cs 134	Cs 137
1	0.26	3.1	12.5	673
2	-	2.1	8.6	485
3	0.49	7.4	29.5	1638
4	-	4.1	24.2	1350
5	0.25	3.9	14.6	816
6	0.4	7.0	17.5	972
7	-	3.6	18.2	684
8	-	5.9	18.4	1017
9	0.34	5.3	20.1	1107
10	-	1.7	5.9	326
11	0.04	2.0	6.8	382
12	-	1.1	4.3	244
13	0.58	6.8	22.4	1242
14	0.78	10.6	39.6	2205
15	0.81	8.9	31.9	1762
16	0.70	8.9	29.0	1588
17	-	4.9	20.6	1125
18	0.57	5.2	15.2	851
19	0.32	6.1	21.7	1332

Research-and-practical problems:

- calibration of instruments and modern equipment under natural conditions;
- carrying out of natural-scale experiments for the estimation of characteristics of surface and overground means used in radiation surveys;
- elaboration of optimal recommendations on provision of economic and rehabilitation activities at radiocontaminated areas;
- elaboration of models for decision-making at radiocontaminated areas;
- elaboration of techniques for provision of economic and rehabilitation activities.

International activities:

- provision and putting into practice of international programs on investigation and alleviation of consequences resulting from radiation accidents;
- implementation of international programs relating to intercalibration, verification of data and models as well as carrying out of examinations;
- organization and holding of international symposia, conferences and seminars;
- compilation of bilingual data bases on the whole complex of scientific problems in compliance with approved standards;
- ensuring effective exchange of information by translation and publishing of the relevant materials;
- solution of the total set of problems concerned with reception and accommodation of foreign specialists.

In the period from 1991 to 1996 within the territory of the ecologo-radiological study area a number of investigations and international programs have been carried out.

For example, in 1992 "Joint Russian-German Measurement Program on Determining Radiation Loads at Radiocontaminated Regions in Russia" [1] was carried out. It was demonstrated that Cs137 intake for the population of different age groups (averaged for the inhabited localities under consideration) living at the investigated districts (Bryansk region) ranged from 5 nCi to 874 nCi for the whole human body, the internal exposure dose being 14 μ Sv/yr-1049 μ Sv/yr. Based on the experimental data an unequivocal relationship of territorial contamination Cs137 density to Cs137 total human intake for people living at this territory has been derived. The investigations of Cs137 contamination of food-stuffs produced at personal subsidiary holdings have demonstrated that the ranges of Cs137 concentrations in the major food-stuffs were as follows:

- milk: 2 Bq/l to 1354 Bq/l;
- potatoes: 2 Bq/kg to 140 Bq/kg;
- vegetables: 2 Bq/kg to 140 Bq/kg.

In 1994 within the framework of ECP1 international program titled "Contamination of surfaces by resuspended material" [2] full-scale experiments on investigating man-made dusting during agricultural operations under working conditions were carried out. The data obtained has become the basis for regulating agricultural operations at radiocontaminated areas.

At the experimental sites included in the study area comprehensive radiation-ecological investigations of radionuclide behaviour in different environmental media are constantly carried out [3]. Based on this work, models for radionuclide migration within soils and in "atmosphere-underlying surface-surface waters" systems have been elaborated and parametrized. The same models have been used for predicting Cs137 and Sr90 radionuclide redistribution under diverse soil-and-landscape conditions as well as for prediction of variation of the exposure dose rate because of radionuclide penetration into depth. It has been shown that for hydrological objects the periods of reduction in the radionuclide concentrations by a factor of 2 were as follows:

- 8 years for Cs137 in river water,
- 10 years for Sr90 in river water,
- 10 years for Cs137 in lake water,
- 15 years for Sr90 in lake water.

In conclusion it should be mentioned that all interested organizations may become participants to works at the ecologo-radiological study area in Bryansk region (Russia) taking into account the scope of the problems they are interested in, on the basis of joint programs and projects.

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Projects To Be Submitted For Possible Joint Investigations

Project 1. Modelling of radionuclide behaviour in soil ecosystems

Objective:

Elaboration of models for quantitative characterization of radionuclide behaviour under different soil-and-landscape conditions and prediction of changes in radiation situation.

Tasks:

1. Experimental investigation of parameters of vertical radionuclide distribution at the natural sites of Bryansk radioecological study area (Russia) regarding their forms of presence at the study area.
2. Ranging of soil ecosystem factors in compliance with their influence on the migration process under different soil-and-landscape conditions.
3. Elaboration and/or parametrization of models of long-lived radionuclide (cesium, strontium, transuranic elements) behaviour in soil ecosystems.
4. Prediction of changing the radiation situation due to vertical radionuclide migration in soil depth.
5. Recommendations on near-to-surface burial of radioactive wastes.

Project 2. Provision of measures on comprehensive protection of the liquidators while handling radioactive wastes resulting from alleviation of impact of radiation accident.

Objectives: Working out of methodological basis and substantiation of measures on provision of the radiation safety for the liquidators engaged in alleviation of impact of radiation accidents.

Tasks:

1. Working out of methodology for prediction and assessment of radiation exposure for the liquidators in the course of alleviating the impact of radiation accidents taking into account all the kinds of operations.
2. Working out of recommendations on choice and substantiation of procedures and methods for handling radioactive wastes during radiation accidents (on the basis of experimental investigations of low-active burials of radioactive wastes in Bryansk region).
3. Experimental investigations for determination of radionuclide migration parameters from burial locations of radioactive wastes that occurred during alleviation of impact of the ChNPP accident at the Russian territory.
4. Safety estimation for near-to-surface burials of radioactive wastes regarding possible radionuclide migration into the environment.
5. Working out of recommendations on monitoring radioactive waste burials for assessment of radiation risk for the population.

Project 3. Management of countermeasures on protection of population on the basis of risk analysis at all stages of the radiation accident progress.

Objective: Working out of methodological basis and computerized system for management of countermeasures aimed at population protection at all stages of radiation accident.

Tasks:

1. Working out of methodological basis for assessment of risk to the population in the course of a radiation accident. Subsequent zoning of the area in compliance with this aspect.
2. Working out of methodological recommendations on optimization of protective and restoration measures taken at the affected territory on the basis of risk analysis.
3. Working out of methodological recommendations on estimation of social-economic losses. Insurance against the economic losses in case of the radiation accident.
4. Working out of methodology for assessing the expediency of territorial investments on the basis of risk analysis.
5. Testing of the methodological approaches taking into account the experience resulting from the operation of study area (Bryansk region).

Project 4. Decontamination of radioactive wastes

Objective: Decontamination of urban areas and areas of inhabited localities.

Tasks:

1. Analysis of the major misdoings made in the course of decontamination activities during alleviation of impact of the ChNPP radiation accident. Elaboration of recommendations on their prevention in case of potential accidents in the future.

2. Scientific-methodological provisions for high-effective and low-waste procedure on the basis of new materials, the procedure being aimed at:

2.1. Decontamination of buildings, structures and rooms;

2.2. Decontamination and localization of radioactive dust at highways, streets and roads.

2.3. Decontamination of cars, machinery and equipment.

2.4. Decontamination of near-to-surface soil and forest litter.

2.5. Elaboration of an independent low-waste technology for surface decontamination of restricted areas.

3. Experimental investigation of the principal parameters affecting the procedures and features of compounds for localization and decontamination of surfaces contaminated with radioactive isotopes.

4. Elaboration of standard procedures in application to the conditions of putting different decontamination procedures into practice.

Project 5: Methods for reconstruction and prediction of the radiation situation on the basis of long-lived radionuclides.

Objective:

Working out of methods for assessment of the radiation situation on the basis of correlation ratios of the major dose-forming radionuclides.

Tasks:

1. Analysis and substantiation for choice of instrumental methods of determining I129, Cs137, Sr90 in environmental objects.

2. Modelling and determining of correlation ratios for the major dose-forming radionuclides in compliance with the results of experimental estimation of Cs137, Sr90, Pu238,239/240, I129, Am241 in the environmental objects.

3. Methodology for reconstruction of radioactive fallout at the vestiges of various nuclear events, nuclear accidents and explosions and during their phases.

4. Prediction of progress of a radiation accident. Working out of the methodology for predicting variations in the radiation situation.

Project 6: Working out of procedures for assessment of local radioactive contamination under conditions of radioactive accidents on the basis of investigating natural radioactivity accumulators.

Objective: Reconstruction of history, locations and composition of radioactive fallout.

Tasks:

1. Substantiation of methods for sampling of natural accumulators.

2. Working out of procedures for determination of Pb210 (Po210) in bottom deposits to reconstruct the history of radioactive fallout.

3. Working out of the methodology for investigating natural accumulators to analyze the radionuclide composition of radioactive fallout.

4. Working out of the methodology for retrospective assessment of the radiation situation in different areas on the basis of comprehensive analysis of natural accumulators.

1. Analysis of the major methodology needs in the context of documentation and their identification in the context of the Library, including the identification of requirements for their provision in case of potential accidents in the future.
 2. Scientific methodological procedures for high effective and low-cost procedures on the basis of new materials, the procedure being based on:
 - 2.1. Documentation of buildings, structures and areas;
 - 2.2. Documentation and localization of activities that are highways, streets and roads;
 - 2.3. Documentation of cars, machinery and equipment;
 - 2.4. Documentation of near-to-surface soil and forest fires;
 - 2.5. Elaboration of an independent low-cost technology for surface documentation of restricted areas.
 3. Experimental investigation of the principal parameters affecting the procedure and factors of computer for localization and documentation of activities connected with protective technology.
 4. Elaboration of standard procedure in application to the conditions of being different documentation procedure into practice.
- Project 2. Methods for documentation and protection of the radiation situation on the basis of long-lived radioisotopes**
- Objectives:**
Working out of methods for assessment of the radiation situation on the basis of correlation ratios of the major dose-forming radioisotopes.
- Tasks:**
1. Analysis and substantiation for choice of instruments methods of determining ^{137}Cs and ^{90}Sr in environmental objects.
2. Methodical and determining of correlation ratios for the major dose-forming radioisotopes in comparison with the results of experimental estimation of ^{137}Cs , ^{90}Sr , ^{241}Am , ^{241}Pu , ^{239}Pu , ^{240}Pu , ^{242}Pu in the environmental objects.
3. Methodology for reconstruction of radioactive fallout at the village of various nuclear power stations accidents and application during their phases.
4. Evaluation of progress of a radiation accident. Working out of the methodology for predicting scenarios in the radiation zones.
Project 3: Working out of procedure for assessment of local radioactive contamination based on the basis of investigation accident on the basis of investigation natural radioactivity contamination.
Objectives: Research method of direct, fast and comparison of radioactive fallout.
- Tasks:**
1. Substantiation of methods for sampling of natural radioisotopes.
2. Working out of procedure for determination of ^{210}Po (^{210}Pb) in bottom deposits as requested for history of radioactive fallout.
3. Working out of the methodology for investigating natural radioisotopes.
4. Working out of the methodology for comparative assessment of the radiation situation in different areas on the basis of comparative analysis of natural radioisotopes.