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Study of the Influence of Forest and Peat Fires on the Radiation Situation in the South-Western Regions of the Bryansk Region

Oleg N. Apanasyuk^{id}✉, Sergey L. Gavrilov^{id}, Sergey A. Shikin^{id}, Artem E. Pimenov^{id}

Nuclear Safety Institute of the Russian Academy of Sciences, Moscow, Russian Federation

✉ aon@ibrae.ac.ru

Abstract

Introduction. The paper considers the influence of radiation forest and peat fires on the spread of radioactive contamination, which affects the well-being of thousands of people. The state of the environment in vast territories is deteriorating; negative socio-economic processes are developing. This is a serious problem of two states: the Russian Federation and the Republic of Belarus. The objectives of the presented work are to study the radiation situation in forests and peat bogs located in the border areas of the Bryansk region, as well as to study the possibility of transferring radioactive materials during forest and peat fires.

Materials and Methods. The facts that clarified the theoretical basis of the presented research are highlighted in the scientific literature. The authors took into account, in particular, that:

- the activity of radionuclides in the soil decreases in direct proportion to the depth;
- a peat fire is an uncontrolled burning;
- emissions of caesium-137 fractions (^{137}Cs) during a fire can reach 3–4 %.

We know the areas of forests in radiation-contaminated territories (RCT) of the Bryansk region from the applied literature and official sources. The most problematic areas from this point of view have been identified.

A mobile radiometric laboratory, a scintillation gamma-ray spectrometer MKS-AT6101S were involved in the expedition research. The results of field gamma-ray spectrometry were recorded in three localities. The calculations for a hypothetical fire were carried out using the SAUR AIUS RSCHS 2030 software tool.

Results. The consequences of large and prolonged fires in the exclusion zone of the Chernobyl nuclear power plant are analyzed. It is established that the incidents did not lead to dangerous consequences for the population. The total effective dose of inhalations was ~0.003 % of the permissible level of irradiation. It is noted, however, that the forest soil of the Bryansk region has received significant damage from ^{137}Cs pollution. The density of such pollution exceeded 5 Ci/km² in 40 % of the affected forests. Of these, an indicator of 15–40 Ci/km² and more was recorded in 16 %, in some quarters — up to 200 Ci/km². It is established that zones with a high contamination density (40 Ci/km²) will remain in the region until 2026. Five districts are particularly problematic: Gordeevsky, Zlynkovsky, Klintsovsky, Krasnogorsky and Novozybkovsky.

When fixing and predicting harm, the authors of the presented work proceeded from the following fact: during fires, the combustion products (forest litter, grass and undergrowth) contain more radioactive substances than the crowns of trees. In this regard, measurements were not made at a significant height.

The field study route was chosen based on the available data on the maximum level of radioactive contamination. The ambient dose equivalent rate (ADER) of gamma radiation recorded at 2,757 points did not exceed 1.2 μSv/h (with an average value of 0.2–0.3 μSv/h). Measurements in the marshes did not reveal traces of ^{137}Cs at a depth of more than 40 cm. The maximum activity of ^{137}Cs was observed in the upper (0–4 cm) soil layer (up to 65 %). Taking into account the data obtained, the possibility of radioactive contamination in the event of a forest fire was assessed. According to the calculations in the software environment, radioactive contamination will spread to 348 hectares. The density of

radioactive contamination of the area may increase by 5–10 % (from the initial one). 33 people will suffer; there is a threat of death of 1 person.

It has been established that a burning peat bog is the most powerful and long-term source of radioactive contamination, therefore it is important to prevent peat and forest fires. This will reduce the transfer of radionuclides and emissions of radioactive fumes. Remote and surface radiation monitoring facilities should be developed.

Discussion and Conclusion. The registered ADER is not dangerous for the health of the population of the Bryansk region. However, frequent fires significantly increase the likelihood of transferring active ^{137}Cs to residential areas. In this sense, timely monitoring and forecasting of fires is relevant. The authors formulated proposals to improve the technical and technological components of the solution of the considered problem.

1. To clarify the radiation situation, all-terrain vehicles should be equipped with:

- means of registering the radiation situation;
- software and hardware complex for automatic collection, analysis of information and its fixation in databases.

2. There should be a reliable cellular communication between all rapid response units in the emergency zone.

Further research is focused on the creation of fast-deployable radiation monitoring modules and mobile aerial photography complexes using drones in the emergency zone.

Keywords: forest fires, peat fires, radioactively contaminated territory, Chernobyl accident, radioactive contamination zones, radiation survey, radiation control, radiation risks for the population.

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Introduction. The data of scientific and applied literature allow us to get an idea of the radiation situation in forests and peat bogs located on radiation-contaminated territories (RCT) of the border areas of the Bryansk region. A number of works have studied the environmental impact of large forest fires in the exclusion zone (EZ) of the Chernobyl Nuclear Power Plant (Chernobyl NPP).

It follows from the materials of the Atlas of the consequences of the Chernobyl accident¹ that forests were exposed to radioactive contamination on the territory of more than 3 million hectares in 15 subjects of the Russian Federation and six regions of the Republic of Belarus. The accident at the Chernobyl nuclear power plant caused the contamination of more than 1.5 million hectares of Russian² and 292.1 thousand hectares of Bryansk forests with radionuclides. It is worth clarifying that the last figure is about 30 % of the forest fund of the Bryansk region.

Fires in forests and peat bogs on the RCT increase radiation risks for the population of adjacent territories, including the south-western districts of the Bryansk region. This determines the relevance of the problem under consideration.

The objectives of scientific research is to study the radiation situation in forests and peat bogs located in the border areas of the Bryansk region, as well as to study the possibility of transferring radioactive materials during forest and peat fires.

Main tasks:

- analysis of the content of ^{137}Cs in forest combustible materials in the event of fires;
- assessment of the danger of fires in forests and peat bogs with high levels of radioactive contamination to the health of the population living on the RCT;
- preparation of proposals for improving technical and technological components of the solution to the problem under study;
- determination of the direction of further research in this area.

¹ Izrael Yu. A. (Ed.), Bogdevich I. M. (Ed.) The atlas of recent and predictable aspects of consequences of Chernobyl accident on polluted territories of Russia and Belarus (ARPA — Belarus). Moscow; Minsk, 2009. 140 p. (In Russ.).

² Voronov S. I. et al. 30 let chernobyl'skoi avarii. Itogi i perspektivy preodoleniya ee posledstviy v Rossii 1986–2016. Rossiiskii natsional'nyi doklad. Moscow, 2016. 202 p. (In Russ.).

Materials and Methods. A significant number of studies have been devoted to assessing the environmental impact of fires in forests and peat bogs of the RCT³ [3–12]. A number of scientists note that the smoke of forest fires can be a carrier of radionuclides on the RCT⁴ [1–9, 12].

It is known from [1] that the activity of radionuclides in soil decreases in direct proportion to the depth. ¹³⁷Cs and transuranic elements are mostly concentrated in the upper (0–5 cm) layer. Here their ¹³⁷Cs content varies in the range of 41–76 %

It is shown in [2] that forest and peat fires are an uncontrolled burning process. This is a disaster for the population, economy and nature. When extinguishing such fires, a radiation factor is added to the RCT.

It was noted in [3] that emissions of ¹³⁷Cs fractions during forest fires can reach 3–4 %.

Work [4] emphasizes the importance of accurate forecasting of fire risks for a successful strategy of extinguishing forest fires. It is proposed to use the software of the decision support system. This software consists of a fire hazard assessment module and a radionuclide transfer module in case of a fire. It allows you to work with the parameters of forest fires based on a database and predict the environmental consequences of forest fires on the RCT (the amount of radionuclide emissions, secondary pollution of territories).

In the field research of the south-western regions of the Bryansk region, a mobile radiometric laboratory of the RCT was used. This equipment made it possible to determine the impact of forest and peat fires on the spread of radioactive contamination. In addition, radiation risks for the population were assessed. The results of field gamma-spectrometry were recorded in three localities. The experiment involved the scintillation gamma-ray spectrometer MKS-AT6101S. Calculations for a hypothetical fire were performed using the SAUR AIUS RSCHS 2030 software tool⁵.

Results

Analysis of the consequences of large forest fires in the Chernobyl NPP area. In April 2020, large-scale forest fires broke out in the Chernobyl zone. Forests and meadows burned intensely for more than two weeks [5]. From April 6 to April 26, fires were recorded within a radius of 25 km around the reactor [6].

On April 3, the fire engulfed a huge area of forests around the EZ [7] (Fig. 1).

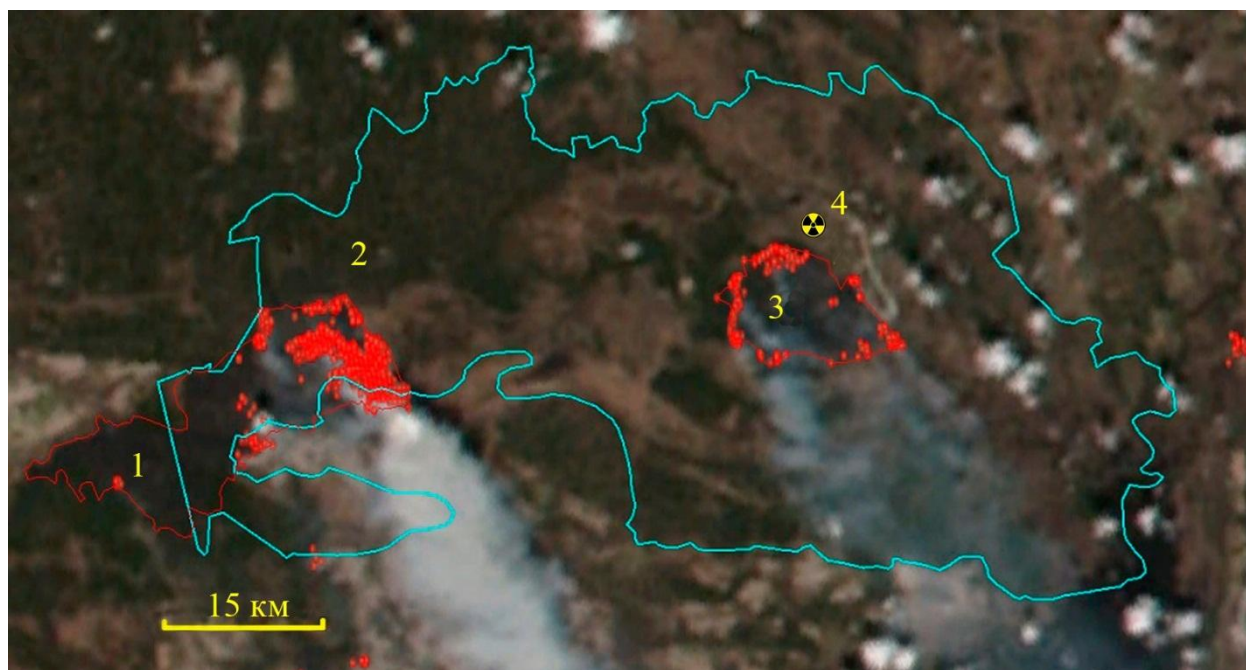


Fig. 1. Satellite image of fire in the EZ (April 2020):

1 — location of a fire on April 3; 2, 3 — the situation on April 8;

4 — location of the Chernobyl nuclear power plant, the blue line is the EZ border [7]⁶

³ Kuzmenkova N. V., Rozhkova A. K., Vorobeva T. A. Radioekologicheskaya otsenka vozdustvnykh pozharov na okruzhayushchuyu sredy v zone otseleniya Bryanskoi oblasti. Radioekologicheskie posledstviya radiatsionnykh aviarii: k 35-i godovshchine aviarii na ChAES : mat-ly mezhdunar. nauch.-prakt. konf. Obninsk. 2021. p. 190–193. (In Russ.).

⁴ Idem

⁵ Informatsionno-analiticheskaya sistema analiza i upravleniya riskami avtomatizirovannoi informatsionno-upravlyayushchei sistemy Edinoi gosudarstvennoi sistemy preduprezhdeniya i likvidatsii chrezvychaynykh situatsii (SAUR AIUS RSCHS-2030). ООО "TsIEKS". Available from: http://www.esrc.ru/sites/default/files/contentuploads/docs/cieks_2020.pdf?ysclid=17q7p6c8cl443523486 (accessed 06.09.2022). (In Russ.).

⁶ Квітневі лісові пожежі 2020 року в зоні відчуження Чорнобильської АЕС стали найбільшими в історії. Лісівник. Available from: https://for-ester.blogspot.com/2020/04/2020_10.html (accessed 06.09.2022).

<https://www.bps-journal.ru>

It was extinguished only after 10 days. The fire, which engulfed about 20 thousand hectares, destroyed a significant amount of forest⁷.

More than 1,000 people, 120 fire trucks, helicopters and airplanes took part in the extinguishing. 10 unmanned aerial vehicles (UAVs) were used for aerial reconnaissance⁸. This made it possible to quickly assess the situation and make the right decisions on the deployment of firefighting equipment⁹.

Most publications in foreign scientific journals have confirmed the absence of radiation danger to the population. The same was stated in the statement of the International Atomic Energy Agency (IAEA)¹⁰. The total effective dose of inhalations received from fires in the EZ was ~0.003 % of the permissible level of exposure of the population (1 mSv/year) [5].

After the Chernobyl accident in 1986, the first significant forest fires in the EZ date back to August 1992. They affected 1 thousand hectares of meadows and forest lands, the crown fire covered more than 5 thousand hectares [7]. During ground fire, there was no noticeable (more than 1 km) advance of radioactive contamination, even in the course of smoke propagation. Combustion products from a crown fire are carried much further in strong winds, but they are less radioactive, since the crowns of trees are much less polluted than the forest floor, grass and undergrowth [7].

In 1994, the content of ¹³⁷Cs in different levels of the pine forest was measured in the western territory of the Red Forest in the EZ: from needles to soil at a depth of 15 cm (Fig. 2 [7, 8]).

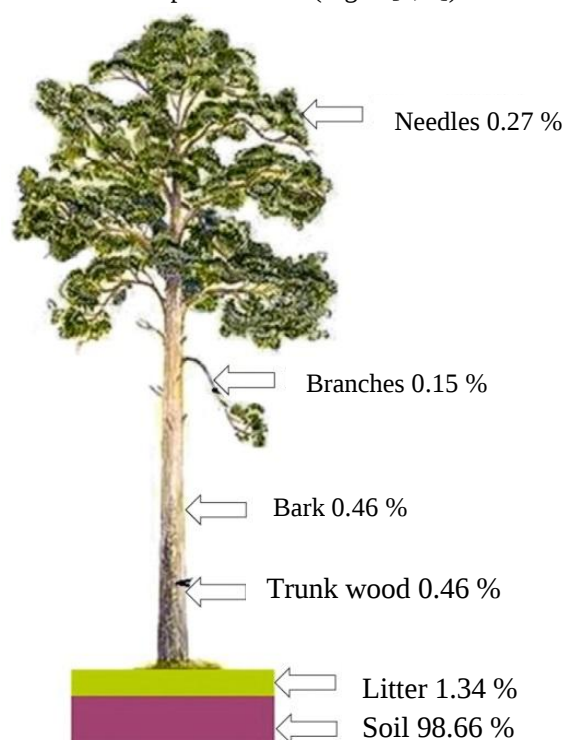


Fig. 2. Distribution of ¹³⁷Cs in parts of pine and soil. Samples were taken in the EZ (10 and 20 km south of the Chernobyl NPP) [7]

For liquidators, the most radioactively hazardous are ground fires of the Chernobyl NPP EZ, since submicron aerosols containing ¹³⁷Cs remain in the atmosphere for a long time and can carry it over considerable distances. A 10-fold decrease in the concentration of radioactive aerosols in the smoke plume was observed at a distance of more than 2 km from the fire front [8].

S. I. Voronov and co-authors found out that the Bryansk region forests are significantly polluted by ¹³⁷Cs. At the same time, more than 40 % of the affected forests belong to the radiation contamination zone (RCZ) with a density of ¹³⁷Cs radioactive contamination of the soil of more than 5 Ci/km². Of these, an indicator of 15-40 Ci/km² and more was recorded on 16 %, in some quarters — up to 200 Ci/km².

⁷ Sivkov P. Ekologi zayavili o vtorichnom radioaktivnom zagryaznenii iz-za lesnykh pozharov v zone ChAES. Available from: <https://tass.ru/obschestvo/10583913> (accessed 06.09.2022). (In Russ.).

⁸ Aviation Code of the Russian Federation of March 19, 1997 No. 60-FZ. State Duma. Federation Council. Available from: <http://ivo.garant.ru/#/document/10200300/paragraph/319340:1> (accessed 08.10.2022). (In Russ.).

⁹ Peng H. Chernobyl: Massive Wildfire Extinguished with the Help of Drones. Available from: <https://enterprise-insights.dji.com/user-stories/chernobyl-wildfire-extinguished-with-drones> (accessed 27.08.2022).

¹⁰ IAEA Sees No Radiation-Related Risk from Fires in Chomobyl Exclusion Zone. International Atomic Energy Agency. Available from: <https://www.iaea.org/ru/newscenter/pressreleases/magate-ne-vidit-radiacionnyh-riskov-v-svyazi-s-pozharami-v-chemobylskoy-zone-otchuzhdeniya> (accessed 06.09.2022). (In Russ.).
<https://www.bps-journal.ru>

In the south-western regions of the Bryansk region, forests of the 1st-3rd classes (according to the classification of natural fire danger¹¹) predominate [9].

In accordance with law¹², since 1991, four types of radiation hazard zones have been established on the territory of the Bryansk region:

- zone of exclusion (EZ);
- resettlement zone (RZ);
- areas with the right of resettlement (ARR);
- zone of residence with preferential social and economic status (ZPS).

EZ is characterized by a density of ^{137}Cs radioactive contamination of more than 40 Ci/km², RZ — more than 15 Ci/km², ARR — from 5 to 15 Ci/km², ZPS — from 1 to 5 Ci/km².

According to the Russian National Report, in 2020, the forest area in the Bryansk region amounted to 226.9 thousand hectares, including:

- ZPS — 127 thousand hectares;
- ARR — 84.2 thousand hectares;
- RZ — 14.9 thousand hectares;
- EZ — 0.8 thousand hectares [10].

Figure 3 shows the forecast of ^{137}Cs contamination in the Bryansk Region by 2026.

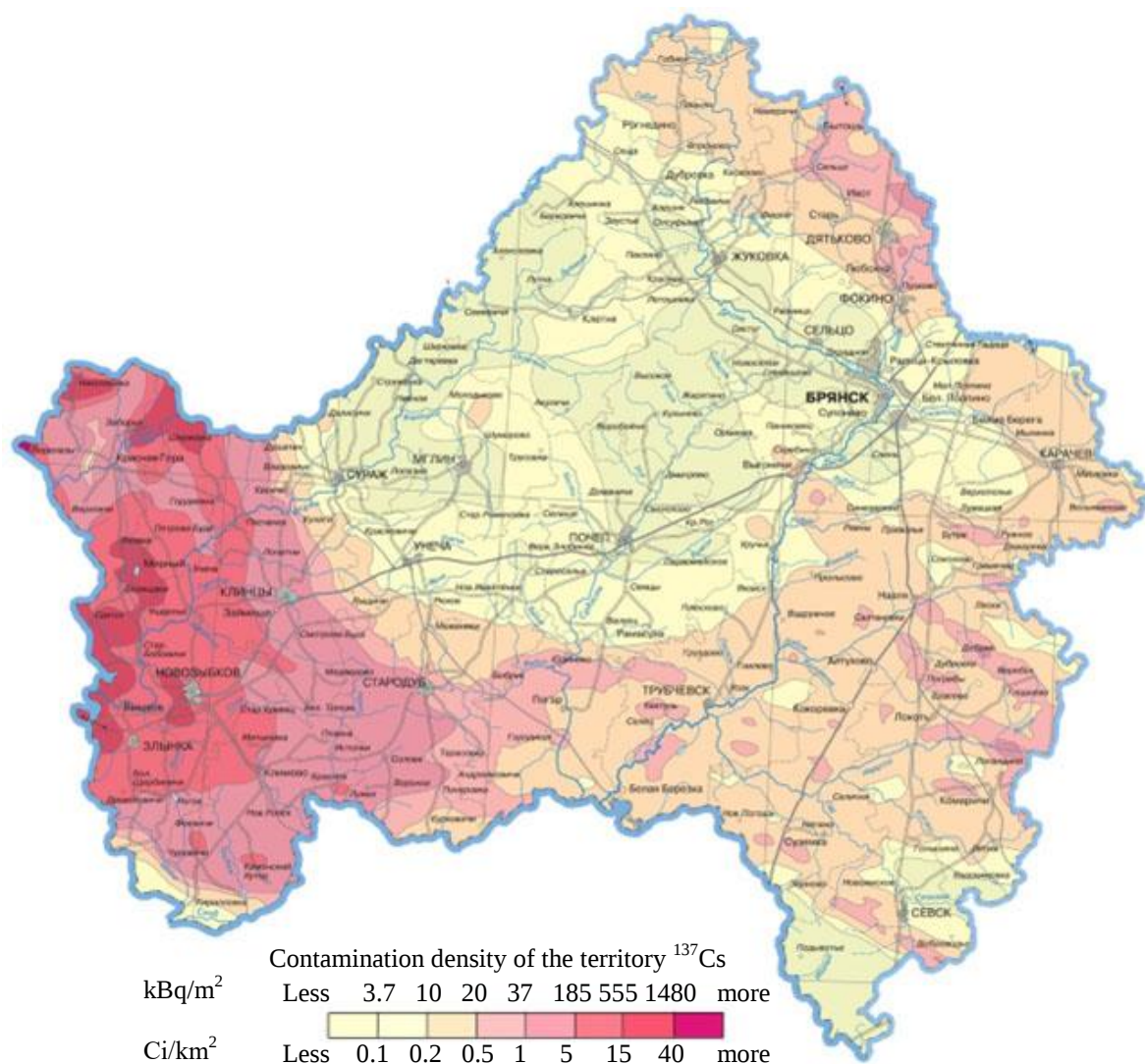


Fig. 3. ^{137}Cs contamination map of the Bryansk region according to the Atlas of the consequences of the Chernobyl accident (forecast for 2026)

¹¹ Klassifikatsiya prirodnoi pozharnoi opasnosti lesov i klassifikatsiya pozharnoi opasnosti v lesakh v zavisimosti ot uslovii pogody. Federal Forestry Agency. Available from: <http://ivo.garant.ru/#/document/12189021/paragraph/9:0> (accessed 06.09.2022). (In Russ.).

¹² O sotsial'noi zashchite grazhdan, podvergnshikhsya vozeistviyu radiatsii vsledstvie katastrofy na Chernobyl'skoi AES. Law of the RSFSR of 15.05.1991 No. 1244-1. Supreme Soviet of the RSFSR Available from: <https://base.garant.ru/185213/> (accessed 06.09.2022). (In Russ.).

The most radioactively contaminated areas: Gordeyevsky, Zlynkovsky, Klintsovsky, Krasnogorsky and Novozybkovsky are located in the Bryansk region and occupy a total of 14.3 % of the region's territory. There are 329 settlements on this area (Fig. 4) [11].

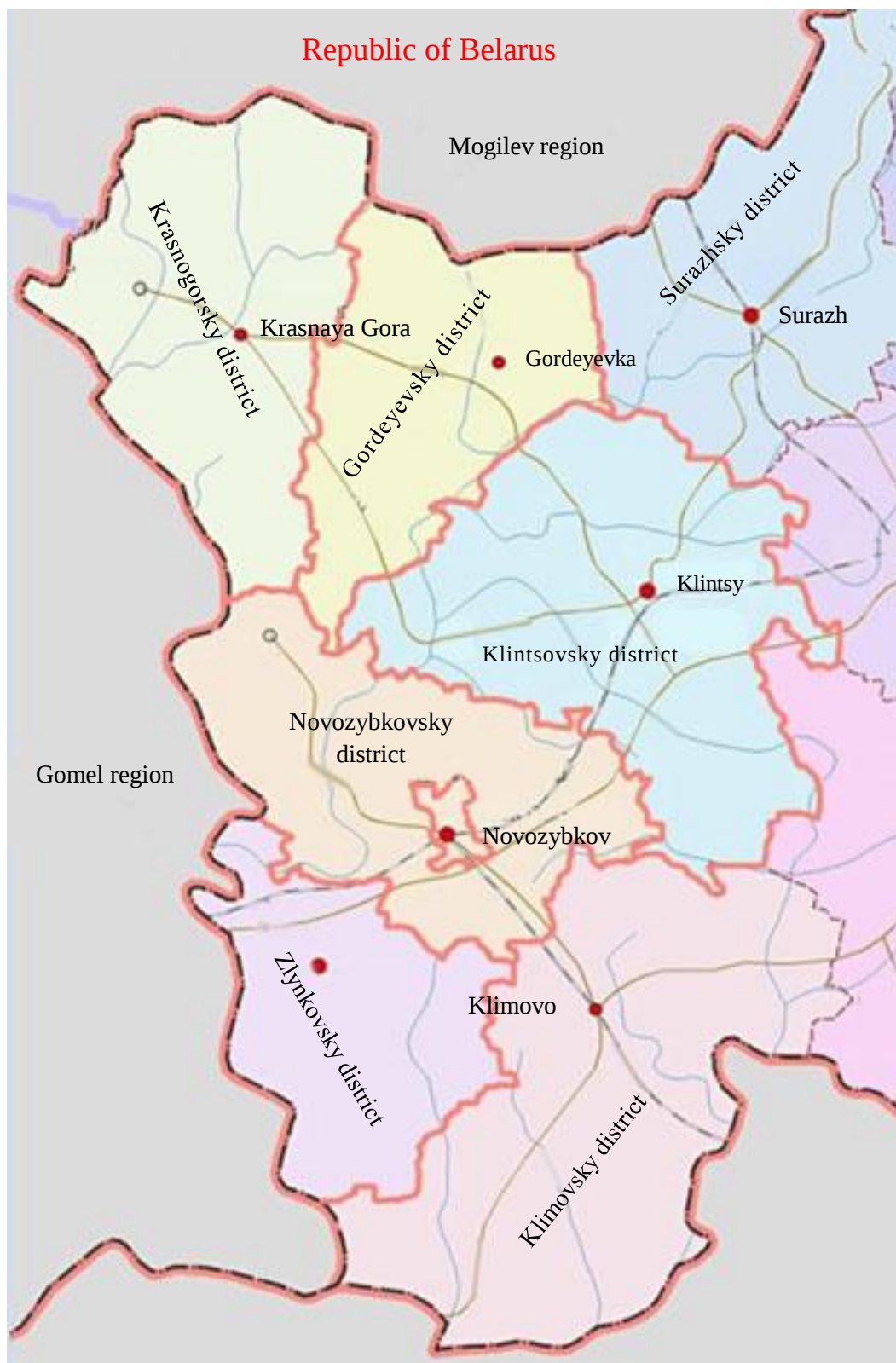


Fig. 4. South-west of the Bryansk region. Administrative municipalities on the RCT¹³

¹³ Raiony Bryanskoi oblasti na karte s granitsami. Available from: <https://maps-rf.ru/brjanskaja-oblast/rajony.php?ysclid=l5p8uis5n9622087709> (accessed 06.09.2022). (In Russ.).
<https://www.bps-journal.ru>

Work [9] presents a similar forecast for 2046. The data relate to four RCZ of the most polluted areas of the Bryansk region. The content of ^{137}Cs in the forest litter was measured. The researchers have confirmed significant pollution, especially in the Krasnogorsky district and Novozybkovsky city district. The exact figures are given below.

- Gordeyevsky district: ZPS — 3.932 kBq/kg; APP — 9.43 kBq/kg; RZ — 18.1 kBq/kg.
- Zlynkovsky district: ZPS — 4.24 kBq/kg; APP — 8.67 kBq/kg.
- Krasnogorsky district: ZPS — 3.1 kBq/kg; APP — 9.25 kBq/kg; RZ — 26.6 kBq/kg; EZ — 81.49.
- Novozybkovsky city district: ZPS — 4.58 kBq/kg; APP — 9.34 kBq/kg; RZ — 21.48 kBq/kg.

It should be noted that one of the causes of peat fires is waterlogging of the Bryansk region's RCZ.

According to official data¹⁴, 175 forest fires were registered in the Bryansk region in 2020 fire hazard season on a total area of 1,351.49 hectares. On the territory of the Bryansk region, 1,449 peat bogs with an area of 77.2 thousand hectares were taken into account. Almost 90 % of the marshes occupy an area of up to 100 hectares, 11 — more than 1 thousand hectares. The largest are located in the floodplain of the Nerussa river (7,462 hectares, Brasovsky district) and Kozhanovsky (6,984 hectares, Krasnogorsky district).

In¹⁵ it is noted that during a peat fire, aerosols containing ^{137}Cs do not spread further than 500 m from the source of ignition, therefore they do not pose any danger to residents of nearby settlements. However, the results of work [12] indicate that a burning peat bog is the most powerful and long-acting source of radioactive contamination. Therefore, it is important to prevent peat and forest fires. This will reduce the transfer of radionuclides and emissions of radioactive fumes.

Expedition surveys of radioactively contaminated territories of the south-western districts of the Bryansk region. In 2019, expedition surveys were conducted in the forests and peat bogs of the border territories of the Bryansk region. The influence of forest and peat fires on the health of the RCT population was studied. Measurements were carried out using a mobile radiometric laboratory (MRL)¹⁶.

The survey route (Fig. 5) was chosen based on the data on the maximum level of radioactive contamination.

¹⁴ Tsublova E. G., Lukashov S. V. Prirodnye resursy i okruzhayushchaya sreda Bryanskoi oblasti. Godovoi doklad ob ekologicheskoi situatsii v Bryanskoi oblasti v 2020 g. Bryansk, 2021. 251 p. Available from: http://www.kpl32.ru/in_doc/20210616_21856_gosdoklad_2020.pdf (accessed 06.09.2022). (In Russ.).

¹⁵ Kuzmenkova N. V., Rozhkova A. K., Vorobeva T. A. Radioekologicheskaya otsenka vozdeistviya torfyanykh pozharov na okruzhayushchuyu sredu v zone otseleniya Bryanskoi oblasti (In Russ.).

¹⁶ Proektirovanie avtomatizirovannoi sistemy monitoringa chrezvychaynykh situatsii s radiatsionnym faktorom na radioaktivno zagryaznennykh vsledstvie katastrofy na Chernobyl'skoi AES territoriyakh gosudarstv — uchastnikov Soyuznogo gosudarstva (AS KRO): otchet o NIR. ANO TsAB IBRAE RAN; headed by Gavrilov S. L. Moscow, 2019, 380 p. No. GR AAAA-B20-220013090244-3. (In Russ.).

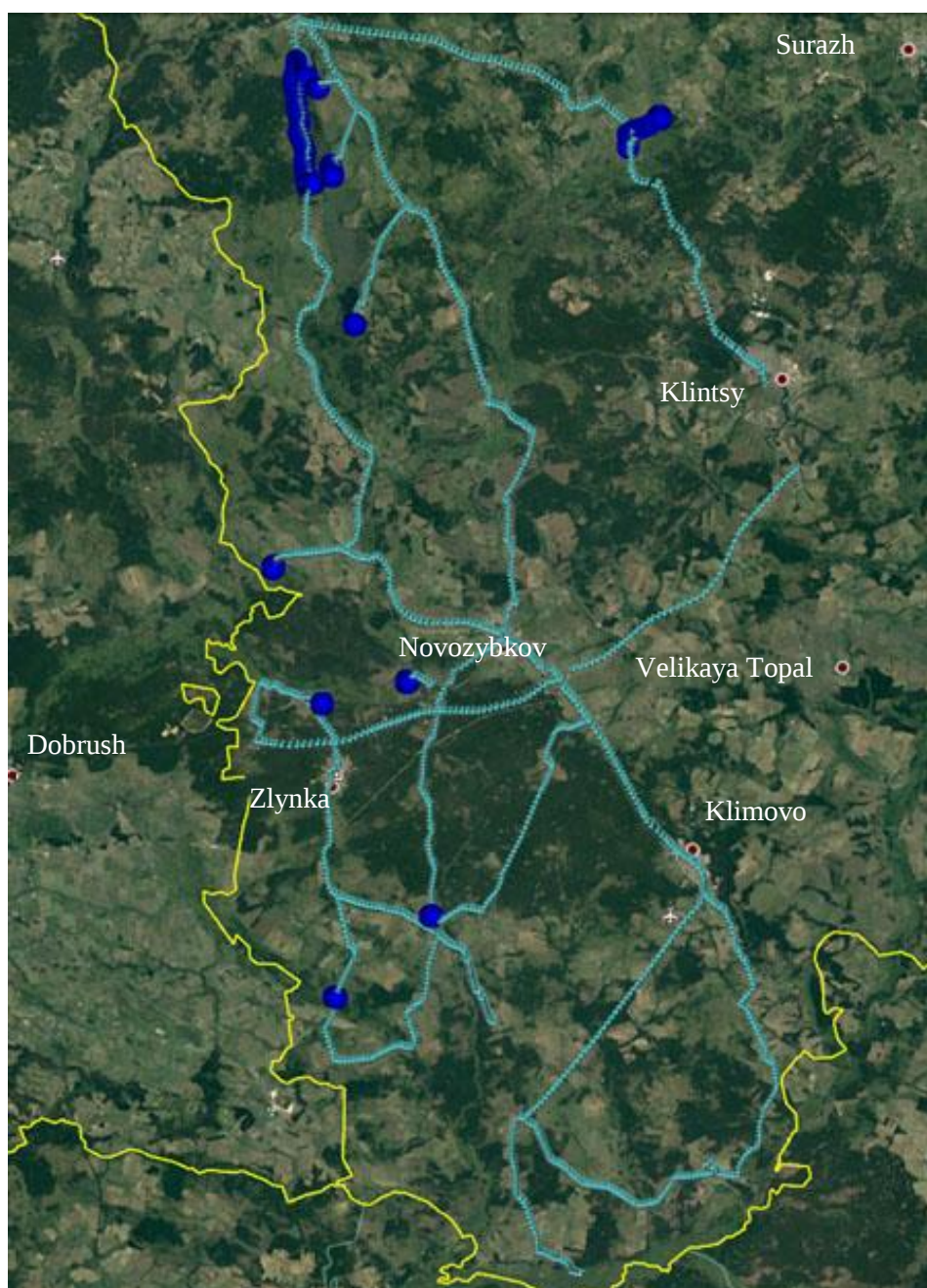


Fig. 5. Radiation survey route map

During the MRL movement through the areas most contaminated with radionuclides, the Gamma Sensor installation conducted continuous gamma-radiation survey. The ambient dose equivalent rate (ADER) of gamma radiation was measured. The measurements were made at 2,757 points.

The MKS-AT6101S spectrometer was used to detect ionizing radiation sources with the identification of radionuclides, and the DKS-96 dosimeter-radiometer was used to confirm the radiation situation data.

At all points of field measurements, gamma radiation ADER did not exceed $1.2 \mu\text{Sv/h}$ (with an average value of $0.2\text{--}0.3 \mu\text{Sv/h}$). This is consistent with the data of the Atlas of the consequences of the Chernobyl accident ($0.1\text{--}0.3 \mu\text{Sv/h}$).

For measurements in the Kozhanovskoye, Belimovo, Chaynoye and Oboleshevo marshes, the Becquerel Monitor LB 200 unit manufactured by Berthold technologies was used. Field measurements did not reveal traces of ^{137}Cs at a depth of more than 40 cm

The greatest activity of ^{137}Cs was observed in the upper (0-4 cm) soil layer (up to 65%). This is consistent with the results obtained by Belarusian scientists (41-76 % [1])

To clarify the radiation situation in the south-western regions of the Bryansk region, radiation surveys were conducted by field gamma spectrometry in three areas with an average ADER level of more than $0.6 \mu\text{Sv/h}$ (Novozybkovsky, Zlynkovsky and Koasnogorsky). The results are summarized in Table 1.

Table 1

Results of field gamma-ray spectrometry, ^{137}Cs

Measuring point (locality)	Measured value		Data from the Atlas of the consequences of the Chernobyl accident, kBq/m^2 (Ci/km^2)
	Bq/cm^2	kBq/m^2	
Perevoz village (Novozybkovsky district)	45.7	457	555–1480 (15–40)
Vyshkov urban-type settlement (Zlynkovsky district)	96.8	968	555–1480 (15–40)
Velikoudebnoye village (Krasnogorsky district)	32.2	322	185–555 (5–15)

A scintillation gamma-ray spectrometer MKS-AT6101S was used in the experiment. The device was mounted on a tripod in such a way that there was a distance of 1 meter between the surface of the earth and the registration center of the scintillator crystal. To account for the distribution of activity by depth when calculating surface activity, several soil cores were taken at the measurement site. The results obtained are comparable with the data of the Atlas of the consequences of the Chernobyl accident.

Assessment of possible radioactive contamination in case of a forest fire. Taking into account the data on the activity of ^{137}Cs in the Bryansk region, the possibility of potential radioactive contamination in the event of a forest fire was considered. For the estimated calculation, a point of ignition was chosen in the forest near the village of Vyshkov (geographical coordinates $52^\circ 28' 45''\text{N}$, $31^\circ 42' 39''\text{E}$)

The following parameters were set as boundary conditions:

- characteristics of a forest fire (type of fire — ground, class of forest fire frequency — deciduous forest, duration of fire — 24 hours, weather fire hazard class — V, i.e. extreme fire hazard);
- weather conditions at the time of the forest fire (wind direction — 90° — azimuth; speed — 10 m/s).

The calculation was performed in the SAUR AIUS RSCHS 2030 software environment for a hypothetically occurred forest fire on 14.11.2019 00:00. On the conditional date 15.11.2019 and the time 00:00, the following results were obtained:

- area of the burnt forest — 3.7 hectares;
- fire perimeter — 0.7 kilometer;
- smoke coverage area — 1,437.6 hectares;
- radioactive contamination zone area — 348.0 hectares;
- number of people injured in the fire — 33 people;
- number of victims — up to 1 person.

As a result of such a fire, the density of radioactive contamination of the area may increase by 5-10% (from the initial one). An increase in the radiation dose in this single case will not lead to significant consequences for the population. However, a series of fires is potentially dangerous. It can worsen the situation in the border areas with background pollution.

During the expedition, it turned out that water barriers (rivers, lakes) on the Bryansk region RCT made it difficult for ground-based mobile radiation monitoring equipment to access the forests of the shore front. In this case, the most effective are:

- remote means of radiation monitoring based on UAVs (detection of fires)¹⁷ [13];
- surface means of radiation control (radiation reconnaissance and refinement of radiation control data).

Unmanned aerial vehicles are an indispensable tool in the fight against forest fires. Thermal images are especially important, as they convey a bird's-eye view of the area and help determine the direction of fire propagation. This allows firefighters to quickly make decisions about where units should move and who should be evacuated.

Discussion and Conclusion. The results of scientific and expeditionary research allow us to make a number of statements. In a fire in a radiation-contaminated area, the content of radioactive aerosols in the smoke plume can exceed the permissible values by orders of magnitude, therefore firefighters risk receiving an unacceptably high inhalation dose of radiation.

It should be noted that the radiation situation in the forests of the Bryansk region RCT is changing extremely slowly. The forest floor is most dangerous. It accounts for more than 70 % of the total stock of ¹³⁷Cs in forest combustible materials. ¹³⁷Cs is active in the forest floor and in the upper layer (up to 40 cm) of peat bogs, so forest and peat fires pose a risk of radionuclide transfer to nearby settlements. It will remain a threat in the coming years.

Expedition surveys with MRL showed that at all points of field measurements, ADER does not exceed 1.2 μSv/h. The average ADER (0.2–0.3 μSv/h) corresponds to the data of the Atlas of the consequences of the Chernobyl accident. Such a dose is not dangerous for the health of the population of the Bryansk region RCT. Nevertheless, frequent fires significantly increase the likelihood of transferring active ¹³⁷Cs to residential areas. In this sense, timely monitoring and forecasting of fires is relevant.

The authors have formulated the proposals to improve technical and technological components of the solution of the considered problem.

1. To clarify the radiation situation, it is necessary to use cross-country vehicles. They should be equipped with:

- means of recording the radiation situation;
- hardware and software complex for automatic collection, analysis of information and its fixation in databases.

This will allow you to quickly clarify the radiation situation in the event of a large fire. Predictive models and electronic databases of radioactive contamination make it possible to optimize the routes of special equipment. Such navigation will be based on the results of past measurements of ¹³⁷Cs activity and up-to-date data updated based on the results of the current route.

2. To provide reliable cellular communication between all operational response units in the emergency zone.

Further research is focused on the creation of quick-deployable radiation monitoring modules and mobile aerial photography complexes using UAVs in an emergency zone. New measuring equipment and software will allow determining in real time the characteristics of radiation fields with geo-linking.

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About the Authors:

Apanasyuk, Oleg N., head of the Laboratory for Targeted Programs Development for Integrated Safety and Protection of the Population, Nuclear Safety Institute of the Russian Academy Of Sciences (52, Bolshaya Tulkaya st., Moscow, 115191, RF), [ORCID](https://orcid.org/), aon@ibrae.ac.ru
<https://www.bps-journal.ru>

Gavrilov, Sergey L., head of the Scientific and Technical Problems of Complex Systems Development Department, Nuclear Safety Institute of the Russian Academy Of Sciences (52, Bolshaya Tulkaya st., Moscow, 115191, RF), [ORCID](#), gav@ibrae.ac.ru

Shikin, Sergey A., head of the Integrated Radiation Monitoring Systems Development Department, Nuclear Safety Institute of the Russian Academy Of Sciences (52, Bolshaya Tulkaya st., Moscow, 115191, RF), [ORCID](#), shickin@ibrae.ac.ru

Pimenov, Artem E., head of the Laboratory for Advanced Methods of Radiation Situation Monitoring, Nuclear Safety Institute of the Russian Academy Of Sciences (52, Bolshaya Tulkaya st., Moscow, 115191, RF), [ORCID](#), artisl@ibrae.ac.ru

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O. N. Apanasyuk: formulation of the basic concept, generalization and analysis of the research results, preparation of the text, formulation of the conclusions. S. L. Gavrilov: academic advising, conducting field studies and calculations, revision of the text, correction of the conclusions. S. A. Shikin: conducting field studies, analysis of the results, revision of the text. A. E. Pimenov: conducting field studies, analysis of the results, revision of the text.

Conflict of interest statement

The authors do not have any conflict of interest.

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