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SUSTAINABLE FOREST MANAGEMENT IN RADIOACTIVELY CONTAMINATED AREAS

The article assesses the radioactivity of forestland in the Republic of Belarus and highlights the long-term dangers of this situation. It presents the distribution of forest land by zones and subzones of radioactive contamination across all forest management authorities in Belarus (Ministry of Forestry of the Republic of Belarus, Administration of the President of the Republic of Belarus, the National Academy of Sciences of Belarus, the Ministry of Education of the Republic of Belarus, the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus and local executive and administrative bodies) in terms of forest categories (nature conservation, recreational and health-improving, protective, and operational forests). Measures are being taken for sustainable forest management to improve the natural environment. In the forestry sector, experts see artificial reforestation, afforestation, combined forest regeneration, species selection, and optimal soil conditions as key solutions to the problem. The article outlines necessary rehabilitation measures for forested areas in radioactive contamination zones. Data on reforestation and afforestation efforts in radionuclide-contaminated areas, broken down by regions and soil contamination density with cesium-137 as of January 1, 2025 is also provided.

Keywords: radio ecological situation, forest plantations, reforestation, afforestation, radiation safety.

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УСТОЙЧИВОЕ УПРАВЛЕНИЕ ЛЕСАМИ НА ТЕРРИТОРИЯХ РАДИОАКТИВНОГО ЗАГРЯЗНЕНИЯ

В статье дается оценка радиоактивности земель лесного фонда Республики Беларусь и указывается опасность этой ситуации на перспективу. Представлено распределение площади лесного фонда по зонам и подзонам радиоактивного загрязнения между всеми лесофондодержателями (Министерство лесного хозяйства Республики Беларусь, Управление делами Президента Республики Беларусь, Национальная академия наук Беларуси, Министерство образования Республики Беларусь, Министерство природных ресурсов и охраны окружающей среды Республики Беларусь, местные исполнительные и распорядительные органы) в разрезе категорий лесов (природоохранные, рекреационно-оздоровительные, защитные и эксплуатационные). В целях оздоровления природной среды принимаются меры по устойчивому управлению лесами. Важное решение этой проблемы в лесохозяйственной отрасли производственники видят в искусственном лесовосстановлении и лесоразведении, комбинированном возобновлении лесов, подборе видов лесных пород и оптимальных почвенно-грунтовых условий их произрастания. Даны мероприятия для реабилитации лесного фонда в зонах радиоактивного загрязнения. Приведены сведения по лесовосстановлению и лесоразведению на землях, загрязненных радионуклидами в разрезе областей в зависимости от плотности загрязнения почвы цезием-137 по состоянию на 1 января 2025 г.

Ключевые слова: радиоэкологическая обстановка, лесонасаждения, лесовосстановление, лесоразведение, радиационная безопасность.

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Introduction. As a result of the accident at the Chernobyl Nuclear Power Plant (ChNPP), the territory of the Republic of Belarus was subjected to widespread contamination by radioactive elements [1]. Currently, the radio ecological situation is determined by the presence of long-lived radionuclides. Among them are cesium-137 (^{137}Cs), strontium-90 (^{90}Sr), and transuranic elements (TUE), mainly plutonium isotopes (^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu). The half-lives of these radionuclides do not inspire optimism, ranging from 14 years (^{241}Pu) to 24.110 years (^{239}Pu), which determines the prolonged duration of the radio ecological consequences of the Chernobyl disaster, affecting many generations of the inhabitants of the Republic of Belarus [2].

As a result of the natural beta decay of plutonium-241 nuclei in radioactive contaminated areas, the formation of a hazardous radionuclide, the alpha emitter americium-241 (^{241}Am), occurs. This isotope has a half-life of 432 years and is accumulating in quantities comparable to the main sources of alpha radiation. Americium-241 is similar in radioactivity to plutonium isotopes (^{238}Pu, ^{239}Pu, ^{240}Pu), making the assessment of its increasing impact on the biosphere particularly important. Currently. ^{241}Am contributes 50% to the total alpha activity, and in a few decades. its contribution is expected to exceed the combined alpha activity of other sources by nearly twice [2–4].

According to Belarusian researchers, the growth of alpha activity in soils contaminated with transuranic elements due to ^{241}Am will continue until 2058 [5]. Even 100 years after the Chernobyl accident, the total alpha activity of soils in contaminated areas will be 2.4 times higher than in the immediate post-accident period. A reduction in soil alpha activity from ^{241}Am to a level of 3.7 kBq/m² is expected only after the year 2400 [4].

As a result of the Chernobyl disaster, Belarusian forests were affected by radioactive contamination. The most severely contaminated areas are located in the Gomel and Mogilev regions [1, 4, 6].

Currently 10–15% of the total radionuclide fallout on forest ecosystems is concentrated in the aboveground parts of trees, creating serious challenges for forestry management in these areas [7, 8].

Natural ecosystem soils have also been significantly contaminated with radioactive elements [1, 8]. The majority of radionuclides remain in the upper soil layers. The migration of cesium-137 and strontium-90 into deeper soil layers occurs very slowly, with an average migration rate of 0.3–0.5 cm per year [9].

In sod-podzolic sandy and sandy loam soils, as well as in peat lands, the proportion of biologically available forms of cesium-137 is 10–15%. For strontium-90, the proportion of available forms reaches up to 70% in sod-podzolic soils and up to 50% in peat soils. The proportion of available forms of plutonium isotopes and americium-241 is 9–10% and 12–13% respectively [7]. Radioactively contaminated soil becomes a long-term, continuous source of radionuclide transfer into forest resources, limiting their potential use.

Main Section. Over the years since the accident, significant changes have occurred in the radiation situation in the territory of the Republic of Belarus. The radioactive decay of short-lived radionuclides, the migration of long-lived radionuclides deeper into the soil, and the reduction in the content of cesium-137 and strontium-90 due to their natural radioactive decay (with a half-life of approximately 30 years) have led to a decrease in gamma radiation levels [9, 10].

The majority of radionuclide-contaminated forests are managed by the Ministry of Forestry of the Republic of Belarus and the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus.

As of January 1, 2024, the area of radioactive contamination within the forest fund under the Ministry of Forestry of the Republic of Belarus exceeded 1.200 thousand hectares. Table 1 presents the distribution of the forest fund territory of the Republic of Belarus by radioactive contamination zones as of January 1, 2024 [6].

An analysis of the presented data shows that. as of January 1, 2024, the area of the forest fund of the Republic of Belarus under all forest management entities accounts for 17.0% (with uncontaminated forests making up 83.0%). Reaching its highest absolute value under the Ministry of Forestry of the Republic of Belarus – 1,284,028.3 hectares.

Zone I – from 1 to 5 Ci/km^2 (residential zone with periodic radiation monitoring) – the area of radioactive contamination of the forest fund of the Ministry of Forestry is 852.9 thousand hectares (69.9%). Zone II – from 5 to 15 Ci/km^2 (zone with the right to resettle) – 281.3 thousand hectares (23.0%). Zone III – from 15 to 40 Ci/km^2 (zone of subsequent resettlement) – 84.3 thousand hectares (6.9%). Zone IV – 40 Ci/km^2 or more (priority resettlement zone) – 0.3 thousand hectares (0.002%).

The radiation situation in the forest fund territory contaminated with radionuclides is stabilizing. Over time, the area of each zone of radioactive contamination decreases, and a transition occurs from a zone with a higher density of soil contamination with cesium-137 to a zone with a lower density [10]. Compared to the previous year, the areas of radioactive contamination of forests by zone were: Zone I – 71.1%, Zone II – 23.79%, Zone III – 5.09%, Zone III – 0.02% [6, 11, 12].

Despite the fact that by now a significant part of radionuclides with a short half-life have ceased to exist, natural ecosystems remain contaminated with cesium-137, strontium-90, isotopes of plutonium, americium-241, having half-lives from 14 to 24,065 years.

In the current conditions, the forest scientific community is faced with the task of rehabilitating forest ecosystems.

Table 1

Distribution of forest area by zones and subzones of radioactive contamination in the Republic of Belarus (area, hectares)

Forest categories, government authority, administrative-territorial unit	Clean forests	Zones and subzones of radioactive contamination by density of soil contamination with cesium-137, Ci/km^2					
		I	II	Total up to 15 Ci/km^2	III	IV	Total
		1–5 (0.95–4.94)	5–15 (4.95–14.94)		15–40 (14.95–39.94)	Above 40 (39.95 and above)	
Ministry of Forestry							
Conservation forests	1,103,864.1	108,859.8	37,903.8	146,763.6	16,253.2	–	1,266,880.9
Recreational and health forests	28,1042.8	18,691.0	2,713.9	21,404.9	366.0	–	302,813.7
Protective forests	1,197,384.0	152,077.5	74,288.5	226,366.0	27,021.5	56.2	1,450,827.7
Production scaffolding	4,784,360.1	616,738.9	175,938.5	792,677.4	52,655.6	463.9	5,630,157.0
Total	7,366,651.0	896,367.2	290,844.7	1,187,211.9	96,296.3	520.1	8,650,679.3
Including percentage	85.2	10.4	3.4	13.7	1.1	0.0	100.0
Administration of the President of the Republic of Belarus							
Conservation forests	467,079.8	8,228.0	–	8,228.0	–	–	475,307.8
Recreational and health forests	8,406.4	486.9	–	486.9	–	–	8,893.3
Protective forests	49,768.1	9,290.9	–	9,290.9	–	–	59,059.0
Production scaffolding	182,720.7	46,282.6	–	46,282.6	–	–	229,003.3
Total	707,975.0	64,288.4	–	64,288.4	–	–	772,263.4
Including percentage	91.7	8.3	–	8.3	–	–	100.0
Local executive and administrative bodies							
Conservation forests	1,491.0	–	–	–	–	–	1,491.0
Recreational and health forests	12,782.5	–	–	–	–	–	12,782.5
Protective forests	–	–	–	–	–	–	–
Production scaffolding	803.6	–	–	–	–	–	803.6
Total	15,077.1	–	–	–	–	–	15,077.1
Including percentage	100.0	–	–	–	–	–	100.0
National Academy of Sciences of Belarus							
Conservation forests	1,330.4	–	–	–	–	–	1,330.4
Recreational and health forests	4,293.2	–	–	–	–	–	4,293.2
Protective forests	9,196.0	–	–	–	–	–	9,196.0
Production scaffolding	26,883.1	–	–	–	–	–	26,883.1
Total	41,702.7	–	–	–	–	–	41,702.7
Including percentage	100.0	–	–	–	–	–	100.0
Ministry of Education							
Conservation forests	418.4	–	–	–	–	–	418.4
Recreational and health forests	1,516.4	–	–	–	–	–	1,516.4
Protective forests	5,613.3	–	–	–	–	–	5,613.3
Production scaffolding	20,237.0	–	–	–	–	–	20,237.0
Total	27,785.1	–	–	–	–	–	27,785.1
Including percentage	100.0	–	–	–	–	–	100.0
Ministry of Natural Resources and Environmental Protection							
Conservation forests	–	–	–	–	748.9	1,932.6	2,681.5
Recreational and health forests	–	–	–	–	75.9	–	75.9
Protective forests	–	–	–	–	14,711.0	37,705.8	52,416.8
Production scaffolding	–	–	–	–	52,377.2	109,325.6	161,702.8
Total	–	–	–	–	67,913.0	148,964.0	216,877.0
Including percentage	–	–	–	–	31.3	68.7	100.0
Total for the Republic of Belarus							
Conservation forests	1,574,183.7	117,087.8	37,903.8	154,991.6	17,002.1	1,932.6	1,748,110
Recreational and health forests	308,041.3	19,177.9	2,713.9	21,891.8	441.9	–	330,375
Protective forests	1,261,961.4	161,368.4	74,288.5	235,656.9	41,732.5	37,762.0	1,577,112.8
Production scaffolding	5,015,004.5	663,021.5	175,938.5	838,960.0	105,032.8	109,789.5	6,068,786.8
Total	8,159,190.9	960,655.6	290,844.7	1,251,500.0	164,209.3	149,484.1	9,724,384.6
Including percentage	83.0	9.9	3.0	12.9	1.7	1.5	100.0

Table 2

Distribution of the forest fund territory of the Republic of Belarus by radioactive contamination zones as of 01.01.2024

Area	The area of soil contamination with cesium-137, thousand hectares					
	total		by zones			
	thousand hectares	in % of the total forest area	1–5 Ci/km^2	5–15 Ci/km^2	15–40 Ci/km^2	>40 Ci/km^2
Total						
Republic of Belarus	1,500.4	15.4	945.5	378.9	138.7	37.3
By region						
Brest region	68.1	4.8	66.2	1.9	0.0	0.0
Vitebsk region	0.0	0.0	0.0	0.0	0.0	0.0
Gomel region	1,020.6	44.2	593.9	286.8	102.8	37.1
Grodno region	10.7	1.1	10.7	0.0	0.0	0.0
Minsk region	30.9	1.8	30.8	0.1	0.0	0.0
Mogilev region	370.1	28.7	243.9	90.1	35.9	0.2
Including those under the jurisdiction of the Ministry of Forestry						
Republic of Belarus	1,218.8	14.1	852.9	281.3	84.3	0.3
By region						
Brest region	68.1	5.1	66.2	1.9	0.0	0.0
Vitebsk region	0.0	0.0	0.0	0.0	0.0	0.0
Gomel region	742.2	39.5	504.5	189.2	48.4	0.1
Grodno region	10.7	1.1	10.7	0.0	0.0	0.0
Minsk region	27.7	1.8	27.6	0.1	0.0	0.0
Mogilev region	370.1	29.5	243.9	90.1	35.9	0.2

To rehabilitate forest resources in areas of radioactive contamination, it is necessary to carry out:

– preventive and precautionary measures for the protection and protection of forests. primarily from fires;

– works on reforestation and afforestation. aimed at preserving forest ecosystems. strengthening of environment-forming agents. protective functions of the forest;

– continuous radiation monitoring to justify protective measures, implement forest management, predict radioactive contamination of forests and forest products;

– mandatory radiation monitoring in order to ensure the radiation safety of forest workers, the population when visiting forests and consumers of forest products [13].

When determining the factors and conditions for effective forest management, primary attention is given to the following aspects [14, 15]:

– predominance of forest regeneration through the establishment of forest plantations, with a gradual increase in the area of natural regeneration forests, as they are more resistant to environmental contamination and other adverse factors;

– improvement of the qualitative composition and resilience of newly established plantations, enhancing the role of selective seed production in increasing forest productivity.

To ensure sustainable forest management in radioactive contamination zones, a set of protective measures is implemented, the main ones being reforestation and afforestation, forest fire protection, and ensuring radiation safety for workers [13–15].

Reforestation and afforestation in radioactive contamination zones are carried out in accordance with the Regulation on the Procedure for Reforestation and Afforestation, issued by the Ministry of Forestry of the Republic of Belarus [16], and the Technical Code of Practice Rules for Reforestation and Afforestation [17]. These activities are strictly performed following the Rules for Forest Management in Radioactively Contaminated Areas [18].

Reforestation on Forest Fund Lands. Afforestation and the establishment of forest plantations are carried out in all radioactive contamination zones.

In Zones I and II of radio-active contamination, the establishment and cultivation of forest plantations are conducted following existing rules, guidelines, approved recommendations, and scientific developments. It is recommended to expand the volume of forest plantations using large-sized planting material, apply fertilizers, and cultivate mixed stands.

In Zone III of radio-active contamination, arable lands unsuitable for agricultural production, as well as non-forested lands within the forest fund, are subject to afforestation or artificial reforestation.

In Zone IV, non-forested and non-forest lands are left for natural forest regeneration. In all cases where sufficiently good natural regeneration of tree species can be obtained, it is advisable to focus on the effective use of seed dispersal capacity from existing stands and individual trees.

Table 3 contains data on reforestation, afforestation, planting, and sowing of forests in areas contaminated with cesium-137 as of January 1, 2025.

Table 3

Artificial reforestation and afforestation on land contaminated with cesium-137 as of 01.01.2025

Area	Planting and sowing forests on lands contaminated with cesium-137, thousand hectares	Including the density of soil contamination, thousand hectares		
		1–5 Ci/km^2	5–15 Ci/km^2	15–40 Ci/km^2
Republic of Belarus	5,002	3,711	815	476
Including: Brest region	119	119	–	–
Gomel region	3,470	2,519	602	349
Grodno region	13	13	–	–
Minsk region	52	52	–	–
Mogilev region	1,348	1,008	213	127
Ministry of Forestry	4,518	3,527	815	176
Including: Brest region	119	119	–	–
Gomel region	3,001	2,350	602	49
Grodno region	13	13	–	–
Minsk region	37	37	–	–
Mogilev region	1,348	1,008	213	127
Of these excluded from agricultural circulation				
Republic of Belarus	438	112	66	260
Including: Gomel region	341	111	12	218
Mogilev region	97	1	54	42
Ministry of Forestry	209	101	66	42
Including: Gomel region	112	100	12	–
Mogilev region	97	1	54	42

Analysis of the table shows that the highest volumes of reforestation and afforestation work are carried out in the Mogilev and Gomel regions. This is natural, as these territories were subjected to the highest levels of radioactive contamination as a result of the Chernobyl NPP accident.

Afforestation of contaminated areas significantly improves the environmental situation, especially on former agricultural lands. Forests help to:

– reduce surface runoff of contaminated water by redirecting it into subsurface infiltration;

– decrease wind speed, thereby reducing the spread of radionuclides along with dust from unvegetated soils.

Reforestation activities are carried out in compliance with radiation safety regulations:

– afforestation of land contaminated with radionuclides should be conducted in early spring or late autumn, on moist soil, and in windless weather;

– the establishment of forest plantations involves a minimum number of operations to ensure the shortest possible work duration.

Radiation monitoring during the afforestation of radionuclide-contaminated land includes:

– monitoring the exposure dose rate in the work area, workplaces, and other relevant locations;

– individual monitoring of workers' skin contamination by radionuclides;

– individual recording of actual working time and its compliance with the maximum allowable work duration.

Conclusion. The Chernobyl accident disrupted the ecological balance of the natural environment, significantly affecting forest plantations [19–21]. To rehabilitate contaminated areas, Belarus is actively engaged in reforestation, afforestation, and tree planting. These efforts will contribute to restoring ecological balance and reducing the negative radiation impact on the environment.

References

1. Ipatiev V. A., Baginskiy V. F., Bulavik I. M. *Les. Chelovek. Chernobyl'. Lesnyye ekosistemy posle avarii na Chernobyl'skoy AES: sostoyaniye, prognoz, reaktsiya naseleniya, puti reabilitatsii* [Forest. Human. Chernobyl. Forest ecosystems after the accident at the Chernobyl nuclear power plant: condition, forecast, reaction of the population, ways of rehabilitation]. Gomel, Rechickaya ukrupnennaya tipografiya Publ., 1999. 454 p. (In Russian).

2. *35 let posle Chernobyl'skoy katastrofy: itogi i perspektivy preodoleniya eye posledstviy. Natsional'nyy doklad Respubliki Belarus'* [35 years after the Chernobyl disaster: results and prospects for overcoming its consequences. National report of the Republic of Belarus]. Minsk, IVTS Minfina Publ., 2020. 152 p. (In Russian).

3. *Radiobiologiya: sovremennye problemy 2020: materialy mezhdunarodnoy nauchnoy konferentsii* [Radiobiology: modern problems 2020: proceedings of the International Scientific Conference]. Minsk, 2020. 204 p. (In Russian).

4. Consequences of the Chernobyl disaster for Belarus. Available at: https://chernobyl.mchs.gov.by/informatsionnyy-tsentr/posledstviya-chernobylskoy-katastrofy-dlya-belarusi/ (accessed 14.01.2025) (In Russian).

5. Semenenya I. N. Does the problem of population irradiation from the Chernobyl disaster exist? *Radio-ekologicheskiye i radiobiologicheskiye posledstviya chernobyl'skoy katastrofy: materialy mezhdunarodnoy nauchno-prakticheskoy konferentsii* [Radioecological and radiobiological consequences of the Chernobyl disaster: materials of the International scientific-practical conference]. Minsk, 2017, pp. 113–118 (In Russian).

6. Radioactive contamination of forest resources. Available at: https://bellesozaschita.by/radiacionnyj-kontrol/radioaktivnoe-zagrjaznenie-lesnogo-fonda/ (accessed 14.01.2025) (In Russian).

7. Chernobyl 20 years later. Strategy for recovery and sustainable development of affected regions. Available at: https://chernobyl.mchs.gov.by/upload/iblock/8e3/8e35c777a1e14ed6f6dbe6aaa813083f.pdf (accessed 14.01.2025) (In Russian).

8. Perevolotskiy A. N. *Raspredeleniye 137Cs i 90Sr v lesnykh biogeotsenozakh* [Distribution of 137Cs and 90Cp in forest biogeocenoses]. Gomel, Institut radiologii Publ., 2006. 255 p. (In Russian).

9. Radiation control. Available at: https://bellesozaschita.by/radiacionnyj-kontrol (accessed 17.02.2023) (In Russian).

10. Karbanovich L. N. The area of forest radiation pollution has decreased. *Belorusskaya lesnaya gazeta* [Belarusian forest newspaper], 2022, January 6, p. 2 (In Russian).

11. Yermak I., Garmasa A., Balakir M. Forest restoration and forestry on territories contaminated with cesium-137. *Sistema upravleniya ekologicheskoy bezopasnost'yu: materialy mezhdunarodnoy nauchno-prakticheskoy konferentsii* [Environmental safety management system: proceedings of the International scientific and practical conference]. Yekaterinburg, 2022, pp. 272–276.

12. Domnenkova A. V., Chernushevich G. A., Ermak I. T., Bosak V. N. Distribution of the territory of the forest fund of the Ministry of Forestry of the Republic of Belarus by zones of radioactive contamination. *Tekhnologiya organicheskikh veshchestv: materialy 87-y nauchno-tekhnicheskoy konferentsii professorsko-prepodavatel'skogo sostava, nauchnykh sotrudnikov i aspirantov (s mezhdunarodnym uchastiyem)* [Technology of organic substances: materials of the 87th scientific and technical conference of faculty, researchers and postgraduate students (with international participation)]. Minsk, 2023, pp. 60–62 (In Russian).

13. *Strategiya reabilitatsii zemel', lesov, vodoyemov i obespecheniya bezopasnykh usloviy zhizni lyudey na zagryaznennykh radionuklidami territoriyakh* [Strategy for the rehabilitation of lands, forests, water bodies and ensuring safe living conditions for people in areas contaminated with radionuclides]. Minsk, Departament po likvidatsii posledstviy katastrofy na Chernobyl'skoy AES Publ., 2007. 10 p. (In Russian).

14. Perevolotskiy A. N., Bulavik I. M. *Osnovy vedeniya lesnogo khozyaystva v usloviyakh radioaktivnogo zagryazneniya* [Fundamentals of forestry management under conditions of radioactive contamination]. Minsk, Belgosles Publ., 2003. 144 p. (In Russian).

15. TKP 047-2009 (02080). Sustainable forest management and forest exploitation. Manual on forest restoration and afforestation in the Republic of Belarus. Minsk, Ministry of Forestry Publ., 2010. 128 p. (In Russian).

16. On some issues of forest reproduction in the field of reforestation and afforestation: Resolution of the Ministry of Forestry of the Republic of Belarus, 19.01.2016, no. 80. *Natsional'nyy pravovoy Internet-portal Respubliki Belarus'* [National Legal Internet Portal of the Republic of Belarus], 2017, 8/31578 (In Russian).

17. TKP 667-2022 (33090). Rules for reforestation and afforestation. Minsk, Ministry of Forestry Publ., 2022. 25 p. (In Russian).

18. Rules for forestry management in areas affected by radioactive contamination as a result of the Chernobyl disaster. *Natsional'nyy pravovoy Internet-portal Respubliki Belarus'* [National Legal Internet Portal of the Republic of Belarus], 2017, 8/31754 (In Russian).

19. Perevolotskaya T. V. *Radiatsionnoye lesovodstvo: osnovy lesokhozyaystvennoy deyatel'nosti* [Radiation forestry: fundamentals of forestry activities]. Gomel, GSU Publ., 2014. 32 p. (In Russian).

20. TKP 250-2010. Radiation monitoring. Forestry facilities, workplaces. Procedure. Minsk, Belstandart Publ., 2010. 27 p. (In Russian).

21. Bosak V. N., Sachivko T. V., Domnenkova A. V. Ensuring radiation safety in forestry of the Republic of Belarus. *Dal'nevostochnaya vesna – 2018: materialy 16-y Mezhdunarodnoy nauchno-prakticheskoy konferentsii po problemam ekologii i bezopasnosti* [Far Eastern Spring – 2018: proceedings of the 16th International Scientific and Practical Conference on ecology and safety]. Komsomolsk-on-Amur, 2018, pp. 221–224 (In Russian).

Список литературы

1. Ипатьев В. А., Багинский В. Ф., Булавик И. М. Лес. Человек. Чернобыль. Лесные экосистемы после аварии на Чернобыльской АЭС: состояние, прогноз, реакция населения, пути реабилитации. Гомель: Речицкая укрупнен. тип., 1999. 454 с.

2. 35 лет после Чернобыльской катастрофы: итоги и перспективы преодоления ее последствий. Национальный доклад Республики Беларусь. Минск: ИВЦ Минфина, 2020. 152 с.

3. Радиобиология: современные проблемы 2020: материалы междунар. науч. конф., Гомель, 24–25 сент. 2020 г. Минск, 2020. 204 с.

4. Последствия чернобыльской катастрофы для Беларуси // Департамент по ликвидации последствий катастрофы на Чернобыльской АЭС М-ва по чрезвычайным ситуациям Респ. Беларусь. URL: https://chernobyl.mchs.gov.by/informatsionnyy-tsentr/posledstviya-chernobylskoy-katastrofy-dlya-belarusi/ (дата обращения: 14.01.2025).

5. Семененя И. Н. Существует ли проблема облучения населения от америция-241 чернобыльского происхождения // Радиоэкологические и радиобиологические последствия чернобыльской катастрофы: материалы междунар. науч.-практ. конф., Хойники, 11–12 окт. 2017 г. Минск, 2017. С. 113–118.

6. Радиоактивное загрязнение лесного фонда // Беллесозащита. URL: https://bellesozaschita.by/radiacionnyj-kontrol/radioaktivnoe-zagrjaznenie-lesnogo-fonda/ (дата обращения: 14.01.2025).

7. Чернобыль 20 лет спустя. Стратегия восстановления и устойчивого развития пострадавших регионов // Департамент по ликвидации последствий катастрофы на Чернобыльской АЭС М-ва по чрезвычайным ситуациям Респ. Беларусь. URL: https://chernobyl.mchs.gov.by/upload/iblock/8e3/8e35c777a1e14ed6f6dbe6aaa813083f.pdf (дата обращения: 14.01.2025).

8. Переволоцкий А. Н. Распределение 137Cs и 90Sr в лесных биогеоценозах. Гомель: Ин-т радиологии, 2006. 255 с.

9. Радиационный контроль // Беллесозащита. URL: https://bellesozaschita.by/radiacionnyj-kontrol (дата обращения: 17.02.2023).

10. Карбанович Л. Н. Площадь радиационного загрязнения лесов уменьшилась // Белорус. лесная газ. 2022. 6 янв. С. 2.

11. Yermak I., Garmasa A., Balakir M. Forest restoration and forestry on territories contaminated with cesium-137 // Система управления экологической безопасностью: материалы междунар. науч.-практ. конф., Екатеринбург, 19–20 мая 2022 г. Екатеринбург, 2022. С. 272–276.

12. Распределение территории лесного фонда Министерства лесного хозяйства Республики Беларусь по зонам радиоактивного загрязнения / А. В. Домненкова [и др.] // Технология орган. веществ: материалы 87-й науч.-техн. конф. проф.-преподават. состава, науч. сотрудников и аспирантов (с междунар. участием), Минск, 31 янв. – 17 февр. 2023 г. Минск, 2023. С. 60–62.

13. Стратегия реабилитации земель, лесов, водоемов и обеспечения безопасных условий жизни людей на загрязненных радионуклидами территориях: утв. М-вом по чрезвычайным ситуациям Респ. Беларусь 3 мая 2007 г. Минск: Департамент по ликвидации последствий катастрофы на Чернобыльской АЭС, 2007. 10 с.

14. Переволоцкий А. Н., Булавик И. М. Основы ведения лесного хозяйства в условиях радиоактивного загрязнения. Минск: Белгослес, 2003. 144 с.

15. Устойчивое лесоуправление и лесопользование. Наставление по лесовосстановлению и лесоразведению в Республике Беларусь: ТКП 047–2009 (02080). Минск: Минлесхоз, 2010. 128 с.

16. О некоторых вопросах воспроизводства лесов в области лесовосстановления и лесоразведения: постановление М-ва лесного хоз-ва Респ. Беларусь, 19 дек. 2016 г., № 80 // Нац. правовой Интернет-портал Респ. Беларусь. 2017. 8/31578.

17. Правила лесовосстановления и лесоразведения: ТКП 667–2022 (33090). Минск: Минлесхоз, 2022. 25 с.

18. Правила ведения лесного хозяйства на территориях, подвергшихся радиоактивному загрязнению в результате катастрофы на Чернобыльской АЭС // Нац. правовой Интернет-портал Респ. Беларусь. 2017. 8/31754.

19. Переволоцкая Т. В. Радиационное лесоводство: основы лесохозяйственной деятельности: практ. рук-во для студентов специальности 1-75 01 01 «Лесное хозяйство». Гомель: ГГУ, 2014. 32 с.

20. Радиационный контроль. Объекты лесного хозяйства, рабочие места. Порядок проведения: ТКП 250–2010. Минск: Белстандарт, 2010. 27 с.

21. Босак В. Н., Сачивко Т. В., Домненкова А. В. Обеспечение радиационной безопасности в лесном хозяйстве Республики Беларусь // Дальневосточная весна – 2018: материалы 16-й Междунар. науч.-практ. конф. по проблемам экологии и безопасности, Комсомольск-на-Амуре, 27 апр. 2018 г. Комсомольск-на-Амуре, 2018. С. 221–224.

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