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СИСТЕМА УПРАВЛЕНИЯ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТЬЮ

Сборник трудов XIX международной научно-практической конференции (Екатеринбург, 15–16 мая, 2025 г.) включает статьи, посвященные различным теоретическим и практическим аспектам экологической безопасности

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RADIATION RISKS FOR TOURISTS IN THE BELARUSIAN EXCLUSION ZONE

The issue of radioactive contamination in the Republic of Belarus remains highly relevant to this day. To prevent the migration of long-lived radionuclides beyond the borders of the evacuation (exclusion) zone, the Polesie Radiation-Ecological Reserve was established. A controlled access regime is in place within the reserve. Although it is a restricted area, certain routes are open to tourists. However, visitors are not guaranteed protection from radiation exposure. This article attempts to highlight the primary reason for this concerning phenomenon.

As a result of the 1986 accident at the Chernobyl Nuclear Power Plant, radiation contamination affected a large portion of Belarus, becoming a major tragedy. The Gomel and Mogilev regions experienced the highest levels of radioactive contamination [1]. Currently, the radio-ecological situation is determined by the presence of long-lived radio nuclides. Among them are cesium-137 (^{137}Cs), strontium-90 (^{90}Sr), and transuranic elements (TUE), primarily plutonium isotopes (^{238}Pu , ^{239}Pu , ^{240}Pu , ^{241}Pu). The half-lives of these radionuclides range from 14 years (^{241}Pu) to 24,110 years (^{239}Pu), meaning the consequences of the Chernobyl disaster will persist for many generations of Belarusian residents [1–3].

To establish a special protected area, the Polesie State Radiation-Ecological Reserve was created on July 18, 1988, in the Belarusian part of the Chernobyl exclusion zone. It covers the three most affected districts of the Gomel region – Bragin, Narovlya, and Khoyniki. The reserve contains 96 abandoned settlements that once housed more than 22,000 residents before the accident [4].

The main functions of the Polesie Radiation-Ecological Reserve are implementing measures to prevent the spread of radio nuclides; protecting the reserve's territory and objects within it; monitoring radiation conditions and conducting ecological assessments of flora and fauna; carrying out scientific research on plant and animal life and the effects of radioactive contamination; developing technologies and strategies for rehabilitating contaminated lands (table).

Table

Distribution of the forest fund territory of the Republic of Belarus
by radioactive contamination zones as of 01.01.2024 [2]

Region	Area of soil contamination with cesium-137, thousand hectares					
	Total		By zones			
	thousand hectares	% of the total area of the forest fund	1–5 Ci/km ²	5–15 Ci/km ²	15–40 Ci/km ²	40 and above Ci/km ²
Total						
Republic of Belarus	1500,4	15,4	945,5	378,9	138,7	37,3
Regions:						
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	1020,6	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

As of today, the reserve spans 217173,8 hectares. The area of land provided to the institution for permanent use is 216877 hectares, including in the Braginsky district 64591 hectares (29,8 %), Narovlyansky – 64 103 hectares (29,5 %), Khoyniki – 88183 hectares (40,7 %). The Polesie Radiation-Ecological Reserve is the largest reserve in the Republic of Belarus and the only reserve of this type in the world [4].

The Polesie Radiation-Ecological Reserve is home to 1251 plant species – two-thirds of Belarus' total flora. Among them, 29 rare species are listed in the Red Book of endangered species. The reserve is also inhabited by 54 mammal species, over 120 nesting bird species, and more than 25 fish species. Forty-three fauna species are included in the Red Book and are protected under international conventions [4]. Polesie Radiation-Ecological Reserve is a unique corner of Belarus. Despite being a closed area, certain safer zones within the reserve are accessible to tourists for a fee. A group of 10 people can visit for 170 Belarusian rubles per person (about \$50) [5].

The official website of the reserve states that tourist routes pass through areas with the lowest radiation levels, making visits safe. However, concerns remain. The same website also states: «Foreign citizens and Belarusian nationals visiting the

exclusion zone for informational purposes are exposed to external and internal radiation due to environmental contamination (air, soil, water bodies, buildings, vehicles, equipment, etc.). Visitors acknowledge that the administration of the Polesie State Radiation-Ecological Reserve bears no responsibility for potential health deterioration (injuries, illnesses, radiation exposure, etc.) during their visit to the exclusion zone [5].

The administration's disclaimer suggests that radiation exposure remains a real risk. Let's try to figure it out.

The territory of the reserve is characterized by highly uneven distribution of long-lived radionuclides, particularly strontium-90 and transuranic elements. The contamination levels in many areas exceed legally permissible values for human habitation and economic activity. Due to the patchy distribution of radionuclides, the territory is legally classified as an evacuation (exclusion) zone rather than being divided by average contamination densities [6].

The reserve contains 30 % of all cesium-137 deposited in Belarus, 73 % of strontium-90, and 97 % of plutonium isotopes. The highest contamination levels are found in the 30-kilometer exclusion zone, classified as a strictly protected area within the reserve. The functional zoning of the reserve territory includes two zones: a zone of experimental economic activity (buffer) and a protected zone (main) [6].

The experimental-economic zone covers an area of 68 380 hectares and essentially serves as a buffer for the protected zone surrounding it. It is intended for the preservation and restoration of natural complexes, where experimental research, forestry, and other activities are permitted. According to research conducted by the reserve's staff, the contamination density in the experimental-economic zone reaches up to 190,5 Ci/km² for cesium-137, up to 28,9 Ci/km² for strontium-90, up to 0,196 Ci/km² for plutonium isotopes, and up to 0,934 Ci/km² for americium-241. The gamma radiation dose rate reaches 3,3 µSv/h. (Note: The normal background radiation dose rate for Belarus is 0,1-0,2 µSv/h) [6].

The protected zone, covering an area of 147 713 hectares, is a territory with the highest level of radiation contamination, where no economic activity is conducted. In

the reserve's protected zone, the contamination density reaches up to 455 Ci/km² for cesium-137, up to 73 Ci/km² for strontium-90, up to 3,8 Ci/km² for plutonium isotopes, and up to 5,3 Ci/km² for americium-241.

The gamma radiation dose rate reaches 200 µSv/h [6].

As a result of the natural beta decay of plutonium-241 nuclei in radioactive contaminated areas, a hazardous radionuclide, an alpha emitter—americium-241 (²⁴¹Am) – is formed. It has a half-life of 432 years and accumulates in quantities comparable to the main sources of alpha radiation. Americium-241 has radioactive properties similar to plutonium isotopes (²³⁸Pu, ²³⁹Pu, ²⁴⁰Pu), making it particularly important to assess the consequences of its increasing presence in the biosphere. Currently, ²⁴¹Am contributes 50% of the total alpha activity, and in a few decades, its contribution is expected to exceed the total alpha activity by almost two times [1, 3].

With their long half-lives, transuranic elements enter trophic chains and the cycle of matter, posing a radiological hazard to humans for thousands of years. Like other transuranic elements, americium-241 is predominantly found in the upper soil layer. The proportion of its mobile forms is 32% (compared to 4–15% for plutonium).

Due to the continuous formation of americium-241 from plutonium-241, the area of surface soil contamination with alpha-emitting transuranic radionuclides will continue to expand [1, 3]. Belarusian researchers predict [1, 3] that the activity of americium-241 in contaminated soil will continue rising until 2056. Even 100 years after the Chernobyl accident, soil alpha activity in affected areas will be 2,4 times higher than immediately after the disaster. A decline in americium-241 activity is expected only after the year 2400.

Given that the distribution of radio nuclides across the territory of the Polesie State Radiation-Ecological Reserve is uneven and that it is practically impossible to mark contaminated areas on the ground, there is a potential risk of radiation exposure. Therefore, the statement from the reserve administration addressed to tourists visiting these beautiful natural sites, that it bears no responsibility for any harm caused to their health, should be understood with full awareness.

Everyone is responsible for their own health!

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РАДИАЦИОННЫЕ РИСКИ ДЛЯ ТУРИСТОВ В БЕЛОРУССКОЙ ЗОНЕ ОТЧУЖДЕНИЯ