Accumulation of ^{90}Sr by *Betula pendula* in the zone of radioactive contamination (East Ural Radioactive Trace, Russia)

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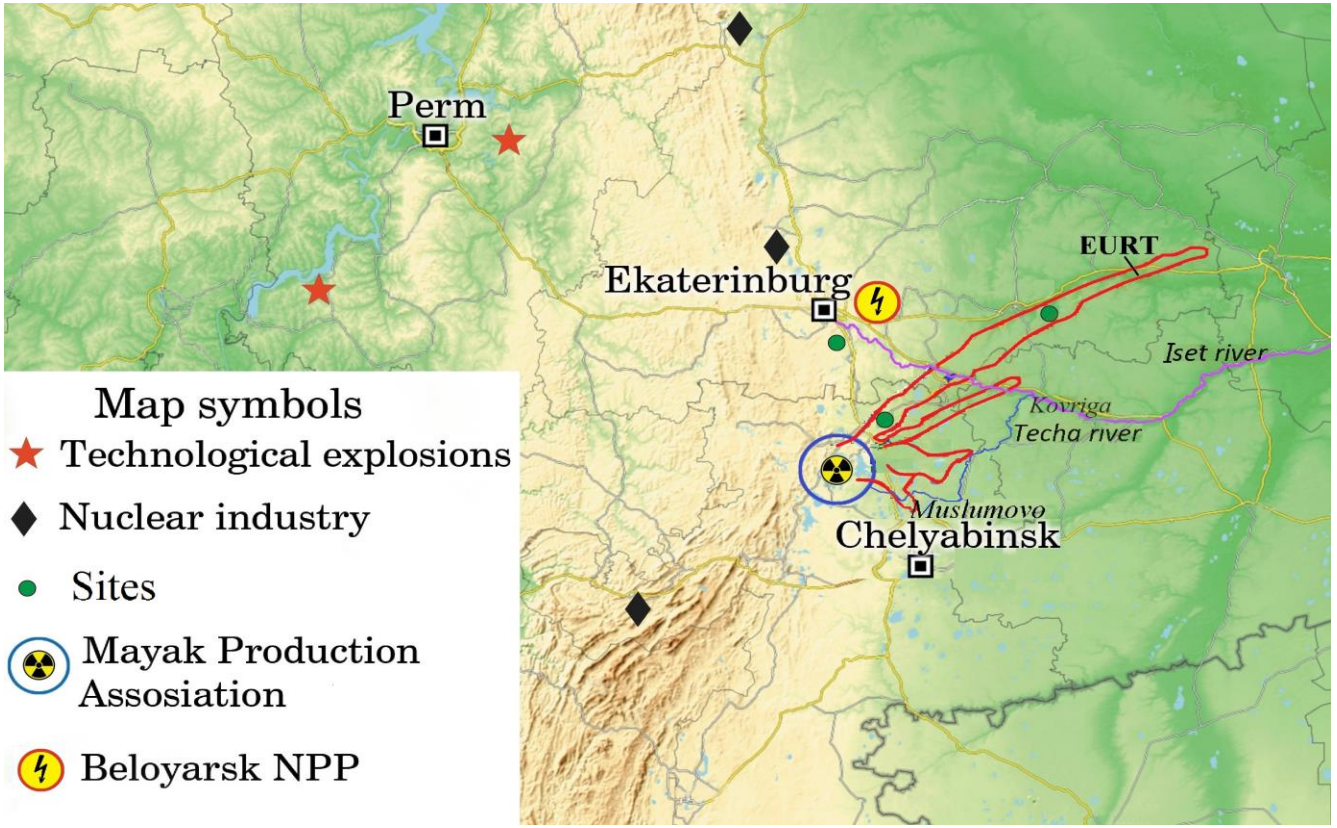
The study area



The East Ural Radioactive Trace (EURT) was formed in 1957 as a result of the accident at the "Mayak" enterprise. Many studies are devoted to the radionuclides entry into plants in the initial period (1–10 years) after the accident. Data of radionuclides inventory over long periods of time are very poor. Now the main pollutant is ^{90}Sr. A study of woody plants growing in a contaminated area for more than 60 years enables to reveal patterns of radionuclides distribution within a trees and evaluate the total stock of ^{90}Sr.

Research purpose

The aim of the investigation was to study the accumulation of ^{90}Sr by the aboveground organs of *Betula pendula* Rott., growing in the EURT zone.

Material and methods

We ranked the EURT territory according to the ^{90}Sr soil contamination density: impact part (5–30 km from the accident epicenter along the central axis, soil contamination density 100–70000 kBq·m^{-2}), buffer part (30–100 km, contamination density 10–100 kBq·m^{-2}). Control plots were selected outside the EURT (soil contamination density 0.5–2.9 kBq·m^{-2}). Samples of soils, leaves, branches 1–5 years old, branches 5+ years old, trunk (wood, bark) of birch were taken.

^{90}Sr from the soil and trees samples were isolated radiochemically. Measurement of β-activity of the preparations was carried out on the radiometer "UMF-2000" (Russia) with a lower detection limit of 0.2 Bq. All the data were calculated for air-dry weight.

^{90}Sr accumulation by birch organs in the impact zone of the EURT and in the background area

Organs	Ash, %	Concentration, kBq kg^{-1}	
		Dry weight mass	Ash
Impact			
Leaves	5.4±0.8	117.2±49.5	2142±573
Small branches	3.8±0.8	162.2±32.2	4302±860
Large branches	2.4±0.3	99.8±33.7	4141±796
Trunk	0.6±0.2	34.9±8.1	5816±1370
Background			
Leaves	5.9±0.2	0.03±0.01	0.5±0.2
Small branches	2.1±0.4	0.04±0.005	2.1±0.5
Large branches	1.6±0.1	0.03±0.001	1.9±0.3
Trunk	0.8±0.2	0.01±0.002	1.3±0.3

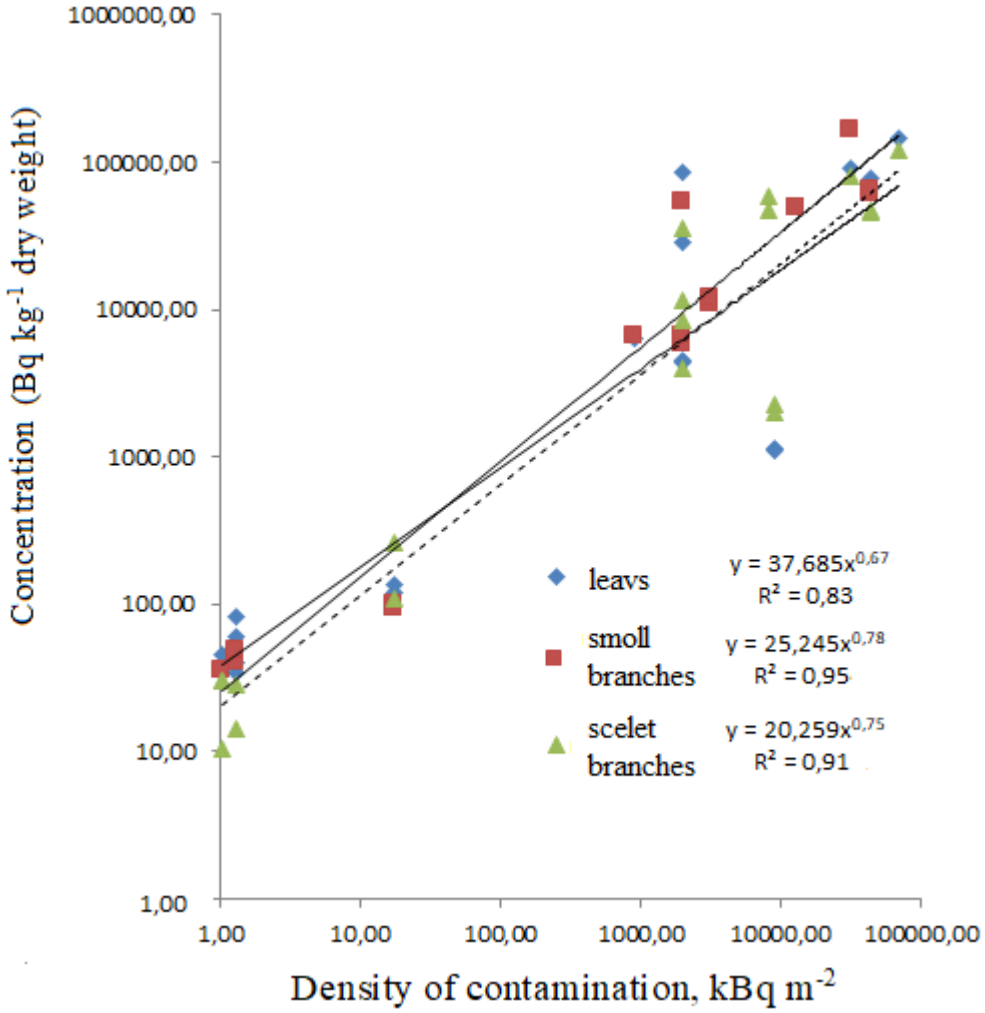
The distribution of ^{90}Sr in the aboveground organs of birch growing in the EURT and in the control plots was relatively similar (although the absolute values differed by 4-5 orders of magnitude). The concentration of ^{90}Sr increases in the line: trunk < large branches < (leaves + small branches).

Birch trunk: dry mass, ash content and ^{90}Sr content

Part of trunk	Mass (dry weight), %	Ash, %	^{90}Sr	
			Bk kg^{-1} dry weight	Total content, %
bark	17.1±2.1	1.81±0.33	44233±7945	47.8±7.3
wood	82.2±2.1	0.39±0.09	9410±1890	50.3±7.3
heartwood	0.6±0.3	2.50±0.81	31523±6299	1.8±1.0

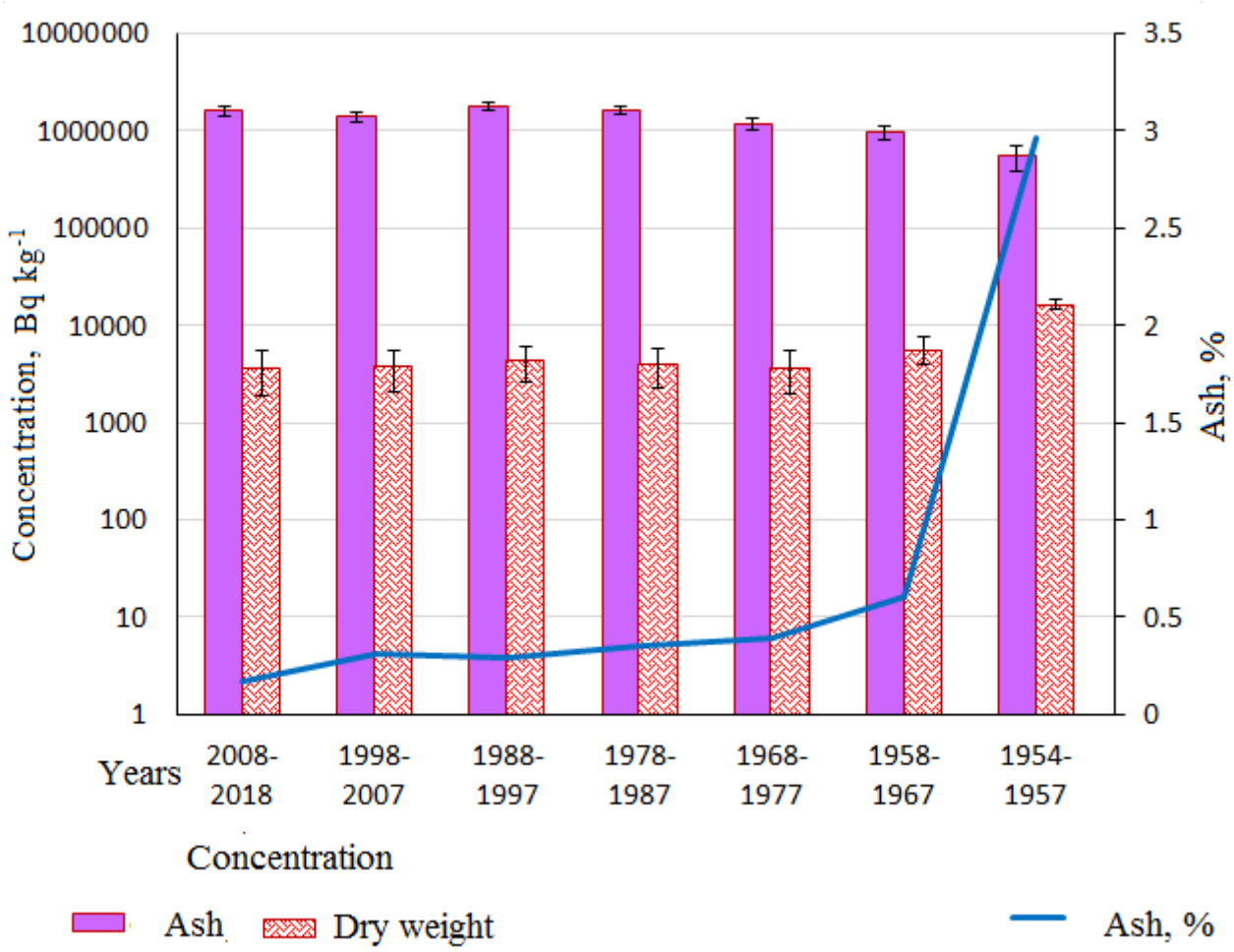
It is shown that the ^{90}Sr concentrations in the bark are higher than in wood. However, the total radionuclides content in the bark and wood is approximately the same. The content of ash elements in the heartwood of the trees was maximum.

Accumulation of ^{90}Sr with Betula pendula in the EURT gradient



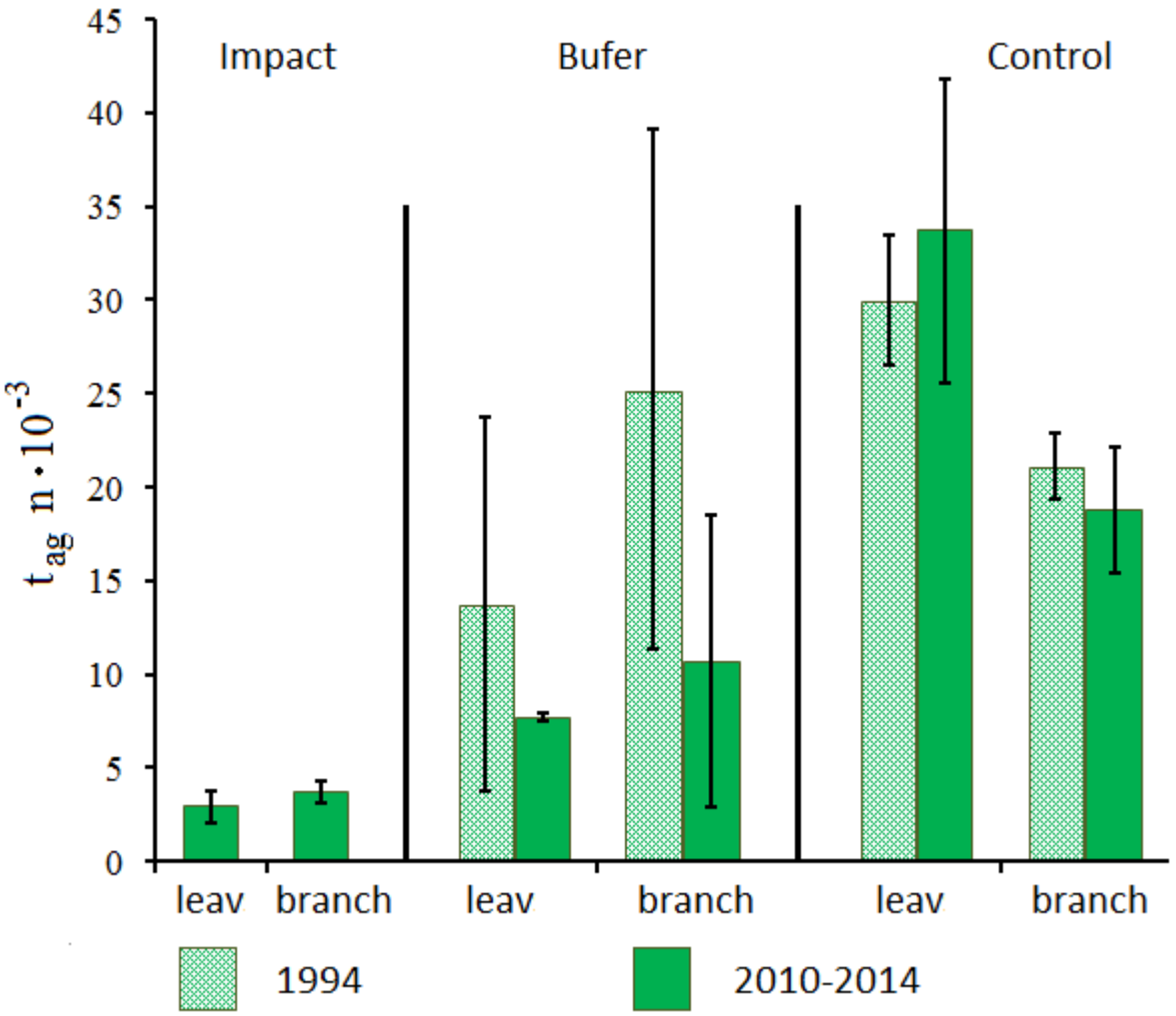
The concentrations of ^{90}Sr in air-dry matter of plants were increased with increasing soil contamination density in accordance with the exponential dependence.

The ^{90}Sr concentration in the annual rings of birch in the period from 1954 to 2018



The concentration of ^{90}Sr in wood annual rings (trees age were over 60 years) does not depend on the age of the wood layer. Its level rises only in heartwood, which was characterized by a high content of ash elements. In all cases, there is a positive correlation of ^{90}Sr concentration with the ash elements content in the organs of *Betula pendula* (R = 0.64–0.99, p = 0.95).

Aggregated transfer factors (t_{ag})



Aggregated transfer factors (t_{ag}) have been maintained at the same level over the past 20 years in each zone.

The aggregated transfer factor for plants of the impact zone is approximately an order of magnitude less than for control trees.

Conclusion

1. The concentration of ^{90}Sr increases in the line: trunk < large branches < (leaves + small branches). It is shown that the ^{90}Sr content in the bark is higher than in wood.
2. The concentration of ^{90}Sr in wood annual rings (trees age were over 60 years) does not depend on the age of the wood layer. Its level rises only in heartwood, which was characterized by a high content of ash elements. In all cases, there is a positive correlation of ^{90}Sr concentration with the ash elements content in the organs of *Betula pendula* (R = 0.64–0.99, p = 0.95).
3. The concentrations of ^{90}Sr in air-dry matter of plants were increased with increasing soil contamination density in accordance with the exponential dependence.
4. Aggregated transfer factors (t_{ag}) have been maintained at the same level over the past 20 years in each zone; t_{ag} for plants of the impact zone is approximately an order of magnitude less than for control trees.


Thank you for your attention!