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Data Article

Dataset of iodine concentration in soils and grassland vegetation and radioactive contamination of pastures of the regions of the Russian Federation affected by the Chernobyl NPP accident

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Dataset link: Dataset of iodine concentration in soils and grassland vegetation and radioactive contamination of pastures of the regions of the Russian Federation affected by the Chernobyl NPP accident (Original data)

Keywords:
Iodine deficiency
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Soils cover
Bryansk region
Oryol region

A B S T R A C T

Iodine is a trace element with an important role in human health. Iodine deficiency is a global health problem that can provoke iodine-deficiency-related thyroid disorders, such as endemic goitre, hypothyroidism, thyroid cancer, etc. Study of iodine in the soils and vegetation was conducted from 2008 to 2022 in the Bryansk and Oryol regions of Russia. These regions are known to exhibit natural iodine deficiency and have been affected by radioactive contamination following the Chernobyl accident in 1986. Soil and grassland vegetation samples were collected from local pastures near rural settlements. The soil core was divided into layers at the following depths: 0–5 cm, 5–10 cm, 10–20 cm. The iodine content in all selected samples was determined in the GEOKHI RAS using the kinetic rhodanide–nitrite method. The information in the dataset could be used to assess the iodine deficiency in the environment of other regions situated on similar soils.

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Specifications Table

Subject	Environmental Chemistry
Specific subject area	Iodine concentration in soils and grassland vegetation and radioactive contamination of pastures
Type of data	Table Analyzed
Data collection	The field studies were conducted between the years 2008 and 2022 during the vegetation period (July to August) on pastures situated in close proximity to human settlements. The gamma radiation equivalent dose and the ^{137}Cs activity in the near-surface layers were measured. A representative sample of the grasses was collected from a 20 × 20 cm or 40 × 40 cm area and the 20 cm soil core in the pastures near the settlements of the studied regions. The core was divided into three equal intervals, 0–5 cm, 5–10 cm and 10–20 cm. The iodine content in the soils and plants was determined using the kinetic rhodanite–nitrite method.
Data source location	Rural settlements of the Bryansk and Oryol regions of the Russian Federation, latitude from 52.05588°N to 53.952496°N, longitude from 031.419983°E to 037.2962229°E.
Data accessibility	Repository name: Mendeley Data Data identification number: 10.17632/9pf65bxy5r.1 Direct URL to data: https://data.mendeley.com/datasets/9pf65bxy5r/1

1. Value of the Data

- Iodine deficiency represents a significant global health concern. The prevalence of iodine deficiency in soils and pasture vegetation can lead to insufficient iodine intake, which in turn can provoke iodine-deficiency-related thyroid disorders. Therefore, it is crucial to identify the environmental factors that contribute to this deficiency.
- The provided dataset [1] presents the iodine content based on soil types. This information can be utilized to assess the natural iodine content in the environment of other regions with similar soil types.
- The data on radioactive contamination of the territory can be used to assess the natural-technogenic risk of thyroid disorders and thyroid cancer in the study area.

2. Background

Iodine is a trace element that plays an important role in human health. It regulates the function of the thyroid gland and ensures the production of thyroid hormones [2]. Iodine deficiency is a global health problem that can lead to a number of adverse health effects [3].

The study of iodine content in the soils and vegetation was carried out in the Bryansk and Oryol regions of Russia as these regions are known for natural iodine deficiency in the area, and because of radioactive contamination of the regions after the Chernobyl accident in 1986. The inhabitants of these regions were exposed to a phenomenon known as the “iodine impact” (significant exposure to ^{131}I), which was further compounded by the natural deficiency of trace elements [4].

The objective of creating this dataset is to evaluate the spatial heterogeneity of these factors in relation to soil types and texture, as this information could be used to evaluate the iodine deficiency in the environment of other regions situated on similar soils.

3. Data Description

3.1. Georeferenced information

The dataset includes information of spatial location of the sampling points: longitude and latitude (in degrees) and altitude (in meters) in WGS-84 coordinates system (Fig. 1), region, district of the region and the locality name.

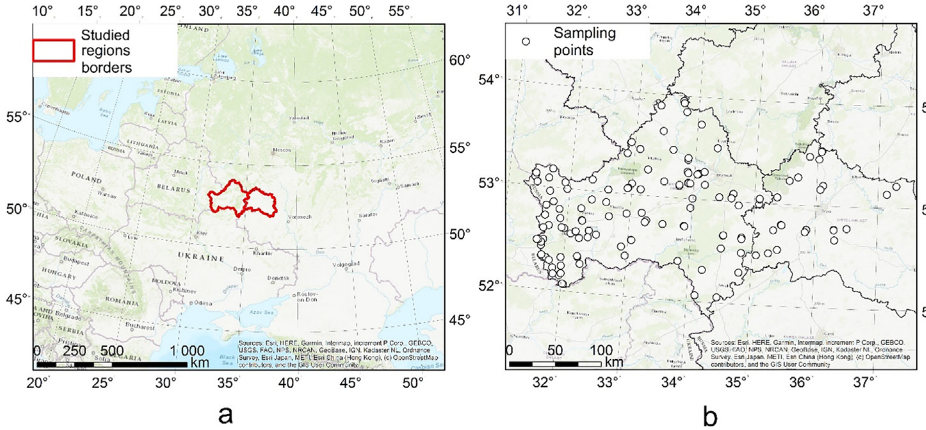

Fig. 1. The location of the studied regions (a) and sampling points (b).

Table 1
Statistics of iodine content in soil in 0–5 cm layer, mg/kg.

Soil type, WRB	N	Min	25 %	Median	75 %	Max	St. dev.
Umbric Albeluvisols Abruptic	85	0.18	0.51	0.78	1.2	3.7	0.63
Greyic Phaeozems Albic	42	0.20	0.69	1.0	1.9	15	2.6
Luvic Stagnosols Dystric	9	0.31	1.0	1.0	1.2	2.3	0.53
Fibric Histosols Eutric	4	0.53	0.81	1.6	2.3	2.6	0.94
Umbric Fluvisols Oxyaquic	8	0.07	0.5	0.84	1.9	3.2	1.1
Gleyic Albeluvisols Abruptic	2	0.78	0.78	0.8	0.82	0.82	0.028
Haplic Fluvisols Oxyaquic	2	0.77	0.77	3.4	6.0	6.0	3.7
Luvic Phaeozems Albic	8	0.42	1.4	2.4	3.1	3.3	1.0
Voronic Chernozems Pachic	2	2.0	2.0	3.8	5.7	5.7	2.6
Total	162	0.07	0.61	0.9	1.5	15	1.6

3.2. Information of the iodine content in soil and vegetation

The soil cover of the Bryansk region is diverse, with the main background soil types being *Umbric Albeluvisols Abruptic* (soil types according to World Reference Base for Soil Resources (WRB) [7]) and *Greyic Phaeozems Albic.*

The soil cover of the Oryol region mainly comprising *Voronic Chernozems Pachic* and *Greyic Phaeozems Albic*. The heterogeneity of the soil cover of the territory is a consequence of the region's location at the border of two natural zones: steppe and forest-steppe. The formation of soils was influenced by the different vegetation cover present in each zone. The statistics of iodine content in soil of different types are provided in Tables 1–3.

The statistics of iodine content in grassland cuttings on different soil types are provided in Table 4.

3.3. Information of the radioactive pollution of the territory

The dataset includes information of ^{137}Cs pollution of the surface (in kBq/m^2) and gamma radiation equivalent dose in the near-surface level (in µSv/h).

Table 2
Statistics of iodine content in soil in 5–10 cm layer, mg/kg.

Soil type, WRB	N	Min	25 %	Median	75 %	Max	St. dev.
Umbric Albeluvisols Abruptic	85	0.036	0.43	0.71	1.2	3.8	0.64
Greyic Phaeozems Albic	42	0.36	0.59	0.94	1.4	11	1.7
Luvic Stagnosols Dystric	9	0.43	0.84	0.92	1.6	2.4	0.62
Fibric Histosols Eutric	4	0.44	0.66	0.98	1.3	1.5	0.45
Umbric Fluvisols Oxyaquic	8	0.27	0.50	0.79	1.1	2.3	0.64
Gleyic Albeluvisols Abruptic	2	0.60	0.60	0.72	0.85	0.85	0.18
Haplic Fluvisols Oxyaquic	2	0.41	0.41	2.7	5.0	5.0	3.3
Luvic Phaeozems Albic	8	0.48	1.6	2.4	2.6	2.8	0.79
Voronic Chernozems Pachic	2	2.4	2.4	3.3	4.2	4.2	1.3
Total	162	0.036	0.50	0.84	1.5	11	1.1

Table 3
Statistics of iodine content in soil in 10–20 cm layer, mg/kg.

Soil type, WRB	N	Min	25 %	Median	75 %	Max	St. dev.
Umbric Albeluvisols Abruptic	77	0.16	0.46	0.62	1.1	4.2	0.65
Greyic Phaeozems Albic	41	0.18	0.72	1.0	1.5	10	1.5
Luvic Stagnosols Dystric	9	0.41	0.69	0.83	1.1	1.3	0.31
Fibric Histosols Eutric	4	0.35	0.48	0.63	1.1	1.5	0.5
Umbric Fluvisols Oxyaquic	8	0.27	0.47	0.63	0.75	2.0	0.53
Gleyic Albeluvisols Abruptic	2	0.52	0.52	0.66	0.81	0.81	0.21
Haplic Fluvisols Oxyaquic	2	1.0	1.0	2.8	4.6	4.6	2.5
Luvic Phaeozems Albic	8	1.1	1.9	2.4	2.8	3.0	0.65
Voronic Chernozems Pachic	2	2.4	2.4	3.3	4.2	4.2	1.2
Total	153	0.16	0.51	0.81	1.3	10	1.1

Table 4
Statistics of iodine content in grassland cuttings, mg/kg.

Soil type, WRB	N	Min	25 %	Median	75 %	Max	St. dev.
Umbric Albeluvisols Abruptic	88	0.027	0.075	0.12	0.23	0.55	0.13
Greyic Phaeozems Albic	42	0.027	0.15	0.25	0.37	0.86	0.18
Luvic Stagnosols Dystric	9	0.089	0.24	0.34	0.45	0.61	0.18
Fibric Histosols Eutric	4	0.11	0.12	0.15	0.24	0.33	0.098
Umbric Fluvisols Oxyaquic	8	0.083	0.1	0.13	0.21	0.32	0.083
Gleyic Albeluvisols Abruptic	2	0.077	0.077	0.08	0.083	0.083	0.0041
Haplic Fluvisols Oxyaquic	2	0.032	0.032	0.085	0.14	0.14	0.075
Luvic Phaeozems Albic	8	0.073	0.11	0.19	0.24	0.25	0.072
Voronic Chernozems Pachic	2	0.17	0.17	0.19	0.2	0.2	0.021
Total	165	0.027	0.09	0.15	0.27	0.86	0.15

4. Experimental Design, Materials and Methods

The field studies were carried out between 2008 and 2022 by 9 sampling companies (in the years 2008–2012, 2016–2017, and 2021–2022) during the vegetation period (July to August). Sampling was carried out on pastures located in the vicinity of rural settlements (within a 2.5 km radius of the center point of the settlement) in the Bryansk and Oryol regions of the Russian Federation. The settlements under investigation were situated in areas affected by varying degrees of radioactive iodine fallout and were located on different types of soils.

In each of the settlements under study, the pastures were selected according to the terrain, with autonomous (dryland) and subordinate (mesohydrophytic and hydrophytic meadows) areas being considered.

During the field survey of the test pastures, the following procedure were carried out:

(1) Georeferencing the sampling point coordinates (longitude, latitude, altitude) using GPSmap 62 stc (Garmin, USA) in WGS-84 coordinate system.
(2) Selection of the representative sampling points, taking into account that terrain, soil, and vegetation are typical for the pasture.
(3) Measurement of soil ^{137}Cs contamination density using a portable gamma-spectrometer Violinist III (TSA Systems ltd., USA) with a scintillation detector of SPA-3 type with NaI(Tl) crystal.
Laboratory calibration of the detector was carried out on ^{137}Cs standard calibration sources and demonstrated a sufficiently high sensitivity (17 % efficiency in the total absorption peak). During the studies the detector was installed directly on the soil surface, after which the spectrum was acquired for 90 s and the count rate in the total absorption peak of the gamma line of the ^{137}Cs was determined.
(4) Measurement of gamma radiation equivalent dose using MIRA-661 (Genitron Instruments GmbH, Germany) and RadiaCode-101 (Scan Electronics LLC, Russia) dosimeters with a scintillation detector with CsI(Tl) crystal. The sensor was situated on the ground surface and the measurements exposition was 90 s. The instrument calibration was performed by the manufacturer in The D.I. Mendeleev All-Russian Institute for Metrology.
(5) Cutting an average sample of the grasses from a 20 × 20 cm or 40 × 40 cm area (depending on the homogeneity and density of phytomass) using shears at a height of 2 cm from the soil surface. Where available, additional sampling of *Trifolium* and *Deschampsia* was separately conducted.
(6) Soil type and texture determine according to Russian national Unified State Register of Soil Resources [5] and WRB [6].
(7) Soil sampling with a soil sampling tube from the top 20 cm layer with partition of the probe in 3 layers: 0–5 cm, 5–10 cm, 10–20 cm.

Chemical analysis of the samples was conducted in the laboratory of biogeochemistry of environment of the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences.

The iodine content in soils and plants was determined by the kinetic method of Proskuryakova and Nikitina [7]. This method involves determining the rate of the oxidation reaction of ferric rhodanide, which depends on the concentration of iodide ions, which act as catalysts. The reaction speed was determined by measuring the change in light absorption of the solution, which is colored with iron rhodanide and has an orange–red color. The color of the solution changes upon oxidation of rhodanide, with the concentration of iodine in the solution influencing the speed of this process. This is demonstrated by the decrease in the optical density of the solution, as measured by a photoelectrocolorimeter KFK-3-01 (ZOMZ, Russia) at specific time intervals. The principal advantage of this method is that the maximum optical density of the iron rhodanide solution is within the visible part of the spectrum (430 nm), which allows the use of any photoelectrocalorimeter. Furthermore, the rhodanide–nitrite reaction is less sensitive to temperature fluctuations than other methods. The determination error was less than 5 %. For chemical determination of iodine content in soil a 0.5 g sample was filled with 30 % K_2CO_3 solution, dried and calcined at 480 °C. The calcined sample was transferred into a 50 ml solution.

For chemical determination of iodine content in vegetation a 0.2 g sample was filled with 3 % K_2CO_3 solution, dried and calcined at 480 °C. The calcined sample was centrifuged and transferred into a 10 ml solution.

Iodine measurements in both soil and plant samples were performed in triplicate, with two control samples for each measurement.

Limitations

The dataset encompasses data solely pertaining to the soil and vegetation sampled across all 27 rural districts of the Bryansk region and 10 of the 24 rural districts of the Oryol region. The dataset excludes information pertaining to the iodine content of soils utilized for private farming or crop production. As detailed in the “Experimental design, methods, and materials” section, only the total iodine content was determined.

Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief and confirming that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms. All samples taken from the private agricultural property were collected with the prior consent of the landowners.

CRediT Author Statement

Vladimir Baranchukov: Writing - Original Draft, Software, Investigation, Resources, Visualization, Data Curation. **Victor Berezkin:** Writing - Original Draft, Methodology, Investigation, Resources. **Liudmila Kolmykova:** Investigation, Resources.

Data Availability

Dataset of iodine concentration in soils and grassland vegetation and radioactive contamination of pastures of the regions of the Russian Federation affected by the Chernobyl NPP accident (Original data) (Mendeley Data)

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The data collection was founded by the state task of the laboratory of biogeochemistry of environment of the Vernadsky Institute of Geochemistry & Analytical Chemistry of the Russian Academy of Sciences (GEOKHI RAS).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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