

CHAPTER 7

RADIOBIOGEOCHEMICAL ASSESSMENT OF SOIL- VEGETATION COVER OF AGROECOSYSTEM OF THE ISSYKKUL REGION, KYRGYZSTAN

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The results of studies on the content of radionuclides in soils and seeds of grain crops in agroecosystems of the Issyk-Kul region are presented.

The geochemical conditions of the Issyk-Kul basin and the presence of carbonaceous-siliceous shales enriched in uranium determine the increased uranium content in the soils of the basin and in the lake. Issyk-Kul lake serve the basis for the emergence of biogeochemical uranium provinces. Uranium tailings dumps and dumps on the territory of the republic are potential sources of pollution of atmospheric air, soil, underground aquifers - sources of drinking water supply, as well as plant and soil cover, wildlife and humans. The need for constant radioecologic monitoring of the territories is emphasized. The growth of plants under these geochemical environmental conditions is of particular interest.

The purpose of this study was to assess the levels of accumulation of radionuclides in soils and seeds of grain crops in agroecosystems of the Issyk-Kul region.

In this article the analysis of the scope of uranium mining in Respublika Kyrgyzstan is given. Current environmental questions connected with environmental pollution are covered. Uranium tailings and waste dumps on the territory of the Republic are potential sources of pollution of atmospheric air, soil, groundwater aquifers, sources of drinking water, as well as land cover, animal world and man. The need for continuous radiation monitoring of territories is emphasized.

Keywords: *agroecosystems, radioecology, radiobiology, monitoring, uranium, radiobiogeochemistry, soils, plants, Issyk-Kul region, Kyrgyzstan*

INTRODUCTION

In Kyrgyzstan, the uranium mining industry began at the beginning of the twentieth century in the south of the republic, in the mountainous frame of the Fergana Valley of the Teo-Moyun deposit. Since ancient times, this mine has been known to the local population for the extraction of copper ore.

Before the development of the 20th century, an ancient mine was located here. In the Middle Ages, it was actively developed by the Chinese. For the first time in the Teo-Moyun copper mine, geologist V.A. Spechev collected uranium minerals; samples were brought to Tashkent, then to the Petrograd Mining Institute. From 1907 to 1913 The Teo- Moyun deposit was exploited by a private enterprise, and ore processing was carried out at the St. Petersburg trial plant.

During the work of the Fergana Society, in the Teo-Moyun deposit 820 tons of ore were mined, of which about 655 tons were exported to St. Petersburg and processed into radium and uranium preparations, which were exported to Germany, since at that time they were not sold on the Russian domestic market. Teo-Moyun radium mine is the only one in Russian Empire and the first in USSR mining enterprise uranium ore (Dzhenbaev & Mursaliev, 2012; Fersman, 1927).

According to academician A.E. Fersman, the Teo-Moyun mine was at that time the only unique uranium vanadium mine in the world. During these years, Academician V.I. Vernadsky, geologists D.I. Mushketov, D.V. Nalivkin, V.N. Weber, D.I. Shcherbakov and other specialists visited the Teo-Moyun mine (Fersman, 1927).

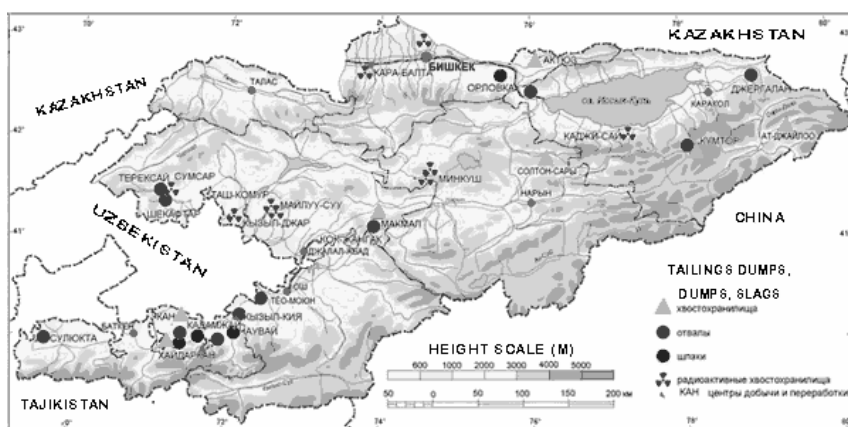


Fig. 1. Tailings dumps, dumps, slags and main centers of mining and processing of minerals in Kyrgyzstan (Torgoev & Aleshin, 2009).

By the estimates of geologists and geochemists, more than 10 thousand are known on the territory of the Republic mineral deposits, of which 1000 are considered promising. The mountains are rich in a variety of minerals, which have been mined from ancient times to the present day, their total radioactivity exceeds 90 thousand curies (Bakirov, 1997; Vasiliev, 2006; Dzhenbaev et al., 2013; Current state and prospects, 2013; Torgoev & Aleshin, 2009) (Fig. 1).

With the outbreak of the First World War, the study of radioactive minerals and ores in the south of Kyrgyzstan almost ceased, although in 1915-1916. Expeditionary research continued under the leadership of Academician V.I. Vernadsky.

In 1923, the mine was transferred for industrial operation to the Association of Bondyuzh Chemical Plants, within which, under the leadership of Ivan Bashilov, who developed the technology for extracting radium from complex Teo-Moyun ores, a radium plant was created. Ore reserves prepared for mining were estimated at 5 thousand tons with a content of 1 gram of radium metal in 250-300 tons of mined ore.

In 1928, the production of uranium and vanadium compounds from Teo-Moyun ore was organized at the Moscow Redelem plant. However, in 1923, the Presidium of the Supreme Economic Council announced that the entire territory of the USSR was closed to the production of allotments for uranium mines. The export abroad of radium ores in general and Teo-Moyun ore in particular was prohibited, i.e. radium was recognized as a strategic raw material, and uranium as a currency value. Thus, the Teo-Moyun mine in Kyrgyzstan for many years was the only source of uranium and radium in Russia and marked the beginning of the development of the uranium mining industry in the USSR.

Soviet historians and archaeologists have proven that mining was widely developed in Central Asia in ancient times. Since 1940, in connection with work on the practical use of atomic energy, primarily for military purposes, the rapid development of the uranium mining industry began and the “uranium” stage of development of radioactive ores and minerals began. By this time, deposits of radiobarite were discovered on board the Fergana Valley in the Majli- Su tract (1929) by academician A.E. Fersman, and they were identified as a large industrially significant object with uranium reserves of over 10 thousand tons, and then a number of uranium deposits were explored in Shekaftar, Kyzyl-Jar, Rishtan, Nikchesay, Shaydansay, Kazanmazar, Charvak, Besh-Bodam, Suzak. In general, the radioactive deposits (radioactive ores and minerals) of Kyrgyzstan for about 100 years first served as the only sources of radium and uranium raw materials in pre-revolutionary Russia, and then the first

Soviet radium was obtained from the ores of these deposits. Kyrgyzstan was the largest uranium producer in the former Soviet Union (Dzhenbaev et al., 2013; Fersman, 1927; Djenbaev et al., 2012).

In Kyrgyzstan, there are serious environmental problems associated with uranium mining and processing. Due to natural disasters: earthquakes, landslides, mudflows, wind and water erosion, the threat of further contamination of the territory of the republic with radioactive substances increases. As a result of these natural phenomena, a number of uranium tailings dumps were damaged. Most of the tailings dumps, mines, and storage facilities are in disrepair and poorly guarded.

The following activities urgently need to be carried out on the territory of Kyrgyzstan: radioecological assessment of the main radioactive sources; assess the volume of rehabilitation work; develop radiation protection infrastructure aimed at the long term.

It is known that all uranium mines in the republic were closed at the end of the 60th year of the twentieth century, but a huge amount of environmentally hazardous waste remained on the territory of the republic, mainly located along rivers in foothill and mountain areas. Currently, in the republic, the majority of tailings ponds and dumps are in disrepair, subject to water and wind erosion and are located in seismic, landslide and mudflow-prone areas.

In the event of their destruction, the likelihood of which is high, vast territories located below, in the valleys where most of the population lives, as well as the flat territories of neighboring states, will be contaminated with substances of the first and second classes of chemical hazard, including radioactive elements (Kyrgyzstan, Uzbekistan, Kazakhstan and Tajikistan).

After the declaration of independence (1991 г.), Kyrgyzstan began to cooperate with many international organizations on this issue, such as: UN, IAEA, EU, UNESCO, UNDP, IMF, etc. The priorities in the territory of Kyrgyzstan, together with experts from the IAEA TC for the medium term, were identified following areas (2007 г.).

Rehabilitation of the consequences of uranium mining and processing pass along with international organizations.

MATERIALS AND METHODS

When selecting soil samples, we used the soil classification adopted when compiling the soil map of the Kirghiz SSR. Soil sampling was carried out in accordance with GOST 28168-89 "Soils. Sampling" (GOST 28168-89. Soils, sampling, 1989; Karpov, Savostin, 2003; Unified rules for sampling environmental objects, 1980).

In the places where soil samples were taken, samples were taken of spikelets of grain crops represented by wheat varieties zoned for the region (Intensive, Erythrospermum-80, Bezostaya-1, Kazakhstan-10). Sampling was carried out according to methodological instructions MU 1.2. 27.42-10 (Karpov, Savostin, 2003; Guidelines. Sampling procedure for the detection and identification of nanomaterials in plants, 2010; Unified rules for sampling environmental objects, 1980).

A general soil analysis was carried out at the Republican Soil-Agrochemical Station. The determination of radionuclides in soil and wheat seeds was carried out using instrumental gamma spectrometry at the Biological and Soil Institute of the National Academy of Sciences of the Kyrgyz Republic.

RESEARCH RESULTS AND DISCUSSION

The results of soil-agrochemical soil analyzes are presented in Table 1.

The control areas of the study region are represented by mountain-valley light chestnut, dark chestnut, light brown soils, the mechanical composition of which is mainly medium loamy. The humus content varies in the range of 2.29-4.32%, which is typical for the values of the types of the region under study.

The soils are sufficiently provided with mineral nutrition elements, the content of total nitrogen varies in the range of 0.106-0.181%, phosphorus 0.147-0.195%, potassium 2.0-2.4%. The described soils are mainly weakly carbonate 0.22-1.76%. The reaction of the soil solution is alkaline 8.0-8.4.

The absorption capacity is 14-24 mg. eq on 100 r. The content of mobile forms of phosphorus varies in the range of 1.12-9.73 mg/100 g, exchangeable potassium 27.8-37.2 mg/100 g.

Table 1. Soil-agrochemical indicators of soils in the Issyk-Kul region

Sampling location (s.)	Type soil	Humus, %	CO ₂ %	pH	Absorption capacity mEq.	Gross %		
						N	P	K
Grigorievka	St. chestnut.	4.32	1.1	8.25	24	0.181	0.170	2.0
Tyup	St. chestnut.	3.85	0.22	8.0	22.6	0.156	0.147	2.4
Maman	Tem.chestnut.	3.28	0.13	8.30	19.6	0.170	0.170	2.3
Barskoon	St. chestnut.	2.29	1.76	8.40	14.0	0.112	0.195	2.0
Tone	St. brown	2.39	0.92	8.40	14.2	0.106	0.161	2.4

The results of gamma spectrometric analysis for the determination of radionuclides in soil samples of the Issyk-Kul region are presented in Table 2.

According to the biogeochemical classification, natural radionuclides (^{238}U , ^{226}Ra , ^{232}Th , ^{40}K) are characterized by weak accumulation in soil (from 2 to 10 clarks). The content of artificial radionuclide (^{137}Cs) in the soil does not exceed permissible intervention levels (NRB-99).

^{238}U (^{234}Th). Clark ^{238}U in soil is 12.4 Bq/kg, for sedimentary rocks - 39.7 Bq/kg, in the soils of the Issyk-Kul region the specific activity of ^{238}U varies in the range of 42.3-106.6 Bq/kg, with an average of 70.6 Bq/kg.

^{226}Ra . In the soils of the Issyk-Kul region, the specific activity of ^{226}Ra varies in the range of 59.4-111.7 Bq/kg, with an average of 75.6 Bq/kg. The radioactive equilibrium between ^{234}Th / ^{226}Ra in soils is shifted slightly towards radium (0.94), however, for chestnut soils in the region. It was (1.55), which indicates the prevailing concentrations of uranium in the soil.

^{232}Th (^{228}Ac). Clark ^{232}Th in the soil is 24.6 Bq/kg, for sedimentary rocks - 45 Bq/kg, in the soils of the Issyk-Kul region the specific activity of ^{232}Th varies in the range of 61-112.2 Bq/kg, with an average of 72.9 Bq/kg

^{40}K . The Clark content of ^{40}K in the earth's crust is 655 Bq/kg, in soil - 370 Bq/kg. In the soils of the Issyk-Kul region, the specific activity of ^{40}K varies in the range of 861-1012 Bq/kg, with an average of 929.4 Bq/kg.

^{137}Cs . The intervention level (MAL) of ^{137}Cs in the soil is 15 Bq/kg, in the soils of the Issyk-Kul region the specific activity of ^{137}Cs varies in the range of 4.1-9.5 Bq/kg, with an average of 7.2 Bq/kg, which is (0.27-0.63), on average 0.48 MPL.

According to literature data, the uranium content in plant ash on soils with content varies from $1.0 \cdot 10^{-8}$ to $5 \cdot 10^{-7}$ g/g (Vinogradov, 1957). As noted by D.P. Malyuga (1963), the ash of plants growing on soils with normal concentrations of uranium contains $n \cdot 10^{-6}$ - $7 \cdot 10^{-5}$ % of this element. The

average uranium content, according to V.V. Kovalsky et al. (1968), ranges from 0.04 to $5 \cdot 10^{-4}$ % in terms of dry matter.

The amount of uranium in the ash of plants in Northern Kyrgyzstan varies from $0.20 \cdot 10^{-4}$ to $10.94 \cdot 10^{-4}$ % (Sultanbaev, Bykova, 1971). In wheat seeds from the Issyk-Kul region, the specific activity of ^{238}U varies in the range of 9-10 Bq/kg, with an average of 9.5 Bq/kg.

The specific activity of thorium-232 in plants of steppe forbs is 2.5 Bq/kg (Kabata-Pendias and Pendias, 1989). In wheat seeds from the Issyk-Kul region, the specific activity of ^{232}Th varies in the range of 4-22 Bq/kg, with an average of 10 Bq/kg.

According to A.P. Vinogradov (1957), the average clark content of radium-226 in plant ash is $n \cdot 10^{-11}$ %. According to other authors, the content of ^{226}Ra in plants varies from $0.3 \cdot 10^{-11}$ to $1.6 \cdot 10^{-12}$ % of dry weight (Vinogradov, 1957; Kabata-Pendias et al., 1989). In wheat seeds from the Issyk-Kul region, the specific activity of ^{226}Ra varies in the range of 9-14 Bq/kg, with an average of 12 Bq/kg.

Potassium-40 is one of the main natural radionuclides widely distributed in soils, plants and other objects of the natural environment. Taking this into account, a special concept of “potassium background” was introduced, reflecting the contribution of potassium-40 to the total content of radionuclides. The content of potassium-40 in wheat seeds in the Issyk-Kul region varied in the range of 4104 - 6519 Bq/kg, with an average of 4987 Bq/kg.

In general, the research results showed that the highest specific activity in wheat seeds is observed for potassium-40, as one of the most common natural radionuclides in nature, which, in turn, is one of the main sources of natural radioactivity. All radionuclides are characterized by weak accumulation, with the exception of ^{40}K , whose CBP is 5.3.

The specific activity of cesium-137 in wheat seeds in the Issyk-Kul region varies between 0.8-1.5 Bq/kg. The results of studies to determine the artificial radionuclide - ^{137}Cs in wheat seeds in the Issyk-Kul region showed that their specific activity is much lower than the established radiation safety standards.

Table 2. Specific activity of radionuclides in soils of the Issyk-Kul region

Place of selection	Type soil	²³⁴ Th, Bq/kg	²²⁶ Ra, Bq/kg	²¹⁴ Pb, Bq/kg	²¹⁴ Bi, Bq/kg	²¹⁰ Pb, Bq/kg	²²⁸ Ac, Bq/kg	²²⁴ Ra, Bq/kg
With. Grigorievka	Light chestnut	49.1 ± 2.6	59.4 ± 3.6	40.6 ± 1.0	38.3 ± 0.8	63.2 ± 3.4	61.6 ± 1.3	61.4 ± 3.8
With. Tyup	Light chestnut	106.6 ± 1.7	68.7 ± 2.1	39.1 ± 0.5	36.0 ± 0.4	82.8 ± 2.0	61.0 ± 0.7	68.0 ± 2.1
With. Maman	Dark-chestnut	42.3 ± 2.5	66.8 ± 3.6	41.4 ± 1.0	39.5 ± 0.9	72.6 ± 3.4	62.2 ± 1.3	65.5 ± 3.6
With. Barskoon	Light chestnut	57.8 ± 2.7	71.5 ± 3.7	50.4 ± 1.1	45.4 ± 0.9	75.3 ± 3.4	67.5 ± 1.3	79.2 ± 3.8
With. Tone	Light brown	97.3 ± 3.2	111.7 ± 4.2	76.7 ± 1.3	69.2 ± 1.0	123.9 ± 4.0	112.2 ± 1.5	121.6 ± 4.3

Table 2, continued

Place of selection	Type soil	²¹² Pb, Bq/kg	²¹² Bi, Bq/kg	²⁰⁸ Tl, Bq/kg	²³⁵ U, Bq/kg	²²⁷ Th, Bq/kg	⁴⁰ K, Bq/kg	¹³⁷ Cs, Bq/kg
With. Grigorievka	Light chestnut	68.7 ± 0.7	56.3 ± 3.0	64.1 ± 1.3	2.3 ± 0.2	1.7 ± 0.7	879 ± 12	4.1 ± 0.2
With. Tyup	Light chestnut	66.8 ± 0.4	56.8 ± 1.7	63.4 ± 0.7	4.9 ± 0.1	3.0 ± 0.4	984 ± 6	9.5 ± 0.1
With. Maman	Dark-chestnut	68.6 ± 0.7	61.2 ± 3.1	64.9 ± 1.3	2.0 ± 0.2	3.0 ± 0.7	861 ± 10	9.0 ± 0.3
With. Barskoon	Light chestnut	77.4 ± 0.7	71.4 ± 3.3	74.8 ± 1.4	2.7 ± 0.2	1.7 ± 0.7	911 ± 10	6.2 ± 0.2
With. Tone	Light brown	119.4 ± 0.9	105.8 ± 3.7	113.4 ± 1.6	4.5 ± 0.2	3.7 ± 0.8	1012 ± 10	7.4 ± 0.3

Computer programs and mathematical modeling are currently widely used in radioecological environmental monitoring. Erica program tool 1.2. is software that is used to assess radiation hazards to terrestrial, freshwater and marine ecosystems. Knowing the content of radioactive elements in soil or water, the program makes calculations and models their content for plants, animals and other organisms, and also provides an estimate of radiation doses.

The results of gamma spectrometric analysis for the determination of radionuclides in grain seeds are presented in Table 3.

Table 3. Specific activity of radionuclides in wheat seeds (for ash)

Place of selection	²³⁴ Th, Bq/kg	²²⁶ Ra, Bq/kg	²¹⁴ Pb, Bq/kg	²¹⁴ Bi, Bq/kg	²¹⁰ Pb, Bq/kg	²²⁸ Ac, Bq/kg
With. Grigorievka	<10	<13	7 ± 1	5 ± 2	42 ± 8	11 ± 3
With. Tyup	<10	<12	<2	<3	70 ± 8	9 ± 3
With. Maman	9 ± 4	<9	6 ± 1	4 ± 1	55 ± 6	<4
With. Barskoon	<9	<12	8 ± 1	4 ± 2	53 ± 8	<4
With. Tone	<9	14 ± 7	9 ± 1	9 ± 2	18 ± 7	22 ± 3

Table 3, continued

Place of selection	²²⁴ Ra, Bq/kg	²¹² Pb, Bq/kg	²¹² Bi, Bq/kg	²²⁷ Th, Bq/kg	⁴⁰ K, Bq/kg	¹³⁷ Cs, Bq/kg
With. Grigorievka	12 ± 7	1.5 ± 0.7	19	<4	5459 ± 55	<1.5
With. Tyup	<11	1.7 ± 0.7		<4	4104 ± 50	<1.2
With. Maman	<8	<0.8	8	<3	4723 ± 37	<0.8
With. Barskoon	12 ± 7	4.2 ± 0.7	10	<4	4134 ± 49	<1.4
With. Tone	<10	3.8 ± 0.7	18 ± 7	<3	6519 ± 55	<1.3

Results of radioecological assessment using the Erica program tool 1.2. show that the calculated risk factor for the agroecosystems of the Issyk-Kul region varies in the range of 0.72-0.90 (Table 4).

Erica program database tool 1.2. If the calculated value of the risk factor is less than 1, then the radiation dose rate to living organisms is insignificant.

Table 4. Sum of risk factors for agrocenoses in the Issyk-Kul region

Settlements	Risk factor
Toru-Aigyr	0.88
Chon-Sary-Oy	0.88
Grigorievka	0.74
Ananyevo	0.79
Chong-Oruktu	0.79
Tyup	0.84
Maman	0.72
Chirak	0.77
Saruu	0.83
Barskoon	0.85
Tone	0.90
Shor-Bulak	0.77

The application of radiation-based methods for the early detection and treatment of cancer is one of the government's top priorities in the health sector of Kyrgyzstan. The use of outdated equipment in radiotherapy and cancer treatment significantly reduces patients' chances of survival; puts the health of medical staff at risk. Moreover, equipment operating costs and shortages of parts and qualified personnel are exacerbating the situation. The planned improvement of radiotherapy services has now become an important component of the IAEA TC program for the country in the medium term. It should include:

- modernization of radiotherapy equipment of the National Oncology Center of the Kyrgyz Republic;
- improvement of the radiotherapy services
- modernization of nuclear medicine and diagnostic services through relevant programs;
- modernization of tomographic and diagnostic equipment;
- strengthening training of medical personnel;
- implementation of modern diagnostic methods.

In 2005 Kyrgyz Republic became a member of the MYAI. The Government of the Kyrgyz Republic is considering the creation of: the National Center for the IAEA Information System; Networks of analytical and calibration laboratories through the IAEA (3 industry laboratories have already been created in the country) (Dzhenbaev & Mursaliev, 2012; Djenbaev et al., 2012; Jakubick et al., 2008).

However, the Kyrgyz Republic does not have the means to rehabilitate tailings and dumps of former uranium production, as well as specialists in nuclear radiation safety. Some efforts are being made to address this problem in the republic, but this is not enough.

According to estimates by the Ministry of Emergency Situations of the Kyrgyz Republic, the (estimated) cost of reclamation and rehabilitation work at tailings dumps alone will be more than 40 million US dollars.

It is known that mostly uranium tailings dumps on the territory of the Kyrgyz Republic were closed in 1966-1973. All these objects were located within populated areas, in transboundary river basins, which create the risk of possible radiation-ecological disasters, for example, for the territory of Lake.

Issyk-Kul in the area of the village Kadzhi -Say, for the population of cities and towns such as Mailusuu, Minkush, Shekaftar, Sumsar, Kan, Kadzhi -Say, as well as the territories of Central Asian countries. The areas of possible contamination may include the territories of the Kyrgyz Republic, the Republic of Kazakhstan, the Republic of Tajikistan and the Republic of Uzbekistan, where about 5 million people live.

According to our latest data, the average power of gamma radiation on the surface of tailings is in the range from 40-100 $\mu\text{R} / \text{h}$, in some (anomalous, open) areas it reaches 1500 $\mu\text{R} / \text{h}$. Despite the relatively low existing radiation doses, for the population of the republic at present, potential risks from uncontrolled objects of former uranium production can be very significant, since tailings ponds and dumps are mainly located along mountain rivers and earthquake-prone areas (Dzhenbaev et al., 2013; Djenbaev et al., 2015; Djenbaev et al., 2016).

The technical condition of tailings ponds and dumps requires thorough rehabilitation and cultivation work, since previously (1990-2000) emergency restoration work and ongoing operational work were carried out sporadically and not in full. Due to untimely work, most of the tailings were exposed to dangerous natural processes. When designing and laying tailings dumps, long-term events, potential landslides, floods, mudflows and other phenomena were not taken into account.

The impact of former uranium production and waste accumulated in the areas where legacy uranium production facilities are located on population irradiation is manifested through direct gamma irradiation; increased concentrations of radon gas; drinking contaminated water that enters rivers and watercourses with drainage water from flooded mines, tailings ponds and dumps, as well as consuming food that is grown in contaminated areas, including using contaminated water for irrigation.

One of the most important tools for providing information support to rehabilitation programs for such sites and zones of influence, as well as restoring the trust of the population, without whose support it is impossible to count on the long-term sustainability of the results of rehabilitation activities, should be the implementation of a monitoring and technical supervision program at former uranium sites and areas of population residence in accordance with with international standards and IAEA recommendations developed by the national program (2015-2019).

To identify and characterize the sources of former uranium production in the republic, it is necessary to carry out a set of works that will allow further observations and assessments of only those objects and irradiation routes that can actually or potentially have a significant impact on environmental pollution and exposure of the population, as well as to establish priority for observation, objects are sources of pollution, the most vulnerable elements of the environment and ways of transferring radioactive (or other polluting elements).

After uranium production was stopped, mountain dumps were destroyed by water flows, quarries were flooded with groundwater, and infrastructure facilities at industrial sites of former uranium production sites were destroyed. Objects for monitoring at former uranium production sites should be:

- Radiochemical production buildings, settling tanks, slurry pipelines, decontamination sites, ore production dumps, mines, former ore yards, etc.;
- Elements of former infrastructure;
- Transportation zones for contaminated materials and waste from uranium production;
- Tailings dumps, dumps, remains of ore stockpiles;
- Storage areas for (temporary) waste management;
- Places of final storage and maintenance (waste relocation);
- Drainage systems and places where filtration water wedges out;
- Springs and groundwater discharge zones (wells) from areas where tailings are located, rivers and other water bodies in the influence zone;
- Natural objects in the area of rehabilitation work outside the established zones of influence, areas of population residence with their own background characteristics of environmental pollution;
- Work areas for reclamation work (decontamination, dismantling of buildings, excavation work, etc.).

The implementation of the national program (2015-2019) will ensure the creation of an environmental monitoring system, reduction and

localization of the negative impact of ionizing radiation sources on the environment. The events will be provided by:

- reducing the negative impact of ionizing radiation sources on the environment and population;
- a unified procedure for technical supervision of former uranium production facilities;
- creation of a network of observation points;
- effective implementation of reclamation work on tailings dumps;
- attracting foreign investment to implement programs and projects;
- expansion of international cooperation in the field of radiation safety.

CONCLUSION

Thus, uranium tailings dumps and dumps on the territory of the republic are potential sources of pollution of atmospheric air, soil, underground aquifers - sources of drinking water supply, as well as vegetation, soil cover, wildlife and humans. Ensuring the safety of such facilities requires studying and establishing: sources and pathways of irradiation from former uranium facilities to the environment, both in existing conditions and in conditions of possible potential manifestations of natural and man-made factors, living conditions and human activities. Therefore, it is necessary to constantly conduct radioecological monitoring in order to make correct management and decisions; we need information about the current state of former uranium production facilities and knowledge about the variability of the characteristics of the influence of sources of environmental pollution.

The results of studies on the content of radionuclides in soil and grain crops of the agroecosystems of Issyk-Kul region are presented. Our research allows us to draw the following conclusions:

1. The humus content in the soils of the Issyk-Kul region varies within the soil types characteristic of this region.
2. Isotopes of radioactive elements (^{238}U , ^{232}Th , ^{226}Ra , ^{40}K) are characterized by weak accumulation in the soil.
3. Isotopes of radioactive elements do not accumulate in the seeds of grain crops; their biological accumulation coefficients are less than 1, with the exception of radionuclide (^{40}K), the BIC of which is 5.3.
4. According to the radiobiological effects database of the Erica program tool 1.2 The dose rate of radiation exposure to living organisms in

the conditions of the agroecosystems of the Issyk-Kul region is insignificant, the risk factor was (0.72-0.90).

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