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Monitoring of uranium concentrations in water samples collected near potentially hazardous objects in North-West Tajikistan

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A B S T R A C T

The water contamination near ecologically problematic objects was investigated between 2009 and 2014 in North-West Tajikistan as a part of a joint project between Forschungszentrum Jülich and Khujand State University. The main part of this work was the determination of uranium in water samples collected near the Degmay tailings dump, the Taboshar pit lake and the Syr Darya river. More than 130 water samples were collected and analyzed to monitor the uranium concentration near the investigated areas. Two different mass spectrometers and an ion chromatograph were used for element concentration measurements. Based on the results obtained, the uranium influence of the Degmay tailings on the rivers Khoja-Bakyrgan-Say and Syr Darya and surrounding water was not found. The uranium concentration in water samples was monitored for a lengthy period at seven locations Great differences in the uranium concentration in waters collected in 2010, 2011, 2012, 2013 for each location were not observed. Drinking water samples from the region of North-West Tajikistan were analyzed and compared with the World Health Organization's guidelines. Seven out of nine drinking water samples near Taboshar exceeded the WHO guideline value for uranium concentrations (30 μg/L). The average uranium concentration of water samples from Syr Darya for the period from 2009 to 2014 was determined to be 20.1 (± 5.2) μg/L. The uranium contamination of the Syr Darya was determined from the western border to the eastern border and the results are shown in this paper.

1. Introduction

In the middle of the last century, uranium mining and processing in Central Asia was important for the nuclear weapons and nuclear energy program of the former Soviet Union. During the Soviet period and a few years after its collapse, uranium production left behind a huge legacy of uranium mining and processing waste. About 1 billion tonnes of waste from mining and processing radioactive ore is stored at the tailings sites of operational and abandoned uranium mines in Central Asia. Considerable amounts of uranium ore were also exported to Central Asia for processing from other countries (Assessment of national experts, 2009; Corcho Alvarado et al., 2014; IAEA, 2012; Kassenova, 2010; Lind et al., 2013).

More than 20% of the uranium produced in the USSR was supplied by Tajikistan. In northern Tajikistan, uranium ores were mainly processed at three isolated sites: the towns of Chkalovsk (now known as Buston), Taboshar (now Istiqlol) and Adrasman. The present state of the waste containment and the radiological situation is a potential hazard for local residents and a risk of environment contamination for the Fergana valley (IAEA, 2011; Ministry of Energy and Industry of the Republic of Tajikistan, 2009; Mirsaidov, 2012).

Several international projects and studies were initiated in the last years to assess the condition of the uranium tailings and their impact on the environment and public (Lespukh et al., 2013; Skipperud et al., 2013a, 2013b; Stegnar et al., 2013; Stromman et al., 2013; Zoriy et al., 2010). The main factors of the estimated contamination risk are dust and radon released from uncovered tailings dumps. In addition, contamination of the ground water which is used for drinking and irrigation increases the potential radiological risk for the population. On this basis, the major part of the radiological investigations is focused on measurements of ground water as well as drinking water contamination. The determination of the uranium concentration in the surrounding water resources is important for understanding and evaluating environment contamination.

In July 2011, the World Health Organization (WHO) released the fourth edition of its guidelines for drinking-water quality (Frisbie et al., 2013; World Health Organization, 2011). In this edition, the drinking-water guidance level for uranium was increased to 30 μg/L (Ansoborlo et al., 2015; Frisbie et al., 2013).

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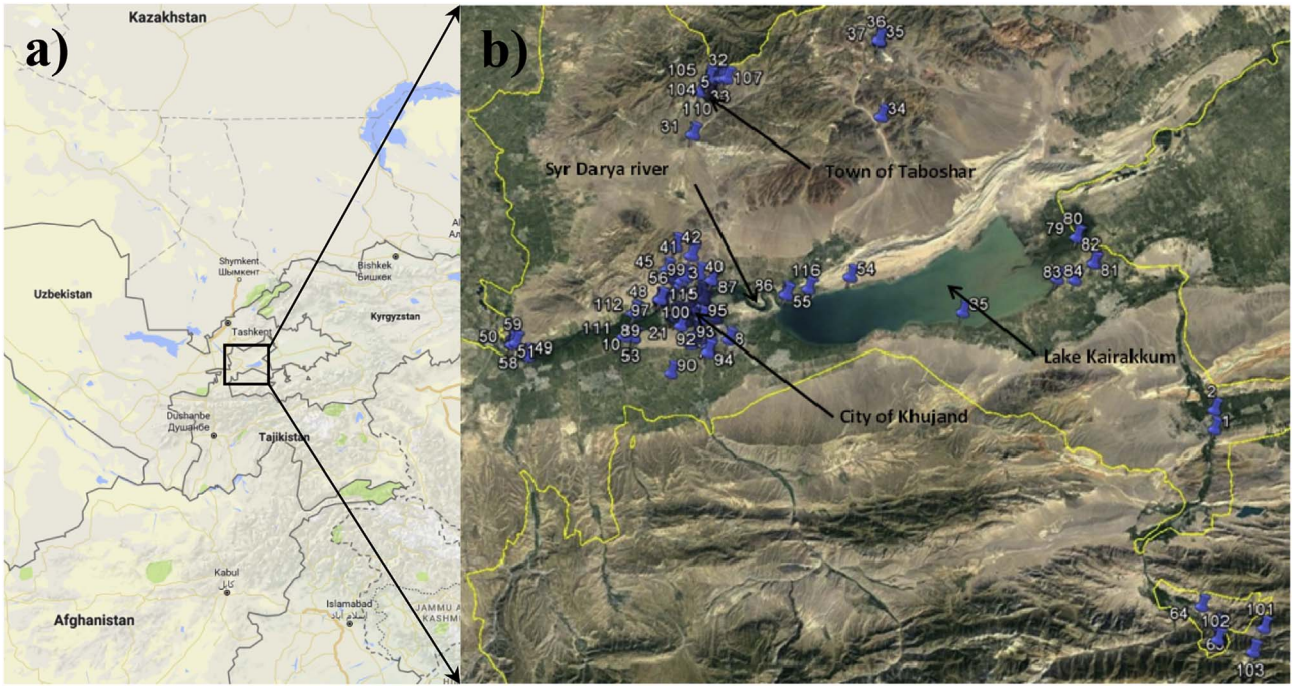

Fig. 1. Central Asia - a) (map data: 2017 Google, Scale 1:20000000). Water sampling points for the period 2009–2014 in North-West Tajikistan - b) (map data: Google, Copernicus; Scale 1:1300000).

The present paper presents the results obtained from the collaborative project between the Department of Safety and Radiation Protection of Forschungszentrum Jülich (FZJ) and the Khujand State University (KSU). This part of the project focuses on the monitoring of uranium concentration in water samples collected near uranium tailings in North-West Tajikistan and on comparison of obtained results with values of WHO guidelines. The analysis of the collected water samples could explain the kind of contamination and its origin. Results on the radon exhalation of the uranium tailings dump Degmay also carried out in this project have been published by Schläger et al. (2016).

2. Material and methods

2.1. Study sites in North-West Tajikistan

Based on our interest in the ecologically problematic objects in North-West Tajikistan, three main sampling areas surrounding these objects were chosen for investigation: Degmay tailings, the town of Taboshar and the Syr Darya river.

Degmay is one of the largest uranium tailings dumps located in the Gafurov region about 1 km to the south of the nearest settlement Goziyan and approximately 10 km from Khujand, the second largest city in Tajikistan. The Degmay tailings dump was in operation in the period from 1963 to 1993. Currently it contains about 36 million tonnes of uranium ore processing waste with a surface area of approximately 1 km^2 (Assessment of national experts, 2009; Mirsaidov, 2012; Skipperud et al., 2013b). The tailings are not covered, thus allowing a significant radon exhalation (Schläger et al., 2016). The areas of potential contamination impact from the Degmay tailings include the Syr Darya river, the longest river in Central Asia, which is located 4.6 km from the dump. One of the tributaries of the Syr Darya is the Khoja-Bakyrgan-Say (Ходжа-Бакырган-Сай) river, which flows near the Degmay tailings. There are several monitoring wells for observing the contamination of underground water around the Degmay tailings. However, no appreciable ground water monitoring has been carried out around Degmay in more than 10 years.

The Taboshar radium/uranium mine was opened in 1936 (large-scale production: 1949–1965) and is one of the oldest uranium mines on the territory of the former USSR. Today, the area of over 0,54 km^2 with 10 million tonnes of uranium ore waste is occupied by open cast mines, a pit lake and areas with crushed rock and uranium ore processing waste. A few kilometers from the disposal sites, the town of Taboshar is located with a population of about 12,000. The artificial pit lake (600 m length x 240 m width x 60 m depth) represents a water reservoir in this region and domestic animals such as cows, sheep and goats feed nearby and also use the pit water for drinking (Skipperud et al., 2013b). Approximately 400 m south-west of the pit lake there is a small stream, which supplies water along the valley over several kilometers towards the Utkan-Sue river, a tributary of the Syr Darya.

The Syr Darya river originates in the Tian Shan Mountains in Kyrgyzstan and eastern Uzbekistan and flows for 2200 km west and north-west to the remains of the Aral Sea. The Syr Darya river basin is located in the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Uzbekistan and the Republic of Tajikistan. In Tajikistan, the Syr Darya flows over 105 km and is used to supply water to its surroundings as well as to the city of Khujand. Moreover, the waters of the Syr Darya are used for irrigating the important cotton-growing and agricultural areas along its course as well as for producing hydroelectric power (Kairakkum hydropower plant). Due to the relative proximity of the Syr Darya to legacy sites and its international significance, the analysis and monitoring of river water is an important factor from both the environmental and political points of view.

2.2. Water sampling

More than 130 water samples were collected to monitor the uranium concentration near the investigated areas. The first field expedition was undertaken in November 2009 and then each subsequent year till 2014(June–July). The locations of the sites investigated and water sampling points in the joint project are shown in Fig. 1. Water samples were mostly collected from water sources such as rivers, lakes, wells and drinking water points (in depth from 0 to 20 cm). There is free access to almost all water sources for both humans and animals.