Аграрен университет - Пловдив, Научни трудове, т. LVI, 2012 г.
Agricultural University - Plovdiv, Scientific Works, vol. LVI, 2012
DOI: 10.22620/SCIWORKS.2016.56.002

ПРИЧИНИ ЗА ПОНИЖАВАНЕ НА РАДИАЦИЯТА НА СЕМИПАЛАТИНСКИЯ ЯДРЕН ПОЛИГОН
CAUSES FOR RADIATION DECLINE ON THE SEMIPALATINSK NUCLEAR TEST SITE

Мадина Токжанова*, Рашид Мирзадинов
Madina Tokzhanova*, Rashid Mirzadinov

Казахски национален аграрен университет
The Kazakh National Agrarian Universities

***E-mail: Madina.tokzhanov@mail.ru**

Abstract

The article discusses the reasons for reduction on the Semipalatinsk nuclear test site: periodic half-life of a radioactive isotope, flushing of radionuclide with water, soaking the soil, picking up the ground water and the influence of organisms to reduce radiation.

Key words: nuclear test, radionuclide, Semipalatinsk, radioactive isotope.

INTRODUCTION

The Semipalatinsk nuclear polygon in Kazakhstan has been the site for 456 nuclear tests performed by Soviet Union during the period 1949–1989. The area of the polygon is 18 540 km^2 and it is situated about 150 km away from the west of Semipalatinsk City. More than 1,5 million people in Semipalatinsk, East Kazakhstan, Pavlodar regions of Kazakhstan and Altay region of Russia were repeatedly exposed to ionizing radiation, partly from the radioactive cloud and partly from the environmental fallout. Thus, between 1949 and 1962, 116 nuclear tests were carried out: 3 high altitude, 83 air and 30 surface explosions. The other 340 test explosions were conducted underground. These explosions varied considerably in type and size, and resulted in global and localised dispersal of radioactive material. During the first period of nuclear testing, the radiation exposure was mainly attributed to 11 surface explosions, since the remaining tests were conducted under the conditions of maximum deposition of their products directly within the boundaries of the test site.

The first nuclear test conducted at STS was on 29 August 1949 and was a plutonium bomb which yielded about 22 kT of explosive power. Between 1949 and 1962, the Soviet Union conducted 118 atmospheric nuclear and thermonuclear tests, 26 of them near the ground. The approximate cumulative explosive yield of these tests, 6.4 MT, is about 6 times greater than the explosive yield of the above ground tests at the Nevada Test Site and about 6% of the yield of the tests conducted in the Marshall Islands (Simon, 2000). In addition, in 1965, two additional atmospheric tests with deliberate soil excavation were conducted (Gusev et al., 1997). Although above-ground testing was terminated in 1962, vented underground detonations occurred through 1989. The last test took place on 12 February 1989 and resulted in a leakage of large amounts of the radioactive noble gases xenon and krypton (Gusev et al., 1997). The radionuclides emanating from these tests resulted in atmospheric and environmental contamination. Testing at the site ceased in 1989 (Peterson et al., 1998).

MATERIALS AND METHODS

In the course of research the following methods were used: general scientific, cartographic method, comparative, quantitative, mass-spectrometry. In 2007-2012 were investigated the number of fallen rainfall in Semipalatinsk nuclear test site. The materials and the information about the weather are taken from Kazhydromet. To determine the amount of water sweeping away the radiation in the soil this formula is used:

$V=V_1*S*h*d*a$, м^3

V_1 - the amount of rain in the warm weather, m^3

S – the area of the region, where water accumulates, m^2;

h - evaporation coefficient

d - the ability to conduct water to the soil during the day, m;

a – the coefficient of flow

RESULTS

Currently, the level of radiation on Semipalatinsk nuclear test site composes from 6 to 20 micro-roentgen per hour. Only at certain points the level of radiation is higher than flatlands. Therefore, our aim is to clarify the reason for the loss of radiation and space distribution of nuclear residues SYAIP. This research is needed to study the radiation on the body. The most basic reason is the half-life of radioactive isotopes. (Table 1) Products of nuclear explosion consist of more than 200 isotopes of 36 chemical elements. Many of the radioactive isotopes are not long lasting radionuclides (Vasilenko et al., 1996). The activity of products of nuclear emissions is reduced to 10, 100, and 1000 times after the explosion on the 7th, 49th and the 343rd day during the partial collapse. In case of discharge of nuclear products excitable radionuclides (^{3}H, ^{14}C, ^{28}Al, ^{24}Na, ^{56}Mn, ^{59}Fe, ^{60}Co, etc.) and unshared uranium and plutonium pollute environment. Subsequently, if the plutonium (^{239}Pu) is based on the soil, ^{137}Cs, ^{131}I especially ^{90}Sr radionuclides may accumulate in the human body, such as bone ^{90}Sr and ^{131}I in the thyroid gland (Vasilenko et al., 1996).

Table 1

Radionuclide products from nuclear tests

Isotope	Energy(charge)	Half-life period	The number of one decay,%	Activity 1 Мт, (10^{15} Бк)
Strontium-89	38	50.5 days	2.56	590
Strontium-90	38	28.6 years	3.5	3.9
Zirconium-95	40	64 days	5.07	920
Ruthenium-103	44	39.5 days	5.2	1500
Ruthenium-106	44	368 days	2.44	78
Iodine-131	53	8 days	2.90	4200
Cesium-136	55	13.2 days	0.036	32
Cesium-137	55	30.2 years	5.57	5.9
Barium-140	56	12.8 days	5.18	4700
Cerium-141	58	32.5 days	4.58	1600
Cerium-144	58	284 days	4.69	190
Hydrogen-3	1	12.3 years	0.01	2.6 10^{-2}

The second reason of the reduction of radiation is that radionuclides are washed with water penetrating the soil before reaching the ground, they are gathered in the groundwater (Aydarkhanova et al., 1998). Sufficient levels of rain during the warm season of the year for the blur of radionuclides (Figure 1, 2). The average intensity of 1 hectare composes 7.2 tons. The module of spreading in the study area of space is not spread equally, in the mountains the amount is more than in the fields.

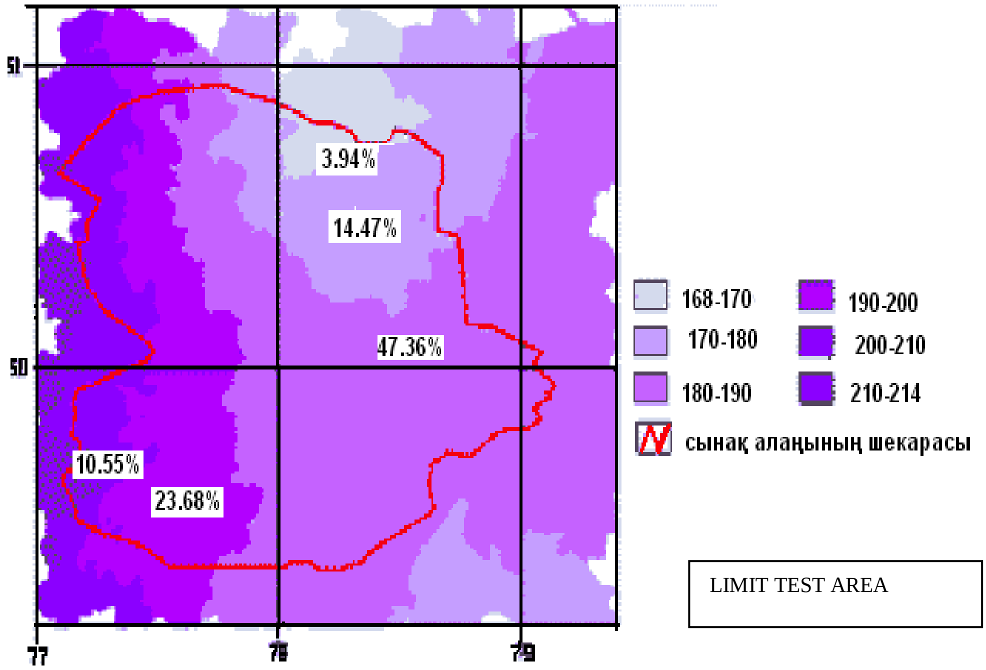

Fig. 1. *Amount of rainfall on the warm days*

We count the number of rinsing water. The process of flushing water from the high hills is fast. A matter of flushing water is connected with rainfall in the warm weather. The coefficient for the forest zone is - 0.4-0.5 m long, without the forest zone is 0.6-0.65 m. Evaporation coefficient for the forest area is -0,4-0,5 m, forest - steppe zone is 0.6, the steppe zone is 0.7-0.8 m. The ability to conduct water to the soil during the day is 0.00025 m. The total area of the region is 18.5 million hectares.

Quantification of the number of the region's rainfall on warm days

168-170 mm per year = 3.94% to 18.5 million from hectares = 728,900 ha
170-180 mm per year = 14.47% to 18.5 million from hectares = 2676950
180-190 mm per year = 47.36% to 18.5 million from hectares = 8761600
190-200 mm per year = 23.68% to 18.5 million from hectares = 4380800
200-214 mm per year = 10.55% to 18.5 million from hectares = 1951750

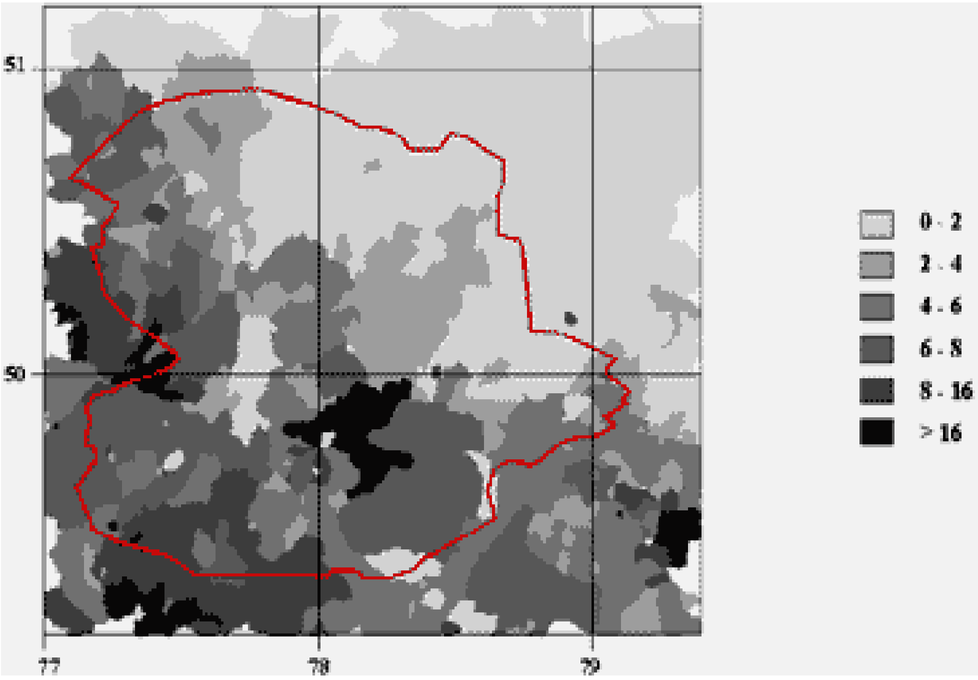

Fig. 2. *The intensity of the flushing* ***t/h***

We determine from each area the quantity of water washing the radioactive isotopes

V=728900 ha *10000 m^2 * 0,00025 m * 0,65 * 0,8 * 0,16 m^3 = 151611,2 m^3

V=2676950 ha *10000 m^2 * 0,00025 m * 0,65 * 0,8 * 0,17 m^3 = 591605,95 m^3

V=8761600 ha *10000 m^2 * 0,00025 m * 0,65 * 0,8 * 0,18 m^3 = 2050214,4 m^3

V=4380800 ha *10000 m^2 * 0,00025 m * 0,65 * 0,8 * 0,19 m^3 =1082057,6 m^3

V=1951750 ha *10000 m^2 * 0,00025 m * 0,65 * 0,8 * 0,2 m^3 = 507455 m^3

The total amount of water washing the radioactive isotopes of Semipalatinsk nuclear testing area

∑=151611,2 +591605,95+2050214,4+1082057,6+507455 = 4382944.15 m^3

As a result we found that each year, 4 382 944 m^3 water washes away the radioactive isotopes to the groundwater. On the well № 1419 there was no nuclear test found in the water of tritium (Ptitskaya et al., 1998). In this regard, it was found that washing radionuclide contaminate groundwater.

Plants and animals participate actively to reduce radiation. The plant makes a lot of biological products. In each ecosystem of the region of Semipalatinsk nuclear test site grow different plants. The overall average productivity of steppe covers of plants is - 4-5 per ha. Cover plant absorbs 5% of radioactive contamination. Here, according to the laws of the ecological pyramid, the number of insects is 10 times greater. On 1 ha of Semipalatinsk nuclear test site there are 45-50 different species of insects. In order to reduce the radiation, the insect feeds on plants, birds feed on insects. In that way the process of reducing the radiation in the area is continued.

CONCLUSIONS

The radiation level of the Semipalatinsk nuclear test site is reducing because of three reasons:

1. The activity of products of the nuclear emission is decreasing to 10, 100 and 1000 times after the explosion on the 7th, 49th and the 343rd day during the half-life of radiation.
2. Sufficient level of rain in the warm season of the year for the blur of radionuclides. Every year 4 382 944 m^3 water washes away the radioactive isotopes to the ground water.
3. Biological expansion reduces radiation.

REFERENCES

Simon, S. L., 2000. Evaluation of possible radiation exposures near the Semipalatinsk nuclear test site. *Unpublished manuscript.*

Gusev, B. I., S. N. Abylkassimova, and K. N. Apsalikov, 1997. The Semipalatinsk nuclear test site: a first assessment of the radiological situation and the test-related radiation doses in the surrounding territories. *Radiat. Environ. Biophys.* 36: 201-204.

Peterson, L. E., Z. S. Zhumadilov, S. Kripalani, U. V. Progulo, T. M. Wheeler, B. I. Gusev, R. Arem, S. Yonov, and A. D. Weinberg, 1998. Diagnosis of benign and malignant thyroid disease in the east Kazakhstan region of the Republic of Kazakhstan: a case review of pathological findings for 2525 patients. *Cancer Research Therapy and Control* 5: 307-312.

Ptitskaya, L.D., 2002. The current state of the radiation situation on the territory of the test site "Balapan" the former Semipalatinsk nuclear test site - // Bulletin NNC "Radioecology, protection of the environment", Issue 3, September 2002, 11-19.

Vasilenko, O.I., Ishkhanov B.S, Kapitonov I.M., Seliverstova J.M., Shumakov A.B., 1996. Radiation. Moscow.: Moscow State University.

Aydarkhanova, G.S., 1998. The influence of underground nuclear testing to underground environment mountain Degelen. Abstract. The candidate of Biological Sciences, Almaty, Kazakh State University.

Рецензент – доц. д-р Димитър Аланджийски