EXPLORATION OF THE RADIOECOLOGICAL STATUS OF THE DRINKING AREA OF VELIKO TARNOVO

ИЗСЛЕДВАНЕ НА РАДИОЕКОЛОГИЧНОТО СЪСТОЯНИЕ НА ПИТЕЙНАТА ЗОНА НА ВЕЛИКО ТЪРНОВО

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Abstract: *The article reviews the environment, radiation transformations and how they affect plants, animals and humans. A theoretical overview of the task is done. Results of measurements of the presence of radioactive isotopes in various non-living and living sites in the region of the main source of water in Veliko Tarnovo - "Yovkovtsi" dam lake and some of the obtained spectrograms are presented.*

Keywords: *control monitoring, radiecological control, radiological risk, earth, structura, gamma background*

1. Introduction

The ever-worsening environmental condition on a global scale due to the rapidly growing consumption potential of the human population and the rapid development of technical progress is of great concern because modern civilization puts a serious test on the equilibrium of the biosphere. Therefore, one of the most current problems of the present day is related to the contamination of the biosphere with radioactive substances, its radiation purity and radiation protection.

On this occasion, the French scientist Dorts says, "The man has made a great mistake when he has thought that he can separate himself from nature and not comply with his laws." The rift between man and the surrounding natural environment existed long ago. a "treaty" linking the primitive man to his habitation was violated by a man who felt strong to recognize only the laws he had created in the future. This position must be fully reconsidered and a new pact signed with nature, "giving possibility a man living in complete agreement with it. "

As a result of the large number of experimental studies conducted in different countries and the accumulation of vast information on the migration of radionuclides in ecosystems under different conditions and the action of ionizing radiation on living organisms on Earth.

In addition to theoretical interest, their results are of great practical relevance as they allow the assessment of the consequences of the introduction of artificial radionuclides into the environment and ways and means to reduce human discomfort. Therefore, systematic control of radioactive contamination of air, water, soil, flora and fauna is carried out in all countries. In the case of the smallest exceeding of the permissible standards, the appropriate measures for the protection of the environment and mainly of man are taken.

Radiation monitoring in our country is being constructed as a modern automated information and control system, ensuring the reliability of the collected information by using modern methods of data analysis and evaluation, creation and maintenance of a specific database and solving a certain class of tasks related to conservation the environment and the proper use of natural resources.

According to modern cosmological knowledge, the solar system has been uncovered about 5 million years ago in a cosmic gas-filled and dusty cloud-rich element. Scientists, observing and studying Earth's processes, conclude that a new environment, called the biosphere, within which living matter exists.

The term biosphere (from Greek bios - life and sphaira - globe) appeared accidentally in 1875 in the works of the Austrian geologist Edward Zuis. Later, three interpretations of the notion of biosphere: biological (substrate), geographic (spatial-substrate) and general science (evolutionary - substrate - spatial) [1]. The initial substrate-biological treatment includes the set of all living organisms on Earth. In geographic sciences, this term is traditionally used to mean one of the geospheres of the geographic envelope along with the atmosphere, the lithosphere and the hydrosphere but distinct from the saturation with living organisms. In fact, it is considered as spatially substrate. Modern teachings on the biosphere were created by the Russian scientist Vladimir Vernadsky (1945). In the light of the new geochemical concept of evolution of life, it reveals the geological role of living organisms as a planetary scale factor in creating the gas composition of the atmosphere, water, sedimentary foundation, in the formation of the upper shell of the Earth. According to Vernadsky, not only does life exist in this envelope, but it is, to some extent, altered and shaped by life. This is the third evolutionary substrate - spatial treatment of the concept. According to Vernadsky, "the biosphere is the thin layer of the living substance and the living substance as a body of organisms that, like a gas mass, surround the earth's surface and exert some pressure on the surrounding environment, bypass objects that obstruct their movement or masquerade and obey them" . In fact, the biosphere is a planetary ecosystem in which the flow of substances and the energy flow are mutually interconnected and interconnected globally. The biosphere is an open system consisting of subordinate subsystems and elements that function and develop in a mutually united unity. In its existence the biosphere maintains its equilibrium thanks to its perfect regulatory mechanisms. In recent years, however, the man with his business has created many problems for the functioning of the biosphere.

2.1. Structure and boundaries of the biosphere

The modern biosphere is a multi-component system with complex construction and heterogeneous composition. According to Vernadsky, the biosphere consists of seven elements:

1) a live substance;
2) biogenic substance;
3) Mineral substances;
4) transitional forms between biological substance and mineral substances;
5) radioactive substances;
6) scattered atoms;
(7) substances of cosmic origin.

It is generally assumed that the biosphere consists of three main components: [2]

1) living organisms - this is the living surface of the Earth - plants, animals, microorganisms;
2) mineral substances - substances included in the biological circle;
3) Organic products - substances temporarily excluded from the biological cycle.

The biosphere covers the whole hydrosphere and the entire land. The theoretically living organisms can populate:

1) the atmosphere - within the troposphere and the lower parts of the stratosphere to the height of the nitrogen layer (25 km);
2) lithosphere (depth up to 10 - 15 km). It is virtually not found at a height of 22 km and a depth of 2-3 km.

The components of biosynthesis are:

- Atmosphere. It is the gas shell on Earth. It consists of nitrogen (- 78%), oxygen (- 21%), water vapor and inert gases with a total volume of 1%. Other gases and impurities are considered to be pollutants. The total mass of the atmosphere is 5,16 . 10^{18} kg.

Depending on the change in temperature, the atmosphere is divided into five layers.

1) the troposphere above the poles h = 8-10 km, above the equator h = 16-18km, and above the moderate widths h = 10-12 km. The average thickness of the troposphere is assumed to be <11 km;

2) stratosphere - with a thickness of 10 <h <50 km;

3) mesosphere - with a thickness of 50 <h <90 km;

4) thermosphere - with a thickness of 90 <h <800 km;

5) exosphere - with a thickness h> 800 km;

After this layer, the atmosphere passes into interplanetary gas.

The atmosphere as a whole is a relatively inappropriate environment for the development of the living substance.

Hydrosphere. It is a set of all the waters of the Earth. It forms a continuous water envelope located between the atmosphere and the lithosphere and occupies ~ 70.8% of the surface of the planet. This includes the waters of the oceans, seas, underground and surface waters on land.

The Radiation Situation subsystem of the NASCRGF of the EEA for the MOEW organizes the creation and maintenance of a database for the change of the natural background radiation as a result of anthropogenic factors, assessment of the content of natural and technogenic radionuclides in the atmosphere, soils and water basins. assessment of the radiation situation, formed in individual localities and regions of the country.

The main tasks of NASCRPF can be formulated as:

1) system regime observations of the radiation characteristics of the environmental elements;

2) Processing and analysis of the received data from the system observations, organization of the information base, servicing the units of the Ministry of the Environment and the state bodies with information on the radiation situation;

3) Assessment of the content of technogenic radionuclides in the natural environment and their migration potential in the "Biological Environment - Man" chain [4].

Functionally, control includes:

1) NPP;

(2) Uranium-producing industries;

3) Thermoelectric power plant;

4) Enterprises, institutions and institutions using radioactive substances in their activities;

5) Local and global post-emergency delays;

(6) Non-ferrous metal mining and processing enterprises.

2.2. Types of radioactive transformations and radiation properties.

There are 6 types of radioactive transformations known in nature. Of these, the most likely are: α-conversion, β-conversion and γ-radiation [3]. A-transformation from the kernel takes off a-particle. It is a heavy charged particle made up of 2 protons and 2 neutrons, i. E. it is the nucleus of helium and the particles move at a velocity of ~ 10 m / s. Their air flow reaches up to 10 cm. Fully swallowed from a sheet of paper and organic tissue. Therefore, any substance (barrier) with a thickness greater than the distance therein provides the protection against external irradiation.

In the β-transformation from the core a β-particle takes off and an electronic antineutrino. β-particles are electrons that move at speeds in the order of light velocity (V? ~ 108 m / s). They have an energy of 10 eV to 10 keV. Their air flow reaches a few meters. They are absorbed in aluminum foil with a thickness of 1mm. β- the particles penetrate the human skin and reach a different depth in the tissues. Ordinary clothing weakens the β-flow by ~ 50%.

γ-radiation is electromagnetic radiation with X <10-10 m. Its energy is from 10 keV to 5 MeV. It has a great penetrating ability. Its air flow reaches hundreds of meters.

2.3. Anthropogenic sources

Radioactive contamination of the environment may occur in the following cases: nuclear weapon experiments, nuclear reactor failures, uranium ore extraction, improper storage and transportation of radioactive materials, and nuclear reactor failures. Of these, the radioactive contamination of the biosphere caused by accidents in nuclear reactors is of significant importance. The normal operation of the NPP is associated with a certain degree of environmental contamination with radioactive substances. Pollution is generated from gaseous radioactive waste (radioisotopes of noble gases ^{13l}I, ^{l32}I, ^{3}H, ^{13}C and aerosols of some Cs, Ru, Co and other radionuclides representing the fission products of the nuclear fuel) emitted into the atmosphere.

2.4. Effects of radioactive contamination on plants, animals and humans

2.4.1. Effects on animals

The striking effect of radionuclides on animals is the result of:

1) external radiation - originating from radioactive substances in the air or deposited on the ground;

2) internal irradiation - is generated by radionuclides that have entered the organism.

In internal irradiation, most of the body's respiratory system, skin, or gastrointestinal tract radionuclides selectively accumulate in certain organs where they generate prolonged ionization. For example, 131I accumulates in the thyroid gland, 90Sr - in the hair, 137Cs - in the muscle tissue. This violates the functions of the individual organs. Single and multiple irradiation of adult animals with large equivalent H doses develops radiation sickness.

At H = 1 -2 Sv - radiation disease - mild degree; H = 2-3 Sv - radiation disease - medium degree; H = 3 - 4.5 Sv - radiation disease - severe grade; H> 4.5 Sv - Radiation Disease - Extremely severe. Young animals are more irradiated and birds have less radiation from mammals.

2.4.2. Impact on man

The impact of radionuclides on humans is similar to that of animals, may occur in direct external irradiation or by internal irradiation. The action of ionizing radiation on the human body passes through three stages: physical, chemical and biological.

During the physical stage the radiation ionizes and excites the atoms and molecules of the biological tissue. Radiolysis (dissociation) of water plays a major role in it. Defeat is partially recovered due to the recombination of part of the ions. The duration of the physical stage is ≈ 10^{-13} s.

During the chemical stage, a number of new compounds are formed that are foreign to the healthy tissue. At this stage, molecules break, DNA damage, and amino acid and enzyme alteration. The immune system restores some of the damage. The duration of the chemical stage is ≈ 10^{-3} s.

During the biological stage some of the cells die and the immune system eliminates them. The lesions at the cellular and subcellular levels lead to a number of morphological and functional changes in individual tissues, organs, systems and in the body as a whole. The length of the biological phase can be minutes, hours, days, weeks, and even years. The end result of processes running through the various stages is the generation of radiation effects (injuries) in different tissues and organs. Radiation effects depend on the type and energy of the radiation, the absorbed dose (D) and the equivalent dose (H), their potency, the irradiance of the irradiated objects, etc. Radiation effects are divided into two main groups - somatic and genetic. Somatic (body) radiation effects are injuries in the body that are not passed on to his or her generations by hereditary route. Depending on the time of development, they are divided into early and late. The somatic effects also affect the radiological effects of the embryo and fetus. Early somatic effects occur within a few weeks after irradiation. These include changes in the radiosensitive human organs: haematopoietic organs (red bone

marrow, spleen, thymus, lymph nodes), gastrointestinal mucosa, gonad, respiratory system. The dependence of the effect of the equivalent dose H is as follows:

1) at H <0.25Sv- changes are not observed;

2) at H = 0.25 Sv - temporary changes in blood count were observed. This value is considered a threshold dose;

3) at H = 0.25-1.0 Sv - slight reversible changes are observed;

4) at H> 1.0 Sv - symptoms of radiation sickness are observed. It is divided into four stages;

5) at H = 1.0 - 2.5 Sv - radiation disease - mild degree;

6) at H = 2.5-4.0 Sv - radiation disease - medium degree;

7) at H = 4.0-6.0 SV - severe disease;

8) at H = 6.0 - 10.0 Sv - radiation disease - extreme severity.

Late somatic effects occur after a prolonged lethal period (after years). These include various forms of leucosis and cancer, common functional changes, darkening of the lens, impairment of sexual function, etc. The genetic effect is related to the damage of the gene, where it passes into a new stable form that is reproduced in daughter cells. This process is called a mutation. When the mutation is in a sex cell, its eventual involvement in fertilization would result in the transmission of this mutation to all the cells of the new organism.

Finally, it should be pointed out that minimal losses of plant and animal damage can be achieved by conducting relevant measures, and hence ensuring the protection of human beings in the consumption of plant and animal products.

3. Experimental part

3.1. General Characteristics of the Yovkovtsi Dam

Yovkovtsi dam is part of the national hydropower system of the country. Strategic site of great economic and economic importance. With a volume of 90 million m 3 of water, the dam supplies 6 municipalities. It is built on the right-hand inflow of Yantra River. Around the dam there is a sanitary-guarded zone with posts to control water purity and ecological status in the area. The flora and fauna in the area of Yovkovtsi dam is varied. All plant and animal species typical of the region predominate. The favorable location of the dam also affects the quality of the water, which meets all the sanitary requirements. The control over the Yovkovtsi Dam is managed by NASEM and the performance is carried out by highly qualified personnel working on the dam. Daily qualitative analysis of samples taken from different control posts is performed. One of the most modern wastewater treatment plants is built on the dam, which provides continuous supply of drinking water to the consumers. In conclusion, we should note that Yovkovtsi dam is a modern facility with a high degree of organization, which will continue to develop in the future.

3.2. Brief description of scintillation spectrometer SCC - 256/91

The experimental part was performed with the scintillation gamma spectrometer type SCC - 256/91.

The scintillation spectrometer SCC - 256/91 is designed for the recording of energy spectra of radioactive sources.

Working conditions:

1) air temperature: 10 to 35 ° C;

2) operates at a relative humidity of up to 80% at t = 20 ° C;

3) mains supply 220V ± 15%, 50 Hz ± 1%;

Samples are placed in glass jars, plastic bags, boxes, etc. so that they can not be spilled or scattered during transport and then used for testing.

The bottom deposits are taken with a special instrument. The samples taken are of a mass of 10g.

The material is shredded and dried at 105 ° C and then burnt in a muffle furnace at 400 ° C. The dry residue is weighed and, depending on the quantity, a thin-film or thick-film preparation is made which is subject to radiometry.

Samples of plant material are taken from different parts of the territory subject to control. The stems are cut at a height of 2-3 cm from the surface of the soil. The mass of the sample taken must be 1 kg. Burn in a furnace and measure the resulting sample.

A sample of fish and other animals subject to radiometry shall be not less than 2 kg.

Prior to processing, the fish is washed thoroughly from the mucus and shaved. Larger specimens can be taken separately. Burn in a muffle furnace to obtain a dry residue of at least 20 g.

The harvesting of algae and aquatic plants does not require special fittings. The sample mass must not be less than 0,5 kg.

Soil samples are collected from equal, untreated plots with good grass cover. The sections from which soil samples are taken must be more than 100 m away from the buildings. The area of each sample should be 10x10 cm and a thickness of 7 cm. The plant and animal organisms are removed from the surface layer at a depth of 2 cm. Each sample shall bear a label stating: the date and place of sampling, the mass of the sample and the name and surname of the person who took the sample. The transport pack must be strong and protect the sample from breakage, spillage and contamination.

3.Conclusions:

1. There is ^{137}Cs in the nettle sample taken after the Chernobyl NPP accident. This conclusion is experimental proof that the apparatus used is working normally and can determine qualitatively ^{137}Cs.
2. No samples of radioactive isotopes were found in the measurements carried out on samples taken from the area of Yovkovtsi dam.
3. The deviations observed in some graphs are within the permissible error of the SCC-256/91 spectrometer.
4. Qualitative environmental monitoring of the environment in the area of "Yovkovtsi" dam is carried out by the Regional Inspectorate of Environment and Waters - Veliko Tarnovo.

4.Literature:

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