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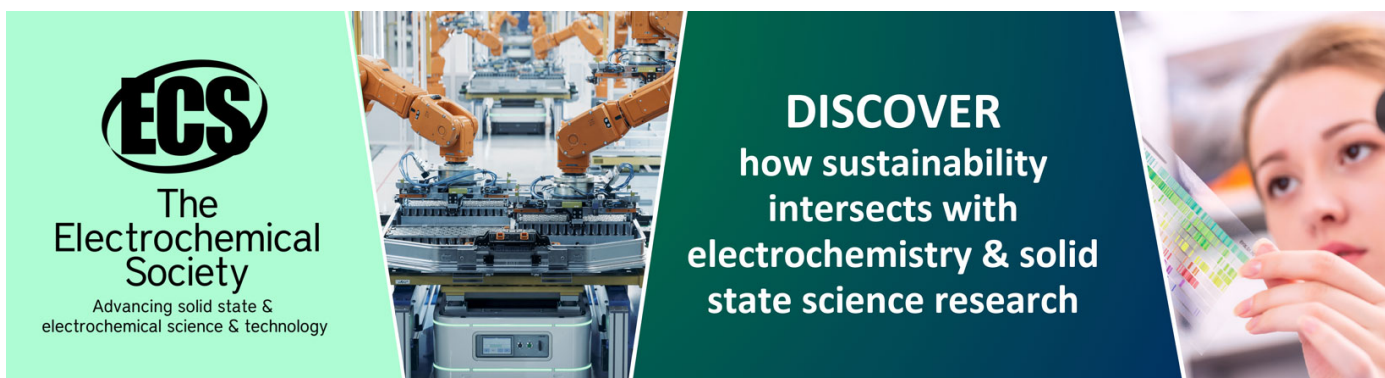
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Geoecological Assessment of the Degree of Risk of the Fuel and Energy System in the Voronezh region

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Abstract. The article analyzes the negative impact of the regional fuel and energy system (RFES) on the environment of the Voronezh region. It is proposed to improve the monitoring system, taking into account the basic geoecological principles of an integrated approach, the stages of the study, with the definition of regional features, which are based on the assessment of socio-ecological and economic conditions and the efficiency of using information. When placing objects of the regional fuel and energy system, it is necessary to take into account the landscape features of the region. The analysis proved the need for a unified geoecological management system of the regional fuel and energy system. It will strengthen the regime of energy saving, reduce the degree of negative impact and improve technological processes, it will also reduce environmental risks to public health. Comprehensive geoecological monitoring will allow predicting the geoecological situation in the region. The historically developed spatial regional fuel and energy system of the Voronezh Region has a number of disadvantages, so there is the need to modernize equipment and the regulation system

1. Introduction

Regional Fuel and Energy System (RFES) has a nodal and latitudinal-meridional structure. Due to a long period of operation, there is a possibility of emergency situations, as well as a daily technogenic impact on the environment creates risks of cumulative effects.

To identify the negative impact of RFES, an ecodiagnostic approach was used, which involves studying geoecological signs that characterize both the current and forecast state of environmental components and landscapes. The ecodiagnostic approach includes the development of methods for identifying negative environmental processes and phenomena.

The main geoecological problem for RFES is the creation of a sustainable system of geoecological nature management, which would effectively provide for the fuel and energy needs of the population and at the same time support the environment-forming functions of landscapes. To ensure the balanced development of the regions, it is necessary to predict environmental tensions and risks. The methodology



and methods of studying fuel and energy systems are developed by A.M. Gareev, A. I. Mazur, E. P. Neznamova, M. D. Sharygin, B. I. Kochurov, A. I. Trofimov [1].

O. V. Kondrakov is engaged in the development of methodological approaches to the assessment of economic risk in the fuel and energy complex [2], and N. P. Karpenko was engaged in the study of the theoretical foundations of geoecological risks [3].

In the works of R. O. Samsonov, research is conducted in the field of assessment and management of geoecological risks in the gas industry [4]. Development of alternative energy sources Zvyagintseva A.V. [5-7].

In foreign studies, the problems of assessing geoecological risks in energy systems are examined by A. Nestico, J. de Mare, and G. Maselli [8]. The study of the stability of energy systems was carried out by E. Santoyo-Castelazo and A. Azapagic, who considered 3 aspects of the fuel and energy system: environmental, economic and social [9]. In Germany, research is being conducted in the field of predictive assessment of the environmental impact of the future fuel and energy system, which is undergoing complex optimization [10]. These studies are carried out as a part of a strategic assessment of the fuel and energy system as a whole [11].

In the UAE, Zishan Omar Inamdar is engaged in studying the environmental impact of the Baraka NPP [12]. Research is also being conducted in the field of assessing the environmental impact of new nuclear power plants in the Mediterranean countries [13]. In China, in the addition of studying the radioactive influence, work is underway to assess the complex environmental impact of nuclear power plants [14]. South Korea is developing mechanisms for assessing the radiological impact on the environment of nuclear power plants for their decommissioning [15]. Studies are also being conducted to assess the impact on the air environment of the OTEC [16].

M. Zelenakova, V. O. Harbunyakova and A. Oleinik, who conducted comprehensive studies, were engaged in assessing the environmental impact of thermal power plants in Slovakia [17].

2. Materials and methods of research

To study regional territorial systems, geospatial, ecodiagnostic approaches are used, as well as balance-geochemical, geophysical, cartographic, and statistical research methods.

3. Results and discussion

The fuel and energy system of the Voronezh Region consists of a complex geotechnical system, including oil and gas pipelines, and linear production controls of main gas pipelines. RFES was formed on the basis of the use of various types of fuel: gas, oil, coal and nuclear fuel. The current energy consumption in the region for eight months is 7749.2 million kWh; there is an annual increase in energy consumption in the region by an average of 2 %.

The thermal power industry of the region consists of three stations; one of them is the Novovoronezh nuclear power plant and two thermal ones. They are: Voronezh CHPP 1 and Voronezh CHPP 2, which were built in the 30 – 50s of the twentieth century. 90 % of the electricity in the region is provided by the Novovoronezh NPP [18]. The structure of the RFES includes nuclear power plants, thermal power plants, oil depots, gas distribution stations, oil and gas pipelines, and gas stations, boiler houses and heating networks.

The territory of the Voronezh region has favorable natural conditions, a favorable economic and geographical position. The structure of industrial and agricultural production is represented by energy and fuel-intensive enterprises. Emergency situations at various facilities of the fuel and energy system are often noted within the region. In this regard, there are high risks of contamination of all components of the environment.

When burning oil, gas and coal, hydrocarbons, carbon monoxide, sulfur dioxide, nitrogen oxides, soot, benzo(a)pyrene are discarded to the atmosphere. In addition to geochemical pollution of the atmosphere, thermal pollution also occurs. Observations carried out in Voronezh in the area of CHPP 1 and CHPP 2 revealed an increase in air temperature by an average of 2 °C. During the functional regime, the regional fuel and energy system uses a significant amount of water resources for cooling turbines;

wastewater is discharged into surface reservoirs, which contain suspended organic substances, petroleum products. In emergency situations, fuel oil and heavy metals enter the surface and underground water, their content is 3-5 times higher than the MPC [19].

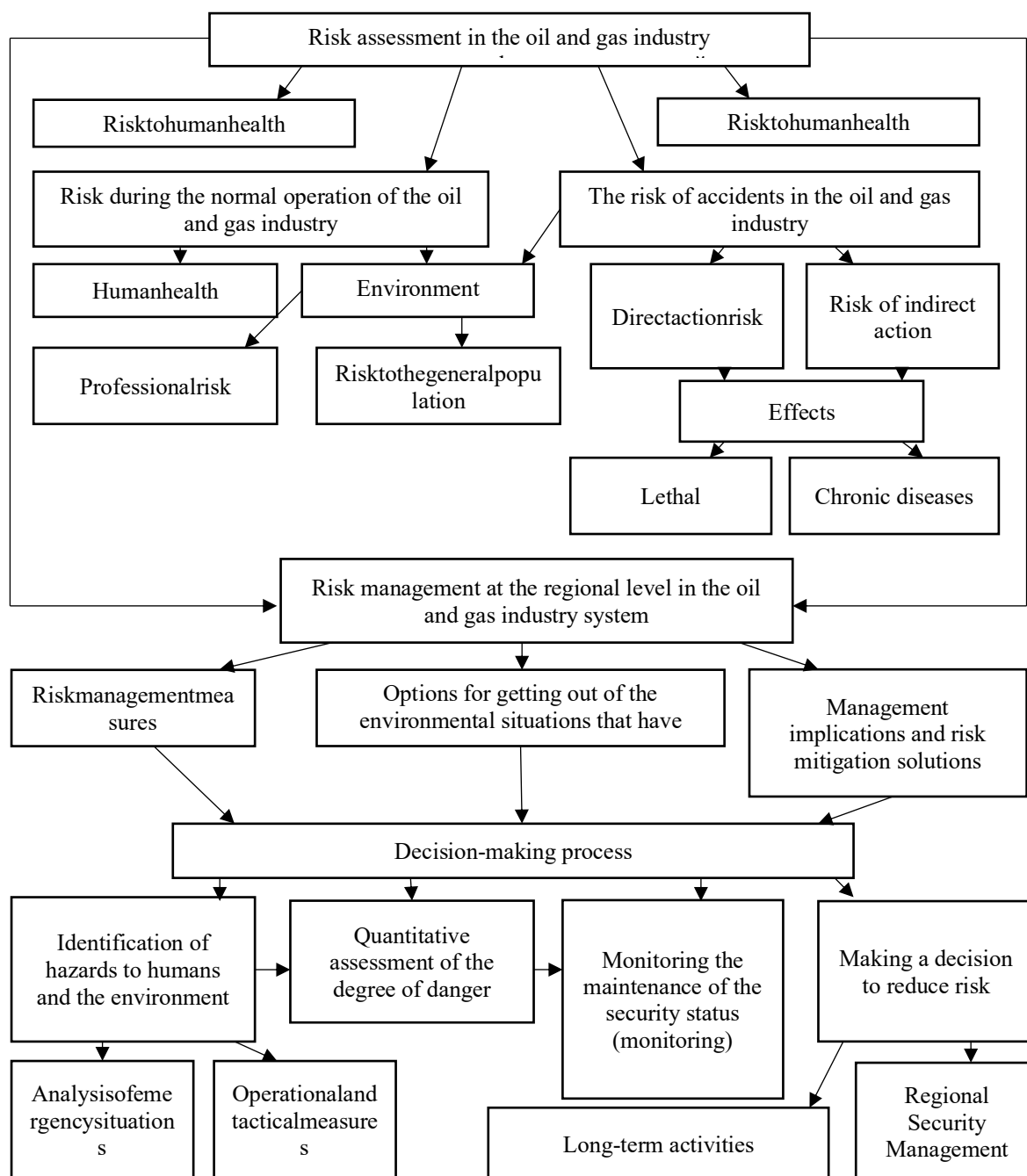


Figure 1. Geoecological model of RTES assessment.

The degradation of the soil cover is observed in the process of alienation of land for the construction of RTPP facilities, for dumps, quarries and contamination of the soil cover as a result of emergency situations. The functional regime and emergency situations at the RTPP affect the biota of the region, when pollutants fall on the surface of the vegetation cover. During field studies, the degree of

degradation of vegetation cover in point and linear objects of the RTES is observed, the stability of landscapes and animal habitats is lost.

Geocological risk is an assessment of the degree of threat to the environment and humans. The geocological model of the RTES assessment is presented in Figure 1.

RTES facilities are chemically dangerous, both in emergency situations and under normal operating conditions.

As a result of the accumulation and dispersion of gas emissions into the atmosphere, clouds containing carcinogenic substances are formed. «Lenses» are formed under the objects of the RTPP, which are formed as a result of the accumulation of petroleum products and, as a result of seepage and migration, enter the groundwater [19, 20]. This phenomenon is not observed when using alternative energy sources [21, 22].

On the territory of the Voronezh oil depot, due to long-term leaks and accidents, the focus of oil pollution of both soil horizons and neogene-quaternary aquifers continues to increase. The structure of pollution is complicated by depression funnels formed as a result of intensive water intakes of enterprises. As a result, dissolved petroleum products spread out through the structure of the groundwater flow and fall into artesian wells. In wells with a lens of oil pollution, it reaches 900-5000 MP. The power of the lens of petroleum products ranges from 0.25 m to 0.74 m, in recent years there has been a tendency to reduce the power of the lens. To some extent, this is due to some increase in the groundwater level and pumping. As a result of the annual monitoring, observations are carried out at 13 wells, contamination of groundwater on 18 hectares with a content of petroleum products of 5 mg/dm³ was detected. The second zone with an increased content of petroleum products up to 100 mg/dm³ on an area of more than 9 ha.

It should be noted that when the oil depot was put into operation, geological and hydrological conditions were not taken into account, sandy deposits predominate, in which hydrocarbons actively migrate, the migration process occurs from east to west, towards the Voronezh River valley and the reservoir.

The radiation situation in the Voronezh Region consists of natural and man-made factors. The Voronezh region is characterized by a natural anomalous radioactive site, its origin is associated with the release of granite in the area of Pavlovsk, with an area of about 700 hectares in the area of the Shkurlatovsky granite quarry. The exposure dose is 17-23 mcr / h, the average annual effective dose for those working in the quarry is 0.4 msv. Novovoronezh nuclear power plant has differences from other TPP facilities [23].

The structure of emissions into the air environment of the region is shown in Figure 2.

Radionuclides from the Novovoronezh NPP come with wastewater, while the discharge occurs directly into the Don River, into technical outlets, into a cooling pond. The discharge volume is more than 100 thousand m³, strontium-90 is about 10,000 mCi / year and caesium-137 is about 20.000 mCi/year. More than 60 % of the volumes of RTPP have a storm sewer system for collecting wastewater. At most of them, more than 400 violations of environmental legislation are detected annually, while some do not have a storm sewer system, there are no contracts for the delivery of waste, there are cases of unauthorized tapping into oil pipelines. The depth of contamination can be about 30 m.

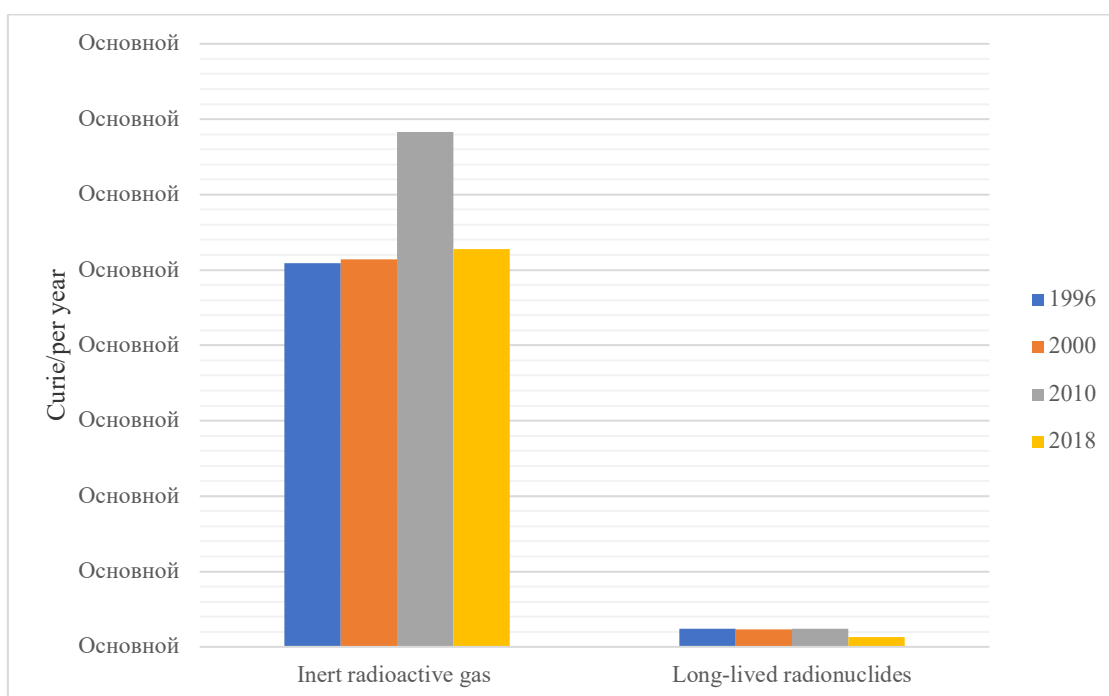


Figure 2. Structure of radiation emissions into the air from the Novovoronezh NPP, Ci/year [18].

4. Conclusions

Thus, the necessity of developing methodological approaches for assessing the impact of RTES on the environment to obtain ideas about the geoecological situation is justified. The degree of influence of RTES elements on the components of nature is determined and is the main source of air pollution in the region, and the total amount of emissions is more than 40 thousand tons per year. RTES is an environmental risk zone in the region.

In the area of oil depots, the content of petroleum products in the aeration zone is about 500 mg/kg, while their content in groundwater can be 50 mg/kg. Soil contamination with heavy metals was detected in the areas of operation of RTES elements. Depending on the geological composition of the soils, they can penetrate up to a depth of 25 m. During the operation of the RTPP, the volume of wastewater is more than 120 million m³, in which the content of petroleum products exceeds from 2 to 20 times the maximum permissible concentration.

To improve monitoring, it is necessary to create a bank of geoecological information of natural, economic, socio-demographic indicators in the zones of influence. It is necessary to use environmental rationing, take into account the assessment of the impact on environmental components and on human health. A special object of the RTES is the nuclear power industry. During the 57-year period, the Novovoronezh NPP did not have a significant impact on the environmental situation in the region. The geoecological situation is mostly stable in the zones of influence of the RTPP, with the exception of local places where an increased degree of environmental risk as a result of man-made accidents has been identified.

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