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# ECOLOGICAL PROBLEMS OF MODERNIZATION OF URAL REGION OF RUSSIA

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## *Abstract*

Throughout century-old history of mankind, exploitation of the environment and its natural resources has not been so active. The acute problems of human relationships with nature did not exist in the past. But in the period of modernization, anthropogenic and technological impact on the natural environment has increased significantly. On the other hand, there is an opportunity to address environmental, scientific and technical issues simultaneously. For the development of effective environmental policies, there is a need for detailed analysis and classification the current situation, related to the impact of human industrial activities on biosphere on both state and regional levels. The Urals is a unique region, unparalleled in the world history. It appears as a region of industrial colonization in the 18th and first half of the 20th centuries; a region of accelerated industrialization in the Soviet era. There was a massive anthropogenic impact on nature, which many times exceeded the regenerating capacity of the environment. All this led to severe environmental and socio-economic consequences.

At present, the Urals are one of the most ecologically polluted regions in Russia. Severe pollution of air, water, soil, a large area of land damaged by techno genesis worsened the natural sphere of life. The environmental situation in the Urals region has a significant impact on the environment in adjacent regions - Siberia, Kazakhstan, the Volga region. This is due to the geopolitical position of the Urals, located on the border of Europe and Asia.



**Keywords:** Ecology, ecological crisis, industry, region, modernization.

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# 1. Introduction

The technogenic approach to the biosphere can be seen as one of the characteristics of the modern world. The consuming attitude to the nature was the result of an emergence of the industrialization phenomenon (Ryabova, 2013). According to the Soviet project of modernization, the primary purpose of development was technological and material progress. The basis of Soviet modernization was the industrialization, which is aimed at accelerated transition from traditional to modern societies. In this regard, the decision of social development problems was pushed aside to the second place.

The industrial modernization has contained national as well as regional specificities. The processes of modernization and the regional development go together and interact with each other (Alekseev, 2004). The modernization helps to equalize the levels of development of certain regions, the universalization of their technological, socio-cultural structures (Lebedev, 2017).

## 1.1. Background to the question

In the period of forced industrialization, in the 1920s-1930s, about eighty industrial centers were formed in the Urals. They varied significantly in terms of the complexity of development and were based on local natural resources, which in their composition were unique. For example, copper ore contained from 25 to 40 different elements. In the conditions of accelerated industrial development, the idea of an equal achievement of several basic goals was replaced by the principle of the paramount importance of one goal (Alekseev, 2004). This goal consisted of the fastest possible growth of industry and the reconstruction of the economy on an industrial basis. This led to a one-sided transformation of the economy. In the industrial centers of the Urals, there were no production facilities for complex processing of minerals, which complicated the ecological situation.

The situation had further deteriorated during the Great Patriotic War and in the post-war years. The country has needed primarily metals, industrial equipment. The structural imbalance in favor of the development of industry (Alekseev, 2011) has resulted in a difficult ecological situation. Solving the problems of environmental protection, facilities were postponed for an indefinite period. Efforts have not been made to develop environmental protection technologies and equipment later on. Too few financial resources were allocated for this purpose and it weren't mastered. The difficult environmental situation in the region was largely resulted from the use of outdated technologies. All of this predetermined a vital necessity for the priority development of the environmental technologies in the man/ technique/nature system (Mitryushkina, 1987).

## 1.2. Environmental components of the technical reconstruction of the region's industry

The anthropogenic pressures exceeded the regenerating capacity of the natural environment in the region. The high concentration of industrial enterprises posed growing environmental problems. A level of economic development of the Urals did not match needs of its population. There has been a significant increase of chronic diseases of the population, decreased levels of life expectancy. This was a consequence mainly of the degradation of the environment.

The many industrial enterprises, especially in the ferrous metallurgy and chemical industry of the Urals, utilized the outdated technical equipment. Wear of the basic production assets in the mining

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manufacturing and the chemical industry was the range from 50 to 60 per cent. It has resulted in an extraordinary high level of air and water pollution. The number of towns in which air pollution was more than 10 times the maximum permissible concentration (MPC) remained unchanged, and the concentration of harmful air-borne substances in Perm, Berezniki city of Perm Region, Chelyabinsk, Kamensk-Uralsky, Ufa, Sverdlovsk was more than 20 times the MPC. There have been increase in the area of lands occupied the slag heaps (Dovgopol, 1978).

## 2. Problem Statement

The interaction of man and the environment in the Urals in the second half of the twentieth century included a whole range of different components. In this article we will focus only on some of them.

### 2.1. Complex use of titanium-magnetite ores of the Urals in the context of greening the industry.

The bulk of the explored reserves of iron ore in the Urals is represented by titanium-magnetite ores. In the industrial reserves of iron ores of the region, titanium-magnetite ores are now 76 per cent. If we compare their share in the total reserves of iron ore, they undoubtedly play a decisive role. It can be argued that the example of the use of the Ural deposits becomes typical (Sergeev, 1979).

In the development of mineral deposits, large amounts are sent to dumps, which occupy significant areas. At the same time, mining dumps are cheap and valuable raw materials, which can be used in construction and other industries.

The complex use of raw materials is a stage in the development of processing industries, when the waste of one process becomes a raw material for others, when the complex relations of production-nature and nature-man are established.

### 2.2. On the way to using low-and non-waste technology in metallurgy.

Since the 1960s, there has been an environmentally safe metallurgical production in the Urals. It was primarily associated with the processing and use of slag. 80 per cent of technological waste in the iron and steel industry is made up of slag. Processing slags, slag screenings was an important condition for improving the ecological situation in the region (Korobelnikov, 1992).

### 2.3. Rational use and protection of water resources.

The degradation of natural waters is mainly due to the discharge into the reservoirs of insufficiently treated or completely untreated wastewater. Pollution of natural environments also occurs as a result of the dispersion of chemicals entering the soil and the atmosphere from solid domestic and industrial wastes, with gas emissions. All these substances end up in the water as a result of migration processes. In this case, a particular danger is represented by those chemical compounds that are difficult to decompose. Their accumulation in water and soil reduces the ability of the latter to self-purification (Chernyaev, 1982).

Hazardous pollutants of water bodies are salts of heavy metals - lead, iron, copper and mercury. Their receipt is connected with industrial enterprises located on the banks of water bodies. Sometimes the concentration of ions of these metals in the body of fish is tens and hundreds of times higher than their initial concentration in the body of water.

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The most effective way to protect reservoirs from pollution is to create a waste-free production process where waste from one stage of the production cycle is used as raw material for another. However, at the present time there is no universal drain less system suitable for various branches of the national economy.

## 3. Research Questions

The changes that the biosphere undergoes nowadays are driven primarily by development of technics, industrial technologies. The technological modernization is a painful process for both humans and nature because the modernization is accompanied by amounting environmental pressures. It is indeed vital to establish the causes of environmental stress, its social roots. With this in mind, we have suggested the following research questions.

### 3.1. Examination of the situation with the environment as an endogenous factor in the modernization of the region.

It is in this context that the environmental constraints as a deterrent to the development of not only individual enterprises but also entire industries are analyzed.

### 3.2. Consideration of the question of the diffusion of scientific ideas and technologies as an exogenous factor in the ecological modernization of the region

In this task, it is essential to discuss on greening the economy, the dependence of the environment on the development of new technology.

### 3.3. Study of the relationship between scientific and technical and environmental policies

The solution of this research task involves analysis of the contradictions between technical and technological development and environmental protection. Overcoming the contradictions caused by man's technogenic activity is a condition for sustainable development of the region.

## 4. Purpose of the Study

The main purpose of research is to study ecological problems of the modernization of the Urals region of Russia in the second half of the 20th century. Its implementation involves the solution of a whole range of tasks:

- identifying the causes for the ecological crisis in the region;
- displaying the directions and the consequences of the influence of the techno sphere on the biosphere of the Urals;
- revealing the main components of the ecological situation: pollution of water, air, soil, destruction of natural systems, radioactive contamination of individual territories;
- detection of the existing dramatic gaps in health and life expectancy.

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## 5. Research Methods

It is impossible to understand the question of the interaction of people with the environment without resorting to a number of theories that developed in the history of social and humanitarian thought in the 20th and beginning of the 21st century.

### 5.1. Methodological "tools" of the research

From the turn of the 20th century, within the framework of such branch of knowledge as anthropogeography, the concept of geographical determinism dominated. Nature was seen as a complex of incentives or irritants, and human behavior was considered only as a mix of reactions to them. Since the 1920s, the concept of geographical nihilism prevailed, within which man and society were elevated to the absolute. They were considered as completely independent from nature phenomena, and in particular, nature was declared as an inert element, and man was viewed as an active element in the environment. From the turn of the XXI century, such interdisciplinary scientific direction as humanitarian geography began to develop, the task of which is to liberate the modern humanist from deterministic distortions and in deterministic mistakes of the past. In fact, theoretically and methodologically, the dynamics of these views suggest that earlier conceptual models are included later, but only partially.

One of the promising conceptual models for our research is the theory of modernization. The classical version of the modernization paradigm focused research interest in development issues, on the factors and mechanisms of transition from tradition to modernity, primarily at the country, national level, in the assessment of the process of transformation of society as a progressive process (Lebedev, 2017).

### 5.2. Ideas used while creating the paper

In this paper, we turned to a neoclassical version of modernization paradigm. Its theoretical core includes the following provisions:

- Important component of the research is the study of spatially-oriented aspects of modernization (Poberezhnikov, 2006). This approach allows undertaking so-called case (situational) studies. The specific region is taken as the object of case studies. Supporters of case studies use modernization theory to explain the unique specific (regional) aspects of development. It is possible to explore regional models of modernization with a local socio-cultural context.
- Modernization is regarded as a contradictory phenomenon and not as a linear process. It is in this context that the ecological crisis in the region should be analyzed.

The interaction of the parameters of traditional and modern societies is explored. Constructive interpretations of the role and place of traditions in the process of modernization are presented. Different variants of traditionalism and innovation are recognized.

## 6. Findings

First time in the worlds practice, in the Urals, the complex use of iron-deficient vanadium-containing titanomagnetite ores was mastered. This process was launched in the first half of the 1960s in relation to the development titanomagnetite ore deposits into the outskirts of the city of Kachkanara. The novelty of the task has caused difficulties in its addressing. Guidance with respect to the industrial uses of these

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resources had not been made yet. But the overriding obstacle to industrial development Kachkanara was in underestimating iron ore mining deposits of the Urals. Iron ore raw materials were multi-component and the iron making industry had the specialized nature. In 1963 Kachkanara mining and processing combine was commissioned. The vanadium started to be extracted from titanium-magnetite ores.

However, metallurgical production in the Urals was abundant with blast-furnace, steel-smelting and ferro-alloy slags. The Ural metallurgy had produced a third of all the slag generated in the country's industry. Processing of slag significantly lagged behind their production. In 1951, the use of blast furnace slags accounted for 57.5 per cent in the USSR, and 41.4 per cent – in the Urals. Therefore, slag processing was an important condition for the integrated use of natural raw materials.

In the early 1960's some enterprise managers has expressed erroneous judgments about the futility of processing and use of metallurgical slag. Therefore, solving the problems of slag processing has required great efforts from the researchers. First of all, their solution was at the intersection of various branches of knowledge. In addition, the slag was more complex in composition and structure than metal. The Urals Research Institute of ferrous metals was entrusted to work out the problems of processing and use of slag. On the basis of research of this Institute all metallurgical enterprises began to apply new technologies (Lebedev, 1997*)*. As a result, the coefficient of integrated use of iron ore in the Urals increased from 28 to 35 per cent in the 1960-1980s.

**Table 01.** Dynamics of integrated use of natural resources of the Urals (in percentage terms)

| **Indicators** | **1961** | **1971** | **1991** |
|---|---|---|---|
| Coefficient of complex use of iron ore | 28 | 35 | 35 |
| Coefficient of vanadium extraction from Kachkanara ores | 13.6 | 21.0 | 26.6 |
| Coefficient of complex use of copper ore | 35 | 59.7 | 64 |
| Level of processing of metallurgical slag: | | | |
| Blast-furnace slags | 41.4 | 73.3 | 77.5 |
| Steel-smelting slags | 2.1 | 2.8 | 11.3 |
| Ferroalloy slags | 3.6 | 39.4 | 67.8 |

The implementation of science and technology achievements during processing of slags had lagged behind the requirements of industrial development and environmental protection. In 1971-1991, processing of blast-furnace slags at Ural enterprises increased by only 26.1 per cent. The processing of steel-smelting slags had been much less developed. Their utilization factor of 11.3 per cent had recorded in 1991. The processing of slags among large enterprises was carried only at Chelyabinsk Metallurgical and Nizhniy Tagil Metallurgical plants. Almost all the plants of the Urals use copper slag.

Among the priorities for industrial policy in the second half of the 20th century was the scientific and technical support of defense projects (Artemov, 2006). Enterprises of defense industries were in the restricted areas and could not be controlled by local authorities. Activities of these enterprises have caused

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significant harm to the environment. For example major technological accidents have resulted in spillages and unplanned releases of radioactive substances at the Mayak facility in Chelyabinsk region in 1948, 1957 and 1968. At the site of the accident, the East-Ural protected area was established. Eighty-five per cent of its territory is designated as an ecological disaster zone. This protected area is one of the two largest ones in the world.

One of the important aspects of the interaction between the techno sphere and the biosphere was efficient use of water within industry. The most progressive element was that ecologically safe technologies were introduced as closed water circulation systems. In the mid-1980s, for the first time in the history of metallurgy, closed water circulation systems have been introduced in the cold rolling workshop of the Verkh-Isetsky Metallurgical Plant (Ozhiganov & Ivantsov, 1985).

However, the introduction of sanitary engineering, ecological and other necessary technology of water resources management was not becoming a prevailing tendency.

**Table 02.** Main indicators of water use in the Urals (in percentage terms)

| Year | Share of industrial water use | Share of reuse and recycling of the water in industry | Level of sewage treatment |
|---|---|---|---|
| 1961 | 89.0 | 50.6 | 27.0 |
| 1971 | 89.2 | 54.0 | 39.8 |
| 1981 | 90.3 | 61.1 | 42.3 |
| 1986 | 92.1 | 73.3 | 51.7 |
| 1991 | 94.5 | 82.4 | 57.3 |

As can be seen, a share of industrial water use has increased by 5.5 per cent and a share of reuse and recycling in industry – by 31.8 per cent, the level of sewage treatment – by 30.3 per cent. And yet in 1991, about 50 percent of industrial wastewaters were being discharged into open waters bodies without any treatment. The sewage pollution of the seas has become a great health hazard through contamination of seafood and degradation of coastal water quality.

One way to tackle the problems of environmental management was to develop projects of territorial redistribution of water resources. Industrial facilities of Sverdlovsk, Chelyabinsk, Orenburg and Kurgan regions had experienced a water shortage. Here there were only 6 per cent of the water resources of the Urals. In the north of Sverdlovsk region, the Tobol, Tura and Tavda rivers flowed, which had made it possible to form 42 per cent of the water resources in these four regions. In the 1970s, there had been widespread discussion in the region about diverting some of the discharge a rivers of the Ural. The Research Institute for the Protection and Rational Use of Natural Resources was established in the city of Orenburg (Khomentovsky, 1980). However, in the mid-1980s, it was considered advisable to stop the implementation of the projects of territorial redistribution of water resources. At the same time, it was suggested that the provision should be given further study on the environmental and economic aspects of their implementation.

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## 7. Conclusion

An analysis of the experience of environmental protection in industry makes it possible to determine its main directions in the context of the technical and technological movement of the region for the future.

### 7.1. Environmental security of the region is a key to the future

Tackling it requires the organization of rescue services to eliminate the environmental consequences of emergency situations; development of registers of ecologically dangerous substances, technologies, manufactures of the Urals; carrying out ecological audit, certification of ecologically dangerous technologies and manufactures.

### 7.2. Minimization the impact of human activities on the environment

This problem will require an introduction of resource-saving and non-waste technologies; a step-by-step reduction of pollutant emissions; development of systems for the use of secondary resources; construction and modernization of treatment facilities only on the basis of modern technologies; remediation of dumps in the territories of enterprises of mining, metallurgical and other industries of the region; development of environmentally friendly modes of transport and fuel.

### 7.3. Scientific, technical and legal support of environmental protection

The research should be carried out through a systematic study of biological systems, determining the limits of stability and ecological capacity of natural systems; development of methodology and methods of environmental and economic assessment in the field of environmental protection, creating the basis for determining environmental risks in order to create a system for managing the quality of the natural environment; development and development of modern methods of environmental monitoring, as well as information technologies for the purposes of state regional management in the field of nature management; creation of legal and economic conditions for the development of entrepreneurship in the field of environmental protection.

In general, the efforts of engineers and mathematicians, political will and a thoughtful strategy are not enough to solve environmental problems in conditions of modernization. The questions become crucial as to how quickly people are ready to understand and accept, how their perceptions of the world and themselves will change, what meanings and values can and should be preserved, and what will have to be abandoned. All these problems are interdisciplinary problems.

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