Progress in environmental safety (review)

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Abstract. The results of studies reflecting the state of environmental safety at the global and regional levels over the last 3 years are reviewed. The mutual influence of environmental and economic problems is noted; since economic security is a vital human interest, it is an integral part of environmental security at all economic levels. It is assumed that great progress in further research can be expected in the use of environmental safety provisions in the field of economics and economic modernization of the general theory of environmental safety.

A brief history of the development of environmental safety (ES) is presented in [1]. The first domestic publications in this area were probably made by Kolbasov O.S. and Timoshenko A.S. [2, 3].

A review of classical works preceding the appearance of ES is presented in an article by S.G. Kharchenko [4].

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The formulation of the problem of creating a general theory of environmental safety (GTES) belongs to the author [5]. The first version of the GTES rationale is given in [6].

The latest rationale for the 3 principles and 4 rules of the GTES is given in [7].

The following is an interpretation of the GTES principles of.

Principle 1 (as amended). The degree of environmental safety is limited by the time and scale of the impacts: short-term exposure can be relatively safe, and long-term exposure can be dangerous; changes
in the local framework can be almost harmless, and large-scale changes can be catastrophic (Reimers N.F., Mileshko L.P.).

Principle 2 (as amended). Any system is a combination of qualitative and quantitative sets of matter, energy, and information that are in continuous change due to changes in environmental parameters (Reimers N.F., Kurazhkovsky Yu.N., Bobukh L.V., Bobukh K.A., Mileshko L.P.).

Principle 3. The energy losses due to informational interactions are insignificant and do not upset the balance in ecosystems, but ensure consistent behavior of subsystems (self-organization); therefore the degree of the system ordering increases, that is, the entropy decreases (Mileshko L.P., Kotenko V.V., Nestyurina E.E.).

The problems of ES provision are relevant both at the international level and domestically. This paper summarizes the main research results on the fundamental and applied aspects of environmental safety at the global and regional levels over the last 3 years.

Issues of providing ES at the international level are considered in the study-guide [8]. Modern conceptual and methodological concepts of sustainable development and ES management are described; the place and role of ES in theories of international relations are determined. The issues of modern approaches to solving basic environmental problems in Russia and at the international level are also touched upon.

According to [9], the intensive development of the technosphere reduces global environmental safety.

Proceeding from the analysis of the development of the biosphere and the technosphere, it is established that the most flexible biosphere systems are composed of multi-purpose elements. In the case of technosphere structures, each element is monofunctional.

Therefore, technosphere is extremely cumbersome, which increases its danger, and leads to excessive flows of raw materials and energy.

Such a difference in the organization and functioning of the biosphere and technosphere stands in the way of their coexistence consensus. This is the main cause of global environmental problems.

The socio-economic content of ES in Russia during the transition to sustainable development was described in [10]. The authors have proposed an original approach to resolving the contradictions between the ES and socio-economic development. Within the framework of sustainable development, ES is considered as one of the elements of a triune “social-ecological-economic” interpretation of safety. It is noted that safety and danger are related concepts: the greater the danger, the lower the safety. Measures to reduce environmental hazards have been proposed, including those based on creating a national culture and ideology that provides for a methodology of conscious attitude to the environment, and rational use and reproduction of natural resources [10].

For all states, ES provision is the most important problem [11].

The current environmental threats in the Russian Federation require the formation of adequate approaches in the field of theoretical developments and practical activities of the state.

The Environmental Safety Strategy in the Russian Federation for the period until 2025 was introduced on April 19, 2017, as a logical continuation of the RF National Security Strategy-2015. These documents made a great contribution to the development of the theoretical and methodological basis for understanding ES as an aspect of national security.

The author [11] focuses on the category “national interests of the Russian Federation in the environmental sphere”, formulates these interests, and classifies the existing approaches. The author specifically emphasizes that the ambiguity of the interpretation of the concept of “environmental safety” carries the danger of undermining the system of ensuring this type of national security to the full in this country.

A brief analysis of publications devoted to the environmental safety of the regions of the Russian Federation is presented in [12] and supplemented in this review.

To maintain the regional ES at the proper level, it is necessary to strictly control production and economic activities with the help of legislative and regulatory acts [13].
In the Belgorod region, the government is taking measures to preserve the territory’s environment and improve the environmental situation [14].

However, at the municipal level, the ES system is characterized by incompleteness and randomness. One of the problems in this area is the uncertainty of the main directions of providing ES in the territories of municipalities. This causes the negative practices in the functioning of local governments [14].

The combination of economic and environmental policies is increasingly manifested in the concept of development of the Russian Federation and its regions [15].

In the Republic of Kalmykia, the main directions of improving state environmental policy include the following [15]:

- scientific approach to the study of the pressing problems of environmental management;
- determination of the effectiveness of the state and municipal authorities in the field of ecology, dissemination of good practices, elimination of negative consequences;
- interaction on the basis of agreements between regions;
- use of the mechanism of public-private partnership for the implementation of projects of public importance, supporting the inherent balance in the nature;
- development of relations in the period of preparation for the implementation of international, state, regional and public policies for the protection of the environment.

According to the results of data processing in the information-analytical system of environmental monitoring (IASEM), it was found that the environmental situation in the city of Krasnodar is “unfavorable” [16].

In particular, in December 2016, it was reported that the content of suspended solids in atmospheric air was up to 1.8 MAC (maximum allowable concentration).

In the Kuban River, at the same time, an excess of iron, copper, BOD5, COD, nitrite nitrogen was observed due to wastewater discharges by housing and communal services [16].

In [17], an approach was proposed to create an information system for managing regional ES in the Republic of Crimea.

In the economy of the Orenburg region, natural resource potential is fundamental due to the diversity of its structure [18]. It is noted that due to the unresolved environmental problems, the problems of social development are exacerbated. This affects demographic and migration indicator. In recent years, the population in the region has declined by almost 10%.

The article considers the problems of sustainable development of the region and the implementation of environmental policy measures. The development of the network of protected areas SPNA (Special Protected Natural Areas), the rational use of water resources and the management of household waste were highlighted as priorities. The main objectives of the regional environmental policy are to prevent de-environmentalization of production on the one hand, and examination of new projects on the other.

In [19], the system of ES provision in the Rostov region and the main strategic tasks of rational nature management for the socio-economic development of the region are characterized.

At the enterprises, it is planned to use technologies to reduce the negative impact of production and consumption waste on the EE (ecological environment). In the field of air protection, it is planned to implement measures to introduce BAT.

To reduce the negative impact on water bodies, measures should be taken to improve the environmental situation around the Tsimlyansk reservoir and the Temernik river basin.

The environmental conditions in the cities of the Rostov Region were estimated as follows: Shakhty: critical, Taganrog: critical, Azov: acute, Rostov-on-Don: critical, Volgodonsk: satisfactory, Novocherkassk: critical [20].

The dynamics of changes in the state of atmospheric air in industrial cities is of great importance for the timely adoption of effective management decisions at all levels.

This confirms the relevance of the work [21], the purpose of which was to identify current trends in ensuring air quality in the region using the example of the Rostov region.
For analysis, we used the values of the atmospheric pollution index (API).

![Figure 1](image1.png)

**Figure 1.** The highest and lowest API values in the Rostov region cities [21].

![Figure 2](image2.png)

**Figure 2.** Urban air pollution index values in 2017 [21].

The results of the analysis of atmospheric air quality shown in Fig. 1 correlate with the assessment of the ecological situation in cities: Shakhty: critical, Taganrog: critical, Azov: acute, Rostov-on-Don: critical, Volgodonsk: satisfactory, Novocherkassk: critical [20].

According to fig. 2, the degree of environmental safety can be qualitatively assessed according to [21] cities: Tsimlyansk: high, Shakhty: medium, Taganrog: medium, Azov: medium, Rostov-on-Don: low, Volgodonsk: medium, Novocherkassk: low.

The analysis of the state of atmospheric air in the city of St. Petersburg in 2016 led to the conclusion [22]: the atmospheric air quality indicators met the standards established by the EU Directives, with the exception of PM$_{10}$ at station No. 20, where it was affected by the development of the territory near the station location.

The average annual concentration of nitrogen dioxide did not meet the standard for EU Directives at stations No. 12, 13, 18 and 20.

The atmospheric air quality for sulfur dioxide, carbon monoxide, PM$_{2.5}$, ozone, 3,4-benzpyrene and benzene was in compliance with the standards.

It was noted that the main sources of water pollution are washes from the fields of nitrogen and phosphorus fertilizers and wastewater discharges that cause eutrophication [22].

Phosphorus plays a decisive role among nutrients that affect eutrophication.

According to [23], in the Sverdlovsk Region programs to support a high level of ES are being implemented. These include the decree “On the approval of the municipal program “Ecology and
environmental protection in the municipality of the city of Yekaterinburg for 2017-2020”. All enterprises develop environmental documentation. Particularly important is compliance with the standards for maximum permissible emissions into the atmosphere and the implementation of established environmental measures. According to this decree, it is planned to solve the problem of improving the quality of atmospheric air and monitoring compliance with sanitary and environmental standards for the maintenance of water bodies and water protection zones, regular treatment works and water quality monitoring [23].

It was noted in [24] that the current growth in the GDP of the Sverdlovsk region has a beneficial effect on the economy, but it is doing more and more harm to the environment. In this regard, at the next stage of the implementation of the “Environmental Safety Concept for the Period until 2020”, it is required to achieve a sustainable reduction in the impact of negative pollution factors on public health.

In the Tula region there is a particularly unfavorable environmental situation compared to other subjects of the Central region of the Russian Federation [25]. Issues of environmental protection and improving the quality of life of the population are more effectively resolved with the direct participation of all citizens, both in the region and at enterprises of the Tula region [25].

The main suppliers of pollutants to the air basin of the region are motor vehicles and enterprises of the fuel and energy industry, ferrous and non-ferrous metallurgy, which accounts for 50 to 85% of pollutants [25]. Compared to all regions in the center of Russia, the Tula region is second only to the Moscow region in concentration of industrial and energy enterprises. Cities such as Tula, Novomoskovsk and Shchekino occupy top the list of 99 Russian cities with an unfavorable environmental situation.

As a result of the study performed in [26], the conclusion was made:

1. In the present-day economy, the rise in the production potential of the region is not necessarily among factors that adversely affect its environmental situation. For the 28 regions studied, the correlation coefficient of the data sets “Rank of production potential” and “Rank of environmental safety” shows a very weak dependence of these factors.

2. The forefront position of the economic leaders of the Russian Federation is largely due to the preservation of production based on outdated equipment and technologies, which are the main sources of environmental pollution.

3. 36–72% of the regional economy sectors contribute to significant environmental pollution. These are very high indicators in comparison with countries with a high level of socio-ecological and economic development.

3. Regions that score high in terms of “production potential” and “environmental safety” include Moscow, St. Petersburg, Krasnodar Territory and Rostov Region. First and foremost, these cities and regions have a more modern GRP structure. Only 25–35% of their economy sectors contribute to the environment pollution.

A large share of the old industrial regions with the economy predominantly based on 3-4 technological structures (with fairly high places in the rating of production potential) occupies very low places in the ES rating. This applies, for example, to the Irkutsk, Krasnoyarsk, Sverdlovsk, Nizhny Novgorod, Chelyabinsk regions, the Republic of Bashkortostan. Along with increased compliance with legislation that regulates the state of ES in the regions, the most important circumstance that ensures the development of production potential in old industrial regions and at the same time improves the environmental situation is a gradual transition to a more modern economic structure [26].

The article [27] examined the environmental situation in the Omsk region and analyzed the main indicators that determine environmental and economic safety.

The formulation to the main directions of increasing the ecological and economic security of the region is given as follows:

- improvement of regional environmental legislation;
- financial incentives for environmentally oriented enterprises;
the implementation of regional economic policies that take into account the environmental factor in the deployment of productive forces in the region;

- optimization of the assessment of the ecological and economic condition of the region and the quality of life of the population of the Omsk Region on the basis of a set of demographic factors, such as indicators of population migration, birth rate, morbidity, mortality, etc.

Consequently, environmental and economic problems are inextricably linked and have a mutual influence on each other.

At the same time, economic security is an integral part of ES at all levels.

The role of natural and climatic factors of ES in the context of socio-economic development of the Baikal region is described in [28].

It is shown that the most thermally favorable territories of river valleys and intermountain depressions have an increased level of pollution. The main air pollutants are enterprises producing and distributing electricity, gas and water. For them, the share of the total emissions of pollutants emanating from stationary sources in recent years has changed in the range of 46-54% in the Irkutsk region, 64-74% in the Republic of Buryatia and 55-60% in the Trans-Baikal Territory. A 1.3 times increase in the incidence of malignant neoplasms in the region’s population was found; one of the main causes of this is air pollution in cities. A cost estimate of the premature mortality risk of the working population was carried out. Economic damage in 2016 amounted to 4.7% of the GRP for the Irkutsk Region, 8.6% for the Republic of Buryatia, and 7.5% for the Trans-Baikal Territory [28].

To control the process of using the space geoinformational system in order to ensure the regional ES, it is necessary to form processes with predetermined properties [29]. In this work, a management concept based on a synthesis that more fully satisfies these requirements is proposed. An innovative approach is to solve the inverse control problem, and the basis is the decision of a person.

The article [30] presents the analysis results of the state of the Bryansk, Smolensk and Pskov regions in terms of the ES and environmental protection levels. The directions of modernization of regional policy with the aim of improving the environmental situation in the constituent entities of the Russian Federation are determined. The results obtained will provide authorities with the opportunity to increase the effectiveness of management decisions in the field of ES and environmental protection at the regional level.

The uneven socio-economic development of the regions poses a threat to economic security not only at the regional, but also at the state level. To stabilize the regional level of economic security Dolganova Y.A. and Rudenko M.N. [31] developed a model of regional economic security, which is based on blocks that contribute to the stabilization of the socio-economic development of regions.

Currently, a new direction research is being conducted: “The Economic Basis for Ensuring Environmental Safety” [32]. This is due to the urgent need to develop new economic approaches to environmental safety management at the global, regional and local levels. It is shown that the general theory of environmental safety is of great interest to the economy of environmental management in terms of providing opportunities for more efficient consideration of the environmental factor in all economic systems.

Therefore, notable progress should be expected in the application of environmental safety provisions in the economic sphere [33].

The results of the latest publications, reflecting achievements in ensuring environmental safety at the global and regional levels are systematized.

The ecological situation in the Belgorod region, the Republic of Kalmykia, the city of Krasnodar, the Republic of Crimea, the Orenburg region, the Rostov region, the city of St. Petersburg, the Sverdlovsk region, the Tula region, the Omsk region, the Trans-Baikal Territory is characterized.

Attention is focused on the mutual influence of environmental and economic problems on each other, since economic security is one of the vital interests of humankind, and, therefore, is an integral part of environmental safety at all levels.
Great progress can be expected in the application of environmental safety provisions in the economic sphere.

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