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A Spatio-Dynamic Modelling of Environmental Safety of the Russian Federation Regions

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Abstract

In this paper, authors suggest an approach to the modelling of the environmental safety of the Russian regional socio-economic systems. Geostatistical methods are used for modelling. They allow to consider spatial relationships between regions and to carry out an analysis of stationarity and spatial variability of the data set describing the environmental security. Assessment of ecological safety of the Russian Federation regions was carried out by the use of the econometric model developed by the authors, and the typology of the regions was performed. This typology allowed to allocate four groups of regions and to develop strategies for their governance. The resulting economic and mathematical model of environmental safety of regional system is needed not only for spatio-dynamic monitoring of the regions ecological status but also for identify sources and factors of environmental problems.

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1. Introduction

Modelling of regional ecological security is a key element in the development of socio-economic programs in a region and for management of decisions concerning the mentioned topic. Therewith, the importance of the study is contingent on the fact that the development of the real sector of the economy in the regions leads to the involvement in economic circulation of an increasing number of natural resources and leads to the transformation of natural

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complexes. Minimization of technogenic impact on the environment is of particular importance for the industrial enterprises in the conditions of increasing mining volumes and increasing production capacity. Since industrial production is inevitably associated with a high risk of negative effects on the ecosystem, up to the catastrophic level, therefore requires effective control of environmental safety. Currently, there are various units, departments, committees and ministries dealing with environmental safety and environmental protection in Russian regions. Therefore, the ability to obtain timely and reliable information on the environmental state of security in the region together with the modelling the environmental situation would give the opportunity to develop environmentally oriented programs and make management decisions based on their ecological condition. Thus, the aim of this study is to model regional ecological security systems based on an evaluation of its level with the use of the multivariate statistical analysis.

2. Review of the approaches to the assessment of environmental safety of regional systems

It should be noted that the issues of environmental safety are not confined to individual scientists, scientific schools and laboratories, but also international centers - the World Bank (World Development Indicators), the Organization for Economic Cooperation and Development (Environmental Indicators System), UN (Millennium Development Goals), the World Wildlife Fund, environmental Protection Centre of the Russian Academy of Sciences and other organizations.

In general, the analysis of the environmental safety studies suggests a large number of approaches to assessing the level of environmental safety of regional systems and a large number of modified local approaches developed by individual researchers. [1,2,3,4,5,6,7,8]

It should be noted that the human and ecological approaches to the assessment of environmental safety involve the use of such indicators as critical environmental load, the maximum permissible environmental pressures, technology-intensive environment, the ecological capacity of the territory, assimilative capacity, and so forth. [3]

Analysis of these approaches to environmental safety assessment allows us to point out their lack of comprehensive study of such multidimensional phenomena as ecological safety. In these approaches, the emphasis is on the environment, it does not take into account the parameters that have a direct impact on the environmental security as indicators reflecting the functioning of industrial organizations and implementing of environmental innovations by the organizations.

In our study we propose to use spatio-dynamic approach to the environmental safety assessment, based on the use of geostatistical tools and methods of multivariate statistical analysis.

The use of geostatistical methods for the analysis of natural and environmental conditions of the area, the state of the environment began at the end of the 20th century. Some scientists, including J. Matern, D. Knige, A. Zhornel, C. Khyubregts, E. Ayzeks, R. Shrivastava, P. Guveretss, S. Ditch etc. have made a significant contribution to the development of theoretical basis of geostatistics [9]

In Russian literature the first attempts to highlight the problems of using a geostatistical approach to the assessment of social development and the environment were independently undertaken by researchers from the Institute of Nuclear Safety Issues (IBRAE) of Russian Science Academy and S.A. Burtseva.

The practical implementation of the methods above is reflected in programs such as ARCGIS, Geostatistical Software Tool, Geostat and others.

3. Modelling of regional ecological security of the regional system

Modelling of regional ecological security of the regional system includes the following steps:

1. Formation of a system of indicators;
2. Development of algorithms of regional ecological security level assessment;
3. The approbation of the developed evaluation algorithm; model building;
4. Analysis of the study results. Conclusions.

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