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PRESENT-DAY SYSTEM OF ECOLOGICAL AND ECONOMIC SECURITY: MANUFACTURING ENTERPRISES AND MATHEMATICAL MODELING

Hostilities, rocket and artillery attacks, destruction of enterprises and houses, deforestation, water pollution and the lack of ecological monitoring on the territory not controlled by Ukraine – today these are the challenges not only to the national but also to the global natural and anthropogenic system. What is more, this all is without taking into account the impact of economic activity of natural and juridical persons.

On the other hand, the revival of Ukrainian economy depends, in particular, on the growth of agricultural and industrial production, capital construction, domestic and foreign trade. However, all the above factors have to be taken into consideration with a due regard to not only ensuring military, food, informational and foreign policy security, but also environmental one.

The ecological approach to solving military, territorial, socio-economic and other issues is a prerequisite for the reconstruction and development of Ukraine as a modern, independent European state.

Ecological-economic (EE) security is a combination of economic, social and environmental conditions and factors that ensure sustainable and efficient development of an enterprise aimed at improving the quality of life of society and the environment.

The solution to the problem of environmental safety requires the elaboration of mathematical models, as well as the optimization (on their basis) of the parameters of the EE system for controlling techno-genic environmental pollution in terms of a full-scale invasion of russian troops to the territory of Ukraine.

The development of such models suggests the creation, adaptation and use of adequate economic-mathematical methods that allow taking into account the inaccuracy, incompleteness and difficulties of formalizing the initial data and the specific interaction of the EE system under studies with the external environment.

The process of building an economic-mathematical model includes the following typical steps:

1. Articulation of the modeling objective.
2. Qualitative analysis of the ecosystem, based on the goal.
3. Articulation of laws and plausible hypotheses regarding the structure of the ecosystem, mechanisms of its behavior as a whole or in individual parts (during self-organization, these laws are to be “found” by the computer).
4. Identification of the model (determining its parameters).
5. Model verification (assessment of the degree of adequacy to the real ecosystem).
6. Model research (analysis of the stability of its solutions, sensitivity to changes in parameters, etc.) and experimentation.

The current challenges to the paradigm of the ecological world justify and require compliance with the following principles of building EE models:

- the principle of discrepancy between accuracy and complexity, proposed by L. Zadeh. It runs as follows: the concepts of “accuracy” and “complexity” in predicting the structure and behavior of ecosystems are inversely related - the deeper the analysis of a real ecosystem, the less certain our judgments about its behavior;
- V. Nalimov’s principle of multiplicity - to explain and predict the structure and / or the behavior of a complex system, it is possible to build several models that have the equal right to exist;
- the principle of omnipotence - it is impossible to take into account the most important factors in any model;
- the principle of counterintuitive behavior of complex systems by J. Forrester -eventually, the ecological system behaves completely differently from what the model predicts.

The scheme of construction and application of G. Kleiner’s economic-mathematical model for a specific EE object, transformed for the EE system, is shown in Fig. 1.

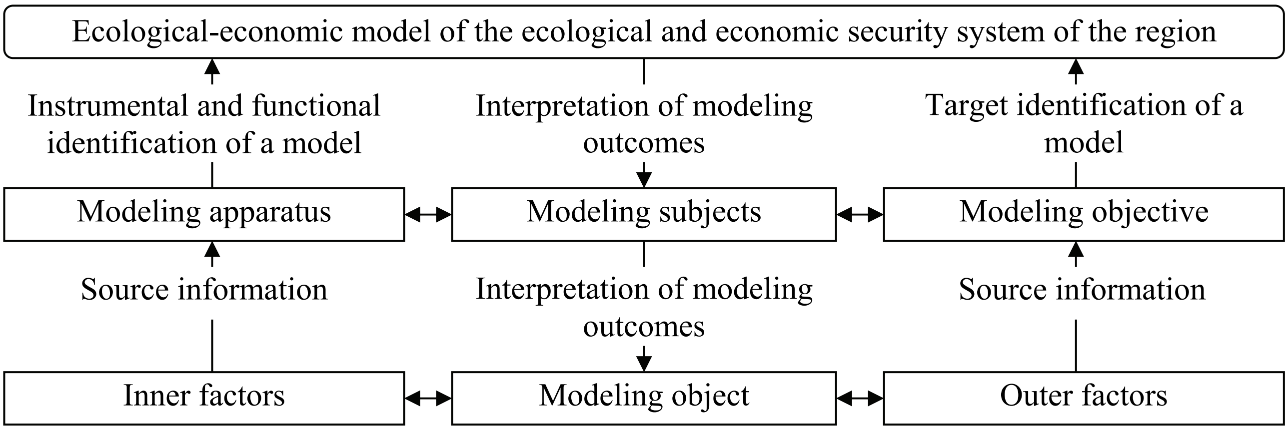


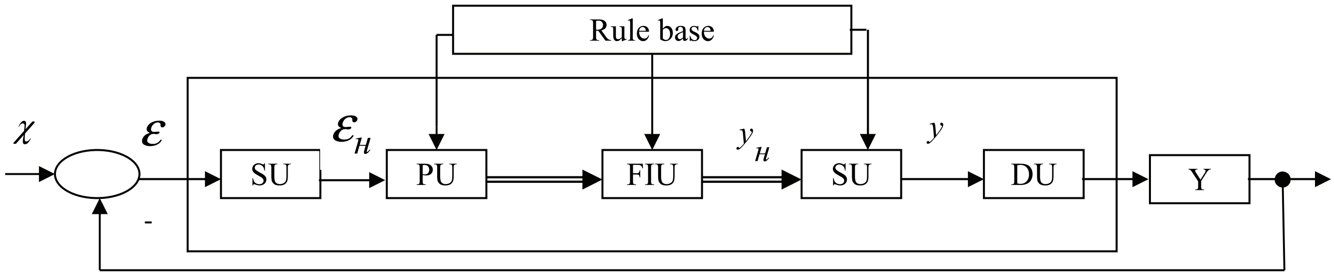
Fig. 1. Scheme of construction and application of economic-mathematical model for a specific EE object [1, p. 204-205; 2, p. 17-20; 3, p. 58-59]

In order to ensure EE security as a system, we need to bear in mind the following:

- a significant number of functions performed, parameters and results of functioning;
- complexity of system behavior, which is reflected in the presence of interconnections and interdependencies between variables;
- uneven and time-varying external interactions;
- constant spatial and temporal connection, which is manifested in the interaction of system elements and is fixed in the form of a certain structure;
- reflection of the views, goals and values of business entities;
- lack of dependence of the structure and nature of the relationships between the elements of the level and type of development of the economic system.

Based on a set of theoretical assumptions that interpret the level of EE security of industrial enterprises as a function of interrelated endogenous and exogenous factors influenced by production and the environment, it is possible to assess the level of threat using the fuzzy logic apparatus, which is widely applied in artificial intelligence systems. The proposed approach makes it possible to more adequately assess the causes and degree of crisis situations, as well as to obtain indicative tools for improving the EE security of an enterprise in the industry.

As a tool that implements the approach under studies, we can recommend the FuzzyLogicToolbox application package of the MatLab computer mathematics environment. It provides for creating systems of fuzzy logical inference and fuzzy classification with the possibility of their integration into the Simulink program. The basic concept of FuzzyLogicToolbox is a FIS-structure that contains data for the functional display of «inputs-outputs» (Fig. 2).



X – input clear vector;
SU – standardization unit. Here, the clear signal of the incoming vector is multiplied by a scaling $k_{єн} < 1$, converted to an interval bounded by, for example, [-1, +1];
PU – phasification unit generates the value of the membership function that corresponds to the normalized value $\varepsilon_н$;
FIU – fuzzy inference unit, in which relying on the fuzzy information about the vector ε, a conclusion is made about the corresponding fuzzy set of values *Y.* Here the so-called inference procedure is implemented, during which the conclusions of individual rules are aggregated. The aggregation results in ”truncated” fuzzy sets;
SU and DU are units of sanitization and deformation that perform inverse procedures: several «truncated» membership functions are used to calculate a clear value $y = y_н / k_{у.н}$ $(k_{у.н} \langle 1)$;
Y – output clear vector of controlled environmental safety parameters.

Fig. 2. Algorithm of the fuzzy inference system

Based on the results of the scenario analysis that applies the method under studies, we may identify the ways to adjust the management activities of the enterprise, taking hereby into account risk and uncertainty. Consequently, this allows to develop recommendations for a set of the most effective measures that ensure a stable state of environmental and economic security of the analyzed system.

Modeling of EE systems using fuzzy inference algorithms allows to increase the environmental and economic efficiency of the planned measures, which, in turn, helps to reduce the negative impact on the environment and, as a result, the costs and penalties for its pollution.

References

1. Білоскурський Р. Р. Еколого-економічні актуалітети в системі розвитку інституціонального середовища України : монограф. Київ : ВНЗ «Національна академія управління», 2017. 324 с.
2. Григорків М. В., Григорків В. С. Двосекторна модель економіки в умовах екологізації виробництва та споживання. *Вісник Чернівецького торговельно-економічного інституту. Економічні науки*. 2021. Вип. 3. С. 140-153.
3. Рилєєв С. В., Романчук А. Л. Еколого-економічні ризики промислового підприємства як об’єкт управління. *Вісник Чернівецького торговельно-економічного інституту. Економічні науки.* 2015. Вип. 4. С. 53-63.