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THEORETICAL AND METHODOLOGICAL FRAMEWORK FOR ENSURING RESOURCE AND ENVIRONMENTAL SAFETY IN THE REGION

The methodological framework for ensuring resource and environmental safety in the region is built up in the article. It includes three stages: hazard identification and determination of areas of the resource and environmental safety; strategy selection for ensuring resource and environmental safety in the region; correction and coordination of solutions. The practical implications of the work are optimization of the strategy for ensuring resource and environmental safety in the region, the implementation of which will help to: improve the resource availability and competitiveness of the region, make additional profit from the use of the secondary resources; preserve primary resources and improve their quality; ensure preservation and restoration of the natural environment of the region, to improve social and psychological climate in the region and health level of population.

Keywords: **resource and environmental safety; use of the secondary resources; primary resources; natural environment of the region**

Statement of the problem

The problem of ensuring resource and environmental safety and more efficient use of natural and economic potential of the area is a priority for each region of Ukraine. According to the natural resource intensity index, which is an integrated indicator of energy and water consumption and airborne emissions hazard, etc. (for Ukraine it makes 8.7), Ukraine is ahead of such countries as Russia, Moldova, Poland and EU-members (this index is equal to 1.0 worldwide) [1]. At the same time, formation of an efficient market economy in the regions requires solution of the problems between the goals of the social and economic system development and negative effects of its impact on the environment considering the influence of destabilizing factors. In this aspect, forming new comprehensive approaches to ensuring resource and environmental safety in the region and creating strategies for improving primary and secondary resources management based on economic models and mechanisms are becoming a priority in regional development.

The analysis of recent studies and publications discussing the problem. B. Burkynskyi, V. Stepanov, S. Kharychkov [2], V. Voloshyn, V. Trehobchuk [3], B. Danylyshyn, A. Stepanenko [4], M. Dolishnii [5], S. Dorohuntsov, M. Khvesyk [6], V. Onyshchenko, O. Komelina [7], N. Chepurnykh [8] and other specialists have made a great contribution to the development of theoretical and methodological framework of a balanced social and economic development of the regions. The works of V. Vernadskyi, A. Klymenko, L. Melnyk, J. Odum, S. Podolinskyi, N. Reimers, M. Rudenko, J. Forester and other scientists are dedicated to fundamental studies of interaction between a society and nature. At the same time, the issues for further scientific research still involve a problem of forming comprehensive approaches to ensure resource and environmental safety of the regions. These approaches are based on developing an innovative methodology for regional social and economic system development, that ensures prevention of ecosystems and human health deterioration while improving social and economic conditions of a given system through a mechanism of more efficient use of natural and economic potential of the area.

Problem definition: to develop and to scientifically substantiate the methodological framework for ensuring resource and environmental safety of the regions of Ukraine, that includes theoretical-methodological approach to

strategy optimization for ensuring resource and environmental safety and scientific-methodological principles for choosing measures for ensuring resource and environmental safety in the region.

Description of the main materials of research

Resource and environmental safety of the region is a state of a regional natural and social and economic system that ensures prevention of ecosystems and human health deterioration while improving social and economic conditions of a given system (minimum entropy) considering the influence of destabilizing resource and environmental hazards of external and internal environments through a mechanism of more efficient use of natural and economic potential of the area, which is focused on resource preservation and substitution.

A comprehensive approach to ensuring resource and environmental safety of the region includes the following components: hazard identification and determination of areas of resource and environmental safety, on which basis a theoretical and methodological approach to strategy selection of ensuring a sufficient level of the resource and environmental safety is formed; a scientific and methodological basis for selecting measures of ensuring a sufficient level of the economic safety on the basis of economic models optimization; correction and coordination of solutions.

According to the theory of ecosystems safety and taking into account the influence of social and economic factors thereon [9], a theoretical and methodological approach to assessing the level of the resource and environmental safety of the regions has been developed. This approach is to calculate a three-component index that takes into account a level of environmental safety of the region's economy (P), a level of environmental risk to the health of population (M) and a level of resource preservation and resource restoration in the region (W):

$$K = f (P, M, W), \qquad (1)$$

$P, M, W \rightarrow 1$, if $P, S, W \geq P_{suff}, S_{suff}, W_{suff}$

$P, M, W \rightarrow 0$, if $P, S, W < P_{suff}, S_{suff}, W_{suff}$

where $P_{suff}, M_{suff}, W_{suff}$ − sufficient value of indexes P, M, W.

To calculate the value of K, the indexes meeting the following criteria have been used:

relevance; reliability; calculability; information availability; simple calculation and affordability; efficiency of use; understandability for greater part of society. The index of the environmental safety of the region (P) is calculated according to the author's methodology as a total economic damage for environmental pollution from anthropogenic load in the region [10]. Assessment of the environmental risk to the health of population may be carried out using the author's model, which addresses different interdependencies in the system of relations "human − environment" [11]. The index of the level of resource preservation in the region includes the following components: an index of environmental and stabilizing areas [12]; energy consumption of a resource management system in the region [13]; economic efficiency of using the secondary resources in the region [14]; economic efficiency of using the bioenergy potential in the region [15].

The 8 theoretically possible values of a three-component index of assessment of the resource and environmental safety level in the region K correspond to 4 areas of the resource and environmental safety of the region (Fig. 1).

A study of the above stated indexes makes it possible to determine areas of the resource and environmental safety of the regions of Ukraine, and 16 regions belong to the areas of fragile and unacceptable resource and environmental safety (Fig. 2). The worst indexes of environmental risk are characteristic for regions where many industrial enterprises are situated and mineral resources are mined (Donetsk, Dnipropetrovsk, Zaporizhzhia and Ivano-Frankivsk regions). Only three regions have a level of resource preservation and resource restoration that is above average (Donetsk, Dnipropetrovsk and Zhytomyr regions).

Optimal strategies for ensuring resource and environmental safety in the region, the characteristics of which are given in Table 1, are proposed for each selected area of the resource end environmental safety.

A principal goal setting and problem definition for developing an eco-efficient

Figure 1 - Zones of resource-ecological safety of region (made up by the authors)
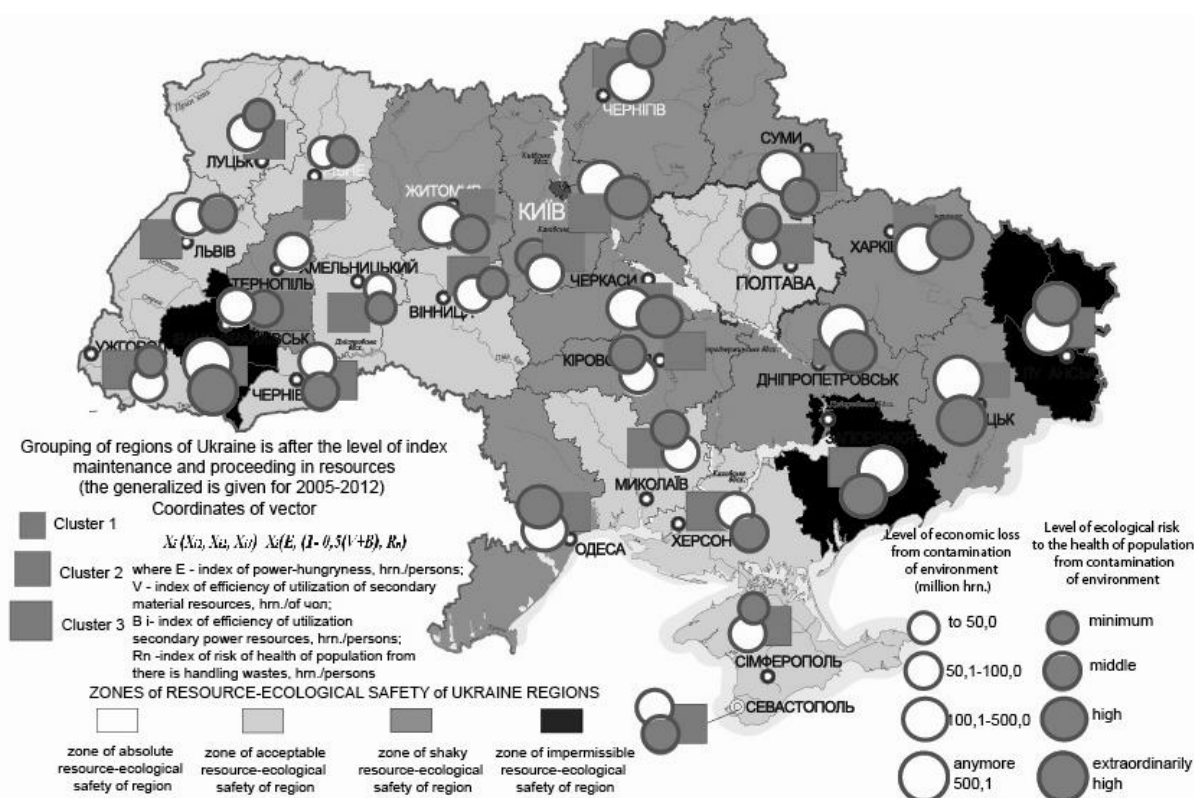

Figure 2 - Typology of the regions of Ukraine according to resource and environmental safety, summarized data for years 2005-2013 (made up by the authors)

development strategy of the region, unlocking innovative investment, resource and environmental potential of the region and assumed ideology of sustainable problem-solving, generally can be formalized and represented as follows:

1) requirements for ensuring effective economic development of the region by the end of the period under consideration (T) may be expressed by the following criteria:

$$\sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j=1}^{J} E_t(f_{i,j}) \rightarrow \max f_{i,j}, \quad (2)$$

Table 1. Typology of the regions of Ukraine according to the direction of improvement of environmentally safe development system*

Resource and environmental safety area	Strategy characteristics	Regions	Primary strategy**
Area of absolute RES of the region. All components are at a sufficient level. The region should continue safety improvement (increase material and energy waste utilization volumes, find new sources for ensuring resource safety, improve the quality of the primary resources).	*Strategy of maintenance.* Assumes maintaining of sufficient RES level, operation results control and prevention of potential hazards.	-	-
Area of acceptable RES of the region. One of the components of the integrated indicator of RES is insufficient. The existing deviations can be detected by conducting an in-depth research.	*Strategy of strengthening.* Assumes measures for strengthening of one of the factors of the resource and environmental safety, which has an insufficient value.	AR of Crimea,	A_2
		Vinnytsia,	A_1
		Volyn,	A_3
		Zakarpattia,	B
		Lviv,	A_2
		Mykolaiiv,	A_2
		Poltava,	A_3
		Rivne,	A_3
		Kherson,	A_2
		Khmelnytsk,	B
		Chernivtsi	B
Area of fragile RES of the region. The level of the RES is insufficient by several components. The existing deviations can be detected by conducting an in-depth research. On the basis of the data received certain measures to eliminate an existing problem can be taken.	*Strategy of adaptation.* Implementation of a strategy towards improvement of the environmentally safe development system.	Kyiv,	A_1A_2
		Sumy,	A_1A_3
		Chernihiv,	A_2A_3
		Cherkasy,	A_2A_3
		Kirovohrad,	A_3B
		Odesa,	A_1A_2
		Ternopil,	A_1B
		Dnipropetrovsk,	A_1A_2
		Donetsk,	A_1A_2
		Zhytomyr,	A_2A_3
		Zaporizhzhia,	A_1A_2B
Area of unacceptable RES of the region. A level of the resource and environmental safety is insufficient by all components of the integrated indicator at once. In this case, first of all the region has to resolve issues of environmental safety.	*Strategy of changes.* Assumes changes in all directions of region development.	Luhansk,	A_1A_2B
		Kharkiv,	$A_1A_2A_3$
		Ivano-Frankivsk regions	$A_1A_2 B$

* – made by the authors; ** – A_1 – effective strategy of air conservation A_2 – effective strategy of water resources conservation; A_3 – effective strategy of soil conservation; B – effective strategy of health care system improvement.

where $E_t(f_{i,j})$ efficiency of *f*-type measures taken in *t*-th year; $f_{i,j}$ – economically available measure to modernize technology of improving resource and environmental potential of the region, which is associated with *j*-substance emissions polluting the environment.

Selecting the measures for modernization of technology of improving the resource and environmental potential of the region is based on optimization of the objective functions: minimization of damage from contamination of the environment; minimization of environmental risks for population health; maximization of

sorting and recycling waste; maximization of profits from the sale of secondary material and energy resources; minimization of energy consumption in the production process, that is ensured by the maximum return of secondary resources into the economy of the region; maximization of profits from operation of the secondary resources handling system in the region, defined as the difference between income from its operations and its expenditures.

2) restrictions on the environmental pollution should be defined by the need to meet environmental standards for each year (*t*):

$$\sum_{j=1}^{J} \sum_{i=1}^{N} E_t(f_{i,j}) \cdot a_t(f_{i,j}) \leq A_i, \quad (3)$$

where $a_t(f_{i,j})$ – emission volume of *j*-component, which pollutes the environment, per unit of the added value of *i*-product production during *k*-measure for modernization of manufacture and improvement of environmental situation in the region in the *t*-year; A_i – permissible cumulative volume of emissions and discharges of pollutants;

3) the search for solutions should be performed with consideration of the general technological, recirculation, transportation, institutional and financial restrictions of the region from the future perspective:

$$\sum_{j=1}^{J} E_t(f_{i,j}) \geq 0; i = (1, ..., N);$$
$$t = (1, ..., T) \quad (4)$$

In general, implementation of said ideology of rational solutions making in developing a strategy of the environmentally safe and economically effective development of the regions of Ukraine assumes the use of a set of specific scientific and methodological approaches, among which one should primarily distinguish: a scenario approach when developing possible strategy options for the environmentally safe development of the region; studying of business plans of the most effective projects of production development and use of resources, the implementation of which is substantiated by both the perspective of estimating an expected economical efficiency and by ensuring the RES of the region. Based on the above stated, we can develop a solution-making algorithm for strategy optimization for ensuring resource and environmental safety in the region (Fig. 3).

Conclusion

The article deals with the development and scientific substantiation of the conceptual framework for ensuring resource and environmental safety of the regions of Ukraine. This framework is focused on increasing the efficient use of natural and economic potential of the area, resource preservation and substitution, which includes: hazard identification and determination of areas of resource and environmental safety, that allows to select a prior strategy for ensuring resource and environmental safety of the region; selecting measures for ensuring a sufficient level of the resource and economic safety of the region on the basis of optimizing economic models and comprehensive assessment of alternative scenarios; correction and coordination of solutions.

The practical implications of the work are strategy optimization for ensuring resource and environmental safety in the region, implementation of which will help to: improve the resource availability and competitiveness of the region, make additional profit from the secondary resources; preserve primary resources and to improve their quality, to return contaminated lands into the economy of the region (addressing the economical and resource aspects); minimize health risk for population from the negative impact of the waste, improve social and psychological climate in the region (addressing the social aspect); ensure preservation and restoration of the regional environment, natural state of ecosystems and entropy minimum (addressing the environmental aspect).
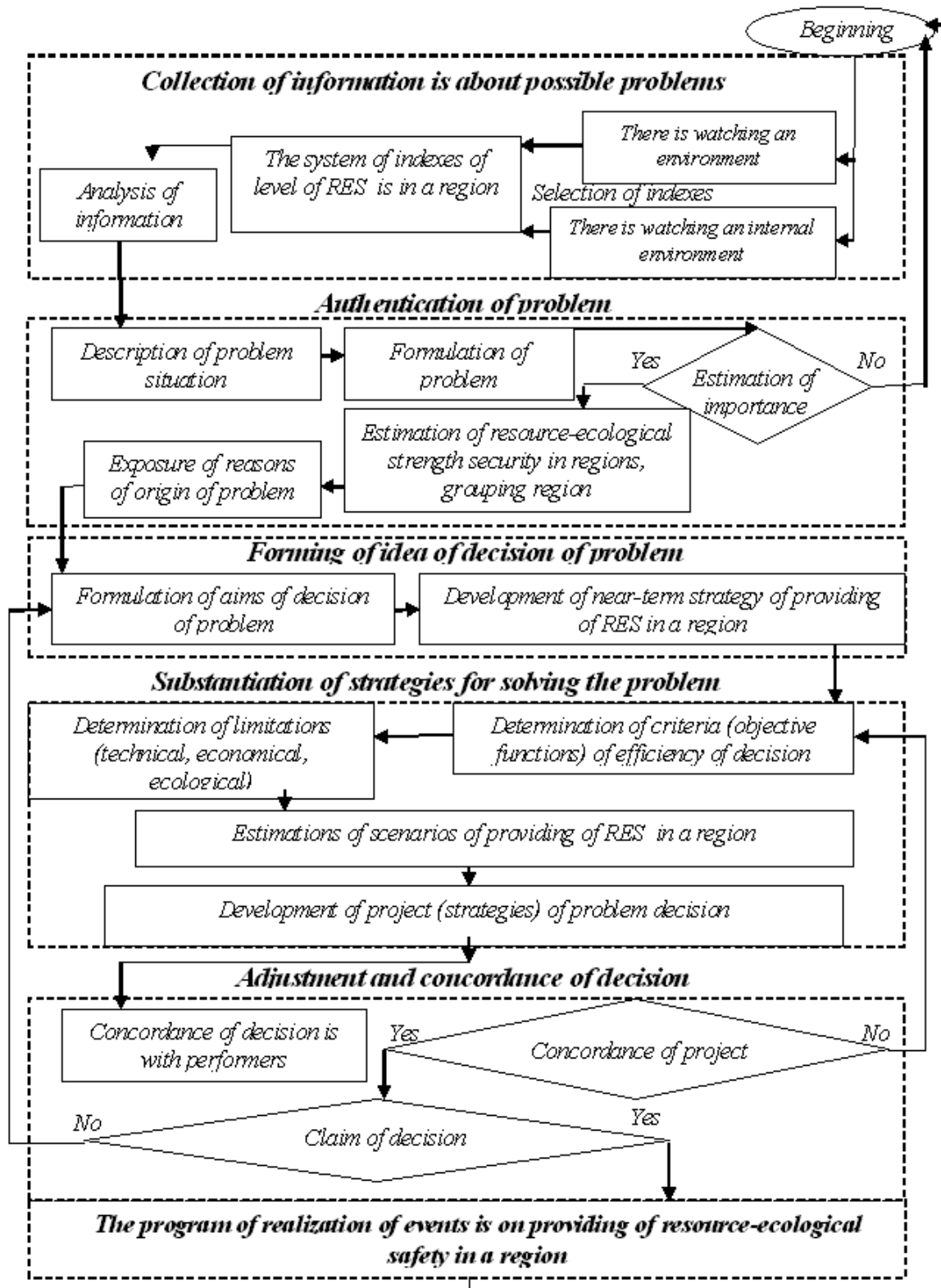
Figure 3 - An algorithm of optimization of strategy of providing of resource-ecological safety is in a region (made up by the authors)

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ТЕОРЕТИКО-МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ ОБЕСПЕЧЕНИЕ РЕСУРСНО-ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ В РЕГИОНЕ

В статье разработаны методологические основы обеспечения ресурсно-экологической безопасности региона, включающие три этапа: идентификацию опасности и определения зон ресурсно-экологической безопасности; выбор стратегии обеспечения ресурсно-экологической безопасности региона; корректировки и согласования решений. Практическая значимость работы заключается в оптимизации стратегии обеспечения ресурсно-экологической безопасности в регионе, реализация которой позволит: улучшить ресурсо-обеспеченность и конкурентоспособность региона, получить дополнительный доход от использования вторресурсов; сохранить первичные ресурсы и улучшить их качество; обеспечить сохранение и восстановление окружающей среды региона, улучшить социально-психологический климат в регионе и состояние здоровья населения.

Ключевые слова: ресурсно-экологическая безопасность; использование вторресурсов; первичные ресурсы; окружающая природная среда региона.

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ТЕОРЕТИКО-МЕТОДОЛОГІЧНІ ЗАСАДИ ЗАБЕЗПЕЧЕННЯ РЕСУРСНО-ЕКОЛОГІЧНОЇ БЕЗПЕКИ У РЕГІОНІ

У статті розроблені методологічні засади забезпечення ресурсно-екологічної безпеки регіону, що включають три етапи: ідентифікацію небезпеки та визначення зон ресурсно-екологічної безпеки; вибір стратегії забезпечення ресурсно-екологічної безпеки регіону; коректування і узгодження рішень. Практична значимість роботи полягає у оптимізації стратегії забезпечення ресурсно-екологічної безпеки у регіоні, реалізація якої дозволить: покращити ресурсозабезпеченість та конкурентоспроможність регіону, отримати додатковий дохід від використання вторресурсів; зберегти первинні ресурси та покращити їх якість; забезпечити збереження і відновлення навколишнього природного середовища регіону, покращити соціально-психологічний клімат у регіоні та стан здоров'я населення.

Ключові слова: ресурсно-екологічна безпека; використання вторресурсів; первинні ресурси; навколишнє природне середовище регіону.