

## APPLICATION OF GEOECOLOGICAL VULNERABILITY ASSESSMENT TO PREVENTION OF EMERGENCIES

*І.Г. Черваньов, Є.О. Варивода. ЗАСТОСУВАННЯ МЕТОДОЛОГІЇ ОЦІНКИ ГЕОЕКОЛОГІЧНОЇ ВРАЗЛИВОСТІ ДЛЯ ПОПЕРЕДЖЕННЯ НАДЗВИЧАЙНИХ СИТУАЦІЙ. Проаналізовані передумови впровадження сучасного методологічного підходу оцінки геоecологічної вразливості в якості інструменту попередження надзвичайних ситуацій (НС). Розглянуто поняття «вразливості» в контексті геоecологічного підходу. Виявлено, що практична реалізація підходів до оцінки впливу надзвичайних ситуацій на довкілля, яка є на сьогодні в Україні, не відповідає світовій практиці забезпечення системи превентивної безпеки, заснованої на виявленні, оцінці і моніторингу факторів ризику та покращення системи раннього попередження. Імпульсом для розвитку даного напрямку може служити розробка і впровадження методології оцінювання геоecологічної вразливості до НС. Зіставлення характерних особливостей понять «вразливість», «надзвичайна ситуація» і «ландшафт» дозволяє припустити, що адаптація концепції оцінки вразливості в Україні може ефективно вирішуватися шляхом застосування інструментарію конструктивно-географічних досліджень. Впровадження методології оцінки геоecологічної вразливості забезпечить перехід на якісно новий рівень управління попередженням, пом'якшення ризиків і наслідків НС, за рахунок переходу від моделі, заснованої на зборі, документуванні та узагальненні даних про НС до аналізу геоecологічних передумов їх виникнення, виявлення природних механізмів саморегуляції, розробці превентивних управлінських рішень на основі типології ландшафтних комплексів за ступенем природної та техногенної небезпеки виникнення НС.*

*Ключові слова:* надзвичайні ситуації, геосистема, геоecологічна вразливість, вплив, навколишнє середовище.

*І.Г. Черванев, Е.А. Варивода. ПРИМЕНЕНИЕ МЕТОДОЛОГИИ ОЦЕНКИ ГЕОЭКОЛОГИЧЕСКОЙ УЯЗВИМОСТИ ДЛЯ ПРЕДУПРЕЖДЕНИЯ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЙ. Проанализированы предпосылки внедрения современного методологического подхода оценки геоecологической уязвимости в качестве инструмента предупреждения чрезвычайных ситуаций (ЧС). Рассмотрено понятие «уязвимости» в контексте геоecологического подхода. Выведено, что практическая реализация подходов к оценке воздействия чрезвычайных ситуаций на окружающую среду, которая есть на сегодня в Украине, не соответствует мировой практике обеспечения системы превентивной безопасности, основанной на выявлении, оценке и мониторинге факторов риска бедствий и улучшения системы раннего предупреждения. Импульсом для развития данного направления может служить разработка и внедрение методологии оценивания геоecологической уязвимости к ЧС. Сопоставление характерных особенностей понятий «уязвимость», «чрезвычайная ситуация» и «ландшафт» позволяет предполагать, что адаптация концепции оценки уязвимости в Украине может эффективно решаться путем применения инструментария конструктивно-географических исследований. Внедрение методологии оценки геоecологической уязвимости обеспечит переход на качественно новый уровень управления предупреждением ЧС, смягчения рисков и последствий за счет перехода от модели, основанной на сборе, документировании и обобщении данных о ЧС к анализу геоecологических предпосылок их возникновения, выявлению природных механизмов саморегуляции, разработке превентивных управленческих решений на основе типологии ландшафтных комплексов по степени природной и техногенной опасности возникновения ЧС.*

*Ключевые слова:* чрезвычайные ситуации, геосистема, геоecологическая уязвимость, воздействие, окружающая среда.

**Introduction.** At present an increasing quantity and a cross-border scale of consequences of the emergency situations (ES), against permanent degradation of environment is the indicator which calls for improvement of the scientific and methodological approaches existing in Ukraine in the field of ensuring geoecological safety.

“The Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters” [16] as one of priority actions defined creation of counteraction of disaster potential at the level of the states and communities: “Identification, assessment and monitoring of risk factors of disasters and improvement of the early prevention. Basic activities to reduce the risk of emergency situations and to teach counteraction to disasters culture is the knowledge of dangers and physical, social, economic and ecological factors of vulnerability to disasters which communities face, as well as models of dangers change and factors of vulnerability in a short-term and long-term

outlook on the basis of which the appropriate measures are taken.”.

Ukraine has joined a number of the international agreements and conventions connected with the solution to problems of transition to a preventive security system. This step means carrying out active actions in the field of harmonization and the subsequent implementation of the normative legal acts, methodological approaches and separate standards aimed at the development and strengthening of counteraction to emergency situations potential at the expense of measures of the early prevention.

Formation of “vulnerability” as a scientific concept originated in the 1970<sup>th</sup> in social sciences where vulnerability was perceived as the response to perception of emergency situations risk of mainly natural character focused on technological solutions. Since 1980<sup>th</sup>, the dominating position has been taken by the alternative concept – definitions and estimation of vulnerability as a starting point

for an assessment of consequences and decrease in risks of emergency situations [7,15].

For the last decades in the European Union countries and the USA numerous scientific works have appeared devoted to a problem of the emergency situations analysis and an assessment of vulnerability [1-2; 5; 17]; leaving their comprehensive review beyond the scope of this work, we consider the concept of "vulnerabilities" in the context of geocological approach.

Experience in assessment of vulnerability to emergency situations in Ukraine is limited to researches in the field of social and economic analysis of emergency situations of natural and technogenic character, and methodical approaches to assessment of emergency situations consequences in the international and Ukrainian practice [18] for today and is absent in relation to an assessment of geocological vulnerability to emergency situations.

We consider that the success of an objective realization in Ukraine will depend on how modern applied direction fits into an outline of basic scientific researches and development within "new" geography [4]. Constructive and geographical approach is a backbone for information integration, analytical and decision-making processes on a uniform methodological basis. This direction of private methodology of estimation of geocological vulnerability to emergency situations can serve a powerful impulse for development.

The purpose of this work is the prerequisites analysis of development and introduction of modern approach to a problem of the ensuring preventive safety based on methodology of an assessment of geocological vulnerability to emergency situations in Ukraine.

**Method.** The theoretic and methodological fundamentals of the paper are based on modern scientific provisions on geocology, constructive geography with the use of the latest achievements in the field of disasters prevention and risk management of emergency situations.

The problem and prospects of geocological vulnerability assessment application of methodology to emergency situations is considered based on an analytical method as the material for which the international normative legal acts, standard and methodical documents, and literary data on ensuring ecological safety serve in the system of the prevention and elimination of emergency situations consequences.

**Results and discussion.** It is obvious that identification and the subsequent assessment of geocological vulnerability to emergency situations demands, first of all, a clear understanding of such "vulnerability" and

distinctive features of "geocological vulnerability".

The term vulnerability ("vulnerare" from Latin – a wound) has been used in English for 400 years. For today there is no uniform definition of the concept of vulnerability, the definition formulated in the UN International Strategy for Disaster Reduction) is the most widely used. It is possible to say that the conceptual base for this term in general has been created [5; 10-11], however the methodological basis as the uniform developed structure with the developed conventional approaches to applied aspects of this concept use, still needs scientific development.

Leading scientists published a number of works on application of geocological approaches in the prevention and elimination of consequences of the natural technogenic catastrophes based both on world, and national experience [6; 9; 12-14]. We consider the specifics of geocological approach application which are insufficiently lit, in our opinion, in a vulnerability to emergency situations assessment.

In spite of the fact that conceptual classifications of "vulnerability" differ in judgments of different scientists and experts, we pay attention to the fact that in overwhelming number of cases it is considered as a reaction or set of reactions to external influence, i.e. as object - the object relation. From this follows that there is an opportunity to unambiguously estimate and determine such relation in objective criteria. But if it was so, we would have an opportunity to make a certain deterministic model of "influence reaction" or a "donor recipient" (as it was accepted in ecological, medical and sanitary assessments). But in works of Adger, 2006; Alexander et al., 2014; Bankoff et al., 2004; Cardona, 2011 it is repeatedly noted that such unambiguity of reactions isn't observed: vulnerability is various depending not only on the type and force of external influence, but also on a system condition which resists to it, or it doesn't perceive, or, on the contrary, strengthens independently. Because of such richness of the possible relations between influence and result we consider it expedient to give another, subject - subject interpretation of concept of vulnerability that will explain, in our belief, a variety of the relations between a donor system and a recipient system if we accept variety and system complexity of each of them - vulnerability is an estimation of a wide range of direct and indirect manifestations of external influence through the internal geocological and social and economic manifestations giving the chance to people and communities to counteract emergency situations influence, or on the contrary, limiting their

ability to interfere with negative impact of emergency situations.

Thus, vulnerability is a type and level of response of natural and social system (geosystem in the broadest sense) of subject - subject character.

The latter is important in several relations: a) explains why there shouldn't be an unambiguous compliance between the level of influence and reaction of a system to it; b) denies possibility of an unambiguous assessment of influence and reaction

to it; c) doesn't give the chance to steadily predict vulnerability, the subject relations can't be determined.

Comparison of key features of "emergency situation" and "geosystem" (table 1) in terms of vulnerability conception allows to assume that adaptation of the concept of an assessment of vulnerability in Ukraine can effectively be solved by the use of research tools of constructive geography and geocology.

Table 1

Comparative analysis of main features of “emergency situations” and “geosystem” in terms of vulnerability conception

Features	EMERGENCY SITUATION (Subject 1)	GEOSYSTEM (Subject 2)
Territoriality/ spatiality	Emergency situations arise within territorial units, having a certain spatial localization. There is a geographical division of the territory which was affected by emergency situations: blow zone; the zone "filtrations" located round a blow zone; zone of rendering a public aid.	The geosystem represents a set of territorial units in which borders of geocomponents are genetically interconnected with human activity. The geosystem is a content of space; which properties depend on their spatial localization, sizes and a form; functioning as ability to maintain autonomy in environment.
Dynamism	In dynamics of emergency situations we allocate 4 characteristic stages: 1. A stage of accumulation of deviations from a normal state or process; 2. Initiation of the extraordinary event which is the cornerstone of emergency situations; 3. Process of an extraordinary event during which there is a release of the risk factors (energy or substance) making an adverse effect on the population, objects and environment; 4. An attenuation stage which chronologically covers the period from overlapping of localization of an emergency situation, to a complete elimination of its straight lines and indirect consequences.	Is the characteristic of geosystem (for example, a stage of succession or seasonal and daily dynamics) which covers all its states and their changes in time, irrespective of time scale and duration – suddenness of changes. We allocate 4 large-scale levels of dynamic changes of a landscape – daily dynamics, seasonal, long-term dynamics and evolution.
Complexity	The emergency situation is defined by result of complex interaction between potentially dangerous physical impacts (for example, floods, fires) and vulnerability of natural and social and economic environment.	Complexity of geosystem is determined, on the one hand, by interaction of the components composing it, and on the other - the morphological units (natural territorial complexes of the lowest ranks) forming the interfaced ranks within a landscape entering it.
Hierarchy	Depending on scale of the consequences caused by an emergency situation, capacity of the technical and material resources necessary for their elimination, the following levels of emergency situations are defined: the global; national; the regional; the local; the object.	three main geosystem levels of the organization of landscape systems are allocated: planetary (landscape sphere; geographical belts; continents, oceans; subcontinents); regional (landscape countries; landscape (zone) areas; landscape provinces; landscapes); local (districts; natural boundaries; subnatural boundaries; facies).

In emergency situations the object of control and monitoring of an ecological state are only certain components of a landscape (atmospheric air, surface and underground water, a biota), but not structure of a landscape in general. Thus, ecologi-

cal parameters in an emergency zone are estimated mainly on the basis of measurements of the polluting substances concentration, and for an assessment of impact on a plant and animal life structurally functional indicators of populations and bioce-

noses are used. Such research demands long time, to estimate the current state of natural ecological components ranging on the territory, based on methods of expert estimation, is often used.

Identification of relationships of cause and effect between influence of emergency situations factors and possible structurally functional changes of a landscape is one of the geoecological vulnerability problems assessment. And if a key postulate of the techniques based on approaches of ecological rationing is the statement "has to correspond", at the heart of the analysis and an assessment of geoecological vulnerability search of the answer to a question lies: "What landscape complex is the least capable to keep structural and functional integrity under the influence of factors of emergency situations?"

The degree of susceptibility of landscape complexes to influence on emergency situations expressed through the concept "vulnerability" can be investigated on vulnerability, as internal property of a landscape which characterizes by its own susceptibility to anthropogenic and/or natural influences which does not depend on the type of emergency situations and specific vulnerability to concrete type of emergency situations.

The analysis and generalization of various techniques and approaches to an assessment of vulnerability show expediency of the generalized integrated methodology development.

Obligatory elements of geoecological vulnerability assessment are: landscape maps as a basis for spatial localization; a set of estimated criteria and indicators in total the landscapes defining de-

gree of vulnerability to emergency situations; analysis of the structurally functional organization of landscape complexes; estimation and classification of landscape complexes by vulnerability degree to emergency situations; development of geoecological recommendations on strengthening of coping capacity to vulnerability.

**Conclusions.** The conducted analysis shows that, despite substantial positive influence from outside, by basic factors, qualificatory introduction of methodology of geoecological vulnerability estimation, there are both internal insufficiently worked out theoretical bases, actually methodologies and on the whole absence of the proper normatively-legal and organizational provision of ecological safety in the field of the state system of prevention and reacting to emergencies of natural and technogenic character.

Introduction of methodology of geoecological vulnerability assessment will provide transition to a qualitatively new level of emergency situations management, prevention, mitigation of risks and consequences for the account: transition from the model based on collecting, documenting and synthesis of the data on emergency situations to the analysis of geoecological prerequisites of their emergence, identification of natural mechanisms of self-control, development of preventive measures; transition from preparation and submission of information for decision-making to preparation of preventive administrative decisions versions on the basis of typology of landscape complexes on degree of natural and technogenic danger of emergency situations occurrence.

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