Principles and basic provisions for a system for assessing the ecological potential of the modern ecosystem

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Abstract. The article deals with current environmental components of the problem of development of the territory (region) as a modern ecosystem. The peculiarities of forming the ecological potential of the territory are characterized. Special attention is paid to the research of terminological problems and the applied conceptual apparatus. Methodological principles providing formation of integral, logically verified methodology of assessment of ecological potential of the territory in modern conditions of development were formulated. The author's approach to developing methodological bases for assessing the environmental situation in the territory is described.

1. Introduction
Planning and management of economic activity in the modern conditions of society development along with the application of economic laws and economic information require the use of data on the state of natural resources and their transformation under the influence of natural and anthropogenic factors. This requires the justification and development of new methods of integrated assessment of the state of natural environments and natural resources. Current methods and methodologies for such assessment \cite{1-3} often do not take fully into account the full diversity of interrelation and interactions in the functioning of the biosphere's structural elements, and are based on different methodologies. The use of such methods in practical work leads to ambiguity in the resulting assessments of the state of territories, which in turn leads to unreasonableness in making management decisions \cite{4-6}. Despite the considerable amount of development, there are no generally accepted established indicators of environmental assessment of natural and territorial complexes that could be used in practical work.

Opportunities for the growth of economic, social and environmental efficiency of functioning of any territory, in particular a region, as a modern ecosystem, depend on the characteristics of its potential. The issue of the potential of the territory, its definition is not resolved, in essence, neither theoretically nor practically. This applies to the conceptual apparatus, component indicators (structural hierarchical characteristics), and methods of quantitative assessment. All these problems are of fundamental importance, as long as they are solved, the growth factors of the region’s potential and the conditions that determine the possibilities of this growth are discovered.
2. Materials and methods

Etymologically, the term "potential" is based on the Latin concept (Latin potentia – strength, opportunity, power), which describes a set of necessary conditions and means available to mobilize them in a certain area [7]. Analyzing the socio-economic essence of the territory's potential, one cannot help but notice that it is an integral category and is formed on the basis of interaction of three potentials: economic, social and environmental [8,9]. In addition, there is the concept of integral or aggregate potential of the territory.

The ecological potential is determined by the level of ecological balance of the biosphere and its subdivisions, which make up the limits for the existence and development of man as a biological species and social organism. The economically valued environmental potential is part of the national wealth of a country or territory. At the same time, the ability to restore, reproduce funds, opportunities in any area is characterized by the concept of capacity. In turn, the potential depends on the capacity and is, in some way, a function of capacity. Therefore, the level of ecological balance, in our opinion, depends on two main factors – the ecological capacity of the territory and the level of pollution of this territory.

Let us compare the concepts of “ecological potential” and “ecological capacity” of a territory in terms of its semantic and essential meaning. Environmental potential means the ability, the ability to give natural resources for human life (society). Ecological capacity is the ability to restore, reproduce natural resources. Based on the concepts considered, the following definition can be formulated: the ecological capacity of a territory is the ability of the environment to reproduce, with a certain degree of probability, the resources and living conditions of the entire biosphere at a normal level with limited consumption of non-reproducible natural resources. In this definition, from the point of view of the study, two important methodological principles are observed: firstly, the term or concept should contain all sufficient features without an extensive interpretation in its information content; secondly, the definition as a whole should be clear to those involved in these problems. The concept proposed by us contains all sufficient signs without an extensive (explanatory, additional) interpretation in its information content. On the whole, it is quite understandable not only to specialists dealing with these problems, but also to specialists in other fields who are interested in environmental protection problems.

Any system, from the point of view of a systematic approach, has variable values (external and internal) and parameters. Therefore, we can definitely say that the integral potential of the territory is the ecological-economic-social potential of the territory, which, in turn, is an environmental-economic-social system with its own trends and development features, due to external and internal factors of influence on this system and its parameters.

The methodological basis of the assessment technology should be the principles reflecting both the fundamental basis of the ecologization process and the specifics of scientific approaches used in its study.

The purpose of the research carried out in this article is to form methodological and methodical basis of the system of assessment of ecological potential of the territory in modern conditions of development.

3. Results and discussion

The analysis of existing in the scientific literature and applied in practice methods for assessing the state of the natural environment as a whole and its individual components [10-13] allowed us to formulate the following basic principles, allowing, in our opinion, to objectively assess the ecological situation in the study area and become the basis for a methodology to determine the ecological potential of the modern ecosystem:

1. Regional orientation, which determines the boundaries of the territory for which the environmental situation is assessed and allows you to distinguish the region as a single ecological, socio-economic system according to a number of classification features [14] – external and internal relations, factors affecting the environmental situation; parameters possessed by the region as a
system; external and internal variables arising under the influence of other regions, countries, as well as their own activities in the field of environmental protection.

2. The complexity of assessing the state of the environment, allowing all natural and man-made resources to be sufficient - the components that an ecosystem (territory, region) possesses.

3. Territorial divisibility of resources of natural and natural-technogenic origin as an object of territorial management [15]. Indivisible resources include atmospheric air and water resources, which are dynamic and capable of transboundary transport.

4. The inverse proportion between the levels of pollution of the component of the natural environment and its environmental potential. The higher the level of pollution, the less ecological potential, and vice versa [16]. Together, these two estimated values for a specific indicator in a certain period (evaluation interval) are constant.

5. Additivity of an estimate of the environmental situation in an area consists of general assessments of the environmental condition of each environmental component, which in turn are presented in groups of indicators [17]. The sum of integral indicators forms this additive assessment of the ecological condition of the territory, which is composed of component integral assessments, and can be called a territory rating. Since the environmental situation in the territory during the study period is assessed by two indicators, the rating of the territory also represents the maximum possible aggregate estimate of the level of pollution (unsustainable use) of environmental components and the environmental potential of these components.

The ecological rating of the territory is the maximum possible indicator that assesses the environmental situation in the territory in a certain period of time. It consists of two indicators -- the level of ecological ill-being and the ecological potential of the territory. The level of environmental ill-being is an additive indicator consisting of summarizing component-wise estimates of pollution levels or unsustainable use of a component of the environment. The ecological potential of a territory is also an additive indicator evaluating the residual ability of all components of the natural environment in a given territory to give natural resources of a certain (normative) quality to human life (society) as a living environment.

6. A clear distinction between the concepts of natural resource and environmental potentials of the components of the environment of the territory [18]. When determining the ecological potential, the pollution level of the component under study is first determined, and then the ecological potential is calculated.

7. Comparability of assessments of the potentials of various components of the environment. This is achieved by applying a ten-point rating scale for each indicator included in any group of indicators that assess the quality (level of pollution) of the component, i.e. its ecological condition.

8. The equivalence or equilibrium of all components of the environment from an environmental point of view means that the components of the environment are not subject to ranking for any one or more of the attributes.

On the basis of these principles, we propose the following key provisions for an environmental capacity assessment methodology.

1. The level of environmental degradation of the environmental component is assessed by one or more indicators, groups of indicators. Each indicator has a range of variation, the lower limit of which is equal to zero, and the upper limit depends on the type of indicator. In our opinion, the upper limit of the variation (scale of estimation) of the indicator can be defined as the maximum value of the already existing (observed) levels of pollution for this indicator, substance, ingredient, specific weight in the total volume, or slightly exceeding this value, which does not lead to an ecological catastrophe on the territory of Russia Federation for the last 5-6 years.

2. Assessment indicators and their groups for each component of the environment should be selected as the "most characteristic" for which there are data published in statistical collections, reports on the state of the environment in periodicals. The whole complexity of the assessment lies in the fact that not all ingredients, pollutants are controlled, but only part of them. Moreover, there is no standard list of these substances, which allows you to change this list annually and does not make it
possible to trace the dynamics of changes in concentrations or specific gravity, to make their comparative analysis [19].

3. The range of variation for any indicator is divided into 10 regular intervals, each with its own score. The first interval is scored 1 point; the tenth is scored 10 points. This makes it possible to move from an absolute, natural and relative system of measurement of indicators of heterogeneous in essence to a single evaluation of their points. Advantages of the point score is that it allows to compare indicators characterizing the levels of pollution of various components of the natural environment, to sum them up and find integral, generalizing indicators of assessment of the state of the investigated area for all components of the natural environment [20].

4. The assessment of the level of pollution of a component of the natural environment depends on its belonging to a group of shared or indivisible resources. In this case, the proposed methodology uses two approaches to the assessment of pollution or environmental disadvantage by the components of the natural environment: by the level of concentration of a contaminant in a component; by the specific weight of contaminated parts in the total volume, mass, area.

5. The period for which the environmental situation in the conducted studies is assessed is 1 year. That is, the assessment, analysis, recording, planning and forecasting of the territory's ecologcal potential should be carried out for a period of 1 year.

6. The maximum estimate of pollution level (irrational use) for a differentiated (private) indicator can reach 10 points. The minimum estimate is 0. That's the evaluation foundation. Since the environmental potential is a value inversely proportional to the level of pollution, the two values for the same indicator totals are 10 points. Hence, the ecological potential is the difference between the upper boundary of the scale of pollution assessment in points (10 points), and the actual pollution level in the investigated area in the evaluated period, in points. The maximum environmental potential assessment can be equal to 10 points with a pollution level of 0 points, the minimum to 0 points, with a corresponding pollution level to 10 points.

The proposed basis for the methodology of environmental potential assessment can be used to determine the environmental situation both in the study area and in urban areas. To assess the rating of cities, the methodology remains the same, only the composition of indicators for some components of the natural environment is changed. Another difference of the methodology is the assessment of pollution which is carried out not for 1 sq.km of area, and 1 inhabitant, because the areas of cities less adequately reflect the density of population.

4. Conclusions
The formulated principles and basic provisions of the methodology for assessing the environmental potential of the territory have practical application for determining the levels of environmental degradation and well-being of the ecological situation in the territory, allow to calculate such an additive index as a set of integral components characterizing the state of the natural environment at a certain point in time. The assessments of the environmental situation serve as a criterion for assessing the functioning of the territorial management system in the field of environmental protection.

Comparative analysis of levels of ecological disadvantage by components of the environment within the limits of the investigated territory will allow defining priority nature protection actions, to develop target complex programs for the territory (region), to estimate their efficiency after implementation by criterion of increasing of ecological potential and dynamics of its change before and after implementation of actions.

When you have an assessment of the environmental condition of each component of the natural environment in the study area for a number of years and additive indicators of the environmental situation, it is possible to build correlation-regression models to identify the impact of the state of the components as factors in the selected performance indicators, which may be the health of the population, morbidity rates. The second type of model, on the contrary, suggests the identification of similar dependencies between factors - the volume of environmental protection measures, the number of new and capacity of existing treatment plants, progressive low-waste environmentally friendly
technologies and performance indicators, which may serve as indicators of environmental disadvantage levels and potential of the territory.

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