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GEOSYSTEM APPROACH TO MANAGING THE SOCIO-ECONOMIC DEVELOPMENT OF THE TERRITORY

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ABSTRACT

The relevance of the research problem stems from deep contradictions between the socio-economic development of the territories and the state of the environment. Therefore, the main task of territorial administration is the need to ensure sustainable development of natural and human systems, which combines a steady improvement in the economic and social conditions of the people with a long-term conservation of ambient environmental quality.

The purpose of the article is to develop theoretical stances for the geosystem approach to managing the socio-economic development of the territories and proposals for their implementation. From the geosystem approach perspective, the functioning of the territorial administration is largely dependent on its optimal territorial organization, which is oriented towards preserving a high level of environmental quality, economic development within limited resources, and solving social problems. The geosystem approach is worked only when coupled with a socio-economic approach to managing the territorial administration, which is a basis for its application.

The methodological framework for this approach is a systems analysis that makes it possible to take effective decisions on managing the territory as part of the coevolutionary development of nature and society. Despite the fact that some elements of the geosystem approach are applied in the practice of territorial administration, its scientific and methodical provisions have not yet been fully formulated.

The article describes the main theoretical provisions of geosystem approach to managing the socio-economic development of the territory. There were considered the characteristics of socio-economic systems on a basin-landscape basis.

The results can be effectively used in managing the socio-economic development of the territories as well as in the development of territorial planning schemes.

INTRODUCTION

Minimizing the damage of anthropogenic impact on the natural environment and maximizing the combined benefits of economic and social effects cannot be achieved without changing the strategy of human behaviour in the management of natural environment, i.e., the development of principles linking the socio-economic and ecological interests of society.

The insufficient inclusion of environmental dimension into the development of concepts, strategies and programmes for the socio-economic development of the Territories, as well as the territorial planning schemes, has led to a significant increase in environmental problems in many regions of our country.

One of the reasons for this situation is underestimation of the geosystem structure of the territory in managing its socio-economic development and preparation of territorial planning documents, which is responsible not only for the many negative environmental effects, but also for the deep long-term imbalances between the economic, social and ecological development of socio-economic systems at different hierarchical levels.

In this regard, many experts in the field of socio-economic development studies of the territories recognize the prospect of environmental management based on a geosystem approach, enhancing the sustainability of natural and anthropogenic systems that are oriented to welfare of modern and future generations [2, 5, 6, 8, 11, 15, 16, 17, 18, 19, etc.]. However, it should be noted that the thresholds for the sustainability of geosystems do not yet have a normative and quantitative expression. Therefore, management decisions in the fields of nature resource use, linked to the territorial organization of the economy, are in most cases captured only as a wish.

The geosystem approach allows for the establishment of a sound environmental management structure based on the interlinked and interrelated economic, social and ecological factors [1, 4, 7, 20, 23, 27]. The basis for action in this direction should be the new methods of territorial planning and land administration, that take into account ecological aspects of environmental management [35].

It follows from the above that, despite the depth and unconditional importance of research in the area of the sustainable development of the territories, there is no uniform approach to environmental management on a geosystem basis. This led to the focus of the study and its relevance.

The study is based on the following hypothesis: if the socio-economic development of the territory is managed geosystematically, this will enhance environmental safety of resource management and the comfort of the human environment, because in the present case it is possible to take into account the stability of geosystems in the performance of their socio-economic functions in the planning of anthropogenic pressure on the natural environment.

Methodological framework

The essence of geosystem approach to environmental management is that the territory being studied is seen as a set of interrelated and interdependent geosystems of the different hierarchical levels that are the administration objects. The geosystem is understood as a part of the Earth's geographic shell, the components of which are closely interrelated and constitute a certain integrity, unity [34].

In a geosystem, as opposed to an ecosystem, biotic and abiotic components are equal, and geosystem research focuses on their spatial patterns.

An analysis of the work on the application of geosystem approach to the development of different types of territorial entities [5, 9, 10, 15, 22, 23, 25, 27, 29, 33] allows for the formulation of its main provisions:

1) there are continuous processes for the transfer of the substance and energy in the geosystems, which causes direct and backward internal links. Elements that have a fundamental impact on the direction of system development are called system-forming. They ensure the integrity of the geosystems at any hierarchical level;

2) systemic links are most evident in the geosystem core, in its space-limited part, characterized by increased activity of system-forming elements. Therefore, the system core and transition areas can be highlighted in any geosystem, where system links are weakened by the influence of neighbouring geosystems;

3) the state of the geosystem is defined through a synthesis of the indicators characterizing its individual components in a particular space and time. In this case, the geosystem is regarded as a spatial-temporal homogeneity inherent in a certain territory.

There are two main approaches to geographical research in the allocation of geosystems based on natural characteristics: landscape and basin.

In the landscape approach, the allocation of geosystems is subject to genetic and morphological criteria. There are four main hierarchical levels: local - facies and tracts; regional -landscapes; mezoregional - landscape subprovinces and provinces; macro-regional - "stretch" of landscape subareas and areas within selected physical-geographic countries [14, 24].

The criterion for highlighting the landscape as the basic taxonomic unit of landscape differentiation of the territory is its geographical identity, which is due to two main factors:

1) landscape, as a genetically homogeneous territory, within which there is a logical combination of interrelated and interdependent natural components, is the last step in the natural-geographic differentiation of the Earth's surface, which retains the main features of the natural characteristics of the larger territories, i.e. it summarizes their individuality;
2) landscape, with genetic homogeneity, is a closely interrelated set of smaller natural and geographical units, none of which alone can give a complete picture of the common natural features of the territory.

Despite some shortcomings, the national landscape study approaches to environmental management on a landscape basis, provide some methodology for managing socio-economic development of the territory.

The overarching purpose of landscape research is to create a single universal teachings on the hierarchical functional structure of natural geosystems. It is only on this basis that it is possible to manage the environment in such a way that it is "built" into the natural organization of the territory and, in general, it is a unified, well-functioning socio-economic system.

The main advantages of landscape approach include the fact that it allows for the inventory of natural resources and the development of their inventories; the study of natural and anthropogenic processes in natural and territorial complexes and the development of proposals to manage them, to make recommendations for optimizing environmental management. The disadvantages include uncertainty of landscape boundaries that impeded the use of landscape research in managing the socio-economic development of the territory.

Under the basin approach, geosystems are selected on geomorphological criterion based on the structure of the natural hydrological network, which is the ecological framework of adjacent territories. With this allocation of geosystems, the system-forming elements are substance flows, energy and information. This method of allocating geosystems takes into account dynamic processes in them.

River basins, as well as landscape geosystems, have a set of structures and functions, hierarchy construction, integrity, sustainability, an ability to self-development [15, 16, 19, 36].

The main structures of the river basin are the slope structure and the hydrographic network, which are closely interrelated because precipitation is transformed into water balance elements on slopes, and the hydrographic network redistributes the run-off over time and space. In addition to transformation of precipitation, functions include drainage, transit of water,

formation of their chemical composition and relief-forming activities. At the same time, it must be stressed that the main function of the river basin, as a geosystem, is the generation of one-way flow of substance and energy into run-off.

The same structure, function and the similarity of topography inherent in river basins allow for the creation of model approaches to the assessment of geoecological situations within their boundaries, and for producing a spatial interpolation and extrapolation of studies results for different basins, taking into account the physical and geographic characteristics of regions [15, 33, 36].

River basins, like landscape geosystems, have four-level differentiation: local level - basins of large streams; regional - basins of small rivers; mezoregional - basins of medium-sized rivers; macro-regional - basins of large rivers. At the same time, large streams are understood to include watercourses with a steeply fluctuating flow of up to 10 km; small rivers - watercourses with fluctuating flow ranging from 10 to 100 km; medium-sized rivers - watercourses with relatively stable flow within a single geographical area; large rivers - watercourses with steady flow within several geographical areas [16, 36].

In view of the fact that river basins are open geosystems, their integrity is based on the horizontal flow of the substance, energy and information. In this case, the real integrity criterion is the flow rate ratio in the elementary basin of the first order to flow rate in the closing range of geosystem. The criterion of integrity is complemented by the energy component, which characterizes the ratio of removal of organic matter with run-off to the gross biological productivity of geosystem, i.e. the ratio of binding energy to the gross amount of energy for the year [16, 36].

The preservation of the "river basin" geosystem is related to self-regulation processes, the essence of which is that the system transforms and, to some extent, "dampens" the disturbing effects, primarily through the redistribution of the substance and energy, and thus supports both the state of internal dynamic balance and the environmental balance. The imbalance transforms not only the ecological and morphological features of the river valleys, but also the active restructuring of the landscapes located within the watershed, in accordance with the new conditions of the geosystem. Self-regulation is effected by the plasticity of connection between geosystem components, self-regulation mechanisms are particularly evident in hydrological processes, for example, changing run-off and evaporation patterns depends on the amount of moisture flowing into the watershed. It should be taken into account that the reaction of river basins to external influences is directly proportional to the force of the impact and inversely proportional to the size of the basin, i.e. the degree of sustainability of geosystem data depends on their hierarchical level [16, 36].

The most important feature of river basins is their dynamic activity, which determines the changing geoecological situations. It depends on the intensity of the substance and energy exchange between its adjacent landscape

complexes. The transport of the substance and energy in the river basins is carried out from top to bottom: from the bedrock slopes to the riverbed, from the source to the mouth. From this point of view, it is important for the assessment of geoecological situations that the regime of the river, floodplain alluvium and the characteristics of run-off in the closing alignments of watercourses are indicators of the overall ecological status of the basin [13, 33]. Consequently, the river basin system has a type of control that has lines of information transfer, carriers and reservoirs of which are moisture streams within the watersheds.

The integrity of the river basin is ensured by substance, energy and information flows, figure 1 [5]. Any changes to the flows within it affect the functioning of the system as a whole.

In assessing geoecological situations within river basins, it is justified to use the macro approach method "black box", where the necessary information on condition of watershed is determined by the indicators obtained at the outlet of geosystem in closing alignments of watercourse.

The merits of the basin approach include the fact that most basins have stable boundaries, represented by watersheds, allowing for spatial information linkage, necessary to make decisions on environmental management; its disadvantages include the discreteness of surface due to the existence of drainless areas or areas with uncertain run-off, as well as the complexity of the study of natural and anthropogenic processes in natural and territorial complexes.

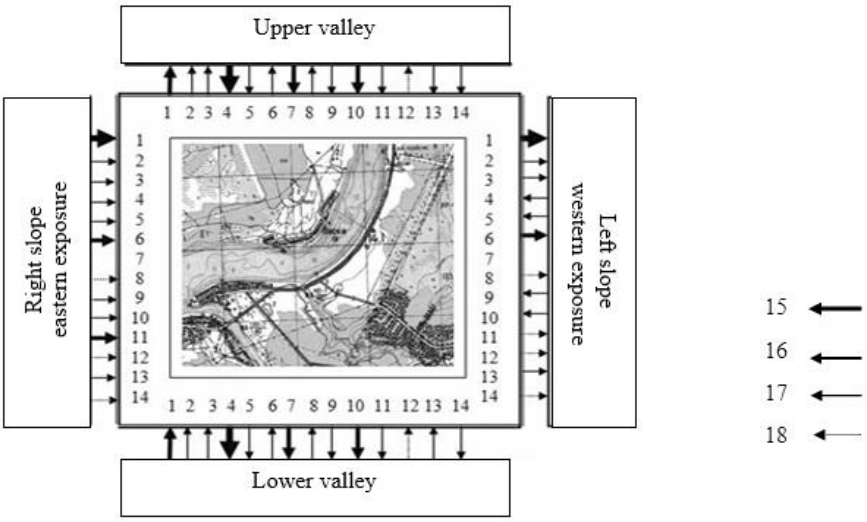

Figure 1. Graphical model for the transport of the substance in the middle of the river valley (1 - wind; 2 - transport of steam by air; 3 - transport of clouds; 4 - surface run-off; 5 - groundwater run-off; 6 - transport of snow; 7- transport of ice by rivers; 8 - transport of dust by air; 9 - solid run-off; 10 - autonomous migration of animals by land and water; 11 - forced migration of animals by land and water; 12 - transport of pollen and spores by air; 13 - transport of seeds by wind and animals; 14 - transport of microbes by water, wind and

animals. The direction and intensity of migration flows: 15 - very strong; 16 - strong; 17 - average; 18 - weak).

RESULTS

In order to reduce the impact of the noted shortcomings, the approaches to differentiation of the territory in environmental management, discussed above, have begun to introduce a basin-landscape approach in practice of natural-resource use since the mid-1980s [4, 10, 12, 28, 30]. This approach has proved to be effective in the management of natural resource potential of a territory.

The following conceptual provisions underlie the basin-landscape approach:

- geographic shell has a basin-landscape hierarchy;
- basin geosystems are characterized by landscape organization;
- natural conditions and economic activities are closely interrelated within basin-landscape geosystems;
- basin-landscape geosystems are optimal territorial units for monitoring the status of the environment;
- related use of cartographic and simulation modelling of basin-landscape geosystems in a GIS environment is the basis for optimizing environmental management.

The basin-landscape approach combines as the advantages of a basin approach allowing for the assessment of substance and energy dynamics within the watersheds and the monitoring of stability system to anthropogenic loads on the characteristics of liquid and solid run-off in the main alignments of watercourse [21], as the advantages of a landscape approach which provides an opportunity to optimize the structural and functional organization of the territory, taking into account the possibility of landscapes to fulfil the socio-economic functions [24, 26].
This approach, based on natural patterns, allows a redistribution of power among administrative entities to establish effective spatial forms of interaction to ensure the organization of economically viable and environmentally sound management.

In managing the development of the territory through a basin-landscape approach, river basins are considered as socio-economic systems consisting of a combination of natural and natural-anthropogenic subsystems (environmental, natural-recreational, natural-industrial, natural-agrarian, natural-residential, etc.), **Figure 2 [5].**

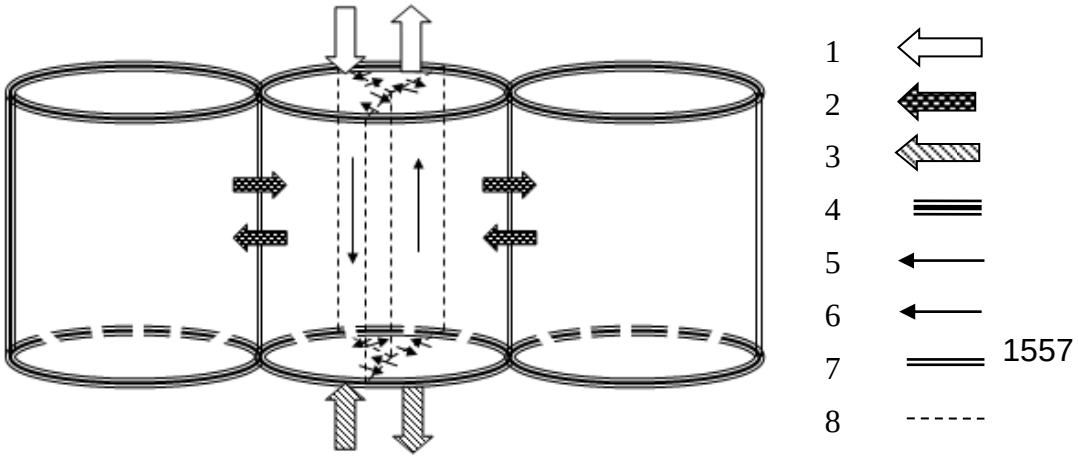

Figure 2. Structure of the socio-economic system "river basin"
(substance and energy flows: 5 - component, 6 - structural and morphological; linkages: 1 - with atmosphere, 2 - between subsystems, 3 - with lithosphere. Border: 4 - natural-economic system "river basin"; 7 - natural-economic subsystems; 8 - structural parts of natural-economic subsystems).

A set of territorial linkages between the elements of nature, economy, population and management within the river basin determines the structure of socio-economic system (SES). There is a hierarchy in SES, as in any complex system, where each hierarchical level has its own specific relationships. The consequence of such an organization is the mismatch and contradiction of development objectives in both subsystems and SES as a whole. As a result, there is a competition for the dominance of the development objectives of a particular subsystem. In view that SES subsystem is not able to comprehend and defend its interests, environmental problems arise.

The sustainable functioning of SES can be achieved only if it is environmentally sound, environmentally oriented, socially and economically viable, and a mechanism for monitoring its processes is well-established [3, 4, 27, 30, 31].

It should be noted that the establishment of SES based on a basin-landscape approach presents a number of difficulties in relation to both the natural and the socio-economic components of the system. Large lowland rivers cross several geographical areas. It is difficult to manage the environmental system in such basins. There is a need to differentiate the basin into relatively homogeneous parts, as well as to take into account the current economic development of the territory, its degree of disruption and the ability to manage the system effectively. In the view of some researchers, the optimum territorial unit for business planning is the watersheds of approximately 60 - 100,000 ha, and in the view of others the basins can have smaller area. However, in the second case, there are interbasin areas that cannot be uniquely attributed to one of the watersheds, thus one of the practical advantages of the basin approach - certainty of boundaries - disappears [33]. In our view, the first stage of river-basin management planning should highlight the area segments with their river network belonging to the large river system and the second stage - the watersheds of the small rivers.

When SES is created on a basin-landscape basis, the saturation of the natural environment of the river basin by economic facilities alters the established structure of linkages and disrupts the "chains" of its organization. This leads to a new system of higher order complexity than the natural environment. The emergence of such a system requires the establishment of an appropriate level

of management. Otherwise, there is a so-called "Von Neumann effect", i.e. degradation and destruction of the created SES.

Consequently, SES, as a managed system, should include a management unit, however, environmental organization based on a basin-landscape approach has no structures to implement management arrangements. The administration is wholly linked to the administrative-territorial entities whose boundaries and hierarchies do not coincide with the boundaries and hierarchy of basin-landscape systems [32]. Therefore, any environmental management projects within the boundaries of basin-landscape systems will inevitably have a predominantly theoretical character.

This problem cannot be solved by a formal act of changing the administrative boundaries as they approach the natural boundaries. Inconsistency is inevitable due to different reasons on which the development of natural and socio-economic systems is based.

The subsystems of the territorial socio-economic structure are of an integrated nature [8, 11]. They cover all components of social reproduction and are formed on a different elemental basis and different territorial links, depending on the hierarchical level. At the same time, at each level of the hierarchy, a certain part of the reproductive system can and should be confined, which is quite rigid in determining the number of hierarchy levels in the territorial organization of the society. Therefore, in a rational organization of an administrative structure, the number of levels of control cannot be arbitrarily changed to bring it closer to the hierarchy of natural geosystems.

It follows that the main task of establishing SES on the basis of a basin-landscape approach is to reconcile the conflicting requirements of different subsystems that compose it. The ideal solution would be a harmonious combination of all available approaches to environmental management, but it is difficult to introduce environmental priorities into the mass consciousness of population and administration that serve it. The purposes of economic (at best social) nature are likely to remain the leading ones for a long time, while the purposes of environmental management are subordinate, although important [8, 11].

Thus, it is appropriate to build a pyramid of purposes according to which SES is to be established. In so doing, the management of such a system is the most important task.

Administrative subdivision and environmental management can be built on the basis of territorial socio-economic systems [8, 11]. Then, one administrative entity may have several basin-landscape systems. In this case, the task of management is relatively straightforward. The authorities of the local administration will be sufficient to integrate environmental management into their policy. There is also a second case where basin-landscape systems are divided between contiguous administrative units, which will require the inclusion of other procedures. Negotiations among all interested parties could be one of the ways to address the problem. The result should be a compromise

that provides for some kind of compensation for the losses to the party concerned.

According to the authors, the establishment of SES on a basin-landscape basis must take place within the framework of the following conceptual provisions. At each level of the hierarchy, watersheds should be zoning on predominant environmental uses. At the same time, the administrative-territorial and basin-landscape principles of SES structure should not exclude but complement each other. At the level of the administrative unit, taking into account the recommendations of the parent body and the results of consultations with the neighbouring administrative units, the purposes and main directions of the socio-economic and environmental development of the territory in general and its individual zones shall be determined. The scope of the economic activities should be planned within the watershed and, within the landscapes - the nature of the activity [4, 27]. It should be borne in mind that the basin-landscape approach to SES management is not sufficiently adapted to the conditions of the developed territories and the features of the management structures.

To give practical effect to the conceptual provisions outlined above, the authors have developed a structural and logical scheme for the establishment of SES on the basin-landscape basis, which is presented in **Figure 3.**

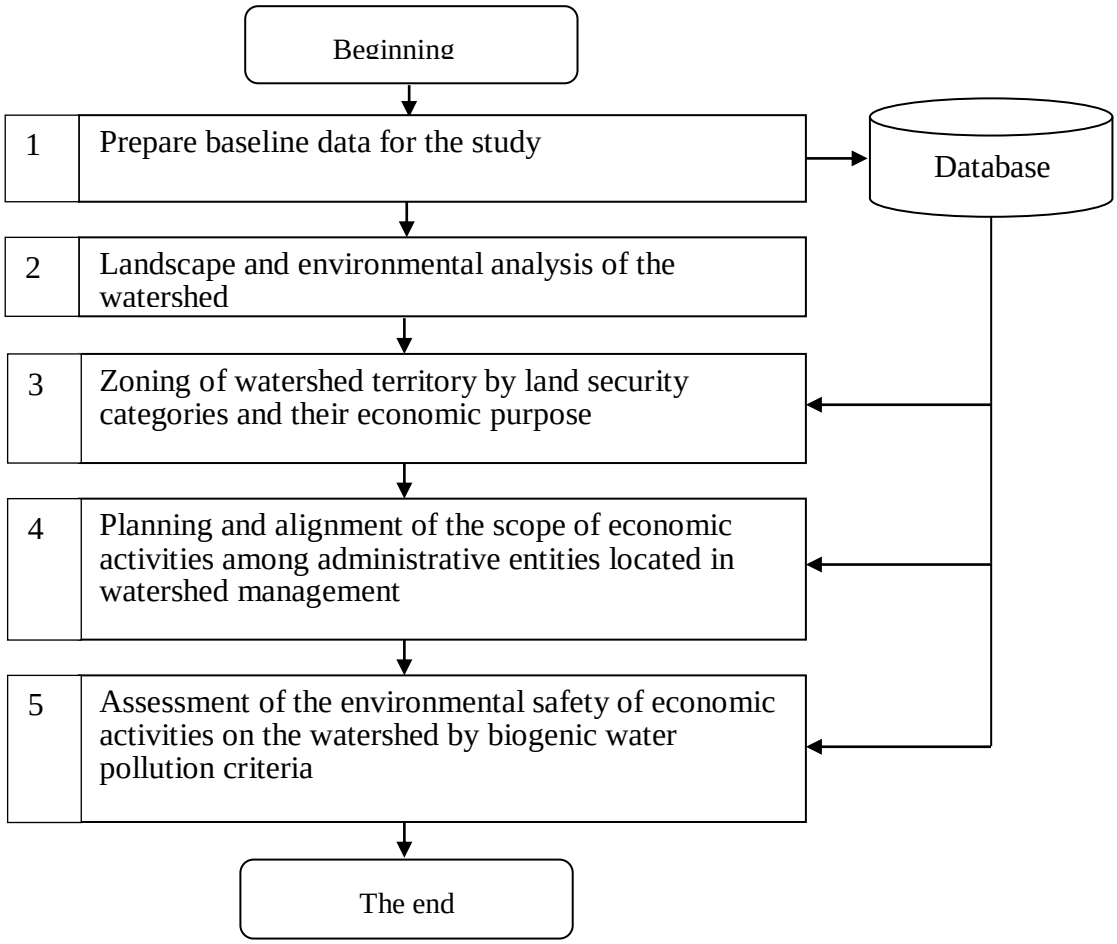

Figure 3. Structural and logical scheme of SES on basin-landscape basis

Let us briefly consider the contents of each unit.

Unit 1. Includes: study of stock, literary, statistical, aerospace and cartographic materials characterizing the physical and geographic, geoecological conditions of both the watershed in general and the administrative entities within it. This stage identifies which collected material will be used as a base, and which is as an additional and determines the technological characteristics of the work.

Topographic maps should be used as a main cartographic base. For work at macro-regional and mezoregional levels, the scale of 1:200000-1:500000 is the most appropriate, in this case the mapped landscape units are the types of landscapes. For the work at the regional level, the scale of 1:50000-1:100000 [32] is the most appropriate, in this case the mapped landscape units are types and subtypes of landscapes. The main diagnostic signs of the type is the similarity of dominant landscape tracts. However, often single-type landscapes, with the common dominant tracts, differ in their composition or area, allowing the designation of its morphological variations (subtypes) within the type of landscape. Common techniques are used to create landscape maps.

The construction of watersheds areas is automated through the digital terrain model of the main cartographic base using GIS software.

Unit 2. Includes: description of the spatial and temporal characteristics of landscapes located within the watershed; analysis of natural and anthropogenic impacts on landscapes; integrated assessment of the natural and resource potential of landscapes, taking into account their resilience to anthropogenic loads; allocation of highly sensitive ecosystems; developing quality criteria for ecosystems at different levels and for environmental management to guarantee the reliable functioning of the planned SES.

Unit 3. Includes: establishing a natural and ecological framework of the territory of regional specially protected natural areas (OOPTs), protective zones along the watercourses, ways of migration and habitats of rare and endangered species of birds and animals, monuments of cultural and historical significance, etc.; design of economic and residential zones; allocation of intensive and extensive agriculture and livestock areas; allocation of areas of recreation and tourism.

Unit 4. Includes: determining the volume of economic and residential loads and their placement on the watershed, taking into account the zoning of the territory and the existing legislation for the protection of natural environment; preparation of a draft agreement between the administrative entities located in the watershed for economic activities.

Unit 5. Includes: establishment of biogenic load schemes for watersheds, taking into account planned economic activities; determination of the transport of nutrients through the closing alignments of the main watercourse;

refinement of the land use strategy on the watershed proceeding from biogenic water pollution.

DISCUSSION

The approaches described for the management of socio-economic systems along the basin-landscape lines are based on studies carried out by the authors from 2002 to the present [3, 4, 5, 8, 9, 10, 11, 28, 32], which have been reported at numerous all-Russian and international conferences, where they have received support and approval.

In previous studies, the authors' attention has focused on the development of selected aspects of the use of basin-landscape approach in the management of natural and agrarian systems, including: assessment of the geoecological potential [3], optimization of spatial structure [4], basis for formation [5], environmental and geographic justification of land use [9] and others, as well as integrated assessment of socio-ecological and economic systems state and quality of life of the population [8, 11].

This article summarizes the results of the work previously done by the authors with a theoretical framework and a scientific and methodological basis for the use of the basin-landscape approach in the formation and management of socio-economic systems, allowing for redistribution of power among administrative entities (taking into account natural patterns and characteristics) to establish effective spatial forms of interaction that ensure the organization of economically viable and environmentally sound land use. The results obtained by the authors are fully in line with the research hypothesis.

The issue under consideration is also devoted to the work of other authors. Many of them [6, 12, 15, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 33 etc.] justify the geosystemic approach for the sustainable development of territorial economic systems and provide conceptual provisions for environmental management based on it, but unfortunately do not reveal the scientific and methodological features of its implementation.

Further research should aim at the creation and testing of methods, models and methodologies that implement the conceptual provisions that the authors have developed.

CONCLUSION

The advantage of theoretical provisions and the scientific and methodological basis for the use of the basin-landscape approach in the management of socio-economic systems, especially within underdeveloped territories and swift developed zones, is a realistic mechanism for the sustainable functioning of natural-anthropogenic systems, which will eliminate many of the contradictions in the environmental and socio-economic spheres of the activities of administrative and territorial entities. In doing so, the researcher can simulate different geoecological situations within natural boundaries and use modelling results to improve the efficiency and environmental security and management.

Recommendations. The results obtained by the authors can be used in the development of an overall strategy for management of socio-economic development of the administrative and territorial entities, in land surveying and in spatial planning.

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