Natural resource zoning: theoretical and methodological approaches

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Abstract. We propose to delineate the territorial combinations of natural resources as a basis for natural resource zoning. The territorial combinations of natural resources are distinguished by the presence of the inter-resource ties of two types: the direct and indirect links of resource-containing components in natural geosystems, and the indirect links of resource-containing components through the components of territorial socio-economic systems that are formed in the process of mastering natural resources. We offer the following algorithm of a natural resource zoning: delineation of a relatively holistic natural geosystem: definition of its allocated resource-containing components, including the deposits of mineral resources, areas of land and forest resources; determination of geosystem inter-resource links, primarily, the links of separate natural resources with the largest ones; setting, as a result, the territorial combinations of natural resources existing in this natural geosystem; exploration of the inter-resource ties, which either exist or can be established in the process of extracting and using certain natural resources through the components of territorial socio-economic systems, including the links of transport systems and certain settlements. These inter-resource ties are superimposed on the geosystem links, and more complete territorial combinations of natural resources are allotted as a basis of natural resource areas.

1. Introduction
Certain kinds of natural resources have specific factors and patterns of genesis and distribution. For example, metals, chemical raw materials, coal, oil, and natural gas resources. Natural resources of areal nature, such as land, forest and water, have quite different factors of their genesis and patterns of spatial differentiation.

The approaches and methods for studying a spatial differentiation of natural resources in their various combinations within large territories by zoning have been already developed in geographical studies. At the same time, either the groups of homogeneous natural resources (ferrous or non-ferrous metals, coal resources, construction materials, lands, forests, etc.) or the combinations of certain natural resources, e.g. fuel, metals, land and agro-climatic resources, etc. [1-3] are delineated. Such assessments are important for regional development programs. Their meaning increases with using the landscape approach in planning. Antipov A.N. was one of the first developers of this approach in Russia [4].

2. Models and methods
Within certain small territories, there are spatial or territorial combinations of natural resources rather than discrete isolated ones. The different territorial combinations of natural resources were delineated using the various types of zoning. Several works were devoted to such a delineation [3, 5, 6]. The
proximity of discrete natural resources to each other, their distribution within a certain territory or region were considered as the main criterion [3, 6, 7]. As a rule, the presence and nature of the links between the distinct natural resource components were not considered. Our studies show [1, 8, 9] various direct and indirect inter-resource ties, linking various natural resource components into the territorial, water and territorial-water combinations (and even systems) of natural resources. A special type of linking is due to spatial contacts, conjugation of resource components.

3. Results and discussion

Before development, extraction and use, all natural resources are the components of natural geosystems, occupying one or another position in their spatial structure. For example, these are certain layers or blocks of rocks and minerals in the earth's crust, the layers of rocks filled with hydrocarbons, the sections of soil cover on the earth's surface (land resources), trees, other forest plants and animals in forest ecosystems, spatial formations filled with surface and underground waters, including flowing river waters, containing the natural resources of water and energy, etc. [1, 2, 4, 5].

If we single out all the natural resource components contained in a particular natural geosystem, such as bodies and processes that can be used by a man in a given historical period to satisfy one or other needs, then we can also identify existing ties and conjugations among many of them. For example, there are always links between the forest and water, soil and water, forest and soil (land) resource components of geosystems. There are rather close conjugations among discrete mineral natural resource components, for example, in complex deposits, as well as between them and water, land, and, in some cases, forest natural resource components, e.g. through some rocks (zeolites and others) that some forest animals periodically eat.

Thus, there are always significant ties and conjugations among the natural resource components located in terrestrial geosystems. It is possible to distinguish the combinations of the most tied natural resource components. Some components may be less linked, although all natural resource components located in the space of a geosystem theoretically have certain ties and conjugations [1, 2, 8].

Any natural resource component is a spatial formation, i.e. layers and blocks of rocks with metal ores, layers and blocks of rocks filled with hydrocarbons, soil layers with separate horizons; tiers of forest vegetation. Ties and conjugations between natural resource components are also spatially expressed. These are the water currents and various portions of moisture circulation, air flows, rock movements, and migration of chemical elements. Finally, a variety of direct contacts, proximity and space conjugations of discrete natural resource components between themselves make them interconnected in their extraction and use by humans.

With some generalization and simplification of the actual spatial ties and conjugations of natural resource components, their spatial combinations can be represented as territorial combinations. At that the same time, spatial inter-resource ties are covered and represented within a certain rather compact territory. The latter is considered a surface layer of the earth’s surface with natural resource components existing directly in it, as well as spatially conjugated natural resource components that lie in deeper layers of the earth’s crust. In the course of their development and extraction, they will be also associated with certain sites and areas of the territory through spatial conjugations.

In general, we propose the following methodological approach to allocate territorial combinations of natural resources, considering their natural geographical connectivity (by the presence of ties and spatial conjugations in natural geosystems). As a result of comprehensive research and physical-geographical zoning, a fairly integrated natural geosystem of medium-scale dimension should be delineated. In the latter, various natural resource components and spatial ties and conjugations between them are defined. By zoning, the space of such a geosystem can be represented as a certain territory or area with a “linking” of all selected natural resource components and their ties and conjugations to it. Within this territory or area, the largest most significant natural resource component (a mineral deposit, a forest ecosystem, a land massif, a water body, etc.) is defined. Then, the presence of its spatial ties and conjugations with other, primarily, adjacent natural resource components, is determined. The combination of natural resource components with tight significant ties and
conjugations will constitute a sustainable territorial combination of natural resource components, i.e. a natural resource system as a “core” of a natural resource region [1]. It is an important object for comprehensive geographical assessments of natural resources since it considers all possible changes in natural resources during their subsequent use due to the presence of inter-resource ties and conjugations.

In the exploitation of natural resources, the ties and conjugations of the second type can be set among some natural resources there. For example, two natural resource components can be interlinked indirectly if a road or a power transmission line passes near them. Two or more natural resource components can be tied if they occur in the zone of influence of an existing or newly formed settlement [8]. The cohesion of natural resource components with the ties and conjugations of the second type is greater in areas with a higher density of transport network, settlements, and, in general, a higher density of population. In other words, the inter-resource cohesion of the second type is greater in more developed areas.

Thus, the algorithm for allocating territorial combinations of natural resources should be supplemented with an analysis of ties and conjugations formed by transport and power transmission networks, settlements, and existing nature management links, which we regard as the components of territorial socio-economic systems.

In maritime and coastal regions, separate in-land natural resource components can be tied or conjugated with discrete natural resource components of the sea or seabed. In this case, the territorial natural-resource combinations turn into the territorial and aqua-territorial combinations. Since natural resources extracted at the sea are usually transported to land, either through pipelines or by ships, these natural resources indirectly, through coastal patterns, contact with the coastal natural resources of land, including the land and forest ones. In this regard, all the large natural resources of coastal land, located approximately in 100 km from the coastline, can form the territorial and aqua-territorial combinations of natural resources as the basis of the seaside natural resource areas [8]. It is advisable to isolate and evaluate such combinations at the forecast stage before the development processes begin. Their identification is based on consideration and the qualitative-quantitative assessment of inter-resource ties of the first and second types.

4. Conclusion

Inter-resource ties in natural geosystems are considered the first type. Natural resource zoning, including fractional zoning, can be carried out as a preliminary stage of assessments. In the presence of a pronounced spatial differentiation of various kinds of resources and some estimates of their conjugations, the territorial combinations of natural resources can be delineated based on specific zoning followed by a deeper analysis of inter-resource ties within certain areas. At the same time, coverage of indirect inter-resource ties of the second type is also required. As a result of the spatial superposition of the inter-resource links of the second type on the previously identified geosystem inter-resource links of the first type, it is possible to determine fuller territorial combinations of natural resources and clarify the borders of the natural-resource zoning.

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