Sustainable development of the Amur river coastal areas

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Abstract. The sustainable development of the coastal areas of the Amur River is considered as an integrated use of the natural-technical system consisting of a set of interrelated elements aimed at ensuring the state of socio-economic sustainability of the coastal areas of the rivers of the Far Eastern Federal District as a whole. The improvement of the integrated management mechanisms was considered on the basis of a comprehensive system analysis of the coastal areas of the Amur River. This analysis was carried out in several stages, using elements aimed at ensuring the sustainability of the development of the coastal areas of the rivers of the Amur River basin.

1. Introduction
The coastal territory of rivers is considered as a special kind of resources. It combines all types of natural resources, population, production capacity, cultural and intellectual potential.

The coastal territory, which includes natural and man-made resources, is characterized most often by superior man-made impacts on the natural possibilities of the territory in question. Sustainable development of coastal areas of rivers is a complex of measures aimed at organizing economic activities in accordance with the principles of sustainable development and subsequent integrated management. The sustainable development of the coastal areas of the Amur River, the characteristics of the exploitation of such lands, the level of anthropogenic and other resources at different times were considered by both Russian [1] and foreign authors [2]. The article presents a study in the development of criteria and indicators that most effectively monitor the achievement of sustainable development of the coastal area by the example of the Amur River.

2. Materials and methods
The object of the study is the territory of the Amur River and its tributaries. The rivers of the Amur basin are key transportation arteries, including those of international importance. In this regard, the Amur River plays a particularly important role. Medium and small rivers are widely used for timber rafting. The energy resources of the rivers in the region are large and amount to millions of kilowatts, whose energy is used at the largest hydroelectric power stations, electricity is supplied to the neighboring states - China, Mongolia.

Intensive economic development in the Amur river basin, in its coastal territory, both from the Russian Federation and from neighboring countries and, above all, China, require close attention to the environmental situation in the region, assessment, forecasting and development of management decisions that contribute to the sustainable development of the coastal areas of the Amur basin, as the
most saturated from an economic point of view, concentration of significant population density and features of international transboundary character and high risk of floods and flooding of adjacent territories.

3. **Indicators of sustainable development of coastal areas of rivers**

Most countries include their policies for sustainable development of coastal areas in the programs of socio-economic and environmental policies aimed at achieving the sustainable development of these areas. The legislation of many states widely stimulates water conservation and environmental protection activities, taking into account the fact that payments for the destruction of elements of nature are much higher than the costs of preventive measures. The effectiveness of the functioning of the coastal territory of rivers is determined by many factors - socio-economic, technological, environmental and political.

The traditional functions of rivers and their coastal territories in the history and evolution of the development of settlements, as world experience shows, are: strategic (water-way, water-border, water-communication); defensive - natural boundary; communication - the river as a transport and trade artery; economic - the river as a factor in the formation of the economic structure; representative - coastal areas as the basis for the formation of the architectural appearance of cities, settlements; public - coastal areas as zones of economic and other activity.

Improvement and development of transport infrastructure in the coastal zone (construction of roads, bridges, and other communications) has become the dominant method in the transformation of coastal areas of rivers. With the development of economic activities in coastal areas, social and environmental functions have become increasingly important. With the growth of the ecological consciousness of society, the quality of the environment of the coastal territories began to be regarded as one of the most important resources for improving the quality of life.

The basis of a systematic approach to solving problems arising in the coastal area is the potential of coastal areas in aspects, among which an important role is played by: the environmental aspect — restoring and maintaining the natural balance; economic aspect - optimization, increase of efficiency of use of land resources, water area. Comprehensive assessment and implementation of the potential of coastal areas in the relationship functional, social, cultural, aesthetic, environmental, economic aspects should be a necessary part of the strategy for sustainable development of coastal areas.

New approaches to the formation and interaction of communication, public, recreational, cultural, representative, ecological functions of the coastal areas of rivers form the basis of the integrated organization of the infrastructure of coastal areas as a factor of their sustainable development and improvement of habitat quality. However, the unsustainable use of coastal territory resources and the lack of scientifically based management approaches often lead to negative consequences [3]: loss of economically valuable land resources; loss of land resources of high natural and aesthetic value; the disappearance of aquatic and terrestrial species of animals and plants; loss of objects of historical, cultural and archaeological value; air pollution and other.

Sustainable development of the coastal areas of the rivers of the Far Eastern Federal District is a set of measures aimed at organizing economic activities in accordance with the principles of sustainable development and their subsequent integrated management based on the definition of a set of indicators of sustainable development of coastal areas taking into account regional peculiarities.

World experience in the development of sustainable development indicators shows that there are two approaches to their construction: 1) building a system of indicators, each of which reflects specific aspects of sustainable development. Most often, within the framework of the overall system, the following subsystems of indicators are distinguished: environmental; economic; social; institutional 2) the construction of an integral, aggregated indicator, on the basis of which one can judge the degree of sustainability of socio-economic development. Aggregation is usually carried out on the basis of three groups of indicators: environmental-economic; ecological and socio-economic; environmental.

We consider it necessary to use the indicator “capacity of the territory” and “ecological condition” as the main indicator of sustainable development. Capacity ensuring its sustainable development, optimal loads due to natural-ecological, demographic and anthropogenic factors. The proposed
indicators require analysis and their selection to adapt to specific conditions and, possible expansion, clarification, which is based on a political decision.

Sustainable development involves targeting indicators to the upper and lower limits. However, this choice is conditional. The loss of controllability of socio-economic and environmental processes, the situation is beyond the lower limit and belongs to the disaster area. Sustainable development of the coastal area is characterized by the efficiency of its use, environmental stability and social security, and demographic integrity, i.e. the ratio of the population of the territory and its possibilities are in balance. Thus, the indicators selected as indicators of sustainable development should be considered in dynamics and have a time reference. The types of indicators and their scope of application are presented in Figure 1 [4].

Figure 1. Types and areas of application of indicators concerning the organization of economic cooperation and development (OECD).

Currently, environmental indicators are the dominant indicator in the sustainable development of coastal areas, since the strengthening of human activities on the sustainable development of coastal areas is becoming increasingly important. The main environmental indicators of sustainable development are considered to include: 1. The volume of emissions of harmful substances into the atmosphere, %. 2. The volume of discharges of harmful substances into water bodies, into the urban sewage system, %. 3. The share of formation and removal of toxic waste production activities, %. 4. The volume of discharge without treatment of polluted and toxic water, %. 5. A share (degree) of danger of technological accidents and accidents, %. 6. The volume of costs for the normalization of the ecological situation and the restoration of disturbed natural complexes, %. The World Bank indicators from the short “green” reference book for the Russian Federation include the following indicators (Table 1) [5].
Table 1. Indicators for the Russian Federation from the World Bank's short “green” directory [5]

| Indicator                              | Subindicator                                                                 |
|----------------------------------------|------------------------------------------------------------------------------|
| **Atmosphere**                         | 1. CO2 emissions from fuel consumption (Roshydromet data)                    |
| **Changing of the climate**            | 2. Greenhouse gas emissions                                                  |
| **Air quality**                        | 3. Concentration of priority air pollutants in urban areas (Roshydromet data) |
| **Agriculture**                        | 4. Emission of harmful substances, total and hazard classes                  |
| **Forest area,% of total land area**   | 5. Agricultural land                                                         |
| **Agricultural land**                  | 6. Mineral fertilizer use                                                     |
| **Pesticide use**                      | 7. Pesticide use                                                              |
| **Forest area, % of total land area**  | 8. Forest area                                                               |
| **Land Desertification**               | 9. Forest area by category                                                   |
| **Urbanization**                       | 10. The intensity of deforestation (using the calculated cutting area)       |
| **Fishing**                            | 11. Deserted lands (regional estimates, one-time estimates)                  |
| **Deserted lands (regional estimates,** | 12. Lands of settlements                                                     |
| **one-time estimates)**                | 13. Lands of industry, transport and other non-agricultural purposes         |
| **Fresh water**                        | 14. Annual catch of major species in main basins                             |
| **Amount of water**                    | 15. Annual intake of groundwater and surface water, in % of the total available water reserves |
| **Water quality**                      | 16. The volume of circulating and consistently used water as a percentage of water withdrawal from water sources |
| **Discharge of polluting wastewater**  | 17. Discharge of polluting wastewater to surface water                        |
| **Discharge of pollutants into surface**| 18. Discharge of pollutants into surface waters                              |
| **Biodiversity**                       | 19. Lands of specially protected natural territories                          |
| **Lands of specially protected natural territories** | 20. Protected areas | 21. Availability of main selected species (one-time estimates) |
| **Species**                            | 22. GDP per capita                                                           |
| **Economic indicators / results**      | 23. Share of investment in GDP                                               |
| **GDP per capita**                     | 24. The coefficient of renewal of fixed capital                              |
| **Labor productivity**                 | 25. Labor productivity                                                       |
| **Trade**                              | 26. «True savings» (assessment)                                             |
| **Trade balance in goods and services**| 27. Trade balance in goods and services                                       |
| **Financial position**                 | 28. Share of debt in GNP                                                     |
| **Inflation rate**                     | 29. Inflation rate                                                            |
The use of only the indicators listed in Table 1 does not allow one to sufficiently assess the impact of the activities of economic entities on the sustainable development of coastal areas. In this regard, the authors expanded the classification of environmental indicators of sustainable development of coastal transboundary territories, proposed new environmental indicators:

1. The share of pollution of the water environment by economic objects in the total amount of pollution, %.  
2. The share of participation of economic entities in environmental measures to reduce the negative impact on the water environment in relation to the total amount of work carried out or projects implemented, %.  
3. The share of damage caused by objects of management - pollutants of the water environment, which can be avoided by implementing investment and environmental projects, participating in environmental activities, %.

As a result of the analysis of statistical materials, reporting materials and recommendations of Federal, regional and international environmental organizations, for the rivers of the Amur basin and the Sakhalin rivers, environmental indicators were selected that reflect the pressure, impact, state of natural and man-made subsystems, which include [6]: seizure and violation of land; violation of the hydrological regime of groundwater and surface water; pollution of water resources with various wastewater; pollution of land with mining waste. In addition, the ecosystem of the Amur river basin can be significantly damaged by the installation of flood control facilities, while there may be: land degradation caused by changes in soil processes; reduction of spawning areas, which adversely affects the fish productivity of rivers; salinization of land; lowering water levels in the river after channel regulation leads to a decrease in the level of groundwater.

4. Conclusion
Thus, the considered mechanisms for the development of coastal areas of the Amur river, taking into account the transboundary nature and a set of recommendations for the selection of sustainable development indicators, can become the main basis for the sustainable development of coastal areas on the basis of ecology, protection of shores and water bodies from destruction and pollution, on the basis of innovation, competitiveness, social responsibility.
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