Water factor in landscape planning of the area

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Abstract. The landscape planning projects consider different aspects of the water component, depending on the aims and characteristics of the natural and socioeconomic state of the areas. The selection of criteria and theoretical justification of the factors for assessing water potential are of special attention in this work. Notably, the water factor of the territorial development and, primarily, its water ecological aspect is a limiting element in many cases. Analysis of the conditions for the runoff formation and transformation as well as the relationship of the quantitative and qualitative characteristics of the runoff with the landscape elements allow determination of hydrological organization of the area and landscape hydrological zoning to substantiate the objectives of the territorial development. The methodology of landscape planning allows the introduction of the theory of landscape hydrological approach into the practice of land use planning. The combination of these approaches provides a functionally sound tool for the practical implementation of the scientific findings into the recommended actions and measures for the ecologically friendly environmental management and the sustainable development of certain areas. The article discusses hydrological aspects of some landscape planning projects that were fulfilled in V.B. Sochava Institute of Geography SB RAS as well as in collaboration with colleagues from Armenia and Germany.

1. Introduction
Theory, methodologies and principles for the practical implementation of landscape planning are tools for rational ecologically friendly management of water resources as well as optimization of environmental management and protection in general [1]. Landscape characteristics of the watershed and even parameters of certain local sites determine hydrological characteristics of an area and regime of water bodies induced by climatic factors. Analysis of the physiographic and genetic conditions of the hydrological regime formation in various natural and anthropogenic landscapes allows for interpretation of the area development based on the water factor, which is applicable to both small and extensive areas.

Methodology of landscape planning implies a certain scheme for assessing natural components by such categories as “value” – resource characteristic and “sensitivity” – potential component stability, which in terms of aquatic environment we regard as “runoff formation” – quantitative resource parameter, and “runoff regulation” – nature-based characteristic of spatial-temporal, as well as qualitative, transformations of natural waters. Further design stages include an integrated assessment of the area combined with the analysis of socioeconomic conditions and subsequent development of measures for optimizing the use and preservation of water resources in the area [2-4].
2. Objects and methods
The landscape planning projects consider different aspects of water component, depending on the aims and characteristics of the natural and socioeconomic state of the areas. It is also shown on various scales according to the level and spatial dimension of the research. The assessment of existing anthropogenic loads, conflicting use and water environmental problems of the area are essential for the functional hydrological zoning as well as the elaboration of recommendations to develop and/or restrict activities and to protect water resources [5-9].

Functional zoning based on the water factor of the Baikalsk town area and its surroundings can serve as an example of a large-scale land use planning project. The aim of zoning was to preserve the quantitative and qualitative indicators of surface and subsurface waters inflowing to Lake Baikal from the anthropogenically transformed area. The main objectives were the analysis and assessment of all natural components and processes that determine the conditions of precipitation transformation into runoff and influx of pollutants to Lake Baikal as well as substantiation of the measures to maintain and improve the environmental and water protection characteristics of natural and anthropogenically transformed ecosystems of the area. For Baikalsk and its surroundings, the main parameters that determine the conditions and quality of the inflow to the lake were as follows: the state of land cover and water-bearing soil layers; sources and sites with polluted natural waters; quality and intensity of subsurface and surface runoff; the protection degree of subsurface waters; the extent and nature of erosion and mudflow processes [10].

3. Results and discussion
The functional zoning of the Baikalsk area and its surroundings based on the water factor resulted in the assessment of the implementation degree of the processes and the allocation of zones responsible for the formation of the water quantity and quality; the development of the recommendations and principles of environmental management focused on improving the characteristics of natural waters inflowing to the lake; the preparation of hydrological and integral maps for the assessment of the regional development objectives for surface waters (figure 1).

Another type of hydrological research in landscape planning was to determine the water development potential of the hydrologically unexplored area of the Kovykta gas condensate field. Assessment of the realization degree of landscape hydrological functions, i.e. formation and regulation of runoffs, considering the transformation conditions for pollutants entering the relief and the surface waters, allowed spatial differentiation of landscapes according to different levels of water resources formation (“value”) and resistance to natural and external changes (“sensitivity”). The final zoning of the Kovykta field area determined the sites requiring the preservation of the landscape structure in order to maintain a balanced water regime and water resource potential as well as indicated areas of possible development, where water and environmental impacts would be minimal for natural complexes during their economic development [11].

Medium scale landscape planning is appropriate for such areas as watershed basins or municipal districts. In terms of water resources, it focuses on the determination of ecological restrictions on water use and activities that have a negative impact on the aquatic environment. Works in the basins of the Goloustanya and Ushakovka rivers, Olkhon and Slyudyanka districts of the Irkutsk Region, at sites of specially protected natural area and special economic zone of the Baikal natural territory, and projects of water protection areas of water bodies, including Lake Baikal, were fulfilled with the presentation of the results on a scale of 1: 50000 - 1: 200000. They are landscape framework plans (water factor). A scale of a small river watershed interprets the results of landscape planning as a tool for water resource management [12]. For the basins of small rivers, the soil-vegetation characteristics of the watershed, morphological structure and sensitivity of the floodplain complex as well as the nature of channel processes are the most important criteria for the assessment stage of landscape planning, since they determine the self-cleaning processes and condition of the runoff into the water body. A degree and trend of the channel and coastal deformations, inundation and flooding conditions, anthropogenic changes in the floodplain channel system and reversibility of these changes characterize
the stability of the system and determine the possibility for the development of activities or the necessity of their strict regulation [13].

Figure 1. Water protection zoning of the Baikalsk territory and its suburban area. Zones: 1 – preservation of the existing state; 2 – intensive development; 3 – extensive development; 4 – preservation of the existing use with improvements; 5 – protection of watercourses; 6 – coastal protection belt of Baikal.

Landscape planning of the municipal district is focused on creating a scheme of ecologically friendly land use, where water resources can be a limiting factor in the territorial development [14]. The objective of planning Slyudyanka district of the Irkutsk Region, which is located on the Baikal coast, was to ensure the inflow of high quality waters to Lake Baikal as well as to preserve water and ecological balance of the area and abilities to the natural self-purification of the surface and subsurface waters. The mountainous nature of the relief and high precipitation throughout the year provide dangerous geomorphological and hydrological processes, which should be of special attention in landscape planning of the area. The maximum runoff of high water and summer floods play a crucial role in the development of erosion and mudflow processes as well as in the influx of pollutants to the lake [15].

The indication of zones forming environment, which require the preservation of the natural structure and abandonment of all kinds of use, are essential for ensuring water resource potential as well as preventing from extreme hydrological and hydromorphological situations (landslides and mudflows) and pollution of natural waters. Such zones are alpine, subalpine and steep slope landscapes with different plant cover as well as mountain valleys and bog complexes. More gentle slopes with dark coniferous vegetation, piedmont plains and boggy valleys, which provide interaction of the surface and subsurface waters as well as regulation of qualitative and quantitative characteristics of the runoff, also require maintaining the existing landscape structure and the conditions for its restoration, but their regulation of economic use is less strict. One more part of the area is recommended for various activities subject to compliance with basic environmental standards.

Water protection zoning of water bodies is one of the preferred directions for the use of landscape planning methods. It is based on landscape hydrological studies combined with the analysis of water ecological and socioeconomic situations as well as the existing environmental regulatory framework. Technical approaches to planning of water protection zone of Lake Baikal as a site with special environmental status are largely based on the methodology of landscape planning, especially, in the areas of economic and recreational use. The establishment of the water protection zone, its functional differentiation and land use regulation are one of the solutions for reconciling various interests of residents, businesses and municipal authorities, and a way to improve water ecological situation of Lake Baikal and its coastal area. The aim of water protection zoning is to preserve and improve the state of the coastal ecosystems, self-cleaning abilities of the lake tributaries and landscapes of their watersheds, as well as to protect surface and subsurface waters in the area that is directly drained by Lake Baikal.
The soil-plant complex, geological, geomorphological and hydrogeological features of the area, which determine the differentiation of the water yield in time and space, are the main factors for the assessment of the area during water protection zoning of Lake Baikal. The forecast of the water ecological situation is based on the assessment of anthropogenic loads, i.e. present and future wastewater disposal, actual use of land, water, forest and recreational resources, conditions for landscapes to provide environmental protection, self-cleaning and water protection functions. Functional differentiation of water protection zone, as well as the objectives of the territorial development and land use regimes, are based on the integrated landscape hydrological and water ecological assessment of the area. Landscape plans for the territorial development of the large settlements and recreational territories should be an important component of the water protection zoning of Lake Baikal [16, 17].

The landscape framework plan of Lake Sevan basin, which was prepared within the landscape planning projects in the countries of the South Caucasus, was also focused on the development of measures and recommendations to preserve and improve the water quality and quantity in the lake as well as environmentally sound development of recreation and tourism in its basin (figure 2). The results showed the direction and necessary actions for the water protection in the lake as well as possible recreational development considering the environmental protection [18].

![Figure 2. The objectives of the territorial development of Lake Sevan basin based on the water factor. Zones: 1 – preservation and abandonment of use; 2 – preservation and extensive use; 3 – extensive development; 4 – intensive development; 5 – improvement with preservation elements; 6 – improvement with subsequent development; 7 – settlements.](image-url)
4. Conclusions
The discussed landscape planning projects have been implemented for various regions and are focused on greening nature management and environmental protection, taking into account the interests of business entities. The final stage of each project included public hearing procedures, widespread information in the media and subsequent approvals aimed to reveal the project weaknesses and attract interested representatives of government and business. These procedures are necessary for successful completion of works on landscape planning and further implementation of the developed plans.

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