Aesthetic resources of the central ecological zone of the Baikal natural territory (within the borders of the Irkutsk region)

A Y Bibaeva
V B Sochava Institute of Geography, SB RAS, Irkutsk, 664033 Russia

E-mail: pav_a86@mail.ru

Abstract. The research considers the results of the aesthetic assessment of landscapes in the central ecological zone of the Baikal natural territory (CEZ BNT). The expert assessment based on a set of indicators was carried out in Quantum GIS using landscape photographs. Cartographic materials (landscape typological map, Forest Resource Management maps, SRTM, areas affected by fire, etc.) were also involved in the assessment. The map «Aesthetic Evaluation of the Geosystems of the Central Ecological zone of Lake Baikal within the Borders of the Irkutsk Region» was created based on the analysis of the estimated indicators of the aesthetic landscape quality. The construction of the map is based on the principle of the priority of landscape scene viewpoints; the assessment is assigned to the polygon from which the landscape scene is observed. The article contains the detailed structure of the landscape scene complexes of the CEZ BNT.

1. Introduction
The main resource of recreation is an undisturbed and slightly changed nature. The assessment of the landscape aesthetic properties, the allocation of their scenic advantages, which require careful treatment and preservation, deserve special attention when rationing tourist and recreational activities in the central ecological zone (CEZ) of the Baikal natural territory (BNT). One of the criteria which served as a reason for including Lake Baikal in the World Heritage List was the landscapes of outstanding natural beauty.

The relevance of the study stems from the increasing interest of the tourist and recreational sector towards the BNT, which is characterized by specific climatic conditions, unique natural landscapes, and a rich historical and cultural potential. The development of tourism and recreation industry in the BNT area, based on the environmental principles, requires first and foremost the solution of the inventory issues, assessment and mapping of the aesthetic resources of the territory.

2. Models and Methods
The methods of landscape and aesthetic research [1-4] are widely used in the foreign practices of landscape planning. The approach to aesthetic assessment of landscapes using geoinformation systems is also being developed [5-8].

Baikal landscapes have a specific combination of aesthetic properties (potentials), giving the observer an aesthetic satisfaction, so they can be seen as natural aesthetic resources, part of the national wealth of our country. Hiking is the best type of tourist activity to fully enjoy the landscapes’ beauty. For this reason, the methodology for assessing landscape qualities is based on the idea that the landscape
structure of a territory is the system of scenic viewpoints interrelated inside a system of geographical location. Each landscape site is characterized by its visual connection with all objects of the visible area.

The source materials for the aesthetic evaluation are the geo-referenced photographs of landscapes obtained by the author and other members of the Institute of Geography of the SB RAS during the field landscape research and from Internet resources. Cartographic materials have also been used for the assessment (thematic maps and plans of various scales): the landscape-typological map of the territory with a scale of 1:500 000, Forest Resource Management maps with a scale of 1:25 000 from the Ministry of Forestry of the Irkutsk Region and the Pribaikalsky State Natural National Park, SRTM radar topographic survey data (https://www.usgs.gov), information on the territories affected by fire, etc.

The basis of the aesthetic differentiation of the territory is a landscape map characterizing the position of the scenic viewpoints in the surface relief and the type of vegetation. Expert aesthetic evaluation was made on a three-dimensional model of relief in Google Earth Pro using the following indicators: the position of a scenic viewpoint in the relief, the openness of the view, the presence of landscape frames, the landscape plane perspective, the visibility of the water surface of Lake Baikal, the presence of other water bodies in the landscape scene, the visibility of the opposite shore (including Olkhon Island and the Svyatoj Nos Peninsula), the presence of mountain ranges and peaks in the background, dissected relief, scenic diversity, and traces of anthropogenic activity.

Morphometric and spatial analysis of perceptual conditions (slope steepness and slope exposure, relief dissection, morphographic type of relief, and relief element) characterizing the landscape scene viewpoints were carried out in Quantum GIS 2.14 using the integrated SAGA and GRASS GIS modules.

3. Results and Discussion
Based on the analysis of estimated indicators of the aesthetic landscape quality, a map-scheme “Aesthetic evaluation of geosystems of the Central ecological zone of Lake Baikal within the borders of the Irkutsk region” was created (Figure 1). The map is based on the principle of priority of landscape scene viewpoints; the assessment is assigned to the polygon from which the landscape scene is observed.

The following part of this paper presents a detailed structure of the CEZ BNT landscape complexes.

Bald mountains (golets) with alpine-type landscape scene complexes can be observed from the Baikal Ridge and Khamar-Daban Ridge slopes at a height of more than 1,600 meters above sea level. The landscape scene view is composed of the rocky massifs of ridges with dissected alpine-type relief, loose rock (kurums) and chaotic assemblage of rock blocks, sometimes covered with crustaceous lichens, forming contrast combinations with the snowfields of the Khamar-Daban Ridge. The vegetation is absent. The circular visual perception (360°) allows one to observe multidimensional landscape scenes with the wide perspective of the coast and water surface of Lake Baikal, picturesque bays, capes, islands, and the lake’s opposite shore.

Landscape scenes of near-summit gently sloping surfaces are found in the Baikal Ridge. They are defined by vast sub-horizontal poorly dissected surfaces of the watershed spaces, occupied mainly by loose rock and giving uniformity and monotonity to the landscape scene. The average perspective and the water surface of Lake Baikal fall out of the landscape scene structure. Fragmentary development of the vegetation cover also reduces its aesthetic qualities.

Landscape scenes of the dome-shaped peaks of the Primorsky Ridge are determined by the visual features of the landscape scene foreground expressed by poorly dissected relief and gentle slopes, intense kurum forming, vegetation growth in groups confined to microdepressions. The elevation of the peaks above the forest belt of about 300 meters provides the opportunity of the perception of the wide panoramas of Lake Baikal (240°).

The aesthetic qualities of mountain-tundra landscapes vary greatly from place to place due to the large ruggedness of the relief, the diversity of ecological conditions, and plant communities. The decrease in the forest stand vitality, tree crown reduction and tree trunk corrosion in strong winds are typical for this area.
Figure 1. Aesthetic evaluation of geosystems of the central ecological zone of Lake Baikal within the borders of the Irkutsk Region (a map tile).

| Level | Description |
|-------|-------------|
| 1     | Unattractive landscapes | New burned areas, closed valley complexes, landscapes with limited visibility and with a lot of buildings in the landscape scene |
| 2     | Non-painted landscapes | Small-leaved forests on burnt areas, dark coniferous forests with fallen trees and deadwood, sparse cedar-fir forest stands on the upper forest edge, near-summit gently sloping surfaces, river valleys on the plains |
| 3     | Slightly attractive landscapes | Closed forest (dark coniferous) landscape scene complexes |
| 4     | Medium attractive landscapes | Dry steppes with poorly dissected relief; landscape scene viewpoints on coastal slopes, from which the water surface of Lake Baikal can be observed |
| 5     | Attractive landscapes | Coastal open plain complexes overlooking the water surface of Lake Baikal, semi-open landscape complexes of low mountains, landscape complexes of mountain tundras on the slopes facing Lake Baikal |
| 6     | Picturesque landscapes | Summit and slope locations with open landscape scene views of mountain ranges and river valleys, without the water surface of Lake Baikal in the composition (bald mountains (golets) with alpine-type complexes, subalpine Siberian dwarf pine complexes, high-mountain meadows) |
| 7     | The most picturesque landscapes | Open landscape scene viewpoints with a 360-degree visibility and a large perspective, the presence of Lake Baikal in the landscape scene structure (bald mountains (golets) with alpine-type complexes, dome-shaped peaks of the Primorsky Ridge) |

A distinctive feature of the landscape appearance of the subgoltsy landscape complexes is the development of Siberian dwarf pine communities, which add openness to the foreground. Landscape scene viewpoints located on the slopes are characterized by the openness and diversity of panoramic views with a long-distance perspective of the forested slopes of the ridges and the Baikal coast. On flat surfaces, the height of Siberian dwarf pine exceeds the human’s height and reaches 2-2.5 m [9]. It determines the isolation and monotony of the landscape scenes limited to a few meters.
Landscape scene complexes of alpine-type meadows are located in separate areals, confined to low relief forms of the subgoltsy belt of the Baikal ridge and the Khamar-Daban Ridge. As a rule, these locations are characterized by closed circular views with an average spatial perspective. The dissected battlement peaks of the ridges act as a frame for a landscape scene with abundantly blooming meadow grasses.

The forest landscape scene complex is characterized by a frontal landscape composition, mainly one-dimensional closed views of the foreground on gentle and medium slopes. The perceived landscape is formed solely from the elements of a particular landscape complex. The landscape diversity and physiognomic characteristics of the locations are determined by the species composition, density, stratification, age and defectiveness of tree vegetation, the species composition of the grass-shrub layer, and their dynamic changes associated with the change in phenological phases. In this case, when perceiving the aesthetics in the foreground, one’s attention is drawn to the distinctive forms of the tree crowns, i.e. *habitus*.

On the steep sections of slopes with sparse tree vegetation facing Lake Baikal, one can observe the dynamically contrasting multifaceted scenes of the sector and panoramic views (30-160°) with a long perspective on the forested slopes, the water surface of Lake Baikal, and its curved coastline with picturesque capes. Crowns of trees create openwork frames, significantly increasing the aesthetic properties of the observed landscape scenes (Figure 2).

![Figure 2. Panoramic view from the steep forested slope of the Primorsky Ridge: eastern exposure.](image)

*Secondary forests* in the study area are represented by deciduous species (birch, aspen) of different ages at the stage of boreal coniferous forest succession affected by fires at various periods of time. The landscape image of these complexes is determined by the tree vegetation density and a limited overview (a few meters ahead) significantly reducing their aesthetic qualities.

Waterways enrich the landscape aesthetically; they draw the eye and become dominant.

The most accessible locations for visual and aesthetic perception of the Baikal landscapes are open coastal *steppe landscapes*. Their landscape scene image is more or less connected to the coast of Lake Baikal, its picturesque coastline with a few rocky capes, inviting bays, and the water surface of the lake. It is characterized by good visibility and deep spatial perspective. These locations are confined to steep slopes, coastal and foothill plains, river valleys in the lower reaches along the coast of the lake. The visual axis of the perceived landscapes is the coastline with a lot of rocky capes, forming many far-reaching dimensions.

Aesthetic qualities of the coastal areas of the western coast of Lake Baikal are expressed in the combination of flat structural-abrasive and bay types of coasts with protruding rocky and accumulative capes, which together create a unique picturesque geometric pattern of the coastline. The western coast of the Maloe More Strait is characterized by the presence of shingle spits separating the lagoons. They are used as a marina and roadway for transporting tourists to a recreation centre located far from the coast and have an exceptional recreational value for beach recreation and fishing.
The exceptional aesthetic value of global significance is the architectural and landscape complex of the Circum-Baikal Railway located on the south-west coast - the «Golden buckle of Russia’s steel belt». The engineering structures of the Circum-Baikal Railway are harmoniously integrated into the surrounding landscape, enhancing the picturesque qualities of the natural complexes. This is a spectacular example of «collaboration with nature» (by the terminology of V B Sochava [10]).

Residential landscape complexes are confined, as a rule, to the intermontane basins and wide sections of the river valleys at the places where the rivers reach the foothill plain in the coastal zone of Lake Baikal. The visual and aesthetic qualities of the landscapes are characterized by haphazard, low-rise, usually wooden housing, and a network of unpaved country roads. These are semi-open landscape scenes with close and medium perspectives and anthropogenic objects occupying a significant proportion of the angular value.

4. Conclusion
The potential for the tourism development and the formation of recreational areas of the CEZ BNT lies in the beauty of its pristine unique landscapes, for which Lake Baikal is a powerful attraction. Most of the tourism infrastructure is concentrated in its coastal zone, which is currently highly subject to anthropogenic transformation. Thus, the problem of visual pollution of the territory requires special attention and should be considered carefully.

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