Geojournal of Tourism and Geosites
ISSN 2065-0817, E-ISSN 2065-1198

Year XVII, vol. 54, no. 2spl, 2024, p.842-848
DOI 10.30892/gtg.542spl08-1259

THE ECOLOGICAL AND TOURIST FRAMEWORKS OF THE LOW MOUNTAIN ZONE AS THE BASIS FOR THE FORMATION OF THE TERRITORIAL STRUCTURE IN THE SOUTHERN PART OF ALTAI KRAI

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Citation: Dunets, A.N., Volkova, A.K., Ramazanova, N.Ye., & Rygalov, E.V. (2024). THE ECOLOGICAL AND TOURIST FRAMEWORKS OF THE LOW MOUNTAIN ZONE AS THE BASIS FOR THE FORMATION OF THE TERRITORIAL STRUCTURE IN THE SOUTHERN PART OF ALTAI KRAI. *Geojournal of Tourism and Geosites*, 54(2spl), 842–848. https://doi.org/10.30892/gtg.542spl08-1259

Abstract: Gain a comprehensive understanding of the environmental and tourism aspects of the formation of the territorial structure of the region. The authors advocate for an ecological framework approach to pinpoint key natural areas crucial for establishing a tourist framework. In the southern low-mountain region of Altai Krai, mountain ranges are integral to the ecological framework, shaping its diverse landscape. This territory harbors specially protected natural areas (SPNA) that comprise natural heritage sites and tourist attractions. Different elements of the ecological framework, including nature reserves and protected zones within natural parks, require varying levels of protection. The study emphasizes that the main river valleys serve as focal points of the tourist framework. Through the development of schematic maps, the research identifies nine distinct tourist destinations in the foothill-low-mountain zone of Altai Krai, each characterized by unique ecological and tourist attributes.

Keywords: Ecological frame, Tourist frame, variety of landscapes, attractiveness of the territory, tourist attractor, attractors, GIS technology, tourist-recreational design

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INTRODUCTION

The versatility and multidimensionality of spatial structures makes them a universal object for the study of many scientific disciplines, including economic geography. The peculiarities of the formation, growth and development of the spatial structures of the economy determine the trajectory of the development of the space as a whole and pose many practical problems for researchers, on the successful solution of which the further development of the districts depends.

The territorial framework significantly influences not only the regional economy but also specific sectors such as tourism. Recognizing tourism development as a pivotal component of spatial development, as underscored in the "Strategy for Development of Altai Krai until 2035," it becomes imperative to explore how the juxtaposition of ecological and tourist frameworks collectively shapes the territorial structure of tourism.The purpose of the study is to analyze the territorial structure of tourist activity in the low-mountain foothill zone of Altai Krai, which is a set of elements of its ecological-tourist framework and, based on their analysis, to identify local tourist destinations.

Currently, there are relevant works related to solving a number of practical problems related to the sustainable development of the territory, which is based on the idea of a supporting frame in the studies of Vedenin, 2019; Molchanov, 2020. This issue is also considered at the macroregional level, including studies not only of the southern foothills of the Altai Territory, but also of the entire Western Siberia (Erokhin and Chernovskaya, 2022). Also important are studies devoted to the updating of theoretical provisions regarding the use of the frame approach in geographical research, including related topics and those mentioned in the works of Fedotov and Tkachenko, 2019; Baklanov, 2020; Patrakova, 2020; Suvorova, 2021; Treivish, 2023. The works of Stepanova, 2019 and Lyulya, 2020 are devoted to the problems of tourism development in the Altai Territory as the basis for the sustainable development of the region. The methodology of territorial planning, essential for spatial development, is deeply rooted in a framework approach. Building on the scientific

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methodology proposed by Obedkov, 2018; Molchanov, 2020; Treivish, 2023 our study delves into understanding the development patterns of the territory and identifying areas that require management decisions.The disadvantage of previously conducted regional studies on related topics, as well as the works noted above, is that they most often consider only individual elements of the frame, while mainly urban settlements were considered as key elements, but insufficient attention was paid to the role of frame structures in rural areas. An assessment of the current territorial structure of the economy is a necessary condition for understanding spatial development and strategic planning. To identify existing problems and opportunities for economic development in the region, a lot of analytical work is needed.

Drawing on previous research, we have validated a method for evaluating and modeling landscape diversity, crucial for tourism development in promising natural areas. This approach, incorporating a quantitative assessment technique for diversity using GIS-based visualization the basis for comparing key ecological and tourist areas within a GIS environment.

MATERIALS AND METHODS

The study focused on the territorial structure in the region, influenced by interconnected elements crucial for development. The foundational linear-nodal structure, as explored by Polyan and Treivish, 1988 and updated in the studies of Vedenin, 2019; Molchanov, 2020 was considered. The impact of the natural environment on the region's economic structure, as evidenced by Baransky 1980; Mayergoiz, 1986; Saushkin, 1973; Pertsik, 2006; Zyryanov, 2008; Baklanov, 2020; Moskvitina, 2020; Suvorova, 2021 was also considered.

The supporting framework elements were classified according to function (nodes, cores, communication elements), degree of natural preservation, and legal status by Elizarov, 2008. Barriers to development, such as mountain ranges and water bodies, were considered alongside nodal and linear elements. These elements, along with landscape contrasts, as highlighted by Zyryanov, 1995, influenced the formation and functioning of the framework, providing insights for spatial development. Also important are studies devoted to the updating of theoretical provisions regarding the use of the frame approach in geographical research, including related topics and those mentioned in the works of Fedotov and Tkachenko, 2019; Baklanov, 2020; Patrakova 2020; Suvorova, 2021; Treivish, 2023.

At a regional level, the framework approach enabled the recognition of variations across different areas by studying connections between elements, generalizing phenomena, and observing process dynamics (Lappo, 1983). The ecological framework, defined by Vladimirov, 1982; Sokhina and Zarhina, 1991 served as a system of zones with specific environmental management regimes to ensure sustainable development. This included areas with restrictions on use, such as wildlife refuges, national parks, and protective forest belts. This issue is also considered at the macroregional level, including studies not only of the southern foothills of the Altai Territory, but also of the entire Western Siberia (Erokhin and Chernovskaya, 2022). The tourist element of the supporting framework, outlined by Rodoman, 2002, focused on organizing tourist space through attractive points, routes, and infrastructure. The maintenance of ecological balance required a careful balance between urbanized and protected landscapes. The tourist framework, with its nodes and lines, formed a stable but dynamic part of the territorial structure, essential for economic development. The study proposed examining interconnected elements within the tourism framework to understand the unified system of tourist elements, encompassing natural, historical, cultural, and socioeconomic aspects (Alexandrova and Sorokin, 2019; Lazhentsev, 2013; Toan et al., 2023). The works of Stepanova, 2019; Lyulya, 2020 are devoted to the problems of tourism development in the Altai Territory as the basis for the sustainable development of the region. Cartographic resources, information materials, and field research served as the information base for this study. Criteria such as attractiveness, accessibility to transport, concentration of tourist objects, and aesthetic appeal were considered to select elements for the tourist framework.

The cartographic research method, combined with GIS analysis, was instrumental in compiling maps that reflect the natural, ecological and tourist frameworks of the territory. This approach facilitated a comparative analysis of these frameworks, helping to identify and delineation of tourist destinations. The general algorithm of work included four stages: 1) selection and justification of a group of assessment indicators of elements of the tourist territorial structure; 2) identifying the main elements of the eco-tourism framework; 3) carrying out computational operations to evaluate frame elements and ranking them based on the results obtained, 4) constructing integrated models and their analysis (Figure 1).

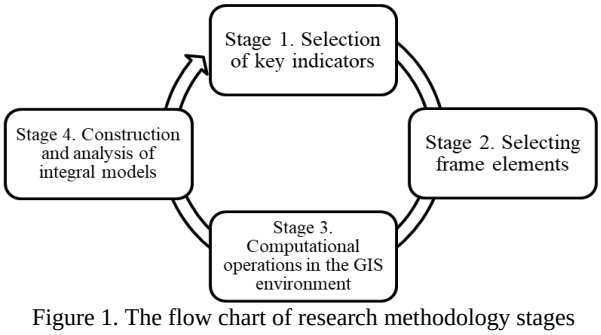

Figure 1. The flow chart of research methodology stages

RESULTS AND DISCUSSION

The mountain ranges have played a crucial role in the economic and tourist development of the Altai region, particularly in defining tourist destinations within river basins. During the past three decades, the region has witnessed the

development of tourist infrastructure, the concentration of local tourist attractions, and the development of tourist routes in the low mountain zone. Currently, based on our findings and the mapped data, the territorial structure of tourism can be visualized as a linear-nodal network within the tourist framework. This visualization enables the identification of promising areas for new infrastructure projects and facilitates efforts to create favorable conditions for tourism investments.

Different types of territorial structure have been identified based on the region's physical and geographical characteristics and its economic history, including concentric, polycentric, linear, polycentric central basin, and central structures (Pozachenyuk, 2003). Alexandrova and Sorokin, 2019 highlight common frameworks such as belt, star-radial, radial-ring, and dispersed tourism frameworks. Our study has identified unique spatial combinations of the framework influenced by the presence of mountain ranges and river valleys in the study area (Figure 2).

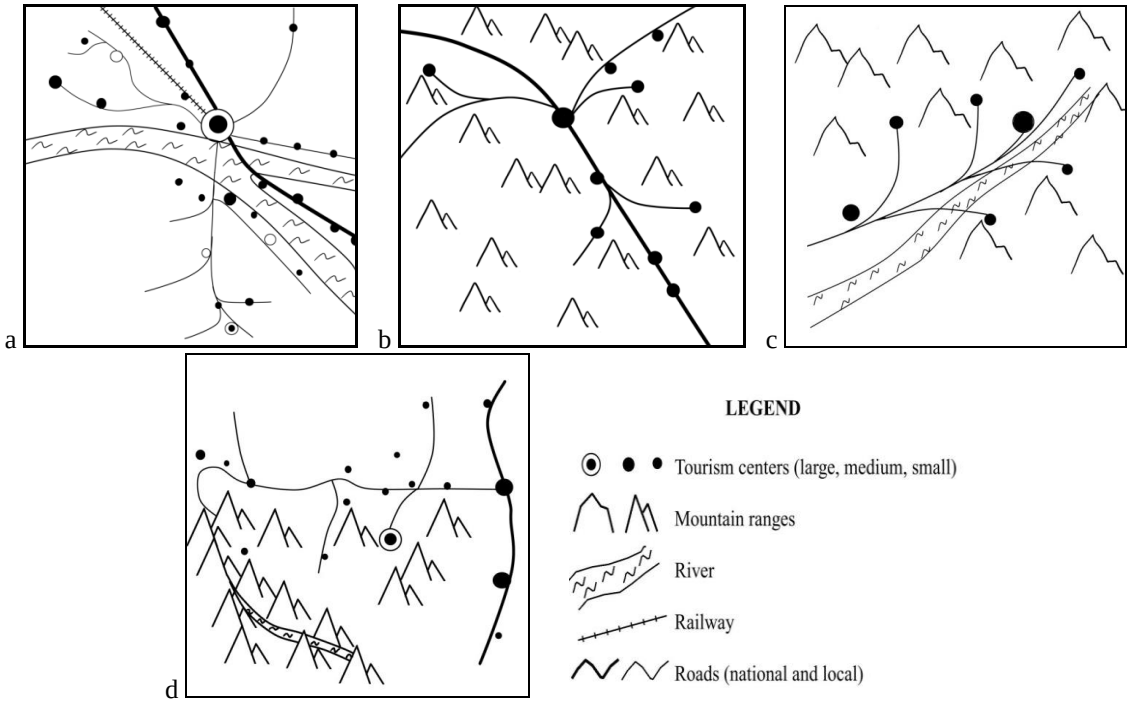

Figure 2. Combination of natural framework elements in the foothill-low mountain zone of Altai Krai

Figure 1 illustrates the combination of natural framework elements in different parts of the low mountain zone of Altai Krai:

a) in the area of the city of Biysk - they are represented by a large urban diversified economic hub, which also performs the functions of an administrative, information and transport center, surrounded by a group of satellite settlements.

b) the valley of an intermountain river of transit significance - a spatial structure represented by large economic centers with complementary specialization and performing the functions of transit nodes of a large transport corridor.

c) closed valley closed intermountain valley - represented by local “dead-end” frame nodes, the development of which is limited by insufficient transport accessibility due to their peripheral location and the complex topography of the underlying surface, performing the functions of stagnant outlying centers.

d) Pre-Altai Plain and Gorny Altai - point structures represented by settlements with enterprises that occupy a deep position in the territory of the region and are located at a distance from the administrative center of their rural municipal district, have transport connections with it, but retain a significant degree of independent development.

In light of the ecological framework concepts, we have created a diagram for the low-mountain region of Altai Krai (Figure 3). The highest sections of mountain ranges (such as Kolyvansky, Tigireksky, Baschelaksky, Anuysky, Cherginsky, Seminsky, Iolgo, and the Salairsky ridge) act as significant barriers to the development of tourism infrastructure, delineating the boundaries of various destinations. These elevated areas can be categorized as linear elements within the ecological framework, resembling stripes. Within the ecological framework, areas with a high level of protection include nature reserves and protected zones within natural parks. It is essential to perform functional zoning of other protected natural areas to identify zones requiring strict protection measures. Key components of the ecological framework include Tigireksky Nature Reserve, Salair National Park, and the natural park "Foothills of Altai," characterized by aspen-fir forests. These forests typically consist of Siberian fir along with aspen, silver birch, Siberian larch and Scots pine. The Tigireksky reserve boasts preglacial plant species, termed tertiary relicts, such as European hoofweed, common wolfberry, broadleaf bell, Brown's grass, and Ural undergrowth. Salair Park is known for its endemic plant species such as Siberian kandyk, blue anemone, Krylov's crosswort, Krylov's forget-me-not, and large-leaved buttercup.

The tourist framework often aligns with river valleys, which serve as prominent linear elements within the ecological framework. These river valleys exhibit diverse landscapes, including forb-grass meadows, fir-aspen-birch shrub forests, high-mountain V-shaped valleys, steeply sloped branched valleys, terraced valleys with birch-pine grass shrub forests, and other variations. The formation of the territorial features is closely tied to the conditions of natural resource conditions.

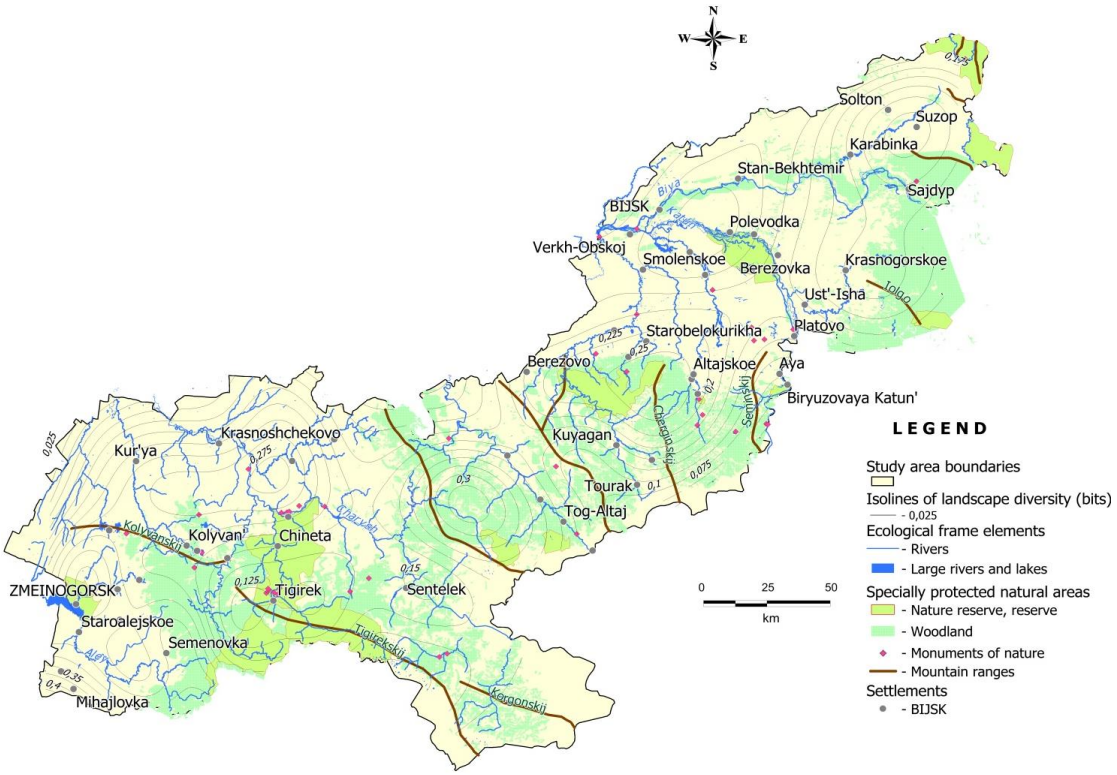

Figure 3. Schematic map illustrating the ecological framework of the low-mountain region in Altai Krai

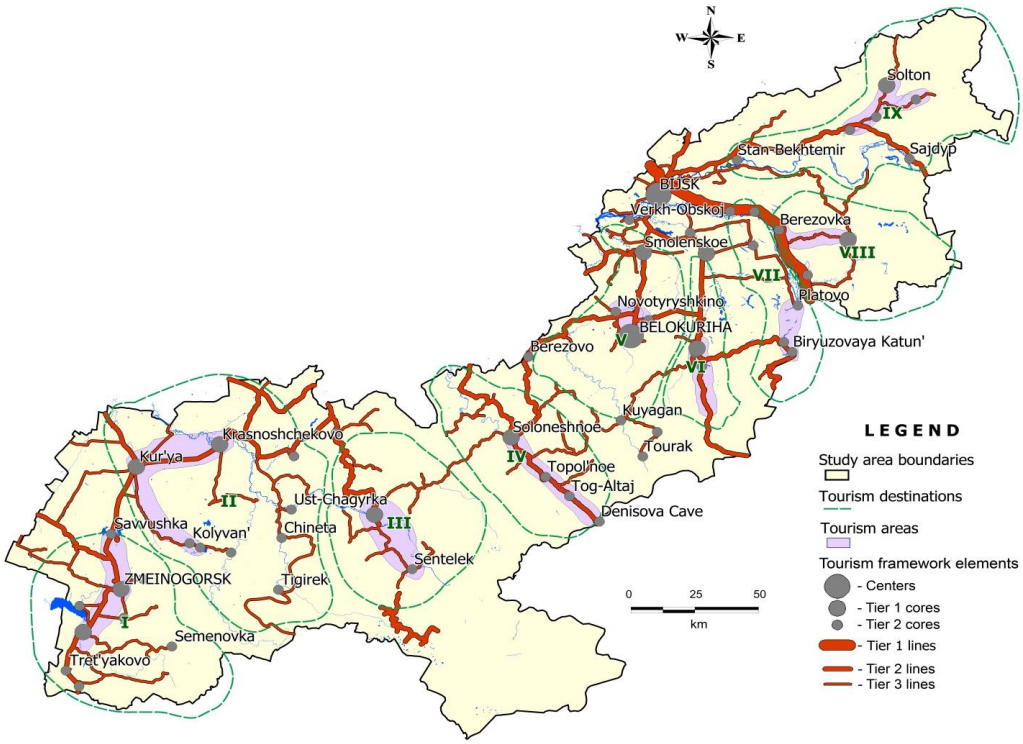

Figure 4. Schematic map showing the tourist framework of the low mountain region in Altai Krai

River valleys play a crucial role in determining the locations of tourist destination centers, as supported by our tourist framework map (Figure 4, Table 1). In the western part of the low mountain zone of Altai Krai, tourism development is linked to exploring the mountain taiga areas of the Kolyvan mountain range and mineral and rock deposits such as Mount Revnyukha, Goltsovskoye, and Semenovskoye. Zmeinogorsk serves as a key tourist center with a rich history of mineral exploration. The Alei River basin and Kolyvan Lake are of ecological and tourist importance. The Kolyvan ridge divides tourist flows, acting as a barrier to auto routes. The eastern part of the Kolyvan ridge features two development directions, extending between the villages of Kurya and Kolyvan and Kurya and Tigirek. The village of Charyshskoe also serves as a destination center, connecting to the mid-mountain region through tourist routes in the Anuy river valley.

Table 1. Structural elements of ecological and tourist frameworks

Destination	Elements of the Ecological Framework	Elements of the tourism framework
I. Aleisko-Zmeinogorskaya	Centers: Tigirek Nature Reserve; Cores: Livlyandsky reserve, Natural monument of the river basin Kolyvanka; Natural lines: axial lines of mountain ranges – Kolyvansky, Tigireksky. Rivers: Alei, Goltsovka, Karbolikha, Kharkovka.	Centers: Zmeinogorsk; Cores: villages – Savvushka, Baranovka, Semenovka, Staroaleiskoe; Tourist lines: vil. Kurya – Zmeinogorsk – vil. Verkh-Aleyka; Alei River.
II. Kolyvano-Tigirekskaya	Centers: Tigirek Nature Reserve; Cores: Natural monuments (Kolyvan Borok, Mount Sinyukha, Lake Beloye); Natural lines: axial lines of mountain ranges – Kolyvansky, Tigireksky. Rivers: Loktevka;	Centers: Kolyvan Cores: vil. Kurya, vil. Krasnoshchekovo, vil. Ust-Chagyrka; Tourist lines: vil. Kurya, vil. Krasnoshchekovo – vil. Tigirek; Vil. Kurya – Kolyvan – vil. Bugryshikha.
III. Charyshskaya	Centers: Tigirek Nature Reserve; Areas: Chinetinsky and Charyshsky reserves; Cores: Yarovskie Rocks, Rock Big and Small Monasteries, Silurian Cut, Log Strashnoy, etc.; Natural lines: center lines of mountain ranges; Rivers: Inya, Belaya, and Charysh.	Centers: Charyshskoe. Cores: Centelec. Tourist lines: vil. Ust-s. Kalmanka – vil. Charyshskoye – vil. Sentelec; vil. Charyshskoye – vil. Small Bashelak.
IV. Anuyskaya	Centers: Baschelaksky reserve; Areas: reserve cascade of waterfalls of the Shinok river); Cores: Mount Budachikha, Troshin Log, steppes near the village of Sibiryachikha, Denisova Cave; Natural lines: axial lines of Bashelaksky and Anuysky; Rivers: Anuy, Karama, Shchepeta.	Center: vil. Soloneshnoye; Cores: vil. Topolnoe, vil. Tog-Altai. Tourist lines: vil. Sibiryachikha – vil. Soloneshnoye – “Denisova Cave”.
V. Bolshaya Belokurikhinskaya	Centers: protection zone of the natural park “Foothills of Altai”; Areas: natural park “Foothills of Altai”; Cores: Lower reaches of the Sychevka river, Four Brothers rocks, Tochilinsky Borok, mineral water deposits; Natural lines, rivers: Peschanaya, Belokurikha, Pomerechnaya.	Center: Belokurikha Resort. Cores: vil. Solonovka, vil. Novotyryshkino, vil. Starobelokurikha, Belokurikha Mountain Kolyvan. Tourist lines: vil. Smolenskoe – Belokurikha; vil. Starobelokurikha – vil. Novotyryshkino – vil. Solonovka.
VI. Kamensko-Sarasinskaya	Centers: Arbanak log; Cores: Mount Berezovaya, Katorzhnaya cave, Kyrkylinsky caves, mineral deposits; Natural lines: spurs of the Cherginsky and Seminsky ridges; Rivers: Sarasa, Kamenka.	Centers: village of Altai; Cores: villages – Makaryevka, Beloye, Nizhnekamenka, Basargino. Tourist lines: vil. Sovetskoe – vil. Altai –vil. Beloe; vil. Kuyagan – vil. Altai.
VII. Nizhnekatunskaya	Centers: Aya Natural Park protection zone; Areas: Caves of the Metlevo plateau, Traces of the catastrophic flood of Platovo, Tigirek caves, Mount Babyrgan; Natural lines: spurs of the Seminsky ridge. River: Katun.	Centers: Lake Aya, the central part of the Turyuzovaya Katun economic zone; Cores: a cluster of accommodation facilities on the left bank of the Katun river; Tourist lines: Aya village – Turquois Katun.
VIII. Katunsko-Ishinskaya	Centers: Mikhailovsky Nature Reserve; Areas: sanctuary “Swans”; Cores: separate forests near the Isha and Katun rivers; Natural lines: spurs of the Iolgo ridge; Rivers: Katun.	Centers: villages – Srostki, Krasnogorskoe. Cores: vil. Novozykovo, Isha Bridge; Tourist lines: Chuisky tract, Biysk – Gorno-Altaisk.
IX. Biye-Neninskaya	Centers: Salair National Park protection zone; Areas: Salair National Park, Neninsky Nature Reserve. Cores: the Skala natural monument, separate areas of forest near the Biya and Nenya rivers.	Center: Stan-Bekhtimir. Cores: Lebyazhye, Solton. Tourist lines: Biysk – Solton – Turochak.

Belokurikha resort exerts influence on its surroundings, particularly in Bolshaya Belokurikha, which includes tourist sites in the Smolensk and Altai municipal districts. Recent years have seen the emergence of tourist infrastructure facilities in the Kamenka and Sarasa River valleys, with the village of Altai as a central hub. The Chuya Highway, situated between the Biya and Katun rivers, serves as a primary route for tourist traffic, although the low-mountain zone attracts relatively few tourists. The right bank of the Biya River and Solton municipal district exhibit an underdeveloped tourist infrastructure. An intriguing case is the development of a destination in the Katun River valley, characterized by its dual role as an ecological corridor and a major tourist infrastructure concentration. This area hosts a multitude of tourist enterprises and specialized infrastructure unique to Altai, housing several local tourist centers like "Lake Aya," "Gorno-Altaisk – Maima," "Lake Manzherok» and "Turquoise Katun." Situated in the low mountains of northern Altai, this region benefits from convenient transport and geographical location, making it easily accessible to Siberia's tourism consumer base. Existing roads and bridges facilitate movement between tourist centers, with pine and birch forests covering mountain range spurs and steppe vegetation occupying flat terrain. The presence of rocky outcrops and karst caves enhances the area's allure, while small rivers and springs contribute to its natural charm.

However, challenges persist concerning the development of tourist infrastructure within the Katun River water protection zone, necessitating vigilant oversight to ensure the river's environmental integrity of the river is maintained. Our analysis has revealed that the environmental and tourist framework centers often differ within the broader study

area. There are overlaps in certain areas and cores of these frameworks in destinations like Nizhnekatunskaya and Bolshaya Belokurikha. Thus, based on the ideas about the ecological framework, we have drawn up a diagram for the low mountain territory of Altai Krai (Figure 2). The most elevated parts of the mountain ranges (Kolyvansky, Tigireksky, Baschelaksky, Anuysky, Cherginsky, Seminsky, and Iolgo, as well as the Salairsky ridge) are the main barriers to the development of tourism infrastructure; they determine the boundaries of destinations. At the same time, they can be classified as linear elements (in the form of stripes) of the ecological framework.

Research on the low mountain zone in the southern part of Altai Krai for tourism purposes gained momentum in the 1990s. During this period, the concept of the South Altai ecological-economic region was introduced. Within this region, two recreational planning subdistricts were identified: Biysko-Belokurikhinsky and Gorno-Kolyvansky. The former served as the foundation for the Altai Medical and recreational area project, located in Belokurikha. Notable natural parks like "Aya," "Altai Foothills," and nature reserves such as "Swans" and "Cascade of Waterfalls on the Shinok River" were established in this subdistrict (Pomorov and Morozova, 2009). Tourist development in the southwest of Altai Krai focused on establishing a network of protected natural areas, including Tigireksky, Chinetinsky, Charyshsky, and Baschelaksky nature reserves, with plans for the Gornaya Kolyvan National Park. This development was influenced by the existing transport infrastructure and the impact of mountain ranges on shaping the tourist environment. We found that the territorial structure of tourism in the foothill-low mountain zone of Altai Krai is shaped by natural, historical, socioeconomic, and administrative-territorial factors. Analysis of the tourist framework in this region revealed that its appeal for tourism is closely tied to the quality of its tourist infrastructure, reflecting the level of territorial development. Further research is needed on the impact of the frame on the prospects for the development of tourism in the Altai region.

CONCLUSION

Our study in the low mountain zone of Altai Krai has identified and analyzed key elements of the ecological and tourist frameworks. These findings have allowed us to define the boundaries of local tourist destinations and provide recommendations for their sustainable development. Using a framework scientific approach supported by methods such as cartographic analysis, geoinformation systems, and comparative techniques, we have highlighted the importance of the natural framework in shaping the tourist framework, highlighting varying levels of protection for ecological elements.

By applying the concept of an ecological framework, we created a schematic map for the region, demonstrating how high-altitude mountain areas act as barriers to the development of tourism infrastructure and define destination boundaries. These areas also serve as linear components of the ecological framework. Our analysis of the tourist framework revealed several local destinations with key attractions crucial for economic growth, particularly linked to the Chuysky Trakt federal highway, fostering interregional cooperation. Through unique methods, we developed a numerical model and an entropy measure map that showcases landscape diversity, correlating the cores of the primary tourist destinations with areas of heightened numerical entropy. This model helped to define destination boundaries and establish functional zoning. Effective planning of tourist infrastructure requires a deep understanding of the ecological framework, influencing tourism accessibility, community participation, and destination competitiveness in domestic and international markets. The structure of the tourism framework is pivotal for achieving harmonious and sustainable development.

Author Contributions: Conceptualization, N.Ye.R. and A.N.D.; methodology, A.N.D.; software, E.V.R. and A.K.V.; validation, A.N.D. and E.V.R.; formal analysis, A.K.V. and A.N.D.; investigation, A.N.D. and N.Ye.R.; data curation A.K.V. and A.N.D. and N.Ye.R.; writing - original draft preparation, A.K.V.; writing - review and editing, A.N.D. and N.Ye.R. and A.K.V.; visualization, E.V.R. and A.N.D. and A.K.V.; supervision, A.N.D. and N.Ye.R. and E.V.R.; project administration, A.N.D. All authors have read and agreed to the published version of the manuscript.

Funding: Not applicable.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study may be obtained on request from the corresponding author.

Acknowledgments: The research undertaken was made possible by the equal scientific involvement of all the authors concerned.

Conflicts of Interest: The authors declare no conflict of interest.

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Article history: Received: 16.03.2024 Revised: 23.05.2024 Accepted: 17.06.2024 Available online: 28.06.2024