BILINGUAL PUBLISHING GROUP

Research in Ecology
https://journals.bilpubgroup.com/index.php/re

COMMUNICATION

Scientific and Practical Issues of Mapping the Ecoturist Situation on the Example of Fergana Region

Mirzakarimova Gulshanoy Mirzarakhmat kizi**, Rasulov Asror Yuldosh ugli, Turdikulov Khusanboy Khudoynazarovich, Khakimova Kamolaxon Rakhimjonovna, Kayumov Odiljon Abduraufovich

Department of Geodesy, Cartography and Cadastre, Fergana State Technical University, Fergana 150100, Uzbekistan

ABSTRACT

Ecotourism is one of the fastest-growing sectors globally, playing a crucial role not only in economic development, job creation, and improving living standards but also in ensuring ecological balance and sustainable development. The Fergana region, with its diverse natural landscapes, historical and cultural heritage, and recreational opportunities, represents one of the most promising areas for the expansion of ecotourism in Uzbekistan. Therefore, this study focuses on identifying the ecotourism resources of the region, classifying them into categories, developing a territorial typology, and visualizing them through cartographic approaches. The research methodology was based on ArcGIS software and modern GIS technologies. Statistical data, existing general and thematic maps, and remote sensing materials were integrated into a unified cartographic database. Using analytical, synthetic, and complex cartographic methods, the ecotourism resources of the Fergana region were classified into high, medium, and low-potential categories. As a result, natural-geographical complexes such as deserts, foothills, mountain steppes, and forest zones, along with historical-cultural monuments and service infrastructure, were systematized and mapped. Furthermore, theoretical and methodological foundations were developed for the creation of the "ECO FERGANA" mobile application, which aims to provide interactive access to ecotourism sites and routes. The findings demonstrate that GIS-based cartographic

*CORRESPONDING AUTHOR:
Mirzakarimova Gulshanoy Mirzarakhmat kizi, Department of Geodesy, Cartography and Cadastre, Fergana State Technical University, Fergana 150100, Uzbekistan; Email: mirzakarimovagulshanoy7@gmail.com

ARTICLE INFO
Received: 17 May 2025 | Revised: 29 May 2025 | Accepted: 25 August 2025 | Published Online: 21 November 2025
DOI: https://doi.org/10.30564/re.v7i5.10061

CITATION
Mirzarakhmat kizi, M.G., Yuldosh ugli, R.A., Khudoynazarovich, T.K., et al., 2025. Scientific and Practical Issues of Mapping the Ecoturist Situation on the Example of Fergana Region. Research in Ecology. 7(5): 268–275. DOI: https://doi.org/10.30564/re.v7i5.10061

approaches are highly effective in assessing and visualizing the ecotourism potential of the Fergana region. The results contribute significantly to expanding ecotourism opportunities, improving tourism infrastructure, and enhancing the competitiveness of the region in both national and international tourism markets. The scientific novelty of the study lies in the comprehensive application of modern GIS technologies and cartographic modeling to evaluate, classify, and present ecotourism resources in an innovative way.

Keywords: Ecotourism; Recreation Networks; Cartographic Basis; Modeling; Methods; Techniques; Ecological Data; Generalization

1. Introduction

In the world, ecotourism has become a global activity that knows no political, ideological, geographical, or cultural boundaries. Today, special attention is paid to scientific research on the use of the recreational-tourist, resource, and recreational-tourist potential of the region, as well as the creation of promising programs for the development of ecotourism based on territorial organization and comprehensive assessment. In this regard, for the purposes of ecotourism, it is important to assess natural and socio-economic geographical conditions, identify their types, develop regionalization, and increase and develop ecotourism opportunities [1]. In the world, more and more geospatial data is used, and today the creation of promising programs for the development of ecotourism based on a comprehensive assessment of the use of recreational and tourist, resource and ecotourism potential of the region, as well as territorial organization, is being modernized worldwide. In this direction, it is important to effectively use the capabilities of information and communication technologies, which are rapidly developing day by day, as well as to obtain, process, and disseminate information quickly and easily by transferring open data posted on the Internet to an interactive dynamic map.

With the rapid development of the ecotourism sector and tourism in our republic, the role and demand for maps of tourist destinations and routes intended for recreational purposes are also increasing significantly. The essence of such maps, the diversity of topics that can be depicted on them, as well as their content and equipment, are of particular importance. In this regard, one of the most important issues in the comprehensive study of the theoretical, methodological, and practical aspects of tourism development is the conduct of modern cartographic research [2].

2. Materials and Methods

In our republic, the ecotourism sector is one of the strategic sectors ensuring the accelerated development of regions, the creation of new jobs, increasing the income and living standards of the population, and the investment attractiveness of the country, and comprehensive measures are being implemented for its development. According to the 35th goal of the New Uzbekistan Development Strategy for 2022–2026, within the framework of the "Travel around Uzbekistan" program, important tasks have been set to increase the number of local tourists to more than 12 million and bring the number of foreign tourists visiting the republic to 9 million. In this regard, the use of existing natural (relief, climate, inland waters), historical and cultural (monuments, pilgrimage sites, crafts), socio-economic (economic and tourist infrastructure), ecological (climate disadvantage, air and water pollution index) opportunities of the regions for ecotourism purposes, assessment and development of a typology of ecotourism potential (highest, highest, medium, low) using the example of the Fergana region, and mapping based on the ArcGIS program of GIS technology are of great importance for each type of scientific research aimed at identifying factors that have a positive and negative impact on the development of recreational and tourist activities [3,4].

The scientific and practical significance of mapping the ecotourism situation is growing day by day. In particular, the system of analytical and synthetic maps, which are considered cartographic regularities, complementing the content and information of ecotourism sites, ecotourism objects or their regionalization, such maps created on socio-ecological topics are distinguished by their visualization.

Special thematic ecotourism maps are classified into three types based on their content, function, and type of

use: general geographically targeted, and practical maps. There are not many ecotourism maps, and very few are devoted to the theory and practice of ecotourism maps. In this case, specific studies are devoted to various problems, and the issue of generalizing the experience of map creation is considered together.

All source data used for mapping by modern methods, including statistical data, general geographic and thematic maps, remote sensing materials, etc., form a single digital environment in the cartographic database, allowing for any automated processing. This approach ensures the implementation of editing and mapping processes, as well as the implementation of modeling.

Most importantly, this includes the work performed by geoinformation systems related to databases, that is, the collection and sorting of data, the interrelation of mapping objects with spatial attributes, spatiotemporal generalization of data, interpolation of fields and time intervals, and primary data processing when restoring missing data. For this purpose, a methodology for creating maps of ecotourism sites and ecotourism resources of the Fergana region has been developed based on improving the methods of creating maps based on geoinformation systems (**Figure 1**).

Figure 1. Methodology for creating maps of ecotourism sites and ecotourism resources.

In general, mapping (carting, mapping) is the process and set of methods for creating geographical maps. Field mapping (surveying natural phenomena and socio-economic objects on the ground) and laboratory (cameral)

mapping (field mapping and processing of other sources of information, including previously created maps) are distinguished [5].

According to the degree of generalization, the following are distinguished: analytical mapping, i.e., creating a generalized or less generalized map of a phenomenon (for example, air temperature); synthetic mapping, in which synthetic maps, as well as series of analytical and complex maps, are created based on the combination of many specific indicators; complex mapping is the multifaceted representation of natural and socio-economic phenomena on geographical maps, taking into account their interrelationships [5].

Systemic mapping deals with the creation of new maps based on a systematic approach to geographical objects as a system, i.e., a whole, consisting of various, but interconnected elements; it deepens the description of individual components of territorial systems, intercomponent connections, their structure, functions, and dynamics.

Thematic mapping includes the creation of special maps (geological, soil, climatic, agricultural, etc.) and belongs to the exact sciences by subject. In addition, all types of mapping are grouped by method (surface, aerospace, and underwater), scale (large scale— 1:100000, medium scale— 1:200000–1:500000, small scale— 1:1000000 and smaller), degree of automation (manual, automated or interactive and automatic), operationality (basic and operational), and other criteria [6].

Complex mapping uses 3 ways:

- preparation of a complex of different, but interconnected geographical maps (a single collection) for one territory (for example, complex atlases);
- creation of a series of closely related, programmatically coordinated maps (for example, geological maps - stratigraphic, geomorphological, mineral, hydrogeological maps, often supplemented by Quaternary deposits, etc.);
- creation of complex maps depicting several interconnected phenomena together, each with its own indicators [7].

The scientific and methodological principles of creating ecological maps are based on the following:

1. Studying the essence and characteristics of the depicted events and phenomena.
2. Determining the characteristic views of objects and their sections and the cartographic representation of the boundaries between them.
3. Selecting cartographic representation methods that perfectly reflect the nature of objects.
4. Studying events and phenomena and developing generalization methods for them.
5. Determining the relationship of the object depicted on the ecological map with other natural objects and developing ways to place special content on the basis of when creating maps based on them [8].

In addition, the identification of connections between natural networks and the correct interpretation of this information, the coordination of maps with different content, etc., are also included in the list of methodological requirements.

Several methods are used in creating ecological maps. The most common is the localization method, that is, the representation of data in three-dimensional space. In this case, existing natural boundaries - relief objects, geological structure, hydrogeological networks, etc. These are used, and based on them, discrete objects are placed at the base. The method of intropalation allows not only to describe quantitative phenomena, but also to describe discrete phenomena in a field. The widespread use of aerospace images in creating natural maps is the basis for including the decoding method among the scientific methods of map creation. The next method is the generalization method, which is not only the method of creating maps, but also the main feature of all maps. In the generalization method, the main events and phenomena are selected, they are exaggerated, and secondary, unnecessary objects removed from the map. In addition to the above methods, the similarity method is also used in map creation. When compiling natural maps with complex content, all the above-mentioned methods are used together [9].

3. Results and Discussion

It is impossible to directly carry out recreational and tourist activities in any natural conditions. For this, it is necessary to assess the natural conditions of the territories from the point of view of ecotourism. Indicators of optimal

natural conditions, climate, water, flora and fauna, ecological and political stability of the territory are also considered the main criteria for assessment. Accordingly, in order to increase the tourist and recreational potential of the Fergana region, based on the share of territories in the total potential, directions were classified by ecotourism-ecological, historical-cultural-geographical, service-geographical tourist objects and territories (**Figure 2**) [10,11].

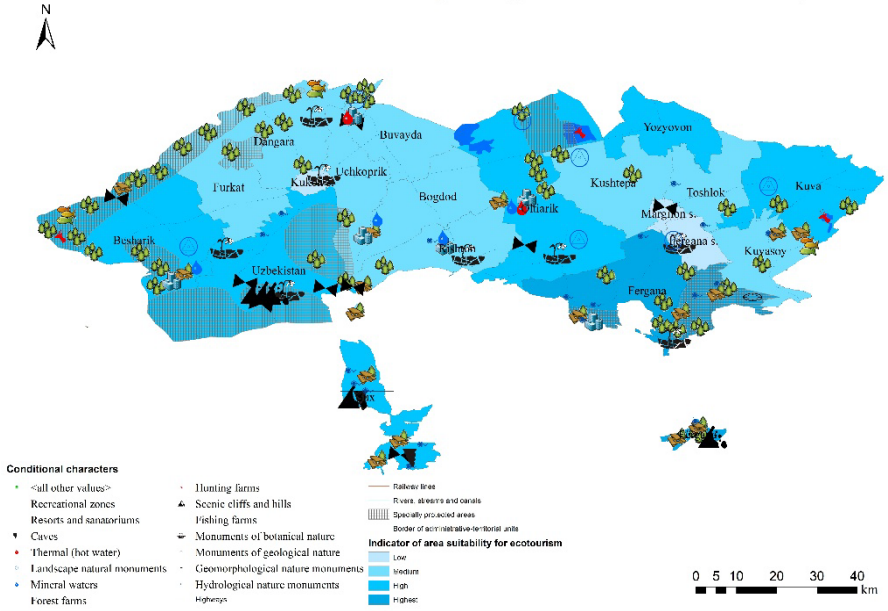

Figure 2. Map-scheme of the tourist and recreational potential of the Fergana region.

Hotels and guests houses (hotels are mainly located near major transport routes); Tourist attractions (interesting and unique parts of natural and natural anthropogenic geocomplexes); Restaurants, canteens, cafes and bars; Recreation areas (tennis courts, viewing areas, wildlife enclosures, etc.); Shops; Special ecological walkways (special ecological walkways are organized to introduce vacationers and tourists to the nature of national parks. Their routes include the most interesting, scenic, and unique natural objects, as well as historical and archaeological monuments); flora and fauna listed in the Red Book; protected natural areas [12].

To create ecotourism and tourist maps, various natural and natural-anthropogenic geocomplexes formed in a specific area are comprehensively studied. For example, the structure of the territory and geocomplexes of the Fergana region is quite diverse and unique. Changes in climatic conditions on various hypsometric surfaces have led to the formation of such geocomplexes as plain-desert, foothill-desert, mountain-steppe, and high-mountain-forest in this area.

When organizing tourism or sightseeing, the natural, cultural-ethnographic, and historical objects or territories within the area are studied. When depicting selected objects and territories on the map, it is advisable to consider all their characteristics and tourist opportunities.

It was established that the objects of cultural heritage in the Fergana region are not as complex in one place as in the Samarkand, Bukhara, and Khorezm regions, but 422 objects, despite their small area, are scattered. In the Fergana region, 6 types of mixed tourist routes have been improved through the integrated use of natural and socio-economic factors. Relations between the service sector and tourism are very weak, the share of the tourism sector in the region's economy is not felt, and it is necessary to strengthen cooperation between them.

In the city of Kokand, Margilan, Rishtan, Chimgan and Vodil (Sokh (Kyzyltepa sanatorium), Shakhimardan (Culture) and Sokhsuv) in areas rich in ecotourism and recreational resources, it is advisable to create a mobile application for route routes on an online interactive map based on public-private partnership for medium and small facilities (hotels, guest houses, campsites, motels, sanatoriums, rest homes, children's camps, cafes and restau-

rants, sanitary and hygiene points, trade and transport services) [13].

4. Conclusion

Targeted studies have shown the expediency of creating tourist plans, maps, and atlases based on modern GIS technologies. At the same time, systematic maps and plans should be implemented to provide tourists, vacationers, and managers with the necessary information. He noted that to achieve the aforementioned effectiveness, it is first necessary to develop a project of ecotourism maps and plans. When implementing the project of tourist maps and plans, the project of territorial cartographic work systems, depending on their scale and purpose, the following were presented and scientifically substantiated:

In general, Uzbekistan is rich in all resources for the development of ecotourism and ranks 15th in the world in this regard. Ecotours organized in our republic should be guided by the following principles:

- ❖ prioritization of environmental protection and sustainable development issues and their reflection in ecotourism directions;
- ❖ environmental and socio-economic interests underlie ecotourism;
- ❖ development of ecotourism in connection with historical, cultural and other types of tourism;
- ❖ state and local government bodies, public interest in ecotourism;
- ❖ The necessity of forming national pride in preserving and developing the homeland.

The goal of the development of ecotourism is:

- ❖ Demonstration of Fergana's ecotourism potential, natural potential, and resources in the global and national tourism services market;
- ❖ stimulating scientific research aimed at more effective use of ecotourism resources and opportunities of territories, especially nature, geosystems;
- ❖ increasing the importance and share of ecotourism in the development of tourism;
- ❖ Fundamental improvement of the quality of ecotourism services and accelerated increase in the volume of ecotourism services in tourism activities implemented in Fergana;
- ❖ It is necessary to create scientific, innovative, and methodological developments aimed at developing ecotourism in the future [14–18].

Taking into account the above, the compilation of complex tourist maps of the region at scales of 1:200000 and 1:500000 is based on the above. The development of maps of this scale for the region fully meets the requirements of the tourism industry. The area of the region is covered to the specified scale. Taking into account the area of the territory, the maps created at these scales contain information about the natural and cultural heritage sites of tourism and the system of tourist infrastructure objects as a whole. These cards allow remote access to tourist resources in the region. These cards are used in the design and development of various tourist trips, sometimes during travel, and for the purpose of visual exploration. Such cards are necessarily developed based on the IT system.

Map of ecotourism routes. Tourist route maps are compiled at a large scale. These maps are also depicted in two types according to the coordinate system: printed and electronic. These maps show the natural features of the area, historical and cultural monuments, and features of the route.

As a result of analyzing the results of research on the application of international models in the development of ecotourism in the context of Uzbekistan in the implementation of the goals and objectives of ecotourism development in Fergana, the following promising areas can be identified.

1. In the development of ecotourism in our country, first of all, it is necessary to study in detail the characteristics and definitions of international models for the development of ecotourism, the goals and objectives of these models, and the work carried out on them.
2. It is necessary to study in detail the objects of application of international environmental models in the development of ecotourism in our country.
3. At the state level, it is necessary to develop legal and regulatory documents for the use of specially protected areas and nature reserves, national parks in the development of ecotourism.

4. In the development of ecotourism, the ecotourism resources and objects of our country are divided into levels of international and domestic tourism, and the possibilities of using these objects in ecotourism are studied.
5. One of the most important issues in the development of ecotourism is the lack of tourist infrastructure in these places, since the resources of ecotourism are located at a considerable distance from cultural centers. Therefore, one of the priority tasks is the creation of an infrastructure system and services for ecotourists in specially protected areas, state nature reserves, and national parks, which is the first issue in the development of ecotourism.
6. The development of ecotourism in our country is one of the urgent issues, and the development of advertising for the application of international models of ecotourism development in this promising direction, as well as its introduction into international and domestic tourism markets, will yield expected results.
7. Another pressing issue in the development of ecotourism in the future is the need to develop preferential state decisions that ensure the interests, entrepreneurship, and initiative of the population in all regions, as well as the social and economic interests of the population.
8. Establishing the development of tourist routes to permitted ecotourism resources for the development of ecotourism in our country and promoting the advertising of these tourist routes to the international and domestic tourism markets.
9. Intensification of work on the development of international and domestic ecotourism in our country. Creation of tourist firms specializing in the development of international and domestic ecotourism in this area.
10. Comprehensive organization of ecotourism in our villages in connection with rural tourism, recreational tourism, pilgrimage tourism, and sports tourism.

Author Contributions

M.G.M.k., T.K.K.—Project Administartion, Methodolgy, Conceptualization and Validation; K.K.R.—Investigation, Resources, Data curation, Original Draft Preparatio, Writing review and Editing; R.A.Y.u., K.O.A.—Supervision, Visulization, Resources and Writing Review. All authors have read and agreed to the published version of the manuscript.

Funding

This work received no external funding.

Institutional Review Board Statement

Not Applicable.

Informed Consent Statement

Not Applicable.

Data Availability Statement

Unavailable due to privacy.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Safarov, E.Y., Abduraximov, X.A., Oymatov, R.K., 2012. Geoinformatsion kartografiya. Cholpon: Toshkent, Uzbekistan.
[2] Oymatov, R., Musayev, I., Baxriyev, M., et al., 2023. Monitoring agricultural land areas using GIS-online program EOS DA: case study of Andijan region. E3S Web of Conferences. 401, 02005. (in Uzbek)
[3] Mirzaliyev, T., Safarov, E.Y., Egamberdiev, A., et al., 2015. Atlas Kartografiyasi. Universitet: Toshkent, Uzbekistan. pp. 1–64.
[4] Reymov, P., Abdireymov, S., 2006. Geoekologicheskiy monitoring i otsenka deltovix ravnin. Turon iqbol: Toshkent, Uzbekistan. pp. 1–128.
[5] Ibraimova, A.A., 2020. Kartalarni loyihalash va tuzish. Darslik. Tafakkur tomchilari: Toshkent, Uzbekistan. pp. 1–13.
[6] Safarov, E.Y., Prenov, S.M., Urayimov, S.T., 2024. Madaniy meros obyektlarini kartaga olish hamda kar-

tografik-geodezik ta'minoti maslalari. In Proceedings of the "Geografik tadqiqotlarda zamonaviy geoinformatsion kartografiya, masofadan zondlash metodlari va texnologiyalarining roli" xalqaro konferensiya, Toshkent, Uzbekistan; pp. 156–159.

[7] Safarov, E.Y., 2010. Tabiiy kartalarni loyihalash va tuzish. O'quv qo'llanma: Toshkent, Uzbekistan. pp. 1–80.

[8] Sturman, V.I., 2003. Ekologicheskoe kartografirovanie. ASPEKT PRESS: Moscow, Russia. pp. 14–27.

[9] Musayev, I., Xakimova, K., Nuretdinova, M., et al., 2023. Qurilish maydonini kengaytirish uchun geodezik o'lchovlarning zamonaviy amaliyoti: O'zbekistondagi amaliy misol. E3S Web of Conferences. 389, 03058.

[10] Xakimova, K., Abduxalilov, B., Qosimov, L., et al., 2023. Farg'ona viloyati turistik xaritasi mazmunini takomillashtirishda GAT texnologiyalarini qo'llash. In E3S Web of Conferences, Vol. 386. EDP Sciences: Paris, France.

[11] Axmedov, B., 2023. Geodezik o'lchash va hisoblash ishlarini bajarishda o'lchash xatoliklari nazariyasi asoslaridan foydalanish. E3S Web of Conferences. 452, 03012.

[12] Marupov, A., Abdukadirova, M., Mirzakarimova, G., et al., 2023. Ma'muriy-hududiy chegaralarni raqamli texnologiyalar asosida belgilash tartibi va usuli. E3S Web of Conferences. 452, 03007.

[13] Xakimova, K., Abduhalilov, B., Ganiyev, Y., et al., 2023. Farg'ona viloyati turistik obyektlari va resurslarining "ECO FERGANA" mobil ilovasini yaratishning nazariy-uslubiy masalalari. IE3S Web of Conferences. 452, 05025.

[14] Egamberdiev, A., 2006. O'zbekistonda geografik kartografiyaning holati, muammolari va istiqbollari. Hozirgi zamon geografiyasi: nazariya va amaliyot xalqaro ilmiy-amaliy konferensiya materiallari: Toshkent, Uzbekistan. pp. 22–26.

[15] Qodirov, R.B., 2016. Farg'ona mintaqasi aholisi va mehnat resurslari. Navruz: Toshkent, Uzbekistan. pp. 1–73.

[16] Abdukhalilov, B.K., 2023. Improving the mathematical and geographical basis of ecotourism maps and the method of developing the essence of the content. International Journal of Education, Social Science & Humanities. 11(3), 1148–1155.

[17] Khakimova, K.R., Abdukhalilov, B.K., 2023. The role, importance and role of ecotourism in the development of the state in foreign countries. Texas Journal of Philology, Culture and History. 18, 51–59.

[18] Khakimova, K., Abdukhalilov, B., Qosimov, L., et al., 2023. Application of GIS technologies for improving the content of the tourist map of Fergana province, Uzbekistan. E3S Web of Conferences. 386, 04003.