Designing Educational Nature Trails for Kumis Glade Protected Natural Area

Alina S. Degteva, Andrei L. Podolsky

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Authors' credentials:
Alina S. Degteva, Master of Science in Ecology & Environmental Management, Postgraduate Student, Department of Ecology, Yuri Gagarin State Technical University of Saratov, 77 Politekhnicheskaya St., Saratov 410054, RF; PhD Student, Department of Early Childhood Education, School of Education, University of Ioannina, University Campus, Ioannina 45110, Greece (degtevaalina13@gmail.com, a.degteva@uoi.gr)

Andrei L. Podolsky, Master of Science in Environmental Studies & Economics of Environmental Management (Yale University, USA), PhD in Zoology & Ecology (North Carolina State University, USA), Division of Science & Research, V.I. Razumovsky State Medical University of Saratov, 10012, Saratov, 112 Bolshaya Kazachya St., Saratov 10012, RF (andrei.podolsky@mail.ru)
Scopus profile name: Podolsky, Andrei L.
Scopus Author ID: 6701398880

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Abstract: This article is aimed at developing the comprehensive environmental education program within the territory of the Kumis Glade Nature Park (*Kumysnaya Polyana*), using existing experience on conducting educational activities within protected natural areas. The problem of studying and developing protected areas is currently relevant, since these territories are designed to preserve the biological diversity and cultural heritage of the region, along with allowing the regions to develop steadily, giving them a large recreational resource and tourist potential. The result of our study is a comprehensive environmental education program with inclusion of educational nature trails, designed by means of geoinformation systems, passing through the territory of the Nature Park. *Kumis Glade* is of great ecological, social and recreational importance. The project of educational nature trails has a scientific and practical novelty: before the proposed developments within the *Kumis Glade*, no stationary nature trails were designed there. We designed four educational routes: Nature trail No. 1 – 6.4 km long, 2.5 to 3 hours travel time (excluding long stops); Nature trail No. 2 – 3.6 km long route, 2–2.5 hours travel time; Nature trail No. 3 – 5.7 km long path, travel time is about 3 hours; Nature trail No. 4 – 5.5 km long route, travel time ranges from 2.5 to 3 hours. The trails are quite accessible: they have access roads; most of the time, they do not run along steep ascents and descents. The routes cross different types of terrain, landscape complexes and ecosystems, which was ensured by planning trails not only on the plateau, but also on the slopes facing various directions, and along the bottom of ravines; as well as by running through both forested and open areas, such as grassland patches and forest edges. The development of environmental education projects, associated with nature trails, solves the problems of environmental education, environmental ethics and environmental culture of the population, along with organization of active and cognitive leisure and environmental protection.

Keywords: educational nature trails, protected natural area, Nature Park, environmental education, environmental management, natural ecosystems.

Introduction

Study goal

Environmental education is an important field of activity for any officially designated by the Russian Government *specially protected natural area* (SPNA). One of the most important SPNA in Saratov Oblast is the

Kumis Glade Nature Park (*Kumysnaya Polyana*) [1]. The process of shaping the environmental awareness of the population is long and complex, and therefore, environmental education should be given considerable attention by employees of SPNA, bodies of public and private specialized services, and volunteer initiative groups [2].

The problem of studying and developing protected areas is currently relevant, since these territories are designed to preserve the biological diversity and cultural heritage of the region, along with allowing the regions to develop steadily, giving them a large recreational resource and tourist potential. Understanding the role of SPNA in the face of an increasing technogenic impact is the condition for maintaining the socio-ecological sustainability of the region in the present and in the future.

The information obtained in the course of developing environmental protection measures may contribute to creating an innovative model of a scientifically grounded and integrated version of the tourist use of the Kumis Glade Nature Park. A comprehensive environmental education program, linked to nature trails, has environmental, social, and recreational significance. The project of educational nature trails has a scientific and practical novelty: before the proposed developments within the *Kumis Glade*, no stationary nature trails were designed there [3].

The object of our research was the Kumis Glade Nature Park. The subject of our research included educational activities within this SPNA. The goal of our project was to develop a comprehensive program of environmental education activities on the territory of the Kumis Glade Nature Park, based upon existing experiences and new developments.

Environmental education: International and Russian experiences

Environmental education is an interdisciplinary field that brings together biological and chemical sciences, physics, mathematics, geography, ecology, and Earth sciences. Sometimes understood as education in the primary school system, the term encompasses all efforts to educate the public and other audiences, including printed materials, websites, and media campaigns. There are also ways of conducting environmental education outside the classroom: aquariums, zoos and nature centers have every opportunity to familiarize the community with its natural environment [4].

The modern movement on environmental education spread in the late 1960s and early 1970s, which was associated with active research and nature conservation activities. In 1962, Rachel Carson's book, *Silent Spring*, was published, which described the negative consequences of environmental impact [5]. Public concern for human health and health of the natural environment lead to the emergence of a phenomenon known as *environmentalism* – the ideology of environmental protection [6].

The fundamental principle of the international standard for environmental education involves '*education about the environment, through the environment and for the environment*', which could be implemented by combining training and recreational activities in the course of walking along the specialized nature routes – educational nature trails [7]. Educational nature trail is a specially designed hiking path running through a natural area; along the route, marked stations are organized, as a rule, located near objects of natural, technological or cultural interest [8]. Stations are informative by their nature, they provide information, for example, on the flora and fauna, soils, geology, ecology, and history of the area. Long trails, linking together widely spaced natural phenomena or structures, and having strong thematic content, can be called *theme trails*, or *themed walks*. The goal of nature trails is to expand information about objects, processes and environmental phenomena, which sometimes is associated with tourism and recreation. The stations often implement creative and interactive ways of getting to know nature [1, 8].

In the international community, environmental education has a high status: teaching *nature* is carried out at different levels and using contemporary methods; in ecologically developed countries, methodological recommendations are used that call for educating the population, first of all, through field observations and research. At the same time, educational nature trails constitute one of the components of quality education [9].

Currently, in Russia, a project-based approach is often applied to environmental education. Domestic education about the environment is undergoing

changes: international standards are beginning to be applied in the national educational system. The technology of the project approach in environmental education system involves the transfer of knowledge and skills through solving practical problems in nature. As an example of domestic organization conducting research in the environment for secondary school students, we consider the experience of the Eurasian Association of Environmental Youth NGOs *Ecosystem* – an informal public association of teachers. Since 1994, the association has been registered as a public non-profit educational organization. To the present day, *Ecosystem* is a methodological center focused on working with educational institutions and public organizations, as well as teachers of secondary schools and instructors of extracurricular education with specialization in natural science [10]. International programs run by *Ecosystem* include environmental education trips of Russian school students to the United Kingdom, joint Russian-American field trips and the courses taught in cooperation with Montana State University, USA, as well as distance education courses in field ecology [11].

The project approach to environmental education in Saratov Oblast is successfully applied at Khvalynsky National Park. The national park was established in 1994 as an environmental, scientific, ecological and educational institution that forms environmental awareness of the population and promotes knowledge about wildlife and the local lore [12]. The project for the implementation of environmental and educational activities at protected natural areas follows the guidelines of the *Concept of Long-Term Socio-Economic Development of the Russian Federation for the Period up to 2020* (Order of the Government of the Russian Federation from November 17, 2008, No. 1662-r), specifically its third task: '*Community-based education and patriotic education of youth, promoting the development of legal, cultural and moral values among youth'*, as well as the goals and areas of environmental safety of the economy and human ecology, specified in this document [13].

The theory of designing educational nature trails

Designing educational nature trails at protected natural areas is a complex task requiring specific knowledge in humanities (information support of the trail, the specifics of working with various groups of visitors), technology (arrangement of a pathway, manufacturing and installation of information stands and signs) and design (trail architecture). The regulatory framework, which can be relied upon in the design, does not currently exist, with the exception of some foreign and domestic methodological recommendations [3, 9]. When developing a project on educational nature trails, one can use the methodological recommendations by the team of American authors: S. Trapp, M. Gross, and R. Zimmerman, published in 1994 [9]. The recommendations were written by specialists in different fields of knowledge – environmental education, landscape design, and management, which allowed us to consider constructing nature trails from different points of view.

Educational nature trails solve the problems of educating the public, teaching and fostering ecological culture – that is, they contribute to the implementation of environmental and educational goals. Also, nature trails have nature conservation goals: the flow of visitors is regulated along the routes, and their traffic is distributed in directions relatively safe for the environment. Additionally, the trail provides the possibility of observing the nature conservation regime in a certain area, as it facilitates control over the number of visitors and the implementation of the rules established at protected natural areas [14, 15].

Walking along educational nature routes contributes to the expansion of elementary information about objects, processes and phenomena of surrounding natural environment. Tourists on the trail learn to notice various manifestations of the anthropogenic factor, acquire the skills of a comprehensive environmental assessment. Recreation is also important: tourists both learn and satisfy their recreational needs on the route [16].

Nature trails can be linear, semi-circular, circular, or radial (in the latter case, the way forth and back follows the same path). From the point of view of landscape perception and information acquisition, the first three types are preferable to the fourth. The trails are also distinguished by the difficulty of terrain and the level of complexity of offered information. It often makes no sense to classify trails by age groups they are designed for: it is obvious that the routes for the younger age group, as well as for senior visitors, should be shorter and easier to walk than for the young adults or a middle-aged public. When creating nature trails, it is necessary to focus

on an average visitor, while developing options for educational tours for different categories of tourists [17].

The main criterion for the classification of trails is what exactly they are designed for. Hence, there are (1) cognitive walking routes, (2) educational tourist routes, (3) environmental education routes and (4) specialized trails (i.e. trails for visitors with special needs). Cognitive walking trails have an average length of 4–8 km. Tourists, accompanied by a guide, get acquainted with the natural and architectural sights of the area along the route. The length of educational tourist trails can reach several hundred kilometers. Such routes are usually laid in the protected zones of reserves and in the tourist zone of national parks. The trail can take up to several days or more to walk; the safety of tourists on this type of route is a priority task for the management of protected areas. Tourists should be familiar with the rules of conduct in nature, with safety precautions [18]. Environmental education trails are specific routes for the implementation of environmental education. Such trails are short, with their length rarely exceeding 2–3 km, since the passage of the training route should not take plenty of time. These trails are designed primarily for the category of school and university students.

In order to preserve the natural environment and ensure the comfort of tourists, the participants of a field trip must obey certain rules. The main ones involve a ban on plucking any terrestrial and aquatic plants and removing natural components from the path: stones, tree branches, etc. Noisy behavior on the trails is also prohibited, since it causes disturbance to the representatives of the fauna. In the zone of the nature trail, fires can be made only in designated places; only dead wood may be used for fuel [19]. It is crucial to post a complete list of the rules of conduct in the natural environment at the very beginning of the nature trail.

Thus, the design of educational nature paths is a complex of tasks in the humanities, technology, and natural sciences. Methodological recommendations of foreign and domestic authors allow to form a holistic vision of the project of creating nature routes as a component of education about the environment. Educational nature trails solve the problems of environmental, educational and nature conservation nature. For example, setting trails in natural environment contributes to the preservation of natural systems.

Characterization of Kumis Glade Nature Park

Kumysnaya Polyana (meaning: *Kumis Glade*) is a nature park within the administrative city limits of Saratov. Kumis Glade Nature Park was established by the order of the Government of Saratov Oblast in 2008 within the forested area of the same name. It included several natural monuments, in order to preserve the unique natural complex of the suburban forest and create conditions for out-of-town recreation and environmental education for the residents of the city of Saratov. The total area of the Kumis Glade Nature Park is 4417 ha. Elements of almost all types of ecosystems inherent, in the region, are represented on the territory of the nature park: forest, steppe, wetlands, and aquatic [20].

The seasons of the year vary in length. The shortest are spring and autumn. They have a two-phase structure and last for 2.5 months each. The spring period begins in early April and is characterized by a sharp rise in air temperature. The beginning of a stable transition of the average daily temperature through plus 10 °C to lower values is timed to the autumn period. Average annual precipitation in the region of Saratov is 496 mm. Most of them occur during the warm season. Precipitation is often of a storm nature. The cold period accounts for only 200 mm of precipitation and its amount varies greatly, depending on the year [21]. The soils under the Kumis Glade ridge retain significant reserves of groundwater discharging at the surface of the earth by many springs. Spring water flows down the bottom of ravines and forest hollows in the form of streams, forming ponds. Most of the ponds are shallow, forested and overgrown with near-water vegetation. There are also some large ponds, for example, *Andrey's Ponds* [22].

The forests of the nature park include elements – and reflect – all specific features, characteristic for deciduous forests of European Russia. Currently, the park contains a variety of oak forests, lime-tree forests, birch groves, aspen groves, maple forests, alder stands, and accompanying species of shrubs and understory: warty euonymus (*Euonymus verrucosus* Scop.) and mountain ash (*Sorbus aucuparia* L.). For a long time, the predominant type of forest stands in the park was represented by oak groves comprised

of English oak (*Quercus robur* L.) At the end of the twentieth century, mass drying of oak forests took place, and forest ecosystems from Norway maple (*Acer platanoides* L.), small-leaved linden (*Tilia cordata* Mill.), silver birch (*Betula pendula* Roth.), and aspen (*Populus tremula* L.) were formed. The forests of the nature park belong to the southernmost forests in the southeast of the European part of Russia [20].

The fauna of the natural park is rich and varied. The variety of flowering plants attracts more than 3000 species of insects, including over 50 species listed in the regional Red Data Book. There are numerous species of mammals, several species of amphibians and reptiles. According to the fifty-year bird census data, collected by one of the authors (A.L. Podolsky), from the 1970s to the present, 175 bird species were found in the Kumis Glade Nature Park (including those flying over it in spring and fall).

The most abundant breeding bird species at present are Chaffinch (*Fringilla coelebs* L.), Collared Flycatcher (*Ficedula albicollis* Temminck), Great Tit (*Parus major* L.) and Blue Tit (*Cyanistes caeruleus* L.). Their numbers are followed by those of the Song Thrush (*Turdus philomelos* Brehm), Eurasian Blackbird (*Turdus merula* L.), Thrush Nightingale (*Luscinia luscinia* L.), Yellowhammer (*Emberiza citrinella* L.), Tree Pipit (Anthus trivialis L.), and Blackcap (*Sylvia atricapilla* L.). These ten species numerically account for almost 90 % of all birds of the *Kumysnaya Polyana*. The rest of the species altogether make up just over 10 % of bird community, among them: migrating birds – such as cranes, gulls, waders, etc.; and wintering birds – such as Common Redpoll (*Carduelis flammea* L.), Eurasian Bullfinch (*Pyrrhula pyrrhula* L.), and Bohemian Waxwing (*Bombycilla garrulus* L.). The most abundant in winter are titmice, including Willow Tit (*Poecile montanus* Baldenstein); woodpeckers – mainly, the Great Spotted (*Dendrocopos major* L.); Eurasian Siskin (*Carduelis spinus* L.), Eurasian Goldfinch (*Carduelis carduelis* L.), and Eurasian Nuthatch (*Sitta europaea* L.). Within Kumis Glade, four bird species from the Red Data Book of Saratov Oblast breed, and fourteen more are observed on migration or in winter [23].

The nature park as a whole restrains soil erosion; improves the microclimate; ensures formation of a natural earth layer – humus, and moisture circulation; forms flora and fauna; enriches the air with oxygen. The entire complex of the Kumis Glade Nature Park has an extremely important environmental, scientific, sanitary and hygienic, recreational, health-improving, aesthetic, and educational significance. On the territory of the nature park, there are health resort sanitaria, recreation centers, stationary summer camps for children, and ski rental centers. The Kumis Glade carries out some forestry operations (afforestation of steep slopes, planting of new forest crops). Work is underway to remove garbage, maintain a proper state of the springs, remove some deadwood, equip recreation sites, and protect forests. Thus, the Kumis Glade Nature Park has enormous educational and recreational potential. A large number of diverse plant and animal communities, water resources, interesting for the study and implementation of educational programs, prevail on the territory of the nature park [1, 20].

Methods, Results and Discussion

Creating GIS map of Kumis Glade Nature Park

MapInfo Pro is a fully functional geographic information system (GIS) designed for collecting, storing, displaying, editing, and analyzing spatial data [24]. With its help, the map of the Kumis Glade Nature Park was modeled. The map shows the Landscape elements of the designated area are presented in Table. The initial map (base map) was the map of the Kumis Glade Nature Park, developed by the Orientation and Tourism Club *Orient* in 1998 [25], presented in Figure 1. In the course of our work, layers were alternately superimposed on the original map, each of which displayed one of the landscape elements present in the area.

The largest area on the map is occupied by green spaces, i.e. forest (Figure 2). Then, the following layers were added to the map: *garden_plots*, *glades*, *recreation_centers_childcamps*, *water_bodies*, *individual_buildings* (Figure 3). Landscape elements *city*, *paved_roads*, *forest_roads* were overlaid on the map in layers last (Figure 4). The map of the Kumis Glade Nature Park with the inclusion of all layers, displaying landscape elements, is shown in Figure 5. After creating a map, displaying existing landscape elements, we determined the frequency of occurrence of the latter in areas of the territory. To do this, we split the map into squares, in each of which we counted the number of landscape elements (Figure 6). This procedure created a new map layer called *elements*. The color gradient (lemon yellow

to dark red) in Figure 7 determines the frequency of occurrence of landscape elements in each square. At the last stage of modeling, the Kumis Glade Nature Park map looked like it does in Figure 8.

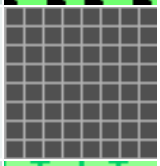
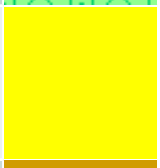
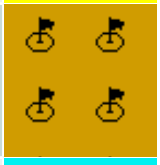
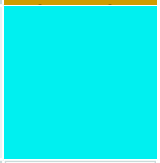
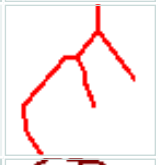
Using the created map, we can judge the sustainability of the natural community and to evaluate the anthropogenic impact on the nature park. To assess the sustainability of the natural community, it is necessary to analyze the frequency of occurrence of landscape elements in the areas (broken down into squares) of the territory of Kumis Glade Nature Park (Figures 10 and 11). Thus, the largest number of landscape elements – six – is found in squares H9, H10, L8, O14, P3, P19, AA12. On these sites, objects of human activity border the forest: recreational centers, garden plots, summer camps for children. Five of the seven above-mentioned squares are located on the border of the nature park with the city boundary, while two squares, O14 and P19, are located in the center of the nature park; a paved road passes through the sections, running through the main centers of anthropogenic impact.

Five landscape elements are found in fourteen squares (G10, H11, J14, K8, L17, M4, M5, O13, O19, P14, P15, Q15, S4, T19). Of these, seven squares are located at the junction with the city limits, seven more are situated near the center of the Kumis Glade, where the main socioeconomic facilities are located. The squares with 4, 3, 2 or 1 landscape elements are distant from the center of the nature park and its borders with the city, and lie mainly within the boundaries of undisturbed forest patches.

We can state that the area in the center of the nature park, where there are camps for children, a radio tower, and where the paved highway goes through, as well as the forest area along the border with the city, are much darker than the adjacent squares and include the largest the number of landscape elements. The lightest areas of the forest park are areas with the least amount of landscape elements. Such zones are located in undisturbed forest, where anthropogenic impact is minimal or absent, and networks of ravines and gullies are located (Figure 8).

The role of ecotone sites (transition zones) in biodiversity conservation decreases as the anthropogenic impact increases. Thus, growing urbanization affects the sustainability of the forest plant and animal communities. The ecotone strip is an important element of natural systems, but at the same time it is now becoming a part of urban ecosystems, which negatively affects the natural functioning of the nature park. As an element of the urban ecosystem, the

TABLE.
Landscape Elements on Created Map of Kumis Glade Nature Park

No.	Landscape elements (layers) as they are called in MapInfo	Symbols
1	Forest	
2	City	
3	Garden_plots	
4	Glades	
5	Recreation_centers_childcamps	
6	Water_bodies	
7	Individual_buildings	
8	Paved_roads	
9	Forest_roads	

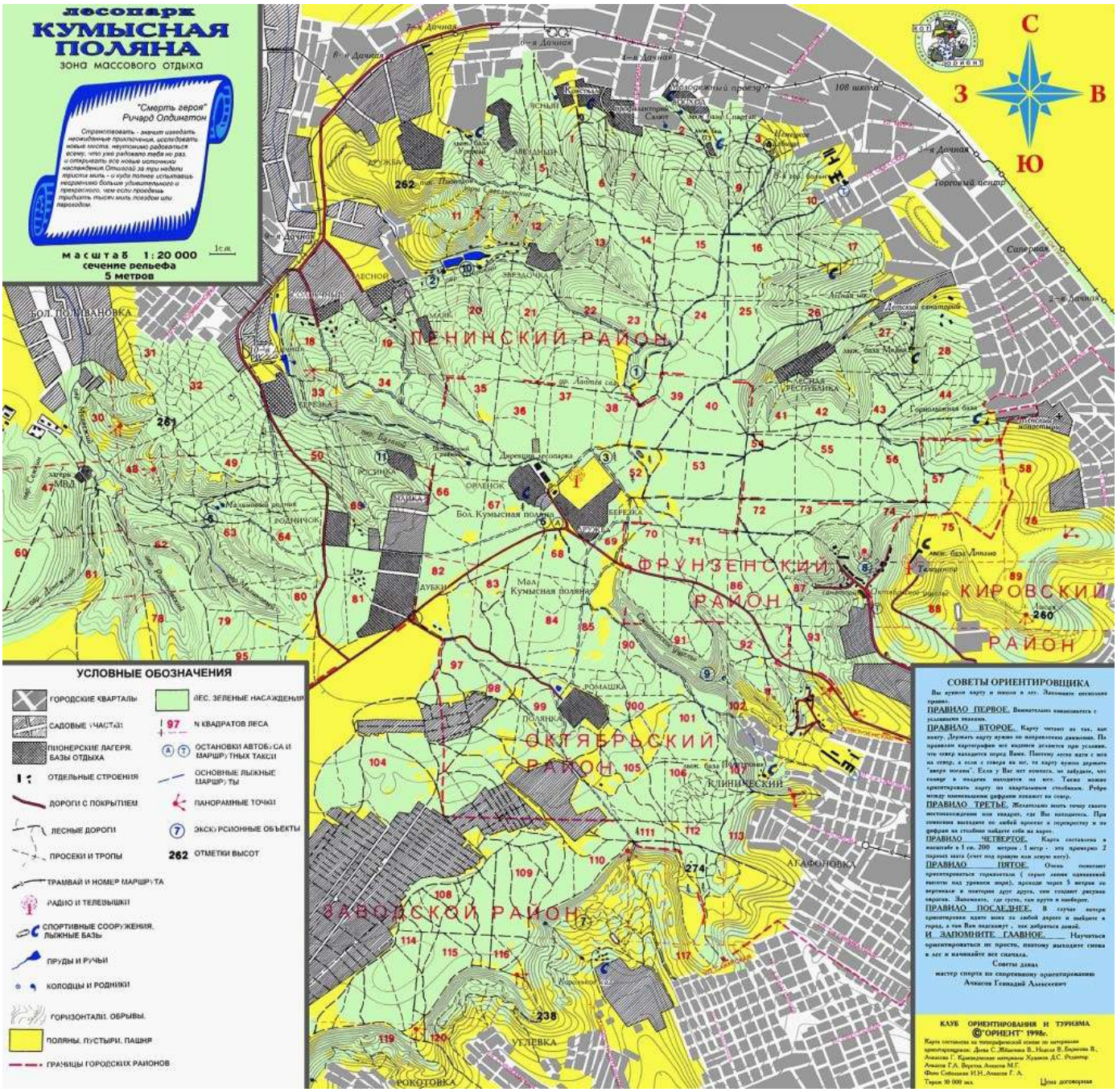


Figure 1. The base map of the Kumis Glade Nature Park developed by the Orientation and Tourism Club Orient in 1998 [25]

ecotone community is not stable, and in this case, using the case-study of the Kumis Glade, one can trace an example of the positive development of a more homogeneous environment – a forest as an undisturbed zone.

Provided that the intensity of anthropogenic impact is maintained, the Kumis Glade Nature Park is subject to serious environmental hazards. With the expansion of economic activity, an increasing number of undisturbed forest zones are being lost. The Kumis Glade is a unique natural monument, which should provide it with protection from construction operations (except those with a social or recreational value), littering, clear-cutting, and any kind of external interference. Protecting the ecosystems of the nature park would preserve the stability of the most important component of the natural environment in

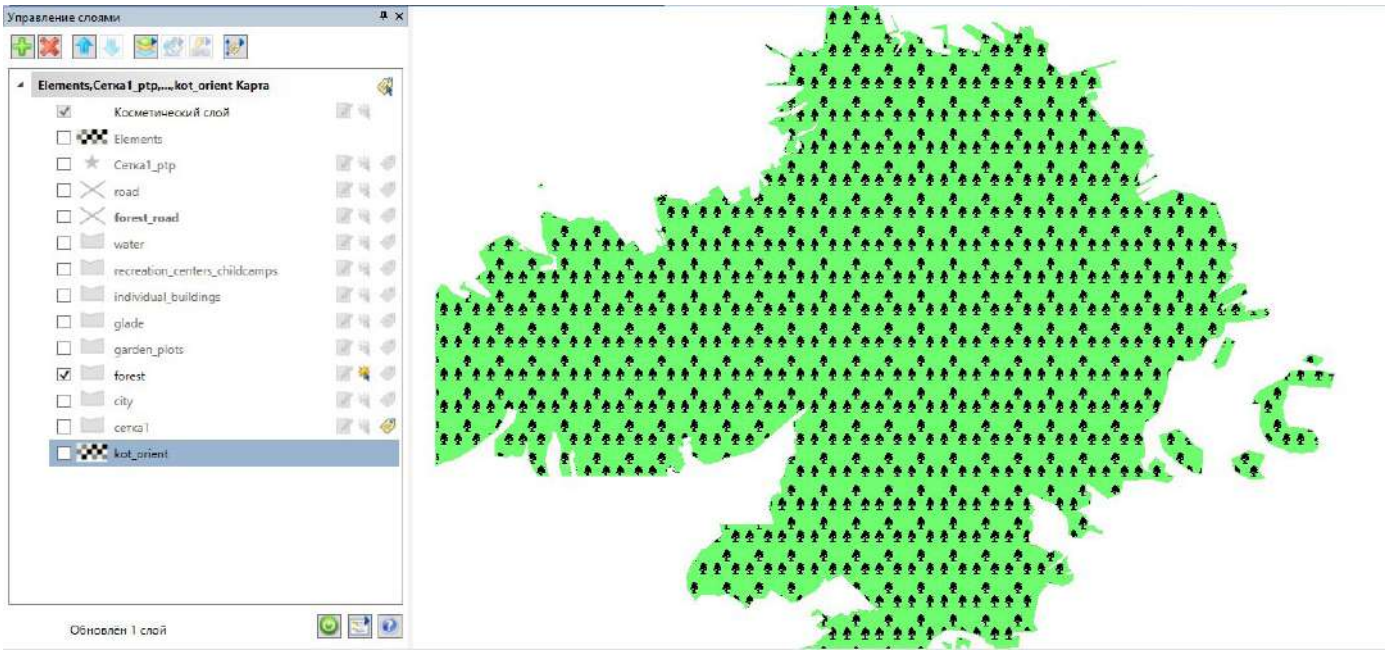


Figure 2. Screenshot of the forest layer in MapInfo Pro GIS

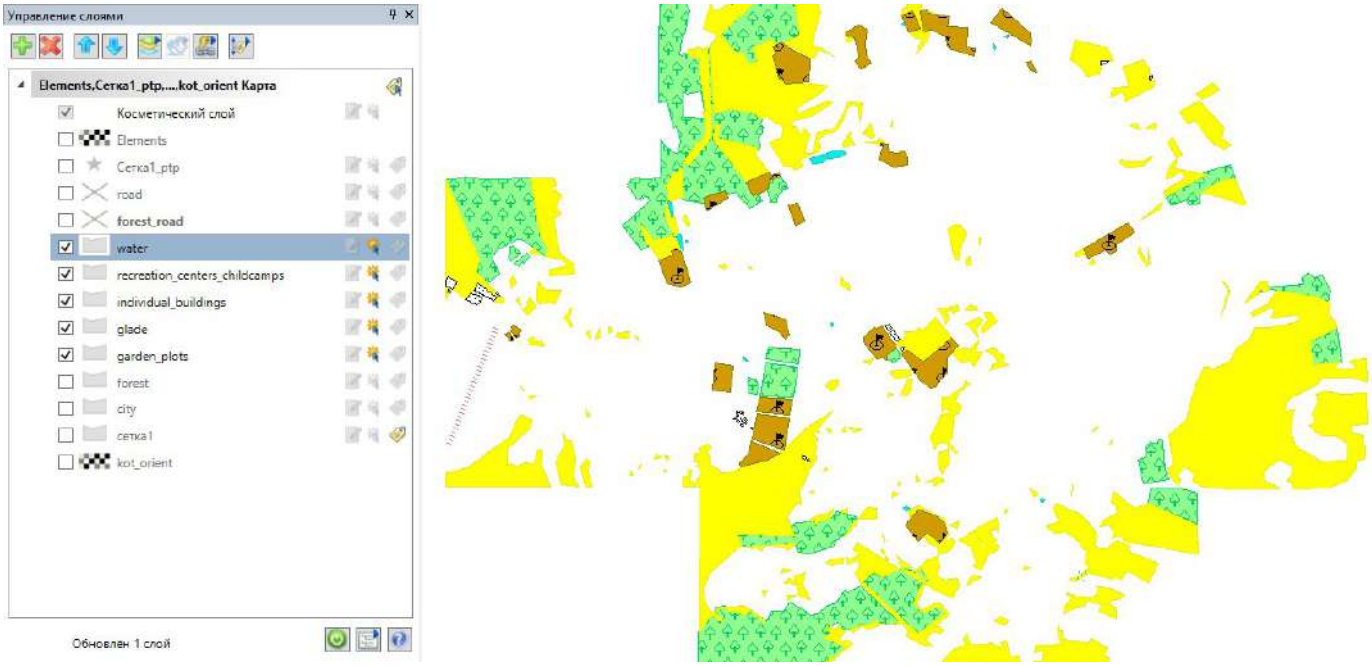


Figure 3. Screenshot of the *garden_plots, glades, recreation_centers_childcamps, water_bodies*, and *individual_buildings* layers in MapInfo Pro GIS

the region. Currently, the nature park faces a serious threat of urbanization, which negatively affects the functioning of its biota. By creating a map in the GIS MapInfo Pro, the most stable zone of the Kumis Glade was identified – an undisturbed forest, and the least stable zones – ecotone communities. The conducted research may allow creating a model of reasonable human behavior and attitude in relation to the Kumis Glade Nature Park, which could preserve the biodiversity in the nature park.

Educational nature trails

We designed four educational nature trails within the Kumis Glade Nature Park, described in some detail below.

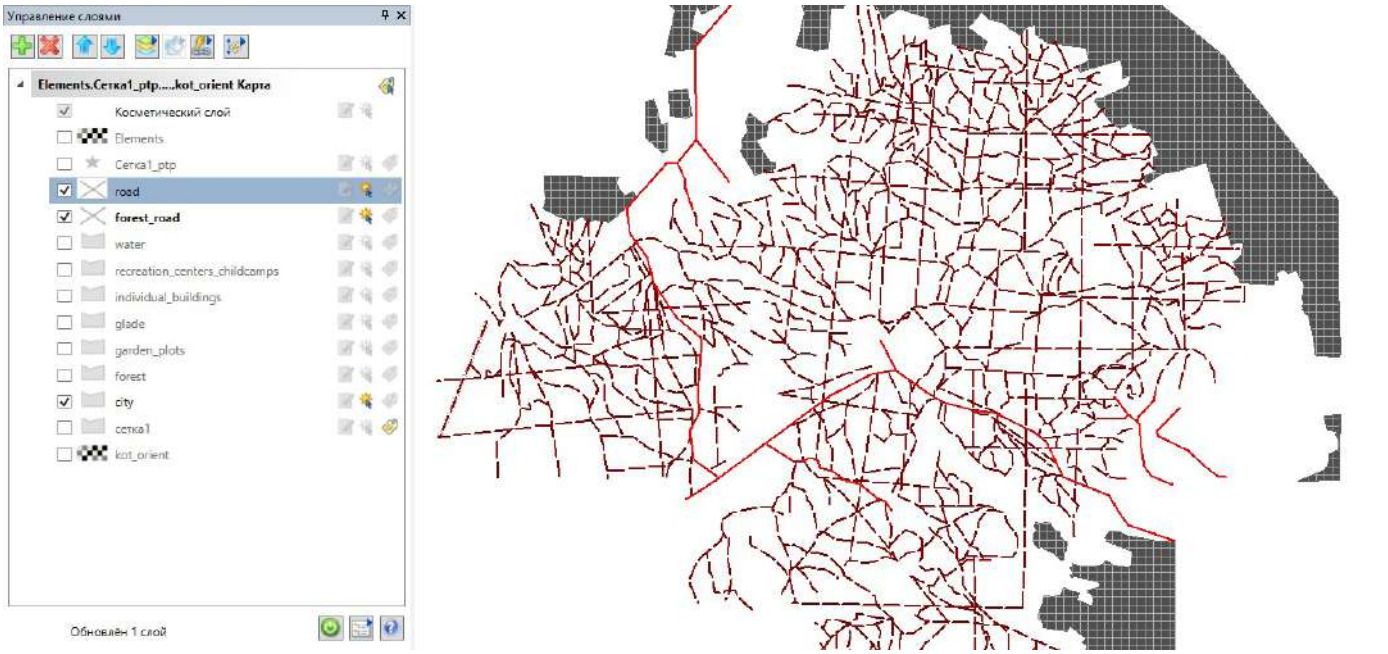


Figure 4. Screenshot of the *city, paved_roads,* and *forest_roads* layers in MapInfo Pro GIS

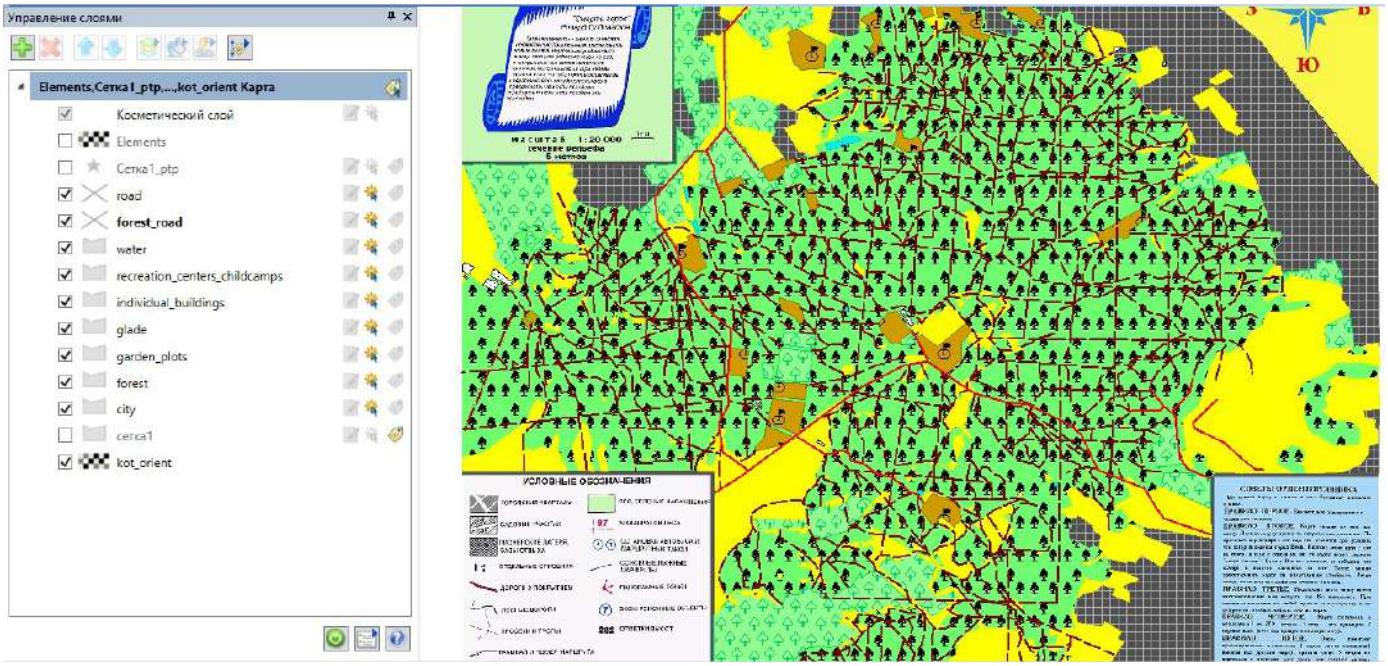


Figure 5. Screenshot of the Kumis Glade Nature Park MapInfo Pro map with all layers

Educational nature trail 1 is a 6.4 km long route that starts from the Dubki Recreation Camp for children and ends by the spring in Denezhnyi (meaning *money*) Ravine (Figure 9). The coordinates of the start and finish points on the map, according to the Yandex Maps, are 51.546800, 45.907211 and 51.558000, 45.875000, correspondingly. The route is linear. The start and finish points of the nature trail have good access roads. Thus, for tourists, it will not be difficult to arrive at the place, where the route starts, and leave from the final destination by public transportation. The total travel time on the route is approximately 2.5 to 3 hours, excluding stops.

Nature trail 1 is an organized route passing through the popular attractions of the Kumis Glade nature

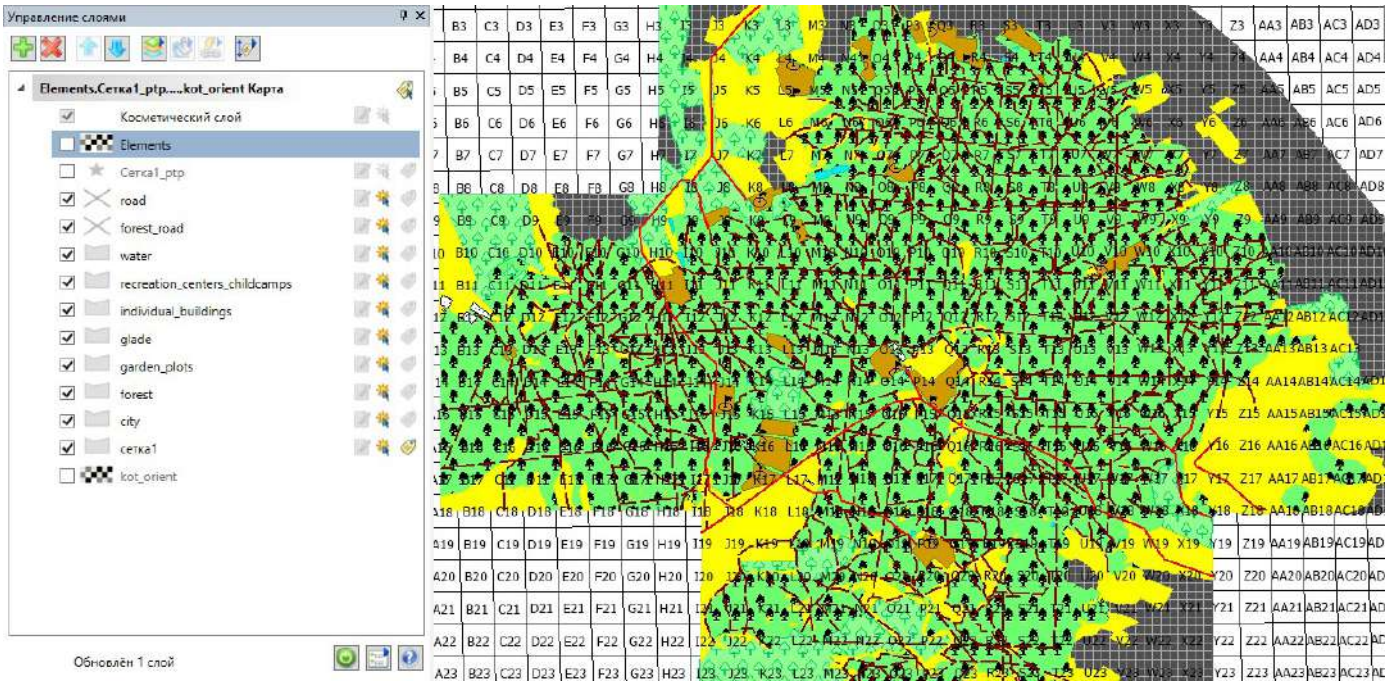


Figure 6. Screenshot of the Kumis Glade Nature Park MapInfo Pro map with a breakdown of the territory into squares

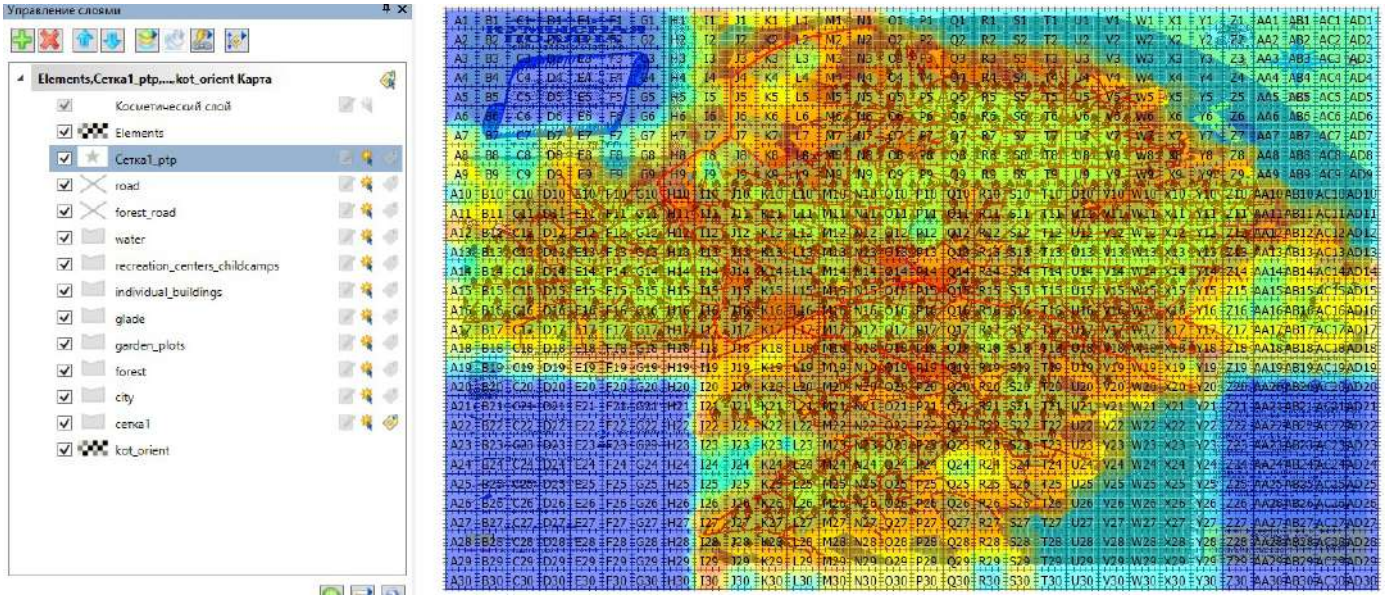


Figure 7. Screenshot of the Kumis Glade MapInfo Pro map with displaying the frequency of occurrence of landscape elements in squares dividing the territory of the nature park

park, habitats of forest animals, and various plant communities. When walking along the route, tourists can familiarize themselves with information about the flora and fauna, presented on the information stands along the path, and the scenic sights of the Kumis Glade.

There is a total of 13 planned information stations on the trail: four major stopping points, associated with significant water bodies (springs), and nine supplementary points, designed to serve as places for obtaining information about the environment, as well as to emphasize the aesthetic appeal of the area. The first spring found along the route is the Tatar Spring (approximately 1.8 km from the starting point), the second is Bogatyr Spring (another 1.1 km down the trail), followed in 2 km by the Raspberry Spring, and in another 1.4 km by the Money Spring.

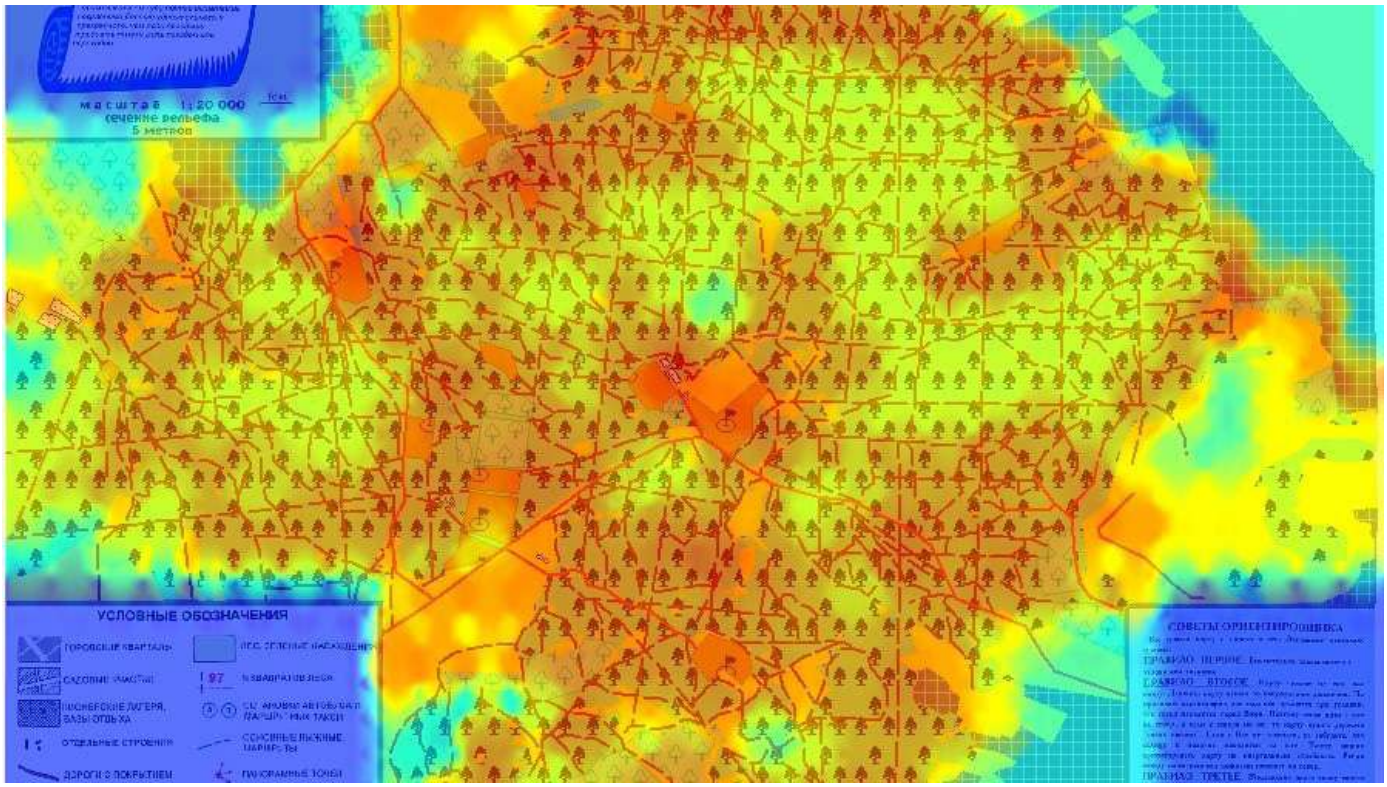


Figure 8. Screenshot of the Kumis Glade MapInfo Pro map with display of the frequency of occurrence of landscape elements within the territory

Figure 9. Educational nature trail 1: satellite view

Figure 10. Information stand for station 1.1 Lily-of-the-valley (*Convallaria majalis* L.)

Figure 11. Information stand for station 1.2 Fieldfare (*Turdus pilaris* L.)

Figure 12. Information stand for station 2 Tatar Spring

Figure 13. Information stand for station 3.2 Black alder (*Alnus glutinosa* L.)

Figure 14. Information stand for station 4.1 Eurasian elk *(Alces alces* L.)

Figure 15. Information stand for station 5.1 Warty strawberry-bush (*Euonymus verrucosus* Scopoli)

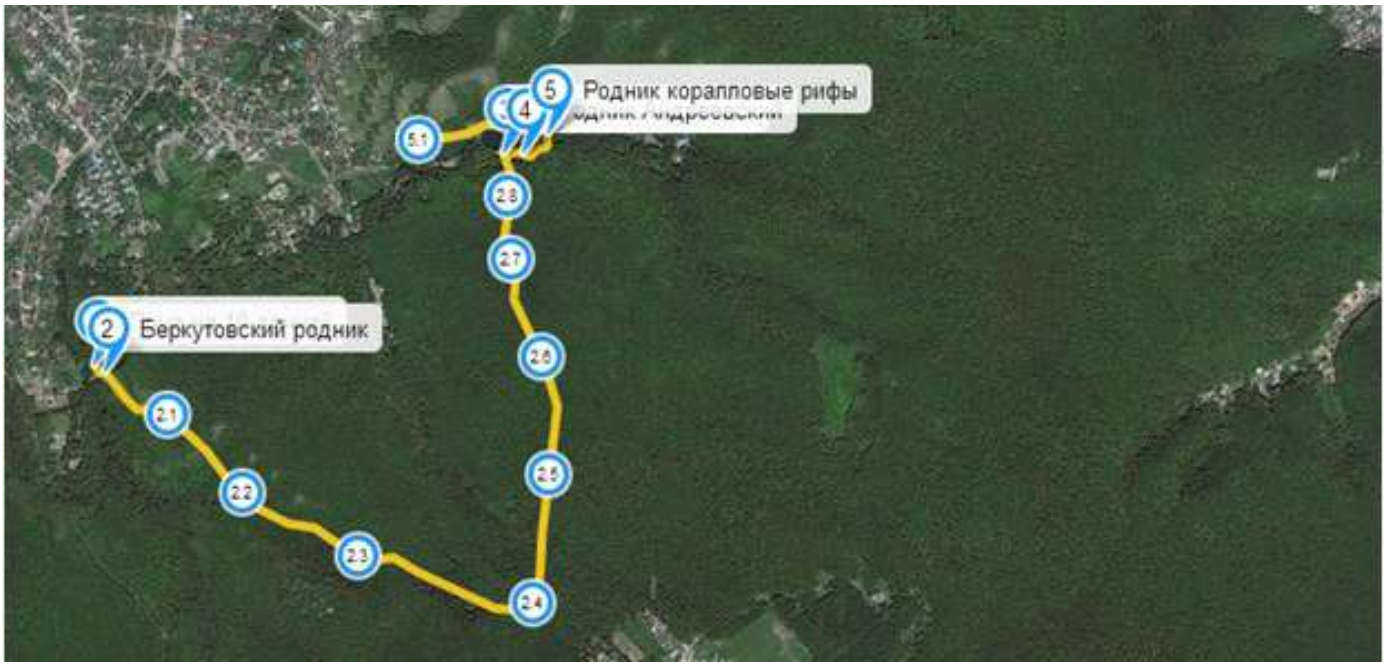


Figure 16. Educational nature trail 2: satellite view

At supplementary stations, tourists are invited to familiarize themselves with the materials of information stands dedicated to the flora (major tree, shrub and herb species) and fauna (major bird and mammal species) of the area. The stands depict typical plants / animals / objects of interest (e.g. springs), describing in Russian language some important details, such as distribution, habitat, biology, protection status, chemical composition, or history.

Of 13 designed weather-proof information stands to be set at information stations on the route 1, five are presented in Figure 10 (Lily-of-the-valley as a typical herb), Figure 11 (Fieldfare as a typical bird of the area), Figure 12 (Tatar spring as an object of interest), Figure 13 (Black alder as a rare intrazonal tree species), Figure 14 (Eurasian elk as an important large mammal species), and Figure 15 (Warty strawberry-bush as a common understory shrub).

Educational nature trail 2 is a 3.6 km long route that starts from the pond at the 10th Dachnaya neighborhood near the Romantic Recreation Camp for children and ends at a point near the Coral Reefs Spring. The coordinates on the map for the start and the finish, according to the Yandex Maps, are 51.564900, 45.895400 and 51.571875, 45.917578, correspondingly (Figure 16). The route of the nature trail 2 is semi-circular. Its start and finish points have good access roads. Thus, for tourists, it will not be difficult to arrive at the place, where the route starts, and leave from the final destination point by public transportation. The total travel time on the route is approximately 2–2.5 hours, excluding stops.

Of 14 information stations on the trail, there are five main information points, associated with significant water bodies of the nature park – springs and ponds; and nine supplementary information stations, dedicated to the specificities of the environment and to aesthetic appeal of the area.

The first water body and the starting point of the nature trail 2 is the pond at the 10th Dachnaya neighborhood near the Romantic Recreation Camp for children. Just 50 m down the trail there is the second aquatic object – the Berkut's Spring. The third water object (3.3 km further down the trail) is represented by two Andrey's Ponds. The coordinates of this point on the map, according to the Yandex Maps, are 51.571500, 45.915400.

The fourth water body is Andrey's Spring 70 m from the ponds, and the fifth water body is the Coral Reefs Spring, located 140 m further on. Currently, this particular spring is littered and is not a source of drinking water. Two of 14 information stands are shown in Figures 17 (Brown hare, as a typical

Figure 17. Information stand for station 2.7 Brown hare (*Lepus europaeus* Pallas)

Figure 18. Information stand for station 3 Andrey's Ponds

lagomorph in the area) and 18 (Andrey's Ponds). The rest are dedicated to various plant and animal species and springs along the trail.

Educational nature trail 3 is a radial route 2.8 km long. Radial route should be understood as a route, the starting point of which is also the finish point (Figure 19). The roundtrip follows the same trail, and in total tourists walk ~ 5.7 km. The trail starts from the Gazebos station near the Birch-Tree Recreation camp for children, and ends at the same point. *Gazebos* is a place for picnics and outdoor recreation in the very center of the Kumis Glade. The coordinates of this point on the map, according to the Yandex Maps, are 51.553100, 45.923200.

The starting (finishing) point of this nature trail has good access roads. For tourists, it will not be difficult to arrive at the starting point of the route and leave the finish point by personal transport or public transportation. The total travel time of the route is approximately 1.5 hours, excluding stops at the information stations, so that the entire route can be completed in approximately 3 hours.

It is worth noting that on the route along the nature trail 3, there are both major stations (5), where tourists will make long stops in order to get acquainted with the environment and its attractions, and additional stops (4), designed to serve as a place for obtaining information about the flora and fauna of the area, as well as to emphasize the aesthetic appeal of the forest.

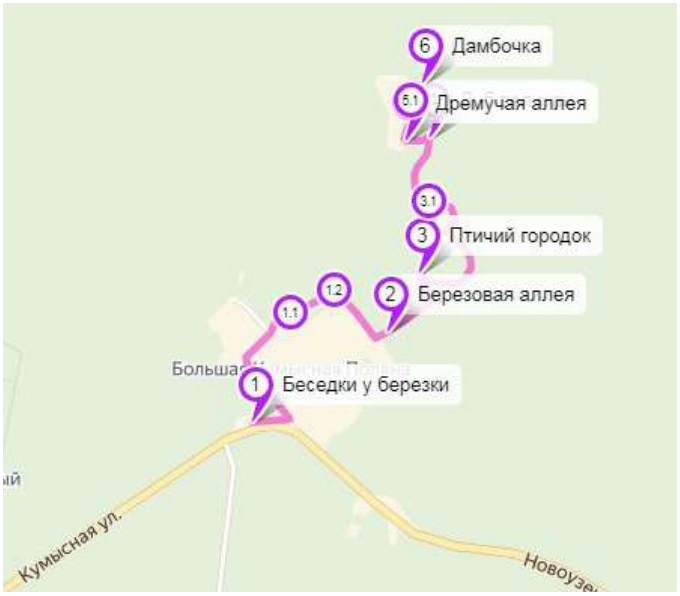


Figure 19. Educational nature trail 3: topographic map view

The starting point, i.e. the first point of the nature trail, is the *Gazebos* station near the Birch-Tree Camp. From the beginning of the route to the second point of the trail – *Birch Alley*, the distance is approximately 1.2 km. The coordinates of the *Birch Alley* on the map are 51.556400, 45.930900. The third information station is set at the *Bird Feeders* point, 340 down the trail. The fourth information station of the nature trail is *Giant Oak* (Figure 20), 950 m further on. The fifth point of interest on the trail is the *Dense Alley*, 95 m from the previous station. The last, sixth, object on the

Figure 20. Information stand for station 4 Giant Oak Natural Monument

Figure 21. Information stand for station 6 The Dam

tourist route is *The Dam* (Figure 21). The coordinates of this point on the map, according to the Yandex Maps, are 51.565184, 45.932923. The distance from *Dense Alley* is about 280 m. From this point, tourists follow the educational path in the opposite direction and complete the nature trail at the *Gazebos*.

At supplementary stations, tourists can familiarize themselves with the materials of information stands, dedicated to wildlife and flora of the natural park: Chaffinch (*Fringilla coelebs* L.), Eurasian Blackbird (*Turdus merula* L.), silver birch (*Betula pendula* Roth), and English oak (*Quercus robur* L.).

Educational nature trail 4 is a 5.5 km long circular trail, starting from the *Gazebos* station near the Birch-Tree Recreation camp for children, and ends at the same point (Figure 22). *Gazebos* is a place for picnics and outdoor recreation in the very center of the Kumis Glade. The coordinates of this point on the map, according to the Yandex Maps, are 51.553100, 45.923200. The starting and finishing point of the trail has good access roads. The total travel time on the route is approximately 2.5 to 3 hours, excluding information stops.

Of nine information stations on the trail, four are major – dedicated to significant natural attractions of the Kumis Glade Nature Park (spectacular birch grove, historical tract, spring, and the largest oak-tree in the area), while five more are supplementary, designed for obtaining information about the

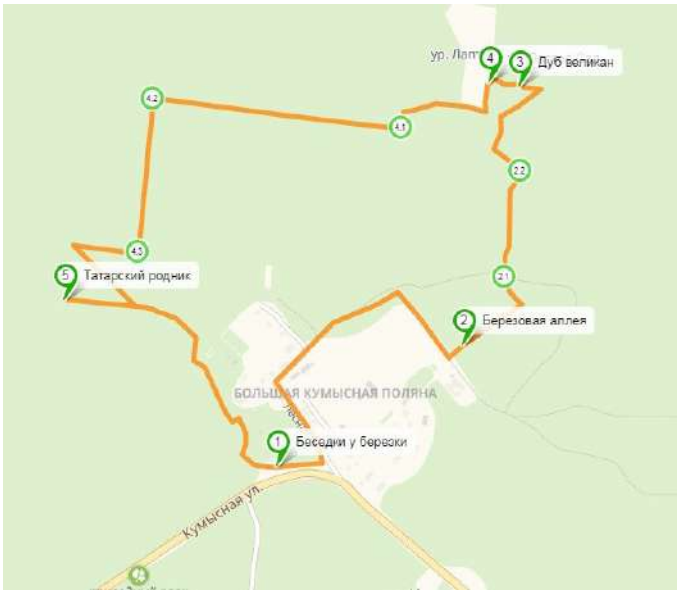


Figure 22. Educational nature trail 4: topographic map view

environment, as well as emphasizing the aesthetic appeal of the area.

The starting point of the trail 4 coincides with the starting point for the trail 3 (*see above*). The *Birch Alley* station is 1.2 km down the trail. The third station, *Giant Oak*, is 1 km ahead. The fourth attraction, historical tract *Laptev Garden*, is just 100 m ahead. The fifth major attraction is historical Tatar Spring 2.2 rm down the route from the tract. From here, tourists follow he nature trail 4 towards the *Gazebos* for nearly 1 km.

Figure 23. Information stand for station 4 Laptev Garden

Figure 24. Information stand for station 4.1 European Robin (*Erithacus rubecula* L.)

At supplementary information stations, tourists are invited to familiarize themselves with the materials of information stands about the key inhabitants and ecosystem-building tree species of the nature park: Chaffinch (*Fringilla coelebs* L.), European Robin (*Erithacus rubecula* L.), Sparrowhawk (*Accipiter nisus* L.), Norway maple (*Acer platanoides* L.), and small-leaved linden (*Tilia cordata* Mill.).

Sample information stands for nature trail 4 are shown in Figures 23 and 24.

The development of educational nature trails allows solving the problems of forming environmental awareness in the population, and organizing active and educational leisure. The establishment of specialized routes, passing through the woods, allows tourists to observe the life of the natural communities, make discoveries and conduct studies, the results of which could have a positive impact on the well-being of the nature park.

Conclusion

Our project resulted in a comprehensive environmental education program, based on the technology of educational nature trails developed with the help of geographic information systems. The trails were designed within the territory of the Kumis Glade Nature Park. This nature park is of great ecological, social and recreational importance. The project of educational nature trails has scientific and practical novelty, since, prior to the introduction of this development, there were no ecological routes on the territory of this natural protected area.

In the international community, environmental education has a high status: teaching *nature* is carried out at different levels by means of using modern methods; in ecologically developed countries, methodological recommendations are used that call for educating the general population – first of all, *via* field observations and research. At the same time, educational nature trails are one of the components of quality education. The project approach is currently actively developing in Russia. There are examples of projects and organizations successfully conducting research activities with audiences of all age groups.

One of the main difficulties existing in the development of environmental education projects is the lack of uniform standards that regulate in detail educational activities at protected natural areas. Designing educational nature routes as a component of environmental education is a complex of tasks in the field of humanities, technology, and natural sciences. In this context, methodological recommendations of foreign and domestic authors allow forming a holistic vision of the project.

Currently, the Kumis Glade Nature Park is threatened by a serious urbanization, which negatively affects the functioning of the nature park biota. The research conducted with the help of GIS makes it possible to create a model of reasonable and responsible human behavior in relation to the Kumis Glade Nature Park, the proper functioning of which could preserve the regional biodiversity. Regional protected natural areas, such as the Kumis Glade, may

act as testing grounds for educational and research activities of school and university students.

We designed four educational nature routes within the boundaries of the suburban SPNA Kumis Glade Nature Park. Trail number 1 is a route with 6.4 km long. The travel time on this path varies from 2.5–3 hours (excluding long stops). Nature trail 2 is a 3.6 km long route. The travel time on it varies from 2 to 2.5 hours. Educational trail 3 is 5.7 km long route with travel time varies around 3 hours. The trail 4 is 5.5 km long path. The travel time on it ranges from 2.5 to 3 hours. All trails are quite accessible: they have access roads; for few exceptions, they do not run along steep ascents and descents. The routes traverse different types of landscape complexes and ecosystems, which is ensured by setting a route not only on the plateau, but also on the slopes of various orientations and along the bottom of ravines and hollows; as well as by setting nature trails through both forested and open spaces, such as steppe, meadows, and forest edges.

The development of environmental education projects solves the problems of fostering an environmental culture and awareness of the general population, organizing active and educational leisure, as well as protecting the environment. Thus, the design of educational nature trails as part of the development of an integrated environmental education system is the task of any protected natural area. Kumis Glade Nature Park acts as a huge air filter, providing the city of Saratov with clean air. The implementation of environmental and educational activities on the territory of the nature park helps preserving ecosystems from anthropogenic impact.

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