

Greenways in landscape planning – case study: Municipality of Subotica

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Introduction

Municipality of Subotica is located at the northern part of the Vojvodina Province and Republic of Serbia, along the Hungarian border. The natural heritage of the Vojvodina Province (North part of Serbia) is extraordinary diverse with important ecosystem diversity. In the Vojvodina province there are extra natural and landscape areas specific for the South – East Europe as Deliblato sands (the biggest sand area in the Europe), hilly areas of Fruška Gora and Vršачki breg. Also, the rivers Danube, Sava, Tisa, Begej, Tamiš and their floodplain zones (Apatinski rit, Monoštorski rit, Koviljski rit, Obedska bara, Carska bara, etc.), the steps zones in Middle and North Banat, loess area along the Tisa and Danube rivers (Titelski breg, Slanka men, Surduk). The protected areas on saline soils (Slano kopovo, Rusanda and Okanj) are also very important. The protected area network consists of about 200 spatial entities, which cover 5.5% of the total Province area (Orlović et al, 2005.).

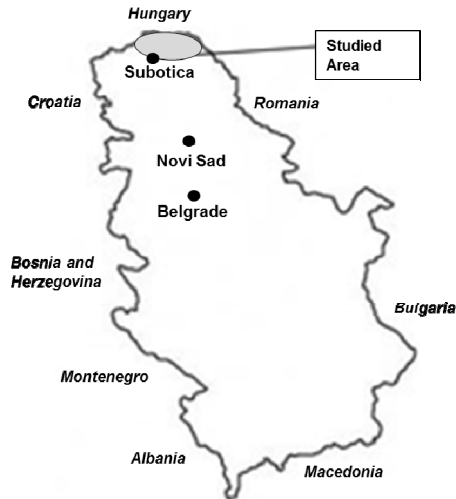


Figure 1. Location of the study area in Serbia

According to the Law of natural protection in municipality of Subotica there are four zones under special protection (Figure 1). Ludaš lake and Selevenj heath are strict nature reserves with total area of 846.33 ha (Official Gazette RS, 2006) and 677.04 ha (Official gazette RS, 1997), respectively. The areas

are important due to rich diversity of lowland habitat types, as well as extremely high levels of floral diversity with a significant number of endangered species of authentic Pannonian flora and fauna. Ludaš lake also has an international significance (Ramsar wetland) because it represents a meeting place and place for rest of migratory bird species. Subotica sands is ranked as land of exceptional feature (5370 ha) which is characterized by unique environmental conditions, in terms of sand geological ground, variety of soil and special regime of ground water (Official Gazzete RS, 2004). The fourth area under special protection is nature park Palić with total area of 712.3 ha.

Besides natural resources and the rich biodiversity, this area is also important for tourism development due to the numerous cultural value: the archaeological sites dating from the Stone Age and the Middle Age as well as examples of architecture in Art Nouveau style. There is also a large number of ethno houses showing the life, traditions and crafts typical for the northern Serbia.

Construction of an international highway that passes through the region caused an additional pressure on the ecosystem of these areas.

According to Ahern (1995): „greenways are networks of land containing linear elements that are planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic, or other purposes compatible with the concept of sustainable land use“. Ecological function of greenway is important, linking isolated areas and helping to improve local biodiversity in several ways: by allowing individual animals access to a larger area of habitat; facilitating seasonal migration and genetic exchange with other local populations of the same species; and offering opportunities for individuals to move away from a habitat that is degrading or from an area that is under threat (Benett and Mulongoy, 2006). Landscape connectivity is not only important because environment protection, but it also has social and cultural goals (Ahern, 1995). Greenways can develop activities, such as nature tourism, environmental education that will promote landscape sustainability and stimulate social, economic and ecological dynamics (Pena et al., 2010).

Goals and objectives

The goal of this study is conservation and enhancement of biodiversity as well as improving tourist and educational capacities through establishment of greenway concept in the territory of Subotica. Objectives are the following: i) defining the problem by analyzing the cultural and natural conditions in the studied area and ii) giving proposal for greenway development in the municipality Subotica.

Methods

The study area is placed in the southern part of the Pannonian Plain, in the northern Serbia, along the Hungarian border. It consists of four parts:

- Strict nature reserve “Selevenj heath“
- Strict nature reserve “Ludaš lake“
- Land of exceptional feature „Subotica sands“
- Nature park „Palić“

This study applied a methodology of greenway design proposed by Penna et al. (2010), but with a few modifications due to the limited scope of investigation. Research was conducted through three phases: i) landscape eco-cultural analysis; ii) synthesis and diagnosis; and iii) proposal. Analysis for this study was done using the data collected in previous studies and researches conducted by other authors. First phase included studying geomorphology, soil, climatic conditions, vegetation (actual and potential), water courses, existing roads as well as landscape cultural heritage elements. Special attention was given to analyzing of vegetation relationship with the environment, in order to prevent disruption of biodiversity in protected areas by establishing greenways.

Results

Landscape eco-cultural analysis

Soil. In the municipality of Subotica are identified several soil types. Dominant soil types are Chernozem (calcareous and sandy loam) and Arenosol. In the northern part of Subotica municipality, near the border with Hungary is more prevalent Arenosol, while southern is Chernozem. Also in a smaller extent, are present Solonchak and Gleysol (Živković et al., 1972).

Hydrological characteristics. The area is poor in surface watercourses and the Kireš river is the main stream. Water resources are complemented by lakes, Palić and Ludaš. These lakes were formed as a result of wind erosion at the contact of sand and loess, with an average altitude 101m and 93m, respectively. In the area of Subotica sands in depressions appearing temporary or permanent ponds due to high groundwater level.

Climate characteristics. According to its geographical position, municipality of Subotica is located in the area of temperate continental climate. Based on the mean daily temperature for each month, the season and during the year, average annual temperatures is 11.2 °C. January is the coldest month with

average temperatures of -0.4°C , and the warmest July with 22.3°C . The annual flow of relative humidity indicates temperate humidity (72% in average). The mean annual precipitation is 571.1mm. Directions of dominant winds are north-west, which occurs mainly in the summer, the north east in winter and southeastern in spring and summer. Average annual wind speed ranges from 2.45-2.95 m sec⁻¹ (RHSS, 2016).

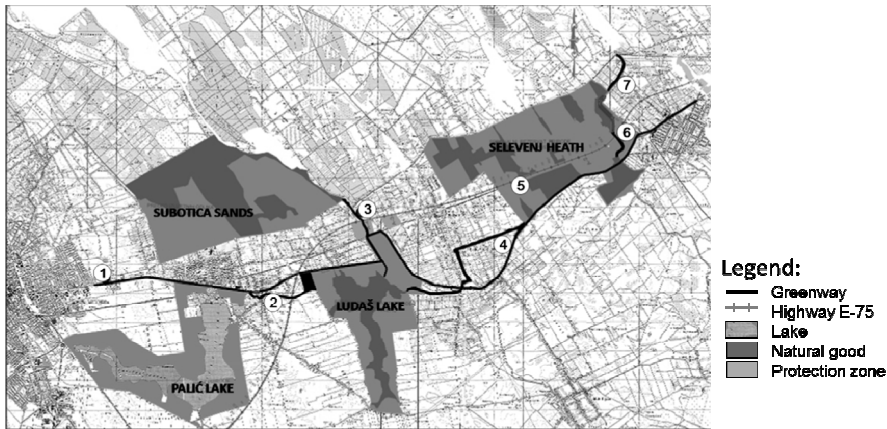


Figure 2. Concept plan with greenways connecting protected areas: 1. Bicycle path- linear type; 2,3,4,7. Eco corridors-linear type; 5.Eco corridor-overpass type; 6. Eco corridor-tunnel type

Vegetation. In general, the vegetation of the studied area has the forest-steppe character. A complex of forest habitats containing green areas, bulrushes and various types of grass communities. The prevailing component of the plant cover represents grass and wetland vegetation, while forest vegetation survived in fragments. In Selevnje heath forests have mainly anthropogenic origin, plantations of *Celtis australis* and *Pinus nigra*. In the nature reserve Ludaš lake appeared forest communities *Aceri-tatarici-Quercion sigmetum* and steppe phytocoenoses *Festucion rupicoale sigmetum*. In the nature park Palić, due to the expansion of agriculture, natural vegetation survived in small areas.

Cultural analysis. The territory of municipality of Subotica has been inhabited since the Stone Age, evidenced by several archaeological sites. In the nature reserve Ludaš lake there are two historical sites: Neolithic settlement Ludaš Budžak and necropolis from the Stone Age Nosa - Pearl Coast. Significant is also the locality medieval Templompart in Subotica Sands. In addition to archaeological sites, cultural and historical value of the area complements and architecture of Palić, with numerous buildings in Art Nouveau style. As part of nature reserves, there are several eco-educational paths, as well as the old rural houses with a demonstration of traditional earning and life.

Table 1. Proposed length and species for greenways

| Ordinal | Greenway | Length (m) | Planned species | Proportion of species (%) |
|---------|------------------------------------|------------|--------------------------|---------------------------|
| 1. | Bicycle path Subotica - Hungary | 26361.7 | <i>Quercus robur</i> | 60 |
| | | | <i>Acer tataricum</i> | 40 |
| 2. | Palić – Ludaš lake | 3130.4 | <i>Quercus robur</i> | 50 |
| | | | <i>Sorbus torminalis</i> | 30 |
| | | | <i>Pyrus pyraeaster</i> | 20 |
| 3. | Ludaš lake – Subotica sands | 1619.5 | <i>Quercus robur</i> | 60 |
| | | | <i>Acer tataricum</i> | 40 |
| 4. | Ludaš lake – Selevenj heath | 6223.0 | <i>Quercus robur</i> | 50 |
| | | | <i>Sorbus torminalis</i> | 30 |
| | | | <i>Pyrus pyraeaster</i> | 20 |
| 5. | Selevenj heath | 1168.2 | <i>Sorbus torminalis</i> | 60 |
| | | | <i>Pyrus pyraeaster</i> | 40 |
| 6. | Selevenj heath – Hungary | 1623.1 | <i>Quercus robur</i> | 50 |
| | | | <i>Sorbus torminalis</i> | 30 |
| | | | <i>Pyrus pyraeaster</i> | 20 |

Synthesis

On the basis of the eco-cultural state analyses, we concluded that the priority measure in this area is planting green ways between protected areas. To avoid disturbance of natural habitats and biodiversity it is necessary to use autochthonous species adapted to the climate and soil features of regions. Also, considering the cultural and historical significance of the area, in order to improve tourism capacity of Subotica construction of cycling paths, is recommended.

Greenways on Subotica municipality

Economic activity and expansion of the local population has seriously undermined the biodiversity of the studied areas. With the intensive development of agriculture, production fields have expanded at the expense of the steppes, wetlands and forests. Natural ecosystems are disturbed and certain plant and animal species are almost extinct. Urbanization and building of infrastructure, especially highway E-75 also had a negative impact in this area.

The municipality of Subotica has a small proportion of forests and green areas in total municipality area and with regard to the climatic conditions soil is heavily exposed to eolic erosion and dryness. The proposed greenways will have also a windbreak role.

The proposed greenways in the study area are shown in Figure 2. The concept plan provided the different types of greenways, selected on the basis of necessity and the assessment of fragmentation of the ecosystem. Most of the greenways are linear type. Designing greenways was done using existing roads, corridors and water courses, in order to avoid disruption of the existing landscape. Greenways 2, 3 and 4 (number 4 only with one part of length) are riparia ribbons and its role is recovering present vegetation. Within Selevenjskih wastelands two different type of greenways are planned. The reason for this is because almost the entire length of the reserve are aligned to E-75 highway. Greenway no. 5 is overpass type, due to the need to link the two zones of strict protection, separated by roads. Corridor no. 6 was found to be more suitable for a tunnel type, because of the existing small watercourses.

Planned greenways differ also according to the use of different tree species and their ratio of presence. The main criteria for the choice of species are the climatic conditions and soil types in the study area and the use autochthonous species in order to avoid disruption of habitats and the introduction of allochthonous, often invasive species. For greenways, it is planned the use of plant species specified in the Table 1.

The longest greenway linking Subotica and Hungarian border. It passing through all protected areas and primarily is designed for cyclists. Bicycle paths can be matched with other roads, but in the case of Subotica, greenways no. 2.-7. primarily have the ecocorridor role and only some parts should be used by the population. For this reason, there is a need for the designing bicycle paths as the separate greenway. In addition to recreation, this path is designed to encourage the tourism by using local resources as well as improve cooperation among the countries and population in the region. Also, given the historical and cultural connection between northern Serbia and Hungary, it is very important to maintain the cross-border cooperation in order to preserve heritage on both sides of the border.

Discussion and Conclusion

The applied plan is similar to the greenway plan for Lisbon (Jongman et al., 2004), where planning criteria has been applied on protected areas including biotic, abiotic, cultural and recreational resources. Developing plan for municipality of Subotica gives priority on linking protected areas with greenways, and to maintain and improve biodiversity. Besides nature conservation, the development of social aspect of the area (cultural and archaeological-paleontological value, environmental education and recreational content) has been taken into consideration. In addition to that, the

concept plan has international importance, as it supports cross-border cooperation by proposing bicycle route from city of Subotica to the Hungarian border as well as eco-corridor from Selevenj heath to Hungary.

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