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Connecting Natural Heritage in Vojvodina Province (Republic of Serbia) with the EuroVelo 6 Route via Greenways

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Abstract

EuroVelo is a network of 17 long distance cycle routes through European continent which length is over 90 000 km long. EuroVelo 6 route connects the Atlantic ocean with the Black sea, and its total length is 3 653 km. It is also called “Rivers Route” because this cycling route runs along some of Europe’s major rivers, such as Loire, Saone, Rhine and Danube. The EuroVelo 6 enters Serbia near the town of Bački Breg and follows the meandering Danube. Through Vojvodina Province, the “Rivers route” is 328 km long and it passes by exceptional natural and landscape totality. In the north – west of Serbia, on the border with Hungary and Croatia, Special Natural Reserve “Gornje Podunavlje” is located. “Gornje Podunavlje” is a protected natural area, and it belongs to the first category of protection. It is used for tourism, forestry, hunting and fishing. Special Natural Reserve “Karadorđevo” is located near the town of Bač, it belongs to the second category of protection, and is used for the same purposes. Only a few kilometers away, near the town of Bačka Palanka, Tikvara Nature Park is located. This natural area belongs to the third category of protection, and it represents the potential of tourism development. Near the end of the EuroVelo 6 route through Vojvodina there is Special Natural Reserve “Koviljsko-Petrovaradinski rit” which represents a mosaic of forest, meadow and swamp ecosystems (Amidžić et al., 2017). Connection of natural heritage in Vojvodina with the EuroVelo 6 route can potentially be achieved via greenways. Greenways are much more complex and richer than the simplistic ways greenspace is often conceived of, as mere open that is, undeveloped space. Because of their various functions, greenways can be important mechanisms for helping fit development to the environment (Hellmund and Smith, 2006). By planting appropriate indigenous species of trees and shrubs would be created more pleasant conditions for cyclists, provide shade, protect from wind gusts and excessive insolation. Greenways would also improve the aesthetic value of landscapes. Besides that, it would also provide increased yields in agriculture, wood production, improvement of environmental conditions and offering other ecosystem services like carbon sequestration and thus reduce climate change, allows the migration of animal, etc.

Introduction

As it is known, cycling as a mode of transport has numerous preferences for cyclist, society and environment: it is a low – cost, health – improving and low – polluting way to travel. The health benefits are reflected in expanded physical action of cyclists. Studies have shown that as a form of physical activity, cycling helps to improve cardiovascular fitness and may help to manage weight (Handy et al., 2014). Besides that, increase in general well-being for cyclists can also be considered as a health-related benefit.

The environmental benefits of cycling appear self-evident and are widely assumed: reduced energy consumption, air pollutant and greenhouse gas emissions, etc. Cycling is pollution-free mode of transport. Bicycle riding preserves roadway and residential space, in this manner, giving opportunities for less concrete and more plant life in urban regions.

Cycling in Vojvodina is quite developed, especially thanks to the EuroVelo cycling routes. Two EuroVelo routes pass through this Serbian province: EuroVelo 6, which is known as “Rivers Route”, EuroVelo 13 which is also called “Iron Curtain Trail”, and also one route in the planning stage – EuroVelo 11 or “East Europe Route”. “Rivers route” is one of the most famous of all cycling routes. Through Serbia it is 667 km long and is divided into 7 stages (Tab. 1), of which first four passes through the Vojvodina Province (Fig. 1).

Table 1. EuroVelo 6 route in Serbia

| Stages | | km |
|-------------------------------------------|------------------------------------------------------------------|------------|
| 1. | Bački Breg (Hungarian border) – Sombor – Apatin | 60 |
| 2. | Apatin – Bačka Palanka | 124 |
| 3. | Bačka Palanka – Novi Sad | 48 |
| 4. | Novi Sad – Belgrade | 96 |
| Total length in Vojvodina Province | | 328 |
| 5. | Belgrade – Pančevo – Kovin – Stara Palanka – Ram | 105 |
| 6. | Ram – Veliko Gradište – Golubac – Donji Milanovac | 95 |
| 7. | Donji Milanovac – Kladovo – Negotin – Bregovo (Bulgarian border) | 139 |
| Total length | | 667 |

Source: Vujko et al., 2014.

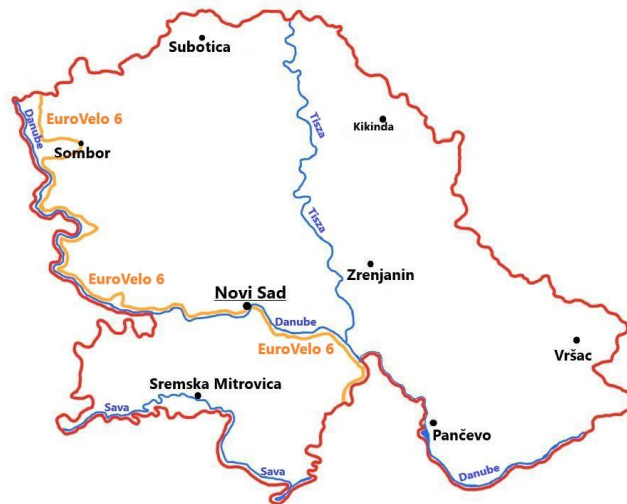


Figure 1. EuroVelo 6 trough Vojvodina Province (Source: Authors)

Background and Literature Review

In academic literature, greenways are defined as networks of land containing linear elements that are planned, designed and managed for numerous purposes as well as ecological, recreational, cultural, aesthetic, or other purposes compatible with the concept of sustainable land use (Horte et al., 2020). Ahern, 2002, defines greenway planning as a strategic action that integrates theories from landscape ecology with theories and methods of landscape planning focusing on realizing a sustainable greenway network of protected areas, managed for compatible multiple purposes. He continues that a greenway system or network includes linear corridors and larger protected lands that are physically and functionally connected. Greenways are strategic and spatially proficient for

managing and overseeing land, since greenway assets are not arbitrarily conveyed, but rather are concentrated in corridors. Hiel et al., 2016, focus on green corridors, and define them as zones or strips that play the role of separating two functionally different zones with natural features usually different types of vegetation (trees, shrubs, flowers and grass) which also have an important role of linking the leafy area into a unique whole.

Salici, 2013, classified the greenways into six categories, according scientists and planners who worked for different goal:

- Urban riverside greenways;
- Recreational greenways;
- Natural corridors of ecological importance;
- Greenways of visual and historical value;
- Greenways that aim at control the urban development;
- Comprehensive greenway systems and networks.

Every of these categories have different functions, so Urban riverside greenways are designed in order to protect, improve and manage water resources such as flood plains, wetland, river corridors and bridges (Palmisano et al., 2016). Recreational greenways are formed along the routes and pathways that are passing through recreational spaces of high visual value (Fábos, 1995). Natural corridors of ecology importance protect wildlife and migration species and also promoting biodiversity (Palmisano et al., 2016). Greenways of visual and historical value are, according to Fábos, 1995, the greenways that attract tourists and thus provide economical benefits. Greenways that aim at control the urban development act as greenbelts that separate urban areas from the surrounding landscape, thereby controlling urban sprawl. Comprehensive greenway systems and networks have function to link different kinds of areas on urban and regional scales (Palmisano et al., 2016).

However, greenways are much more complex and richer than the simplistic ways greenspace is often conceived of, as mere open that is, undeveloped space. Because of their various functions, greenways can be important mechanisms for helping fit development to the environment (Hellmund and Smith, 2006). Greenways provide a range of benefits such as wind gust and excessive insolation protection and giving shade (Fig. 2). They also improve the aesthetic value of landscape. Besides that, greenways could be considered as a type of agroforestry systems and thus they would provide increased yields in agriculture, wood production, improvement of environmental conditions and offering other ecosystem services like carbon sequestration and thus reduce climate change, allow the migration of animals, etc. Studies have shown that the agroforestry systems may reduce soil erosion and minimise nutrient losses from soil due to higher uptakes of nutrients by tree and crop roots from varying soil depths. Also, when used as windbreaks, trees modify the microclimate, decrease wind erosion and protect crops from wind. Under ideal circumstances, these effects may increase crop growth and yield, providing a sustainable combination of tree and crop morphology, phenology and physiology (Nerlich et al., 2013).



Figure 2. Schematic representation of wind gust and excessive insolation protection by Greenways
(Source: Authors)

Greenway planning in Serbia is still not at a sufficiently developed level. In 2016., the first greenway in Serbia between Užice and village Vrutci is opened. The city of Užice has, in 2015-16., reconstructed the old railway bridge and asphalted the first 5 km of the narrow gauge railway route in the canyon of the Ćetinja river to Stinarska Banja, along the route of the old “Ćira Railway” which led to Sarajevo and Dubrovnik. The arrangement of the macadam route to the village Vrutci and the lake of the same name was successively extended, so that the route is now 12 km long. In 2017., The European association of Greenways awarded the city of Užice the second prize for excellence – for landscaping, content and accessibility (Pavlović et al., 2018).

Method and Data

Vojvodina Province is, geographically, the northern region of Serbia, and is located in the Pannonian lowlands. It borders with Hungary on the north, Romania on the east and on the west with Croatia. Across her territory flow three significant rivers: Sava, Tisza and Danube which establish three sub-regions: Srem, Banat and Bačka.

According to the definition from the Act of Nature Protection, protected areas are areas that have a pronounced geological, biological, ecosystem and/or landscape diversity and are therefore declared protected areas of general interest by an act of protection. Depending on the value and importance, they are classified into the following categories:

- I category – a protected area of international, national or exceptional importance;
- II category – protected area of provincial or regional, i.e. great importance;
- III category – protected area of local importance.

In Vojvodina Province, there are 135 protected areas with a total area of about 138,000 ha, which covers 6.4% of the province territory. These are: 1 National Park (NP), 16 Special Natural Reserves (SNR), 9 Nature Parks (NP), 3 Landscapes Of Exceptional Features (LOEF), 2 Protected Habitats (PH) and a large number of Nature Monuments (NM).

Special Natural Reserve Gornje Podunavlje

Special Natural Reserve (SNR) Gornje Podunavlje is a protected area of I category of protection and it covers a total area of 19,605 ha. It is located in the north – west of Vojvodina Province, along the left bank of the Danube river from 1,433rd km to the 1,367th km. SNR Gornje Podunavlje is one of the largest floodplains in Europe, a large marsh complex that is a part of the UNESCO Trans-boundary Biosphere Reserve “Mura – Drava – Danube”, which is also called Europe’s Amazon. SNR Gornje Podunavlje includes marshes Monoštorski and Apatinski (Trbojević et al., 2019). In 2007., SNR Gornje Podunavlje was included in the list of wetlands of international importance, based on The Ramsar Convention (Obradović et al., 2021). This Natural Reserve, because of its botanical values, has the status of Internationally Important Plant Area (IPA). The most common species of trees in SNR Gornje Podunavlje are *Quercus robur* L., *Fraxinus excelsior* L., *Populus alba* L., *Populus nigra* L., *Cornus mas* L., *Salix alba* L., etc. It also represents home to 51 species of mammals, 248 species of birds, 50 species of fish, 11 species of amphibians, 9 species of reptiles, a large number of invertebrates, of which the butterfly fauna stands out with over 60 species of diurnal butterflies and more than 1000 plant species (Stojanović et al., 2021). It is used for tourism, forestry, hunting and fishing.

Special Natural Reserve Karađorđevo

SNR Karađorđevo is located near the town of Bač, about 50 km south – west from Novi Sad. It covers an area of 2,995 ha, and it spreads along the left bank of the Danube river. SNR Karađorđevo includes space units: Bukinski rit and Mostonga, that includes Vranjak and Guvnište. Bukinski rit is one of the few preserved marshes along the Danube where are present common oak (*Quercus robur* L.) and communities of almond willow (*Salix triandra* L.), white poplar (*Populus alba* L.), black poplar (*Populus nigra* L.) and common ash (*Fraxinus excelsior* L.). Especially significant is the presence of Hungarian hawthorn (*Crataegus nigra* Waldst.). Mostonga unit is consisted of acacias and oak communities with a kind of flora and fauna. SNP Karađorđevo has two-level protection regime (II and III), where Bukinski rit belongs to II category of protection and Mostonga (Vranjak and Guvnište) belongs to III category of protection.

Nature Park Tikvara

Nature Park Tikvara covers a total area of 554.52 ha of which 138.85 ha (25%) belongs to II category of protection and 415.67 ha (75%) belongs to III category of protection. This nature park is dominated by softwood forests, and the whole area is intertwined with the Danube tributaries and marshes.

Nature Park Begečka jama

Nature Park Begečka jama is located along the left bank of the Danube River, between the town of Bačka Palanka and Novi Sad, and it covers a total area of 489.5 ha. This nature park has two-level protection regime (II and III) where 26.6% (130.14 ha) belongs to II category of protection, and remaining 73.4% (359.37 ha) belongs to III category of protection. The essential natural values of the Nature Park Begečka jama are reflected in the presence of 122 species and 3 subspecies of higher plants, almost 150 species of birds, 14 species of fish, 11 species of amphibians, 6 reptiles and 18 species of insects of national and international importance. This marshy habitat type is dominated by communities of white (*Salix alba* L.) and almond willow (*Salix triandra* L.), white

poplar (*Populus alba* L.) and black poplar (*Populus nigra* L.).

Special Natural Reserve Koviljsko-Petrovaradinski Rit

SNR Koviljsko-Petrovaradinski Rit covers 5,895 ha, it is located near the town of Novi Sad and it spreads along both left and right banks of the Danube (Štetić et al., 2018). It comes under the first category of protection and it may be a rare illustration of flawless nature, where the original features of a marsh biotope are protected. Natural vegetation of SNR Koviljsko-Petrovaradinski Rit includes woodland communities of willow and poplar (Štetić et al., 2018; Igić et al., 2016).

Results

All three special natural reserves and also both nature parks are located along the bank of Danube River and they all have orographic and hydrographic features of marshes. Natural vegetation of these protected areas includes communities of willow and poplar (Trbojević et al., 2019; Obradović et al., 2021; Štetić et al., 2018; Igić et al., 2016).

As the EuroVelo 6 route stretches along the bank of Danube River, greenways that would stretch along this bicycle route would properly create a sustainable network of protected areas (Fig. 3). In addition, this route passes through mostly nature area of 10 municipalities, but also 34 settlements. The land of the planned greenway is owned by various state institutions (e.g. Vode Vojvodine, Vojvodina Šume, Local Self-Government, etc.), which is potential problem due to non-communication between these institutions. Also, insufficient funds could be a problem for the development of this greenway. In this area, according to the 2011th census, there are approximately half a million people which could benefit from this greenway by developing greenway tourism in both rural and urban areas. Also, as EuroVelo 6 route passes through arable and agricultural land, thus would impact of greenway would be in reducing the potential for aeolian erosion, changing the microclimate of space which all contributes to better yields.

This greenway network would be modeled on the development of the Royal Canal Greenway from Maynooth to Cloondara, Ireland, which is planned to be the longest off-road greenway in Ireland of total length of 130 km and it would spread along the western section of EuroVelo 2. In our case, as planned greenway stretches along the international bicycle route EuroVelo 6, and the international waterway of the Danube river, the development of a greenway in this area would be an exceptional starting point for the development of the Greenway system in Serbia.

To create this greenway network it is essential to require under consideration the orographic and hydrographic characteristics of the region, i.e. wetland environment as it is in this region. The best solution is to utilize species that have demonstrated appreciative for this type of biological system – poplar and willow communities. Thus would the greenway system include linear corridors and protected areas that would be both physically and functionally connected.



Figure 3. Potential Greenway by EuroVelo 6 route that would connect protected areas in Vojvodina Province (Source: Authors)

Discussion and Conclusion

This greenway system could be classified in more than one category of greenways (Salici, 2013), as it could be used for multiple functions: Urban riverside greenway, Recreational greenway, Natural corridor of ecology importance and also as the Greenway of visual value. Benefits of this greenway system would be numerous. Firstly, it would create more pleasant conditions for cyclists by providing shade and protecting from wind gusts and excessive insolation and providing adequate space for socialization, recreation and improving physical and mental health. Another benefit would be improving of the aesthetic value of landscapes. Greenways would also improve microclimate and environmental conditions, protect wildlife and migration of species and promoting biodiversity.

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