Development of a New Urban Country on the Danube Arms near Bratislava

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Abstract. The importance of the watercourse for the city as a whole and for the waterfront urban structure is given historically, geomorphologically, ecologically, and urbanly. The context of the city and the water can significantly determine the city, in the individual stages of its development shape and model its embankment, and then offer its benefits, but also alarm in the form of possible threats connected to current climate change. Bratislava is honored to be a city on the Danube and a city with the potential of waterfronts, promenades, bridges, bays, ports, but also industrial, sports, recreational and cultural use of urban structures in contact of the city's edge with the watercourse. Restoration of old arms of the Danube, the extension of the main river by the bypass arm southwards opens up amazing possibilities of return of the landscape - urban development of Bratislava and its background. Return scenario of the Danube arms, restoration of floodplain forests and the Danube meander landscape with sensitive urban development are ecologically modeled on the climate protection of the city against summer overheating and drying. The idea of the blue-green cover of Bratislava also offers the development of new housing sites, culture, sport, recreation and new forms of eco-management in the country. Case studies in localities of Bratislava - Rusovce, Jarovce, and Čunovo on the restored meanders of the river point to possibilities of construction of ecologically structured urbanization in the bays of the Danube arms with islands. Bratislava has the opportunity to develop its suburban development with parameters of the city's climate protection. At the same time, there is an opportunity to propose a concept of peri-urban landscape with the recreational forests and by creating transition zones in contact with the protected landscape.

1. Introduction
The Danube, with its banks, floodplain forests, beaches, arms and islands, is a strategic and vital natural element and bearer of identity for Bratislava and its inhabitants. In the past, the Danube created natural conditions for the urbanization of the city. Originally there was a so-called inland Danube delta with many islands and arms, with characteristic flora and fauna. This inland delta has been gradually reduced and today only a small part has been preserved [1]. The context of the city and water is decisive in the history of Bratislava. On the changes of the city waterfront and in the related public spaces we can observe the benefits of the city on the river from compositional through functional to ecological points of view [2], but also possible threats of floods and climate change. The flood protection system has been improved gradually, up to the today’s form of a comprehensive flood protection line. Currently, Bratislava uses only fragments of the promenade embankment, only a partial contact of the built-up area with the watercourse using the system of transport bridges.
Potentials remain in urban areas in contact with the river – in the area of the dilapidated Winter Harbor, localities Pálenisko, Lido, but also in the southern direction, with the potential of development of urban and recreational lands in the case of restoration of old Danube arms. The value of the Danube landscape is unique [3]. Territorial protection of the values of the natural landscape along the Danube in Slovakia is currently ensured through a system of small and large-scale protected areas, protected areas NATURA 2000. In the image of this environment, the plastic imprint of the inland delta is still present – the relief structure, which was not eliminated by technical regulation of the river and drying the river arms [4].

The subject of the research was the development of a new urban landscape in locations in contact with the Danube and its arms - the transformation of unused Danube embankments in the city and new urbanization in the southern part of Bratislava on the renewed Danube arms. In the city center position, it is necessary to verify the feasibility of completing the promenade of the Danube embankment [5]. At the sites of the old-new Danube arms near the rural settlements Rusovce, Jarovce and Čunovo, it is necessary to verify the transition of urban fabric from urban to the rural and to verify the attractiveness of the area for residential, cultural and sports-recreational functions [6].

2. Methods
The method of processing the Danube site research consisted of four phases. The first phase involved field surveys, mapping and processing of territorial potential analyzes. The second phase was followed by the selection of selected representatives of under-utilized territories with a potential for development of the given locality. In the third phase, the urban design proposals for selected areas were elaborated. In the last phase of the research, case studies were gradually evaluated in terms of urban quality and landscape-ecological benefits for Bratislava, in connection with the revitalization of the Danube arms.

Case studies examining the possibilities of developing Bratislava in contact with the river focused on solutions in the following locations:
- the transformation of the unused Danube embankment in the central location of the city at the Winter Harbor and Pálenisko Area,
- the urban development south of Petržalka – development of the Southern Town,
- landscaping and urban transformations in natural locations in contact with the Danube River and its branches,
- and landscaping solutions for rural sites in contact of the renewed Danube arms – in the locations Jarovce, Rusovce and Čunovo.

Urbanization was verified in contact with the proposed canals and traces of dead arms, in the scope of possibilities of involving this potential in the development of the area for housing, culture, sport, recreation and new forms of eco-management in the landscape. The qualitative level of the case studies was focused on the symbiosis with the landscape embankment relief, the creation of public spaces and the intensity of greenery versus water in the penetration of the surrounding natural formations.

3. Results
Exploiting the potential of the Danube River in the position of Bratislava's waterfront, Winter Harbor, Pálenisko, Lido, the potential of further development of urban and recreational landscape south of the city center and south of the Petržalka district, and the potential of landscape-urban transformation of natural sites in contact with the Danube as well as landscaping solutions for rural sites in contact of the renewed Danube arms – in Jarovce, Rusovce and Čunovo concentrated on forms of urbanization that primarily took into account the current ecological problems of the city and tried to penetrate the river
landscape with respect to nature identity, with benefits for suburban housing, work, culture, sports and recreation.

3.1. Case studies in the localities of Bratislava – Winter Harbor and Pálenisko

Case studies, which were carried out for the areas in the localities of Bratislava - Winter Harbor and Pálenisko (figure 1, 2), showed:

- the need to connect the city with the river by adding a continuous promenade in the city center,
- a compositional outline of urbanization with views of Bratislava Castle, the center and a new vertical development east of the historic city center,
- the need to preserve the industrial character of the Winter Harbor and Pálenisko area while preserving objects, lines and premises of existing and potential heritage value,
- incentives for urbanization as a transition zone from the stable structure of the historic city center to the vertical structure,
- the need for green infrastructure and green areas and lines, with banks and piers, contact functions to the banks of the Danube, multifunctional use of the waterfront, contamination with the restoration of the Danube arms as a flood control solution for the Danube level and urban climate protection,
- the need to locate representative cultural and social functions, squares and pedestrian routes with sufficient greenery and water features, the need for multifunctional objects and recreational and sporting functions both inside and outside the premises.

![Figure 1. New urbanization of the Winter Harbor area and Pálenisko in Bratislava, author D. Repiský, 2019 (Photo: Archive of the author)](image1)

![Figure 2. Transformation of Winter Harbor in Bratislava to the multifunctional area in continuation of the Danube promenade, author P. Horkava, 2011 (Photo: Archive of the author)](image2)
3.2. Case studies in the locality of southern development of Bratislava – Southern city

Case studies in the locality of southern development of Bratislava – in relation to the Southern City (figure 3) showed:

- the need to complement the new Danube landscape adapted to the urbanization of residential structures with amenities and waterfront promenades,
- the need for higher urban amenities in the core of the territory and the availability of public transport stops,
- the need to integrate urban structures into the landscape relief of the Danube arms using an ecologically characterized type of development and recreation,
- variations of residential structures from compact, block and scattered buildings,
- the need for a system of linking green, alley and low green lines towards watercourses,
- the possibility of using urban water transport.

![Figure 3. Southern development of Bratislava integrated to blue and green infrastructure, author: T. Rudý, 2019 (Photo: Archive of the author)](image)

3.3. Case studies – natural localities in the contact with the Danube River and its arms

Case studies of natural sites in contact with the Danube River and its arms (figure 4) focused on:

- design of a network of natural and artificial elements of greenery, restoration of dead Danube arms, water bodies and a bypass channel to take into account the surrounding natural area and spatially define the green ring of Bratislava.

The conceptual landscape-urban design of the site at the Danube water reservoir (figure 5) was focused on:

- revitalization of landscape and urban identity and the possibility of partial urbanization, in connection with the natural development axis, with a sensitive proposal of the use of natural values for recovery, tourism, recreation and leisure activities,
- the revitalization of a dysfunctional area devastated by the construction of a water reservoir on the Danube in order to search for the identity of the landscape, with a new functional use of the contact area and water area,
- linking sports-recreational activities of city-wide, regional and international importance, involving the river, floodplain forests, the international cycling route Eurovelo 6 and the rural border area.
3.4. Case Studies – rural localities in the contact with renewed Danube arms

Case studies of rural sites in the contact with the renewed Danube arms (figure 6) have tried to:
- complete existing built-up areas to attractive city districts with greenery (parks, forest parks,...), and connections to the proposed green infrastructure of the city.
- design a new zoological, botanical garden, ecological park and museum of floodplain forests, city cemetery, leisure and recreation area, sports and recreational area, ecological campus and others in the green corridor (figure 6),
- restore ecological ways of agricultural land management in the country - return to fruit growing, fishing and small farms,
- complete design of water transport, cycling, walking routes.

Figure 6. Development of the contact areas of rural-urban structures with relation towards the natural environment of renewed Danube arms, authors I. Kožehubová, M. Pavlík and L. Medlenová, 2019 (Photo: Archive of the authors)

4. Conclusions
The landscape of the inland delta of Danube represents exceptional values not only of natural but also of cultural heritage [7]. The case studies in the contact points with the Danube and proposed canals and traces of dead arms verified the possibility of a sensitive involvement of urbanization in the recreational development of the area with the aim of improving the lives of the city residents and visitors. The results of the research and the case studies of the alternative solutions of the selected sites on the Danube embankment and on the old arms of the Danube in the wider hinterland of Bratislava have shown the possibilities of exploiting the potential of the river and the southern area of the city. A sensitive approach to existing urbanization and landscape, complemented by the Danube arms and the return of floodplain forests, is an environmentally-friendly way of developing riverside and suburban urbanization. The proposed blue-green cover of Bratislava should provide the city with flood protection and climate improvement in the summer months. This principle is in line with the trend of European cities and their projects and programs facing climate change.

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