The Relationship between Residential and Natural Environments in Metropolitan Regions

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Abstract

The harmonious relationship between landscape and settlement is one of the important factors of sustainability, especially in the context of the climate crisis, but also in the context of social changes. The hinterland of large cities is characterized by a trend of suburbanization, which affects the way it is used, as well as its character. A special position in this context is represented by metropolitan cross-border regions. The issue of optimizing their mutual connections, as well as harmonizing the relationship between their settlement and landscape structures, has been receiving attention for several decades. Within this context, metropolitan suburban areas were perceived as stereotypical in the past. On the contrary, their heterogeneous character is increasingly evident today, both in terms of the application of diverse forms of housing, storage-production and recreational functions, and the way of land use. It is a kind of interweaving of urban, rural and landscape elements and forms. The paper presents the results of research aimed at evaluating the potential and optimizing the relationship between landscape and settlement in the border area of Slovakia and Austria. It is a territory that is shaped by characteristic natural phenomena – the Danube river landscape, intersected by the massif of the beginning Carpathian arc, and the cultural landscape, shaped over millennia. The territory is simultaneously under the pressure of strong suburbanization conditioned by the attractiveness and economic power of the two capitals of Vienna and Bratislava, as well as their own growth towards the countryside. The research is therefore focused on the analysis of the relationship between settlement and the dominant natural phenomenon – the Danube landscape on the one hand, and on the analysis of the relationship between settlement and agricultural landscape. The paper presents the problems, as well as the potentials of interaction between natural and settlement structures in the given area. At the same time, it points out appropriate conceptual solutions and regulatory tools for their symbiosis and mutual enrichment.

Keywords: *Cross-border synergy, Landscape, Danube, Settlements, Suburbanization, natural phenomenon*

1. Introduction

Natural and cultural landscapes can only be studied in their context. For this reason, the presented research on the landscape in the border regions of Lower Austria and Western Slovakia is studied in mutual synergy. The Danube landscape, which is characteristic of this area, has its own specificities, with dominated by the Danube, its branches and floodplain forests. The above-mentioned landscape types show varying degrees of human intervention. This also applies to the natural landscape in the given area. It is consistently protected, used for recreation, or even degraded (through the intervention of a technical work that rewrote the original landscape image). The cultural landscape has undergone centuries of cultivation with its agricultural use, up to its exploitation by construction and economic activity.

Lower Austria, the Danube Region and Záhorie are regions that have a common border. It is largely formed by the Danube River. The Danube river system creates a unique internal delta. This is a specific natural phenomenon with several protected areas. The accompanying floodplain forests are a rare ecosystem with rare fauna and flora of river communities, lakes, or wetlands. The mentioned regions have a great wealth and diversity of natural habitats. Along the Danube, the protected area of the Danube Floodplains stretches with a huge number of legally protected species of animals and plants.

The majority of the territory of the Danube Region and Lower Austria is occupied by a lowland, which has exceptionally fertile soils that determine its agricultural character. Wheat, corn, vegetables, fruit and vines are grown here. In addition, the territory is characterized by a pleasant climate.

The cultural and natural landscape along the Danube in the mentioned cross-border regions is complemented by historic towns, rural settlements and many sites with monuments. Many of them had defensive significance (due to the border of Roman territory, protection against Turkish raids, or for the protection of important trade routes). The fertile land conditioned the development of mansions, manors, farms, but also irrigation and drainage canals.

The regions studied are significantly differentiated in terms of the hierarchy of the settlement network. However, they have a common basic characteristic – a connection to the capital of their country. The Danube region and Záhorie are closely connected to Bratislava, the capital of Slovakia and its wider area. The Lower Austria region is dominated by Vienna.

The development of each area depends on the level of transport connectivity. The studied regions are linked to multimodal corridors of European importance. The attractiveness of the two capitals as centers of economy and administration of the two countries, their excellent connectivity creates significant pressure on the surrounding landscape.

The research follows up on the the DANUrB project, within which a methodology for assessing natural and cultural heritage was developed, as well as a strategy for developing sustainable tourism based on the established potentials. The research was focused on the area of the middle and lower reaches of the Danube. The sustainable tourism development strategy within the DANUrB project has

set out several thematic areas that are characteristic of the entire Danube region. The so-called "green and water routes" have been designed for the natural environment around the Danube. The routes mentioned respond to the characteristic features of the entire Danube region, as well as the individual regions that they interconnect. They thus bring added value to the regions themselves, have a synergistic effect for the cross-border regions that they interconnect, as well as the whole Danube area. The "water" route is linkin to spas, waterways, riverside promenades, beaches, thermal baths. The green route is linking to the natural and cultural landscape; The project also focused on assessing the relationship of settlement to the Danube, with the focus of research being small and medium-sized towns and the quality of their public spaces in relation to the waterway [1].

Many conceptual and strategic materials related to the development of tourism around the Danube have also emerged from projects supported by the European Union, particularly within the framework of the Interreg scheme (Danube transnational Programme). The Danube Tourism Laboratories (DaTuLabs) project created an online platform of cooperating actors along the Danube (Centre for Sustainable Tourism) as well as a transnational strategy for Danube tourism based on ecological initiatives. The project "DanubeHIKE – hiking routes along the Danube" focused on tourist routes in relation to natural features with cross-border overlaps.

A significant number of publications are also focused on the potential of the Danube landscape and the natural heritage of the area. Part of the research is devoted to the importance of green infrastructure as a factor that strengthens the development of sustainable tourism in settlements around the Danube. In this context, the research pointed out the need to improve the direct contact of the urban structure with the waterway through a system of public spaces (promenades and parks) [2]. Several contributions focused on problematic interventions in the landscape [3], or on the problems of suburbanization around large cities [4].

2. The relationship of settlement with the Danube River, as a dominant natural element.

As part of our research, we focused on the harmonization of settlement and landscape. The research was aimed at examining the relationship of settlement to the natural landscape in the studied area of Lower Austria, Podunajsko and Záhorie. The relationship is following:

- The relationship of settlements and the Danube, including its tributaries, branches and floodplain forest, as a dominant accompanying element;
- The relationship of settlements and the cultural landscape.

Several aspects were examined in the relationship of settlement to the Danube:

- The location of the settlement to the river, with regard to the use of its potential;
- The method and intensity of the ties between the settlement and the river;
- The nature of the contact zone of the settlement and the degree of interaction with the natural element;

The relationship of the settlement and the watercourse can be divided as follows:

- Direct contact between the settlement and the river;
- Contact of the settlement with the river through a natural accompanying natural element (floodplain forest, park, cultural landscape);
- Settlements without direct contact with the river.

The determining factor in this relationship is geographical conditions. The most frequent form of contact of settlements with the Danube is through the interface of the floodplain forest, which is conditioned in the cross-border metropolitan region of Vienna - Bratislava by the existence of the significant nature reserve Dunajské Luhy. The given territory is also typical of the frequent overgrowth of floodplain forests into the castle park, or a park linked to the manor house, both in Austria (in the settlements of Orth, Eckesau, Petronell, Wolfstahl) and Slovakia (Rusovce, Čuňovo). The situation is different in the case of the contact of the Danube with the Carpathian massif, which creates a strait. Settlements in this position contact the watercourse directly (Heinburg, Devín, Bratislava). A special situation is represented by the areas around the Gabčík Reservoir, which has fundamentally changed the landscape of the area.

The studied contact areas of the settlement and the river can be divided into the following groups in terms of their functional use based on their characteristics:

- Floodplain forest - as a recreational background, supplemented by educational trails, hiking and running trails, cycling trails, Danube promenades.
- The cultural landscape in most cases in the studied area continues to the floodplain forest massif and consists of agricultural landscape, areas of gardens, orchards, vineyards.
- Recreational areas - sports fields, playgrounds, facilities for cyclists, spaces for social contacts.
- Contact urbanized environments – represents city promenades, active public parterre, public functions..., cultural facilities, historical - monumental objects...

At the settlement level, from the point of view of the accessibility of the settlement and the natural environment, the predominant method/form of connection of the communication/street network of the settlement and the natural element is essential. It can be parallel to the watercourse, or perpendicular to it, or a combination of both...

The current state of interaction between settlements and the "Danube landscape" is significantly different in Austria and Slovakia. In the Lower Austria region, the settlement structure reacts sensitively to direct contact with the Danube watercourse or the accompanying floodplain forest. The aforementioned valuable natural potential is adequately evaluated in the form of promenades, parks, "green" recreational areas, cycling and running trails, or nature trails. In Slovakia, there is an obvious lack of interconnection between the urban structure of settlements and the Danube. Municipalities do not sufficiently use the potential of the Danube and floodplain forest for the recreational purposes of their residents. Settlements are often almost intact to the area around the Danube, especially in terms of insufficient pedestrian and bicycle connections, or suitable social and recreational use, although the built-up part of the municipality is in direct contact. On the contrary, areas in which tourism and recreation are developed are often overloaded, especially due to the fact that there are few of them. Therefore, they are sought after: low supply - high demand. Unfortunately, existing public embankments, as contact points with the flow of the Danube, do not have adequate quality and equipment.

Tab.1: Analysis of the relationship between settlements and the “Danube landscape”

Settlement	Contact with the river	Contact through river forest	Contact through park	Contact through recreation areas	Contact throught cultural landscape		Settlement
					Fields	Gardens, orchards	
Viena	●	○	●	○		○	Viedeň
		●	○		●	○	Orth/AT
		●	○				Eckersau/AT
Petronell/AT		●	○				
Deutshaltenburg/AT		●	○				
Heinburg/AT	●	○		●		○	
Wolftahl/AT		●	○				
							Devín/SK
Bratislava/SK	●	●	●	○		○	**Bratislava/SK**
Rusovce/SK		●	○				
Čuňovo/SK		●	○				
	●					●	Hamuliakovo/SK
		○		●	●		Šamorín/SK

Legend: degree of contact: ● predominant ○ combined

3. Structure of Agricultural Landscape

In relation to settlement and cultural landscape, several aspects were studied:
- Different structures of cultural landscapes on the Austrian and Slovak sides of the border region.
- The character of the contact zone between settlements and the cultural landscape
- Changes in the structures of the cultural landscape caused by urbanization and functional changes in the countryside.

3.1 Austria

The conditions for agriculture in this region are very favorable. The Marchfeld area is one of the main centers of agricultural production in Austria and the primary supplier of vegetables for the city of Vienna. The structure of the cultural landscape typical for this region stems from the historical arrangement of land in the built-up areas and the outskirts of settlements. Settlements historically developed along roadways, which also served as the main social and public spaces [5]. In some cases, these roads expanded or split to create squares (e.g., Scharndorf, Zurndorf, Haringsee). Perpendicular to the road were plots of land with houses arranged in an L-shape, where the front facades clearly enclosed and defined a common public space. Houses and courtyards opened toward the countryside. Behind the houses were gardens with agricultural buildings. This structure created a natural, gradual transition from the built-up center of the settlement through the garden to the open countryside. The majority of the land was farmed by local farmers. Fields alternated with open spaces used as meadows and pastures, which belonged to the village or the lordship. The structure of fields and natural areas harmoniously complemented the shape of the settlements, and vice versa, the settlements harmoniously complemented the image of the landscape.

Much of the wetlands were drained due to intensified agriculture, and pastures, meadows, and smaller forests were converted into farmland. Some of the former hunting grounds and ornamental parks have been preserved, especially those directly linked to castles (e.g., Schloss Batthyany in Kittsee, Schloss Hof, Schloss Prugg, and Harrachpark in Bruck an der Leitha). Over time, several tree alleys connecting settlements also disappeared. A few of them have been preserved (e.g., Stopfenreuth - Witzeldorf, Bad Deutsch-Altenburg - Petronell-Carnuntum). Tree alleys and greenery now mostly line the main roads in settlements, linking them to the surrounding landscape.

3.2 Slovakia

The cultural landscape on the Slovak side of the border region between Vienna and Bratislava differs in structure, primarily due to the sociopolitical conditions of the twentieth century and the related changes in land management. Due to the common development within the Austro-Hungarian monarchy and similar topographic conditions, until the mid-twentieth century, the image of the agricultural cultural landscape and settlements in Slovakia was nearly identical to that in Austria. Here too, settlements harmoniously complemented the structure of fields and natural areas [5]. Many of the original houses have now been replaced with newer ones.

The arrival of communism and the centrally planned economy marked the end of the gradually developing agriculture and the peasant life tradition [6]. The centrally planned economy meant that private land was either nationalized or confiscated by new collective farms: Agricultural Cooperatives, built on the outskirts of each village or small town. The diversified fields, previously cultivated mainly by family farms, were merged into larger fields for industrial farming. Agricultural cooperatives were modeled

after Soviet kolkhozes, representing Soviet ideology of equality and collective ownership. However, in reality, these ideals were not fulfilled, and farmers were treated as employees, not co-owners [6]. Dissatisfied farmers thus ended their involvement in agriculture and moved in large numbers to cities to seek other employment. After the collapse of the Soviet Union, one of the main goals of the transformation from a centrally planned economy to a free market was to return state-owned property to private hands. Unlike other former Soviet states, such as Lithuania, where cooperatives were destroyed and replaced with new family farms, Slovak cooperatives were privatized and continued their land farming system as during the communist era [7]. The restoration of property rights from before the communist era led to high fragmentation of land ownership, which remained divided among the descendants of former farmers during the communist period.

4. Changes in the structures of the cultural landscape

Only a small percentage of people living in rural areas are still employed in agriculture. Since 1970, the number of agricultural enterprises in Austria has decreased by more than half [8]. The number of people working in agriculture in Slovakia is also decreasing every year [9]. The presence of the two main cities, Vienna and Bratislava, represents the greatest economic power in the border region of Slovakia and Austria. Their attractiveness puts the region under significant pressure from suburbanization. The urbanization of lifestyle and changes in employment opportunities in rural areas create new hybrid urban-rural forms. Digitalization and technologies are transforming the countryside into a zone of intensive agriculture and highly efficient bioenergy. The countryside is increasingly integrated into globalized production processes. Spatial changes associated with new functional, social, and technological transformations contrast with established, idealized images of traditional rural life [10]. The article further discusses the most common changes in the structures of the cultural landscape, associated with urbanization and land use patterns.

4.1 Suburbanization

The greatest changes occur in the landscape due to the continuous expansion of settlements on open land and the encroachment on agricultural land. The situation is particularly alarming in the Slovak part of the region. Settlement growth is occurring chaotically and without regard for the existing settlement and cultural landscape structure. Zoning plans emphasize the functional use of land, without deeper analysis of open spaces within existing settlements, without a concept for public spaces, and without systems for recreational green spaces and green biocorridors. There is also a lack of coordination between neighbouring settlements via bike paths, sidewalks, and tree alleys. The area is being developed solely based on economic parameters for maximum profit, dividing the land into a high number of small plots for individual housing construction. The width of access roads is also minimized, with roads designed only for car movement and a single sidewalk. Streets lose their function as public spaces, and there is a lack of space for greenery. Streets end with fences, plots, roundabouts, and no connection to the landscape in the form of sidewalks, parks, or recreational elements ‘Fig. 1’ [13]. Another typical phenomenon of suburbanized areas is their lack of compactness. New residential neighbourhoods are being created far from existing settlement structures, without service centers, sometimes even without road or bike path connections ‘Fig. 2’ [13].

A significant paradox is that although people are moving to suburban municipalities because of their connection to nature, many plots are fenced off with high, opaque walls, in various colours and materials. The natural gradation from the built-up center of a settlement, through gardens to the open countryside, creating a harmonious image of rural landscape and its genius loci, is completely ignored in suburbanized areas. New neighbourhoods are created without any connection to nature and the landscape.

Even in villages outside the main suburban areas of Bratislava and in Austrian villages, there is an intensification of built-up areas and the development of new construction. This is primarily realized by connecting to new development, but also on smaller plots outside the original structure ‘Fig. 3’ [13].

Fig. 1. The village of Hviezdoslavov (left),
Fig. 2. The village of Rovinka (center)
Fig. 3. The village of Engelhartstetten (right)

4.2 Highways and roads

Urbanization is directly related to the construction of new roads and highways. Roads are planned based on the shortest distances and efficient vehicle movement. Not only do they occupy agricultural land and pollute the environment, but they also physically divide the natural environment and local ecosystems ‘Fig. 4-6’ [13]. The cities of Bratislava and Vienna are connected by highways A4 and A6, leading south of the Danube. There is also a planned expressway S8, connecting these two capitals through the northern part of the Danube, crossing the agricultural area of Marchfeld. The start of construction is uncertain due to multiple complaints and repeated approval processes.

A more suitable mode of transport would be cycling and pedestrian connections. Austria is systematically building cycling routes through the cultural landscape. Slovakia significantly lags behind in the construction of cycling routes.

Fig. 4. Highway D4 near Rovinka (left)
Fig. 5. Highway A6 near Gattendorf (center)
Fig. 6. Highway D4 near Most pri Bratislave (right)

4.3 Recreation by water

The border region contains gravel pits, some of which no longer serve their original purpose. Some have been flooded, and new residential developments are emerging around them (Seepark Kittsee, the lake near Parndorf) 'Fig. 7-8' [13]. Houses benefit from the view of the water surface and from planned green spaces intended for recreation. Due to the original location of the gravel pits in the outside areas of settlements, however, the new residential neighbourhoods are separated from services and settlement centers. Many other gravel pits in the region represent the potential for similar types of development.

Fig. 7. Seepark Kittsee (left)
Fig. 8. Flooded gravel pit Parndorf (center)
Fig. 9. Flooded gravel pit Rovinka (right)

Residences by water are not a new trend in the region. Several examples of artificially created water surfaces around which new development has formed can be found. Originally, these were recreational houses, but many of them are now permanently inhabited. The settlement Erholungszentrum Lassee was established in the 1970s and consists of 14 artificial elongated lakes surrounded by small houses. Feriendorf Breitensee also emerged in the second half of the 20th century, at the location where historical maps show wetland unsuitable for farming - Breiter See. Freizeitzentrum Berg and Lakes in Prellenkirchen create similar typologies. Since these settlements were originally planned as recreational areas, they are spatially separated from the existing center of the village. However, they fit into the structure of the agricultural landscape 'Fig. 10-11' [13]. Flooded former gravel pits are also found in the Slovak part of the region, for example in the villages of Dunajská Lužná and Rovinka, where recreational and leisure areas have formed around the water 'Fig. 9' [13]. The second flooded gravel pit in the village of Rovinka and gravel pits in the village of Podháj are used for swimming and nature walks.

Fig. 10. Erholungszentrum Lassee
Fig. 11. Feriendorf Breitensee

4.4 Urban functions

Urbanization of rural lifestyles brings large-scale entertainment, sports, and commercial services to the region. These services, except for golf courses, are located on the outskirts of settlements, in close proximity to main transportation routes. They are intended for consumers from a wider area, requiring the construction of large parking lots. New shopping centers are typically large single-story halls in standardized designs. Their scale and shape ignore existing settlement and landscape structures. There is no connection to the surrounding landscape, such as through recreational greenery or tree alleys. 'Fig. 12-14' [13].

Fig. 12. Outlet and shopping center Parndorf (left)
Fig. 13. Golf Schönfeld im Marchfel (center)
Fig. 14. Freizeitzentrum Bruck an der Leitha (right)

4.5 Energy Source

With the increasing push for a transition to sustainable energy sources, the countryside, with its vast space, is becoming a location for capturing energy from wind, sun, and earth. In 2009, the Austrian parliament adopted the goal of obtaining 3,000 MW of wind energy by 2020, with the southern Austria region producing nearly two-thirds of the required energy. The Burgenland region is also rich in wind farms. Both regions, Southern Austria and Burgenland, have established zoning plans for the placement of new wind turbines. Several factors are taken into account when creating these zoning plans, such as assessing the wind potential of a specific location, economic benefits for local actors like landowners or municipalities, and the impact on nature conservation, including bird flight paths over the area [11].

Wind turbines have a significant impact on health and safety. They produce sound emissions, flickering shadows, and in low temperatures, ice may fall. The Distance Law (Abstandsregelung) therefore sets minimum distances between wind turbines and affected areas. Such areas include residential zones, standalone residential buildings, campsites, and gardens. The minimum distance from residential areas is 1,200 meters, which includes an 800-meter barrier from pollution and a 400-meter reserve for potential settlement growth. Eliminating the placement of wind farms near settlements dictates their location in natural and agricultural landscapes. Turbines can reach heights of 200 meters, significantly altering the landscape even from great distances. Previous rural environmental landmarks, such as church towers and silos, are being replaced by new landmarks—wind turbines 'Fig. 15-17' [13]. Slovakia lags behind in the construction of wind farms. To date, there are only five turbines in the country, and they are located outside the studied area.

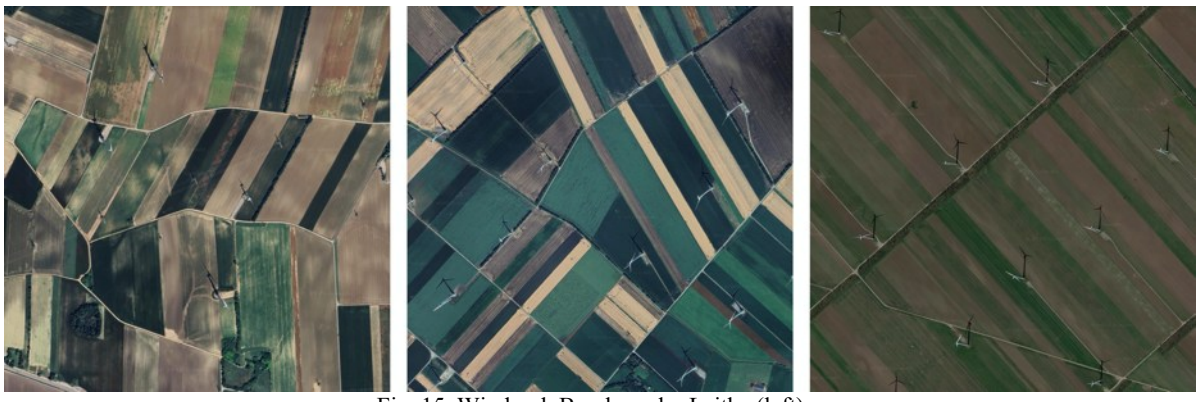

Fig. 15. Windpark Bruck an der Leitha (left)
Fig. 16. Windpark Scharndorf (center)
Fig. 17. Windpark Neudorf am Parndorf (right)

5. Conclusion

As follows from the previous analysis of changes in the structure of the cultural landscape in the border region, the cultural landscape is shaped and altered based on specific natural and cultural factors such as topographic conditions, methods of land management, access to land and land ownership. Thus, the landscape is a spatial phenomenon in which traces of ecological and social structures are recorded. Sören Schöbel compares the cultural landscape to the image of a city and its gradual formation through social, economic, and ecological influences [12].

The complexity of new relations in the countryside and the urbanization of its environment raises the question of whether current planning mechanisms are sufficient. The current development is leading to the degradation of the landscape, and

agricultural land is rapidly disappearing. Zoning plans inadequately address the connection between urbanized environments and the surrounding landscape.

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