BOUNDLESS SETTLEMENTS – TENDENCIES AND FUTURE OF URBAN SPRAWL IN THE AGGLOMERATION OF BUDAPEST

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Abstract
In this paper we wish to draw attention to the ecological and landscape protection aspects of urban expansion by analyzing two study areas located within the Budapest agglomeration. The natural conditions of the eight studied municipalities – four in each study area – are quite similar, as both study areas are located on islands of the Danube: Szentendre Island and Csepel Island. However, their ecological connections are significantly different, and so is their vulnerability to land use change. We analyzed the reasons behind these differences and the prospective processes based on recent tendencies using data on land use and land cover changes.

Keywords: Urban sprawl, Budapest Metropolitan Area, ecological network, Natura 2000, ecological conflicts, landscape history, settlement fringe, land cover

1. Introduction

The concept of the environment as a potential built-up area, focusing on the monetary value of land was the typical point of view of the last century. However, in recent years the expansion of built-up and permanently altered areas on former agricultural and natural sites has created a demand for building regulations based on a different, new approach in several European countries.

In historical times, population growth was the main factor in the growth of settlements. After the Turkish rule, the defensive role of walls and fences was diminished, which led to the first wave of urban expansion. Later, the appearance of new settlement types – farms, ranches, manors etc. –, due to intensive agriculture gaining land over extensive

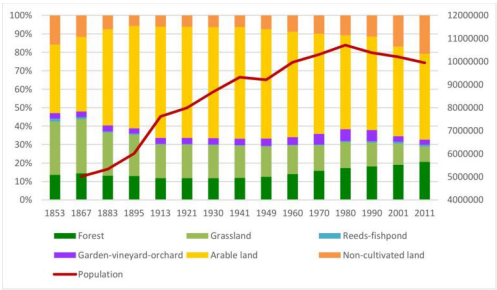

Fig. 1. Proportion of different land uses and the population in Hungary (1853-2011) (KSH 2012a; KSH 2012b; KSH 2012c; KSH 2014)

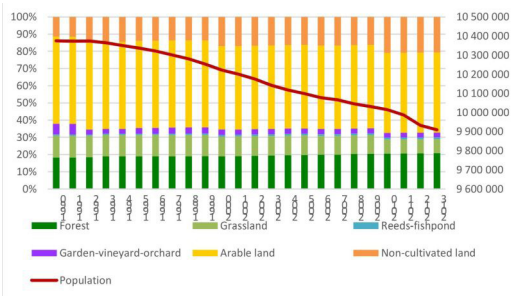

Fig. 2. Proportion of different land uses and the population in Hungary (1990-2013) (KSH 2012a; KSH 2012b; KSH 2012c; KSH 2014)

husbandry, allowed the network of built-up areas to expand even further. The proportion of cultivated land in Hungary was highest in the first third of the 20th century (Fig. 1), at this time non-cultivated land – which is essentially synonymous with built-up areas – covered barely over 6% of the country's total area. In contrast, in 2013 non-cultivated land covered more than 22% – approximately the same area as Natura 2000 sites and forests. This means that by today, spatial structure contains an almost equal amount of ecologically important areas and significantly altered areas (settlements, infrastructure and mines), which generally have low ecological value or even cause ecological problems.

The background of non-productive land uses changed significantly in the second half of the 20th century. Hungary's population reached its peak around 1980, and has been decreasing ever since. However, since 1980, the proportion of non-cultivated areas has still grown from 11% to 20% (Fig. 2). This phenomenon can only partly be explained by the dramatic changes in lifestyle – the lower number of persons per household and the increase in the number of households. Another, perhaps even moreprominent reason is the differences in profit between continuous agricultural land use and real estate development.

Naturally, the speed of this change has been different in each part of the country. It is significantly faster in urban agglomerations with increased property values, while in rural, depopulating areas forest cover is increasing. On a national scale, however, the growth of built-up areas still outweigh the growth of forest cover. This process is partly due to the decreasing amount of land necessary for the food supply of the same number of people, which, combined with the population decline, naturally causes the shrinking of agricultural areas. This would not raise environmental concerns in itself – ecological problems are not caused by the decrease in arable land, but by the dynamic expansion of land uses with even less ecological value. Construction sites, monocultural plantations of exotic species with low ecological value and spontaneous forests of invasive species occupy the place of grasslands, gardens, vineyards, reeds and marshlands, which has an adverse effect on biodiversity and landscape diversity. Therefore, the question is whether the network of areas with virtually no ecological value will overcome the system of traditional land use and whether the ecological system will remain sustainably functional in the changed spatial structure. It is very urgent to determine the characteristics and proportions of a spatial structure for the future that does not threaten the ecosystem within a specific region.

The Budapest agglomeration is a region particularly affected and threatened by the change process. The Environmental Management Programme of the region drew attention to the predominance of greenfield investments, the resulting conflicts between nature conservation and investment purposes and the ongoing loss of natural

green surfaces as far back as 2007 (Budapesti Agglomerációs Fejlesztési Tanács 2007). This process is especially prominent regarding small and already fragmented habitats and (semi-)natural green surfaces which have no particular value by themselves and are not under specific legal protection but belong to the National Ecological Network (Országos Ökológiai Hálózat, thereinafter OÖH) and function as a locally important refuge for wildlife.

Such problems in the Budapest metropolitan area were brought into focus by the regional development journal Falu Város Régió in 2008, having dedicated a complete issue to the topic (Issue I, 2008). It stated, among others, that biologically active surfaces had been constantly shrinking in the Budapest agglomeration, while built-up areas had been steadily expanding. As the extent of non-productive land use had been expanding at an increasingly fast rate, by 2008 their proportions approached – and in the inner ring of the urban agglomeration even exceeded – the 1/3-2/3 ratio of built-up and non-built-up areas regarded to be the limit of regionally sustainable land use. The proportion of forested areas had also been decreasing, and with the expansion of paved surfaces, the runoff coefficient declined as well, resulting in a deterioration of drainage and water management conditions (Schuchmann 2008).

The spatial structure of the municipalities of the Budapest agglomeration are regulated by the Spatial Plan of the Budapest Agglomeration (Budapesti Agglomeráció Területrendezési Terve, thereinafter BATrT). A 2011 amendment of the BATrT was aimed at restricting urban sprawl using regulatory tools. For this purpose, proposals for building new apartment complexes and industrial facilities have been restricted, settlement coalescence has been prohibited (5§ (3)), and the designation of new developments is now restricted in a 200 meter wide zone around the administrative boundaries of the municipality. The restriction of the growth of built-up areas (a limit of 2%) was aimed to increase the value of brownfields. Requirements have been imposed on some developments, while new regulatory procedures are being implemented. The BATrT, while restricting new developments in general, creates a possibility, named „land switch", for municipalities to change their previous, sites for proposed development and, according to a revised urban development concept, designate new sites of the same size in their amended Structural Plan. Land switch does not decrease new developments, but at least makes structural corrections possible).

Apart from influencing urban sprawl, another way to secure a sustainable spatial structure is to conserve areas that are still in favourable ecological conditions. EU member states had to recognize in the early 1990s that the previous practice of nature conservation – based on species protection and the designation of protected areas – is unable to efficiently ensure the survival of natural habitats. The shrinking and fragmentation of these habitats brought attention to the importance of ecologically less valuable, but widespread associations in the conservation of interconnected habitat networks. As a result, in 1993 in Maastricht the idea of a European Ecological Network was born. The main principle behind the creation of the network was to surpass the previous dichotomy of „protected areas vs. non-protected areas" and to protect habitats from further degradation and fragmentation together with their surroundings.

In 1995, on the proposal of the Council of Europe, all accessing states signed the Pan-European Biolological and Landscape Diversity Strategy (PEBLDS) in Sofia, which set the designation of the Pan-European Ecological Network (PEEN) as one of its main goals. The directive for the creation of a unified network stated that the network is a coherent spatial system of natural and semi-natural ecosystems, habitats and landscape elements, consisting of core areas, ecological corridors, buffer areas and restoration areas, which, following habitat restoration,

may even join the network as core areas. According to the original proposal, buffer zones would have protected core areas and ecological corridors in a continuous, wide belt. However, their designation often failed or their area was reduced due to the interests of urban development, agriculture, industry and mining (Nagy 2004).

In Hungary, the aforementioned restrictive protection system reached its full extension with the adoption of the National Spatial Plan (Országos Területrendezési Terv, thereinafter OTrT) in 2003. Nevertheless, both the spatial structure and the content of conservation measures has changed a lot on several planning levels since then. On the regional level, Figure 3 shows the elements of the ecological network and built-up areas as designated by BATrT. Buffer areas (yellow) apparently do not meet the original principles of PEEN designation: not only do they fail to form a wide belt, but they are basically missing in most of the agglomeration area, which means that core areas and ecological corridors are often directly adjacent to residential areas, without any buffer zone.

2. Materials and Methods

In our paper, we wish to reveal the local aspects, causes and spatial context of the aforementioned land-use change processes, along with the ecological conflicts they cause, on the example two settlement groups located in the Budapest agglomeration (Fig. 4). The settlement groups are located in a similar geographical environment, but they have had markedly different histories of settlement development.

Our analysis comprises of three distinct – but thematically connected – topics, which are the following:

- Based on population dynamics and the changes in land use we analyze the dynamism of settlement development and the characteristics of urban sprawl tendencies. By comparing the two factors we wish to analyze how much the processes in spatial structure reflect to changes in the population and what the prospective sprawling (or shrinking) tendencies are in each of the settlements.
- In order to determine the efficiency of regulations and restrictions as planning tools, we analyze the territorial protections on our study sites. Based on the history of protected areas we wish to determine their roles both in conserving ecologically important habitats and in reducing urban sprawl.
- The Corine Land Cover database- en-

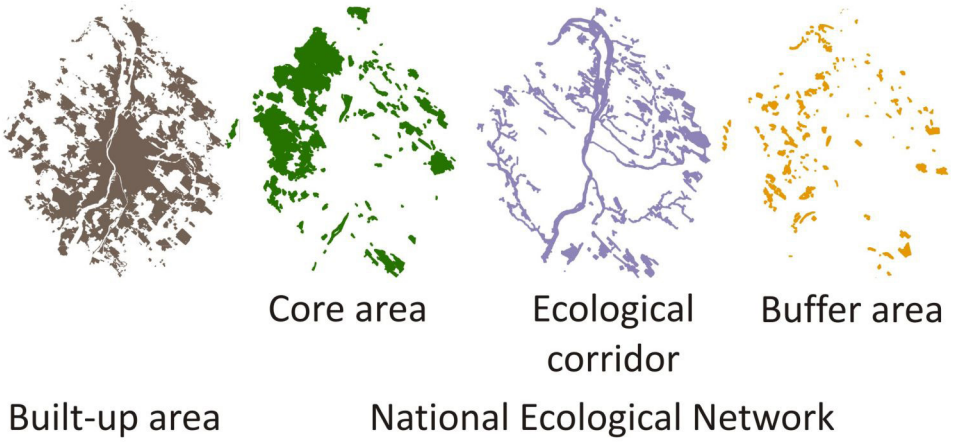

Fig. 3. Built-up areas and the OÖH according to the Structural Plan of the Budapest Agglomeration (Pestterv 2011)

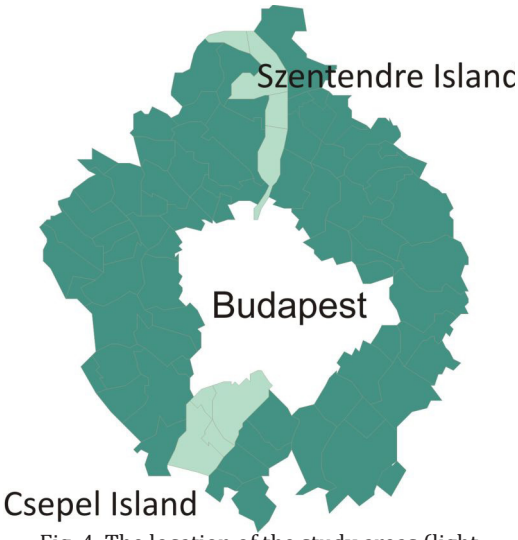

Fig. 4. The location of the study areas (light green) within the Budapest Metropolitan Area

compassing four surveys – makes it possible to analyze and assess ecologically valuable areas and habitats destroyed on all studied municipalities by the expansion of urban areas in the last 20-25 years. The comparative analysis of this data and the proposed land use system designated by regional plans shows the valuable – but unprotected – areas threatened by land use change and therefore allows us to predict the scale of future ecological loss. By this analysis we wish to determine what areas have been eliminated from the ecological structure due to the lack of protection, and which are the habitats that are expected to disappear in the future.

By comparing the two study areas in each of the three topics we wish to reach conclusions about the complex interactions of urban sprawl, population dynamics and regulatory measures.

3. Results and discussions

History and characteristics of urban expansion within the study areas

The settlements of the Northern study area (located on Szentendrei Island) were already in existence prior to the 20th century, with a population between 1000 and 6000 – the same range as today. The population of almost all municipalities were stagnating until the change of regimes – and even though population has been growing since then, the growth rate is significantly lower than that of the other study area. This stability is also reflected by land use proportions, the extent of non-cultivated land (the land use category including built-in areas as well) has only been growing at a moderate rate in the last two decades. The population growth is facilitated by the more intensive use of already built-in recreational areas and only partly by gardens, orchards or vineyards. The settlements of Szentendre Island have been moderately expanding (Fig. 5).

The municipalities located in the southern study area took their present form later, Szigethalom and Halásztelek only becoming independent in the second half of the 20th century. Their population shows a constant and dynamic growth, today they have between 10,000 and 40,000 residents. The population growth has been especially fast since the change of regimes and the construction of the M0 ring road around Budapest. Changes in land use are proportional to population growth, the amount of non-cultivated land is growing rapidly. Built-up areas have completely replaced the gardens, vineyards and orchards formerly characteristic of the area, and also have reduced the proportion of arable lands. The settlements on Csepel Island are among the most intensively expanding settlements within the agglomeration (Fig. 6).

The role of territorial protection in nature conservation and in controlling urban sprawl

Several tools have been implemented to restrict development in planning practice. Protection zones, protected areas and land use categories preventing or restricting building-in help controlling urban sprawl in situations threatening intended land use

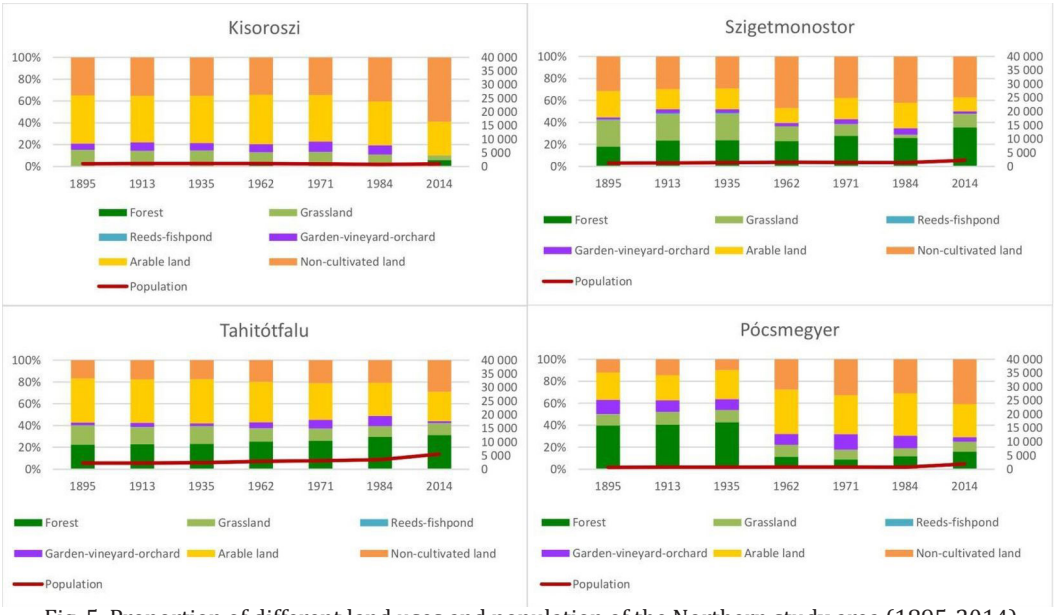

Fig. 5. Proportion of different land uses and population of the Northern study area (1895-2014) KSH 2012a; KSH 2012b; KSH 2012c; KSH 2014)

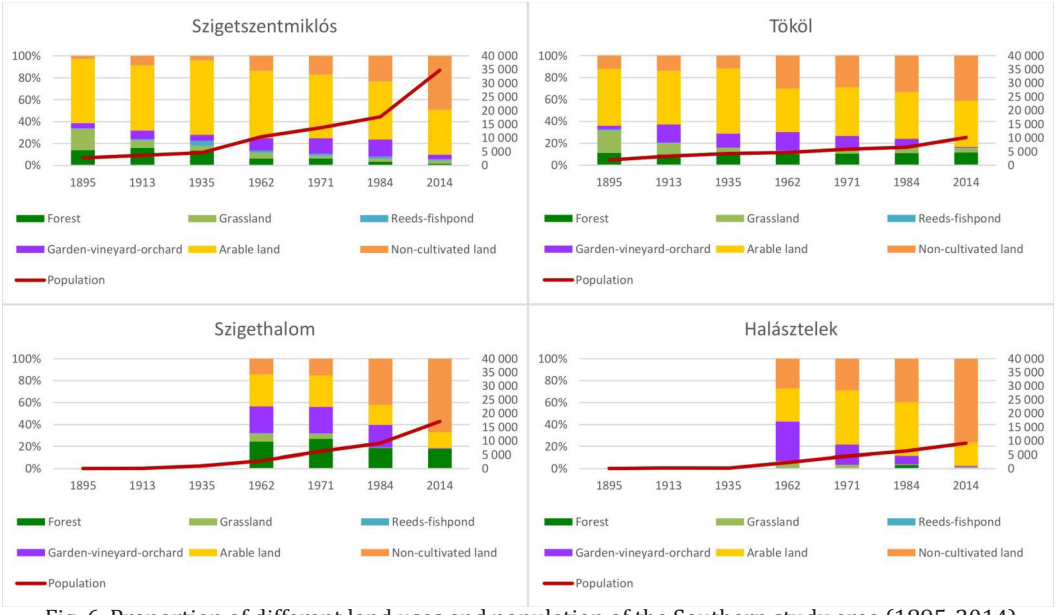

Fig. 6. Proportion of different land uses and population of the Southern study area (1895-2014) KSH 2012a; KSH 2012b; KSH 2012c; KSH 2014)

or natural conditions. Nature conservation, water source protection and the designation of the National Ecological Network (OÖH) aim at protecting natural resources directly. However, several land use (military areas, airports, etc.) that restrict development do not aim at the conservation of nature, it is merely a result of restricted use. In our paper, we analyze the history of both study areas, focusing on the spatial and temporal connections between restrictions, the survival of natural resources and urban

expansion. A common feature of the two study areas is that drinking water extraction from gravel terraces of the river Danube had an important part in the history of their land use.

Northern study area

The expropriation of waterworks and the riverbanks – to ensure the water supply of Budapest – has been restricting the development of riverside areas, but restrictions had been in place even before that. The construction of the first row of wells on Szentendre Island started in 1897, and the presence of territorial protection on the island can be dated from this year (Károlyi – Tolnai 2008). Since the 1980s, the conservation of the quality of vulnerable aquifers has become the centre of attention. The conservation of vulnerable water resources – like the bank-filtered aquifers of Szentendre and Csepel Islands – has been regulated by a Governmental Decree since 1997. Protective areas and zones (inner and outer areas, hydrogeological A, B and C zones) have to be designated for the protection of the water resources, based on the travel-time of the hypothetical pollution to the water extraction site. The prohibitions and restrictions regarding development, land use and access within the zones, even though they are not based or aimed at ecological purposes, contribute significantly to the conservation of the remaining alluvial habitats, as the designated ecological network contain these areas almost entirely (Fig. 7).

Several levels of protection ensure the conservation of natural values of Szentendre Island. The first protected area was designated in 1974 within the municipal boundaries of Tahitótfalu. By 1981, three other, smaller and isolated protected areas were designated. The protection of the largest area was designated in 1985 by a decree of the Pest County Council, extending the county-level protection to cover the entire island.

The council decree stated that the goal of protection was the conservation of the image of the island's landcape, the botanical, zoological, geological and cultural values within the area and the aquifer providing water supply for a significant amount of people. This protection was not really efficient in preventing urban expansion, but it drew the attention of municipalities to the importance of restricting certain land uses.

In 1990, the authority over county-level protection and the power to designate new protected areas was passed over to municipalities. In 1992, the municipalities of the island unanimously lifted the protection from the entire island and ensured the protection of areas of significant value – islets, alluvial forests, pastures – via municipal decrees. Upon creation of Duna-Ipoly National Park (DINP) in 1997, the municipal-level protected areas were lifted to the national level as part of the new National Park. The valuable wildlife of the parts of the island that do not belong to the DINP is protected by the Natura 2000 network of the European Union. Two Special Areas of Conservation are designated on the island. One of these is „Duna és ártere" (HUDI20034), an elongated area stretching along the river Danube, touching many settlements apart from those on Szentendre Island, protecting mostly floodplain habitats. The other one is „Szigeti homokok" (HUDI20047), designated for the protection of the remaining sandy grasslands that formed on the higher elevations in the centre of the island (European Union 1995-2016).

The core areas and ecological corridors of the National Ecological Network, designated in 2003, were based on DINP's areas and the elements of the Natura 2000 Network on Szentendre Island. Ecological corridors were designated chiefly on the inner and outer protection areas of water resources and protective forests of the hydrogeological „A" zone. Elements for the ecological corridor network were only designated without any previous protection South from Szigetmonostor, on a forested area with protective functions. Buffer areas were only designated on a few smaller plots, but

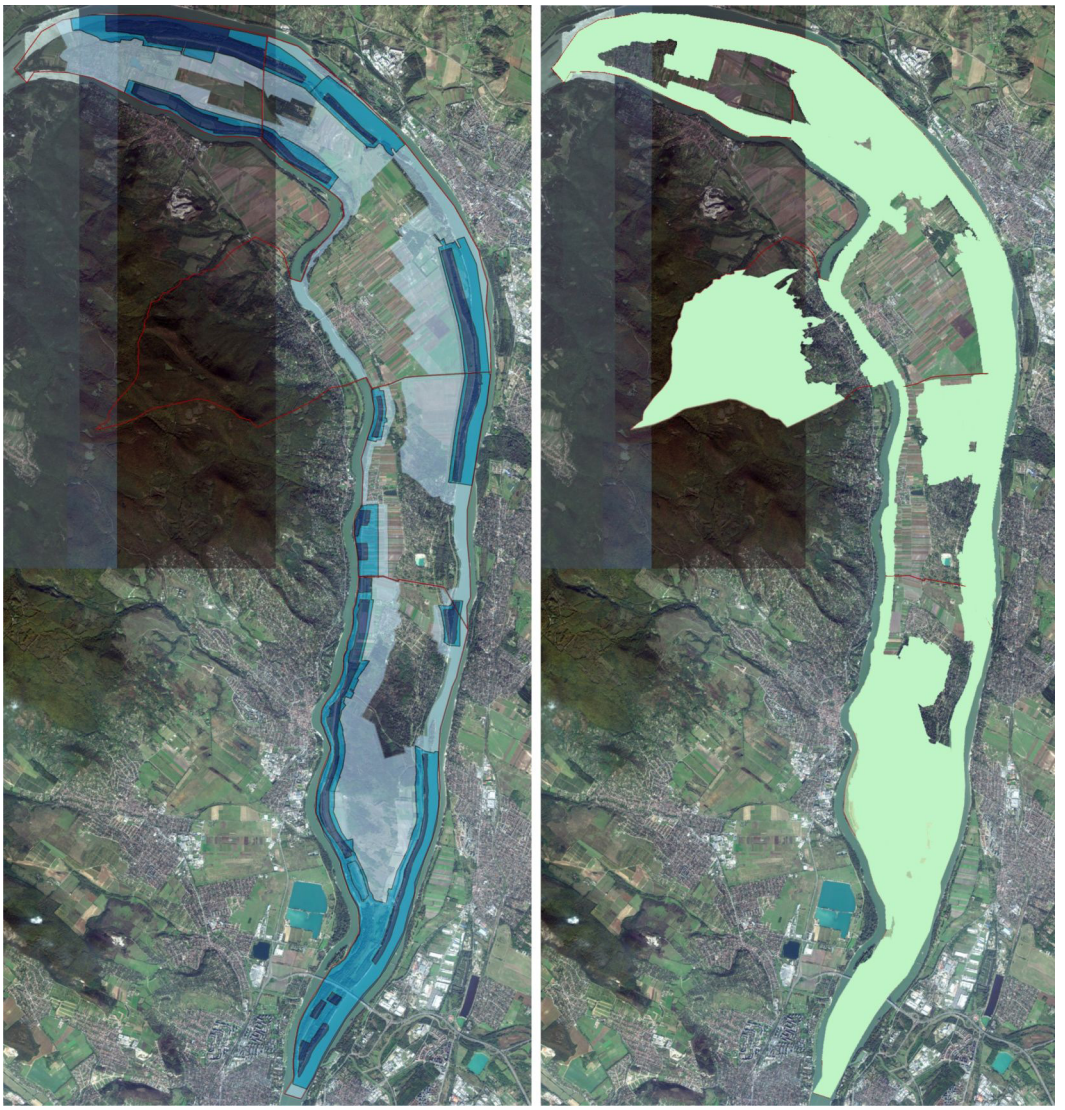

Fig. 7. Water resource protection (blue) and nature conservation (green) in the Northern study area

even there without the originally described function of a „protective zone" around core areas.

Southern study area

Water extraction from the Csepel Island aquifers for Budapest began only in the 1980s – due to the high concentration of iron and manganese – when Szentendre Island has reached its full capacity, its wells completely constructed (Debreceny 1993). Protective zones were designated at the same time, therefore water resource protection could only contribute to the conservation of ecologically valuable areas in the last 30 years. Aquifer protection contributes to building restrictions and, partially, to the conservation of ecologically valuable areas here as well, altough to a lesser extent that in the northern study area. The Natuira 2000 area „Szigethalmi homokbuckák" used to be a fenced, guarded, closed area as the protective zone for the waterworks of Csepel Works (a highly important industrial facility of the era). Its environmental value mainly consists

of the remaining patches of forests and sandy grassland. Another example of a buffer area designated in connection with the protective zone of a technical facility is the radio tower of Lakihegy – the element of the ecological network is based on an earlier restriction in this case as well (Fig. 8).

The National Ecological Network is mainly based on Natura 2000 areas on Csepel Island („Duna és ártere" HUDI20034, „Szigethalmi homokbuckák" HUDI20045, „Ráckevei Duna-ág" HUDI20042) (European Union 1995-2016). Building and land use restrictions for the elements of the ecological network are described in the National Spatial Plan. Development plots cannot be designated – only in exceptional cases – on core areas and ecological corridors. An exception from this restriction may be requested – the settlements of the southern study area have submitted such a request based on existing recreational use, while the northern settlements have submitted similar requests for the same reason and also for a harbour expansion.

Comparison

Both areas have in common that their ecologically valuable areas currently belonging to the National Ecological Network (OÖH) used to have (and often still have) some other protection or restriction that helped their survival indirectly by restricting land use. This phenomenon is almost exclusive on both study areas – virtually all areas protected by nature conservation are based on earlier types of territorial protection.

Table 1 shows the proportions of different protection types within the boundaries of each municipality. It shows that the proportion of areas affected by restrictions in the Northern study area is considerably higher than on Csepel Island. The data shows that National Ecological Network (OÖH) is the most extensive, integrational area, covering and connecting smaller areas, which are often affected by several different types of protection. There is a high level of correspondence between the ecological network and aquifer protection. The low proportion of buffer areas is also notable.

Land cover types replaced by urban expansion

In order to determine the efficiency of territorial protection and the effectiveness of property speculation strategies we analyzed the parts of the ecological system that have been replaced or destroyed by urban development in the last 20-25 years, using

Fig. 8. Water resource protection (blue) and nature conservation (green) in the Southern study area

Table 1. Comparison of the extent of territorial protection types in the two study areas.

Municipality	Territorial protection (nature conservation)						Territorial protection (protection of water resources)	
	National-level protected areas	Natura 2000 (SCI)	National Ecological Network (OÖH)				Inner and outer protective area	Inner and outer protective area + hydrogeological protective zone "A"
			Core area	Buffer area	Ecological corridor	OÖH combined		
Northern study area								
Pócsmegyer	22%	35%	12%	-	31%	53%	21%	62%
Szigetmonostor	23%	62%	23%	-	58%	81%	41%	80%
Tahitótfalu	34%	44%	24%	2%	30%	56%	13%	41%
Kisoroszi	26%	35%	-	13%	47%	60%	41%	81%
Southern study area								
Halásztelek	-	15%	-	9%	18%	27%	27%	54%
Szigethalom	-	3%	-	-	20%	20%	-	-
Szigetszentmiklós	-	5%	3%	2%	4%	9%	1%	7%
Tököl	-	9%	-	-	25%	25%	5%	16%

the Corine Land Cover (CLC) database. Using the database, the change of the land cover – and therefore the change of land use with ecological value – can be studied as well. We compared the changes in land use data between the different CLC surveys (1990, 2000, 2006 and 2012) published so far on the survey areas, with special regard to areas turned into artificial built-in surfaces in order to monitor the scale of urban expansion.

We considered the following Corine land cover categories as built-in areas (Commission of the European Communities 1995): 1.1.1 „Continuous urban fabric", 1.1.2 „Discontinuous urban fabric", 1.2.1. „Industrial or commercial units", 1.2.2. „Road and rail networks and associated land", 1.2.3. „Port areas", 1.2.4. „Airports", 1.3.3. „Construction sites", 1.4.1. „Green urban areas", 1.4.2. „Sport and leisure facilities". (We did not consider mineral extraction sites (1.3.1.) and dump sites (1.3.2) as built-in areas despite their artificiality.)

Afterwards, we compared the latest (2012) land cover data with areas designated as built-in areas in the current Structural Plan of the Budapest Agglomeration (BATrT), which shows the amount of land use change and urban expansion allowed by the current regulation compared to the land cover of 2006, making it possible to determine the areas threatened by development.

Northern study area

Between 1990 and 2000 very little changed in the studied land cover types of Szentendre Island. Only one formerlny biologically active area was turned into a category considered as settlement area: the Magyar Golfing Club appeared in Kisoroszi to replace former agricultural land (Fig. 9). The golf course, covering just over 30 ha represents 0.33% of the combined area of the settlement group. The area affected by urban development on the northern study area was even smaller between 2000 and 2006 – four sites, with a combined area of 17,2 ha, became built-up areas – a new horse ranch in Tahitótfalu and a new Danube bridge (Megyeri Bridge) near the southern tip of the island. Less than 0.2% of the total area of the four municipalities were affected. Urban development has apparently become even slower between 2006 and 2012, as only one site, with an area of 5,39 ha (0,06%) was built in. It is also worth noting that a majority of the sites we considered to be transformed into non-productive areas are actually newly created recreational areas with considerable green surfaces.

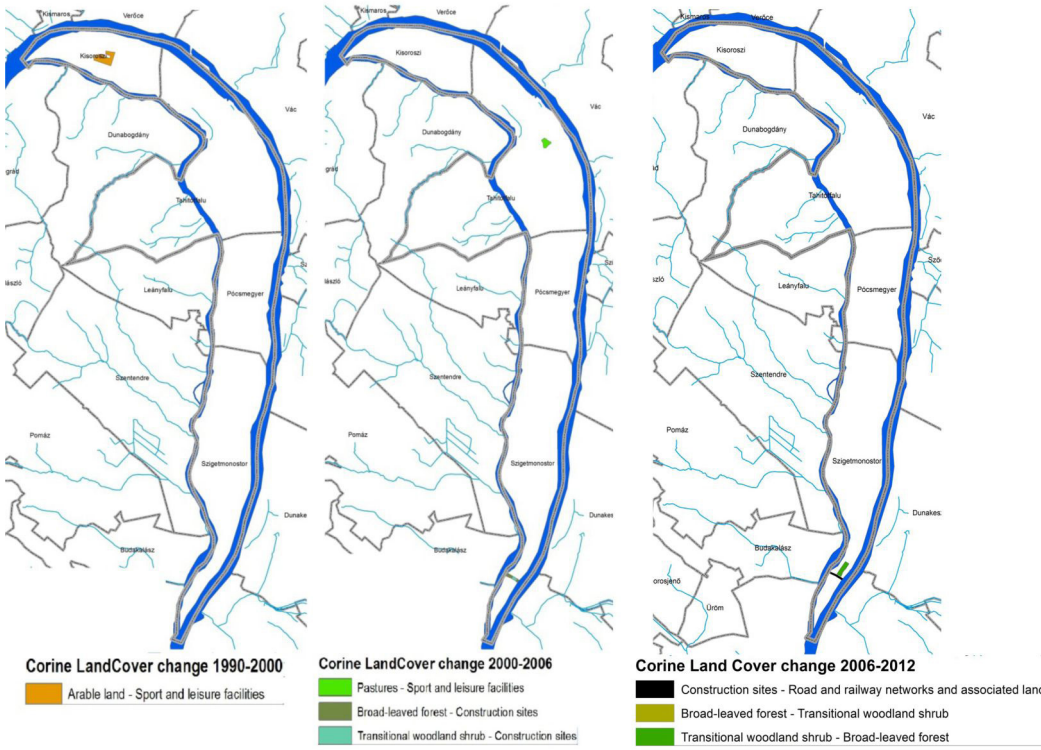

Fig. 9. Changes in land cover in the Northern study area between 1990 and 2012 (Comission of the EC 1995)

The network of built-up areas designated in the most recent BATrT allows a relatively low amount of expansion on Szentendre Island compared to the built-up areas shown by the data of the 2012 CLC survey – urban sprawl is stagnating (Fig. 10). It is also worth noting that according to the Agglomeration Plan, the settlements of Pócsmegyer and Szigetmonostor (and also Surány and Horány, which are under their respective jurisdiction) could hypothetically merge, which would result in a built-in area of considerable size in the centre of the island, occupying current fringe areas. Areas designated as parts of the National Ecological Network restrict the expansion of Pócsmegyer (and Surány) to the north and Szigetmonostor (and Horány) to the south, therefore their urban areas are approaching each other. As Kisoroszi is almost completely (at 90% of its fringe) surrounded by the ecological network, its built-up areas are almost completely unchanged since 2012 and this trend is not likely to change in the foreseeable future.

Potential built-up areas designated by the BATrT and built-in surfaces recorded by the CLC survey in 2012 in Tahitótfalu are also almost completely identical. However, in this case not due to the ecological network, as the proportion of joined fringes here is only 43% m – the ecological network does not cover the inner parts of the island. Potential built-up areas designated by the BATrT cover 14.5% of the total administrative area of the four municipalities of the island.

Southern study area

Between 1990 and 2000, five formerly undeveloped sites were changed into built-in land cover types, all of them within the administrative boundaries of Szigetszentmiklós and all five replacing arable land. The new land uses were residential, industrial and transportational

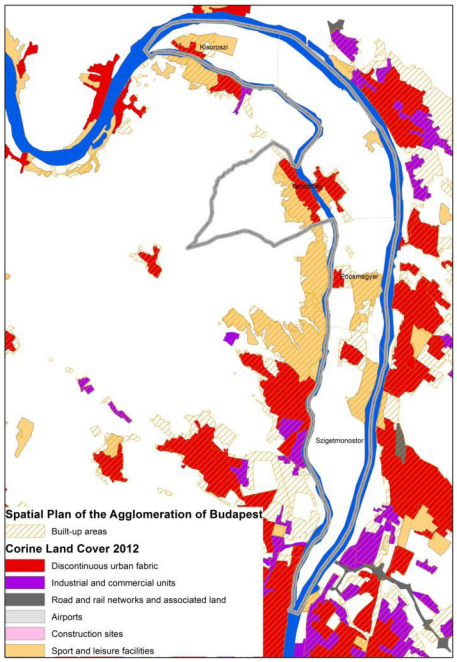

Fig. 10. Comparison of the potentially built-up areas in BATrT and the built-up surfaces in CLC 2012 in the Northern study area (Commision of the EC 1995; Pestterv 2011)

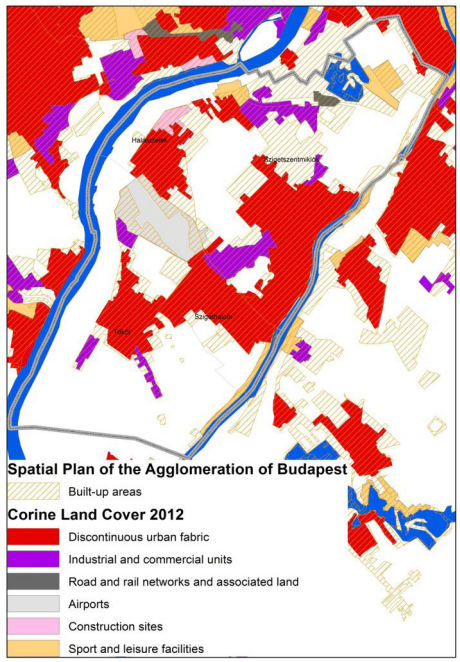

Fig. 12. Comparison of the potentially built-up areas in BATrT and the built-up surfaces in CLC 2012 in the Southern study area (Commision of the EC 1995; Pestterv 2011)

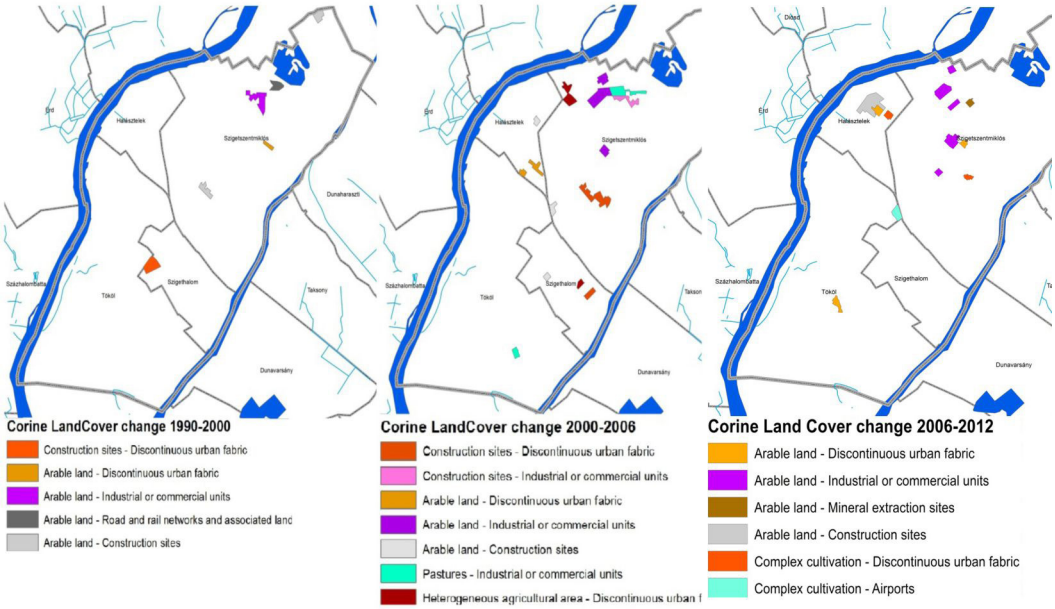

Fig. 11. Changes in land cover in the Southern study area between 1990 and 2012 (Comission of the EC 1995)

(Fig. 11), covering a total area of 75.7 hectares (0.74% of the administrative area of the four settlements). The speed of land cover change increased significantly between 2000 and 2006 – twice as much land was affected by development during this period as between 1990 and 2000. More than 158 hectares – mostly former arable lands and grasslands – were permanently altered, which represents 1.55% of the total study area. These tendencies continued between 2006 and 2012 as well: 160 hectares (1,57%) were consumed by the settlements in this period.

Built-up areas of the four municipalities designated by the BATrT are significantly larger than the extent of artificial land cover in 2012 (Fig. 12). According to the Structural Plan, the creation of a continuous urban area is possible, with Tököl and Halásztelek the only two settlements without a direct connection to each other. Furthermore, the Agglomeration Plan allows a direct connection of Szigetszentmiklós and Budapest. The significantly lower proportion of areas protected by the National Ecological Network on Csepel Island compared to Szentendre Island has a role in the expansion of designated built-up areas – apart from the Danube and its floodplains, only six isolated sites of variable size represent the Ecological Network. Therefore, the elements of the National Ecological Network are unable to form a real network, which opens the gate for urban development. The designated built-up areas cover 44.6% of the area of the four studied municipalities, which means that almost half the southern study area can be considered as potential settlement area.

In case the designated built-up areas were actually fully built-in in the future, the ecological network of the Csepel Island study area would be reduced to isolated elements with no connection to each other, increasing the threat of degradation even in the remaining habitats. The spatial connection of the residential and industrial areas of Szigetszentmiklós would cut the connection between the Danube and its side-branch called Ráckeve Danube. Although presumably development will continue to occur on agricultural lands, the potential coalescence of the settlements poses a threat to the survival of remaining wildlife by itself.

4. Conclusion

As sites within the study areas in an ecological condition worthy of protection have survived – or appeared – due to former land use restrictions, it can be stated that long-term restricted use has an important role in the conservation of the ecological system.

Analyses of two regions of the agglomeration of Budapest, an area critically affected with urban sprawl showed that mutual dynamic factors are an essential part of the spatial systems of both urban and ecological areas. High proportions of heavily restricted areas compared to the total municipal area result in a direct contact of built-in areas and areas with significant ecological value. A high conservational index leads to the passing of problems instead of solving them.

In contrast, a lower proportion of protected areas leads to the loss of ecological connections and the isolation of valuable sites. A low level of conservation, as a weaker resistence, attracts development.

In conclusion, the two situations hold different dangers for the ecological system: permanent disturbance on the fringe of the ecological network due to the proximity of built-in areas on the northern study area and isolation on the southern settlement group.

According to these two main results, the current spatial structure and functional units of the National Ecological Network (OÖH) are incapable of protecting ecologically important habitats in agglomerating regions. In order to prevent the complete coalescence of built-up areas, current arable lands have to be integrated into the ecological network as buffer zones, with continued agricultural land use – with restrictions. This can create a protective zone between the urban fabric and valuable habitats.

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