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Introduction

Green infrastructure (GI) planning as a complex, multifunctional tool is appropriate to realize objectives related to nature conservation, rural development, and sustainable agriculture. In a rural region of Hungary, we carried out a project covering wide range of activities: elaboration of new reservoirs, habitat rehabilitation enhancing the ecological stability of the Koppány-creek and suggestions for the improvement of the sustainability and multifunctionality of agricultural production. The pilot area is situated in Koppány Valley that is a hilly landscape rich in natural values located south of the popular tourist destination Lake Balaton and is affected by extreme aging and emigration processes. A rural development association emerged in the region to establish the Koppány Valley Nature Park. The association aims to develop innovative, sustainable tourism services based on natural values, to develop active recreational facilities, to strengthen local economy, and particularly to promote the diversification of agriculture and to create the social, economic and environmental sustainability of agricultural production. We elaborated a complex revitalization program in the frames of green infrastructure projects. Our green infrastructure development plan aims to develop the Koppány Valley natural capital: to increase the biodiversity and enrich the landscape.

The green infrastructure project had the following objectives:

- Elaboration of a complex analysis including economic, social and ecologic conditions,
- Assessment of water management in the creek valley,
- Assessment of functionality and connectivity of ecologic network,
- Elaboration of a strategy for enhancing the ecologic value of the riparian vegetation and the surrounding landscape.
- Elaboration of tourism development proposals based on the enhanced ecologic value of the region.

Background

Green infrastructure is becoming a widely used term in literature but especially a practical tool for conservation and development. While grey or technical infrastructure refers to the facilities that support social and economic production (Van de pol, 2010, pp 17), green infrastructure is described as an integrated network of natural and semi-natural areas and features which deliver a variety of benefits to humans (Naumann et al., 2011). Green infrastructure has different benefits as lower capital, maintenance and operational costs, significantly reduces carbon emissions compared to grey infrastructure (Benedict and McMahon, 2006; Laforteza et al., 2013). While grey infrastructure is designed to perform only single functions, green infrastructure networks serve multiple functions as ‘ecosystem services’ (Ely and Pitman, 2014). Green infrastructure differs from conventional open space planning because it has a complex approach considering conservation values and actions in concert with land development, growth management and built infrastructure planning (A. Benedict, M. A. McMahon, E. T. 2001). Green infrastructure can be an important tool in rural development because of its multifunctional approach.

Typology of green infrastructure:

- Natural and semi-natural ecosystems, such as pastures, woodland, forest (no intensive plantations), ponds, bogs, rivers and floodplains, coastal wetlands, lagoons, beaches, marine habitats,
- Extensive agricultural and forest landscapes, large marsh and bog areas, rivers and floodplains,
- Restored ecosystem types,
- High nature value farmland and multi-use forests (such as watershed forests); protection forests,
- Greenways, green belts, metropolitan park systems (Dancsokné Fóris, 2015; Civic, and Siuta, 2014).

In 2013 the European Commission has adopted a Green Infrastructure Strategy (Green Infrastructure (GI) (COM(2013) 249 final) in which highlights the contribution of GI projects to territorial cohesion and development, using a ‘place-based’ approach preserving the physical features and identity of the locality. The EU intends to integrate GI into different policies like Biodiversity Strategy to 2020,¹ the roadmap to a Resource Efficient Europe,² the Commission’s proposals for the Cohesion Fund and the European Regional Development Fund,³ the new Common Agricultural Policy⁴, the new Forest Strategy⁵ (especially relevant since many GI elements might be forest-based), or the forthcoming communication on “land as a resource”. The EU accepted

in 2011 the Biodiversity Strategy that sets the following objectives: by 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems.

GI projects are important not just in urban environment but also in countryside for mitigating negative effects of climate change and enhance areas with a high nature value. Some authors highlights the importance of green infrastructure in a new approach of urban-rural relationship (Dancsokné Fóris, 2015). While GI approach is still a new phenomenon in Hungary, it is a common tool in several countries like in the United Kingdom where GI is introduced in local development frameworks and in local plans. The National Biodiversity Strategy 2015-2020 highlights the importance of it's integration into spatial planning. GI has the following functions:

- To conserve and highlight the historic characteristic of the landscape.
- To improve the possibilities of social use of the landscape especially through connection by means of footpath and bicycle paths.
- To conserve and improve the connectivity of natural habitats.
- To contribute to adapting to climate change and its mitigation (P. Sala et al, 2014, Mark A. Benedict and Edward T., 2006, Jia et al., 2016).

Method(s)

Green infrastructure projects have a positive effect on rural development as well. The Koppány valley is situated on the peripheries of Balaton recreational area. The tourist potential originates from the relative vicinity of Lake Balaton and the natural values of the landscape. However, in the lake-side settlements tourism can offer a decent living, agriculture dominates in the background region. The majority of the settlements are small, “dead-end” villages hit by severe depopulation. Their infrastructure, public services are underdeveloped. In the formerly flourishing agricultural region with complex production structure (wine production, medicinal herbs, different kinds of horticulture, pastures, horse keeping) now just plough fields dominate the hilly landscape. There are no characteristic local products. One of the most serious problems of the region is the emigration of the Young especially those with higher education. This hopeless situation (there are no jobs no possibilities of spending pastime etc.) have started harmful processes among youngsters (passivity, aggression, alcoholism, crime) (Local Action Plan, 2013).

There are no major polluting industries, the busiest traffic routes bypass the region. The most important environmental pollution source is the agriculture inappropriate for the landscape conditions. The proportion of forests is higher than the national average, but it is decreasing because of the inappropriate

maintenance. Clearcutting is the most popular method of logging causing the loss of the topsoil, erosion, decrease of ground water level, loss of natural habitats, and spread of invasive plants. The new plantations are of low ecologic value. The inappropriate water management cause severe environmental damage as the loss of wetlands, decreasing water retention capacity, speeding up run off water causing severe erosion.

We carried out a complex analysis revealing the natural, social and economic characteristics of Koppány-valley consisting 10 settlements focusing on three pilot areas along the creek: Törökkoppány, Karád, Somogyacsa.



Figure 1. The pilot region; a, Situation of Koppány-valley in Hungary, b, Wilderness along the creek, c, Creek Koppány in Törökkoppány, d, Architectural values of Törökkoppány

The general analysis was followed by detailed soil, water, habitat surveys on the focus areas. We explored the major land use conflicts related to the inappropriate land use system and the deficiencies of the green network. The main problems of the region are the soil deterioration and the groundwater depletion caused by the improper cultivation of hillsides for decades. The other

major source of conflict in rural areas is that the topsoil, nutrients and pollutants washed down due to the erosion and accumulated in lower-lying areas. Land use conflicts are caused by the following:

- the development of large, continuous fields not suited to the region's specific characteristics destroyed the ecologically important forests and forest belts, groves and deteriorated the landscape;
- drainage destroyed the wet, swampy habitats and destroyed the water balance,
- the intensive use of chemicals contaminated the soil, the surface and subsurface waters, contributed to the spread of resistant pests and invasive plants.

We examined the landscape history, the changing land use system and the existing landscape values. On the three focus areas major projects will be carried out to improve the hydro-morphological status and nutrient load control of Koppány creek by creating small lakes, restoring wetlands along the watercourse. The water restoration projects will be completed by enhancement of the ecologic value of the creek valley by restoring wetland habitats, removal of invasive plants. The landscape rehabilitation project can not be effective without the greening of agricultural production. We assessed the production structure and methods and elaborated complex suggestions for a more environmental friendly farming methods with regard to the greening of the Common Agricultural Policy of the European Union. We added small scale tourism development plans to the environmental restoration projects such as study trail plans, look out towers, tourist paths.

Results

Based on the analysis and complex assessment we elaborated a strategy. For the rehabilitation of the green network the following suggestions were made:

- increasing the level of water retention by the development of two reservoirs and a backwater area,
- creating wetlands, protecting the wildlife (habitat rehabilitation)
- creating buffer zones and other ecological zones and wetlands, reviving ecologic corridors,
- greening projects to mitigate the erosion of soil, suggestions for more sustainable agricultural production methods,
- creating a nature trail to present the landscape history.

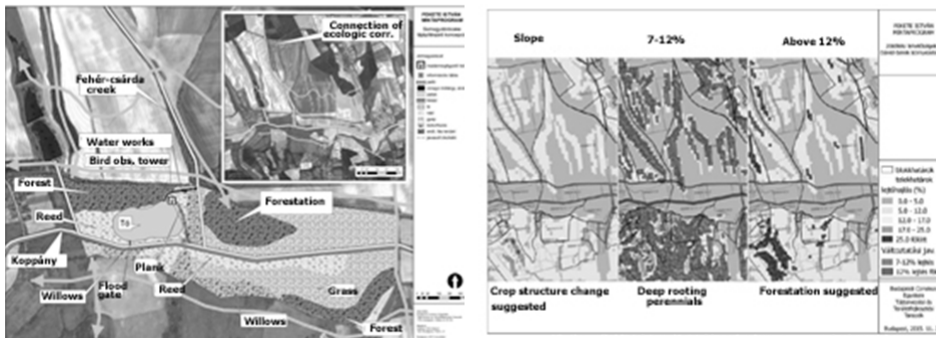


Figure 2. Wetland rehabilitation and suggestions for greening of agricultural production

On the three focus areas water engineers cooperating with landscape architects designed three lakes of natural shape with wetlands and natural riparian habitats. The most important aim was to prevent sedimentation and absorb the nutrition load of the creek. Furthermore, by reducing the spread and ratio of invasive plants the ecologic value of the valley will grow drastically.

The European Union has introduced so called ‘greening measures’, including obligatory crop rotation, grassland maintenance, and more specific agri-environment measures. We suggested greening of agricultural fields in the Koppány-creek valley. We analyzed the geographic conditions of the region and highlighted the areas of steep slopes. The slopes steeper than 12% supposed to be covered by forest in order to prevent contamination and erosion. On slopes of 7-12 % in the frames of crop diversification we suggested deep rooting, nitrogen fixing crops or ecologically suitable plants for the planned biogas power plant or fodder crops.

At least in a 5 or 10 meter wide zone along the creek we suggested to maintain grass fields or other ecological focus areas. We recommended the elaboration of agricultural management plan/s for the farmers in order to harmonize ecologic and production aspects as a base for greening of agricultural production.

The rural area with high natural value on the peripheries of Balaton recreational region is suitable for recreational, eco-tourism development. We proposed study trails, lookout towers and tourist paths along the creek, lakes and wetlands of enhanced ecologic value. Two of the focus areas will be suitable for complex environmental educational programs.

Discussion and Conclusion

The objectives of nature protection and agricultural production often contradict each other. These contradictions can be eliminated by the complex approach of green infrastructure development. The improper agricultural management cause severe negative effects, which on the long run hinders the effective and profitable production. The improved water retention capacity and habitat restoration along the creek and the greening of agricultural production improve the ecologic network and the efficiency and diversity of production and local economy.

The efficiency of the green infrastructure project depends on the commitment of local stakeholders and population. That's why it is important to offer such kind of development possibilities, which can provide profit next to the environmental benefits. So we emphasized recreational projects based on ecologic developments. Our final goal was to create a base for further educational and tourism development by the preservation of cultural values and improvement of ecologic value. The green infrastructure project results contribute to development of local community, local identity and enhancement of the long-term population retention capacity.

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