A concept and case study of ecological network planning in the Fertő-Hanság basin in Hungary

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Introduction

The concept of ecological networks has emerged from the landscape planning on the one side and from the landscape ecology on the other. Landscape planning has been seeking to create greenways and green networks for people. Whereas landscape ecology provided the scientific basis for the assessment of landscape structure thus gave the opportunity to turn the nature conservation approach from the protection of isolated nature reserves into a spatial system approach. A systematic analysis and evaluation of the existing ecological network provides a larger context for the habitat preservation, so an opportunity of more efficiency for the nature conservation. However the purpose is not uniquely the conservation of a present state, but also the restoration of the spatial coherence, the connectedness between the natural areas.

This paper presents a new planning methodology for the restoration of the ecological network through a case study of the Fertő-Hanság basin, located on the north-western lowland of the county between the Alps and the Carpathians. Parts of this diverse area are everyday landscapes, but parts are rather particular, designated as national park, word heritage cultural landscape, Ramsar area and biosphere reserve.

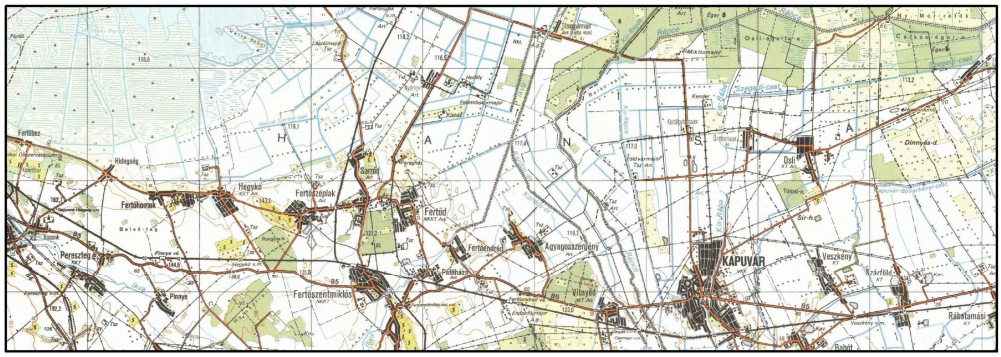

Figure 1. Excerpt from the study area

Background and objectives

Ecological network is a web of all ecosystems or land cover types on the Earth, where any transport or migration of the living creatures is possible. That is our definition expressing the strong biological significance of the ecological network, and also the inclusion of all surfaces, even artificial ones that could serve as pathway between the natural habitats. This is the green infrastructure shrinking more and more because of the expansion of the technical infrastructure and built up areas. The concept of ecological network has its roots in the landscape planning, appeared first in the USA as greenway planning (Fabos 1995) and also in other European countries by the creation of the green space network in the settlements (Jámbor 1982). First aims at creating a web of attractive natural and semi-natural greenways between large designated sites (e.g National Parks) for ecotourism in huge distance outside the settlements, second had the purpose of establishing an interconnected network of green surfaces in the cities and in their surroundings for a better environmental quality and for recreation.

The scientific background was born in the landscape ecology focusing amongst others on the analysis of the landscape structure. The leading concept in this respect is the patch-corridor-matrix theory (Forman 1995). There is a direct link between this theory of the landscapes spatial distribution with the functional elements of the ecological networks (core areas, corridors). Finally the development and the implementation of the concept is related to new nature conservation policies of the 90-ies. The World Nature Conservation Strategy expressed that the biodiversity and the processes of the natural systems cannot be preserved in isolated nature reserves. (Benett 1994, IUCN et al 1980). Initiated also by the Convention on Biological Diversity of Rio de Janeiro (UN 1993) as well as its implementation measures the Pan-European Landscape and Biodiversity Strategy, the planning of the European Ecological Network (EECONET) has started and gave impetus to several national and regional projects.

In Hungary policies and planning instruments include ecological network planning since the mid 1990-ies. The first indicative map of the national ecological network has been prepared by the IUCN Hungary (Németh 1995). Afterwards it became part of the national and the regional spatial plans as one layer of the nature conservation zones. The designation of the ecological network in the spatial plans however means mainly the maintenance of the status quo by hindering the intensification of the land use and did not comprise restoration. In Hungary, where the spatial coherence of the natural, semi-natural habitats is highly destroyed in most of the intensively used agricultural surfaces we can not be satisfied with the preservation of the present state. Thus a restoration of the ecological network is necessary. The purpose of the ecological network restoration is to enhance the coherence of the landscape by improving the connectivity of the natural and semi-natural surfaces through landscape and habitat restoration and by creating green corridors.

Methology and case study of the rehabilitation planning of the ecological network in the Fertő-Hanság basin

In the proposed methodology the planning process is divided into three main parts: 1) assessment of the actual ecological network, 2) evaluation of the internal and external impacts and 3) rehabilitation plan. The description of the planning process will be illustrated by a representative section of the study area. (Figure 1.)

Assessment of the actual ecological network

Identification and mapping of the present state of the ecological network is based on the naturalness and the spatial structure of the different habitat complexes or land cover types. Naturalness, patch size and distribution are the determining factors in the connectedness of the landscape. Natural and semi natural habitats provide of course more favourable conditions for migration and transport than e.g. homogenous arable land or cities. Although also artificial habitats (agrarian areas and green spaces) cannot be disregarded as they also have beneficial effect in the functioning of the ecological network especially in an industrial or urban environment. Accordingly beyond naturalness and spatial structure the land cover context of the landscape has also be taken into account.

The main **information source** for the ecological network planning available in Hungary is the CORINE LAND COVER 1:50.000 (CLC 50)[16] digital map. This is the only GIS dataset that covers the whole territory of the country that is suitable for the assessment of the spatial structure of the habitat complexes. Given that land cover dataset provides detailed information about the different ecologically degraded, transformed and artificial land cover types, it is also adequate for defining land use intensity and barriers. Furthermore digital maps of the designated areas and the different layers of the Spatial Plan of the County Győr-Moson-Sopron served for identifying human impacts.

First step is the identification of the **naturalness of the land cover**. The 79 categories of the CLC 50 map have been graded into five naturalness level according to the level of human transformation of the given surface. At the same time intensity of the human use has also been identified, which were used later in the evaluation phase. Few examples of them are shown in the Table 1.

Categories of the naturalness:

I. Areas covered by natural, semi natural surfaces
II. Semi natural and moderately transformed surfaces
III. Significantly transformed surfaces
IV. Significantly transformed mosaic like surfaces
V. Dominantly artificial surfaces
VI. Built up surfaces

[16] http://www.fomi.hu/corine/clc50_index.html

Table 1. Examples of the naturalness and intensity of the land cover

	Categories of the CORINE Land Cover M=1=50.000 (Hungary)	**Natural-ness**	**Intensity**
1. ARTIFICIAL	**AREAS**		
1.1.1 Continuous urban fabric	1.1.1.1. Areas of urban centres	VI	9
1.2.1. Industrial, commercial units	1.2.1.1. Industrial and commercial and agrarian units	VI	10
1.4.1. Green urban areas	1.4.1.1. Parks	IV	6
2. AGRICULTURAL	**AREAS**		
2.1.1. Non irrigated arable land	2.1.1.1. Arable land with large fields	V	8
2.3.1. Intensive pastures, degraded grasslands	2.3.1.1. Intensive pastures, degraded grasslands without trees and shrubs	III	5
2.4.2. Complex cultivation patterns	2.4.2.1 Complex cultivation patterns without scattered houses	IV	7
3. FORESTS and	**SEMI-NATURAL AREAS**		
3.1.1.Broad-leaved forest	3.1.1.1.Broad-leaved forest with continuous canopy in dry area	I	1, 2*
	3.1.3.9. Plantations of mixed forests	III	5
3.2.1. Natural grasslands	3.2.1.1. Natural grassland prevailingly without trees and shrubs	I	1, 2*
3.2.4. Transitional woodland-scrub	3.2.4.1. Young stands and clear-cuts	II	4
4. WETLANDS			
4.1.1. Inland marshes	4.1.1.1. Fresh-water marshes	I	1, 2*
*1-2 depending on the	protected status		

Second step comprises the identification of the **spatial structure**. Categories (see Figure 2) are defined according the extent, naturalness and spatial distribution of the habitat complexes. This is a crucial step in the planning process, as the real functioning of the habitat complexes in the ecological network is mainly determined by the spatial pattern.

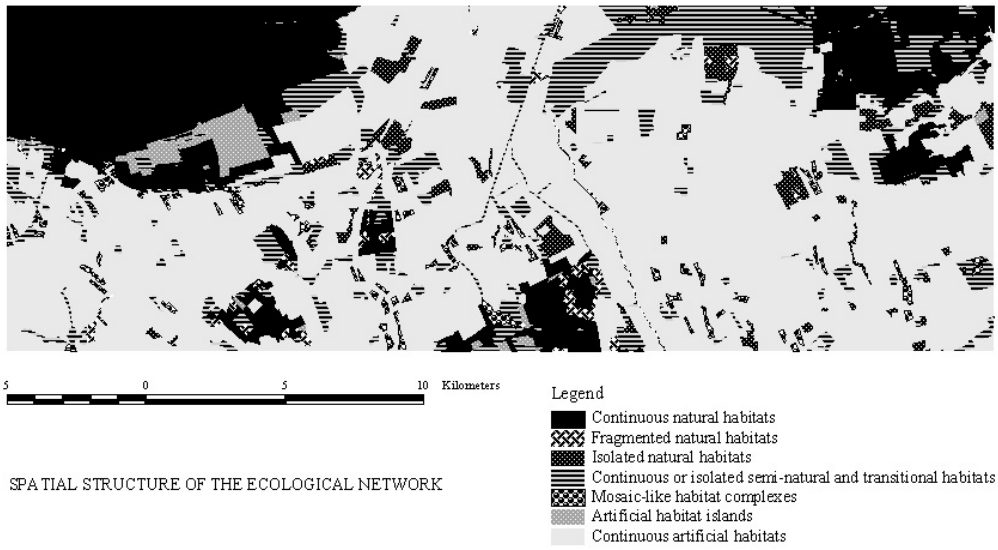

Figure 2. Spatial structure of the present ecological network

The third step defines the **functional structure** of the ecological network. Element of it as follows:

- *Core areas*: large natural and semi-natural habitat complexes, where the evolution processes of the ecosystems are not endangered due to their stability provided by the large extent and the lack of threatening external impacts.
- *Ecological corridors*: mainly semi-natural habitat series, which support the transport processes between the core areas. There are two main types the continuous corridors and the stepping stones that are distinguished in the planning phase.
- *Areas with low transport potential*, where isolation and barrier effect of the artificial surfaces block migration or transport.

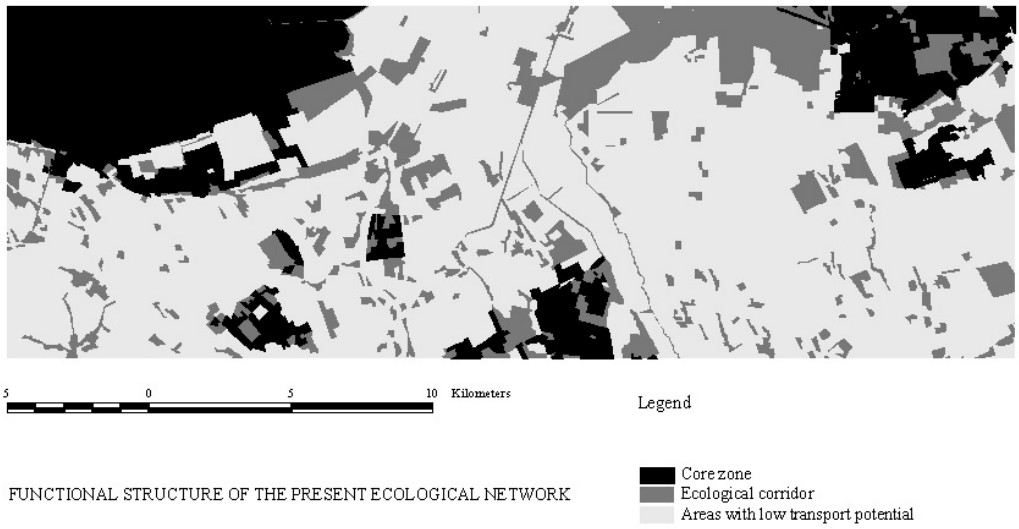

Figure 3. Functional structure of the present ecological network

Evaluation of the external impacts

Ecological network is not a static but continuously changing dynamic system. Changes are partly caused by natural processes but mainly by human activities. The impact assessment aims at revealing the factors that can influence the functioning by increasing or decreasing stability or vulnerability of the habitat complexes.

Stability or vulnerability of the habitat complexes are determined by the *intensity and impact of human uses*. This has been identified on the basis of three factors. First is the *land use intensity*, derived from the land cover types (see values in Table 1). Second is the protection level *of the nature conservation* and third is the effect of the *fragmentation* and some *further threats* endangering natural processes.

Categories of land-use intensity:

1. Areas exclusively devoted to nature conservation, without any land use

There is no human activity, only indirect anthropogenic impacts could occur. These are the wilderness areas and the core zones of national parks, forest

reserves, peat bogs etc.) Main landscape function is nature conservation and environmental regulation.

2. *Areas of extensive land use devoted primarily to nature conservation*
   Designated natural and semi natural areas outside the core zones of nature reserves and other protected areas, where human activities aim at serving the purpose of nature conservation. Main landscape function is the conservation of habitats and their coherence as well as environmental regulation.
3. *Areas of environmental friendly, extensive land use*
   Rural areas of a harmonious man-nature relationship, where no environmental degradation or pollution exists and habitat fragmentation is insignificant. Protected landscapes, Nature 2000 and other semi-natural areas are part of this category. Landscape function is agricultural and forestry production as well as habitat conservation and environmental regulation.
4. *Temporarily set aside areas and water reservoirs*
   Extensive rural areas characterised by periodically set aside agricultural areas in a certain phase of nature regeneration, clear cuts and young forest stands, as well as artificial water reservoirs and canals. Landscape function is mainly environmental regulation and biomass production.
5. *Medium intensity of land use with positive environmental impact*
   Rural areas with permanent vegetation cover, mainly intensive grasslands and forest plantations. Landscape function is predominantly agriculture and timber production but environmental regulation plays a role too.
6. *Complex land use with positive environmental impact*
   Cultivated landscapes over woven with semi-natural surfaces, recreational areas, historical gardens or urban green spaces. Landscape functions are agricultural production, environmental regulation and recreation and preservation of cultural heritage.
7. *Complex land use*
   Mixed extensive and intensive agricultural areas with a diverse, small scale mosaic structure. Characteristic are the fine grained pattern of traditional vineyards and orchards with patches of grasslands and forests. Landscape functions are agriculture, environmental regulation and recreation and preservation of cultural heritage.
8. *Intensive land use*
   Intensive agricultural areas and rural settlements with a risk of local environmental degradation. Predominantly large scale arable land and intensive horticultural surfaces or discontinuous built up areas. Main landscape function is agricultural production and settlement.
9. *Intensive land use with negative environmental impact*
   Urban settlement and infrastructure zones with high proportion of built up areas. Typically urban centres, large cities, main transport axes where environmental threats are significant.
10. *Intensive land use with significant pollution and environmental hazards*
    Areas of high emission, with a hazard of spreading pollution. Mostly industrial areas and mining surfaces, waste deposits.

The relative impact of the different categories of the land use intensity, the conservation level and the fragmentation on habitat stability is defined in the table 2. Impact values are ranged in a scale of 7 values (+3 - - 3).

Table 2. Impact of human uses on stability of the habitat complexes

Land use Intensity	**Impact on stability**
1. Areas devoted to nature conservation, without any land use	+3
2. Areas of extensive land use devoted primarily to nature conservation	+2
3. Areas of environmental friendly, extensive land use	+1
4. Temporarily set aside areas and water reservoirs	-1
5. Medium intensity of land use with positive environmental impact	0
6. Complex land use with positive environmental impact	0
7. Complex land use	0
8. Intensive land use	-1
9. Intensive land use with negative environmental impact	-2
10. Intensive land use with significant environmental pollution and hazards	-2
Impact of nature conservation and landscape protection (examples)	
Strict nature reserves, core zones of national parks forest reserves etc.	+3
Designated landscapes, World heritage areas, - MAB Biosphere Reserves, - Ramsar sites, protected peat bogs, etc.	+2
Nature 2000 areas, - ESA areas etc.	+1
Impact of fragmentation and some further threats	
Fragmentation by linear infrastructure: motorways, large urban areas	-3
Highways, railways, sensitivity of the groundwater bodies	- 2
Danger for water or wind erosion, for land slide	-1

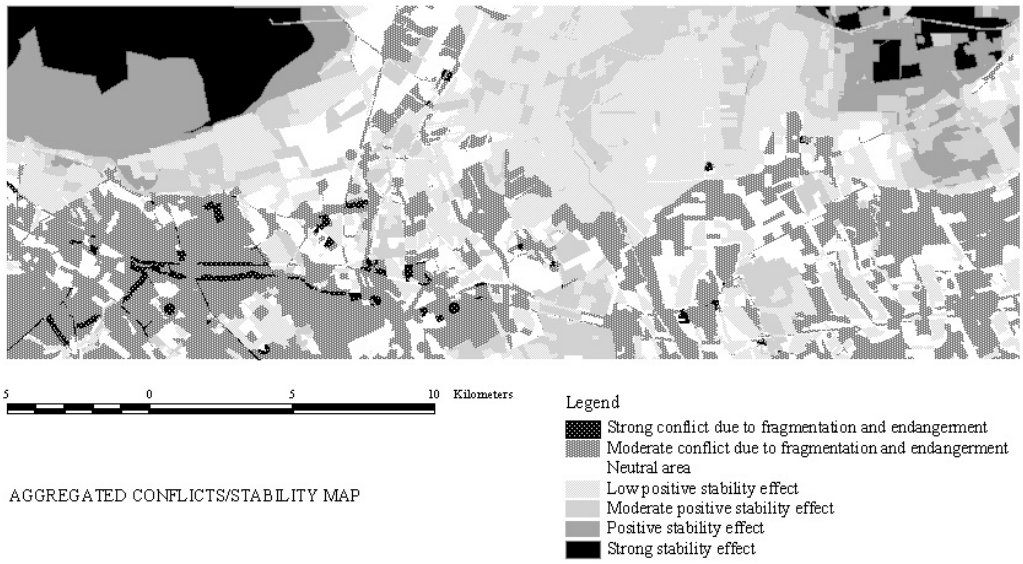

Figure 4. Aggregated impact map

Restoration plan of the ecological network

The planning begins with the final designation of the actual core areas and ecological corridors according to the aggregated impact/conflict map, followed by the designation of buffer zones and restoration areas. Beyond the four functional categories of the present state additional planning categories are as follows:

— *Rehabilitation of the core areas*: habitat complexes where the positive impact values or rehabilitation opportunity will result in a better naturalness or natural areas that are endangered thus do not fulfil the requirement of stability but can be changed by land use regulation
— *Buffer zones*: protecting zones around the core area filtering and hindering the unfavourable external impacts. In the buffer zones transport processes take place; therefore they have a corridor-role too.
— *Rehabilitation of the buffer zones*: areas not fulfilling the requirement of the buffer role thus need rehabilitation.
— *Rehabilitation of the continuous ecological corridors and stepping stones*: areas where possible habitat restoration can take place in order to enhance connectivity.
— *Areas with low transport potential, where the connectivity has to be enhanced by creating a green corridor network*. Green corridors are special type of ecological corridors, planned and established by man so they are not part of the natural habitat system, although they play an important role in transport and migration processes.

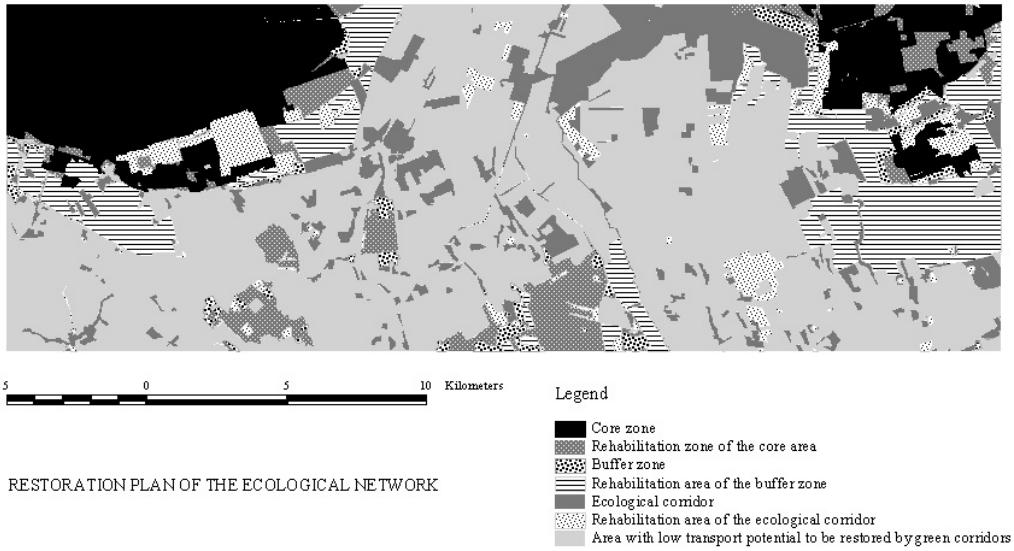

Figure 5. Restoration plan of the ecological network

Final step of the planning is the regulation proposal for the land use intensity. Beyond the designation of the restoration areas it is necessary to assure the functioning of the network by defining the highest level of possible land use intensity. Therefore a maximum intensity level should be defined for all planning

categories. Indicative proposal for the maximum land use intensity level: core areas and their rehabilitation areas: level 3; buffer zones and their rehabilitation areas: level 6; ecological corridors and their rehabilitation area: maximum intensity: level 7.

Summary

The paper presented a brief summary of a new planning methodology for the restoration of the ecological network. It gave an example both of a conceptual and methodological development of the planning technique and a practical implementation of it through a case study in the area of the Fertő-Hanság basin, situated on the north-western border of the county on the lowland between the Alps and the Carpathians. The proactive planning of the ecological network is one of the most important tasks of the landscape planning today as it can achieve the necessary shift from the protection of the status quo to a restoration.

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