# Introduction to the Concept of Ecological Networks

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Sustainable development is a widely accepted strategic framework in decision-making about the future use of land (IUCN, 1992). However, ecological sustainability is not yet well developed in landscape planning. The explicit inclusion of ecological principles in landscape planning is quite a recent advancement (Ahern, 2002). Steiner (2000) introduces “ecological planning”, defined by “the use of biophysical and socio-cultural information to suggest opportunities and constraints for decision-making about the use of landscapes”. Sustainable landscape development requires that landscape planning aims for “a condition of stability in physical and social systems achieved by accommodating the needs of the present without compromising the ability of future generations to meet their needs” (World Commission on Environment and Development, 1987 ; Ahern, 2002). This implies that in decision-making about a future landscape a balance is achieved between ecological, cultural and economic functions (Linehan and Gross, 1998), so that resources of prime importance to future generations are not depleted and destroyed. Today, in many regions, the ideas about ecological networks have developed into various concepts and plans for terrestrial systems of ecological stability, or networks of linear habitats connecting habitat islands on different geographical and administrative levels. The landscape system should afford conditions that allow natural populations to recover in time from environmental, political and socio-economic perturbations. With respect to

species diversity, a landscape is ecologically sustainable if two conditions are fulfilled. First, the spatial pattern of the landscape should support the ecological processes required for resilient populations in respect of a species diversity target and the spatial scale that is ecologically relevant to that target. Second, the changes that are associated with landscape development in the spatial pattern of the landscape do not push the long-term persistence probability of the target populations to an unacceptably low level. Thus, with respect to species diversity, sustainable development of landscapes should comply with these two conditions. A third condition is related to the transfer of knowledge : local and regional actors deciding about landscape and land use changes should be able to apply these conditions in a complex planning and design process, even in the absence of expert knowledge about ecological processes.

The concept of ecological networks as a land use planning method has its origin both in Europe and North American population dynamics, community ecology and landscape ecology (Fahring and Merriam, 1994 ; Harrison and Bruna, 1999). Russian and East European landscape sciences have to a higher degree been based on geographical sciences : geomorphology, hydrology and climatology. In addition, soil data has been a most characteristic product of the Soviet era. American and English landscape science did not really develop as in continental Europe ; the major issue has been landscape ecology as a landscape systems approach and it has mainly been based on ecosystem ecology, population ecology, and its new branch of conservation biology. Generally speaking, the Anglo-American tradition has concentrated on the vertical (chorological) processes in the landscape, whereas the German and Eastern tradition has concentrated more on the horizontal (topological) and regional aspects for physical planning (Jongman et al., 2004).

Originating from terminology of American landscape architecture and planning, sometimes the ecological networks are referred to as “greenways”. Greenways have been originally defined as, “linear open space established along either a natural corridor, such as a riverfront, stream valley, or ridgeline, or overland along a railroad right-of-way converted to recreational use, a canal, a scenic road, or other route” (Little, 1990 ; see also Flink and Searns, 1993). Furthermore, comprehensive greenway networks include ecological, recreational and cultural heritage aspects (Fabos, 1995). In his book, Greenways for America, Little (1990) defined greenways as protected linear corridors that improve environmental quality and provide for outdoor recreation. Although much attention has been drawn to greenways recently, they have been a component of landscape planning for over a century (Fabos, 1991). Only recently, however, have greenways been considered systematically as integral to the protection of ecological structure and function, and central to the open space planning process (Ahern, 1991a). Greenways provide an opportunity to reduce the impacts of habitat fragmentation. Habitat fragmentation is considered one of the most serious threats to biological diversity and is a primary cause of the extinction crisis (Harris, 1984 ; Wilcox and Murphy, 1985 ; Brown et al., 1991 ; World Resource Institute et al., 1992). The two major effects of fragmentation are loss of habitat and habitat isolation. Habitat loss decreases population sizes and increases extinction rates, and isolation decreases the likelihood of recolonization of otherwise productive habitat (MacArthur and Wilson, 1967 ; Burgess and Sharpe, 1981 ; Wilcove et al., 1986 ; Opdam, 1991 in Linehan et al., 1995).

In Europe, the first ecological networks were developed in Baltic countries and in former Czechoslovakia in the late 1970s (Míchal and Plesník, 1995). Here, concepts like ‘natural carrying capacity’, ‘self-purification capacity’, ‘ecological compensation’ and ‘ecological stability’ of the landscape for human functions are

the basis for the ecological networks. In the late 1990s, ecological networks have started to be planned, developed, designed, accepted as policy tool and implemented in 18 European countries (Jongman and Kristiansen, 1998). In some of them, e.g. in the Netherlands, they have been included into landscape planning (Cook and van Lier, 1994). The OostvaardersWold ecological corridor is a "New Nature" project in the Netherlands, transmuting agricultural land into a robust ecological zone for wildlife migration. It is recognized that diversity affords ecological resiliency. By designing for landscape diversity that also re-embeds work, education, trade and recreation into the land, cultural and economic resiliencies are afforded. These combined resiliencies strengthen the likelihood of ecological, cultural and economic success across local, regional, and global scales. On a European level, ecological networks are proclaimed to be a leading objective in the Pan-European Biological and Landscape Diversity Strategy ― *conservation*, *enhancement and restoration of key ecosystems*, *habitats species and features of the landscape through the creation and effective management of the Pan-European Ecological Network* (Council of Europe et al., 1996). The importance of wider landscape for nature conservation has been recognised in the European Union's Habitat Directive (EC 92/43), when referring to importance of landscape elements and structures for the favourable conservation status of habitats and species.

For the countryside, extensive destruction of balks, field roads and small tree and bush groups in the fields was carried out. The consolidation of the original private land plots resulted in formation of large tracts of land, with an area of 100 to 200 ha, used for growing monocultures and plantations, as the main feature of a monotonous agricultural landscape. These tracts of land complied best with heavy mechanisation and industrial agriculture. In 1996, from the total area of the Czech Republic (7,886,621 ha), agricultural land covered 4,279,823 ha, and non-agricultural land covered 3,606,798 ha, out of, which 2,630,129 ha were

forest areas, 159,11 l ha water areas, 129,293 ha urban areas, and 688,265 ha the other areas.

The landscape modifications which were implemented during the period of the collectivisation and communist land ownership in general had the following effects:

– Accelerating recession and disappearance of original species and communities and rapid degradation of biological and landscape diversity.

– Declining of total sources of soil biomass and soil humus in the territory of the Czech Republic.

– Accelerated soil erosion, territorial threat of degradation of natural fertility of soil.

– Further deterioration of the retention capacity of soil, hydrological balance of some river basins and quality of water sources.

– Intensifying of ecological contrasts between the areas with relatively favourable natural/high productivity conditions/ for agriculture, which have low ecological stability, and the areas with marginal productivity (less favourable areas) with relatively high ecological stability.

– Degradation of aesthetic values of landscape and landscape character.

– Degradation of ecological stability in the whole territory of the Czech Republic, including areas most strictly protected by the State.

The predecessor of what is now the Territorial System of Ecological Stability can be seen in windbreaks and strips of vegetation preventing soil erosion. Later the bases of the TSES theory were laid down as a reaction to extensive changes in the cultural landscape.

The Territorial System of Ecological Stability consists of both the existing

and proposed elements. The whole system is a network of ecologically significant segments of landscape, efficiently distributed on the basis of functional and spatial criteria (Low et al., 1995). The minimum necessary spatial parameters are stated in the following manner (according to Löw et al., 1995). In case of regional biocorridors (i.e., biocorridors of regional importance), so-called 'complex biocorridors' are used: after 4,000-1,000 m, according to the permissible length of a simple corridor, biocentres of local importance are inserted. Thus the length of a functionally qualified regional biocorridor can be substantially extended, reaching up to 5-8 km. For representative supra-regional biocentres, the minimum area of l,000 ha and more is required, and for unique biocentres, an area of less than l,000 ha is considered to be suitable. Supra-regional biocorridors have a defined axis and a buffer zone. The minimum width of the axis of a supra-regional biocorridor corresponds with the width of the regional biocorridor of the respective type and is 2,000 m. The maximum width of the buffer zone derives from the maximum distance of local biocentres (2 km away from the axis of the supra-regional corridor on both sides).

The supra-regional TSES is considered to be an important tool for the increase of diversification of the landscape degraded by the economy and agriculture in the last decades. In the Czech Republic, there is a total number of 109 supra-regional biocentres of the TSES, which represent 89 individual biogeographical units (bioregions) and 14 unique biocentres of Central European significance. All the 123 supra-regional biocentres cover an area of 222,616 ha (Bínová et al., 1997). It will be necessary to establish supra-regional biocentres covering an area of at least 6,500 ha on agricultural land, if they are to fulfil their functions. All these biocentres were identified on the basis of their relative intactness according to the knowledge of the local experts, literary data, the presence of the typical elements of the biota and group of ecosystems (eco complexes) and the occurrence of significant

geological and geomorphological features. For reasons of representativeness, supra-regional biocentres can also include compensatory communities, areas in some cases substantially modified by human influence whose potential at the site corresponds with the missing ecosystems.

Maintenance or improvement of biodiversity, especially in supra-regional biocentres, is desirable with regard to the descriptive land use during the past 50 years. In some regions, the implementation of the territorial systems of ecological stability has been successful, but there are still many projects to be done to achieve the full implementation of all tiers of the territorial system of ecological stability in the Czech Republic. Only active management, which requires excellent knowledge of the region, can be successful in establishing the Territorial Systems of Ecological Stability. These systems have huge potentials in ecological perspectives. Among the most important potentials is their function as both an ecological and social network on different levels. The system has a potential to increase co-ordination across the human borders of administrations, regions and local spots and to increase co-operation between administrative sectors, local people and NGOs. It can raise awareness and funding for nature conservation. It might potentially widen our understanding of interaction with nature in a socio-economic context. Inside the framework of nature conservation, there is generally an awareness of a need to implement considerations about ecological connections in the landscape into spatial planning. There is also a reported need to broaden the perspectives of ecological networks to make co-operation possible with the actors in the field. For the future development of TSES as a strategy within nature conservation, it is important :

・to make implementation possible through the integration of nature conservation objectives into the economic sectors of agriculture, forestry and tourism ;

・to develop instruments for implementation and management, especially at the

regional levels ;

・to develop cross-border projects ;

・to exchange and share experiences and disseminate results ;

・to support multi-disciplinary research programs concerning public involvement, and mutual understanding of the diversity of nature conservation and perception of nature in the context of socio-economic development.

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