Land Use Policy 57 (2016) 574–581

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Mapping an ecological network of green habitat patches and their role in maintaining urban biodiversity in and around Debrecen city (Eastern Hungary)

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ARTICLE INFO

Article history:
Received 16 March 2016
Received in revised form 12 June 2016
Accepted 20 June 2016

Keywords:
Landscape ecology
Neophytes
rNECONET
Urbanisation
Urban flora

ABSTRACT

Urbanisation is a leading process on the Globe causing a massive loss of natural habitats. In parallel variety of habitats were created in urban environments, which may also support species diversity. Our aim was to identify urban green areas and their connections with the Regional Ecological Network surrounding the city of Debrecen (East-Hungary), and to explore the biodiversity potential of the network of these parks. We found that whilst industrial areas, airport and mixed land covered a relatively large area, parks and other functional green spaces had a relatively small extent. However the green space system of the city is well connected to the Regional Ecological Network. We also surveyed the functional and potential green spaces in the city and in the studied patches of the Regional Ecological Network in and around the city. We found that 65% of the functional green spaces are potentially connected thus there is a possibility for species typical to semi-natural open habitats to disperse between the green spaces of the city. Based on the survey of the spontaneous flora and planted ornamentals we found that the ratio of native species was high in the studied urban parks. We found that native species were the most typical (>50%) in the spontaneous flora of the studied urban parks, although the ratio of archaeophytes and neophytes were also high. Among ornamental plants, both the proportion of native species and neophytes were considerable in each park, and the proportion of archaeophytes was low. Our results suggest that the studied urban habitats have some biodiversity conservation potential; they mostly harbour species which can cope with the local environmental conditions of the city parks, such as increased temperature, drought and nutrient enrichment.

1. Introduction

As a result of urbanisation and land use changes in the past centuries natural habitats became reduced in size and fragmented in the whole world (Williams et al., 2009). Habitat fragmentation reduces the connectivity between habitat patches by extending the distances between the remaining habitat stands, which lead to the loss of biodiversity in the long run (Lindborg et al., 2012; Bogyó et al., 2015; Deák et al., 2016). Thus preserving biodiversity, creation and maintenance of ecologically stable landscapes have a high priority in conservation (Zipkin et al., 2009). Habitat connectivity is an important factor that supports the preservation of biodiversity in fragmented anthropogenic landscapes by allowing gene flow and the movement of individuals between populations (Lindborg et al., 2012). In landscapes transformed by human activities, artificial elements can constitute barriers for species dispersal and hinder complex propagation processes, which can threaten the survival of the populations (Jaeger, 2000).

Ecological networks are in the focus of ecological researches since the 1980s (Jongman and Kristiansen, 2001). Exploration, designation and protection of ecological networks support the maintenance of biodiversity and reduce the isolation in intensively used fragmented landscapes. GIS-applications are suitable to explore ecological networks in fragmented landscape and estimate connectivity between habitat patches (Vuilleumier and Prélaz-Droux, 2002; Nikolakaki, 2004). An ecological network can be described as a mosaic of functionally connected habitat patches, facilitating species dispersal and therefore, supporting biodiversity conservation (Boitani et al., 2007). It is crucial to ensure the coherence of ecological networks and to identify and eliminate the

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http://dx.doi.org/10.1016/j.landusepol.2016.06.026
0264-8377/

threatening barriers in order to support the survival of numerous species typical to natural and semi-natural habitats (Jordán et al., 2007; Ziółkowska et al., 2014). Greenway and green space planning have a long history; roots of the greenway idea are more than 100 years old (Zube, 1995; Vasas et al., 2009). The first example of this kind of planning was the Adirondack Park Region Concept in the United States (Howard, 1898). A catalogue of plant species suitable for urban greening was also prepared in Europe during the 20th century; such plans were also developed in Berlin, Budapest, and Prague (Kavaliauskas, 1995). As a result of human impacts, such as increasing urban sprawl and land use changes formed barriers in natural environment; various barriers for example cities, industrial and transport areas as well as intensively cultivated agricultural lands decreased the area of semi-natural habitats. In these landscapes semi-natural habitat fragments are usually separated by degraded, transformed areas. Thus, the maintenance of biodiversity requires conscious planning in urban environments (Linehan et al., 1995).

In Europe, the idea of a continent-wide ecological network, the European Ecological Network (EECONET) was introduced in 1993, in the frame of an IUCN initiative (Jongman and Kristiansen, 2001). The initiation aimed at preserving the natural values of Europe by identifying and sustaining the core and buffer areas of natural habitats, and also the ecological corridors (Madgwick and Jones, 2002). The EECONET consists of several National Ecological Networks (NECONETs). Designation of the Hungarian NECONET was initiated in 1993; and the task was done at regional levels by the National Park Directorates, which resulted in detailed maps of the Regional Ecological Networks (rNECONETs) at a scale of 1:50,000 (Nagy, 2004). Although ecological networks can have a key role in sustaining biodiversity of a region, there is a considerable lack of information about the effectiveness of urban ecological networks in biodiversity conservation. Even though urban green areas are generally small and have diverse utilization; these areas can constitute a large-scale network supporting urban biodiversity (Lososová et al., 2011). Remaining semi-natural habitats such as forests or urban parks but even rooftops and road verges have the potential for preserving the species of the native flora and fauna (LaPaix and Freedman, 2010). The importance of the urban habitats in preserving biodiversity was proven by several studies; for example Müller (2010) found that great cities such as Berlin, Brussels and Maastricht harbour at least half of the regional flora.

Even though green areas of the cities are essential parts of the ecological network, their role has not been sufficiently evaluated till present day. One of the main reasons is that currently the rNECONETs have low resolution, thus, further efforts are needed for a complex evaluation of urban green areas. For instance, in the majority of the cities, only the larger parks are indicated as green areas in the rNECONETs. A detailed inventory of urban green areas would be essential for the complex evaluation of urban ecological networks. Such complex analyses could reveal the role of urban green areas in biodiversity conservation or could provide essential data for action plans against invasive species (Hunter, 2007; Talley et al., 2007). For studying the role of urban green network in biodiversity conservation, the city of Debrecen provides unique research opportunity. Debrecen it is the largest city in East-Hungary, harbouring several urban green areas with various land use types. In our study we explored the land use types and the green space system of Debrecen. Our aim was to identify urban green areas and their connections with the Regional Ecological Network surrounding the city. We especially focused on the composition of the urban flora, regarding the native species and adventive flora elements.

2. Materials and methods

2.1. Study area

Debrecen is the second largest city, and one of the largest regional centres in Hungary (N 47.531000 E 21.625000). Its administrative area is 461.65 km^2, its urbanized area is 109 km^2 and it has 208,000 inhabitants (HCSO, 2012). The climate is continental, the mean annual temperature is 10 °C; the mean annual precipitation is 560–590 mm (Marosi and Somogyi, 1991). The city has an extended agglomeration zone. The downtown is bounded by urban-suburban areas and urban settlement rings (Kozma, 1999). Urbanization processes are similar to other large cities: increasing land use intensity, conversion of grasslands, forests and arable lands to residential and industrial parks with a dense traffic network. Land use of the peri-urban areas around Debrecen has been considerably altered in the past centuries. Many of the former agricultural areas were transformed to urban areas and the formerly extensively

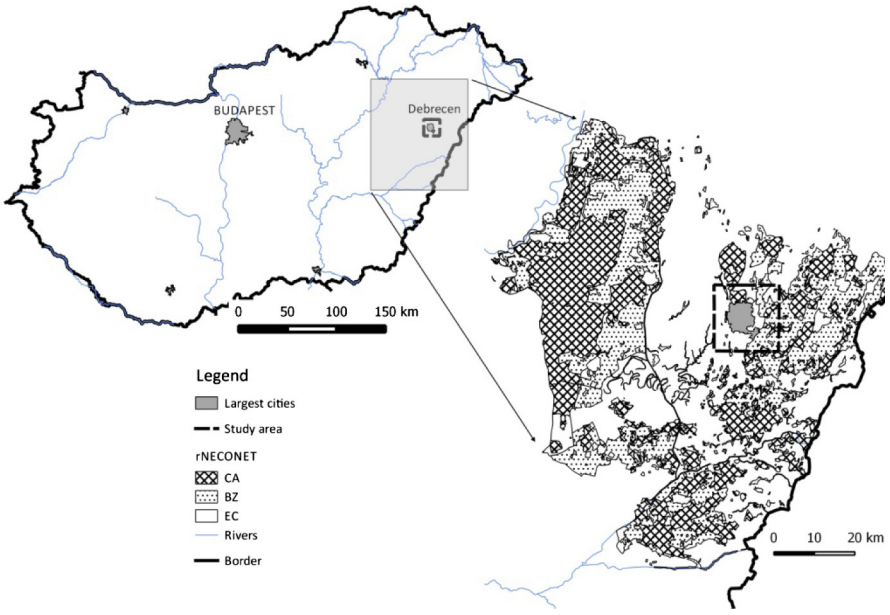

Fig. 1. Debrecen city and its surroundings, with the map of the rNECONET. Abbreviations: CA—core area, BZ—buffer zone, EC—ecological corridor.