Spreading of invasive species in greenways: a GIS-based case study in Hungary

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Introduction

The fast spread of invasive species is leading to a reduction in biodiversity and habitat loss for native species. It is especially important to consider the environmental aspects during greenway planning. Ecological corridors are designed to assure the migration of species between the valuable conservation areas and to reduce the spreading ability of invasive species.

This paper analyses the proportion invasive species on the greenways (ecological corridors) of the Southern Hungarian Great Plain NUTS 2 statistical region, in Hungary. The spreading conditions and dynamics of invasive species were compared inside and outside greenways. The study aims to define the ecological factors that influence the spread of two invasive species: silver berry *(Elaeagnus angustifolia)* and common milkweed (*Asclepias syriaca*). Another goal was to prepare the hazard map of invasive species for a study area based on the results. This map can be used to make recommendations for the modification of ecological networks.

Georeferred point based landscape photographs of the EU project LUCAS (Land Use/Cover Area Statistical Survey) were used for our research. LUCAS allows monitoring of environmental changes because of the fieldwork based landscape photographs were taken in every (more than 1000) sample points of the study area. The LUCAS points with a high number of silver berry *(Elaeagnus angustifolia)* and common milkweed (*Asclepias syriaca*) were easily identified from the photos based on the morphology. The chosen points of the database give good opportunity to examine how large the proportion of invasive species is in the elements of the ecological network (ecological core area, corridor and buffer area) in the Southern Hungarian Great Plain NUTS 2 level statistical region study area. To assess the degrees of hazard the geographical factors influencing the spread of invasive species were examined using digital databases referring to soil, land cover, land cover change and drainage system maps. Based on these analyses the hazard map was prepared considering the above mentioned invasive species. The showed methods and results will be able to add some new useful tools for greenway, and ecological network planning.

Literature review

Previous research has underlined that, if the ecological corridor is not well chosen, if it allow the migration of valuable and invasive species. (Hobbs, 1992) According to Fu et al (2013) urban, rural and natural areas connecting greenways are more likely to become infested by invasive species. He emphasises that the greenway planners often do not have enough ecological and biological knowledge therefore different exotic species can be imported and they can easily become invasive. Ahern, J. (1995) in his work summarises the strategy of greenway planning and states that the connectivity, especially in case of watercourses, can allow the growth of infected areas. The habitat needs of the two investigated invasive species were examined by Mihály B.- Botta-Dukát Z. (2004), Pearce & Smith (2009), Jarnevich and Reynolds (2010) and Bagi I. (2004).

Goals and objectives

The main objective of this study was mapping of silver berry *(Elaeagnus angustifolia)* and common milkweed (*Asclepias syriaca*) using the sample points of LUCAS database. Then the geographical factors affecting the spread of invasive species were identified with intersection of the used digital databases. The spread conditions and dynamics of invasive species are compared inside and outside National Ecological Network in Hungary (NEN), furthermore the numerical variables of the proportion of invasive species in NEN was examined.. The study aims to investigate the spread and presence of species in accordance to soil, land use and drainage-network conditions. Further aims of the research were to study the connections between the geographical factors and the spatial distribution of points invaded by invasive species as well as to make a hazard map that may well be used for ecological network planning and in proposing recommendations for the modification of NEN.

Methods

The following thematic map databases were georeferred in the Uniform National Projection (EOV) before using. These maps contain data of the sample area: soil type, land cover change and data about the distance from drainage system.

1. LUCAS (Land Use / Cover Area statistical survey) The identification of the studied invasive species was based on the photos which were taken in the geo-refered points of the LUCAS project (Land Use/Cover Area Statistical Survey). In each point 7 land cover categories were

distinguished (*artificial land, cropland, woodland, other tree area, shrubland, grassland, water area*). The surveys were repeated every three years. In this paper the landscape photographs from the field survey points of the years 2006, 2009, 2012 were used. The invasive species can be easily recognized on these photos. Each in the three examined years, the average distance of the points was 3-5 km from each other.

2. Digital soil maps (agro-topographic database) The digital map was created based on a survey in 1980 on a scale of 1:100000, cover whole Hungary. The percentage distribution of invasive species were examined within the 31 soil types of Hungary, then the soil types were classified into five hazard categories according to their infection level.

3. CORINE Land Cover (CLC) This land cover survey covers the whole area of the EU. 5 main land cover categories were identified based on visual interpretation of the satellite images: *1.Artificial surfaces, 2.Agricultural areas, 3. Forest and semi-natural areas, 4.Wetlands, 5.Waterbodies.* Percentage distribution of infected sample points were examined within 28 land use categories in Hungary. Afterwards land use categories were classified in five hazard categories according to their infection level. CLC maps from 2012 on a scale of 1:100000 and land-use change polygons from 2006 to 2012 were used. The average distances between infected/ not infected points and areas from land use change polygons were measured, then those land-use change types were selected which play big a role in the spread of invasive species.

4. NNCIS (National Nature Conservation Information System of Hungary) National Ecological Network (NEN), which was examined in the paper, is also the part of this digital database. Hungarian Ecological Network is the part of the PEEN (Pan-European Ecological Network). The vector digital maps of the network are available on a scale of 1:50000. The proportion of infected points were investigated in 2006, 2009 and in 2012 inside and outside of NEN.

5. Digital map of drainage system Rivers, streams and artificial channel network of the NUTS 2 statistical region (study area) were digitized from topographic map sheets (scale 1:10000).

Hazard maps were preparedbased on the identified geographical conditions that play big role in spread of the investigated two invasive species.. In case of silver berry the soil maps, land cover maps and maps about the distance from the drainage system were taken into account to make the hazard map. In case of common milkweed the soil type, land cover and land-cover change buffer maps were considered to make the hazard map of common milkweed.

Results

Common milkweed is rather common outside NEN. Only 15,6 % of the common milkweed infected points can be found in the NEN so it is less common within the ecological network. In the case of silver berry, it is more common within the NEN, because 37 % of the silver berry infected points can be found inside the NEN).

Watercourses (channels, streams) play big role in spreading of this species (Pearce and Smith, 2009; Jarnevich and Reynolds, 2010). According to our results the infected points by silver berry are closer to watercourses than points that are not infected. This fact has to be considered under the planning of green infrastructure and NEN. According to our findings, the hazard of the silver berry spreading is high and very high in the most part of the study area (Fig. 1.)

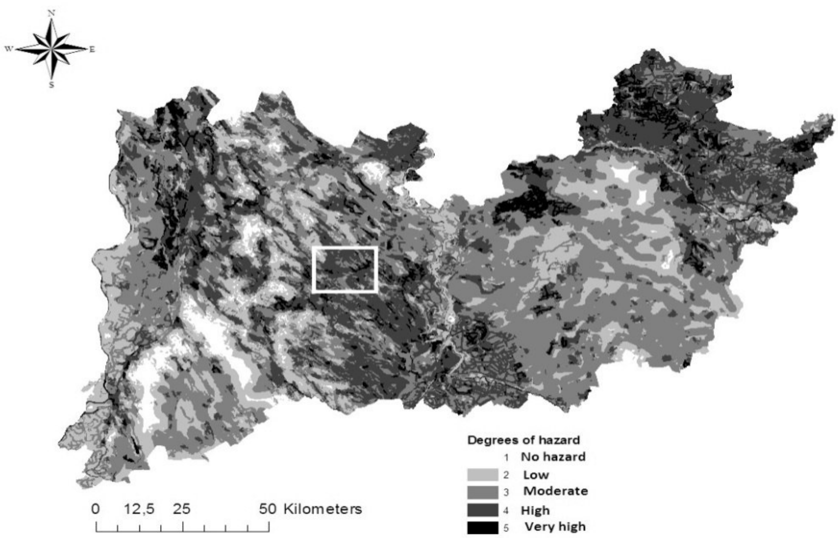

Figure 1. The silver berry hazard map of Southern Hungarian Great Plain (NUTS 2 level) –Degrees of hazard: 1 – no hazard, 2 – low hazard, 3 – moderate hazard, 4 – high, 5 – very high; white frame – case study area

Inside the selected smaller sample area can be found some ecological corridors which have also high degrees of silver berry hazard. In this case elimination of greenway corridor is recommended. Some ecological network element of the sample area, shows slow hazard of invasive species. Under no circumstances can these areas be connected with new green corridors (Fig.2.). The areas with no or low hazard regarding the spread of silver berry can be appropriate for creating new, different ecological corridors. On these areas it is recommended to create new NEN elements that could function as step-stones and help spread of species (Fig.2).

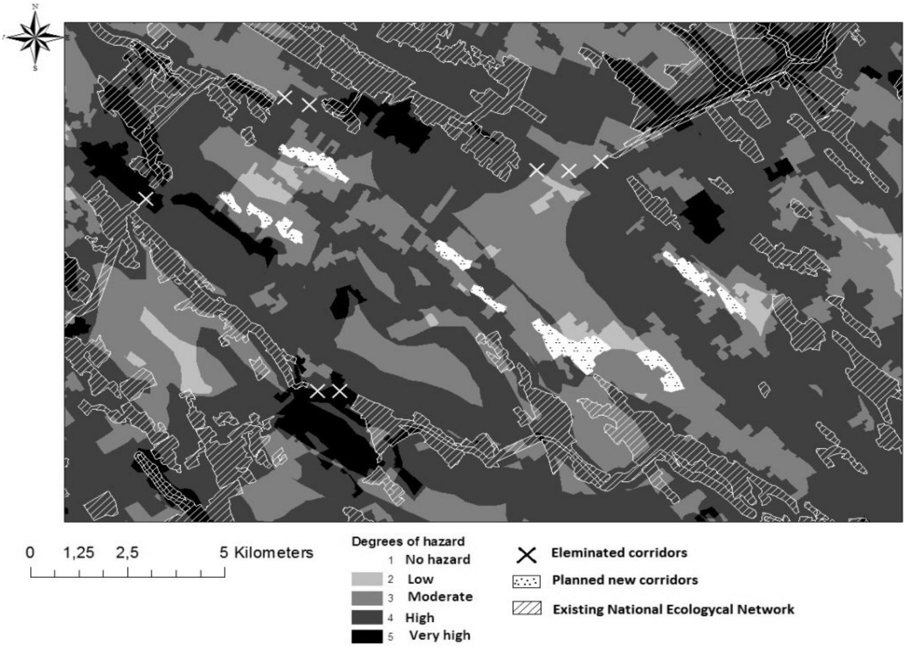

Figure 2. Recommendation for modifying of the National Ecological Network, and the silver berry hazard map of the sample area

Continuous connection in some cases can help to spread invasive species but the step-stones allow migration of valuable species that are considered important in terms of nature conservation.

Discussion, conclusion:

Field based landscape photographs of LUCAS database were used to identify the points where invasive species are present. We demonstrate that, the silver berry is more common within the elements of NEN than the milkweed, and the green network helps its spread. Five hazard categories were created according to the recent proportion of the investigated invasive species. Based on these categories, the hazard map of Southern Hungarian Great Plain NUTS 2 statistical region was prepared. Based on our results we can frame recommendations for modifying existing ecological network. Ecological corridors around the artificial irrigation channels can help spreading of silver berry thus in case of these areas the elimination of corridors is recommended.

Creating new corridors and ecological step-stones as new ecological network elements are recommended in case of low hazard degree areas. The presented method can be useful tool of ecological network planning.

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