# CHYBĚJÍCÍ ZELENÁ INFRASTRUKTURA A POTENCIÁL PRO JEJÍ ZLEPŠENÍ – PŘÍKLAD JIHOMORAVSKÉHO KRAJE

# MISSING GREEN INFRASTRUCTURE AND POTENTIAL FOR ITS ENHANCEMENT – EXAMPLE OF THE SOUTH MORAVIAN REGION

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## Abstrakt

Zelená infrastruktura (ZI) může být považována za jeden z konceptů, jehož optimalizace nabízí potenciál zmírnění některých současných environmentálních problémů (např. klesající biodiverzitu, akcelerace změny klimatu, nadužívání krajiny). Současná kulturní krajina představuje mozaiku, v níž se prolínají oblasti s bohatým výskytem ZI s oblastmi, kde je ZI výrazně zredukována či zcela chybí. Typickým příkladem krajiny s často nedostatečným výskytem ZI je Jihomoravský kraj. V našem příspěvku proto představíme probíhající projekt, zabývající se identifikací tzv. problematických lokalit (s nedostatečnou/chybějící ZI), ale také nástinem možností využití dostupných dat (např. výskyt zaniklých habitatů, výskyt lokalit se zvláštní/obecnou ochranou, potenciálně dostupná obecní/státní půda či dokončené pozemkové úpravy) směřujícím k optimalizaci sítě ZI v zájmovém regionu.

**Klíčová slova**: chybějící části zelené infrastruktury, historické habitaty, Jihomoravský kraj, environmentální problémy

## Abstract

Green infrastructure (GI) can be considered as one of the concepts that can help in combating today's environmental problems – loss of biodiversity, climate change, overexploitation, etc. There are localities with abundant GI on one hand, and localities where the GI is severely reduced or completely missing. South Moravian region is one of the regions in the Czech Republic where the localities from the second group are frequently found. In our contribution, we will therefore present an ongoing project, whose focus is to not only identify so called problematic localities (with underrepresented/missing GI) but also to provide some general thoughts if we can use information about past habitats and other existing information (e.g. presence of areas with special/general protection, potentially available municipality/state land, or completed land consolidation projects) to enhance the current GI network.

**Keywords:** Green infrastructure gaps, historical habitats, South Moravian region, environmental problems

https://doi.org/10.11118/978-80-7509-979-2-122

# INTRODUCTION

With worldwide increasing population and corresponding consumption, the pressure on the environment and specifically landscape has steadily increased. It lead to landscape transformation and overexploitation, degradation of natural functions and processes and subsequently to ecosystems fragmentation, biodiversity decline and weaker protection against climate change impacts. To lessen negative effects of human activities, there has been an increased effort to implement various environmental policies (seen from the Central European perspective), such as Biodiversity strategy for 2030 (European Commission, 2020) or Nature restoration law (European Commission, 2022), and introduce various concepts, such as Agroforestry (Mosquera-Lasada *et al.*, 2018) or Green Infrastructure (European Commission, 2013).

The concept of green infrastructure (GI) considers natural systems important to achieve both economic and social well-being at lower costs than man-made infrastructure and with additional benefits, such as fostering connectivity between natural and semi-natural habitats, delivering various ecosystem services and generally leading to more resilient landscapes and higher biodiversity. Its role and contribution to combating current problems (loss of biodiversity, climate change, overexploitation) has been recognized and lead to an increase effort for its mapping (e.g. Liquete *et al.*, 2015; Skokanová *et al.*, 2020). As a result, areas with abundance of GI as well as areas with the lack of GI can be identified. Identification of gaps in the GI network can then lead to proposals how to fill in these gaps, which is also main aim of this study.

## Study Area

Our study is a part of an ongoing five year project, which focuses on assessing the potential of how the historical GI can help to increase the connectivity of present GI (in case of restoration) in the whole Czech Republic. It was launched in 2023. The work is done subsequently for individual Czech regions and the first year was dedicated to creating a methodology and testing this methodology in two regions – South Moravian and Zlínský regions. Here, we present the results from the South Moravian region. This region can be characterized as one of the most agriculturally used regions where the lack of GI can be highly expected. It is warm and dry (from Central European perspective), with large proportion of lowlands and hilly lands, which are predominantly used for agriculture, and a smaller proportion of upper highlands and mountains, which are predominantly forested. The lowest elevation (150 m above sea level) can be found at the confluence of two large rivers – Dyje and Morava. The highest elevation is in the Bílé Karpaty Mountains in the southeast and reaches 836 m above sea level.

# MATERIALS AND METHODS

Thanks to the regional level for which all analyses were carried out, we chose a regular 1 × 1 km grid, which enables easy visualization of the results and comparison of the results between different regions.

We used Consolidated Layer of Ecosystems (CLE) database to identify localization of present GI. This database contains 40 land cover classes, out of which 30 were grouped into four groups of ecosystems serving as GI – forest, grassland, water bodies (including wetlands) and other (including shrubs, orchards and vineyards). For identification of historical GI, we used TopoLandUse database containing five land cover layers from 1840s till 2000s, in particular layer from the 1840s, which captures the most preserved landscape structure with high presence of grasslands and water bodies. Since the TopoLandUse database does not contain rivers, we vectorised them separately and added them to the layer in the form of 20 m wide buffer. GI in this layer was represented by forests, grasslands, orchards, vineyards and water bodies.

To assess presence of GI, we calculated proportion of the GI in each grid cell and divided it into five categories: no presence of GI (0 % of the proportion of the grid cell), very low presence of GI (< 10 %), low presence of GI (10–25 %), high presence of GI (20–50 %) and very high presence of GI (> 50 %).

Besides identifying presence of the GI and its proportion, we focused also on identifying causes of the lack of GI. Two main causes were identified – maximum effort for agricultural use and increased urbanization together with spread of road network. Maximum effort for agricultural use was represented by high proportion of arable land (higher than 75 % of a grid cell area), based on the CLE database, and by mean size and mean slope of plots with arable land, which was based on the LPIS database. Increased urbanization was captured by the proportion of urban areas larger than 33 % of the grid cell area, based on the CLE database, and spread of road network was based on the road density, calculated from the road network captured by ZABAGED data.

Based on the proportion of GI and anthropogenic pressure, represented mainly by maximum effort for agricultural use, we identified so called problematic localities with lack of GI. These localities had to fulfil at least two out of three conditions: proportion of arable land exceeding 75 % of a grid cell area; no presence of GI; very low presence of GI and at the same time mean size of plot with arable land higher than 10 ha and mean slope of these plots higher than 5°.

For the localities with the lack of GI, further analyses were completed in order to formulate recommendation how to enhance GI in them. These analyses included analyses of ownership, complex land consolidation projects (CLCP), presence of protected sites and presence of historical GI.

Ownership analysis focused on presence and proportion of municipal land, in particular arable land that could be used for spread of GI. We distinguished localities without presence of municipal land and with presence of municipal land smaller/larger than 10 % of the grid cell.

Analyses of CLCP provided information whether identified locality belonged to a cadastre where CLCP were carried out and therefore some efforts to increase presence of GI could be expected in the nearest future. We distinguished localities without CLCP and with CLCP covering less/more than half of the grid cell.

Regarding presence of protected sites, we focused on sites with general (represented by Territorial System of Ecological Stability) and/or special nature protection (represented by small-scale special protected areas and NATURA 2000 habitat sites). We calculated proportion of these sites in the grid cells and the coverage of these sites with GI. As such we were able to distinguish potential relationship between protected sites and GI, i.e. if the GI covers more than half of the protection sites or not.

Analyses of historical GI again focused on its proportion in a grid cell and enabled distinguishing localities without historical GI and with less/more than 10 % of the grid cell.

## RESULTS

More than half of the South Moravian region (55 %) is covered by localities with high or very high presence of GI. These localities can be found mainly in the higher dominantly forested elevations or in the lower elevations with the remnants of large forest complexes and with vineyards. The lack of GI is typical for fertile lowlands (deforested, agriculturally used). Low and very low presence of GI can be found in 42 % localities and 3 % localities have no GI at the regional scale (Fig. 1 top).

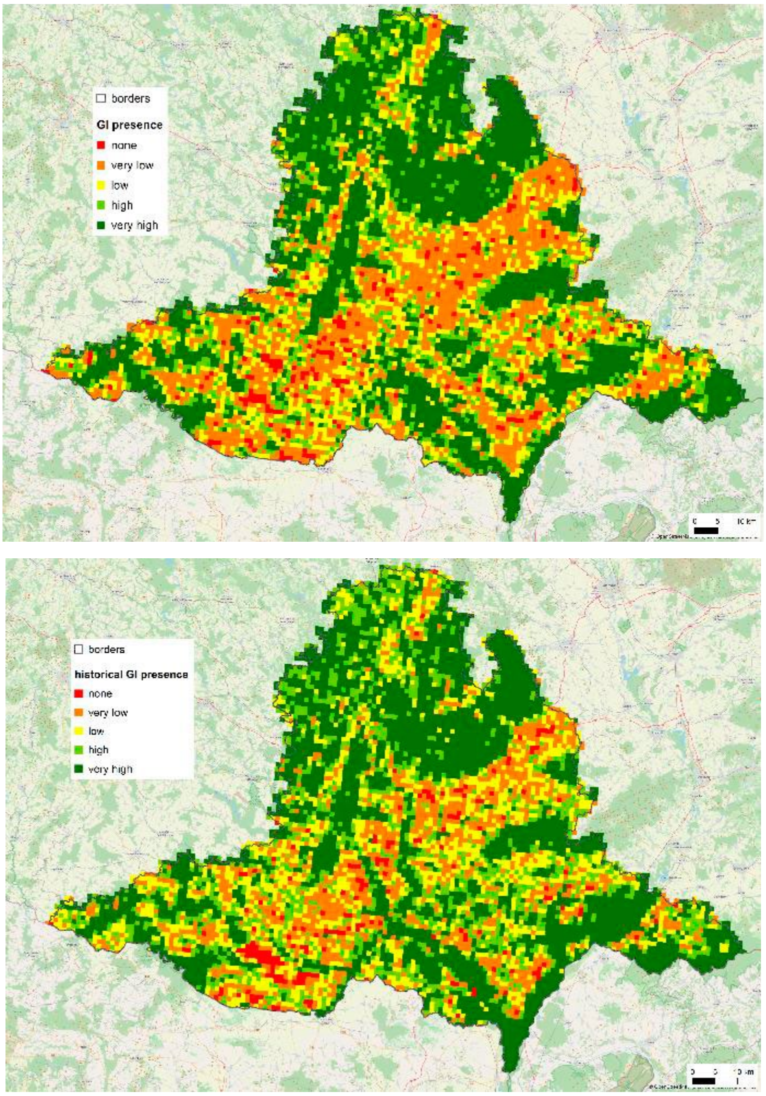
Compared to current situation, localities with high or very high presence of historical GI covered larger area (63 %). They were also typical for higher elevation with forest complexes; however, high or very high presence of GI could be found in lowlands with forested and grassed floodplains of large rivers (Fig. 1 bottom). Localities with very low and low presence covered 34 % of the South Moravian region, which was less than at present. Localities with low GI presence dominated, while nowadays the localities with very low GI are the dominant category. No presence of historical GI could be found at similar localities as in present and covered similar proportion.

Lack of GI in the South Moravian region can be explained mainly by intensive agricultural use. Indeed, about 30 % of the region is covered by localities where the proportion of arable land exceeds 75 % of a grid cell. On the other hand, plots with arable land, where their mean size is smaller than 10 ha, dominate (they are present in 70 % grid cells with arable land of the South Moravian region). Still, around 12 % of the region can be classified as under the maximum agricultural use, i.e. with arable land covering more than 75 % of a grid cell and mean size of arable plot higher than 10 ha. Urbanized areas cover only 9 % of the region and create clear settlement nodes or axes.

Problematic localities, i.e. localities with lack of GI and at the same time under high anthropogenic pressure, were identified in 255 localities. Majority of them show no GI at the regional level (200 grid cells) and are concentrated mainly in the south-western, mainly flat terrain. Smaller group of localities (55 grid cells) has very low presence of GI but identified plots with arable land exceed 10 ha and are situated on steep slopes mainly in the hilly lands in the eastern part of the region. Analyses of municipality ownership show that more than 70 % of the problematic localities have at least 10 % of municipality arable land and in seven localities the proportion of municipality land exceeds 10 % of the grid cell. At the same time, more than half localities belong to cadastres with finalized complex land adjustments and more than 70 % of the localities used to have some presence of historical GI. On the other hand, no protected sites were found in 80 % of the localities.

Based on the results of the analyses, we can distinguish four groups of localities in which we can offer various forms of enhancing GI presence (Fig. 2). The first, and smallest, group is represented by seven localities with only presence of protected sites and some presence of municipal arable land. CLCP were partly finalized only in five of these localities.

The second group consists of 22 localities. Here, both protected sites as well as historical GI were detected. Municipal arable land is present in 19 localities and 16 localities have at least some CLCP. The biggest group (161 localities) consists of localities with historical GI only. More than 80 % of these localities have municipal arable land and CLCP were partly finalized in more than half of them. Finally, 65 localities show no presence of historical GI or protected sites. Nearly 40 % of these localities don't have any municipal arable land but CLCP were partly finalized on more than half of them.

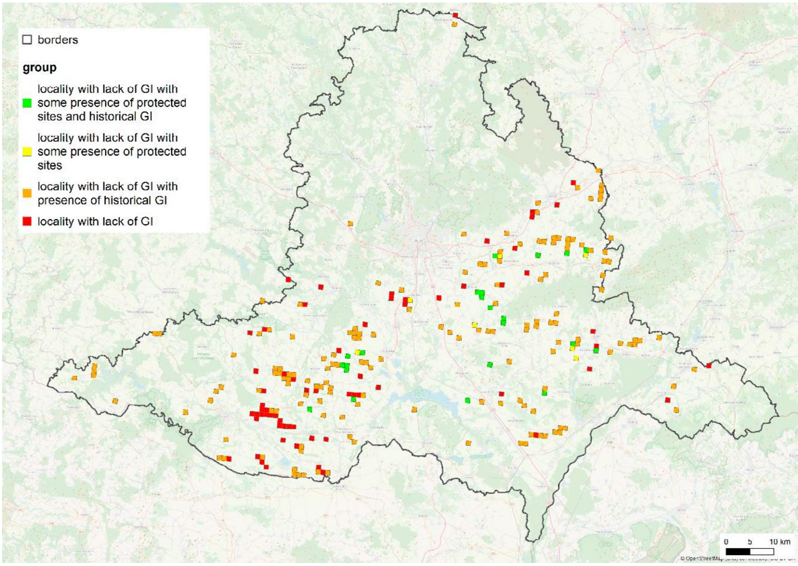



1: *Presence of current (top) and historical (bottom) GI in the South Moravian region*

## DISCUSSION AND CONCLUSIONS

From the statistical perspective, the South Moravian region is quite well covered by GI, despite the fact that its area decreased compared to GI from the 19$^{th}$ century. However, spatial localization (Fig. 1) shows that the GI is distributed unevenly and that there are localities where it is either heavily underrepresented or completely missing. These localities at the same time are heavily used for agricultural purposes and are significantly threatened by the impacts of climate change like increased soil erosion or draught, and at the same time create a barrier for wildlife migration. Therefore, introduction of at least some GI elements in these localities would help mitigating mentioned issues.

Introduction of new GI elements can be inspired by historical presence of GI elements (Fig. 2) and their restoration. Especially those that can be considered as natural or




2: *Groups of localities with various form of enhancing GI presence*

semi-natural (like woodlands, grasslands or water bodies with accompanying vegetation) can provide a natural (dormant) seedbank (seed that will germinate under favourable conditions). Focusing on localities with present protected areas should be one of priorities, since implementation of GI elements in them would have strong support in already existing territorial plans as well as nature conservation law. Using municipal or state land and completed complex land consolidations can enable easier and more flexible implementation of GI elements. A larger share of municipal or state land can also contribute to easier implementation of GI elements with the help of subsidy titles, like the Landscape Care Program of the Ministry of Environment, Strategic Plan of the Common Agricultural Policy, especially support for rural development, etc.

Here presented methodology and results are based on already existing data and their combination, which can be seen as an advantage. Applied analyses for detecting localities with missing GI are also quite simple. This fact could be seen as a disadvantage since they don't have to capture all potential problems and intricacies, however, we believe that they are adequate for regional and national analyses and can be reproduced by authorities' personal with some GIS skills.

## REFERENCES

EUROPEAN COMMISSION. 2013. *Green Infrastructure (GI)* — Enhancing Europe's Natural Capital. Communication from the Commission to the European Parliament, the European Economic Council, The European Economic and Social Committee and the Committee of the Regions. COM (2013) 249.

EUROPEAN COMMISSION. 2020. *EU Biodiversity Strategy for 2030*. COM(2020) 380.

EUROPEAN COMMISSION. 2022. *Proposal for a Regulation of the European parliament and of the Council on nature restoration.* COM (2022) 304.

LIQUETE, C. *et al.* 2015. Mapping green infrastructure based on ecosystem services and ecological networks: A Pan-European case study. *Environmental Science and Policy*, 54, 268–280. https://doi.org/10.1016/j.envsci.2015.07.009

MOSQUERA-LASADA, M. R. *et al.* 2018. Agroforestry in Europe: A land management policy tool to combat climate change. *Land Use Policy.* 78, 603–613. https://doi.org/10.1016/ j.landusepol.2018.06.052

SKOKANOVÁ, H., LASALA GONZÁLEZ, I., SLACH, T. 2020. Mapping green infrastructure elements based on available data, a case study of the Czech Republic. *Journal of Landscape Ecology.* 13(1): 85–103. https://doi.org/10.2478/jlecol-2020-0006

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