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How can historic cultural landscapes be identified via open data? A case study from the Czech Republic

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ABSTRACT

Historic or traditional cultural landscapes can be identified in areas where land cover and land use changes are less intensive. They are characterised by low-intensity land management, a high degree of multifunctionality and species and habitat diversity. They are site-specific, and research on them is often based on case studies. Our research aims to propose methods for identifying different historic cultural landscapes on the basis of characteristic landscape elements via freely accessible Europe-wide (CORINE Land Cover) or nationwide (ZABAGED, Geonames) data. The method of historic cultural landscape identification is demonstrated in the Kutná Hora Region of central Bohemia, where eight different types of historic cultural landscapes were identified. Our approach can make the process of identification easier and faster and can provide basic knowledge about the presence and location of landscape types.

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Historic cultural landscapes; landscape values; identification; Czech Republic; Kutná Hora region

Introduction

The cultural landscape has become the object of many studies in recent decades; nevertheless, it is still a relevant research topic. The landscape has changed dramatically over the last two centuries in Europe, and these changes were caused by two main driving forces: intensification of anthropic pressure in core areas and extensification in marginal areas (Antrop, 2005; Jepsen et al., 2015; Vos & Meekes, 1999). Historic or traditional cultural landscapes can be identified in areas where the abovementioned changes have been less intensive. The two adjectives, historical and traditional, are often used synonymously, and both include material as well as nonmaterial landscape values and memories. However, traditional cultural landscapes are perceived as landscapes connected initially with human historical economic activity (Antrop, 2005; Cullotta & Barbera, 2011). In this work, we prefer the term historic cultural landscape because it is more general and includes memorial and associative values, as well.

The natural and cultural heritage of historic cultural landscapes is often transmitted from hand to hand (Enache & Craciun, 2013; Scazzosi, 2004). Historic cultural landscapes are characterised by low-intensity land management and a high degree of multifunctionality (Cullotta & Barbera, 2011) and provide many ecosystem services (Xu, Plieninger, & Primdahl, 2019). Many studies have shown that historic cultural landscapes contribute to landscape stability, environmental protection (eg soil protection) and the maintenance of high

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biodiversity (Bazan, Castrorao Barba, Rotolo, & Marino, 2019; Cristofoli, Monty, & Mahy, 2010; Šantrůčková, Dostálek, & Demková, 2015). No less importantly, historic cultural landscapes are significant for landscape and societal identity and maintaining cultural diversity and heritage (Penko Seidl, Kastelec, & Kučan, 2015; Stephenson, 2008). They are attractive and often have high recreational and touristic potential (Sklenicka, Kottová, & Šálek, 2017; Xu et al., 2019).

On the other hand, historic cultural landscapes are endangered by landscape changes, and many cultural landscape elements are declining at a dramatic rate. Both of the abovementioned common processes that play key roles in landscape changes – intensification and abandonment – have led to a reduction in cultural landscape elements (Bürgi et al., 2017). Moreover, some traditional urban activities, such as intensive recreation and tourism, have tended to move towards the countryside (Di Fazio & Modica, 2018; Sklenicka et al., 2017).

Several landscape typologies are used to describe cultural landscapes, and some are useful for historic landscapes. UNESCO World Heritage distinguishes cultural landscapes in three main categories: (a) the clearly defined landscape designed and created intentionally by humans; (b) the organically evolved landscape; and (c) the associative cultural landscape (Rössler, 2006; UNESCO World Heritage Centre, 2008). These three landscape categories became the basis for the national categorisation of historic cultural landscapes created to serve the needs of the Ministry of Culture of the Czech Republic (Ehrlich et al., 2020). This categorisation aims to identify areas with important cultural values that are worthy of heritage protection. They distinguished 34 types of historic cultural landscapes in the territory of the Czech Republic on the basis of the presence and concentration of specific structures typical of each type. A typology of historic cultural landscapes based on a cluster analysis of 51 historic landscape elements was proposed by Jelen, Šantrůčková, and Komárek (2021). This typology fits the Central European landscape and distinguishes seven historic cultural landscape types (water management landscape, industrial landscape, forestry landscape, agricultural landscape, memorial/religious landscape, designed landscape, and military landscape).

The first step for historic cultural landscape protection is the identification of the values that form the landscape character. However, the set of landscape values can be very diverse, depending on the character of the studied landscape, and many ways to identify historic cultural landscapes have been proposed. The most common approach is the complex analysis of a wide set of tangible landscape values of the model area on the basis of a detailed study of historical sources, especially old maps, digital relief models, and terrain research, eg in southern Germany (Bender, Boehmer, Jens, & Schumacher, 2005); the Wiar River Basin in Poland (Affek, 2016); Java in Indonesia (Lukas, 2014); Nováky (Chrastina & Lukáč, 2012) and Čadca (Belčáková, Olah, Slámová, & Pšenáková, 2021) in Slovakia; and Mount Etna in Italy (Cullotta & Barbera, 2011). Intangible heritage has often been represented by local names that have been identified on maps (Penko Seidl et al., 2015) or by interviews with local people (Cogos, Roué, & Roturier, 2017; Pătru-Stupariu, Pascu, & Bürgi, 2019).

Many papers have focused specifically on historic agricultural structures because they were very common in the past and are highly endangered by landscape changes (Fanta et al., 2022; Sklenicka et al., 2017; Slámová, Jančura, & Daniš, 2013; Špulerová, Bezák, Dobrovodská, Lieskovský, & Štefunková, 2017). Sklenicka et al. (2017) and Fanta et al. (2022) identified the remaining originally medieval field patterns called 'plužina' in Bohemia visually from up-to-date orthophoto maps. Slámová et al. (2013) used the method of identification and assessment of characteristic landscape appearance, which contains steps of quantitative geodata processing, landscape attribute evaluation via GIS and axiological attribute assessment, to identify historic agricultural structures. The process also includes archival and fieldwork. Špulerová et al. (2017), similar to Fanta et al. (2022), performed a nationwide traditional agricultural landscape inventory in Slovakia using aerial photos on which they were identified according to four criteria (for more details, see Špulerová et al., 2011).

Another approach published by Solymosi (2011) defined characteristics for identifying cultural landscape hotspots in Europe on the basis of a literature review, including site-specific grey literature and content analysis. The ABC landscape assessment proposed by Giné (2018) is an attempt at complex landscape assessment on the basis of the abiotic, biotic, and cultural landscape characteristics of the land cover. This approach is similar to landscape character assessment; however, landscape character assessment is more focused on the visual quality of the landscape and is closely connected with spatial planning. The concept of landscape character assessment has been adopted in many European countries (Wascher, 2005). A special approach derived from landscape character assessment and focused on the historical qualities of the landscape, named historic landscape characterisation, was proposed by Dabaut and Carrer (2020). The ABC landscape assessment, landscape character assessment, and historic landscape characterisation require detailed site-specific research, including field research.

In the Czech Republic, attention has been given mainly to the historical field patterns in two regions (Fanta et al., 2022 for Bohemia and Kolejka, Krejčí, & Nováková, 2020 for Moravia). Studies of both regions identified the remaining old structures of the agricultural landscape by analysing recent orthophoto maps and verified the age of the structures on the old maps and their presence via field research. Old ponds and their remnants in the present landscape, mainly dams, were examined via comparisons of the ponds on old maps from the mid-19th century and the present state (Frajer, Kremlová, Fiedor, Pavelková, & Trnka, 2021; Pavelková et al., 2014). The designed landscapes were identified by Kulišťáková et al. (2014) on the basis of old map analysis. Kučera, Kučerová, and Chromý (2008) proposed an evaluation of the importance of the areal preservation of cultural and natural values in the entire territory of the Czech Republic on the basis of legal, cultural and natural heritage protection areas. They compared the administrative districts of municipalities with extended powers where cultural or natural heritage prevails and their positions on development areas and axes.

Our research aims to propose methods for identifying different historic cultural landscapes on the basis of their characteristic landscape structures via freely accessible Europe-wide or nationwide data. Unlike the detailed bottom-up description or identification of each historic landscape structure, we propose a way to identify historic cultural landscapes in large areas easily and with reliable accuracy. This method is based on GIS analysis of a set of landscape structures that are representative of historical landscape values.

Model area

The model area is an administrative unit, Kutnohorsko, within the boundaries of the administrative district of a municipality with extended powers, Kutná Hora. Kutnohorsko, with an area of 643 km2, is located in the central part of the Czech Republic in hilly terrain, with a high point at 555 m a.s.l. between the Elbe and Sázava Rivers (see Figure 1). Only the northeastern part has flat terrain, with an elevation of approximately 200 m a.s.l. The landscape of the model area has mainly agricultural–forest characteristics with some urbanism and traditional architecture. It represents a common countryside landscape with scattered cultural and natural values. According to Kučera et al. (2008), Kutnohorsko is not part of the development area or axis and is a region where cultural heritage prevails.

Moreover, in the last decade, several partial studies have focused on different types of heritage in the area. The designed landscape of the Chotek family has been studied by Lipský et al. (2011), Šantrůčková (2022), and Šantrůčková and Weber (2016). The components of the organically evolved landscapes have been analysed for abandoned orchards in the Kaňk hill (Šantrůčková, Dostálek, & Frantík, 2020), forest (Bürgi et al., 2020; Skaloš, Engstová, Podrázský, Šantrůčková, & Trpáková, 2012), and water areas (Šantrůčková, Demková, Weber, Lipský, & Dostálek, 2017). A complex assessment of land cover changes based on old maps in the northeastern part of the area protected as a landscape conservation zone was published by Skaloš et al. (2011). The overall

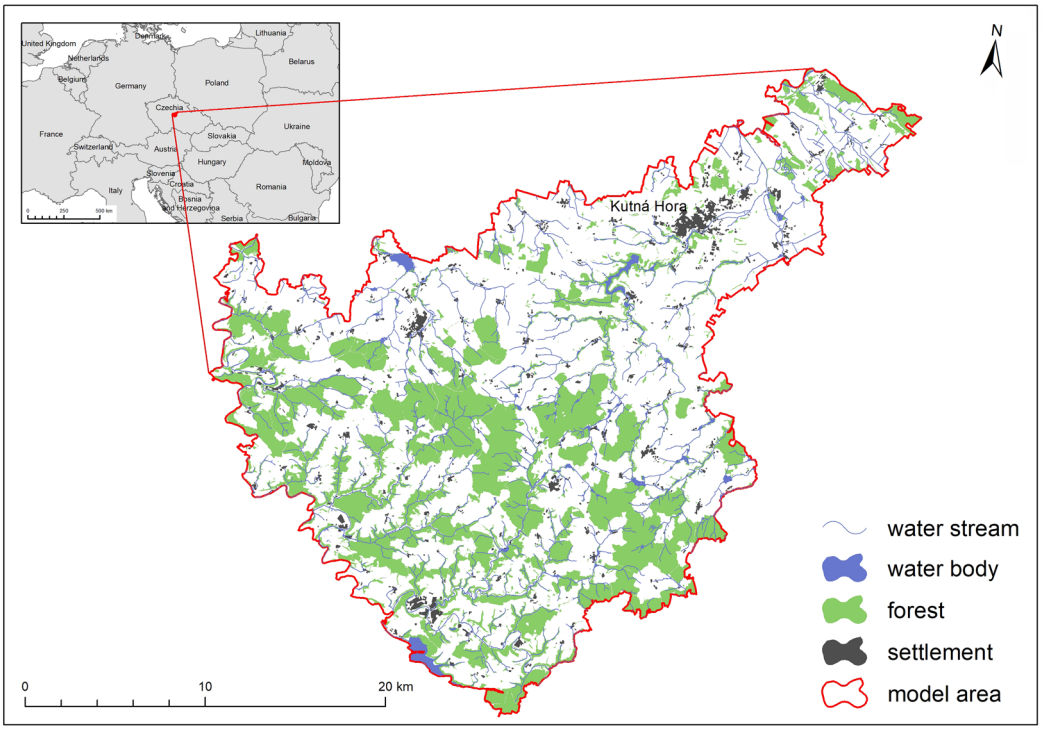


Figure 1. Model area.

enhancement of the landscape conservation zone, Žehušicko, was documented by Kuča et al. (2015). The area around Kutná Hora town was also proposed for protection as a landscape conservation zone but has not yet been legally declared (Kuča et al., 2020).

Kutnohorsko was chosen for testing the identification of historic cultural landscapes via open data because it is sufficiently large in terms of the richness and diversity of the heritage landscape structures identified in previous studies. It was highly probable that all historic landscape types would be found there, which was proven by our research.

Data and methods

Datasets

To meet the needs of subsequent research, we combined the national typology (Ehrlich et al., 2020) and the more general Central European typology (Jelen et al., 2021) mentioned above. The seven types proposed by Jelen et al. (2021) were extended by landscapes of permanent crops and recreational landscapes according to Ehrlich et al. (2020). However, military landscapes were joined with memorial landscapes, which is in accordance with both Jelen et al. (2021) and Ehrlich et al. (2020). Each historic cultural landscape type can be described by a set of specific landscape structures (see Ehrlich et al., 2020; Jelen et al., 2021). From these heritage landscape structures proposed by Ehrlich et al. (2020) and Jelen et al. (2021), the selection further used in the analysis was narrowed to the type-specific structures that are included in freely accessible public digital databases.

Suitable digital databases for a nationwide evaluation of landscapes in the Czech Republic that are open to the public are as follows:

CORINE Land Cover is a project of the European Environmental Agency for the uniform inventory of land cover in Europe. The European landscape is divided into 44 classes according

to the type of land cover (mostly agricultural). In the Czech Republic, there are 29 classes of land cover. The minimum mapping unit is 25 hectares (ha) for areal phenomena, and the minimum width for linear phenomena is 100 m (equivalent scale 1:100 000). To date, five surveys have been conducted. The last version from 2018 was used.

The natural habitat mapping data of Natura 2000 from the Nature Conservation Agency of the Czech Republic (© AOPK) consist of a digitised vector output at a scale of 1:10 000. The data were developed from 2001 to 2005 during the establishment of Natura 2000 (according to the Habitat Direction), and a revision is regularly processed. The September 2019 database version was used for the analysis. The classification and names of the habitat units correspond to those presented in the national interpretation manual for Natura 2000 biotopes for the Czech Republic (Chytrý, Kučera, Kočí, Grulich, & Lustyk, 2010).

The Fundamental Base of Geographic Data of the Czech Republic (ZABAGED® – planimetric components) is a digital vector geographic model of the territory of the Czech Republic that is administered by the Land Survey Office in the public interest. It is used as a base layer in geographic information systems (GIS), primarily in the information systems of public services, and for the creation of base maps at scales from 1:10 000 to 1:100 000. ZABAGED® consists of 131 geographic objects (point, linear and planar elements) containing spatial and descriptive information that is regularly revised and updated. Moreover, objects are defined in an object catalogue with additional attributes.

The database of geographic names of the Czech Republic (Geonames) was created at the level of detail of the base map of the Czech Republic at 1:10 000 and is administered by the Land Survey Office. Geonames are part of the surveying information system and constitute one of the information systems of the state administration. It contains a complete set of spatial and attribute data on standardised geographic names. The geometric representation of some Geonames objects is the same as the geographic objects of ZABAGED®, to which the name applies.

The combinations of characteristic heritage landscape structures that indicate the presence of the historic cultural landscape selected from the databases are presented in Table 1.

For the postprocessing of the preliminarily identified polygons of the historical cultural landscapes, the old maps and orthophoto maps available for the entire Czech Republic were used, namely, maps from the First Military Survey (1760s–1780s), Second Military Survey (1840s–1850s), and Third Military Survey (1870s–1880s); military maps from the 1950s; and orthophoto maps from the 1950s.

Data processing

Simple buffer analysis was applied (at a distance of 1000 m from the object) for all point structures selected from ZABAGED and Geonames. Only buffer polygons with a minimum of three points were further studied and verified. The others were excluded from subsequent research.

The polygon layers of CORINE Land Cover, Natura 2000 natural habitats and polygons of ZABAGED in each landscape type were first merged. Then, all polygons with a minimal final area of 20 ha and a distance of 100 m were aggregated via the 'Aggregate polygons' tool. The result of this first step was the identification of many relatively small and dispersed polygons that were proven for further analysis to be the core areas of the traditional agricultural, forest, permanent crop and pond and water body landscapes. Only 'Rock structure' polygons (ZABAGED polygons) were aggregated, with a minimal final area of 20 ha and a distance of 500 m, because these structures were very small in the original dataset and had relatively long distances from each other. The parameters were thoughtfully selected so that all potential areas were included and nonsignificant small areas were omitted.

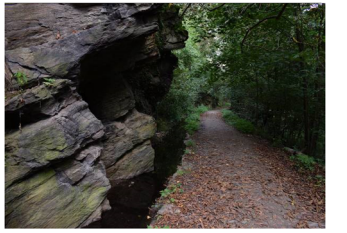
In the case of designed landscapes, the intersection of the polygons of the park and/or ornamental garden and the chateau point within a distance of 200 m was applied. Afterwards, only gardens with a minimal area of 5 ha were selected to eliminate isolated chateaus with small gardens. Analyses were performed via ArcMap 10.8 (Figure 2).

Table 1. Historic landscape types and their characteristic heritage structures.

UNESCO cultural landscape categories	Landscape type	CORINE Land Cover[a] (polygons)	Natura 2000 Natural habitats (polygons)	ZABAGED® (polygons)	ZABAGED® (points)	Geonames (points)	Illustrative photographs
Designed landscapes	Designed landscape	x	x	Park/ornamental garden, botanical garden	Chateau	x	 Photo: A. Rudl, 2018
Organically evolved landscapes	Traditional agricultural landscape	231 – Pasture; 242 – Complex cultivation pattern; 243 – Land principally occupied by agriculture with significant areas of natural vegetation	Natural and seminatural grassland	x	x	x	 Photo: T. Brázdová, 2021
	Landscape of permanent crops	221 – Vineyards; 222 – Fruit trees and berry plantation	x	Hop field; vineyards	x	x	 Photo: O. Malina, 2022.
	Forest landscape	311 – Broad-leaved forest; 313 – Mixed forest; 324 – Transitional woodland-shrub	Forest	x	x	x	 Photo: L. Kočárník, 2009.

(*Continued*)

Table 1. Continued.

UNESCO cultural landscape categories	Landscape type	CORINE Land Cover[a] (polygons)	Natura 2000 Natural habitats (polygons)	ZABAGED® (polygons)	ZABAGED® (points)	Geonames (points)	Illustrative photographs
	Landscape of ponds and water areas	512 – Water body	x	Water area	x	x	 Photo: M. Šantrůčková, 2022.
	Recreation landscape	x	x	Rock structure	Waterfall, solitary rock, group of rocks, castle	Cave, waterfall, valley, lookout tower, castle ruins, group of rocks, rock town	 Photo: O. Malina, 2019.
	Industrial landscape	x	x		Industrial building, smokestack, pit, mine, quarry, disposal site	x	 Photo: O. Malina, 2019.

(*Continued*)

Table 1. Continued.

UNESCO cultural landscape categories	Landscape type	CORINE Land Cover[a] (polygons)	Natura 2000 Natural habitats (polygons)	ZABAGED® (polygons)	ZABAGED® (points)	Geonames (points)	Illustrative photographs
Associative landscapes	Associative landscape	X	x	x	x	Monument, memorial, tomb, spring, protected tree, building/ castle ruins, gallery, museum	 Photo R. Urbánek, 2021.

[a]The last version CORINE Land Cover from 2018 was used.

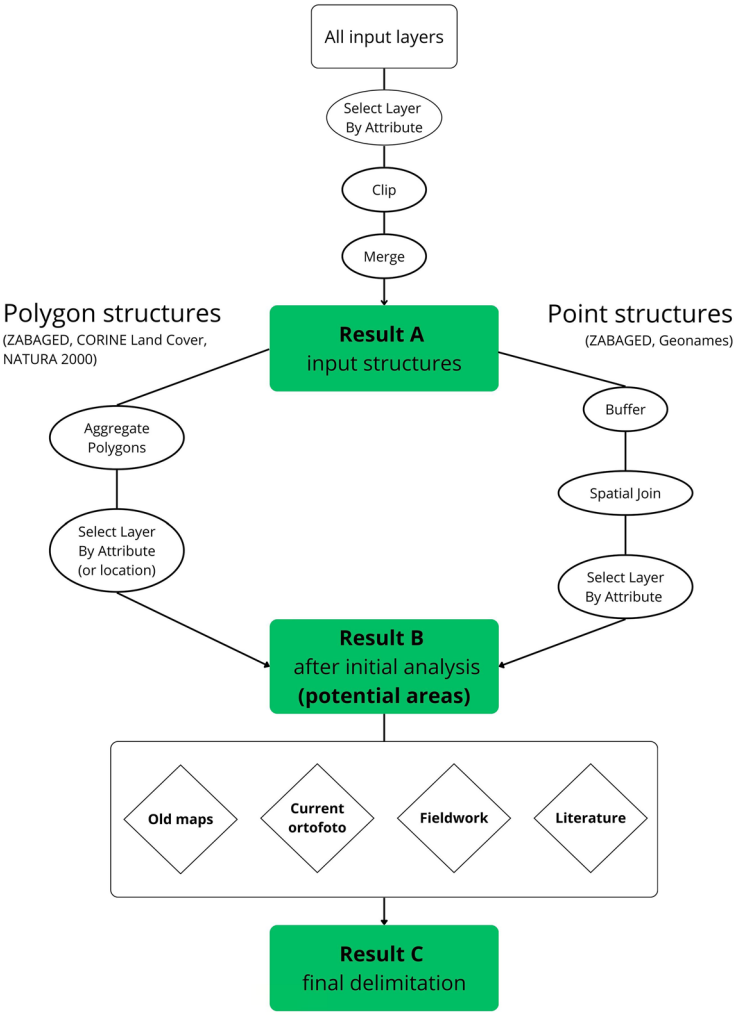


Figure 2. Flow chart visualising the analysis.

The preliminary polygons of potential historic cultural landscapes identified by the abovementioned analysis were further verified, and their boundaries were specified. For specification, commonly available old maps of the entire area were used to determine the ages of the identified landscape structures. Generally, we assumed that the features established before the 1960s were historical. Additional information on the landscape structures was obtained from the regional grey literature. Finally, the present state (at the scale of good×damaged×nonexistent) of the old landscape structures was verified via fieldwork. The areas of the potential historic cultural landscapes were visited once and the main landscape structures and their state were marked to the sheets and field maps. The photo-documentation was provided. This postprocessing was necessary but less time-consuming because it focused only on areas predefined in the first step when open data analysis was applied.

When the presence of traditional agricultural, forest, permanent crop, pond and water body and industrial areas was proven by the old maps and fieldwork, large polygons were drawn according to the fieldwork results and current orthophoto maps. Recreation landscapes were identified only by cultural and natural objects. Recreation buildings, cottage areas and campsites were excluded from the analysis because it is difficult to determine whether they are historic. Designed landscapes characterised by manor houses and ornamental gardens must be overlaid

by old maps from the 18th and 19th centuries (first, second, and third Military Maps), where other structures linked with designed landscapes are depicted (eg roads with alleys, axes, vistas, and buildings such as gloriettes and summerhouses).

Nevertheless, we used actual visual boundaries such as forest edges and roads or administrative boundaries such as cadastres for delineating boundaries. The present orthophoto map of the Czech Republic and the field sheets from the field research were used for the final set of the historic cultural landscape polygon boundaries. We prefer to use the present orthophoto map instead of the old maps because we delineated the preserved historic cultural landscapes that could be used in landscape planning documents.

Results

According to the presented method, areas of eight types of historic cultural landscapes were identified in the Kutnohorsko region.

The traditional agricultural landscape (Figure 3(a–c), A 1 in Supplementary Material) is concentrated in the hilly terrain in the southern part of the region, where agriculture was traditionally related to manor farms that were established before the second half of the 18th century (they are marked on the maps of the First Military Survey, 1760s–1780s). On the other hand, the landscape of permanent crops (Figure 4(a–c), A 2 in Supplementary Material) is not large and is concentrated in the area surrounding the most important town of the region, Kutná Hora, where products can be sold or easily transported to more distant markets. Fruit orchards, especially cherry trees, are traditionally planted on the slopes of the Kaňk hills north of Kutná Hora. Vineyards were marginal in the 19th and 20th centuries, but they often replace orchards today. The forest landscape (Figure 5(a–c), A 3 in Supplementary Material) complements farming in the uplands. It also encompasses game reserves related to manor houses, especially chateaus and designed landscapes.

The landscape of ponds and water areas (Figure 6(a–c), A 4 in Supplementary Material) encompasses dams on the Želivka and Vrchlice Rivers and ponds near Vavřinec. Most of the existing ponds have been maintained from the 18th century (when they were marked on the maps of the First Military Survey) to the present day, but many others, especially small ones, have disappeared.

The recreation landscape (Figure 7(a–c), A 5 in Supplementary Material) is concentrated along the Sázava River around Rataje nad Sázavou, which were very famous tourist centres at the end of the 19th century and the first half of the 20th century. Currently, the popularity of this region has waned. The second recreation landscape is situated south of the town of Kutná Hora along the Vrchlice River. The high concentration of natural tourist attractions, such as valleys, rocks and waterfalls, is typical of both. The Sázava River is very famous for paddling as well.

The most important industrial landscape (Figure 8(a–c), A 6 in Supplementary Material) is around the town of Kutná Hora, where many relics of medieval ore mining have been preserved. Other industrial landscapes were found in Uhlířské Janovice in the western part and Zruč nad Sázavou in the southern part of the study area; these landscapes were connected with modern industrialisation during the first phase of the industrial revolution at the end of the 19th century and the first half of the 20th century.

A relatively high concentration of manor houses with small gardens is situated in the southern and northern parts of the Kutnohorsko region. This is related to the abovementioned traditional agricultural landscape. Today, maintained and designed landscapes (Figure 9(a–c), A 7 in Supplementary Material) are situated near the manor houses Kačina and Roztěž, whose garden areas are 66 and 9 hectares, respectively. Many structures indicate that the designed landscapes are still preserved. Other chateaus with gardens maintained to the present day no longer represent the designed landscape.

In our study area, associative landscapes (Figure 10(a–c), A 8 in Supplementary Material) were identified south of the town of Kutná Hora. They are associated mainly with the late medieval Hussite wars in Bohemia and important national writers of the 19th century. Battles and persons are commemorated by monuments: battlefields (battle in the 15th century near

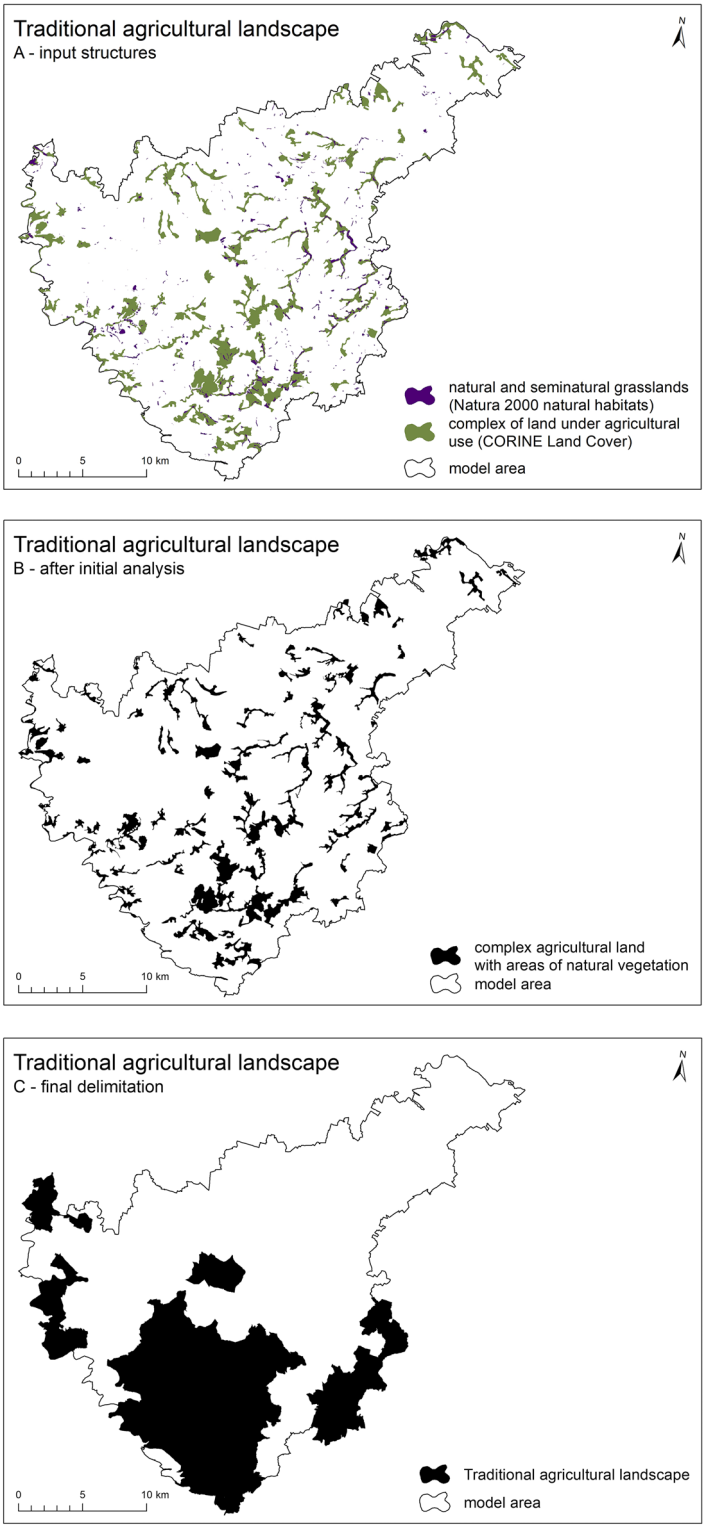


Figure 3. (a–c) Delimitation of the traditional agricultural landscape; A – input data, B – initial analysis, and C – final delimitation. *Source:* CORINE Land Cover, Natura 2000 Natural Habitats.

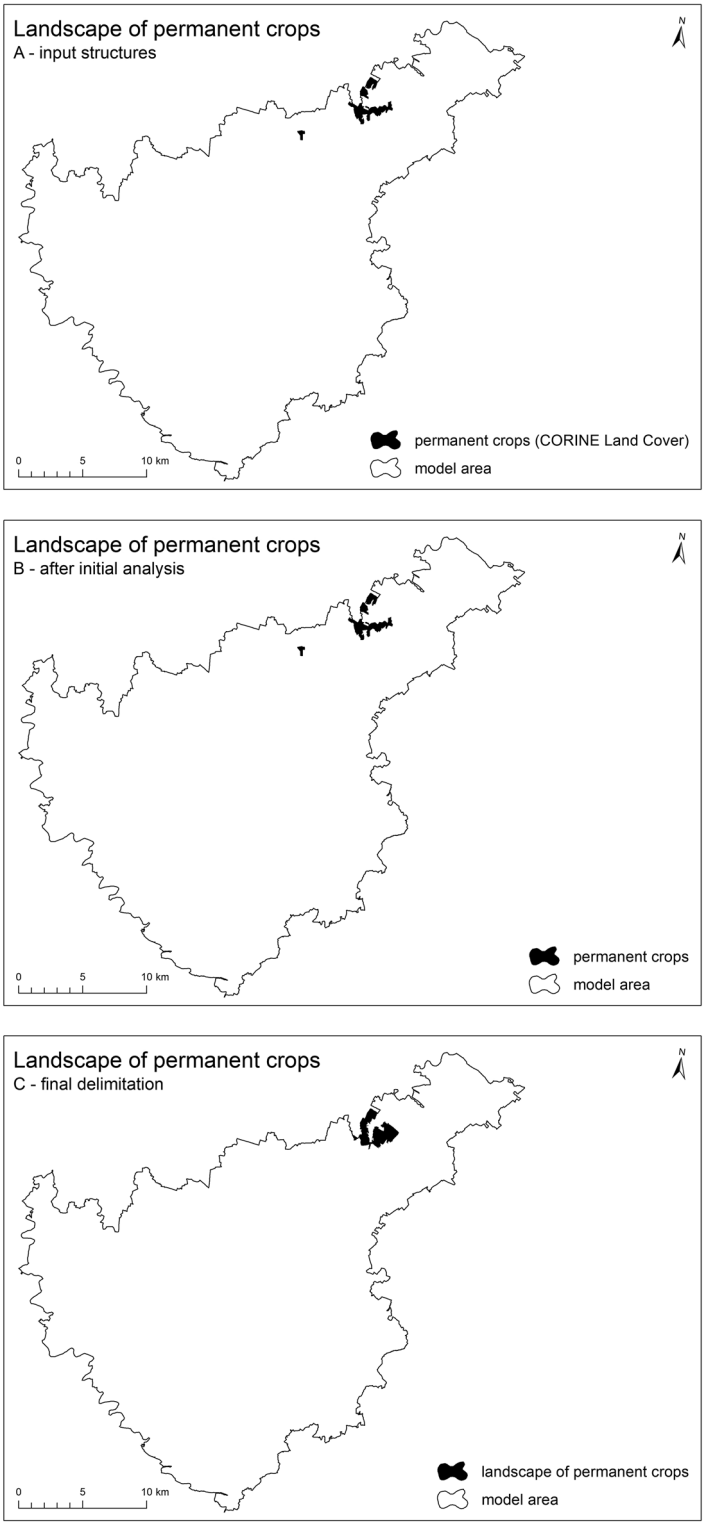


Figure 4. (a–c)Delimitation of the landscape of permanent crops; A – input data, B – initial analysis, and C – final delimitation. *Source:* CORINE Land Cover, ZABAGED®.

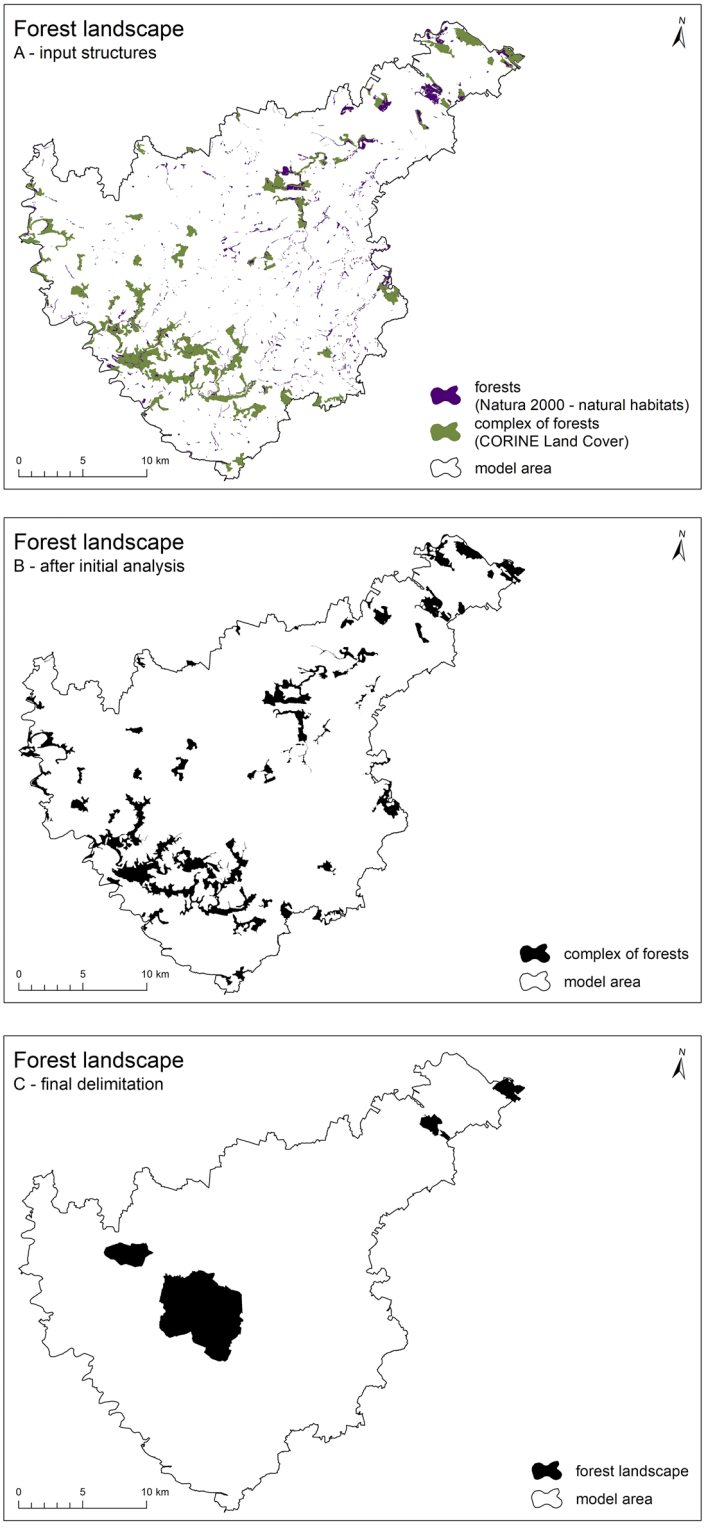


Figure 5. (a–c) Delimitation of the forest landscape; A – input data, B – initial analysis, and C – final delimitation. *Source:* CORINE Land Cover, Natura 2000 Natural Habitats.

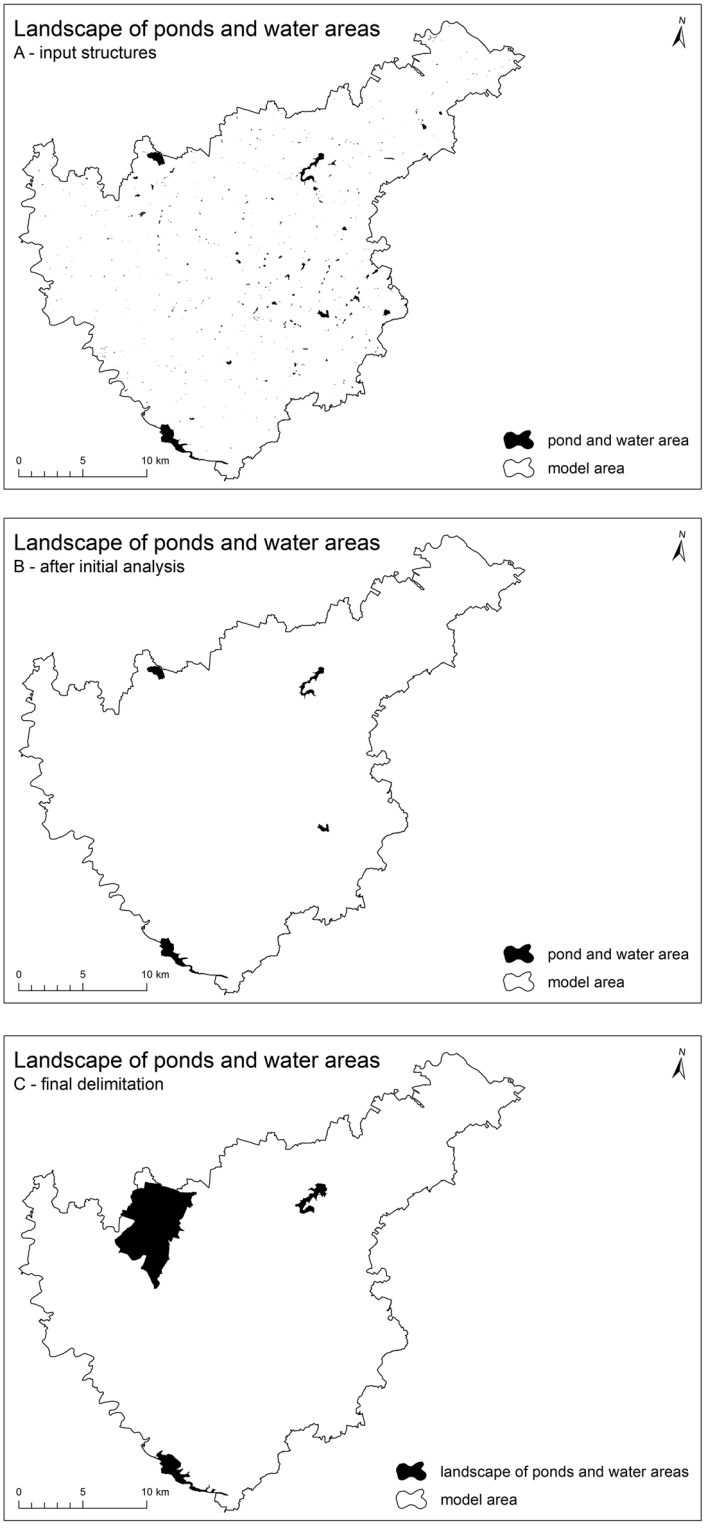


Figure 6. (a–c) Delimitation of the landscape of ponds and water areas; A – input data, B – initial analysis, and C – final delimitation. *Source:* CORINE Land Cover, ZABAGED®.

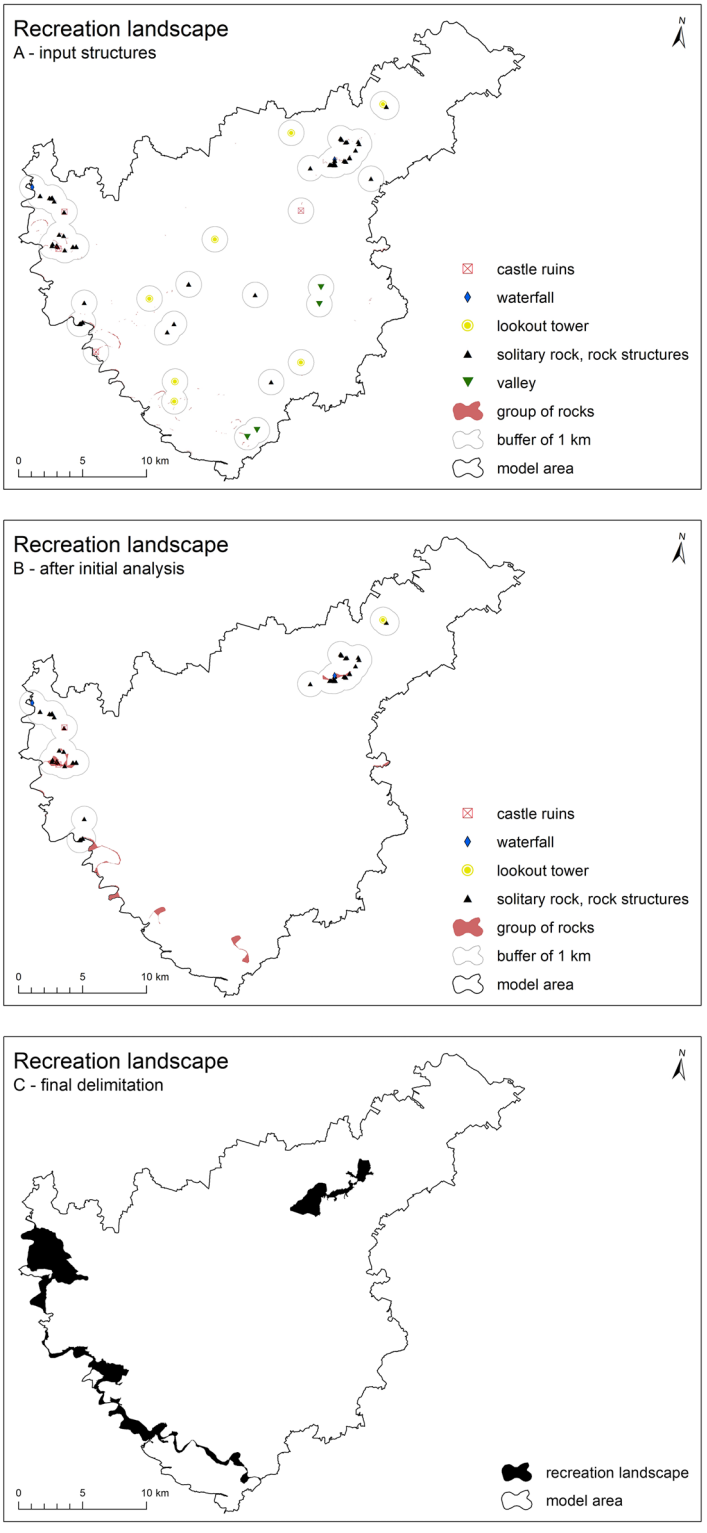


Figure 7. (a–c) Delimitation of the recreation landscape; A – input data, B – initial analysis, and C – final delimitation. *Source:* ZABAGED®, Geonames.

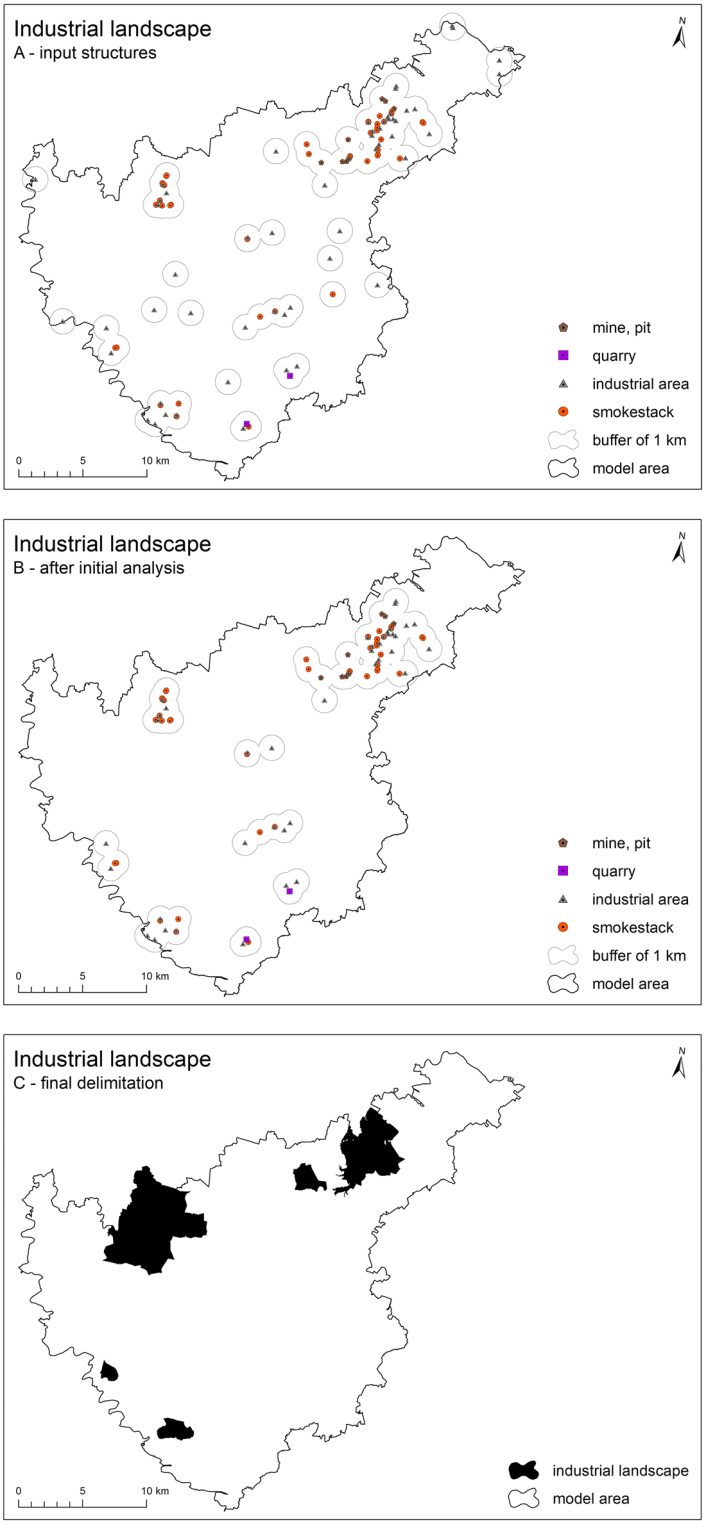


Figure 8. (a–c) Delimitation of the industrial landscape; A – input data, B – initial analysis, and C – final delimitation. *Source:* ZABAGED®.

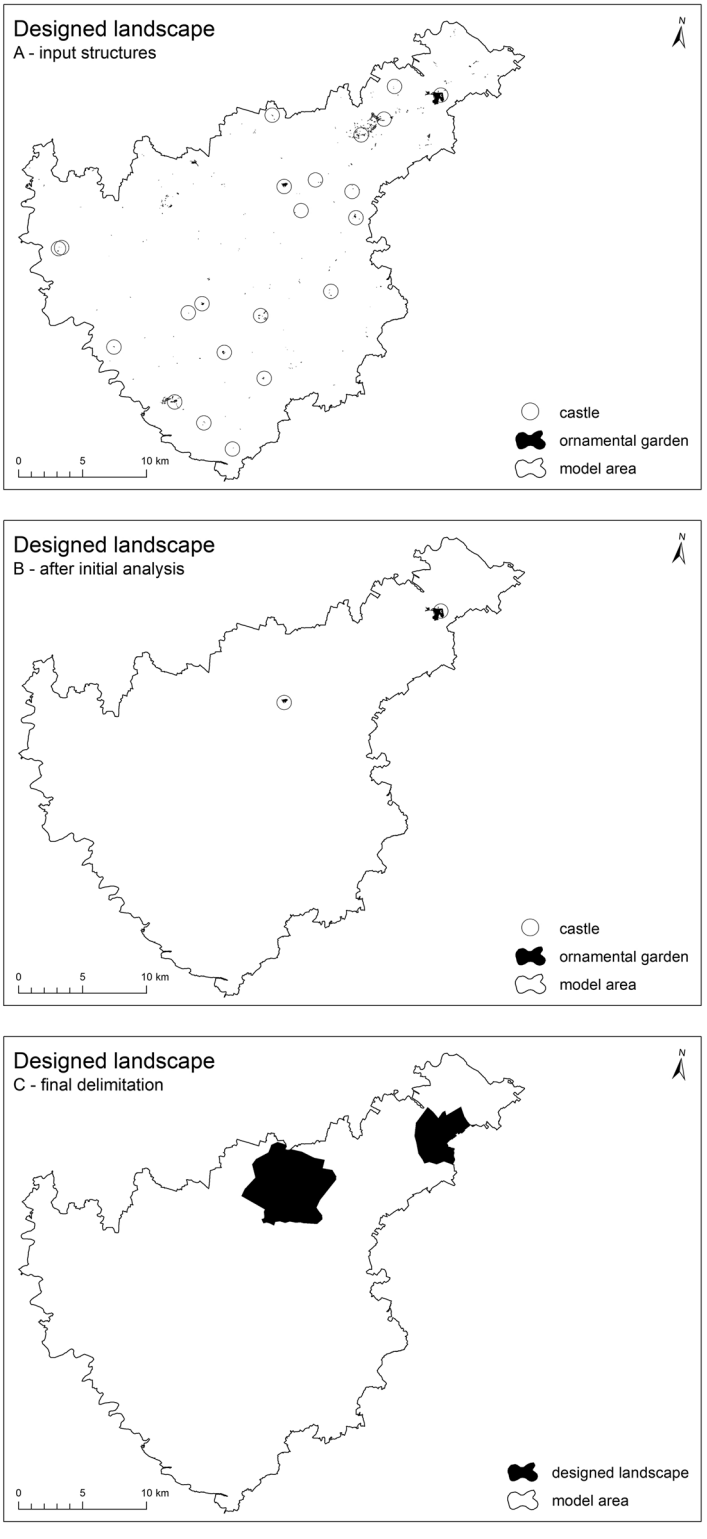


Figure 9. (a–c) Delimitation of the designed landscape; A – input data, B – initial analysis, and C – final delimitation. *Source:* ZABAGED®.

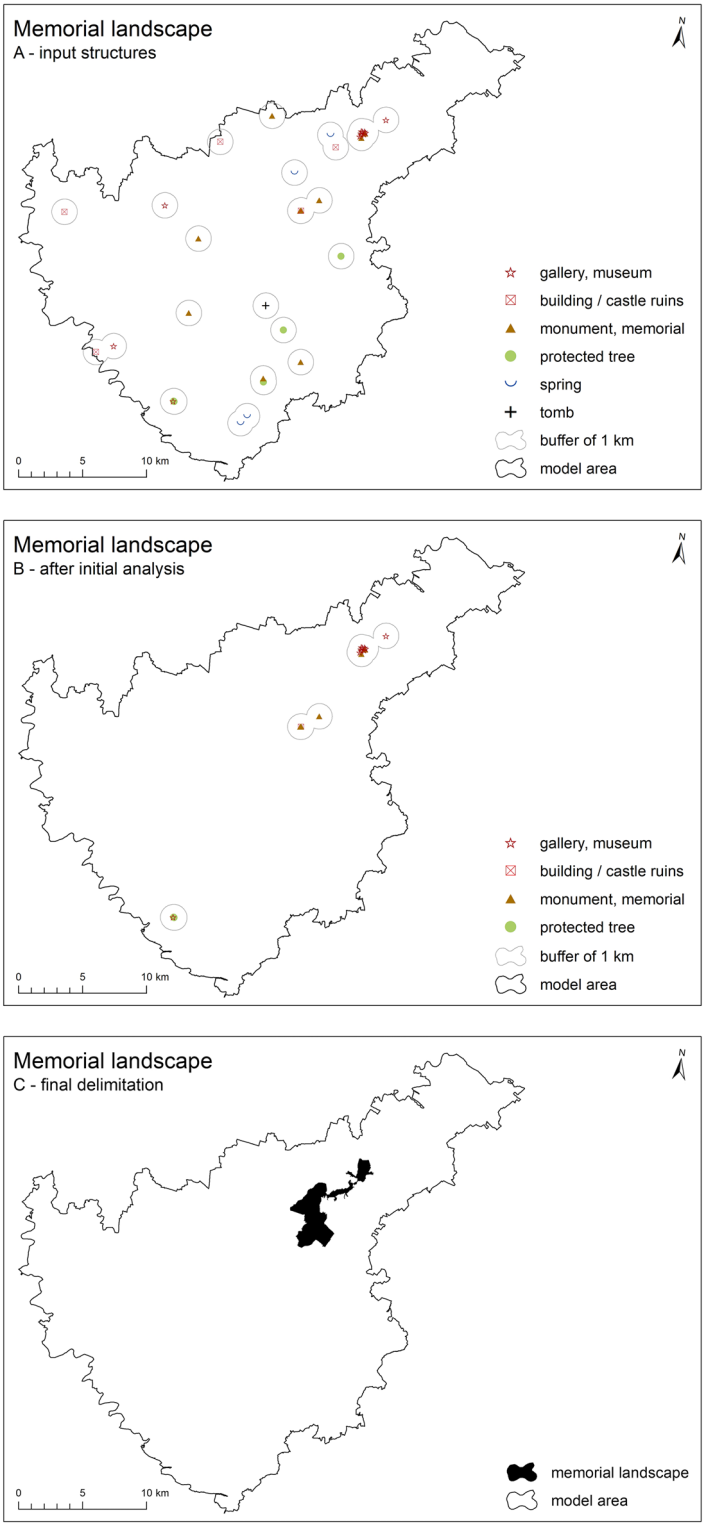


Figure 10. (a–c) Delimitation of the associative landscape; A – input data, B – initial analysis, and C – final delimitation. *Source:* Geonames.

Malešov), important persons (J. Vrchlický and J. K. Tyl – authors of the Czech anthem), and battlefields and persons (the siege of the Sion castle in the 15th century).

Discussion

Historic landscape identification

For the identification of historic cultural landscapes, the bottom-up method is typically applied. However, this approach requires an extensive literature review, searching in archives, mapping, etc., which is time-consuming and expensive. Many studies were very detailed but focused only on relatively small areas or specific landscape features (eg Cullotta & Barbera, 2011; Daugstad & Grytli, 1999; Pătru-Stupariu et al., 2019). Studies at the regional or national level are rare and require long-term work or a large research team. These studies have focused mainly on traditional agricultural structures because they are greatly endangered by landscape changes. The methods are based on the classification of present and old aerial photos and old maps; traditional agricultural landscapes have been identified in Slovakia (Špulerová et al., 2017), Moravia (Kolejka et al., 2020), and Bohemia (Fanta et al., 2022; Janečková et al., 2021). Our results are comparable with results for Bohemia (Fanta et al., 2022; Janečková et al., 2021), where scattered remnants of sectional 'plužina' were identified in the Kutnohorsko region. Because this identification was performed via orthophoto map analysis and not supported by field research, the results are very similar to the core areas of the traditional agricultural landscape that we identified via analysis of the CORINE Land Corer and Natura 2000 databases. Old map analysis, especially second Military Maps from the mid-19th century, was used by Pavelková et al. (2014) to identify old ponds (both still existing and vanished) in the Czech Republic. They also reported that many water ponds in Kutnohorsko experienced drought; however, the concentration of ponds around Uhlířské Janovice still remained high. Another possibility is working with legally protected areas (Kučera et al., 2008), but this method is approximate and requires good legislative protection of historic cultural landscape structures (Rosická & Sýkorová, 2014).

Our approach can accelerate the process of identification, because it provides basic knowledge about the presence and location of landscape types. Such identified historic landscapes represent areas with a high probability of the existence of heritage landscape values. A subsequent detailed study of the identified historic cultural landscapes is still needed. However, in this step, we can fully concentrate on preidentified places and regions and go into detail.

We verified our preliminary results based on the GIS analysis via field research in the entire model area. Six landscape types representing organic evolved landscapes according to the UNESCO categorisation (Rössler, 2006; UNESCO World Heritage Centre, 2008), i.e., traditional agricultural landscape, landscape of permanent crops, forest landscape, landscape of ponds and water areas, recreation landscape, and industrial landscape, were identified satisfactorily according to the analysis of the datasets presented above. The most reliable area and shape was the identification of the historical landscapes of permanent crops. The data analysis of the traditional agricultural landscapes and landscapes of ponds and water areas revealed the core areas of these historic landscape types. The final area was enlarged significantly by old maps and field research. Additionally, the analysis of forest landscape data revealed the core areas of the historical areas, but the bias was more serious because of the many scattered woods in the traditional agricultural landscape on the one hand and the underrepresentation of the large former game reserves because of coniferous monocultures on the other hand.

In the case of historic industrial landscapes, which are often highly endangered, it is necessary to revise the structures in the terrain or use street views to exclude non-historic and nonexistent structures. Thus, the reliability of the analysis is very good in terms of the area and shape of the historic industrial landscape. For recreation landscapes, only cultural and natural objects were selected. Most recreation buildings, cottage areas and campsites have logically

not remained there until the present day. They have often been rebuilt, and if not, they do not have a very large landscape extent. The significant areas and entire cores of recreational landscapes were identified via data analysis.

In the case of designed and associative landscapes, the databases used were less sufficient, and the applied analyses were less reliable. Data from ZABAGED® and Geonames provided us with only basic information on the presence of some structures that can refer to designed or associative landscapes. However, this information must be further verified cautiously. A deeper search for more information in map portals (orthophoto maps, street views, and old maps such as maps from military mapping) or in the grey literature and archive documents is necessary. Field research is inevitable.

The proposed data analysis revealed only the small cores of the designed landscapes characterised by manor houses and ornamental gardens. To determine the entire area of the designed landscape, the cores must be overlaid by old maps and verified via field research. Therefore, the method of Kulišťáková et al. (2014) can be used to identify designed landscapes more reliably via old map analysis and many special spatial analyses in a GIS environment. In the model area, two designed landscapes remained, both of which were well documented in the literature (Flekalová & Kulišťáková, 2014; Šantrůčková & Weber, 2016) or even already protected.

For associative landscapes, the digital data can be used to infer important historical events or objects (battlegrounds, places that have been depicted in art or literature, places associated with important events or persons, religious traditions or ceremonies and feasts). The obtained information is rather insufficient; therefore, further investigation is needed to identify more relationships between landscapes and historical events or objects (databases of protected cultural monuments, literature, archival documents, etc.). The results of the data analysis have only indicative characteristics.

Dataset availability

The presented approach works with national digital datasets (ZABAGED, Geonames, Natura 2000 Natural habitats) at the same scale (1:10 000). Although the European CORINE Land Cover dataset differs in scale (1:100 000), it is the best land cover database freely accessible for Europe as a whole. Moreover, the present study focused on landscape extent. Because the CORINE Land Cover data do not cover the heritage landscape features needed for the assessment of historic cultural landscape types, we used more detailed national data. The point features were selected from more detailed national databases. Using these data and their combination, it is possible to find places with a relatively high concentration of historic cultural values that should receive attention.

Consequently, the repeatability of the presented approach in other European countries depends on the availability of national databases. According to the European INSPIRE Directive (2007/2/2014EC), all member states should have a uniform set of digital data at their disposal. The Directive addresses 34 spatial data themes needed for environmental applications, including habitats and biotopes and geographical names. However, they are accessible only for some states, eg Austria, Belgium, Denmark, Estonia, Hungary, Malta, Norway, Poland, Portugal, and Romania (they have geographical names downloadable from the official website of INSPIRE Geoportal). Nevertheless, they differ in terms of scale and detail. Habitats and biotopes are downloadable from the same geoportal for Austria, Denmark, Estonia, Luxembourg, Malta, Poland, Portugal, Spain, and Sweden. Although states such as Germany, Slovakia and Lithuania have created these datasets as well, they are probably available only from national geoportals. Datasets that are equivalent to the Czech ZABAGED include, eg the German ATKIS (the Authoritative Topographic-Cartographic Information System, see Walz & Stein, 2014), BD TOPO® from France, BDOT10k (Topographic Objects Database) from Poland (Feltynowski et al., 2018) or the Slovak ZBGIS (basic database

for the geographic information system). A less detailed but worldwide database of geographical names is available at https://www.geonames.org/.

Conclusion

Historic cultural landscapes play an important role in cultural and natural heritage protection, biodiversity and landscape stability, landscape or community identity, and climate change prevention. Several historic cultural landscape types and their structures have been established (i.e. traditional agricultural landscape, landscape of permanent crops, forest, pond and water areas, recreation, industrial, designed, and memorial landscapes). However, methods for identifying preserved historic cultural landscapes are still under development. The detailed methods are time-consuming, expensive or cover only limited areas. Existing inventory, monitoring and policy approaches have not been designed with regard to historic cultural landscapes and hence are not fully able to identify regions with historic cultural structures.

In the presented research, eight historic cultural landscape types (see above) were identified in the Kutnohorsko Region (Czech Republic) using European and national open data such as CORINE Land Cover, ZABAGED, Geonames and Natural habitat map. Applied simple GIS analysis with minimal costs on labour and skills enable the repeatability of the process. Hence, this approach can be the first prerequisite for systematically identifying and studying historic cultural landscapes and eventually protecting them.

Although it is the first step towards further analysis, it helps to establish the probability of the presence of historic cultural landscapes; further research will concentrate on the identification of such regions. Historic cultural landscapes delineated via the proposed methods represent the first step in cultural heritage conservation, encompassing territorial planning and presentation to the general public to prevent these landscapes from being damaged due to ignorance of landscape values (Ehrlich et al., 2020). The advantage of the proposed method is that it uses freely accessible European or national databases that can be easily downloaded and analysed via GIS tools and could be repeated in other regions.

Authors contributions

Markéta Šantrůčková made the concept of the research, did the archival work, old map analysis, and field research. She shared on writing of the introduction, methods, results, and discussion sections. Katarína Demková did the old map analysis, and field research. She shared on writing of the introduction, methods, results, and discussion sections. Alois Vokoun did the GIS analysis and shared on writing of the methods, results, and discussion sections.

Disclosure statement

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Data availability statement

The data CORINE Land Cover that support the findings of this study are openly available in the European Environmental Agency at https://land.copernicus.eu/en/products/corine-land-cover/clc2018. The natural habitat mapping data of Natura 2000 that support the findings of this study are openly available in the Nature Conservation Agency of the Czech Republic (© AOPK) at https://data.nature.cz/ds/21. The Fundamental Base of Geographic Data of the Czech Republic and the Database of geographic names of the Czech Republic that support the findings of this study are available from the Land Survey Office. Restrictions apply to the availability of these data, which were used under licence for this study. Data are available from the authors with the permission of the Land Survey Office.

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