HISTORIC CULTURAL LANDSCAPE IN DANGER FROM NATURAL RISKS

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Abstract
Historic cultural landscapes are an important part of our natural and cultural heritage and subject of its protection. At the same time, they have a high potential in the development of recreation and tourism. Climate change can be expected to affect historic cultural landscapes in a significant way. Correct identification and interpretation of historic cultural landscapes features, as well as precise prediction of the risks that threaten them, are prerequisites for setting up optimal landscape management and protection. The paper presents an interactive map that is a partial result of the research project "Historic cultural landscape in danger and vision of its development in the context of current landscape changes" including creation of a spatial database of units of historic cultural landscapes of the South Moravian Region, the selection of suitable indicators for the assessment of drought and flood risks, and the interpretation of the overlap of natural risk layers with the database. The map was constructed as an interactive map usable for planning and decision-making in the area, for orientation of municipalities in the issue and as an educational tool for public awareness.

Key words: landscape protection, landscape heritage management, interactive map, South Moravian Region

Introduction

The aim of the research was to evaluate the expected impact of climate change on the types and units of the historic cultural landscape (HiCL) of the South Moravian Region and to process them in the form of an interactive map. The sophisticated expert basis created in a user-friendly environment displaying the expected impact of drought and flood risks on the historic cultural landscape of the South Moravian Region. From the methodological point of view, the authors had to deal with several research questions that have not been addressed in this form in the Czech Republic so far. In particular, the search for a suitable methodological approach and the selection of a technological solution for:

- Creation of a database and digital map of types and units of the historical cultural landscape of the South Moravian Region at a relevant scale;
- Selection of suitable indicators for drought risk assessment for the South Moravian Region;
- Selection of suitable indicators for flood and inundation risk assessment for the South Moravian Region;
- Creation of a digital map of zones of increased natural risk for climate change scenarios PCR 4.5; PCR 6.0 and PCR 8.5.
- Construction of a series of interactive maps in online environment.

Materials and methods

The creation of the interactive specialised map is based on the validation and refinement of the methodology for the identification of the types and units of the historic cultural landscape and identification of the HiCL features, (Ehrlich et al., 2020). The methodology was applied for the first time at the regional scale (South Moravian Region, data acquired with a precision of 1 : 10 000, scale of optimal map display 1 : 50 000), which triggered the need to specify in particular the method of defining features and boundaries of individual units depending on the category and type of historic cultural landscape. The units of the HiCL of the South Moravian Region were supplemented with descriptions and photographic documentation or links to relevant information sources. The map of the historic cultural landscape units was then overlaid interactively with layers showing the increased risk of drought and floods according to pre-selected indicators. The indicators selected were those that best describe the risks of the impacts of expected climate change on the landscape.
The map was created in the GIS environment (ArcGIS, QGIS) by entering the results of searches on the base layer of the Basic Topographic Map 1 : 10 000 and the Orthophoto map of the Czech Republic from ČÚZK. The units of historic cultural landscapes were entered into the map in the form of polygon and point layers (shapefile) with the same database structure. Each type of historic cultural

landscape was then assigned drought and flood vulnerability attributes to reflect the need for increased attention if the HiCL unit falls within a risk area.
The layers of areas at risk of drought and flood were created by combining the underlying data into a single shapefile, with the Representative Concentration Pathway scenarios (RCP) attribute distinguishing which level of threat the area falls into. For the layer of drought-prone areas, a generalization to a hexagonal grid with an edge size of 580 m (hexagon height 1000 m) was performed to represent the smaller scales.
ArcGIS online environment was used to create and share the interactive map. The individual shapefiles were uploaded as hosted layers, and the symbology and display of information was set up. The interactive map contains three basic layers - a database of historic cultural landscape units, drought-prone areas, and flood-prone areas. To improve the readability of the maps, an application was created in ArcGIS online that allows multiple interactive maps to be presented using a bookmark system.
HiCL units are depicted on maps using polygons and points in a colour scheme that distinguishes three main categories of HiCL (designed, organically evolved and associative landscapes). The database of HiCL units has been supplemented with references to literature, photographic documentation and, in the case of conservation, a reference to the National Heritage Institute's Catalogue. The photographic documentation was acquired by ground survey and UAVs. The photo documentation can be continuously added to the interactive map or updated thanks to the openness of the photo database.
Risk of flood. The assessment of drought and flood risk is based on IPCC predictions. Three scenarios of projected climate change PCR 4,5; 6,0; 8,5 (Trnka et al., 2015), were chosen to select appropriate indicators.
Isolines of n-year flows were chosen to spatially delineate flood-prone areas.
Risk of flood was divided into 3 levels of intensity:

1) Frequent threat from surface water runoff slightly above normal seasonal fluctuations; the level was spatially expressed by the 5-year flow rate (Q_5). Corresponds to RCP climate scenario 4.5.
2) Rare spill threats well above seasonal fluctuations with significant damage. The degree of risk is spatially expressed by the inundation of 20-year flow rate (Q_{20}). Corresponds to the RCP 6.0 climate scenario.
3) Emergencies with catastrophic course and threat to human life. The degree of risk is expressed by the 100-year flow rate. Corresponds to the climate scenario RCP 8.5.

The data used were from the DIgital Database of Aquatic Data (DIBAVOD).
Risk of drought. In the analysis of historic cultural landscapes threatened by drought, the causes were distinguished: I) natural or II) human-induced.
The first group included: areas of rainfall shade; areas of arid agricultural soils; areas of drying forest soils (forest type sets); quicksands in altitude vegetation levels (AVL) 1 and 2; limestone karsts in AVL 1.
The second group included: areas with reduced soil moisture levels in the layer up to 40 cm; to 100 cm; up to 100 cm and landscapes of extensive water management with accelerated runoff.
Spatial data of the Nature Conservation Agency, Biochory layer 2002 were used to spatially delineate areas at risk of drought in the 1st group of data. For the evaluation of the second group, data from the geoportal Intersucho.cz were used.

Results

The interactive map is available in Czech language online (Salašová et al., 2024, see a print screen in Fig. 1). A total of 298 units of historic cultural landscape (points and polygons) with a total area (taking into account the overlap of units) of 371 345.6 ha were defined on the territory of the South Moravian Region. The area of the South Moravian Region according to the Czech Statistical Office is 718 800 ha. Thus, the historical cultural landscape constitutes 51.66 % of the South Moravian Region.
The overlap of HiCL units with drought and flood risk zones has been quantified (see a general summary in Tab. 1 and 2).

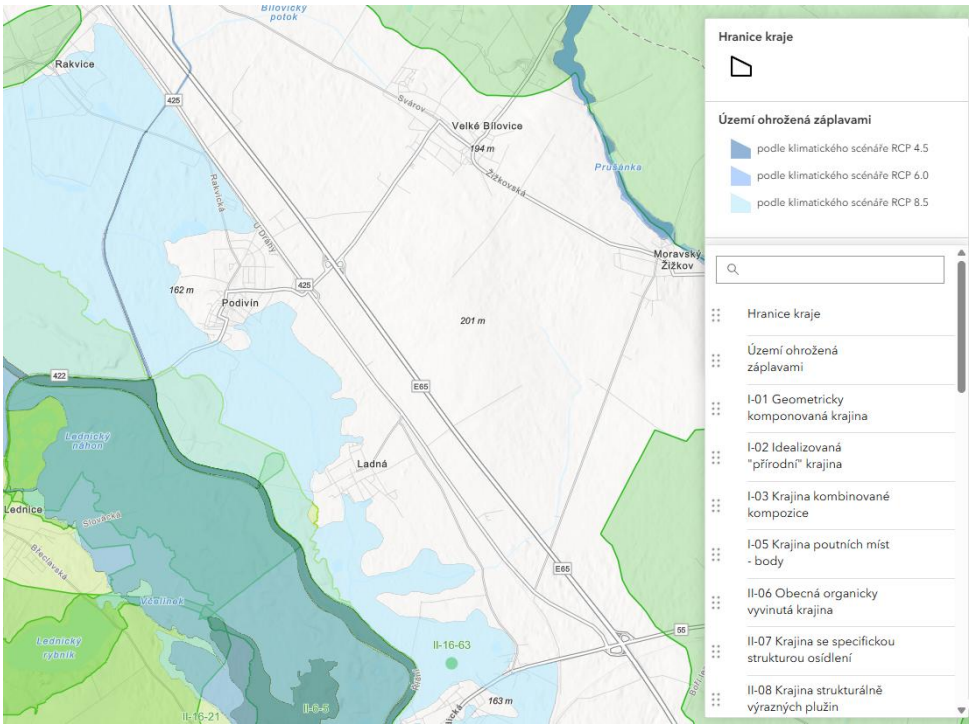

Fig. 1: Sample of the interactive map. Green (HiCL), Blue (inundation zone). Available from https://mendelu.maps.arcgis.com/apps/instant/portfolio/index.html?appid=c8aa8763caaa4a5683abe8840747c6bc

Tab. 1: Changes in the magnitude of the impact of flood risk on the historic cultural landscape according to the scenarios studied.

	PCR 4,5 flow rate Q_5	**PCR 6,0 flow rate Q_{20}**	**PCR 8,5 flow rate Q_{100}**
Total number of HiCL units at risk zones (polygons)	97	112	122
Number of HiCL risk-sensitive units at risk zones (polygons)	60	70	78
Area of HiCL* units at risk [ha]	8105,2	21302,1	34576,4
Area of HiCL* sensitive units at risk [ha]	6211,5	17266,9	24882,8
Total number of HiCL units at risk zones (points)	1	4	8
Number of HiCL risk-sensitive units at risk zones (points)	0	0	0
Number of HiCL units completely without threat (polygons)	81		
Number of HiCL units completely without threat (points)	87		

***** Taking into account unit overlap.

Tab. 2: Changes in the magnitude of the impact of drought on the historic cultural landscape according to the scenarios studied.

	PCR 4,5	**PCR 6,0**	**PCR 8,5**
Total number of HiCL units at risk zones (polygons)	153	164	164
Number of HiCL risk-sensitive units at risk zones (polygons)	126	136	136
Area of HiCL* units at risk [ha]	96922,6	100173,5	100173,5

Area of HiCL* sensitive units at risk [ha]	73004,02	92649,51	92649,51
Total number of HiCL units at risk zones (points)	25	30	30
Number of HiCL risk-sensitive units at risk zones (points)	0	0	0
Number of HiCL units completely without threat (polygons)	39		
Number of HiCL units completely without threat (points)	65		

***** Taking into account unit overlap.

Discussion

Flood. Considering the PCR 4.5 scenario, which is already an emerging reality, the units most significantly affected by inundation (or flash flooding) will be Type II-18 (landscape of water reservoirs) and II-25 (linear industrial landscape). In both cases, 100% of the units will be affected, at an assumed 25% spatial extent. Given that these are historic cultural landscapes linked to watercourses, this conclusion is to be expected. The following scenarios are more significant for the future. We consider PCR 6.0 to be very likely even assuming the implementation of a range of mitigation measures planned today. In addition, data evaluation has shown that in this case the majority (75%) of the geometrically designed landscape units will be threatened and the extent of threat to the linear industrial landscape will increase from 25% to 47%. The RCP 8.0 scenario can be considered largely catastrophic, yet cannot be ruled out after the experience of the 1997, 2002 and 2006 floods. The active flood zone due to the Q_{100} flow rate is already quite large and covers the territory of a number of other HiCL units, in addition to the above, in particular the historic fishpond landscape (80% of the units with a territorial extent of 27.2%) and the landscape of game preserve and forests (46% of the units with a territorial extent of 42.10%).

While in the case of landscape of water reservoirs, artificial water channels, fishpond or designed landscapes, floods and inundation can lead to irreversible damage to cultural heritage, the risk of damage is less clear in the case of game preserve and forest HiCL. This is particularly true of floodplain forests, for which spring flooding is more of an existential necessity. However, even in these forests, damage to historic structures, including historic water management, can occur.

Drought. Comparing the data, it is clear that the historic cultural landscape of the South Moravian Region will be more affected by drought with its attendant risks than by flooding. The most moderate scenario PCR 4.5 may significantly endanger especially the designed landscape with combined composition (all units will be affected, up to 59.85% of the territory will be affected), general organically evolved landscape (94% of units within 42.5% of the type's territory), landscape of Landlords manorial farms (85% of units, 43.22% of the type's territorial extent), orchard landscape (83% of units, 40.3% of the territorial extent), landscape of game preserve and forests (53.5% of units, 37.2% of the territorial extent), landscape of camping settlements (100% of units, 71.6% of the territorial extent). In most cases, these are landscape types where their character and historical value is largely determined by the nature of the vegetation. Should there be a significant change in vegetation cover (e.g. dieback of forest and non-forest trees) or a significant change in cultivated crops (e.g. disappearance of orchards), the cultural landscape will be irreversibly altered and its cultural and historical value lost.

The result of the PCR scenarios 6.0 and 8.5 is already alarming for the territory of the South Moravian Region. The risk of drought threatens most of the mapped units, with a significant increase in its territorial extent and intensity of influence caused by a combination of several factors (e.g. climatic, topographic and pedological). In addition to the above, the risk of drought increases in the landscape of structurally distinct ploughed fields (all units, 39% of the territorial extent of the type).

Conclusion

The result of the research was the elaboration of a specialized interactive map depicting types and units of historic cultural landscapes in a combined display with anticipated risks.We consider innovative especially the newly developed method of defining zones of natural risks potentially threatening the form and existence of historic cultural landscapes on the example of the South Moravian Region, which is verified and specified through a specialized map with regard to its usability in conservation and spatial planning. We consider the screening of the historic cultural landscape in the territory of the South Moravian Region, which has not been processed in such a comprehensive

and detailed way so far, to be significant. The identification of units of historic cultural landscape of the South Moravian Region and the evaluation of their possible threat of predictable natural hazards in the form of an interactive map are the original results of the research.

References

Ehrlich, M.; Kuča, K.; Kučová, V.; Pacáková, B.; Pavlátová, M.; Salašová, A.; Šantrůčková, M.; Vorel, I.; Weber, M. (2020). Typology of the Historical Cultural Landscapes of the Czech Republic. Methodology certified by the Ministry of Culture of the Czech Republic No. 203, MK 40137/2020 OVV. Prague: The National Heritage Institute.

Salašová, A.; Dohnal, J.; Dohnalová, B.; Fialová, Z.; Klepárník, R.; Kohoutková, K.; Kříčková, K.; Kučera, P.; Lacina, D.; Matějka, D.; Sedláček, J.; Šamánek, D.; Žallmannová, E. (2024). Historic cultural landscape in danger from natural risks. Interactive map available from: https://mendelu.maps.arcgis.com/apps/instant/portfolio/index.html?appid=c8aa8763caaa4a5683abe8840747c6bc

TRNKA, M. et al. (2015). What Will the Climate Be Like?. [2024]. In: Climate change. Brno: Ústav výzkumu globální změny AV ČR. [cit. 2024-01-08]. https://www.klimatickazmena.cz/download/4a603d6a3e4d4236b930b709fa6e5e14/7.%20kapitola_jake%20bude%20klima.pdf

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Souhrn

Historické kulturní krajiny jsou nezastupitelnou součástí přírodního a kulturního dědictví. Správná identifikace a interpretace nejen hodnot a znaků historických kulturních krajin, ale také rizik, která je ohrožují, jsou předpokladem pro nastavení vhodného managementu krajiny a zvážení možných ochranných režimů. Příspěvek představuje dílčí výsledek výzkumného projektu NAKI III "Historická kulturní krajina v ohrožení a její vize v kontextu soudobých proměn". Výsledek zahrnoval vytvoření prostorové databáze jednotek historických kulturních krajin na území Jihomoravského kraje, výběr vhodných indikátorů pro vyhodnocení rizik sucha a záplav, zonaci těchto indikátorů pro tři scénáře klimatické změny a interpretaci překryvu vrstev přírodních rizik s databází. Mapa byla konstruovaná jako interaktivní mapa využitelná pro potřeby územního plánování, pro orientaci obcí v problematice i jako edukační nástroj pro seznámení se s problematikou ohrožení historické kulturní krajiny přírodními riziky.

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