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RESEARCH ARTICLE

'Sense of place' and conservation: Toponym diversity helps to maintain vegetation naturalness

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Abstract

1. Place names are an important but vanishing part of cultural diversity, and their relevance for environmental sciences is increasingly acknowledged. Still little is known about whether the diversity of toponyms affects human–nature relationships and the decisions of humans on how to use certain parts of the landscape.
2. To investigate this question, we combined approaches from social sciences and ecology in a comprehensive multidisciplinary survey of 1521 cultural landscape features in Hungary. The landscape features studied were ancient millennia-old burial earthen mounds built by nomadic steppic tribes, that often hold the last remnants of grassland vegetation and provide safe havens for grassland specialist plant and animal species in the intensively used agricultural landscapes of Eurasia. In our research, we (i) compiled a comprehensive database of the mounds in the 5150 km^2-sized study region, (ii) collected all toponyms of the mounds recorded since the 18th century, (iii) derived the height and distance from settlements for each mound and (iv) visited all the mounds in a field survey, and evaluated their vegetation naturalness.
3. We found that despite the intensive landscape transformation in the region, and independently of topographical factors, a higher number of toponyms was associated with a higher degree of naturalness of the vegetation on the landscape features. Independently of the protective effect of the height of the mound against ploughing, and the distance from settlements that reflects to decreasing land use intensity, we found that the vegetation on the mounds with more names had a higher degree of naturalness.
4. *Synthesis and applications*. Cultural recognition of these places has eroded considerably in the past centuries, but its effect is still noticeable, suggesting an extinction delay of culture-driven biodiversity patterns. Our results suggest that reestablishment of the lost cultural connections between people and nature can contribute to reversing the deterioration.

KEYWORDS
degradation, genius loci, grassland conservation, kurgan, mound, place name, steppe, toponym

Orsolya Valkó and Ádám Bede authors contributed equally to the manuscript.

1 | INTRODUCTION

Humans are often considered external factors of ecosystems acting as destructive agents that harm biodiversity (Díaz et al., 2019). However, we interact with natural systems in various ways, and our cultural relatedness to nature can also be a positive source to conservation biology (Szabó & Hédl, 2011). Nature–culture relations are most evident in the case of people living in close contact with nature and still holding traditional ecological knowledge and spiritual ties (Bhagwat & Rutte, 2006; Boillat et al., 2013; Díaz et al., 2018). *Genius loci*, that is, the 'sense of place', is an ecosystem management concept that translates the emotional and spiritual bonds of people to certain places into positive nature conservation outcomes (Williams & Stewart, 1998). The importance of human culture for nature conservation is less studied in industrial or agricultural landscapes, where people have not had daily contact with nature for centuries. In these heavily transformed landscapes, a large proportion of natural habitats have already been destroyed by human activities, while remaining ones may persist on particular landscape features in the form of small habitat islands embedded into the matrix of agricultural, industrial or residential areas (Deák et al., 2022). Our aim was to evaluate whether the degree of naturalness of vegetation on these landscape features is influenced by cultural aspects and the diversity of traditional toponyms still in use.

For studying the complex interactions between nature and culture, several millennia-old earthen burial mounds built by ancient cultures are ideal model systems (Deák et al., 2016). Burial mounds are man-made landscape features present on all inhabited continents, and in the Eurasian steppe and forest steppe biomes, there are approximately half a million mounds called 'kurgans' (Deák et al., 2022). After their erection, grassland vegetation recovered rapidly on these landscape features from propagule sources in the surrounding vast steppes and from the soil seed bank (Deák et al., 2016). Due to their cultural importance and the mystical reverence they were held in by local people, the mounds often remained undisturbed, and also their steep slopes made them unattractive for ploughing. As a result, spontaneously recovered grasslands persisted for millennia on the mounds and acted as safe havens for grassland specialist plant and animal species. Indeed, in many cases these man-made objects are the only remaining grassland habitats in heavily transformed agricultural landscapes (Apostolova et al., 2022; Deák et al., 2022; Dembicz et al., 2020). Mounds can be regarded cultural keystone places (Cuerrier et al., 2015) also harbouring high biological diversity (Deák et al., 2022). Despite the small size (less than one hectare) of the mounds, they act as safe havens or stepping stones for several grassland specialist plant and animal species even in highly transformed agricultural landscapes (Apostolova et al., 2022; Deák et al., 2020; Dembicz et al., 2020). These landscape features can be considered sacred natural sites (Dudley et al., 2009), which have had spiritual importance since the Late Copper Age. However, with the changing cultural and religious context, the public attitude towards mounds has changed and with the industrialization the connection of local people to the mounds has weakened in the past centuries (Deák et al., 2022). In parallel, their vegetation also has changed, nowadays ranging from favourable (covered by grasslands of high conservation value) to degraded (covered by degraded noncrop vegetation), transformed (ploughed) and even to destroyed (Bede & Csathó, 2019, please see details in the Section 2).

Mounds are ideal places for studying place names (Bede, 2016), as these landmarks often bear several toponyms that reflect the characteristics and the history of the mounds and the landscape (please see examples in Supporting Information S1). Toponyms reflect the cultural importance of a place that depends on various perceived values such as material, immaterial and relational values (Bott et al., 2003; Jordan, 2010). Giving a name is a fundamental way of recognizing and identifying a place as its bearer (McDowell, 1977). Bearing one or even more names is an important indicator of the cultural importance of sacred natural sites (Boillat et al., 2013; Cuerrier et al., 2015). Consequently, the erosion of cultural diversity can be traced by the disappearance of place names and related biocultural knowledge in many parts of the world (Fagúndez & Izco, 2016). There is a vivid connection between linguistic and biological diversity; for example, place names derived from plant or animal names can be used as an indicator of local biodiversity (Fagúndez & Izco, 2016) or landscape changes (Sousa & García-Murillo, 2001). However, there is little evidence on the relationship between toponym diversity and the conservation status of landscape features in general, and sacred natural sites in particular.

To address the knowledge gap mentioned above, we studied the association between the diversity of mound toponyms and the degree of naturalness of vegetation on these landscape features. We hypothesized that the vegetation on mounds with more names has a higher degree of naturalness than that on those with one or no name. We tested whether recognition of mounds by local residents during the past has affected the current degree of naturalness of habitats on landscape features. For this, we assembled a large-scale dataset on mound toponyms and locations using written sources covering three centuries and comprising an area of 5150 km^2 in a lowland agricultural region of Southeast Hungary. To separate the effect of toponym diversity from other factors that could also influence the vegetation of mounds based on the findings of previous studies (Deák et al., 2016; Dembicz et al., 2020), we controlled for the potential effect of the height of the mound and its distance from settlements.

2 | METHODS

2.1 | Mapping, field survey and assessment of vegetation naturalness degree

The study region, the Maros–Körös Interfluve covering an area of 5150 km^2, is situated in the Great Hungarian Plain in Southeast Hungary (Figure 1). The region is a heavily transformed agricultural landscape with scattered remnants of formerly widespread continuous dry grasslands (Biró et al., 2018). In our research, we (i) compiled

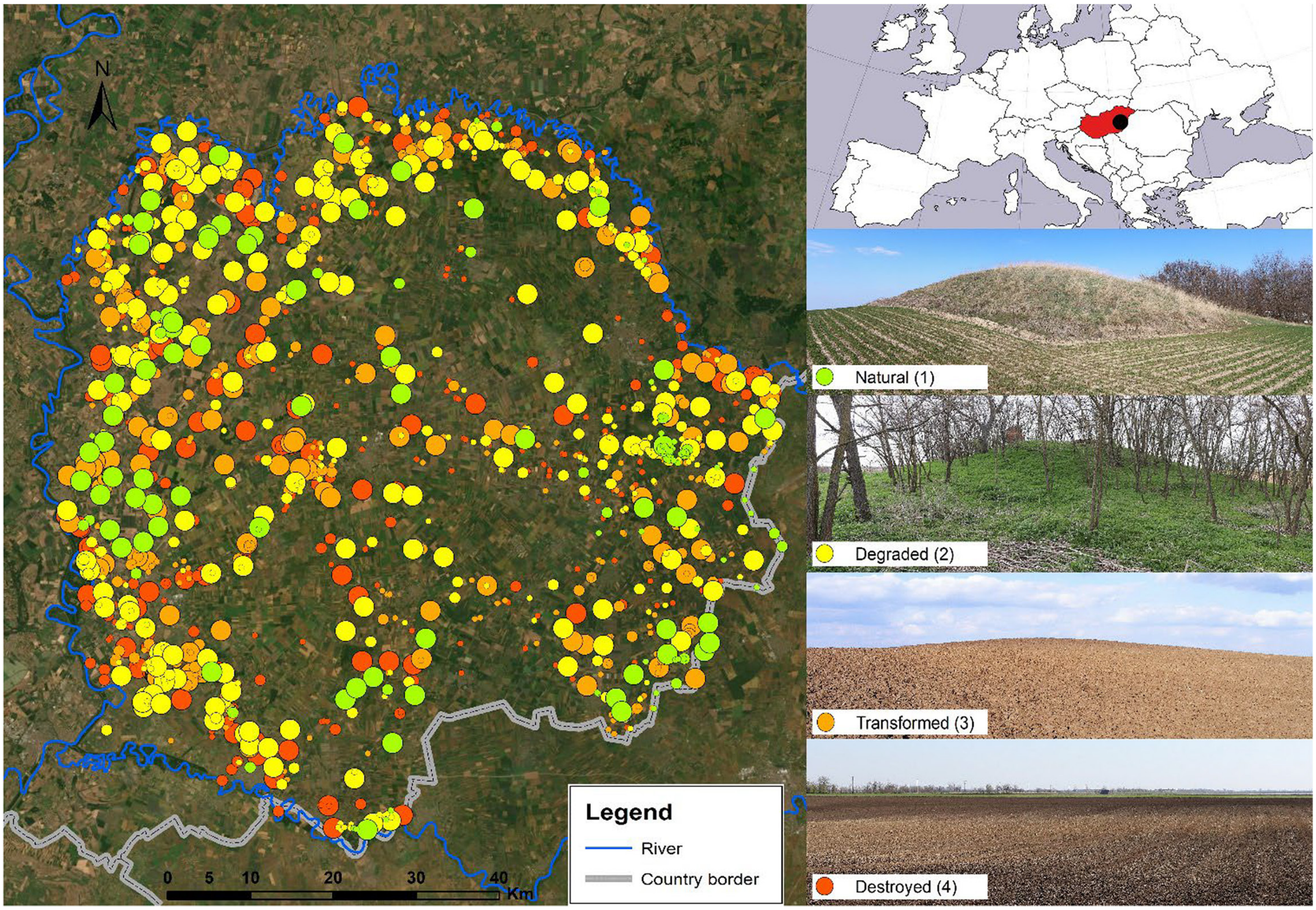

FIGURE 1 Map of the study region (Maros–Körös Interfluve) and its location within Hungary and Europe (denoted by a black circle). Circles denote the surveyed mounds; the size of a symbol refers to the number of place names: small—anonym; medium—one name; large—more than one name. The colour of a symbol refers to the degree of the naturalness of the vegetation on the mound (please see the legend of the photos, which show examples of the four categories), photos © Ádám Bede.

a comprehensive database of the mounds in the study region, (ii) collected all place names of the mounds recorded since the 18th century, (iii) derived the height and distance from settlements for each mound and (iv) visited all the mounds in a field survey and evaluated the degree of the vegetation naturalness.

In our study site, the vast majority of the burial mounds were built between the Late Copper Age and the Early Bronze Age (3300–2500 BC) by the Yamnaya Culture (Gamba et al., 2014) and a few were built by the Sarmatians (Roman Ages; AD 50–450; Demkin et al., 2014). Mounds have been the most constant and spectacular elements of the studied lowland plain landscape for millennia, and therefore they were the most important orientation points for cartographers. On archived maps (e.g. the military surveys of the Austro-Hungarian Empire) mounds are marked as orientation points and are thus clearly recognizable. Using archive maps and other written sources (see examples in Supporting Information S2), we identified a total of 1521 ancient millennia-old mounds that existed in the 18th century in the study area (Figure 1). We collected toponyms of the mounds using various written sources, such as hand-drawn and printed maps, boundary charters, geographical place name catalogues and other onomatological sources. We did not conduct field interviews in our study. A detailed list of 428 map sources used to determine the locations and names of the mounds is given in Supporting Information S3.

We used topographic maps for calculating the height and area of the mounds and also their distance from the nearest settlement. The height of the mound is a good indicator of its spectacularness and recognition of the mound by the local population. Additionally, higher mounds with steeper slopes can maintain larger biodiversity of grassland specialist species (Deák et al., 2016). The distance from settlements was used as an indicator for the level of disturbance; mounds closer to settlements are more likely to be disturbed. Mounds closer to settlements have probably been more important in the daily life of people.

We visited all the 1521 identified mounds in a field survey between 2007 and 2010 and evaluated the current degree of naturalness of their vegetation according to the criteria of Bede and Csathó (Bede & Csathó, 2019), using the following four categories: (1) *favourable* (dry grasslands of high conservation value cover at least part of the mound), (2) *degraded* (degraded noncrop vegetation, that is degraded grassland or plantation forest is present on the mound, but grassland of high conservation value is missing), (3) *transformed* (the body of the mound is still visible, but its surface is completely ploughed and only crop vegetation is present) and (4) *destroyed* (completely destroyed mound, whose body is not recognizable anymore; Figure 1). In the first category, we considered three grassland habitat types listed in the Habitats Directive of the EU Natura 2000 network as dry grasslands of high conservation value: Pannonic loess steppic grasslands (6250), and Pannonic salt steppes and salt marshes (1530).

Prior tests, we constructed a categorical variable from the number of toponyms belonging to a certain mound. We used a categorical variable instead of a continuous one, because the number of cases decreased markedly with increasing toponym number and we aimed to have a balanced sample size per category. Potential values were zero (for mounds with no documented names since the 18th century), one (for mounds with one name) and two (for mounds with two or more names). In consequent analyses we used this variable to analyse the connection between the number of toponyms and the degree of vegetation naturalness.

2.2 | Statistical analysis

To test how the degree of vegetation naturalness of the mounds was affected by the number of toponyms, height of the mound and the distance from the closest settlement, we fitted an ordered (ordinal) logistic regression model. We used the ordinal score to express the degree of naturalness of vegetation as a response variable, the categorical variable representing the number of toponyms, and the log10($x+1$)-transformed height and distance from the nearest settlement, as explanatory variables. The significance of the predictors was evaluated using analysis of deviance with the R-package CAR (Fox & Weisberg, 2019), while marginal trend estimates for transformed continuous variables (height and distance) were acquired with the R-package EMMEANS (Lenth, 2019). Using the PERFORMANCE R-package (Lüdecke et al., 2021) we detected high variance inflation (VIF) scores from this model; thus, we applied *z*-score transformation to the log10-transformed height and distance measures as well, which decreased VIF scores below 2.6 for all variables. In particular, we identified the number of names and height as those variables that show substantial correlations, based on the Conover–Iman test (CONOVER.TEST R-package; Dinno, 2017) on the nontransformed variables (Kruskal–Wallis $X^{22}=235.67$, $p<0.001$).

To quantify the relative importance of the three explanatory variables, we used hierarchical partitioning of variance with the R-package HIER.PART' (Mac Nally & Walsh, 2004), which can estimate the individual relative importance of the explanatory variables, taking individual and conjoint influences into account as well. Furthermore, by fitting separate models for each explanatory variable, we extracted Nagelkerke's R^2 that provides an approximation of the individual explanatory power of each variable, similar to hierarchical variance partitioning. For this we used the *R*-package PERFORMANCE. Nagelkerke's R^2 comes from a pseudo-*R*-squared estimation method and can be taken as a coefficient of determination in nominal or ordinal variables. Data handling and analyses were carried out in R (ver. 4.2.0; R Core Team, 2022). For calculating the distance of mounds from the closest settlement, we used QGIS (QGIS.org, 2021).

3 | RESULTS

The mounds in our study had 0 to 20 names. They showed a considerable variation with respect to their height (mean: 0.86 m; 1.6 SD; range 0–10.1 m) and distance from settlements (mean: 2138.9 m; 1613.6 SD; range 0–8803.0 m). We found that all the predictors studied were associated with the degree of naturalness of the vegetation. The degree of naturalness of the vegetation increased with the number of toponyms ($\chi^{2(df2)}=59.21$; $p<0.001$; Nagelkerke's $R^2=0.046$; Figure 2, Supporting Information S4), greater height ($\chi^{2(df1)}=926.9$;

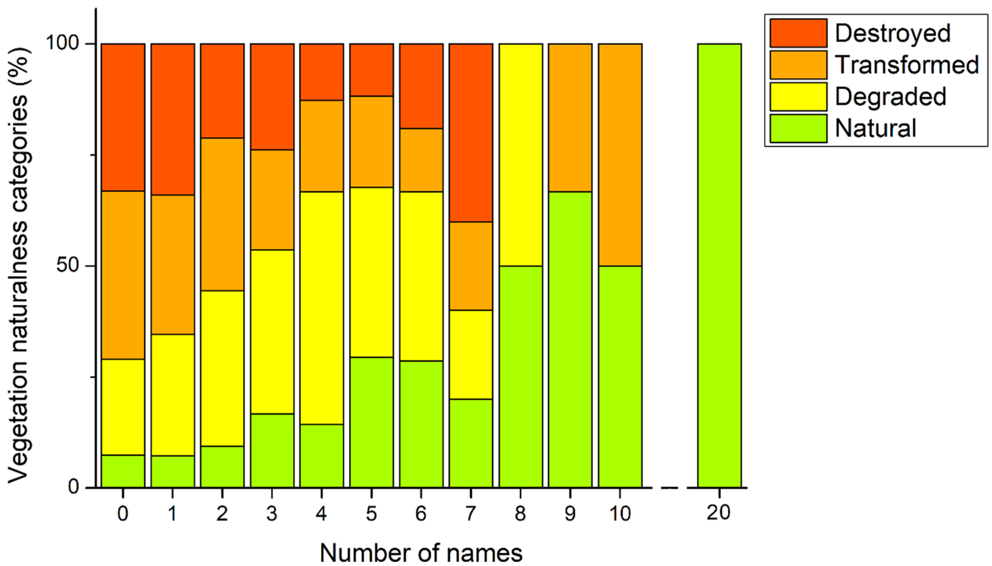

FIGURE 2 Proportion of the vegetation naturalness categories (green—natural; yellow—degraded; orange—transformed; red—destroyed) of mounds with different numbers of place names (0–20). The break in the *x*-axis indicates that there were no mounds with 11–19 names.

$p<0.001$; Nagelkerke's $R^2=0.500$), and greater distance from settlements ($\chi^{2(df1)}=8.84$; $p=0.003$; Nagelkerke's $R^2=0.017$). The results of the ordered logistic regression models are included in Supporting Information S5. Based on the result of the hierarchical partitioning, independently explained variation by number of toponyms, height and distance was 6.5%, 91.2% and 2.4% respectively.

4 | DISCUSSION

We revealed that in addition to topographic attributes (mound height and distance from settlements), cultural values twit to the mounds (toponym diversity) were also associated with the degree of naturalness of vegetation on them. Among topographical attributes, the height of the mound probably had a protective effect against ploughing (Deák et al., 2016). The distance from settlements reflects a decreasing intensity of land use which can be a plausible reason for our result that mounds located further from settlements had a higher degree of naturalness of vegetation, compared to those closer to settlements. We found that vegetation on mounds with more names had a higher degree of naturalness of vegetation. Places with more toponyms probably had greater cultural importance and thus played a more important role in the everyday life of residents than places with one or no name.

Mounds have been culturally important places used differently from other parts of the landscape, and there have been social conventions and taboos that have prevented their destruction and therefore maintained grassland habitats on these sacred natural sites (Deák et al., 2022). Our results suggest that this cultural protection might have been more apparent on mounds with multiple names. Our results pointing to the positive correlation between the number of names and height suggest that despite the fact that in our model the height of the mound had the most important role in preserving conservation values, it probably should not be considered solely as a topographic factor. Higher mounds being characteristic elements of the plain landscape were plausibly more recognized and respected by local populations, which might explain the fact that height and number of toponyms are correlated.

In many developed regions around the world, industrial and urban development has resulted in a considerable loss of natural habitats (Biró et al., 2018) and also in the erosion of the diversity of place names (Hoffmann et al., 2017). However, as we pointed out, the *genius loci* can hinder the degradation, transformation or destruction of the vegetation even centuries after large cultural and socio-economic transformations. This suggests the existence of a time lag between the disruption of culture–nature relationships and the subsequent degradation, transformation and destruction of habitats. This delay between the extinction of cultural and biological diversity can contribute to reversing the deterioration by applying the *genius loci* concept. The concept would be especially effective for the protection of small habitats outside nature reserves, where the existence and survival of habitats do not depend on governmental strategies, but on decisions and behaviour of local residents. In highly transformed agricultural and urban landscapes, elements of biocultural diversity are often lost (Elands et al., 2019). In such landscapes, human–nature relationships could be restored with supporting landscape stewardship by engaging land users in the responsible management and use of the land (Bieling et al., 2020; Enqvist et al., 2018). Our results suggest that revitalizing public recognition of place names could enable effective and meaningful communication about cultural ties towards residents about particular landscape elements. In addition, this could help inform decision makers about the importance of natural sites of sacred, cultural or spiritual importance, and mitigate the destruction of such places. In a broader context, our results call for a more widespread integration of ecology and human sciences and show the unique benefits of recognizing the interconnectedness of social and ecological spheres (Hartel et al., 2023; Pretty et al., 2009).

AUTHOR CONTRIBUTIONS

Ádám Bede conceived the idea of the regional survey of mounds, mapped and surveyed all the mounds, collected the toponyms and digitalized the data. Orsolya Valkó, Ádám Bede and Balázs Deák conceived the idea of the analysis. Zoltán Rádai conducted the analysis. Orsolya Valkó and Balázs Deák wrote the manuscript with contributions from all authors. All authors contributed critically to the drafts and gave final approval for publication.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The dataset used for the calculations is available at the figshare data repository (https://doi.org/10.6084/m9.figshare.22582444).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Supporting Information S1. Examples for the potential origin and meaning of mound names in the study region, based on the work of Ádám Bede (Bede 2016).

Supporting Information S2. Representation of the mounds on historical maps from the 18th (upper row) and 19th (lower row) centuries.

Supporting Information S3. Used maps and references for identifying kurgans and place names in the Maros–Körös Interfluve.

Supporting Information S4. Distribution of mounds characterized by different vegetation naturalness on mounds with assigned to different name categories (0 = without name; 1 = only one name; 2 = more than one name) ($n = 1521$).

Supporting Information S5. Results of the ordered logistic regression models.

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