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RESEARCH ARTICLE

Applying the Cultural Values Model to assess biocultural change in Eastern European wood-pastures

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Abstract

1. Traditional wood-pastures are emblematic of multifunctional farming systems. Despite their exceptional ecological and cultural value, these systems are undergoing rapid transformation under the combined pressures of modernization, land-use intensification and shifting societal values.
2. We apply the Stephenson's Cultural Values Model to assess the biocultural complexity of 110 ancient wood-pastures across Transylvania, Romania, a unique region of Eastern Europe, where traditional land-use systems persist amidst accelerating institutional and economic change. The three dimensions of the Cultural Values Model—'Forms' (material structures), 'Practices' (land-use activities) and 'Relationships' (cultural meanings and memories)—were quantified through field surveys and 32 semi-structured interviews with local stakeholders.
3. Our results reveal diverse biocultural profiles, with traditional and modern elements (i.e. 'Forms' and 'Practices') frequently co-occurring. While many sites retain legacy features such as scattered veteran trees and extensive grazing, signs of social-ecological reconfiguration are evident, including electric fencing, mechanized infrastructure, and declining communal governance. Landscape-level analyses show that traditional features ('Forms', 'Practices' in the Cultural Values Model framework) persist more often in rugged terrains, whereas modernization predominates in flatter, more accessible areas. Interview data show an erosion of cultural engagement, stewardship norms and local agency.
4. Our findings suggest that the transformation of ancient wood-pastures can be effectively traced through the three pillars of the Cultural Values Model: 'Forms',

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'Practices' and 'Relationships'. The framework proved especially valuable in disentangling how material, functional and symbolic dimensions of these landscapes evolve in response to socio-economic and institutional pressures. We also showed that the Cultural Values Model can be a practical tool for assessing biocultural complexity and identifying early signs of system reconfiguration of traditional farming systems.

KEYWORDS
biocultural diversity, Cultural Values Model, social-ecological systems, wood-pastures

1 | INTRODUCTION

Traditional biocultural systems emerge from centuries-long co-evolution between people and nature, in which the structure, function and identity of ecosystems and landscapes are closely interwoven with human livelihoods and cultural practices (Barthel et al., 2013; Merçon et al., 2019). These systems typically encompass distinctive ecological knowledge, land stewardship traditions and symbolic associations. Through sustained interaction, these systems shape cultural landscapes in which biodiversity, land-use structures and symbolic meanings are co-produced. The resulting landscapes and ecosystems are often mixtures of ecologically valuable elements (such as species-rich grasslands, old trees or patchy mosaics) and built features, customary practices and place-based identities (Gavin et al., 2015; Hanspach et al., 2020).

Understanding how cultural values are expressed in landscapes and ecosystems (and how they shift over time) requires integrative frameworks that bridge elements often considered in isolation, such as biophysical features, functional roles and symbolic meanings of place. One such framework is Stephenson's 'Cultural Values Model', which conceptualizes landscape values through three dimensions: 'Forms' (physical structures and features), 'Practices' (human activities) and 'Relationships' (associative meanings such as memory, belonging, and identity) (Stephenson, 2008; see also Table 1 for a distilled presentation). Although the Cultural Values Model has inspired numerous conceptual discussions, only a limited number of European studies have operationalized its three dimensions through field-based data collection (e.g. Bieling & Plieninger, 2013; Bieling et al., 2014). To the best of our knowledge, no studies have yet applied this framework to examine changing traditional biocultural systems in Europe.

TABLE 1 Adapting the Stephenson's Cultural Values Model and presenting the landscape context in the study of the ancient wood-pastures in Transylvania (Romania).

Dimension	Definition (adapted from Stephenson, 2008)	Examples form the current study (see Annex S1)	Methodological and use details (see also Annex S1)
Forms (structures: natural, human made)	Tangible elements of the landscape, such as physical structures, archaeological remnants, vegetation and landforms.	Large old trees, scattered trees, regeneration patches, bear activity Traditional buildings (abodes, fountains, watering systems) Modern structures (electric fences, info panels) Crosses, benches, historical remnants	Field-based survey of 110 wood-pastures using a standardized presence/absence protocol. Natural features shaped by use were included under Forms.
Practices (human activities)	Intentional human activities defined as ongoing or historical activities associated with the place, such as land-use, harvesting, recreation, or rituals.	Grazing (cattle, sheep, pigs, buffalo), pollarding, coppicing, gardening, mechanization, fencing, road construction, tree graffiti, garbage piles	Activities categorized as traditional or modern based on literature (e.g. Dorner, 1910), local knowledge and field evidence. Reflect ongoing, ceased, or new uses.
Relationships (meanings, narratives, identity)	The connections people have with the place, such as memories, identity, spiritual significance, or emotional attachment.	Interview insights into stewardship, local identity, human-nature connections and how these changed in time	Based on 32 interviews with 55 participants in 16 settlements. Two guiding questions on past and current use. Quotations support interpretation of values and meanings.
Landscape context (not part of the Cultural Values Model)	Variables describing terrain and land-use context of each wood-pasture, used to interpret the spatial configuration of forms and practices.	Terrain ruggedness (600, 1500 m), land cover types (pasture, forest, arable, built-up)	Extracted using GIS buffers at two spatial scales (600, 1500 m) from wood-pasture centroid.

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This suggests that the full empirical potential of the Cultural Values Model, particularly in regions undergoing rapid socio-ecological transformation, remains underexplored. Our study aims to bridge that gap by applying a structured, field-adapted version of the Cultural Values Model to investigate the biocultural characteristics of wood-pastures, an ancient land-use system once widespread across Europe and still present in regions such as the Mediterranean, the UK, Scandinavia and Central and Eastern Europe (Bobiec et al., 2019; Garrido et al., 2017; Hartel et al., 2017; Sandberg & Jakobsson, 2018). Wood-pastures consist of grasslands interspersed with scattered trees, shaped over centuries by grazing, pollarding and low-intensity agriculture. Wood-pastures hold exceptional cultural and ecological value, acting as repositories of biodiversity, ecological memory and place-based identity (Plieninger et al., 2015). Their origins trace back to both natural systems (open, grazed woodlands maintained by megafauna and disturbance) and cultural continuity since the Neolithic (Bergmeier et al., 2010; Hartel & Plieninger, 2014). Today, the persistence of ancient trees, structural heterogeneity and symbolic features makes them ideal systems for biocultural analysis, particularly as these features are under increasing pressure from abandonment, land-use intensification and socio-political change (Bobiec et al., 2019; Torralba et al., 2018).

The Cultural Values Model offers a robust framework for holistic biocultural analysis of ancient wood-pastures by integrating physical structures, lived practices, and intangible meanings into a single interpretive framework. This enables a nuanced understanding of how traditional (or even ancient) cultural landscapes are constituted, maintained and altered through social-ecological interactions.

Romania presents a particularly compelling context for studying ancient wood-pastures from a biocultural perspective due to the co-existence of long-standing traditional social-ecological systems and ongoing pressures from globalization and institutional transformation (Fischer et al., 2012). It retains one of the largest rural populations in Europe (Romanian National Institute of Statistics, 2015), which supports the persistence of low-intensity farming practices. Romania also harbours some of the largest and most structurally diverse traditional wood-pastures in Central and Eastern Europe (Plieninger et al., 2015). At the same time, the country has experienced major political, economic and social transitions, from the fall of communism to European Union accession, that have reshaped land use, governance, and value systems (Manolache et al., 2020). EU agricultural policies, especially the Common Agricultural Policy, have introduced new institutional and economic pressures that often conflict with traditional management. Meanwhile, aspirations for modernization and increasing external investment are altering societal expectations and land-use priorities (Hartel et al., 2023). Nevertheless, emerging discourses around sustainability, biodiversity conservation and heritage protection are gaining traction in some rural areas (authors, personal observation).

These intersecting dynamics make Romania an ideal case to study how traditional biocultural systems, such as ancient wood-pastures, persist, adapt or erode under these ongoing changes. The Cultural Values Model provides a powerful framework to capture these dynamics by integrating field-based assessments of landscape structures and practices with interviews that reveal evolving relationships, meanings and identities (see 'Conceptual framework' in Section 2 for details).

In this study, we analyse 110 wood-pastures across Transylvania through the lens of the Cultural Values Model. Our aim is to adapt and apply the Cultural Values Model framework to assess the biocultural richness and variation of these changing ancient wood-pastures. Specifically, we:

1. apply the Cultural Values Model framework to identify and classify the human constructed and natural features ('Forms' and 'Practices' in Stephenson, 2008) recorded at each wood-pasture, distinguishing between traditional and modern elements as indicators of biocultural character and change;
2. analyse how 'Forms' and 'Practices' co-vary with land cover and terrain ruggedness at local (600 m) and landscape (1500 m) scales, to identify biocultural profiles of wood-pastures; and
3. analyse how community relationships with wood-pastures have changed over time, using interview data, thereby documenting the 'Relationships' dimension of the Cultural Values Model.

2 | MATERIALS AND METHODS

2.1 | Adapting the Cultural Values Model

We adapted the Cultural Values Model to our empirical context by linking each of its dimensions (Forms, Practices and Relationships; Stephenson, 2008) to specific field-recorded variables and interview-derived insights (Table 1). The 'Forms' dimension was represented in our research through features such as buildings, fences, water sources and infrastructure categorized into 'Traditional forms' (e.g. wooden watering systems, old sheepfolds, historical buildings; Annex S1), 'Modern forms' (e.g. electric fences, tourism infrastructure; Annex S1) and 'Natural features' (e.g. woody vegetation, wetlands, wild animal signs; see Annex S1). The 'Practices' dimension of the Cultural Values Model was represented in our study by land-use activities such as grazing, coppicing, ploughing or mechanization (Table 1). Practices were again coded as 'Traditional practices' (e.g. pollarding, buffalo grazing; Table 1; Annex S1) and 'Modern practices' (e.g. use of modern tractors, road construction, garbage piles; Table 1; Annex S1). Further details are presented in the data collection section; see below.

The 'Relationships' dimension of the Cultural Values Model was represented by the information gained through 32 individual and group interviews with 55 participants from 16 settlements, selected for their in-depth knowledge of wood-pastures and their surrounding communities (methodological details are presented below). These narratives provided insight into memory, identity, belonging and symbolic meanings of the wood-pastures as well as the Forms and Practices recorded there.

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By systematically integrating both structured field data and qualitative interview material within the Cultural Values Model, we are confident that our analytical framework can capture both persistence and transformation in biocultural systems, hereby showing the usefulness of the Cultural Values Model in assessing changing traditional biocultural systems. This approach enabled us to trace patterns of continuity, erosion, and hybridization in the material and symbolic constitution of wood-pastures under contemporary pressures.

2.2 | Data collection from the wood-pastures and variable description

We surveyed 110 wood-pastures across Transylvania in 2022 and 2023, spanning an altitudinal range of approximately 200–1200 m (Figure 1). The wood-pastures were selected in a way to cover three distinct cultural regions of Transylvania (Romania) (Figure 1). Each wood-pasture was opportunistically (based on accessibility and safety considerations) and comprehensively surveyed across its full area. Our field protocol followed the Cultural Values Model conceptual framework (Table 1) and previous studies addressing the cultural manifestations in the landscape (e.g. Bieling & Plieninger, 2013). At each wood-pasture, we recorded a standardized set of 62 variables reflecting visible material features and land-use elements (Annex S1). These included human-built structures, land management indicators and ecological elements such as vegetation patterns and animal traces. We organized these variables into the Cultural Values Model (see Section 2.1; Table 1). This grouping allowed us to interpret the recorded features in relation to cultural values as expressed materially and functionally across the wood-pastures. The original variable list was derived from prior research experience and refined through a stakeholder consultation involving 17 participants from local farming, governance, and conservation sectors. This consultation led to the inclusion of features relevant to tourism, education and accessibility (Annex S1). Prior studies have highlighted the importance of small human-made and natural features in supporting biodiversity and ecosystem functioning in traditional farming systems (Gállé et al., 2017; Tölgyesi et al., 2018; Lindenmayer, 2017; Hartel et al., 2014).

In addition to field-based variables, we extracted landscape context indicators using GIS for each site, at two spatial scales (600 and 1500 m buffer zones from the wood-pasture centroid) (Table 1; Annex S1). This included terrain ruggedness and the percentage of

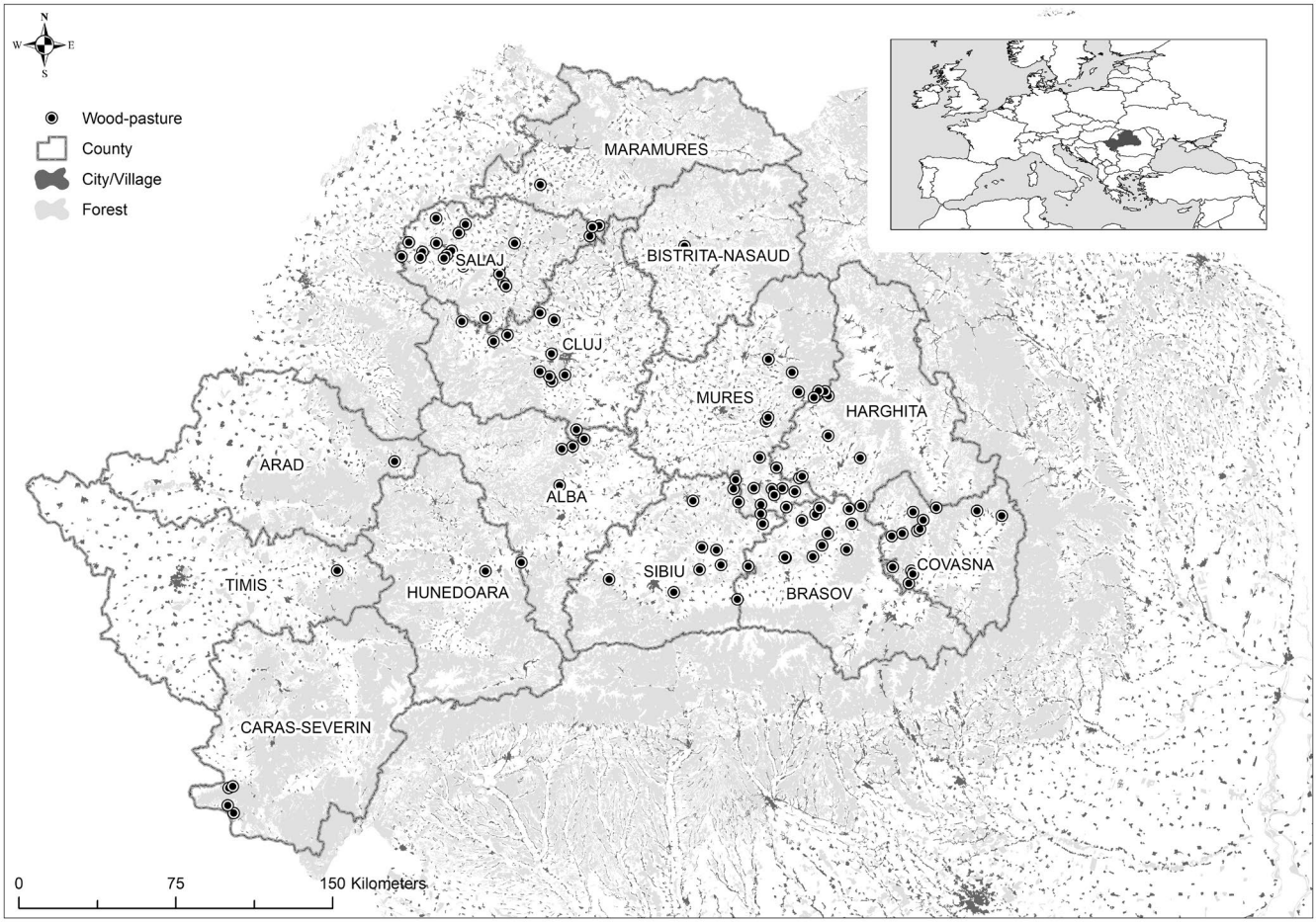

FIGURE 1 Map of the 110 wood-pastures surveyed for this research. The position of the studied area within the context of Europe is shown in the upper right corner of the map.

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surrounding land types: built infrastructure, arable land, pastures and forest or woodland (see Annex S1 for definitions). These spatial variables provide a landscape ecological context for interpreting variation in the expression of Cultural Values Model dimensions across sites.

2.3 | Interviews

While the field-recorded variables allowed us to document the material and functional dimensions of wood-pastures (corresponding to the Cultural Values Model's 'Forms' and 'Practices'; Table 1), they offer limited insight into the local memories and symbolic meanings. The Cultural Values Model captures these through the 'Relationships' component (Stephenson, 2008). To address this aspect, we conducted 32 semi-structured individual and group interviews with a total of 55 participants (36 males, 19 females) across 16 settlements in Western, Southern, and Eastern Transylvania (regions where wood-pastures were surveyed). Interviewees included farmers, foresters, commune officials, and members of civil society organizations involved in conservation and advocacy related to wood-pastures. Interviewees were selected based on their in-depth local knowledge of the wood-pastures and community dynamics. The interviews explored two core questions aligned with the Cultural Values Model's 'Relationships' dimension:

(1) '*How would you characterize the use of wood-pastures by the local community in the past?*' and (2) '*How would you characterize the current relationship between the local community and the wood-pastures?*'

These questions were designed to elicit narratives of memory, customary norms, symbolic associations, and evolving meanings. Photographs of characteristic wood-pasture features ('Forms' and 'Practices') were used as visual prompts to support recall and discussion (see Hartel et al., 2017). Conversations were conducted in Romanian and Hungarian to ensure inclusivity across the region's major ethnic groups: Romanians, Hungarians, Saxons, and Roma. Every discussion was recorded with the permission of the interviewees. Age of participants ranged from 45 to 85 years. Although this work does not provide a full thematic analysis of the interviews (which will be presented separately), selected excerpts and insights are used to enrich the interpretation of the 'Forms' and 'Practices' observed in the field. In this way, the interviews enhance the contextual understanding of material features and land-use practices characterizing wood-pastures. Ethics approval for this component was granted by the Babes-Bolyai University's Ethical Committee.

2.4 | Data analysis

To address Objective 1, we used descriptive statistics to quantify the frequency of occurrence of each recorded feature across the 110 surveyed wood-pastures. Specifically, we calculated the percentage of sites where each feature (as defined in Annex S1 and categorized in Table 1) was present, allowing us to characterize the material and functional aspects of the wood-pastures according to the 'Forms' and 'Practices' dimensions of the Cultural Values Model.

To address Objective 2, we applied principal component analysis (PCA) to explore how variables representing the 'Forms' and 'Practices' dimensions of the Cultural Values Model co-vary with land cover characteristics at the local (600 m) and broader landscape (1500 m) scales (Annex S1). This approach provides insights into how surrounding landscape context may influence the expression and persistence of biocultural features manifested through the variables 'Forms' and 'Practices' within wood-pastures. Due to the high number of binary variables and the need for dimensionality reduction, we aggregated the variables representing the Cultural Values Model dimensions of 'Forms' and 'Practices' into five composite categories. Within 'Forms', we distinguished between 'Traditional_structure' and 'Modern_structure', while natural features were retained as a separate composite category labelled 'Nature'. For 'Practices', we similarly distinguished between 'Traditional_practice' and 'Modern_practice' (see Table 1; Annex S1). To help interpretation, we evaluated the squared cosine (cos^2) values of each variable and selected representative wood-pasture photos with high loadings for each axis. All analyses and visualizations were conducted in R version 4.2.2 (2022-10-31).

The interview data (Objective 3, the 'Relationship' component of the Cultural Values Model) were analysed using open coding (following Hartel et al., 2014, 2017; Biggs et al., 2021). This approach uses inductive qualitative analysis, allowing themes to emerge from the data without imposing predefined categories. Narratives from interviews were particularly informative for the 'Practices' and 'Relationships' dimensions of the Cultural Values Model (Table 1), helping to contextualize local perceptions of stewardship, change and cultural attachment to specific features. This interpretive process highlighted the interplay between material conditions (Figure 2) and symbolic meanings. Selected transcripts were purposefully chosen to reflect a diversity of perspectives and to deepen understanding of key thematic linkages identified in the field data. This aligns with recommended practices in qualitative research, where triangulation, reflexivity and transparency in coding are critical to ensure rigour and credibility of findings (Biggs et al., 2021).

2.5 | Ethics statement

Approved by Babeș-Bolyai University Scientific Council (Approval No. 1347/03.02.2023; ref. 111/30.01.2023; PI Tibor Hartel). Informed verbal consent was obtained from each interviewee. Signature was not requested, but the verbal consent on recording the interviews was recorded. Data were anonymized and handled under GDPR.

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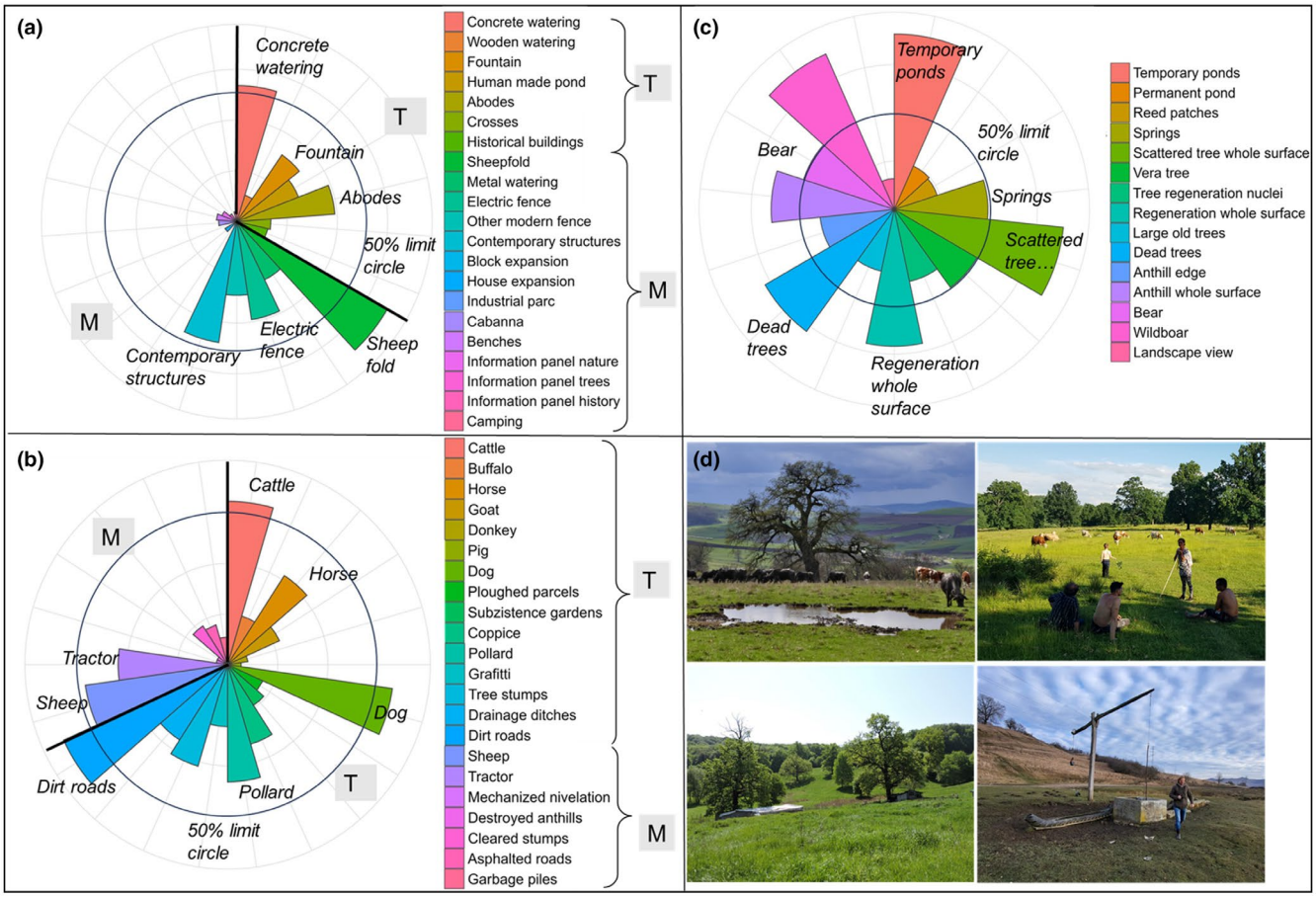

FIGURE 2 Star-plots presenting the proportion of built structures (a), practices (b), and the natural features (c) recorded in the field ($n = 110$ wood-pastures). M, modern; T, traditional (see also Section 2 and Annex S1). Four representative pictures are also presented (d): A temporary pond maintained by buffalo and cattle activity with ancient oak in the back; traditional cattle herders explaining the economic and cultural challenges of this lifestyle; newly established sheepfold; traditional fountain and concrete watering complemented by modern watering structures.

3 | RESULTS

3.1 | Forms and practices characterizing the ancient wood-pastures (Objective 1)

Of the 110 surveyed wood-pastures, 48% were located within Natura 2000 sites. Based on the frequency of forms and practices (see Figure 2 and below), the combined presence of traditional and modern elements suggests that a process of social-ecological change is ongoing, with traditional features persisting alongside increasing signs of modernization and structural transformation. Across all sites, the most frequently observed human-made structures ('Forms') included sheepfolds (70%), concrete watering systems (54%) and dirt roads (72%). Electric fences were present in 39% of sites, and contemporary structures such as gas extraction installations and electricity infrastructure were recorded in 48% of sites (Figure 2). The most common natural features (also categorized as 'Forms') included scattered trees covering the entire pasture area (89%), regeneration patches (71%), dead trees (78%), temporary ponds (91%), and bear (50%) and wild boar (88%) activity (Figure 2). In terms of land-use activities ('Practices'), sheep grazing was recorded in 57% of sites, followed by cattle (65%) and the presence of shepherd dogs (66%). Other practices such as pollarding (46%), the use of tractors (44%) and horse grazing (42%) were also frequently observed (Figure 2). Less commonly recorded practices included buffalo, goat and pig grazing, as well as graffiti, garbage piles and mechanized levelling.

3.2 | Forms and practices in the context of the surrounding landscape (Objective 2)

To assess variation across the 110 wood-pastures, we conducted a PCA using five composite variables representing forms and practices, alongside eight GIS-derived variables describing land cover and terrain characteristics at two spatial scales (600 and 1500 m) (Table 2). The first four PCs explained 71.1% of the total variance. PC1 (29.65%) is defined by strong positive loadings for modern structures and modern practices, and strong negative loadings for ruggedness at 600 and 1500 m and forest cover at 600 and

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TABLE 2 Factor loadings of the first four principal components (Dims) of the wood-pasture features recorded in the field, the local level, and landscape level variables.

	Dim.1 'Low use of inaccessible wood-pastures'	Dim.2 'Pasture versus crop'	Dim.3 'Traditional farming-nature co-occurrence'	Dim.4 'Building, infrastructure'
Traditional structures ('Forms')	0.59	0.09	**0.63**	−0.08
Modern structures ('Forms')	**0.59**	0.16	0.49	0.07
Traditional practices ('Practices')	0.52	0.00	**0.67**	0.17
Modern practices ('Practices')	**0.55**	−0.11	0.13	−0.32
Natural features ('Forms')	0.06	−0.28	**0.54**	−0.20
Ruggedness 600 m radius	**−0.61**	−0.06	0.40	0.12
Built area at 600 m radius	0.18	0.26	−0.02	**0.77**
Arable land at 600 m radius	0.44	**0.66**	−0.14	−0.19
Pasture at 600 m radius	0.54	**−0.69**	−0.16	−0.01
Forest at 600 m radius	**−0.78**	0.30	0.19	−0.01
Ruggedness 1500 m radius	**−0.74**	−0.12	0.35	0.11
Built area at 1500 m radius	0.21	0.29	−0.03	**0.70**
Arable land at 1500 m radius	0.55	**0.63**	−0.14	−0.29
Pasture at 1500 m radius	0.40	**−0.69**	−0.16	0.23
Forest at 1500 m radius	**−0.79**	0.08	0.20	−0.15
Eigenvalues	4.44	2.16	1.83	1.49
% variance	29.65	14.42	12.21	9.96

Note: In bold, we highlighted the variables with highest *squared cosine* values. Colour symbols: grey, human-made Forms and all Practices; green, Natural features (Forms); blue, landscape/topography.

1500 m. These patterns indicate a gradient from accessible, open wood-pastures with substantial modern infrastructure and management to rugged, forest-adjacent pastures with low accessibility and minimal modern interventions (Table 2). PC2 (14.42%) contrasts arable-dominated wood-pastures (positive loadings for arable land at 600 and 1500 m) with pasture-dominated ones (strong negative loadings for pasture at both scales), while Cultural Values Model-related features are minimally represented. PC3 (12.21%) captures the co-occurrence of traditional forms, practices, and natural features, representing wood-pastures with high biocultural continuity. PC4 (9.96%) primarily reflects built area at both 600 and 1500 m, distinguishing wood-pastures embedded in more developed surroundings. Representative photos were selected along the PCA axes to visually illustrate these profiles (Figure 3).

3.3 | Community relationships with wood-pastures: Insights from interviews (Objective 3)

Interviews conducted in 16 Transylvanian settlements provided contextual insights into the patterns observed in the field (see above). Several changes in local use, management and interaction with wood-pastures were consistently noted, directly corresponding to the 'Forms' and 'Practices' recorded.

Traditional pasture governance has weakened according to the interviewees. Previously, local communities organized wood-pasture use through informal systems of elected stewards who coordinated seasonal tasks, such as rotational grazing, scrub clearance, and well maintenance. These practices, closely tied to livestock ownership, were typically implemented manually. Today, such roles are rare and often replaced by mechanized clearing or bureaucratically enforced maintenance plans linked to subsidy compliance. Some interviewees reported a loss of local governance due to land redistribution and privatization, sometimes benefiting individuals with political ties. One farmer described how 80 ha of pastureland he had legally leased and managed were reassigned by the local council not according to livestock ownership but based on political favouritism. As a result, he was unable to fulfil the conditions of his 5-year eco-certified agri-environmental contract with the Agency for Payments and Intervention in Agriculture (APIA, responsible for distributing EU and national subsidies to farmers in Romania). This breach triggered a penalty requiring him to repay previous subsidies, amounting to approximately 90,000 EUR: '*They took away about 80 ha of land, and redistributed it, but not according to the number of livestock one has, but to friends of officials… Now I must pay a fine of about 90,000 EUR, because my contract with APIA was for 5 years, I had eco-certification done, and because I can no longer fulfil this contract, I have major problems going on in my life*' (Izvoru Crișului—Körösfő, male, 45, farmer). Elsewhere, however, efforts to reinstate collective governance based on historical records were described positively: '*That was the decision of the people. They investigated the property documents, and they created this commons administration of the pastures when the people got*

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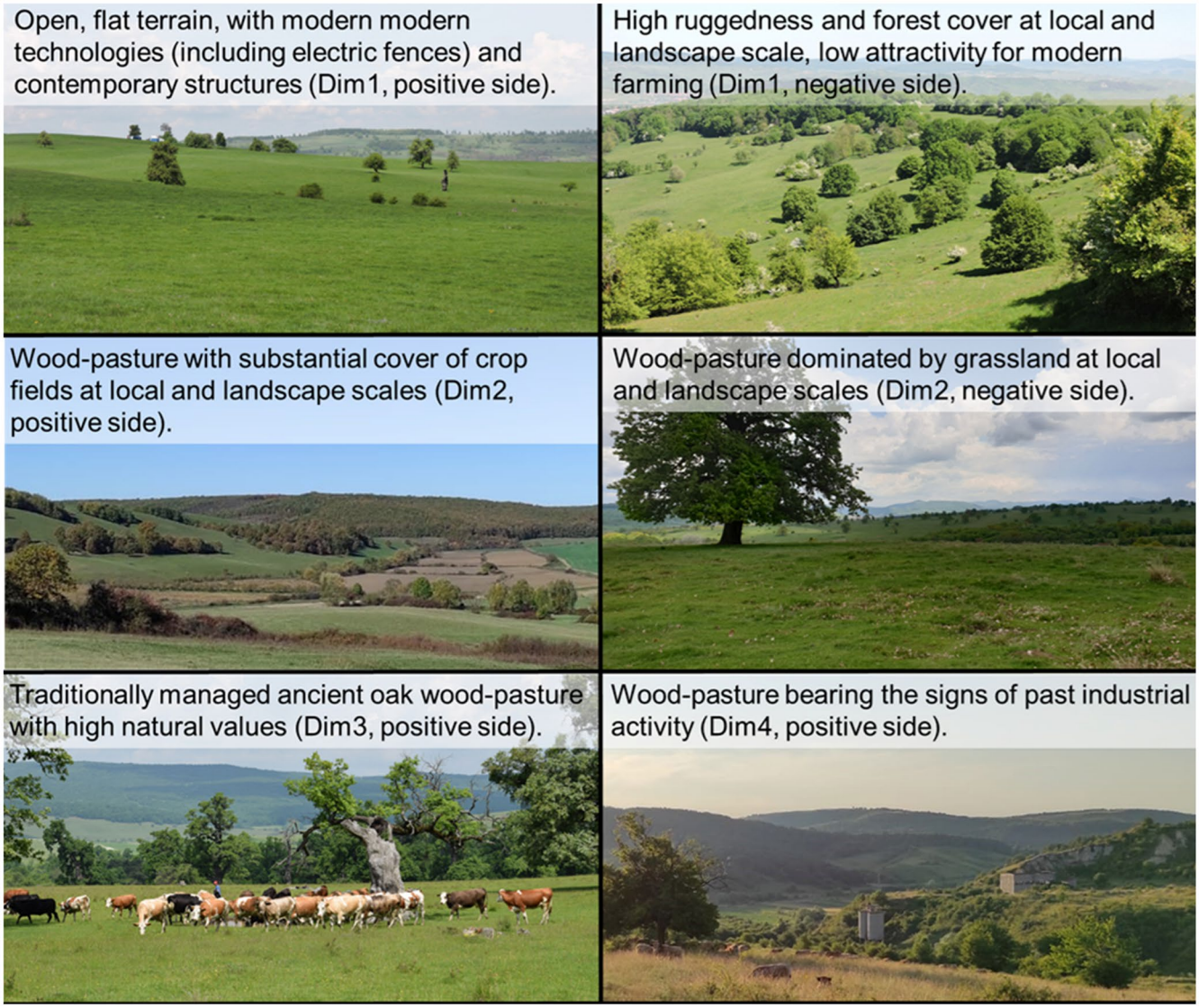

FIGURE 3 Representative pictures presenting the wood-pastures with high loadings on the first two principal component analysis axes (see Table 2 for statistical details).

back their lands after the fall of communism' (Săula—Sárvásár, group of three farmers, two males and one female, 40–50 years).

Several interviewees pointed to reduced access to previously communal pastures. The installation of electric fences, recorded in 39% of surveyed sites (see above), was commonly attributed to herder shortages, increased presence of carnivores and shifting labour availability. '*There is not enough manpower. The farmers use electric fences since these have been available. There are not enough knowledgeable people*' (Jibou—Zsibó, sheep owner, 35 years). While often seen as necessary, fencing has also limited traditional movement and access across pastures, altering historical patterns of use. Field-based reports of abandoned pastures, particularly in steep or forested areas (see PCA results; Table 2), were echoed in interviews. In many cases, terrain and labour constraints discourage the use of these more difficult pastures, contributing to a trend of abandonment or selective clearing.

According to the interviewees, livestock ownership has declined and become concentrated among fewer commercial-scale farmers. Historically, households grazed diverse livestock, including cattle, buffalo, sheep, goats, pigs and horses, creating close daily interactions with the land. '*There used to be animals belonging to every household. Now, there are only a few herds, belonging mostly to one or two people*' (Jibou—Zsibó, sheep owner, male 35 years).

Today, grazing is dominated by sheep and cattle, with other species largely absent. '*Back in the day… multiple species composed the ecosystem of the wood-pastures […] buffalo, cattle, sheep, goats, in some cases horses and pigs. In the present day this diversity has been reduced to mainly two species: cattle and sheep*' (Sărmașu, farmer, male 65 years). The observed shift from diverse, small-scale herding to intensive, often industrial grazing is reflected in reduced community participation and limited engagement in pasture management beyond the few remaining large-scale operators.

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Cultural practices associated with wood-pasture use (such as foraging for rosehips, mushrooms, and medicinal herbs) were once widespread but are now infrequent. Interviewees linked this decline to reduced animal ownership and less time spent in the landscape. '*They would go out on Sunday afternoons for a walk and would pick a basket full of rosehips. We used those for tea infusions or for gem*' (Sărmașu, farmer, female, 55 years). Manual labour such as scrub clearing is still practised by some users, especially where tractors cannot access: '*I do the clearing work as well. With the tractor where possible, and manually, where the tractor cannot go in*' (Nusfalau—Nagyfalu, farmer, male, 50 years). However, such work now often occurs in isolation or under formal requirements tied to subsidy schemes. '*They come with the drones… and because we are getting subventions for the pasture, we get fined if they see bush there*' (Nusfalau—Nagyfalu, farmer, male, 50 years).

Socially embedded practices such as communal pasture clearing and seasonal gatherings have become occasional. '*What I remember from back in the day, is that we had these gatherings mostly during the pasture clearing. That was very social. And at that time, if there was a dried-out, or fallen tree, the question was posed: "What are you willing to give for it?" Because if we didn't take it home, someone else would come. And for example, I may have offered a litre of pálinka* (i.e. alcoholic drink), *another one two, and the one, who offered three, would take it home. Then we would drink the little pálinka, we would talk, maybe even a little singing… What we have now, we have this commons administration, and when we have the yearly gatherings, or the sorting of the financial situation, we have the tenant there as well, and we usually make a goulash* (traditional food) *or something together, a little dinner, we drink wine and talk. On the pasture. We invite everyone*' (Sărmașu, farmer, male 65 years).

4 | DISCUSSION

4.1 | Biocultural properties of wood-pastures: Insights from the Cultural Values Model

Following Loos and von Wehrden (2018), we situate wood-pastures within the land-sharing paradigm, emphasizing that these landscapes have co-evolved as multifunctional arenas where biodiversity and human activity are deeply interlinked. We used the Cultural Values Model of Stephenson (2008) to quantify 'Forms' and 'Practices' through a suite of human- and nature-related variables recorded in the field, and simultaneously, to assess the 'Relationships' dimension through semi-structured interviews (see below). The Cultural Values Model framework allows us to capture the persistence of traditional features as well as the emergence of cultural and technological shifts, such as mechanized land management or the use of electric fences, that reflect a growing decoupling from traditional, community-based land-sharing practices. In doing so, the Cultural Values Model helps us identify the transitions through which biocultural systems, once rooted in shared stewardship and multifunctionality, may drift towards more individualized, efficiency-oriented configurations. Such transformations challenge the long-standing identity of wood-pastures as land-sharing systems and raise questions about the sustainability of their social and ecological functions in the absence of active communal and cultural support.

Our study revealed that many ancient wood-pastures in Transylvania are still ecologically rich. The frequent presence of veteran trees, deadwood, temporary ponds and signs of large carnivore activity suggests that these systems retain semi-wild ecological functions (Lindenmayer, 2017). However, transformations such as the expansion of electric fencing (present in 39% of the wood-pastures at the period of our research) and mechanized land interventions (Figure 2) point to a growing disconnection from traditional management modes (Fischer et al., 2012; Xu & Huntsinger, 2022; Nita et al., 2024). The strength of the Cultural Values Model lies in its ability to conceptualize values as dynamic relationships across material, practical, and interpretive dimensions (Stephenson, 2008). This aligns with Fischer et al. (2012), who argue for an approach that allows ecosystem identities and functions to persist while accommodating legitimate processes of social and cultural change. In this light, the maintenance of ecosystem identity in wood-pastures could be understood as a negotiation between continuity (of the ecosystem and its contributions to people) and adaptability (of the society to maintain functional ecosystems while the society changes). We will highlight below that the opportunities for such negotiations are reduced, as the connections between locals and wood-pastures are eroding and the local communities themselves are undergoing abrupt changes. The presence of megabiota-like features (such as large old trees (e.g. Hartel et al., 2018) and bear activity) suggests that wood-pastures could serve as foundational landscapes for rewilding-based management (sensu Schweiger & Svenning, 2020). However, this necessitates a careful integration of cultural dimensions, recognizing that societal acceptance, local knowledge, and historical values are essential for any rewilding strategy to be viable and ethically grounded.

4.2 | The landscape context and the biocultural changes in ancient wood-pastures

Our multivariate analysis shows that variables denoting 'Forms' and 'Practices' (Table 1) vary systematically along broad landscape, topographic and ecological gradients. PC1, which explained nearly one-third of the total variance, captures a continuum from accessible, open wood-pastures with substantial modern infrastructure and management to rugged, forest-adjacent pastures with low accessibility and minimal modern interventions (Moga et al., 2016; Plieninger et al., 2015). This gradient reflects how accessibility mediates the pace and extent of cultural and technological change: under the current socio-cultural and technological context, accessible landscapes are more prone to the establishment of modern structures and practices (e.g. Perpiñá Castillo et al., 2020), and this establishment frequently co-occurs with traditional forms and

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practices (Torralba et al., 2018). The absence of strong negative correlations between traditional and modern features in the PCA suggests that modernization does not necessarily displace traditional forms and practices in the short term but instead produces hybrid (and likely transitional) configurations where traditional and modern co-exist (Gómez-Baggethun et al., 2013; Hanspach et al., 2014; Hanspach et al., 2016; Plieninger et al., 2015) for a given period. The PC3 captures sites where biodiversity-relevant natural features (e.g. scattered veteran trees, regeneration patches, wildlife signs) are strongly associated with traditional structures and practices. The moderate positive loadings for ruggedness and forest cover and moderate negative loadings for built area, arable land and pasture cover at both spatial scales suggest that such co-occurrence is more frequent in wood-pastures that are harder to access, where reduced human pressure allows natural processes to operate alongside continued traditional use (Hanspach et al., 2014, 2016).

4.3 | Changing relationships between people and wood-pasture

The interview findings reveal dramatic changes in the relationship between local communities and wood-pastures. The decline in traditional governance and embedded practices mirrors a fragmentation of human–nature connectedness, particularly in its material, experiential, and emotional dimensions (as noted by Balázsi et al. (2019) in other traditional systems). As subsidies, market logic and top-down bureaucracies replace locally adapted stewardship, management becomes increasingly decoupled from lived cultural experience (key for the 'Relationships' component of the Cultural Values Model; Stephenson, 2008). The transition from communal to individualized land ownership (manifested e.g. through the massive establishment of the electric fences, see Section 3, Objective 1) coupled with the intensification of agricultural practices is expected to further accelerate this disconnection. Relational values, defined as the preferences, principles and virtues associated with meaningful relationships between people and nature, are derivative of these relationships and responsibilities, rather than properties of nature itself (Chan et al., 2016). They can be grounded in care, responsibility, identity, and place, but also encompass other forms of connection, including values linked to a good life, stewardship ethics (West et al., 2018). Such values are particularly prone to erosion when industrialized land-use systems become established, as these often simplify landscapes, concentrate decision-making, and weaken the local governance structures and everyday practices that sustain meaningful human-nature relationships (Riechers et al., 2020). Furthermore, a failure to engage the plurality of values attached to nature's contributions to people can lead to decisions that marginalize relational and non-instrumental values of nature, thereby undermining both social cohesion and sustainable land use (Pascual et al., 2017). Rebuilding meaningful connections will require integrating these relational values into both research and governance processes, as advocated by Chan et al. (2016) and the IPBES conceptual framework (Pasqual et al., 2017).

5 | CONCLUSIONS AND IMPLICATIONS

In this study, we employed the Cultural Values Model (Stephenson, 2008) to analyse the evolving biocultural changes of Transylvanian ancient wood-pastures. By integrating field-based indicators of 'Forms' and 'Practices' (110 wood-pastures) with interview-derived insights (32 interviews, 55 persons) about 'Relationships', we showed that this framework can capture both visible and intangible transformations in traditional rural systems. Our analysis revealed that broad landscape context, particularly accessibility and terrain ruggedness, structures the expression of both traditional and modern structures and practices. Our qualitative assessment, on the other hand, shows a shifting arrangement of social relations and governance.

Although our study was not designed to explicitly address the land-sharing versus land-sparing framework, the patterns we identified provide context-specific insights that can refine and nuance this debate. Our findings point towards the emergence of land-sharing (i.e. the co-existence of human use and biodiversity; Fischer et al., 2014) in at least two distinct modes. In 'landscape-buffered sharing', rugged, inaccessible terrain can slow external pressures and sustain traditional uses, though in some cases abandonment may also occur. In 'technology-dependent sharing', typical of more accessible wood-pastures, modern infrastructure and practices co-occur with biodiversity-relevant features, but persistence of high natural values is more likely to require active institutional support (Fischer et al., 2014; Kremen, 2015). For example, the spread of electric fencing in formerly open, socially shared wood-pastures can reduce wildlife incursions but may also restrict human access, potentially exacerbating both human–wildlife and human–human conflicts (Xu & Huntsinger, 2022). Our interview data show a weakening of stewardship roles, a decline in everyday interactions with the land, and concentration of livestock management in fewer farmers. These changes likely underpin the sustainability of the centuries-old land-sharing, even in wood-pastures which are isolated and less accessible.

From a policy and management perspective, our research supports the need for context-dependent policies to sustain farming systems with exceptional natural and cultural values. As multifunctional farming landscapes of Europe can meet the goals of biodiversity conservation, climate resilience, and rural sustainability, our work supports a shift in governance paradigms: from conserving static 'heritage' to fostering living, adaptive biocultural systems. This requires approaches that are not only ecologically informed, but culturally reflexive, attuned to the relational values, historical depth and evolving practices that define landscape identity and resilience.

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AUTHOR CONTRIBUTIONS

Tibor Hartel, Alexandru Sabin Bădărău, Dacinia Crina Petrescu, Ruxandra Malina Petrescu-Mag, Laura Bouriaud and Frank Wagener conceived the ideas; Tibor Hartel, Alexandru Sabin Bădărău, Mihai Pop and Andreea Nita designed the methodology; Mihai Pop, Viorel Arghius, Alexandru Sabin Badarau, Frank Wagener, Till Wagener, Imola Pusök and Tibor Hartel collected the data; Tibor Hartel, Cristian Maloș, Andreea Nita and Imola Püsök carried out the formal analyses; Tibor Hartel and Imola Püsök curated the data; Tibor Hartel, Tibor Hartel and Andreea Nita prepared the visualizations; Alexandru Sabin Bădărău and Tibor Hartel led the writing of the manuscript. All authors contributed to data collection and writing, review and editing and approved the final version for publication. Tibor Hartel, Kinga-Olga Réti and Frank Wagener supervised the work; Tibor Hartel and Frank Wagener acquired funding; project administration was provided by Tibor Hartel, Kinga-Olga Réti, Mihaela Spac and Frank Wagener.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interests.

DATA AVAILABILITY STATEMENT

The dataset supporting this article is archived on Zenodo: *Biocultural features of 110 ancient wood-pastures in Transylvania (Romania), 2022–2023*, https://doi.org/10.5281/zenodo.17157697.

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SUPPORTING INFORMATION

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

Annex S1. The variables used to describe the surveyed wood-pastures.

Table S1. The description of the variables used for this study.

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