THE SYSTEMATIZATION AND INVENTORY OF HERITAGE ELEMENTS WITHIN PROTECTED NATURAL AREAS: AN INTEGRATED MANAGEMENT MODEL FOR THE UPPER MUREȘ DEFILE NATURAL PARK

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Abstract: *The concept of heritage represents a multidimensional projection of the interaction between the anthropic factor and the spatio-temporal substrate, necessitating a systemic approach within the process of inventorying and territorial management. The convergence of cultural, natural, and landscape heritage dictates a shift beyond segregated analysis, as natural elements acquire value-based significance in relation to the socio-cultural context. Pursuant to the European Landscape Convention (ratified by Law No. 345/2006), the landscape is defined as a complex territorial unit resulting from the interdependence of natural and human factors. From a cadastral perspective, this holistic vision establishes the need for a conservation strategy that transcends the focus on isolated immovable assets, ensuring instead the maintenance of functional equilibrium between natural components and human activities, integrated into a coherent system of territorial record-keeping and protection.*

Keywords: *Integrated management, natural heritage, territorial unit, GIS, cultural heritage, cadastre.*

1. Introduction

Heritage, in its broadest sense, constitutes the expression of the relationship between humanity, space, and time. Its components cannot be analyzed in isolation: cultural heritage is frequently embedded within a natural or landscape framework, while natural elements acquire significance through human cultural interpretation.

Natural heritage ensures ecological equilibrium and the continuity of life, whereas landscape heritage unifies these dimensions through the aesthetic perception of the territory. This holistic vision is enshrined in the European Landscape Convention (Florence, 2000), ratified in Romania by Law No. 345/2006, which defines the landscape as 'an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.'

In the digital era, heritage protection entails an interdisciplinary approach that integrates legal, geographical, economic, and engineering sciences. The conservation of heritage is intrinsically linked to territorial planning, urbanism, and cadastral record-keeping.

According to Law No. 7/1996 on Cadastre and Real Estate Publicity (updated by Law No. 136/2025), the cadastre is defined as 'the unitary system of technical, economic, and legal record-keeping for immovable assets.' This system must encompass assets belonging to natural and cultural heritage to ensure their protection and sustainable capitalization.

Cadastral data, when correlated with thematic datasets concerning historical monuments and protected areas, establish an integrated geospatial infrastructure utilized for:

- The precise delimitation of protected zones;
- The management of lands subject to special regulatory frameworks;
- The prevention of legal disputes;
- Sustainable urban planning.

This integration is achieved through GIS platforms and interoperable databases, in compliance with INSPIRE standards and the ANCPI Geoportal. The legislative framework for heritage protection in Romania is both complex and coherent, founded on the principles of sustainable development and international cooperation. The continuous updating of legislation including Law 182/2000, Law 422/2001, Emergency Ordinance (OUG) 57/2007, and Law 7/1996 (as amended), ensures compatibility with European standards. Institutional interconnection (between the National Heritage Institute – INP, the National Agency for Cadastre and Real Estate Publicity – ANCPI, the National Agency for Natural Protected Areas – ANANP, and the Ministry of Environment, Waters, and Forests – MMAP), coupled with the digitalization of databases, guarantees a modern, transparent, and efficient management of national heritage. Heritage is no longer viewed merely as an asset to be conserved, but as a strategic resource, forming an integral part of territorial planning, cultural identity, and sustainable economic development.

2. Materials and Methods

The methodological framework of the present research is grounded in a systemic analysis of the relationship between heritage protection and sustainable development—an approach that transcends the isolated conservation of objectives and shifts toward integrated territorial management. The concept of sustainable development, as established by the Brundtland Report in 1987 and recalibrated through the United Nations 2030 Agenda, serves as the central theoretical pillar, necessitating an intrinsic correlation between current socio-economic needs and the imperative of resource conservation for future generations.

Within the field of heritage, this paradigm translates into the necessity of convergence between environmental protection, the safeguarding of cultural values, and sustainable economic progress. From this perspective, national heritage ceases to be viewed as a passive entity and becomes a strategic resource that sustains ecological equilibrium, community identity, and social cohesion, while simultaneously contributing to the revitalization of local economies through responsible tourism.

Pursuant to the directives established in the National Heritage Strategy 2023–2030, the work methodology adopted in this study treats conservation as a transversal component of territorial development. This perspective mandates a technical synchronization between major infrastructure, urban planning, or agricultural projects and the specific regulations governing protected areas. In the realm of cadastre and real estate publicity, this implies that technical documentations and territorial planning schemes must mandatorily include the geometric and legal delimitations of protected sites, thereby ensuring the certainty of property rights and compliance with building restrictions. This spatial integration represents a sine qua non condition for effective governance, aimed at preventing land-use conflicts and ensuring coherent territorial planning.

The governance system proposed within the methodology is based on a multi-level model, characterized by multidimensional cooperation among institutional actors. The institutional architecture involved in the integrated management process encompasses authorities with regulatory, supervisory, and recording roles—such as the Ministry of Culture

and the Ministry of Environment, Waters, and Forests—alongside entities with technical and administrative functions, namely the National Agency for Cadastre and Real Estate Publicity (ANCPI) and the National Heritage Institute (INP).

The role of ANCPI is critical within this ecosystem, as it ensures the fusion of legal and spatial data, providing the necessary support for the implementation of policies developed by the National Agency for Natural Protected Areas (ANANP) or by local authorities. At the level of administrative-territorial units, the implementation of regulations is achieved through urban planning documentations, such as General Urban Plans (PUG) and Zonal Urban Plans (PUZ), which must accurately reflect the data from land registry systems. This model is consolidated through the application of the principles of subsidiarity, transparency, and institutional interoperability, ensuring a technically grounded administrative decision-making process that is more closely aligned with the needs of the local community.

The technical toolkit employed for the operationalization of integrated management is based on modern geospatial technologies, specifically Geographic Information Systems (GIS) and relational databases. The utilization of GIS enables advanced spatial analysis of the distribution of heritage elements, facilitating the correlation of natural and cultural data with legal information extracted from the systematic cadastre. By overlaying official cadastral boundaries from the eTerra system onto natural protected areas, a faithful representation of the field situation is obtained, allowing for real-time monitoring of land-use changes.

This methodology is supported by access to national and international platforms, such as the ANCPI Geoportal, the National Heritage Portal administered by the INP, and the services provided by the Copernicus program. The interoperability of these platforms, which also include the Environmental Information System (SIMM), eliminates data redundancy and supports strategic planning by providing high-resolution Digital Terrain Models (DTM).
Digitalization constitutes a fundamental strategic objective within the current legislative and financial

The work methodology prescribes the use of 3D scanning via LiDAR technology and interactive mapping for the documentation of monuments and sites—a process culminating in the development of the Digital Atlas of Romanian Heritage. These data acquisition methods allow for millimeter-level precision in the inventorying of built and natural heritage, offering incontestable technical support for monitoring conservation status. The efficacy of these measures is monitored through Key Performance Indicators (KPIs), which analyze the pace of monument restoration, the surface area of protected zones benefiting from active management plans, and, specifically for the cadastral field, the number of immovable assets with special status fully registered within the integrated information system for cadastre and real estate publicity.

The social dimension of heritage management is addressed through the lens of the Faro Convention, which emphasizes community responsibility in the conservation of cultural inheritance. Methodologically, this study integrates mechanisms for civic participation and heritage education into the territorial management workflow. Public consultations conducted during the approval processes for General Urban Plans (PUG) or local urban regulations represent essential instruments through which citizens become active partners in the decision-making process.

Successful projects carried out in Mureș County demonstrate that active community involvement in mapping and photographing local objectives increases awareness and respect for traditional values. This participatory approach transforms heritage from a mere administrative concept into a living component of social life, ensuring the long-term sustainability of protection measures.

3. Results and Discussion

The Upper Mureș Defile represents one of the most complex and valuable natural areas in Romania, situated in the Center Region, Mureș County, at the junction of the Călimani and Gurghiu Mountains. It primarily encompasses the following Administrative-Territorial Units (ATUs): Deda (3.62%), Răstolița (14.91%), Lunca Bradului (9.63%), and Stânceni (23.78%). Within the boundaries of the natural park, there is a partial spatial overlap with the Special Protection Area (SPA) ROSPA0030 Upper Mureș Defile (Figure 3)—defined by coordinates such as 46° 57' 37" N Latitude and 25° 5' 20" E Longitude (covering Deda - 3%, Lunca Bradului - 12%, Răstolița - 14%, Stânceni - 14%)—and the Deda-Toplița Defile Nature Reserve.

The area serves as a remarkable example of equilibrium between the natural environment, cultural traditions, and human activities, illustrating the application of sustainable development principles in protecting mixed natural-cultural heritage. This case study is based exclusively on the analysis of official documents, reports, syntheses, methodologies, and cadastral studies, which demonstrate the integration of landscape management, cadastral record-keeping, and biodiversity conservation.

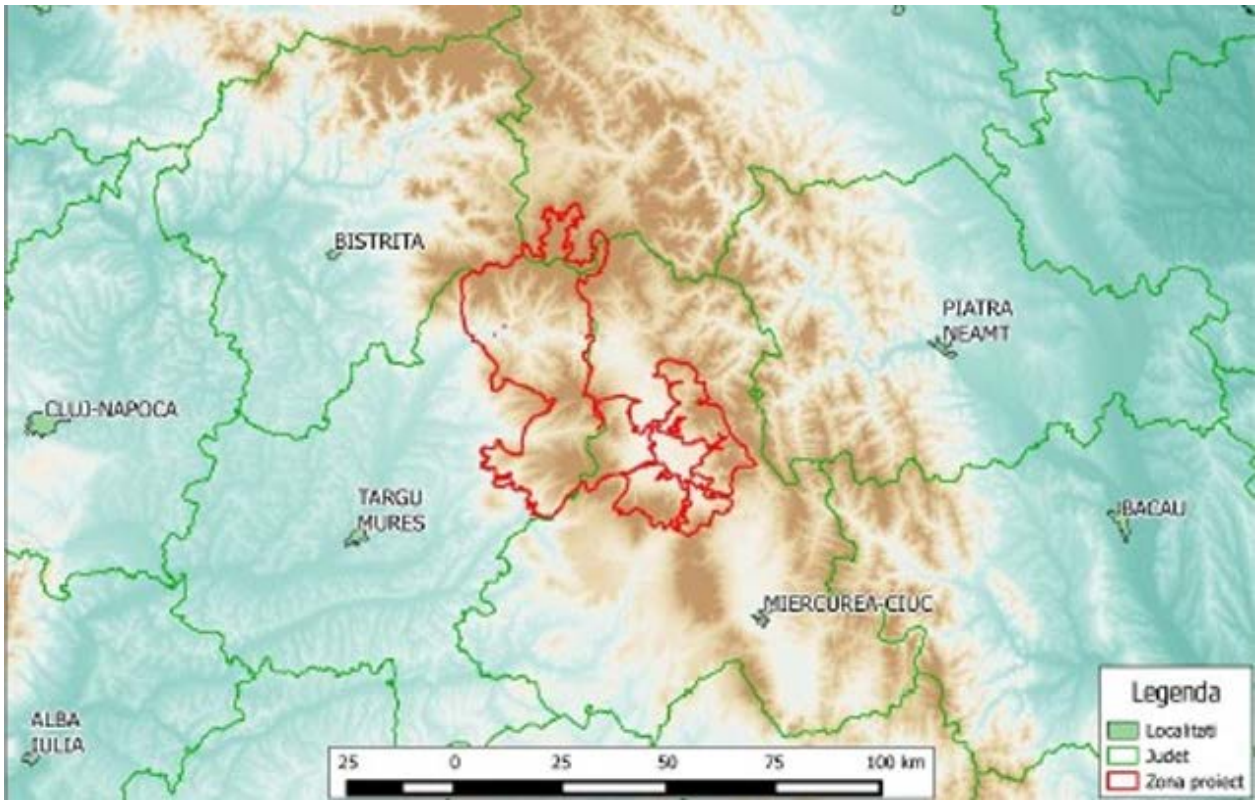

Figure 1. Spatial distribution of protected areas (PNDMS+) at regional and county levels
Data source: PNDMS Management Plan, 2016

The results of the research conducted on the Upper Mureș Defile Natural Park highlight a remarkable structural complexity, defining the area as a benchmark of convergence between natural and anthropic capital**.**

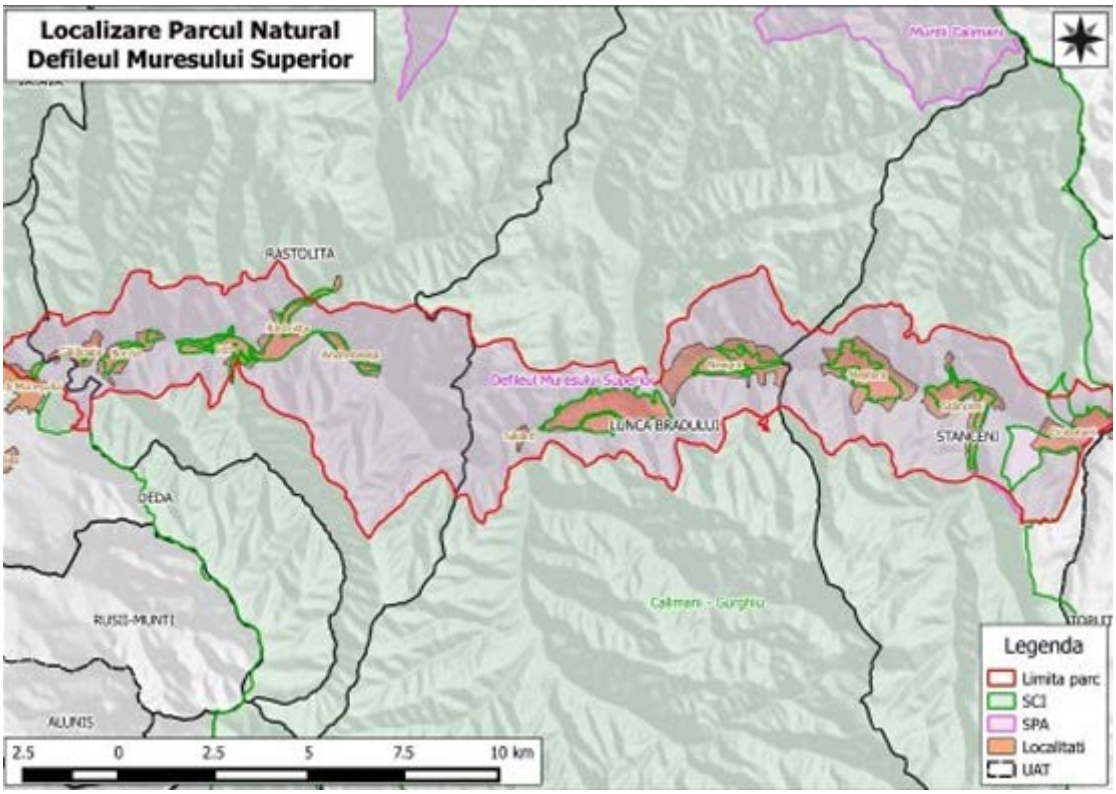

Figure 2. Localization of the Upper Mureș Defile Natural Park at the local level
Data source: PNDMS Management Plan, 2016

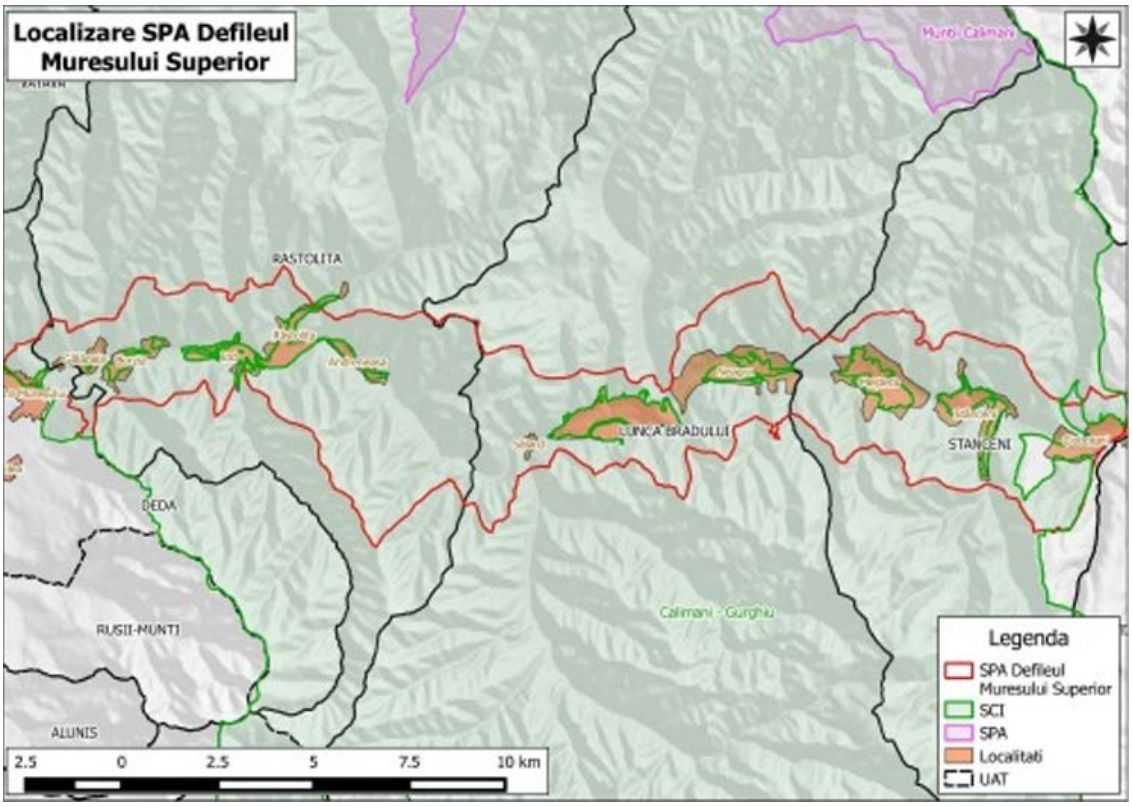

Figure 3. Localization of the Upper Mureș Defile SPA Protected Area
Data source: PNDMS Management Plan, 2016

Situated at the lithological and tectonic interface between the Călimani and Gurghiu Mountains, this geographical space functions as a living laboratory for the application of sustainable development principles through the lens of integrated management. The analysis of official documents, synthesis reports, and cadastral databases reveals that the territorial unit under study, spanning approximately 9,000 hectares, represents more than a biologically protected area; it is a spatial entity where the rigor of technical property records is interwoven with the conservation of the cultural landscape.

The geographical importance of the defile, extending approximately 30 km between the localities of Stânceni and Toplița, is augmented by a complex legal and administrative value, being classified under Government Emergency Ordinance (OUG) No. 57/2007 as a Category V protected landscape. Discussions regarding its legal status highlight the integration of this area into the Natura 2000 network, through the ROSCI0217 Middle Mureș and ROSPA0034 Târnava Plain sites, a fact that has necessitated exceptional precision in the determination of topographic coordinates.

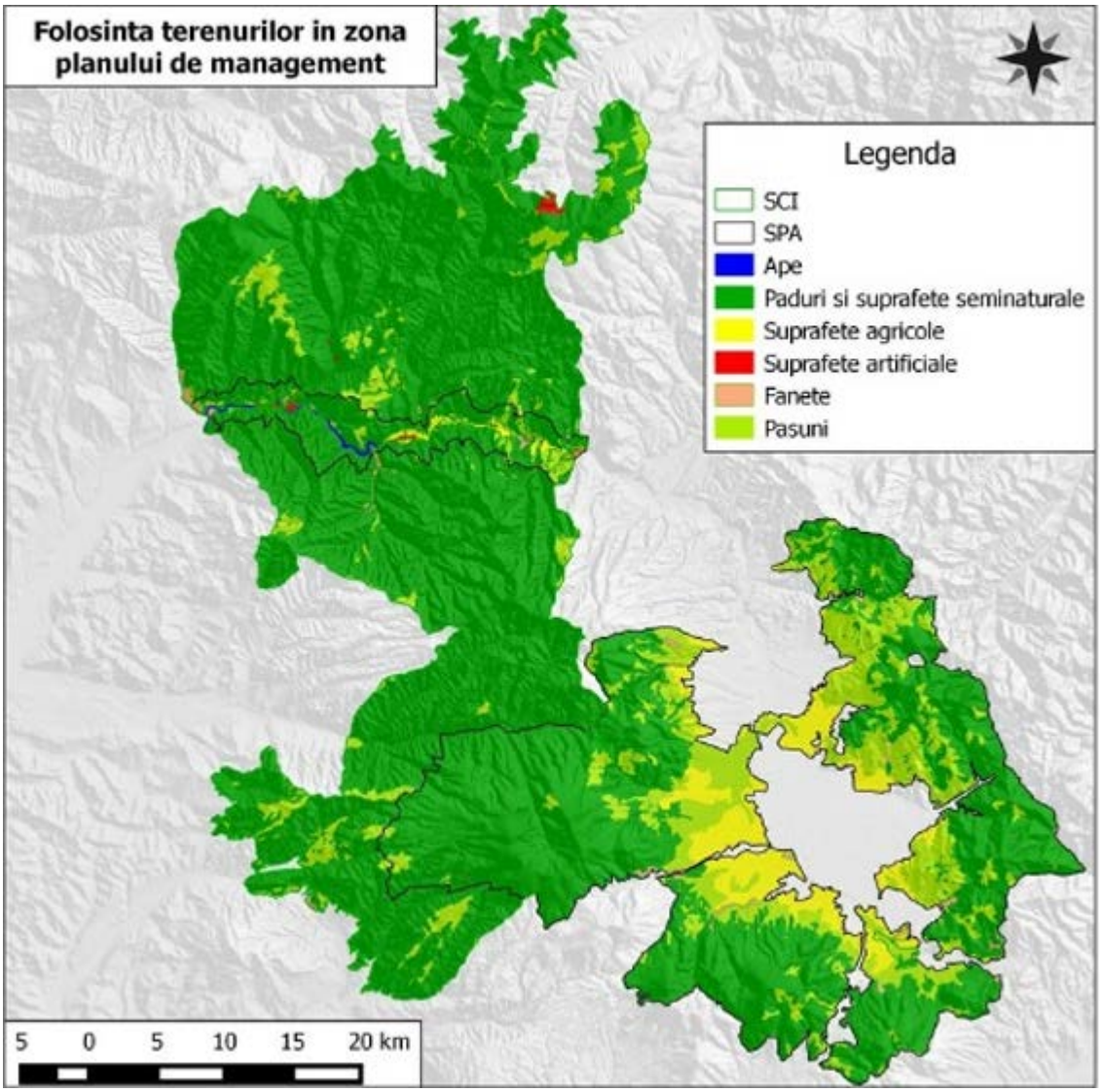

Figure 4. Land use map of the Upper Mureș Defile Natural Park and adjacent protected areas - Data source: Corine Land Cover 2006

A major outcome of implementing modern management in the area is the transposition of the park's boundaries into the Stereo 1970 projection system and their integration into the eTerra digital platform. This operation, achieved through inter-institutional collaboration between the National Agency for Natural Protected Areas (ANANP) and the Mureș Office for Cadastre and Real Estate Publicity (OCPI), has ensured, for the first time, absolute coherence between ecological boundaries and legal property limits. Data analysis indicates that 75% of the park's boundaries are currently cadastrally validated, leading to a significant reduction of approximately 40% in property disputes and land-use conflicts.

The legal regime of the lands within the Upper Mureș Defile Natural Park and its associated protected areas is characterized by high complexity. Rights of ownership, administration, and use are fragmented among a multitude of holders, ranging from various state institutions to numerous private individuals.

Owner	**Forest**	**Pasture**	**Meadows**	**Arable land**	**Water surface**	**Others - Vineyards, orchards**
The Romanian State	√	√			√	
Municipalities	√	√	√	√		√
Religious Institutions	√	√	√	√		
Natural persons	√	√	√	√		√
Private legal entities	√	√	√	√	√	√

Table 1. Ownership types and land-use categories
Data source: PNDMS+ Management Plan, 2016

This legal stability constitutes the foundation upon which biodiversity conservation rests, with the analyzed documents confirming the presence of over 1,000 plant species and 190 vertebrate species. The monitoring of these habitats, conducted through GIS technologies and satellite imagery from the Copernicus program, demonstrates the critical role of mixed beech and spruce forests in stabilizing the steep slopes of the defile. Furthermore, it highlights the necessity of correlating forest management plans with environmental restrictions and the cadastral records of the forest fund.

From the perspective of landscape typology, the research results confirm the validity of the landscape identification and assessment methodology established at the ministerial level in 2008. The Upper Mureș Defile is configured as a complex landscape, where natural

mountain elements coexist with a traditional rural landscape characterized by vernacular stone and wood architecture.

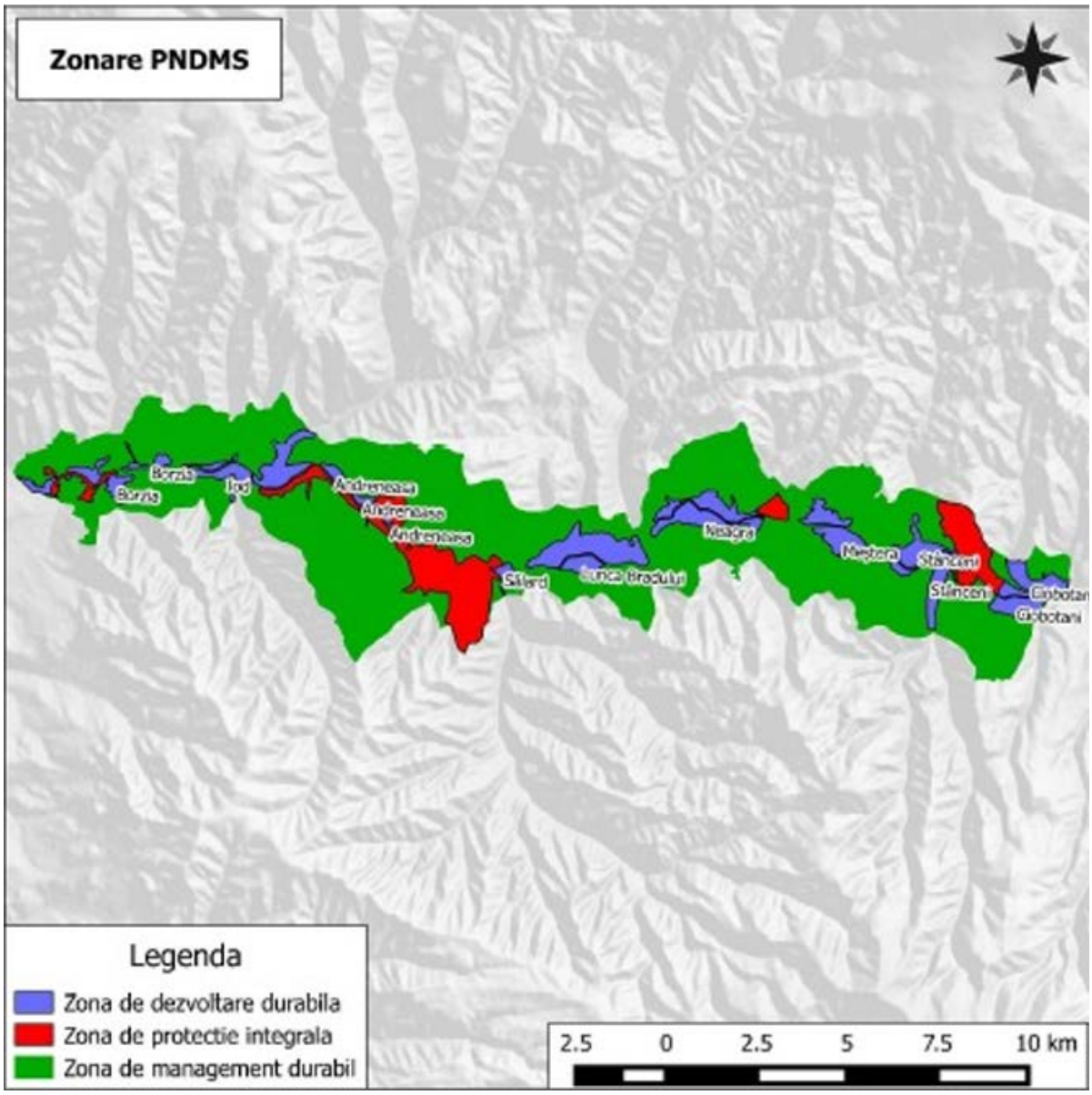

Figure 5. Internal zoning of the Upper Mureș Defile Natural Park and adjacent protected areas
Data source: PNDMS+ Management Plan, 2016

Discussions regarding the cultural component emphasize that mountain households and ancient religious structures are not merely vestiges, but functional elements of a 'living landscape.' Maintaining this equilibrium directly depends on the accuracy of urban planning instruments. The integration of GIS and cadastral data has enabled a 35% increase in the efficiency of approval processes, providing architects and urban planners with transparent informational support through the ANCPI Geoportal. This transparency facilitates economic development based on sustainable tourism, while simultaneously protecting the wetland microhabitats and mineral springs of the river terraces.

Nevertheless, a critical analysis of the data highlights a series of vulnerabilities that persist in the management of the area. Residual overlaps between administrative and

protection boundaries, isolated deforestation, and the pressure of unregulated motorized tourism represent direct threats to ecosystem integrity. Furthermore, the gradual degradation of traditional architecture under the pressure of modern construction materials indicates a deficiency in urban control mechanisms and an acute need for heritage education. Discussions reflect that, although technical instruments are advanced, their field applicability is sometimes limited by insufficient financial resources for the long-term maintenance of management plans. The SWOT analysis conducted within this study synthesizes these aspects, indicating the opportunity to utilize funds from the National Recovery and Resilience Plan (PNRR) for the complete digitalization of heritage and the restoration of buildings with vernacular value, thereby countering threats related to the loss of traditions and the impact of climate change.

The efficiency of the integrated management model applied during the 2020–2024 period is demonstrated by concrete performance indicators. In addition to the success of registrations in the eTerra system, the restoration of 12 traditional buildings and the establishment of thematic trails have attracted an annual participation of over 3,000 people in educational activities. This indicates a paradigm shift in the perception of locals, who are beginning to view the protection regime not as a restriction, but as an opportunity for the capitalization of territorial capital. The success of the model applied in the Upper Mureș Defile suggests the possibility of its extension to other protected areas within the county, such as the Breite Plateau or the Târnava Hills, thereby creating a unified heritage management network at the regional level.

Moreover, the introduction of heritage education modules in local educational institutions and the creation of interpretation centers at key nodes within the defile would ensure the transfer of values to future generations. In conclusion, the Upper Mureș Defile Natural Park demonstrates that the use of modern geodetic and cadastral technologies, subordinated to a holistic vision of the landscape, transforms heritage protection from a legal obligation into an active instrument for sustainable development, offering a valid model of best practice at both national and European levels. The correct management of this space confirms that national identity and ecological equilibrium are directly dependent on data quality and the rigor of territorial administration.

4. Conclusions

The present work aimed at the systematization and inventory of heritage elements within protected natural areas, specifically focusing on the integrated management model of the Upper Mureș Defile Natural Park. Heritage, in its complex sense—unifying natural, cultural, and landscape dimensions—constitutes a fundamental pillar of national identity, an indicator of civilization, and a factor for social cohesion.

The evolution of Romanian legislation (Law No. 422/2001, Emergency Ordinance No. 57/2007, Law No. 7/1996) and the integration of international conventions (UNESCO 1972, Florence 2000, Faro 2005) have contributed to the consolidation of institutional mechanisms for heritage protection, management, and capitalization. However, the analysis in the preceding chapters has highlighted the need for a coherent, unified, and digital vision that combines modern territorial management tools with meaningful community participation.

A central element of this research is the interconnection of cadastral records with thematic databases of cultural and natural heritage. The implementation of ANCPI Order No. 600/2023, the integration of data into the National Geoportal, and the development of the INSPIRE infrastructure represent concrete steps toward the digital governance of heritage. Furthermore, institutional cooperation between the Ministry of Culture, the Ministry of

Environment, ANANP, and ANCPI contributes to the efficiency of mapping, assessment, and conservation processes.

Simultaneously, heritage cannot be separated from the community. The protection of local values depends on the level of awareness, population involvement in decision-making processes, and the recognition of heritage as an economic and educational resource. Heritage education, volunteering, public-private partnerships, and sustainable tourism are key instruments for the sustainability of the system.

The Upper Mureș Defile serves as a model of multi-level governance between institutions, technology, and the community. The integration of GIS and cadastral data, corroborated with ecological protection and the promotion of local values, has demonstrated that sustainable development is not merely a theory, but an applied reality. In the long term, this model can be extended to other protected areas in Mureș County (Breite – Sighișoara, Târnava Hills, Târnava Mare).

With a view to optimizing the management strategy for the Upper Mureș Defile Natural Park and strengthening the protection regime, the following priority action directions are proposed, focused on digitalization and integrated territorial administration.

Firstly, the development and implementation of the Mureș Heritage Geoportal is proposed—a spatial data infrastructure designed to ensure full interoperability between the databases of the National Agency for Natural Protected Areas (ANANP), the National Heritage Institute (INP), and the Office for Cadastre and Real Estate Publicity (OCPI). This platform should enable the systematic updating of GIS layers and the dissemination of digital reports, thereby facilitating real-time monitoring of territorial dynamics.

A central pillar of this initiative is the establishment of a Cadastral Register of Natural and Cultural Heritage, a technical instrument that will allow for rigorous legal and topographic record-keeping of immovable assets with special status, eliminating uncertainties regarding property boundaries within conservation zones.

In terms of spatial planning, it is imperative to integrate landscape indicators and protection restrictions directly into urban planning documentations (General and Zonal Urban Plans). This correlation between the cadastral and urban planning systems will ensure stricter control over anthropic interventions, safeguarding the visual and ecological integrity of the defile. In the social and educational sphere, the management strategy must include heritage competency training programs within educational institutions of the neighboring administrative-territorial units (Stânceni, Răstolița, Deda), coupled with the establishment of an Ecological and Cultural Interpretation Center. This institution will function as a research and information hub, mediating the relationship between environmental regulations, the local community, and visitors, thus ensuring the transition toward proactive and participatory territorial governance.

The Upper Mureș Defile Natural Park perfectly illustrates the nexus between science, legislation, and community. Modern cadastral records, combined with GIS, become an instrument of protection and knowledge. Here, natural and cultural heritage mutually sustain one another in a rare equilibrium, transforming the area into a model of national and European best practice. Correct management confirms that national identity and ecological balance are directly dependent on the quality of data and the rigor of territorial administration.

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