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Article

Assessing Geotourism Resources of the Moldavian Plateau. Case Study: Repedea Geomorphosite

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Abstract. Repedea Hill, located approximately 9 km south of Iași City, Romania, is a site of exceptional geological, geomorphological, ecological, and cultural importance. Situated at the boundary between the Central Moldavian Plateau and the Jijia Hills, the area stands out for its high geodiversity, primarily shaped by Sarmatian limestone formations that create distinctive karst landscapes. Repedea was the subject of Romania's first geological paper written in Romanian, which laid the foundations of Romanian geoscience and advanced the understanding of the Moldavian Plateau's geomorphology.

Despite its scientific significance and remarkable geodiversity potential, the site remains underutilized in terms of geotourism development. This study assesses the potential of Repedea Hill to be integrated into a future UNESCO Global Geopark, focusing on its geoheritage and sustainable valorization. The research combines field surveys with an extensive literature review to evaluate the site's geological, geomorphological, ecological, and cultural features. The findings emphasize the exceptional scientific value of Repedea Hill while identifying major challenges, such as inadequate infrastructure, limited accessibility, and insufficient conservation efforts. Consequently, the paper proposes a set of management and geotourism strategies centered on sustainable development, environmental education, and improved visitor facilities. These include the development of thematic trails, interpretive panels, and a visitor center designed to foster public awareness and ensure the site's long-term protection. Overall, Repedea Hill holds strong potential as a model for sustainable geotourism in the Moldavian Plateau, capable of enhancing the visibility of Romania's geoheritage and contributing to the economic revitalization of one of Europe's less-developed regions.

Keywords: geodiversity hotspots, geoheritage conservation, UNESCO global geopark, Moldavian Plateau, Repedea geomorphosite

Résume. La colline de Repedea, située à environ 9 km au sud de la ville d'Iași (Roumanie), constitue un site d'une importance géologique, géomorphologique, écologique et culturelle exceptionnelle. Localisée à la limite entre le Plateau Moldave central et les collines de Jijia, cette zone se distingue par une géodiversité élevée, principalement façonnée par les formations calcaires sarmatiques qui génèrent des paysages karstiques remarquables. Repedea a fait l'objet du premier article géologique rédigé en langue roumaine, ce qui a posé les bases de la géoscience

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roumaine et a contribué à la compréhension de la géomorphologie du Plateau Moldave. Malgré son importance scientifique et son potentiel géotouristique remarquable, le site demeure largement sous-valorisé du point de vue du développement géotouristique. Cette étude évalue le potentiel d'intégration de la colline de Repedea dans un futur Géoparc mondial de l'UNESCO, en mettant l'accent sur son géopatrimoine et sa valorisation durable. La recherche combine des observations de terrain à une analyse approfondie de la littérature existante afin d'évaluer les caractéristiques géologiques, géomorphologiques, écologiques et culturelles du site. Les résultats soulignent la valeur scientifique exceptionnelle de la colline de Repedea tout en identifiant plusieurs défis majeurs, tels qu'une infrastructure insuffisante, une accessibilité limitée et un manque de mesures de conservation adéquates. Par conséquent, l'étude propose un ensemble de stratégies de gestion et de développement géotouristique fondées sur le développement durable, l'éducation environnementale et l'amélioration des installations pour les visiteurs. Celles-ci incluent la création de sentiers thématiques, de panneaux d'interprétation et d'un centre d'accueil destiné à renforcer la sensibilisation du public et à assurer la protection à long terme du site. Dans l'ensemble, la colline de Repedea présente un fort potentiel en tant que modèle de géotourisme durable dans le Plateau Moldave, capable de renforcer la visibilité du géopatrimoine roumain et de contribuer à la revitalisation économique de l'une des régions les moins développées d'Europe.

Mots-clés: **Z**ones à géodiversité élevée, conservation du géopatrimoine, géoparc mondial UNESCO, Plateau Moldave, géomorphosite de Repedea

Introduction

Geographical research in the Moldavian Plateau has a long and rich tradition, with valuable contributions accumulated over time from multiple disciplines, such as history, linguistics, economics, and anthropology. For the assessment of the geotourism potential of the Moldavian Plateau, the most relevant studies are those emphasizing the geographical dimension. One of the earliest and most significant works remains Dimitrie Cantemir's Descriptio Moldaviae (18th century), which offers comprehensive descriptions of the population, social structures, and settlements. Iași is portrayed as a major political and economic center of Moldavia, confirming its historical importance in the territorial organization of the region (Cantemir, 1973 [1716]). Later, Ungureanu (1985) analyzed the economic and urban situation of Moldavia in the second half of the twentieth century, while Muntele (1998) synthesized the demographic evolution of the region over the past two centuries.

The geological and geomorphological conditions of the Moldavian Plateau have played an important role in shaping human settlements and in the exploitation of natural resources. Recent studies have emphasized both petrographic features (Brânzilă, 1999; Ionesi et al., 2005) and landform evolution (Băcăuanu, 1968; Niculiță, 2020), highlighting the interdependence between the geological substrate and the regional landscape dynamics.

This relationship between geological structure, landform development, and human use has also been emphasized in recent international studies linking geoheritage assessment with sustainable geotourism and landscape conservation (Gupta et al., 2024; Guju et al., 2025; Kubalíková et al., 2025). Furthermore, several reviews have synthesized global approaches to geoheritage and geotourism research,

outlining methodological trends and knowledge gaps (Ólafsdóttir & Tverijonaite, 2018; Herrera-Franco et al., 2022).

In Romania, recent studies have addressed this broad field from multiple perspectives and objectives, focusing on different regions such as Țara Hațegului (Grigorescu, 2020; Guju et al., 2025), the Ciucaș Mountains (Comănescu et al., 2025), the Apuseni Mountains (Ilieș & Josan, 2007; Papp et al., 2023), the Buzău Land Geopark area (Andrășanu, 2010; Comănescu & Nedelea, 2013; Melinte-Dobrinescu et al., 2017), the Trascău Mountains (Cocean, 2011), Dobrogea (Seghedi et al., 2025), or the Ceahlău Massif (Comănescu & Dobre, 2009), among other regions of geomorphological and geoheritage interest across Romania. By contrast, the Moldavian Plateau, and particularly the Repedea Hill area, has not yet been the subject of any systematic geoheritage or geotourism assessment.

These form the structural framework that underpins the diversity of geosites identified in Iași County. The interrelation between geology, landform, climate, water, vegetation, and soils has been constantly underlined, preparing the ground for later human-geographical interpretations focusing on settlement evolution, cultural heritage, and interdisciplinary approaches. Building upon these foundations and on the results of previous research (Anastasiei et al., 2025), the present study aims to correlate the natural potential of the Moldavian Plateau with its valorization through geosites and associated facilities, also considering the growing emphasis on geoheritage education and public awareness at both formal and non-formal levels in Romania (Comănescu & Nedelea, 2020).

For this purpose, an inventory of geosites within the Iași urban area was conducted, and the Repedea Geomorphosite was selected as a representative case study. The analysis integrates field observations with bibliographic data to propose management, conservation, and geotourism development strategies applicable to natural sites located near major urban centers. The paper aims to serve as a methodological model for peri-urban geosite analysis, replicable at both regional and national levels, contributing to a coherent framework for the sustainable management of natural areas surrounding large cities. Accordingly, this paper aims to evaluate the geotourism potential of Repedea Hill as part of the Moldavian Plateau's geoheritage framework.

The aim of this study is to evaluate the geotourism potential of the Repedea Geomorphosite within the Moldavian Plateau by applying an indicator-based assessment matrix adapted from Nyulas et al. (2024), integrating field observation and Geographic Information System (GIS) mapping, benchmarking the results against the Hațeg Country UNESCO Global Geopark, and, based on these results, proposing a site-specific geotourism development and management plan.

1. Methodology

This study followed a six-step methodological workflow integrating field data, literature synthesis, indicator-based evaluation and GIS-supported planning (Figure 1). The steps were: (1) data collection; (2) literature review; (3) indicator selection; (4) evaluation and scoring; (5) interpretation of results; and (6) management and geotourism strategy proposal.

The methodological workflow combined field mapping, literature synthesis, indicator selection, and GIS-supported evaluation. The assessment matrix and weighting procedure were adapted from Nyulas et al. (2024), originally developed for the Hațeg Country UNESCO Global Geopark, and adjusted to the specific context of the Repedea Geomorphosite.

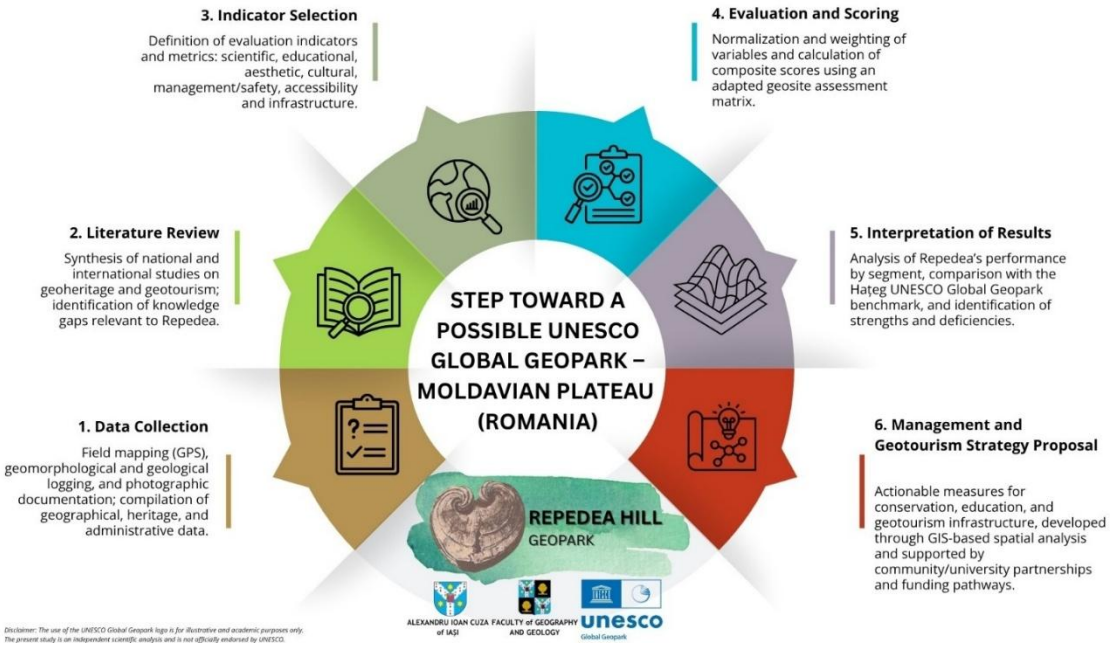

Figure 1. Methodological framework of the study
Source: authors

2. Study area

Iași County and the city of Iași are located in the northeastern part of Romania, forming part of the Moldavian Plateau - one of the most extensive landform units within the Carpatho-Danubian-Pontic region. The county is geographically delimited by the valley of the Moldova River to the west and the Prut River to the east, a configuration that reflects both the monoclinal structure of the Moldavian Platform and the general northwest–southeast orientation of the landform. This positioning provides the county

with a distinct geographical identity, shaped by long-term natural processes as well as by historical and socio-cultural developments.

The administrative surface of Iași County is estimated at approximately 5,476 km², placing it among the medium-sized counties of Romania (INS - Iași County Directorate of Statistics, 2024). The geographical position and the configuration of its boundaries have favored the development of a dense settlement network, particularly in areas of morphological contact and along major communication routes. The spatial relationships among the Moldavian Plateau, Iași County, Iași City, and the Repedea Geomorphosite are cartographically represented in Figure 2, which emphasizes the regional geomorphological framework and administrative configuration. The Municipality of Iași, serving as the county's administrative center, has established itself as the main economic and cultural hub of northeastern Romania, exerting influence well beyond its administrative limits. Its geographic location - at the intersection of natural corridors and historical routes - has been a key factor in the city's continuous development and its role as a regional pole of attraction.

Consequently, the geographical setting and administrative boundaries of Iași County should not be regarded merely as descriptive spatial attributes, but as important factors explaining the diversity of landscapes and the richness of the county's

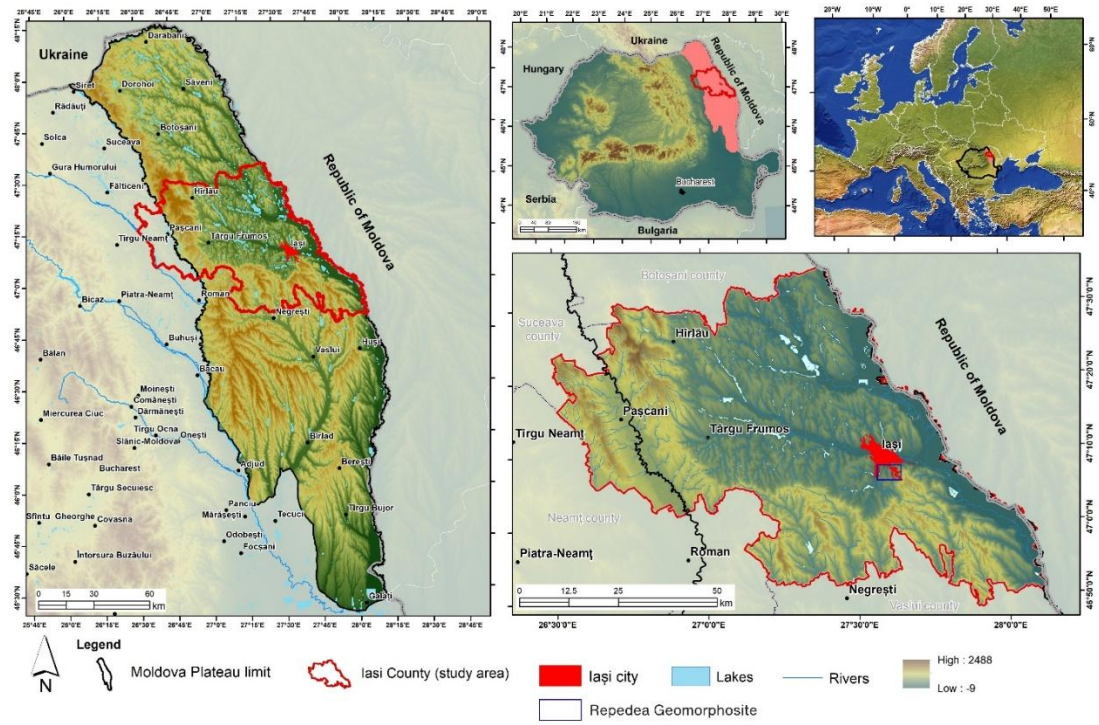

Figure 2. Regional geographical setting of Iași County within the Moldavian Plateau and spatial position of the Repedea Geomorphosite
Source: authors

geoheritage. The area represents a complex natural and cultural environment with significant potential for geotourism development and for integration into regional and national thematic routes.

3. Inventory of Urban Geosites in Iași City

The inventory of urban geosites in Iași City was not an arbitrary undertaking but a structured and evidence-based process built upon three methodological pillars: (i) critical analysis of existing literature, (ii) integration of official databases on architectural and historical heritage, and (iii) field observations to analyze the specific natural and socio-economic characteristics. This integrated methodology, increasingly applied in international geoheritage studies, stresses the need to correlate documentary information with direct field verification (Ilinca et al., 2022; Marjanović et al., 2024).

In the first stage, synthesis works on the architectural and historical heritage of the city were reviewed, together with the official List of Historical Monuments (LMI-IS, 2015) managed by the Ministry of Culture. The second stage involved a geotourism-based selection, identifying those sites where the relationship between natural components-lithological substrate, geomorphological context-and the built fabric is evident and interpretable for educational or touristic purposes. The third stage consisted of on-site inspections, aimed at validating theoretical data, assessing conservation status, and identifying overlooked resources.

A particular emphasis was placed on the building stones used in Iași's monuments, which directly link local geological resources to cultural expression. Four oolitic-limestone samples were analysed (Anastasiei et al., 2025), representing both the natural geological context and its historical applications in the urban landscape. Sample S1 was collected from the Răducăneni - Pârâul Pietrei -Bâzga outcrop (~43 km S of Iași), characteristic of Sarmatian oolitic–oncolitic limestones rich in bioclasts. Sample S2 came from restoration debris at Barboi Monastery Church, used as a representative of the historical construction material. Sample S3 originates from the "Mihai David" Petrographic Collection (collected in 1949 at Goian Hill, 240 m) and serves as a historical reference of local stone types. Sample S4, collected near the Repedea quarry, documents one of the main historical extraction sites providing oolitic limestone to the city's builders.

All samples underwent petrographic and mineralogical analyses. Macroscopic descriptions captured texture and fabric; thin-section microscopy detailed mineral composition, cementation, and fossil assemblages. In samples S1 and S3, microscopic examination revealed oolites and oncolites with diverse nuclei (shell fragments, quartz, bioclasts), alongside microfossils typical of the Bessarabian Sarmatian.

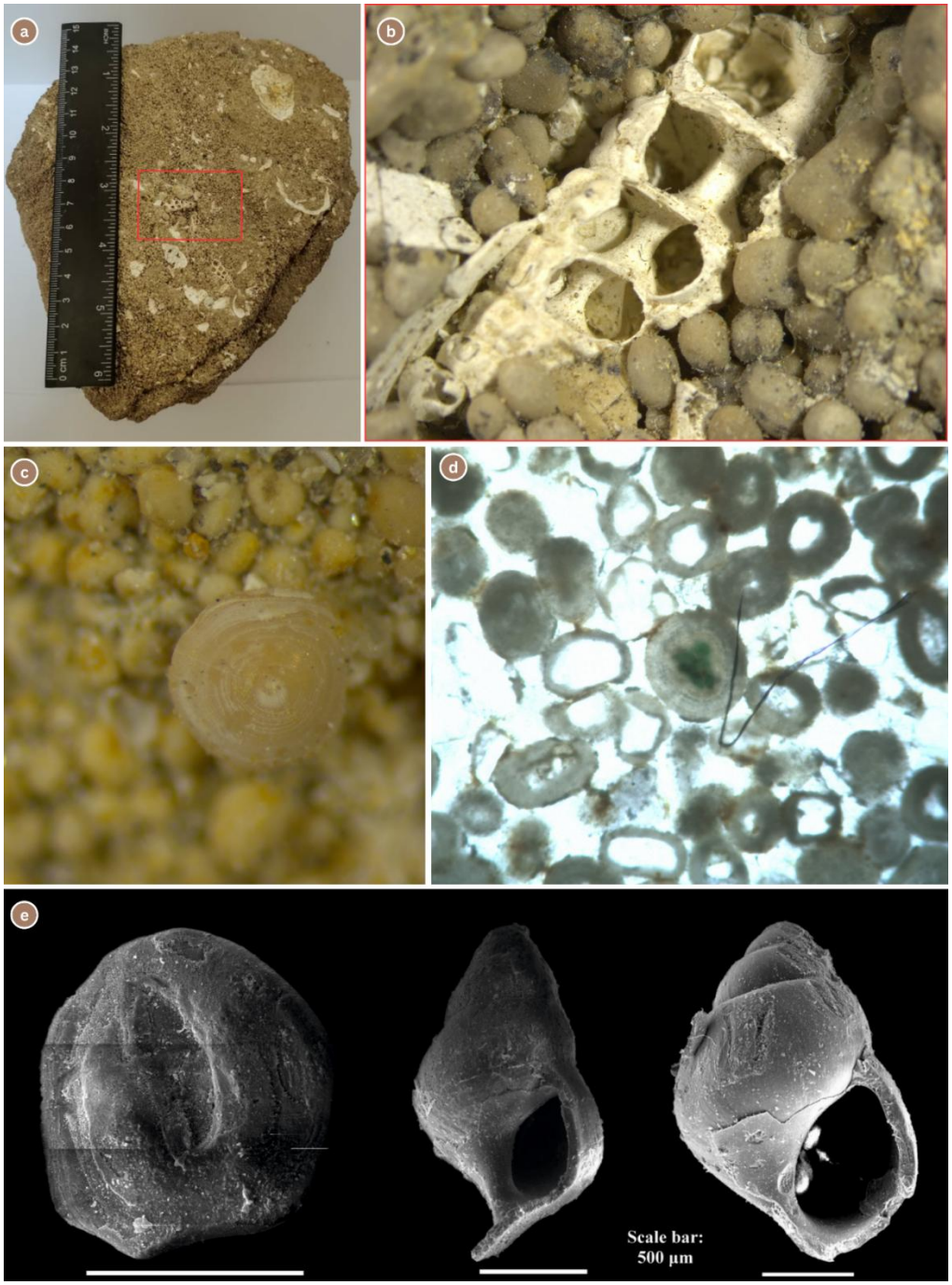

Figure 3. Representative features of the analysed oolitic limestone: (a) macroscopic sample from the Răducăneni outcrop; (b) fossiliferous structures within the oolitic matrix; (c) oncolite with concentric growth; (d) thin section in transmitted light showing oolites with diverse nuclei; (e) SEM images of microfossils – fish otolith and micro-gastropod shells (Hydrobia sp., Pseudamnicola sp.) after Anastasiei et al. (2025)
Source: authors, except (e) adapted from Anastasiei et al., 2025

Additional SEM imagery identified micro-fossiliferous structures such as fish otoliths and micro-gastropod shells (Figure 3).

These results enable a detailed characterization of the oolitic limestone used in Iași's built heritage, linking natural sources (Răducăneni, Repedea) with historic materials (Goian Hill) and restoration fragments (Barboi Church). Historically, the use of local stone was driven mainly by proximity and availability rather than mechanical performance-builders from the 15th–19th centuries relied on what was most accessible (Mihăilescu & Grigore, 1981; Grasu et al., 2002). Quarries such as Repedea, Păun, and Hârlău supplied both dressed blocks for visible structures and fragmented stone for mortars and fillings, showing the close dependence of urban and monastic development on local geological resources (Sandu et al., 2009).

From a spatial perspective, the distribution of the 105 identified urban geosites is fully represented in Figure 4, which depicts their geographical arrangement and current state of conservation. The concentration of sites within the historical core of Iași highlights the city's morpho-functional nucleus and the areas most affected by both natural and anthropogenic processes. Detailed information on 16 representative

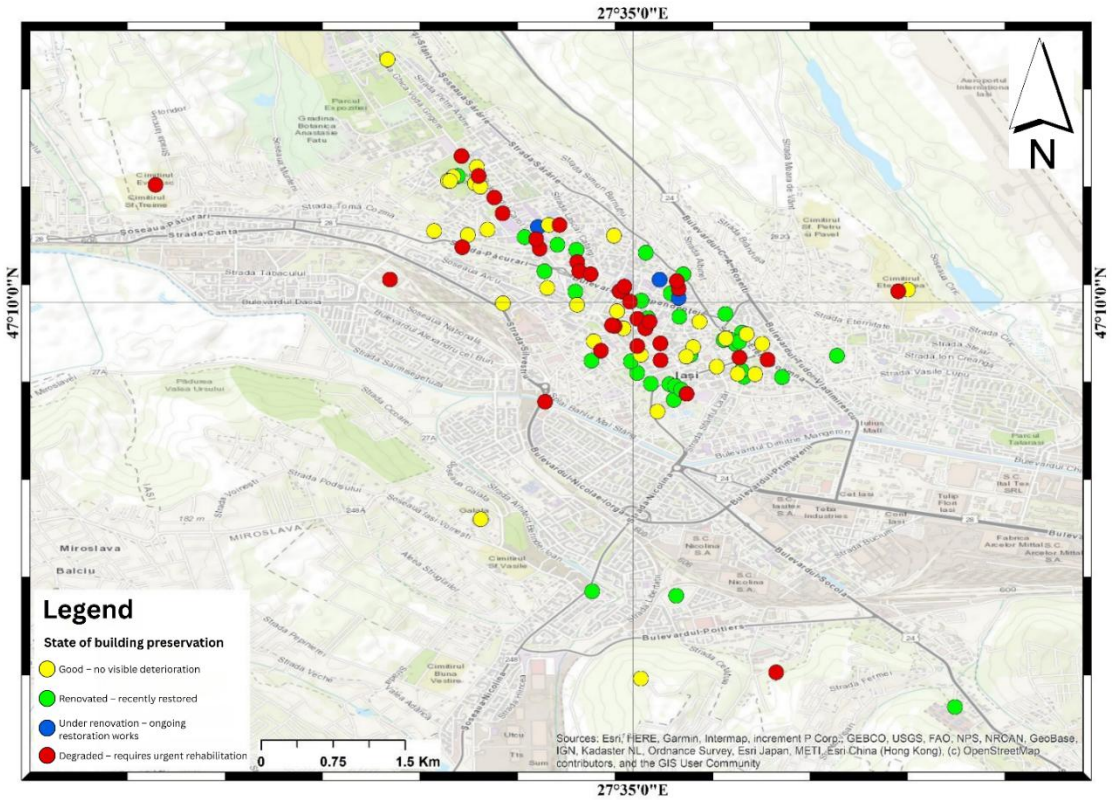

Figure 4. Spatial distribution and conservation state of the 105 identified urban geosites within Iași City
Source: authors

geosites was previously published in Anastasiei et al. (2025). Statistically, around 63 % of the recorded sites (34 restored and 32 in good condition) present a satisfactory conservation state, while 34 % (36 sites) show advanced deterioration, stone loss, or structural risk. Only 3 % (three buildings) are currently undergoing restoration. This classification provides a practical basis for heritage management and geotourism planning, as well as for prioritising interventions.

Beyond documentation, the inventory supports interpretation and valorisation: monuments can be read as urban geosites, combining geological, architectural, and historical narratives. A thematic geotourism trail could, for example, include religious buildings made of local stone (e.g., Barnovschi Church, Metropolitan Cathedral) alongside public and utilitarian structures (e.g., the Stone Bridge over Bahlui, "Alexandru Ioan Cuza" University), each interpreted not only through cultural history but also through the lens of their geological materiality. Similar relationships between geology and built heritage are seen in Suceava and Botoșani within the same northeastern region, and in international cases such as Perugia (Italy) (Melelli, 2019), Lviv (Ukraine) (Bornyak et al., 2020), Rio de Janeiro (Brazil) (Silva et al., 2024), and Kraków (Poland) (Górska-Zabielska, 2023). Thus, Iași fits within the broader framework of geocultural cities, where the local substrate has shaped urban identity.If the inventory of urban geosites demonstrates how local stone shaped the architectural character of Iași, a logical follow-up question arises: from where was this fundamental resource extracted? The spatial coherence between urban geosites and their lithological sources underscores the importance of Repedea Hill as a key node within Iași's geoheritage system. The answer lies in the former network of stone quarries, particularly concentrated in the central-southern area of the county, where Sarmatian oolitic limestones and sandstones outcrop at the surface. The distribution of these extraction sites, with Repedea Hill as the historical and geological core, is shown in Figure 5.

This map clearly indicates that the Repedea area represents both the natural source of building material and a geomorphosite of exceptional scientific and educational value, bridging the geological history of the Moldavian Plateau with the cultural heritage of Iași. The next section therefore focuses on the Repedea Geomorphosite as a distinct case study-one that transcends its role as a quarry to become a symbolic and functional node in regional geoheritage and geotourism networks.

4. Case Study: The Repedea Geomorphosite

Repedea Hill marks the northern margin of the Central Moldavian Plateau, reaching altitudes of up to 407 m at Păun Hill and contrasting sharply with the lower Jijia Hills and the Bahlui Valley, where altitudes drop to approximately 35 m. This prominent

escarpment, commonly referred to as "Coasta Iașilor" ("Iași's Slope") (Ioniță, 2000), provides one of the clearest and most representative exposures of the Sarmatian deposits of the Repedea Formation (Formațiunea de Repedea), first described by Grigore Cobălcescu in his seminal paper Calcariul de la Răpidea (1862). The Repedea Geological and Paleontological Reserve, covering 47.47 hectares, was designated in 1955 as Romania's first paleontological reserve. Its scientific significance was later expanded to include its avifaunal value, with over 117 bird species identified within its boundaries.

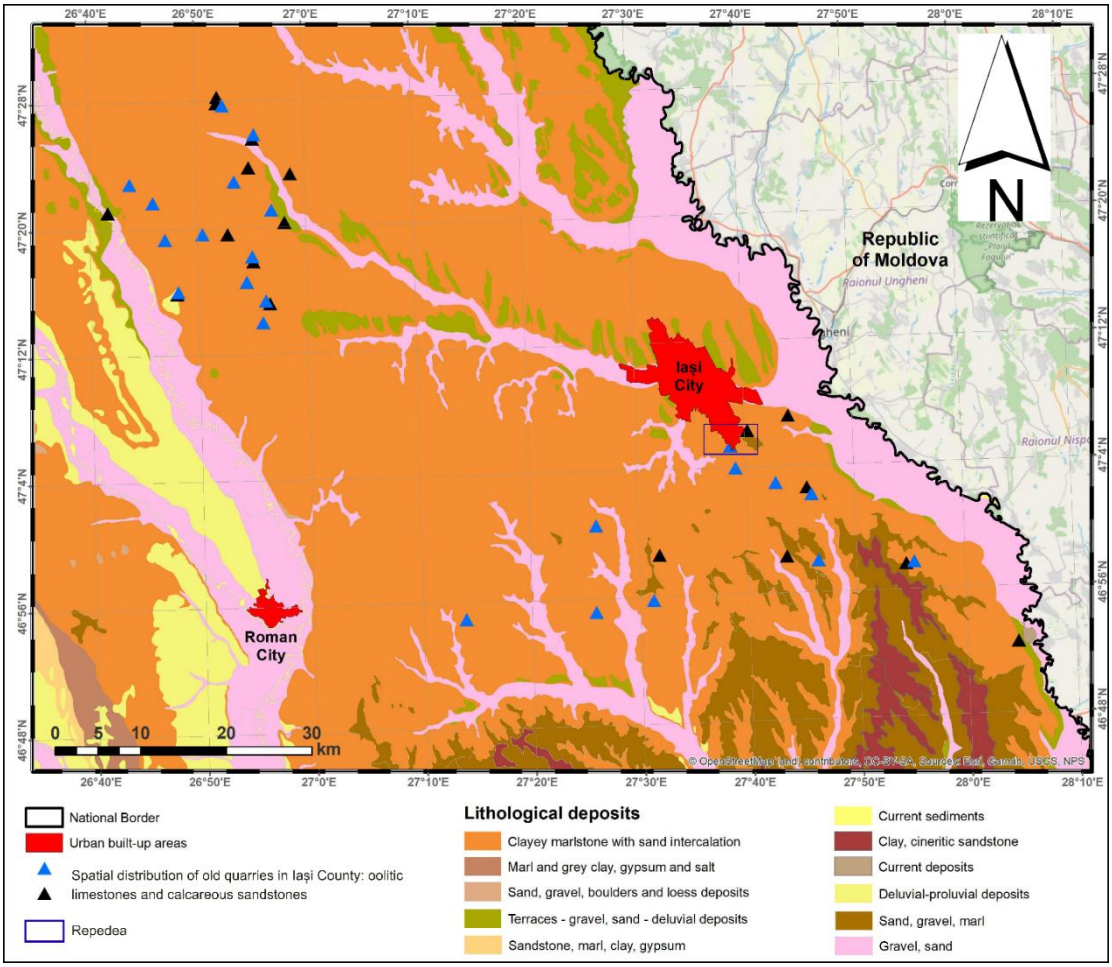

Figure 5. Spatial distribution of former quarries within Iași County: oolitic limestones and calcareous sandstones

Source: Quarry locations from Anastasiei et al. (2025); map compiled and redesigned by the authors

Before proceeding with the detailed analysis of Repedea, it is important to clarify the terminological and conceptual framework that underpins this study. The classification of Repedea as a geomorphosite rather than a simple geosite is not merely

terminological but reflects a methodological orientation that emphasizes morphogenetic processes, landform dynamics, and landscape perception over strictly lithological or stratigraphic criteria. In the field of geoheritage research, geosites are generally defined as locations of geological significance - representing rocks, minerals, fossils, or structural features that document the Earth's history (Brilha, 2016; Gray, 2013). By contrast, geomorphosites highlight landforms as expressions of surface processes, integrating their scientific, aesthetic, and cultural dimensions (Panizza, 2001; Coratza & Giusti, 2005; Reynard, 2009; Reynard & Coratza, 2013). The distinction thus lies not only in the nature of the object but also in the interpretative scale: geosites express geological substance, while geomorphosites embody both the product and the process, uniting form, function, and perception.

Although Repedea was initially designated as a geological and paleontological reserve due to the exceptional exposure of Sarmatian deposits (Cobălcescu, 1862), its current relevance extends well beyond the geological domain. The escarpment known as "Iași's Slope" (Coasta Iașilor), the karstic cavities (Lesenciuc, 2010) developed in oolitic limestone, and the elevated vantage point overlooking the Bahlui Valley represent landforms whose morphostructural and aesthetic characteristics justify their interpretation within the geomorphosite framework. Under clear atmospheric conditions, visibility extends toward the Ceahlău Massif, located in Neamț County within the Eastern Carpathians, approximately 120 km to the west-southwest, further reinforcing the site's landscape significance. In line with the broader theoretical approaches developed by Reynard et al. (2016), Brilha (2018), and Comănescu & Nedelea (2010), Repedea is interpreted here as a geomorphosite of complex value - scientific, ecological, and cultural - where geological history, morphodynamics, and human perception converge within a single territorial unit. This conceptual framing does not derive from regional studies but from general geoheritage methodology, enhancing the site's inclusion within the geoheritage inventory of the Moldavian Plateau and supporting its potential integration in future geotourism and educational programs aimed at the sustainable valorization of peri-urban natural areas.

From a geological perspective, Repedea Hill preserves oolitic and sandy limestones formed through the cementation of molluscan shell accumulations deposited following the retreat of the Sarmatian Sea during the Miocene (approximately 5-7 million years ago). These formations, studied by Cobălcescu (1862) and subsequently by Simionescu, David, and Ionesi (Grasu et al., 2002), have provided essential data confirming the brackish nature of the Sarmatian Basin and have served as a basis for defining the regional stratigraphic framework.

At a broader scale, the Repedea deposits are part of the Paratethyan domain, as represented in the Miocene paleogeographic map (Figure 6). This map shows the position of the Dacian Basin relative to other Paratethyan units and helps to

understand the connection between regional-scale geological processes and the local lithological resource that would later shape Iași's urban and architectural identity.

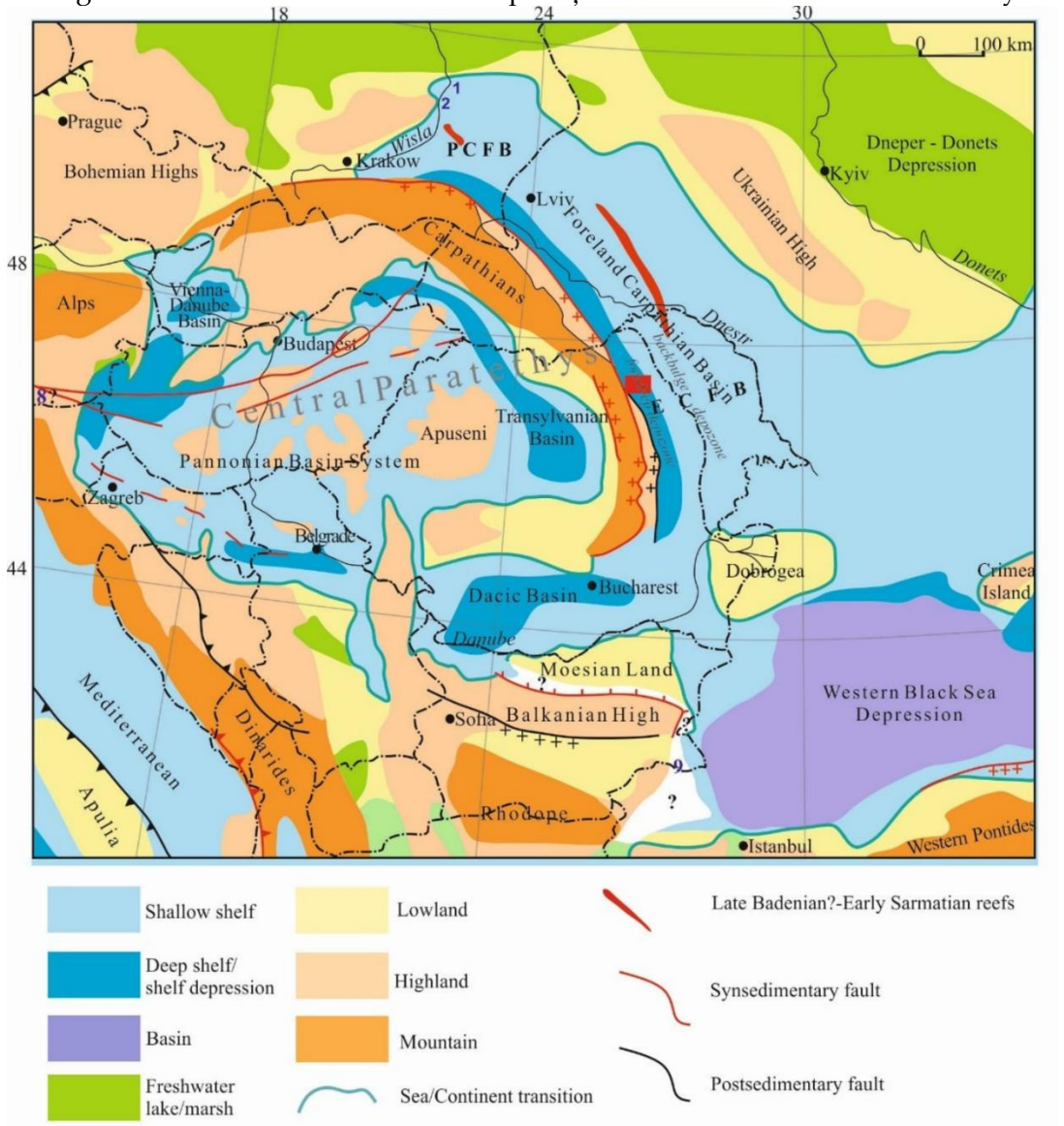

Figure 6. Paleogeographical framework of the Sarmatian deposits within the Paratethys domain, highlighting the position of the Repedea Formation within the Dacian Basin
Source: Loghin (2022)

Historically, the Repedea and Pietrăria quarries provided the oolitic limestone and calcareous sandstone used in numerous buildings across Iași, from religious monuments (Barnovschi, Golia, and the Metropolitan Cathedral) to public and utilitarian structures such as the Stone Bridge over the Bahlui River and "Alexandru Ioan Cuza" University (Mihăilescu & Grigore, 1981; Grasu et al., 2002). The Sarmatian limestone and sandstone thus established a direct connection between the geological

substrate and the city's architectural expression-an aspect also emphasized in the urban geosite inventory presented above.

Beyond its geological and historical relevance, Repedea possesses remarkable geotouristic potential. The site offers extensive panoramas over Iași and the Bahlui Valley, while under clear atmospheric conditions, the view extends as far as the Ceahlău Massif, located in Neamț County, within the Eastern Carpathians, approximately 120 km to the west-southwest. This far-reaching visibility, combined with the area's lithological diversity and geomorphological contrast, enhances its landscape value and interpretive potential. The site's accessibility and the coexistence of geological, ecological, and cultural heritage components make it an important natural landmark suitable for both educational and sustainable tourism activities.

Thematic routes can provide visitors with explanations regarding the genesis of the oolitic limestone, the Sarmatian fossil fauna, and the historical exploitation and use of these lithic resources within Iași's urban landscape. In this regard, Repedea Hill functions not only as a geological and paleontological reference site but also as a key location for developing geotourism in the Moldavian Plateau. The geomorphosite fulfills a dual function: it represents both a historical source of construction material that shaped the architectural identity of Iași and a natural setting suitable for the scientific interpretation of the interrelations between geology, landforms, and cultural development (Sandu et al., 2009).

Situated at the southern boundary of Iași, near the village of Pietrăria (Bârnova commune), the Repedea Geomorphosite occupies a strategic peri-urban position. Its proximity to the city facilitates accessibility for educational and recreational purposes, while its relative isolation preserves the characteristics of a semi-natural environment. This duality enables Repedea to serve simultaneously as a site of scientific investigation and field education-regularly used in university teaching and research-and as a natural protected area with ecological and recreational significance.

The geographical position of the Repedea Geomorphosite within Iași County and its altitudinal configuration are represented in Figure 7, which provides a hypsometric model of the area and its geomorphological context within the Central Moldavian Plateau.

Recognition of the scientific and cultural importance of the site was officially established through Decision No. 8/1994 of the Iași County Council (Iași County Council, 1994), when Repedea was declared a protected area. The administrative framework of the site includes several protection levels:

- the Repedea Paleontological Reserve (4.98 ha), preserving the fossil fauna characteristic of Sarmatian oolitic limestones, of national scientific importance;
- a protective buffer zone (37.55 ha), which also includes strictly regulated sectors: 0.82 ha within the administrative boundary of Iași Municipality and 4.12 ha within Bârnova Commune;

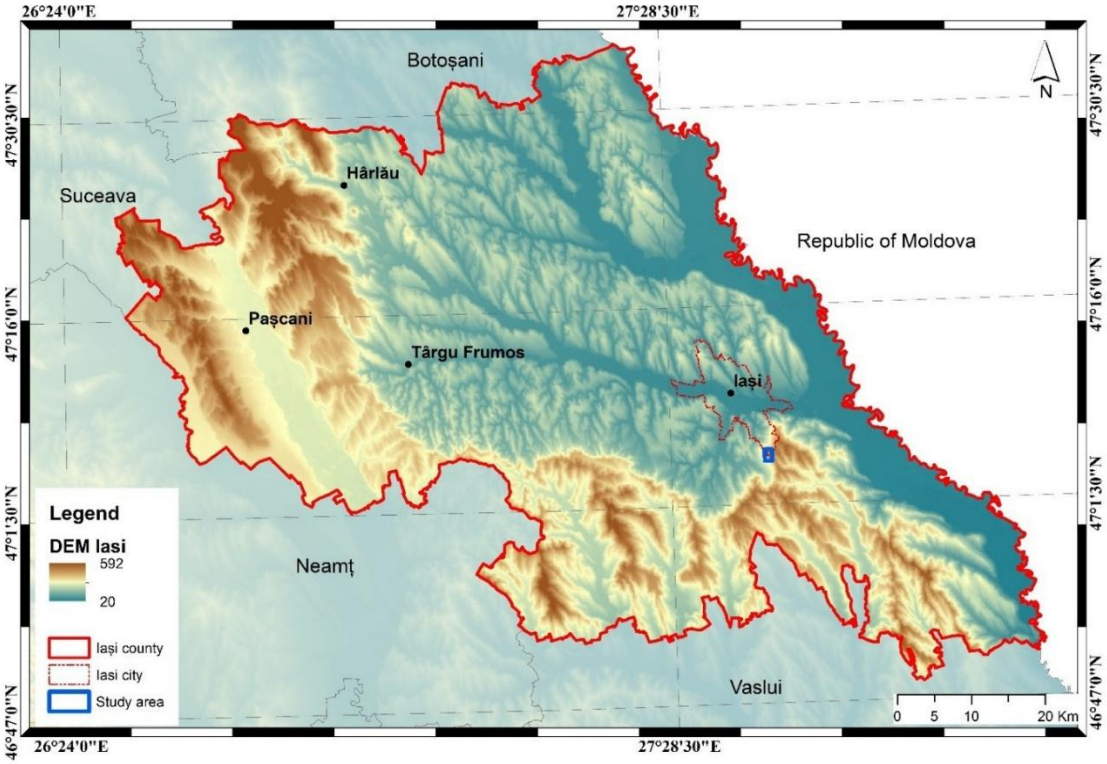

Figure 7. Geographical location of the Repedea Geomorphosite within Iași County (hypsometric model)
Source: authors

• the Repedea-Bârnova Avifaunal Area, part of the larger forested massif of the same name, where 117 bird species have been recorded, out of a total of 383 identified in Romania's fauna.

The administrative delimitation of the site, showing the boundary between Iași Municipality and Bârnova Commune, is presented in Figure 8.

From a morphological perspective, the Repedea site displays a complex spatial structure that can be divided into two main units (Figure 8). The first is the steep escarpment zone, characterized by limestone outcrops, vertical slopes, grottoes, and small karstic caves (Figure 9). These cavities, formed through dissolution processes in the Sarmatian limestone, are of special scientific interest both as geological witnesses and as microhabitats for fauna (e.g., bats and cave-dwelling invertebrates) (Lesenciuc, 2010). The second unit is the plateau zone, formerly used as secondary pastureland but now functioning as a multifunctional space for educational, recreational, and landscape observation activities.

The dual morphological organization of the site is represented in Figure 10, which highlights the spatial contrast between the steep limestone escarpment and the upper plateau surface. The map defines the two main geomorphological units - the

escarpment zone, characterized by grottoes, caves, and forest plantations, and the plateau zone, consisting mainly of secondary pastures.

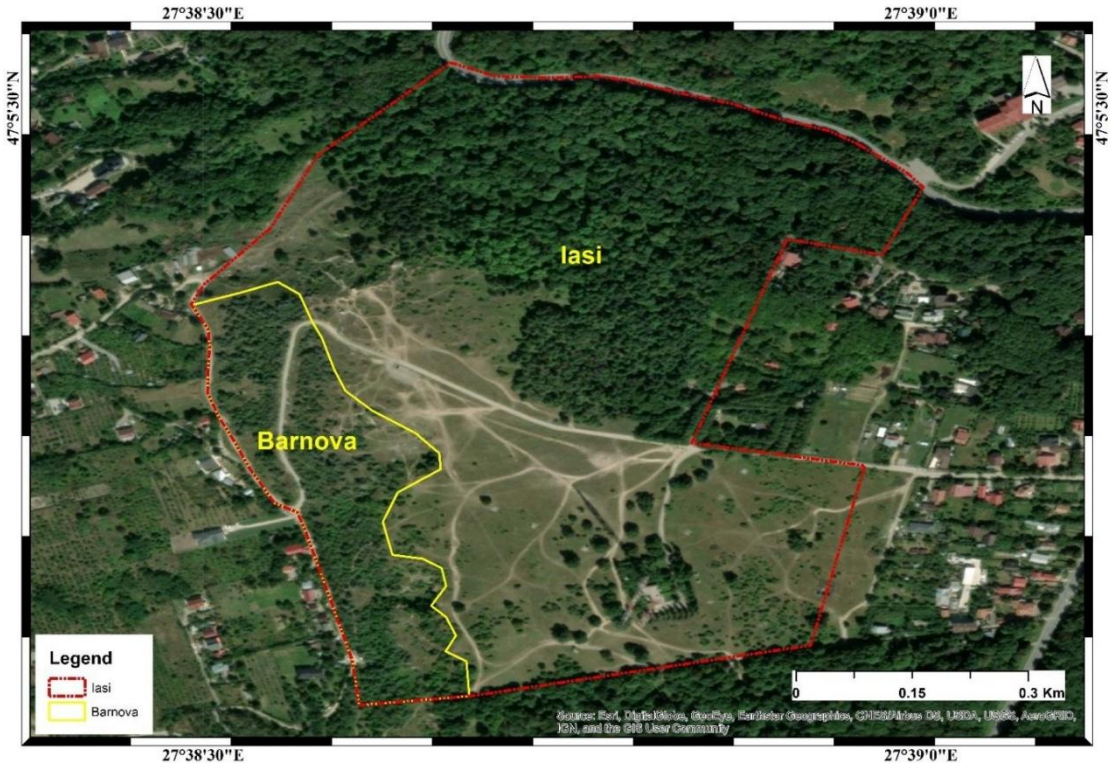

Figure 8. Repedea as a peri-urban space: administrative delimitation between Iași Municipality and Bârnova Commune
Source: authors

This configuration clearly reflects the interaction between geological, geomorphological, ecological, and cultural values. In the escarpment area, the fossiliferous limestones record the evolution of the Sarmatian Basin and stand as witnesses to the beginnings of Romanian geology, initiated by the pioneering work of Grigore Cobălcescu (1862). Meanwhile, the diverse avifauna and silvosteppe vegetation emphasize the ecological significance of the site, while the historical exploitation of limestone for Iași's construction heritage demonstrates its cultural and economic importance (Mihăilescu & Grigore, 1981; Grasu et al., 2002; Sandu et al., 2009).

Consequently, Repedea represents a typical peri-urban geomorphosite, where natural and cultural dimensions coexist, creating opportunities for both research and education while also offering a strong potential for sustainable geotourism. This integrative character makes Repedea a representative space for the geotouristic valorization of the Moldavian Plateau and a natural laboratory that can contribute to the awareness and protection of geological heritage (Reynard et al., 2016; Brilha, 2018).

Figure 9. Representative caves and grottoes developed in the limestone escarpment of Repedea Hill: (a) Peștera Liliecilor (Bats' Cave) – the main karst cavity in the limestone cliff; (b) wooden directional sign indicating the path toward Peștera Liliecilor; (c) interior view of a small grotto showing the opening toward the outside; (d) exterior view of limestone grotto within the Repedea escarpment
Source: authors

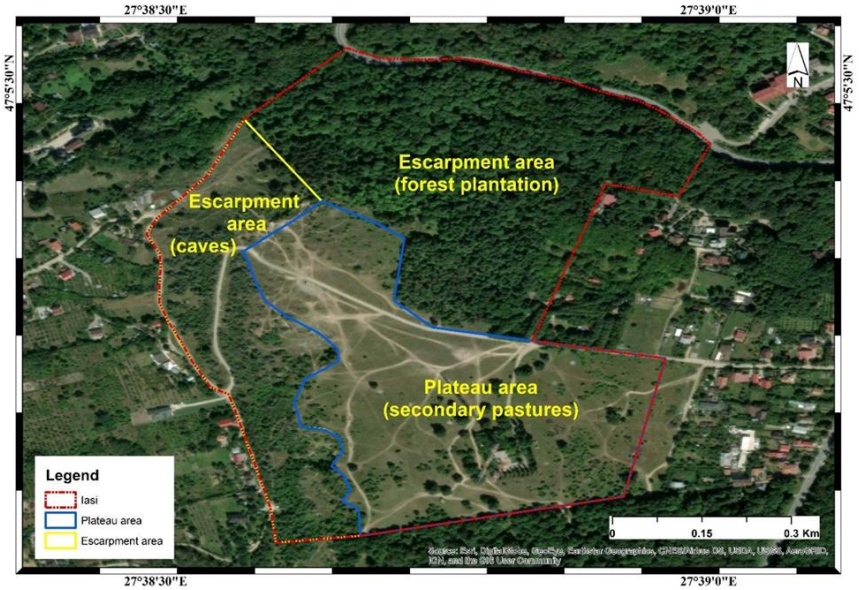

Figure 10. Morphological delimitation of the Repedea geomorphosite: the escarpment zone (grottoes, caves, forest plantation) and the plateau zone (secondary pastures)
Source: authors

Although its status as a protected area provides a legal framework for conservation, Repedea faces numerous challenges caused by anthropogenic pressure (Figure 11). Repeated deforestation in the buffer zone, illegal stone extraction, uncontrolled waste dumping, and overgrazing have led to the degradation of key sectors of the reserve (Dumitriu et al., 2015). Furthermore, the absence of coherent management and appropriate visitor infrastructure has exacerbated the site's vulnerability, gradually diminishing both its landscape quality and its educational and tourism potential.

This situation highlights what may be called the Repedea paradox: a site of outstanding scientific, historical, and geotouristic value, yet still exposed to visible degradation processes. In this context, integrating Repedea within a sustainable management strategy becomes imperative - not only for conserving its geological and natural heritage but also for coherently valorizing the cultural and recreational resources it offers.

Therefore, the case of Repedea highlights the urgent need to integrate peri-urban geomorphosites into regional planning frameworks, ensuring that scientific and educational values are aligned with local socio-economic development.

4.1. Specific geotourism features of the Repedea site

The natural setting of Repedea Hill is defined by Sarmatian oolitic limestones, associated microkarst landforms (grottoes and small caves), and the characteristic silvosteppe biodiversity. Calcareous-soil flora coexists with forest plantations established for slope stabilisation, while the avifauna comprises over 117 species recorded within the wider Repedea - Bârnova area-an assemblage that confers both geological and biological value (Iași County Council, 1994). This combination of geodiversity and biodiversity provides the foundation on which the site's other geotourism dimensions are built.

A distinctive geo-landscape emerges here, perceived through the strong visual contrast between the limestone escarpment - known locally as Coasta Iașilor - and the gentle cuesta backs and valley floors of the Jijia and Bahlui systems (Ioniță, 2000). From the natural viewpoints along the ridge, the city of Iași unfolds at the base of the slope, offering a panoramic understanding of the relationship between geological substrate and urban development. Repedea is therefore not only a place for observing nature but also a cultural landscape where geological resources have been historically exploited and incorporated into local identity.

The scientific value of the site has long been acknowledged. The fossil-bearing limestone at Repedea constitutes the holostratotype of the Repedea Formation, first described by Grigore Cobălcescu in 1862 - a milestone often regarded as the beginning of modern Romanian geology (Cobălcescu, 1862; Grasu et al., 2002). The fossiliferous deposits provided key evidence for defining the brackish environment of the Sarmatian

Sea and for establishing the regional stratigraphic framework, which makes Repedea a reference site of national scientific significance (Figure 12).

Figure 11. The contradiction between Repedea's protected status and the on-site reality of degradation
Source: authors

Building on this scientific foundation, the site's geotourism dimension has naturally evolved. Its peri-urban location ensures accessibility, while informal visiting paths attract students, researchers, and local visitors seeking recreation and environmental education. The panoramic views across Iași, together with the historical use of limestone extracted here for emblematic buildings (Figure 12), strengthen its geotouristic potential and support sustainable tourism based on interpretation and education (Mihăilescu & Grigore, 1981; Sandu et al., 2009).

Repedea should also be seen as part of the broader regional geoheritage network. Its official status as a geological and paleontological reserve, complemented by the protected avifaunal area, confirms its national value (Iași County Council, 1994). Beyond these administrative boundaries, the hill functions as an open-air natural museum, where visitors can simultaneously experience geological processes, historically exploited resources, and a dynamic cultural landscape.

In addition, the site concentrates numerous natural and cultural assets that reinforce its geotourism relevance. Natural features include fossiliferous outcrops, karst microforms, and notable biodiversity - comprising a rare calcicole plant, several invertebrate species, and five species of mammals (including four bats) - as well as forest habitats of European conservation importance (type 9130 Asperulo-Fagetum beech forests) (Lesenciuc, 2010). The cultural dimension is equally significant: Repedea forms part of the emblematic landscape of the Moldavian Hills and serves as a visual landmark for Iași. The limestone quarried here was used in the construction of key monuments, demonstrating the direct connection between the geological substrate and the city's architectural identity (Mihăilescu & Grigore, 1981; Grasu et al., 2002). Moreover, Cobălcescu's studies on these limestones laid the foundations of Romanian geological science (Cobălcescu, 1862).

Figure 12. Representative features of the Repedea Formation and its use in heritage buildings:(a) Repedea Hill escarpment; (b) fossiliferous Sarmatian limestone with molluscan shells (Repedea Hill); (c) Frumoasa Monastery built of local limestone; (d) wall detail showing fossiliferous calcareous sandstone
Source: authors

Finally, Repedea carries symbolic and spiritual meaning for the local community. Landmarks such as "Piatra Sfântă" highlight the site's cultural resonance. Altogether, the natural, scientific, cultural, and symbolic attributes of Repedea turn it into a genuine natural and cultural museum - a key node for education, research, and sustainable geotourism in the Moldavian Plateau.

4.2. Accessibility and existing infrastructure

The accessibility of the Repedea site is primarily determined by its peri-urban position on the southern margin of Iași Municipality. This proximity constitutes a major advantage, ensuring a steady flow of visitors composed of local residents, weekend tourists, and school or university groups. However, the existing access infrastructure and visitor facilities do not meet the standards expected for a geosite of recognised scientific, educational, and tourism value.

Road access is provided mainly by secondary routes, only partially modernised, and by informal paths that favour soil erosion and increase environmental pressure. In the absence of an efficient public transport solution, access relies almost exclusively on private vehicles, resulting in issues such as unauthorised parking, soil compaction, and an increase in waste accumulation. Consequently, accessibility - although high in quantitative terms - translates into significant qualitative pressures on the protected area.

In terms of tourism infrastructure, several initiatives have attempted to facilitate visitation and interpretation of the site, but these have proved insufficient and largely ineffective. A relevant example is the thematic trail "Codrii Iașilor", designed to integrate Repedea within a broader circuit for the valorisation of the region's natural and cultural heritage. While the initial concept aimed to provide an educational and recreational experience through informative panels and observation points, its practical implementation was flawed. The panels, originally made of low-quality materials, did not withstand weathering, and in the absence of regular maintenance were soon destroyed or vandalised.

Later replacements followed the same pattern - constructed from inadequate materials and arbitrarily repositioned without regard for the logical sequence of the trail or a coherent interpretive strategy. As a result, the trail gradually lost its educational function, becoming an example of a superficially applied tourism project lacking long-term vision and administrative continuity.

Another infrastructural element, the wooden viewing platform, was initially designed as a privileged observation point over the city of Iași and the Moldavian Plain. Yet rather than serving as a model of sustainable design, it now reflects the same conceptual and practical shortcomings. The use of untreated timber in an environment already affected by the degradation of forest structures has led to rapid decay. At present, the platform is in an advanced state of deterioration, visibly affected by weather conditions, lack of maintenance, and acts of vandalism (graffiti, litter). This situation epitomises the Repedea paradox: a legally protected area of high scientific and educational value, yet lacking the adequate infrastructure needed to support responsible conservation and valorisation.

The contrast between declared intention and on-site reality thus becomes a critical point in analysing accessibility and infrastructure. While conceptually these

projects sought to integrate the site into a sustainable, education-oriented geotourism framework, their deficient implementation and lack of administrative continuity have led to opposite outcomes: degraded facilities, poorly maintained trails, and low public awareness.

Overall, the combination of high accessibility with insufficient and poorly maintained infrastructure creates a structural imbalance between the site's tourism potential and its current management reality. For Repedea to become a model of responsible geotourism, a paradigm shift is required - toward durable infrastructure (clearly marked trails, weather-resistant interpretive panels, viewing points built from treated and sustainable materials), integration with public transport routes, and the development of permanent educational programmes.

Only through a coherent and integrated approach can the site fully realise its role as a peri-urban geosite - offering high-quality educational experiences and serving as a model of best practice for regional geotourism in the Moldavian Plateau.

4.3. Conservation and tourism management strategies

Although Repedea benefits from protected area status, field observations reveal ongoing degradation caused by deforestation, vandalism, and the lack of visitor infrastructure. To ensure its sustainable valorization, it is necessary to establish or assign a responsible institution to coordinate conservation, access control, and environmental monitoring, while rebuilding the thematic trail and viewing platform using resistant materials and installing informative panels. Accessibility should be improved through better public transport and bicycle routes to limit car traffic and reduce pressure on the protected area. Education and community involvement also play a key role, through guided tours and partnerships with local schools, universities, NGOs, and residents that can strengthen awareness and shared responsibility for conservation. Additionally, funding should be sought through European environmental and tourism programmes to support infrastructure and management efforts. By integrating these measures into a coherent plan, Repedea can become a model peri-urban site that combines scientific research, education, and sustainable geotourism.

4.4. Geotourism development proposals for the Repedea site

Integrating the Repedea site into a coherent geotourism circuit requires a complex approach that balances natural and geological conservation with responsible educational and recreational use. The proposed plan focuses on developing sustainable infrastructure capable of ensuring controlled accessibility, scientific interpretation of key features, and diversification of visitor activities (Figure 13).

Access and mobility

Given the site's proximity to Iași City, accessibility could be improved by introducing a dedicated bus line with stops at the main entry points (A1 – Păun village, A2 – Bârnova, A3 – Bucium Motel, A4 – Pietrăria Monastery). A main parking area (P1) should be developed with facilities adapted to visitor flow, while the unregulated parking area (P2) should be removed due to its negative visual and environmental impact. Additionally, a bike rental system could encourage ecological mobility and reduce dependence on personal vehicles.

Roads and paths

The current informal road network requires complete reorganisation. Motorised access should be limited to essential zones, and illegal roads eliminated. Instead, marked pedestrian educational trails should be developed, together with a separate cycling circuit designed to avoid ecologically sensitive areas.

Thematic trails

To highlight the site's diversity, three thematic routes are proposed:

T1 – geological and geomorphological trail, focusing on oolitic limestone outcrops, karst microforms, and escarpment landforms;

T2 – biodiversity trail, centred on silvosteppe vegetation, oak forests, and local avifauna;

T3 – cultural-anthropic trail, illustrating the historical relationship between limestone extraction, Iași's architectural heritage, and the site's present uses.

All trails should include durable interpretive panels, interactive educational materials, and detailed maps.

Functional facilities

In the central area, a multifunctional visitor centre (C1) is proposed, incorporating a reception, a small thematic museum, conference space, research lab, and administrative offices. Complementary to this, a service area (C2) could include a café with a scenic terrace and sanitary facilities.

Recreational spaces

To accommodate diverse audiences, a recreational zone (SA) should be created, including picnic areas, children's play spaces, and small-scale sports fields (mini-football, volleyball, basketball). These should be located at the site's periphery to avoid interference with strictly protected sectors.

Viewpoints

Panoramic observation points should be redesigned using durable and weather-resistant materials, with structures integrated harmoniously into the landscape. These would serve as landmarks for visual interpretation of the geological and cultural connections between the Repedea escarpment and Iași's urban development.

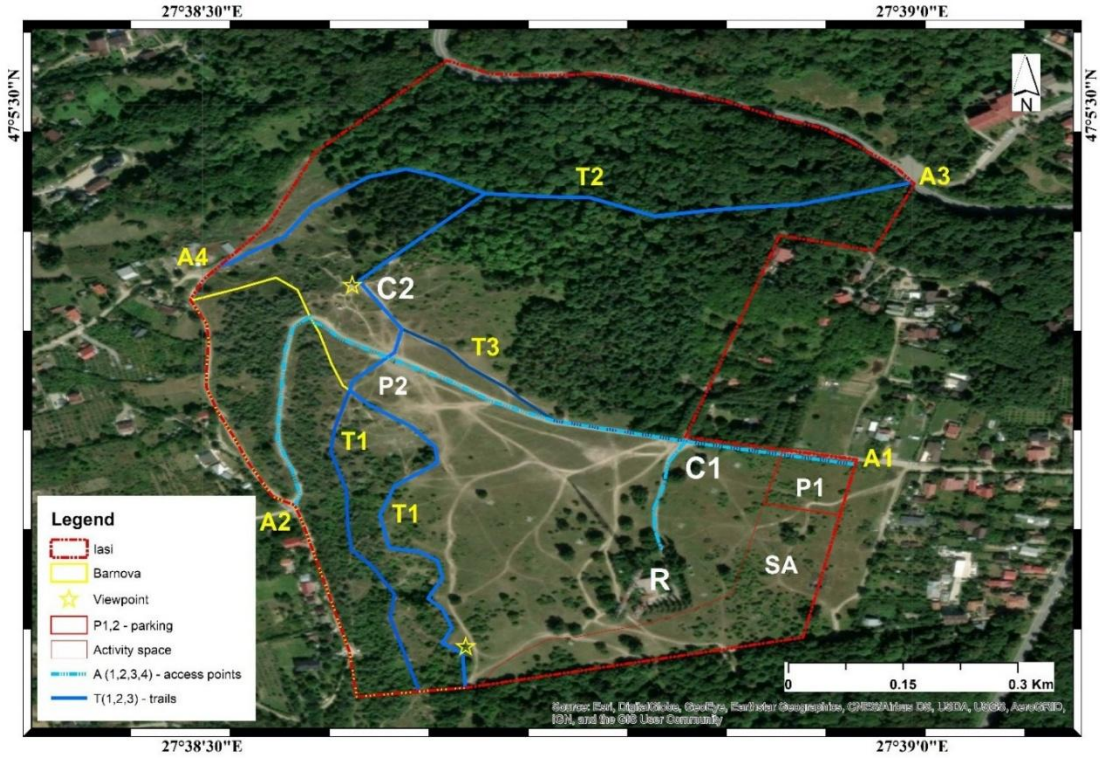

Figure 13. Proposed geotourism layout of the Repedea site (functional organisation scheme)
Source: authors

Through these measures, Repedea could evolve from a vulnerable protected area into a model peri-urban geopark-combining scientific research, public education, and responsible tourism within a coherent and sustainable management framework.

5. Evaluation of Repedea Hill's capacity to become a UNESCO Global Geopark

The capacity of the Repedea Geomorphosite to be included in a future UNESCO Global Geopark was assessed through a comparative, multi-criteria framework inspired by the methodology proposed by Nyulas et al. (2024). The evaluation followed the structure and weighting principles previously applied in national and European studies and used the Hațeg Country UNESCO Global Geopark - Romania's first and most extensively documented geopark - as the benchmark (etalon). Hațeg was selected as a reference model due to its mature management system, balanced integration of geoheritage, biodiversity, and cultural values, and its internationally recognized role in geotourism and education.

The assessment was implemented in several stages, beginning with the harmonization of surface areas and the normalization of all parameters per square

kilometre (Repedea 0.475 km2; Hațeg 1,025 km2). For each indicator, raw values were derived from field observations and literature data, then standardized according to their direction of influence - benefit or cost. The standardization followed the relationships si = Xi / Xmax for benefit-type indicators, which increase with higher values, and si = Xmin / Xi for cost-type indicators, which decrease with higher values, in line with the procedures defined by Nyulas et al. (2024). Each standardized value was then multiplied by its respective weight factor (wi), and the resulting products were summed to obtain the Benchmark Attractiveness Index (BAI), according to the equation:

$$\mathbf{BAI} = \sum_{i=l}^{n} (wi \times si)$$

where s_i represents the standardized score of each attribute and w_i its assigned weight. The complete set of 33 measurable indicators was grouped into nine thematic segments: Geodiversity, Biodiversity, Tangible cultural heritage, Intangible cultural heritage, Accessibility, Infrastructure, Singularity (Rarity), Scientific value, and Safety. Indicator definitions, units, and weights are provided in Annex 1.

The evaluation was carried out for the Repedea Geomorphosite and its officially designated protected area (47.47 ha or 0.475 km2), as defined by Iași County Council Decision No. 8/1994. To ensure strict comparability with the Hațeg Country UNESCO Global Geopark (1,025 km2), all quantitative parameters - such as lengths, numbers, or densities - were normalized per square kilometre. The resulting weighted scores were then summed to determine the BAI, representing the site's overall performance relative to the Hațeg etalon. The results show that the BAI for the Repedea Geomorphosite is approximately 0.572, indicating a moderate-to-good level of attractiveness compared to the benchmark. The distribution of weighted contributions by segment (Figure 14) reveals significant variability between categories. The highest contributions are recorded for Singularity (Rarity) and Geodiversity (each around 0.11), confirming that Repedea's strongest attributes lie in its unique Miocene (Sarmatian) fossiliferous deposits, its remarkable escarpment known as "Coasta Iașilor," and its overall geological and geomorphological significance. These findings are consistent with the site's scientific importance, established since the groundbreaking work of Grigore Cobălcescu (1862).

Intermediate contributions are observed for Biodiversity and Infrastructure (approximately 0.08 each), reflecting the ecological richness of the Repedea - Bârnova forest and the partial existence of interpretive elements such as the "Codrii Iașilor" thematic trail. Safety also contributes significantly (around 0.06), as no incidents or accidents have been reported within the protected area. Tangible cultural heritage (≈0.06) reinforces the connection between the geological resource and the built heritage of Iași, where the same oolitic limestone was historically used in religious and civic

architecture. By contrast, Accessibility (≈0.02) and Intangible cultural heritage (≈0.007) display the lowest scores, highlighting limited public transport connectivity, insufficient visitor facilities, and the lack of recurring educational or cultural events related to the geomorphosite. Scientific value (≈0.04) remains above average due to the site's historical research significance, though it is slightly reduced by the relatively limited number of recent publications and doctoral studies compared to the Hațeg benchmark.

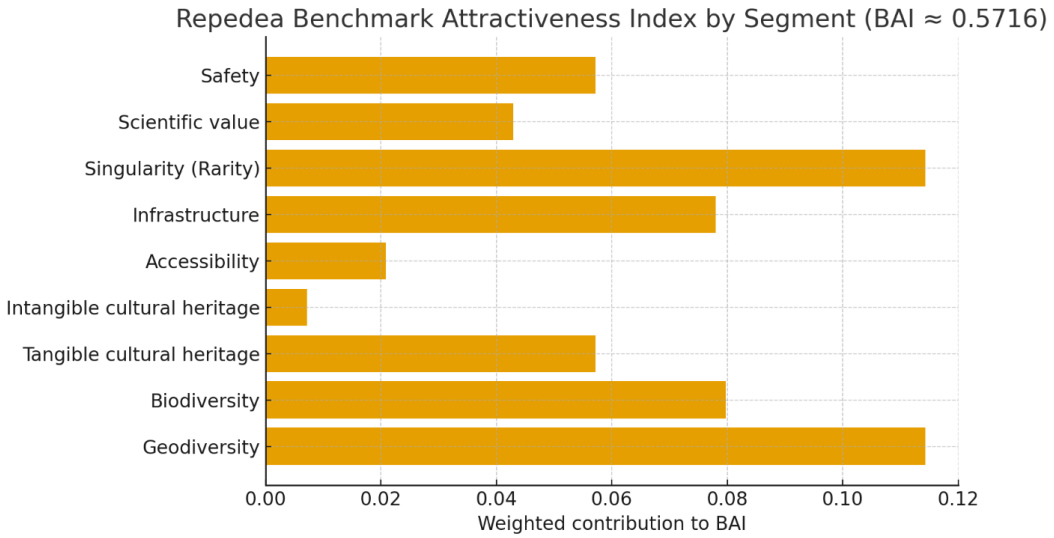

Figure 14. Segment-level contributions to the Benchmark Attractiveness Index (BAI) for the Repedea Geomorphosite. The total BAI (≈ 0.5716) results from the weighted sum of standardized values by segment

Source: authors, based on field data and the evaluation matrix (Annex 1)

A sensitivity test varying all weight factors (wi) by ±10% produced a narrow BAI range (0.558 -0.587), while increasing the weights of the weakest segments (Accessibility, Infrastructure, Intangible heritage) by 20% changed the total BAI by less than 0.02. These results confirm the robustness of the model and show that Repedea's intrinsic strengths - Geodiversity and Singularity - dominate irrespective of moderate parameter variations. Overall, the analysis indicates that Repedea Hill performs very well in the segments related to intrinsic geoscientific value (Geodiversity, Singularity, Scientific value) and environmental stability (Safety, Biodiversity), while it remains underdeveloped in visitor-oriented components (Accessibility, Infrastructure, and Intangible heritage). This imbalance is typical of peri-urban sites where natural and scientific capital is strong but tourism and interpretive infrastructure lag behind. Nevertheless, these are precisely the components that can be improved through targeted interventions.

From the perspective of UNESCO Global Geopark evaluation, which relies on three main pillars - (i) internationally significant geoheritage, (ii) effective management and infrastructure for education and sustainable tourism, and (iii) community involvement and visibility - Repedea already fulfils the first criterion and partially the third, but requires substantial improvement in the second. In other words, the site is scientifically ready but geopark-technically incomplete. To align with UNESCO standards, several strategic measures are recommended: establishing a visitor and interpretation centre, rehabilitating thematic and educational trails, improving public transport connectivity and cycling access, and developing geo-education events and local geoproduct initiatives. Such measures would directly enhance the low-scoring segments and contribute to an integrated visitor experience consistent with sustainable geotourism principles.

If these improvements are implemented, model simulations based on the weighting system of Nyulas et al. (2024) suggest that the Benchmark Attractiveness Index could increase to 0.65 - 0.70, positioning Repedea among the emerging geopark-grade sites in Eastern Europe. The evaluation matrix and graphical outputs (see Annex 1 and Figure 13) therefore confirm that Repedea Hill possesses the geological, geomorphological, scientific, and ecological foundations required for geopark inclusion, and that its transformation into a fully operational geopark candidate depends primarily on infrastructure development and community engagement. Consequently, the Repedea Geomorphosite can be regarded as a scientifically mature but infrastructurally underexploited area, with strong potential to become a reference site for sustainable geotourism and geoeducation within the Moldavian Plateau.

6. Limitations of the study

While the study provides a comprehensive evaluation of the geotourism potential of the Repedea Geomorphosite, several limitations should be acknowledged. First, the analysis is constrained by the small spatial extent of the site and the limited availability of detailed socio-economic and visitor data. Second, the weighting of indicators, although based on established methodologies (Nyulas et al., 2024), still involves a degree of subjectivity. Third, the comparative analysis used a national benchmark (Hațeg UNESCO Global Geopark), which may emphasize differences related to scale rather than intrinsic geotourism value. Additionally, the implementation of the proposed geotourism infrastructure and management measures depends on the availability of adequate financial resources and institutional coordination. This challenge is amplified by the fact that the Repedea site extends across two administrative units - Iași Municipality and Bârnova Commune - which complicates management responsibilities and funding allocation. Finally, future research should

integrate stakeholder perception surveys, long-term GIS monitoring, and multi-site comparisons within the Moldavian Plateau to validate the methodological approach.

Conclusions

The present study demonstrates that the Moldavian Plateau, although often perceived as a touristically underdeveloped region, possesses a significant and underappreciated geotourism potential. The integrated inventory and analysis of Iași's urban geosites have shown that the relationship between geological and geomorphological substrate, built heritage, and cultural identity is both strong and interpretable. The Repedea Geomorphosite, selected as a representative case study, exemplifies this connection in an exemplary way, combining outstanding scientific value with landscape and educational relevance.

The comparative evaluation based on the Benchmark Attractiveness Index (BAI ≈ 0.572) confirms that Repedea has a moderate to high level of attractiveness when measured against the Hațeg Country UNESCO Global Geopark standard. Its greatest strengths are found in geodiversity, singularity, and scientific importance, while the main weaknesses concern infrastructure, accessibility, and the lack of visitor information and educational facilities. Despite these limitations, the geomorphosite already fulfils most of the criteria related to geoheritage significance and environmental stability, proving that it is scientifically mature but geopark-technically incomplete.

Future progress will depend largely on how effectively local institutions and communities coordinate their actions. The development of Repedea into a geopark-grade site requires balanced, well-planned, and consistent implementation of conservation and infrastructure measures, guided by scientific expertise and community involvement. If these conditions are met, Repedea can evolve from a vulnerable protected area into a model of sustainable peri-urban geotourism, demonstrating that the Moldavian Plateau is not a marginal space, but a region with valuable and distinctive geoheritage resources, capable of contributing meaningfully to Romania's national and European geotourism network.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Annex 1

Evaluation matrix of Repedea Hill geomorphosite compared to the Hațeg benchmark

Segment	Criteria	Attribute	Parameter and Units of Measurement	Benchmark Value (Hațeg UNESCO Global Geopark)	Evaluated Value (Repedea site)	Direction	Formula Standardized Value	Weight Factor	Weighted score & Index	Explanation
Geodiversity	C1. Paleography	A1. Range of geological periods	Number of geological periods [#/km2]	0.008	21.28	benefit	1.00	0.0286	0.0286	Unique Miocene (Sarmatian) site with remarkable paleontological value.
	C2. Relief structure data	A2. Geomorphological relief types	Number of items [#/km2]	0.006	42.55	benefit	1.00	0.0286	0.0286	Karst landform with small caves; limited landform diversity
	C3. Protected areas	A3. Geosites	Number of geosites [#/km2]	0.018	21.28	benefit	1.00	0.0571	0.0571	Protected since 1955; paleoclimate evidence preserved.
Biodiversity	C4. Natural reserve	A4. IUCN protected areas	Number of items per km2 [#/km2]	0.009	21.28	benefit	1.00	0.0286	0.0286	IUCN Category IV, part of Natura 2000.
		A5. Protected natural areas	Proportion of land covered by forest [%]	38.16	38.00	benefit	1.00	0.0286	0.0285	Barnova forest adds biodiversity but is fragmented.
	C5. Structural quality indicators	A6. Forest area	Overlay [%]	53.13	53.00	benefit	1.00	0.0143	0.0143	Large forested areas enhance ecological stability.

Segment	Criteria	Attribute	Parameter and Units of Measurement	Benchmark Value (Hațeg UNESCO Global Geopark)	Evaluated Value (Repedea site)	Direction	Formula Standardized Value	Weight Factor	Weighted score & Index	Explanation
		A7. Land cover diversity	Shannon Diversity Index (H)	1.032	0.60	benefit	0.58	0.0143	0.0083	Moderate land-cover diversity; fragmentation reduces heterogeneity.
Tangible cultural heritage	C6. Manmade buildings	A8. UNESCO World tangible cultural heritage site	Number of cultural heritage per km2 [#/km2]	0.001	0.00	benefit	0.00	0.0571	0.0000	No UNESCO cultural heritage.
		A9. Museums, church, monuments, archaeological sites	Number of cultural heritage per km2 [#/km2]	0.08	63.83	benefit	1.00	0.0286	0.0286	Historic monuments nearby, not geopark-integrated.
	C7. Grouping in the territory	A10. Spatial distribution	Density of cultural point groups at d = 1 km	0.027	21.28	benefit	1.00	0.0286	0.0286	Limited cultural groups, moderate density near the site.
Intangible cultural heritage	C8. Traditions	A11. Intangible cultural heritage and traditions protected at national level/international	Number of items per km2 [#/km2]	0.003	0.0	benefit	0.00	0.0571	0.0000	No registered traditions.
	C9. Events	A12. Range of cultural events	Type of events/year [#/year]	4	1.0	benefit	0.25	0.0286	0.0072	Few geology-geomorphology related thematic events.

Segment	Criteria	Attribute	Parameter and Units of Measurement	Benchmark Value (Hațeg UNESCO Global Geopark)	Evaluated Value (Repedea site)	Direction	Formula Standardized Value	Weight Factor	Weighted score & Index	Explanation
Accessibility	C10. Transport	A13. Public transport (Road and rail)	Number of trips/day/destination [#/day/location]	3.95	1.0	benefit	0.25	0.0143	0.0036	Limited public transport connectivity.
		A14. Road and rail networks and associated land	Proportion of land covered by network areas [%]	1.17	0.6	benefit	0.51	0.0143	0.0073	Partial road network, no rail.
	C11. Number of connections	A15. In-links (inside territory)	Number of trips/day destination[#/day/location]	10	3.0	benefit	0.30	0.0143	0.0043	Weak internal links between attractions.
		A16. Out-links (outside territory)	Number of trips/day destination [#/day/location]	0.51	0.2	benefit	0.39	0.0143	0.0056	Poor external tourist connectivity.
Infrastructure	C12. Public information	A17. Visitor center	At least 1/area	6	0.0	benefit	0.00	0.0286	0.0000	No visitor center.
		A18. Information center	At least 1/area	5	0.0	benefit	0.00	0.0286	0.0000	No information facility.
	C13. Signposting	A19. Geologic map	1/area	1	0.0	benefit	0.00	0.0286	0.0000	No geological maps for visitors.
		A20. Entrance panels to the territory	Number of items [#]	1	0.1	benefit	0.10	0.0286	0.0029	Very few entry panels.
		A21. Signage along the roads and/or at	Density of signage [#/km2]	0.043	1.00	benefit	1.00	0.0286	0.0286	Very limited signage in the area.

Segment	Criteria	Attribute	Parameter and Units of Measurement	Benchmark Value (Hațeg UNESCO Global Geopark)	Evaluated Value (Repedea site)	Direction	Formula Standardized Value	Weight Factor	Weighted score & Index	Explanation
		important sites								
	C14. Routes	A22. Sustainable car-free routes	Length of carefree route per geopark territory, Density [km/km2]	0	0.0	benefit	1.00	0.0286	0.0286	Both areas lack such routes (tie).
		A23. Thematic trails	Sum of trails length geopark territory, Density [km/km2]	0.3	21.28	benefit	1.00	0.0143	0.0143	One thematic trail exists; poorly maintained.
	C15. A wide range of excursion offers	A24. Range of tours (geotourism; ecotourism etc.)	Number of items [#]	4	1.0	benefit	0.25	0.0143	0.0036	Few eco/geotourism tours.
	C16. Gastronomy	A25. Organic food and gastronomy (bioproduct-geoproduct and local gastronomy)	Type/number [#]	3	0.0	benefit	0.00	0.0286	0.0000	No geofood initiatives.
	C17. Shopping	A26. Souvenir shop	Number of shops [#/km2]	0.001	0.0	benefit	0.00	0.0286	0.0000	No souvenir shops available.
Singularity (Rarity)	C18. Rarity of geoheritage	A27. Unique geological heritage	Number of sites	1	1.0	benefit	1.00	0.0857	0.0857	Unique Miocene fossil site of high research and education value.
	C19. Geopark	A28. Distance from other geopark	Distance > 100 km	163	300	benefit	1.00	0.0286	0.0286	Geographically isolated; enhances rarity value.

Segment	Criteria	Attribute	Parameter and Units of Measurement	Benchmark Value (Hațeg UNESCO Global Geopark)	Evaluated Value (Repedea site)	Direction	Formula Standardized Value	Weight Factor	Weighted score & Index	Explanation
Scientific value	C20. International value	A29. International importance sites (with international recognition or international publications)	Number of items [#/km2]	0.004	0.0	benefit	0.00	0.0571	0.0000	No internationally recognized sites.
	C21. Research	A30. Scientific studies	5-Within the past five years Sum of academic research: books, articles, academic papers [#]	10	5.0	benefit	0.50	0.0286	0.0143	Several studies exist, but research intensity has decreased.
		A31. PhD thesis	1-Within the past three years	0	0.0	benefit	1.00	0.0286	0.0286	No PhD theses; similar to benchmark.
Safety	C23. Security of the site	A32. Safe place	Incident frequency: Number of incidents/accidents /1000 visitators	0	0.0	benefit	1.00	0.0286	0.0286	No recorded accidents; site is safe.
	C24. Risk	A33. Extreme temperatures (Natural hazard)	Deviation from average temperature [°C]	26	3.0	cost	1.00	0.0286	0.0286	Low climatic variability; negligible hazard risk.
Benchmark Attractiveness Index (BAI) = 0.5715										

Source: authors, 2025; method adapted from Nyulas et al. (2024).