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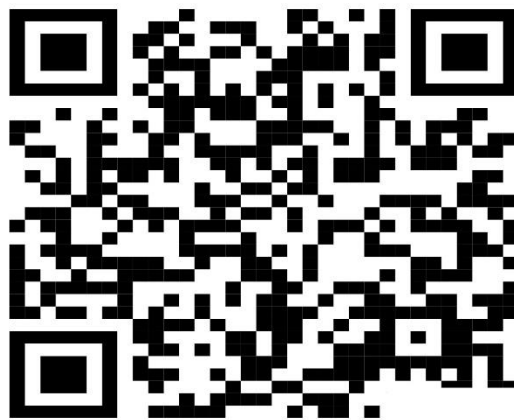


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Enhancing the Elaboration of an Inspiring Mountain Narrative

Thomas Dax  and Ingrid Machold 

Federal Institute of Agricultural Economics, Rural and Mountain Research (BAB), Dietrichgasse 27, A-1030 Vienna, Austria

Abstract. Over the last decades, mountains have been recognized as “sentinels of change” for climate warming trends and global change. The rising attention for local and regional action in mountain areas has therefore not only been oriented at long-standing challenges due to their specific topographical location, but increasingly fostered considerations of resilience and global sustainable development pathways. However, perspectives for mountain regions are overwhelmingly set in bleak pictures of remote and less-favoured areas that fail to catch up with more favourable lowland and central areas. This mainstream narrative is hardly beneficial to nurture emerging concepts of innovative futures and renewed visions for an increased valuation of nature-based assets of mountain regions. This paper intends to synthesize the increasing stock of inter- and trans-disciplinary studies on the complexity of “mountain” development. They argue that research issues need to be focused on a wide range of local to global levels, and underline the need for trans-disciplinary perspectives to understand the challenges for sustainable development. This also implies convincing arguments for a reinforced focus on storylines of mountain agency that regard place-specific assets and enable development strategies that harness the respective potential. This conceptual shift implies policy approaches that highlight the specificity of social-ecological systems of mountain areas and incite actors at the various administrative levels to enlarge their perspectives and raise confidence to shape place-sensitive opportunities of mountain areas.

Keywords: mountain research, rural development, territorial balance, spatial assets, local action

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1. Introduction

Mountains have attained a particular image in European citizens' spatial contemplation, representing wide spaces of supposedly pristine nature, rugged topography, harsh climate, and vast regions for experiencing detachment from industrial and crowded centers. Since they account for about 36 percent of Europe's area (Drexler et al. 2016, 9) and about 24 percent of the Earth's land surface (Price 2015, 3), they have attained increasing interest in the discussion on sustainable development, stepping up over the last decades. Its high relevance is underpinned by the fact that 12 percent of the world's population live in the mountains, and a further 14 percent very close to them (Price 2015, 3). Threats to the ecological quality have been increasingly recognized, particularly with the rise of climate change concerns, and analyses in many mountain contexts led to visions that capture mountains as decisive places for resilience and global sustainable development pathways. They have been addressed as “sentinels of change” (Belmont Forum 2015) and early indicators of “global change” (Price 1999), deserving particular attention due to the wide-ranging and long-term impact of (non) action in these areas for large spaces beyond mountain boundaries.



The strengthened understanding of the need for integration of environmental considerations, particularly articulated since the 1970s, eventually fostered the inclusion of “mountain” themes in global development processes. Thus, specific challenges of mountain areas were addressed in the final Agenda 21 document of the Earth Summit at Rio de Janeiro in 1992 (UN Conference on Environment and Development) as a global challenge (United Nations 1992, Chapter 13: Managing Fragile Ecosystems: Sustainable Mountain Development). “Ever since then, the research remit and activities in many countries of the world increased and focused on a more comprehensive approach” (Dax 2017). The discourse underpinned the perception of mountains as a global heritage value (Chakraborty 2020) that demands particular concern for its future development.

The global relevance of the issue is visible through the declaration of the International Years by the United Nations General Assembly for 2002 (International Year of Mountains) and for 2022 (International Year of Sustainable Mountain Development), which constitute an opportunity and impetus to promote understanding, visibility and targeted action for mountains. The policy debate reflects the increasing awareness of mountain research priorities, highlighting tremendous (global) ecological threats, place-sensitivity and interrelations of mountain ranges with lowland regions throughout all parts of the world. An increasing stock of comprehensive, inter-disciplinary studies has identified the complexity of these “mountain” issues at local to global levels, and underpinned the need for trans-disciplinary perspectives to understand the challenges for sustainable development.

This paper aims to go beyond the research need on the issue and argues about the crucial necessity to change present mainstream arguments on mountain “backwardness”, “disadvantage”, challenges of “remoteness” and “peripherality” and policy “traps” from which no escape is thought to be conceivable. Storylines about mountain development therefore need to be reshaped and emerging “narratives” should take account also of opportunities, local assets, positive effects of mountain action and ecosystem services delivered not just for local communities, but available and essential for societies outside mountain regions as well.

The paper hence will start with an appraisal of the core arguments about misleading representations in current dialogues and underline the need for a renewed, meaningful narrative that might enhance sustainable spatial development. In the following chapter, policy concepts, implementation, and their restricted impact in reducing socio-economic disparities between mountains and lowlands will be presented. In particular, the evolution of policies will be shown as rich in varying concepts, but with weak effects in terms of enhancing mountain development and territorial convergence. The analysis of the mainstream narratives employed so far will point to a set of challenges but also emerging awareness of assets. From this juxtaposition, key criteria for encouraging narratives will be deduced and presented in the following chapter to support discussions on how to overcome policy traps with regard to mountain development policies. Finally, the conclusion will underpin the wide array of recent studies to increase transformation considerations, focus on communication priorities and science-policy exchange to make knowledge sensible for both practitioners and politicians as well as for local and external people.

2. Why we need inspiring narratives for mountain areas

The intensified commitment to analyzing specificities of mountain areas over the last decades underpins the awareness of the array of pressures weighing on mountain regions and attenuating socio-economic activities and future options for locals (Klein et al. 2019). The threats to mountain social-ecological systems discerned by these analyses point to the long-term and often cumulative effect of spiraling-down forces, visible in several dimensions: Pressures are denoted particularly through the mountain characteristics of (i) marginalization, (ii) isolation, (iii), a multitude of hazards, (iv) the spatial divergence of provision and use of ecosystem services (“cross-scale ecosystem services”) and (v) the higher complexity of subsistence-oriented mountain socio-ecological systems.



The complex interactions of mountain ecological, social, cultural and economic drivers are increasingly understood as fundamental building blocks of mountain socio-ecological systems and obstacles to policy and economic changes (Alessa et al. 2018). To sustain the provision of beneficial ecosystem services by mountain areas, the characteristics of complex and “wicked” problems inherent to many coupled natural and human systems of mountain regions have to be seen and taken into account in searching for policy responses (Ariza et al. 2013). Interlinkages in both directions, e.g. water provision for lowlands (Immerzeel et al. 2020) or appreciation of mountains as places of amenities (Moss 2006), untapped potential for renewable energy use (Faraj et al. 2025) and attractive landscapes (Dax and Tammé 2023) are increasingly recognized examples of cross-scale implications.

However, local actors in mountain areas are often peripheralized, and economic and political decisions, in general, are taken by outsiders. Many products and services rendered by mountain people are not appreciated in their full quality and hence not adequately remunerated, or revenues don’t accrue for local providers. Despite the potential realized for mountains, they are still primarily conceived as marginal places, facing regional disparity and challenges which often lead to significant regional development traps (Sarkki et al. 2025). Such conceptual arguments become visible in the continued framing of the predicament of mountains by the following adverse terms: From “global change” challenges (Price 1999), a set of compounded terrific “pressures” inducing a series of “paradoxes” (Klein et al. 2019), through alarming “risks”, “natural disasters” and “hazards” due to climate change processes (Schneiderbauer et al. 2024) to the pervasive governance challenge visible through “weak local governance” in many mountain areas (Tucker et al. 2021), all these concepts underpin a bleak vision of mountain development options. Conversely, designing mountain action that supports sustainable development pathways requires more priority to references addressing the place-specific assets and characteristics that would enhance beneficial future action.

Assessment of policy and rural development strategies reveals that action for enhancement of mountain regions comes to a deadlock if they don’t depart from the still predominating conception of highly polarized spaces. Problems in the peripheralization discourse either dissimulate the challenges by pointing to the diversity of contexts and the “fuzziness” of problem definitions or forestall efforts for shaping sustainable strategies by “bad talking” through framing peripheries “as under-performing economically, specialized in commodity extraction, located far away from the main decision centres, decoupled from the main contemporary processes of development, and subordinate to the core” (Pugh and Dubois 2021, 270).

To overcome these negative perspectives, communication on the role of mountains in spatial development, their interrelation with other spaces, and an awareness of a balanced view of opportunities and threats of these areas seems inevitable. The need to rectify the misleading present mainstream representations of mountain options and tasks is increasingly realized and addressed by recent analyses (Schneiderbauer et al. 2024, Grecchi et al. 2025, Grüner and Gruber 2025). Nevertheless, we should acknowledge that a series of ambitious policy concepts are tackling this predicament and advocate for place-based concepts that foster local perspectives and agency. Initiatives are linked primarily to objectives of territorial cohesion (Dax 2008), smart mountain development (Euromontana 2022) and, most recently, the Andorra Declaration, entitled “Elevating Mountain Action Beyond 2030” (Euromontana 2026). At the global level, the important role of mountains in climate change vulnerability is addressed in a specific chapter of the report of the Intergovernmental Panel on Climate Change (Adler et al. 2022). The concern for place-based and impactful local action is also visible increasingly in widely discussed documents on rural development, in particular the future policy vision of the EC, i.e. the Long-Term Vision for Rural Areas (LTVRA; EC 2021) and ensuing Rural Pact declaration (EC 2024) as well as OECD’s plea “to rethink rural not as the periphery of progress, but as a core partner in a more resilient and equitable global future” (OECD 2025). Even if these declarations of intent of high-level policy documents testify to the integration of place-based concern and balanced territorial visions, there remains an important implementation gap in



the current practice of regional development. This is apprehended as a persistent science-policy gap in addressing promising mountain narratives

Applying place-specific narratives hence would suggest a more balanced account of mountain options, including a promising framework for mountain strategies and action, advocated by scholars from different mountain contexts (Ornston 2021, Dax 2022, Bandyopadhyay 2023). Such a perspective would strengthen mountains as places of community building and attractiveness, and agency options suitable for all societal groups, including newcomers to mountain areas. In this vein, mountain places would be framed differently from former images, and representation should include the following aspects (Dax et al. 2022, 41):

- Priority should be placed on framing mountains as places that conceive attractive living modes, implying a balanced assessment of challenges and opportunities linked to location and context. This would involve acknowledging desires, aspirations, capacities and troubles of all groups of local population, including newcomers and in-migrants, to enable appropriate strategies for participation in community life and personal well-being.
- A particular focus for these places is on empowerment and participation of all inhabitants (Rappaport 1995), taking account of and modifying existing power relations if required for achieving social justice. Transformation should not remain a buzzword encapsulating a rhetorical summary of transition need, but address the multitude of contextual conditions and drivers as well as basic assumptions underlying the implicit understanding of the relevant policy processes (Dax and Copus 2020).
- Mountain places would not be seen as stand-alone locations but rather considered in their interdependence with lowlands and central locations. Mountain-lowland exchange would be an inherent value of appreciating specific functions.

This renewed perception points essentially to the “power” of narratives, and within mountain development, its ability to foster sustainable development pathways (Guske et al. 2019). As Bruner outlines, narratives are not just storylines but might “operate (...) as an instrument of mind in the construction of reality” (Bruner 1991, 6). Describing a number of diverse features of narratives, he particularly underpins the application of “intentional state (ments)”, their function as a “basis of interpretation” of observed agency, their “generic” truth and “normative” value. The hermeneutic nature of narrative shaping implies a tight dependence on context and common “knowledge background” to approve new explanatory stories as valuable paradigms. To accept such a shift in paradigms and achieve appropriate narratives of change (Wittmayer et al. 2019), it needs to respond to the core challenges and convey meaning to local and regional actors why previous theories (of change) should be altered.

For mountain regions, such narratives have to use a positive language, carefully reconsidering the emerging options and presenting visions for a “good life” in mountain places. The focus is explaining change through a convincing narrative that has been elaborated by assessing, in a comprehensive discourse, opportunities and challenges, knowledge and institutional background, and the role and activities of actors in a given place. Such a process implies a strong commitment to “social innovation and an understanding of transformation oriented to empowerment, participation and community development which enhances local strengths and is open to new ideas and exchanges with other places” (Dax et al. 2022, 41).

3. The evolution of mountain policy discourse and respective narratives

Mountains have gained recognition as policy targets over the last century, leading to specific programmes intended to support, respectively secure particular functions attributed to those areas. While these activities were at the beginning rather complementary approaches, conceived to relieve the detrimental effects of extending market forces and primarily complementing deficiencies of restricted competitiveness in mountain and remote regions, more profound concepts by and by gained importance and favoured



“integrated” policy consideration. At the same time, the incumbent policy changes are linked to how mountain development options are perceived, interpreted and designed in explanatory narrative frameworks. In the following, the policy evolution, particularly explicit in European countries, is briefly described, and afterwards interpreted in terms of shifting narratives, leading up to the current state of representation of mountain development issues.

4. Mountain policy evolution

Despite the difficulties in accessing and settling mountains, all over the world they have long been powerful places of awe, attractiveness and fascination to communities beyond the mountains themselves. Coping with ruggedness and harsh climates, valleys and slopes have been settled, and later on mountaineering became an exhilarating appeal of more and more mountain sites (Macfarlane 2003). As market influence and interrelation increasingly extended and reached out to remote areas, pressures on mountain regions altered local economies and called for policy regulation. At the end of the 19th century, forest legislation addressed mountain concerns; then, from the beginning of the 20th century, agricultural policy action began to be conceived, and from the 1970s onwards the commitment to comprehensive integrated policies gained significance (Barruet 1995). There is little awareness and documentation of these early policy activities, but for several decades concerns for “mountain” policy have been addressed by an increasing number of European, and by and by also non-European countries. This led to policy concepts targeting integrated mountain policies, including an integrated perspective of the interconnectedness and combined effects of sectoral policies (forestry, agriculture, infrastructure, mobility, public services, regional and environmental policies, etc.) and a search for territorial cohesion of mountain programmes (Dax 2008). A recent global survey of governance in mountain socio-ecological systems revealed that beyond a few formal regulation concepts (through explicit “mountain policies”), a wide range of informal regulation frameworks is applied (Tucker et al. 2021). Elaboration of respective policy approaches is particularly supported by institutionalization of mountain issues, including a notable recognition in global discourses of human-nature relations. This recognition of the global relevance of mountain sustainable development (Ariza et al. 2013) is highlighted by the declaration of the UN International Years of the Mountains (2002 and 2022), with the outcome of the proclamation of the current “Five Years of Action for the Development of Mountain Regions” (2023-2027).

5. Changing narrative thinking

Since long it is uncontested that managing the Earth’s ecosystems is an interdisciplinary challenge (Daily and Ehrlich 1999). In particular, for the elaboration of mountain resilience strategies and action (Wyss et al. 2022), the awareness of the fundamental services provided by mountain regions (Chakraborty 2020) and the need for the integration of local perspectives through transdisciplinary methods have been underscored (Otero et al. 2020; Ibarra et al. 2023). In order to understand the complex interrelations of mountain social-ecological systems, it is therefore crucial to apply inter- and transdisciplinary methods enabling the elaboration of new narratives on mountain research that address pressing societal challenges.

Few studies have synthesized the spatial practices and policies in the great diversity of mountain regions in a comparative way. In Europe, the first one encompassing the whole continent was carried out at the beginning of the 2000s and revealed the predominance of sector-based policies and fragmented initiatives for mountain areas (Nordregio 2004). Multi-sectoral approaches and/or specific “mountain laws” in some countries and regions underscored the reasoning for place-based mountain development action and enhanced policy coordination (Price 2010) as well as the vision for territorial cohesion (Gløersen et al. 2016).



Table 1. *Divergent Narratives for Mountain Development, with main characteristics and policy focus*

Narrative	Core argument	Challenges	Assets	Policy focus
Less-favourable conditions	Harsh climate and production handicaps for land use	Limited efficiency of agricultural and forest production; difficult market access; hardly adequate scale for market integration	“traditional” images of niche products; alternative options; local examples of aberration	Less-Favoured Areas (LFA) policy; niche markets support
Ecologically sensitive areas	Threat of ecological loss and conservation need due to mountain features	Loss of biodiversity and ecological value; natural disaster prevention	Places of retreat, consumption, countryside and natural experience and awe	Nature conservation policy; Zoning areas of protection
Peripheralization	Difficulties in access, due to remoteness; and obstacles to economic integration and well-being	Ruggedness and remote locations; lock-in and perpetuating downward-spiralling process of economic and demographic decline	Advantages of low-densities and alternative outlines	Territorial Cohesion Policy (CP); infrastructure development, service provision
Land abandonment	Downward spiral of reduction in land use, loss of agricultural and landscape diversity, resulting in out-migration	Outcome of “traditional” views on predominance of high pressures in mountain areas; hardly any counter-acting policy, but rather structural policy as further driver	Relaxation of threat to reduced ecological quality; new options for less-intensive land use systems	Common Agricultural (CAP) and Rural Development Policy (RDP), partly; structural adjustment
Functional exchange	Provision of substantive ecosystem services; interrelation with lowland areas	No market signals for remuneration of ES so far; provider and user are located far from each other and no direct communication; often delayed and long-term effects	Visibility of positive functions and services provided from mountains; transparency of public goods enhances spatial balance and bargaining power	Public goods remuneration; Ecosystem Services (ES) payments; “smart” approaches; mountain-lowland exchange
Local assets and attractiveness	Important assets available, shaping place-specific amenities and attractiveness	Local knowledge of specific assets threatened; embedded in small places, no “economies of scope” applicable; high diversity of place-specific assets and wide range of values of attractiveness	Nature; nature-based resources; landscape diversity and tourist landmarks; concept of atmosphere; adventure and sports	Place branding support; designation of origin and geographical indication; Asset Based Community Development (ABCD)

Source: based on Copus and Dax 2011; and Dax 2022

While mountains have been perceived in vernacular discourse as constant and hardly changing topography, this has never been valid in a long-term perspective (Price 2015). However, the actual perceptions of mountain agency also changed dramatically over the last five decades. A number of different perspectives for addressing mountain challenges and opportunities can be discerned. The list of six particular views on mountains' role emerging over this period indicates the shift in narrative thinking (Table 1). However, the various perspectives on mountain support action are overlapping in time and space. Narratives might be contested by various actors and in different places according to contextual discourse. The perspectives exposed are representative of the most influential views on explaining mountain



development approaches over the past decades, but appear up to now in an overlapping pattern according to spatial and group-specific notions of grasping triggers of mountain policy:

- The first impactful European policy measure for mountain areas elaborated in the 1970s was conceived as agricultural compensatory allowance for Less-Favoured Areas (LFA), thus termed LFA policy and particularly essential for mountain areas of livestock production in the EU and at that period non-EU countries like Switzerland, Austria and Norway. The idea was to alleviate agricultural productivity constraints and higher costs in mountain land management through these (partial) compensation payments (Dax and Hellegers 1999). Later on, this policy instrument was relabelled as Policy for “Areas with Natural Constraints” (ANC), indicating the close relationship to its natural condition as an explanatory factor for production difficulties (EC 2023).
- Already the LFA concept addressed ecological sensitivity of LFAs and mountain areas as main criteria for granting payments, a view that was particularly enhanced through discourses of the 1990s and 2000s on the “rural development” framework, arguing that these areas provided a wide set of essential public goods and ecosystem services, and mountains could be seen as “ecological backbone” (Price 2010; Grumbine and Xu 2011, Nigmann et al. 2018). Valuing the natural characteristics of mountain areas, protection of large areas gained particular significance, often linked to landscape preservation, disaster prevention and ecosystem services provision (Schirpke et al. 2022).
- The discussion also highlighted the differences in policy implementation and revealed low LFA policy realization and impact in regions and countries of highest need. These were in general equated with remote regions and thus learning processes aiming at transformation of knowledge and policy approaches gained increased relevance (Price 2011, 167; Glass et al 2018).
- Some countries called very early for an “integrated mountain policy”, including various sector activities, infrastructure investment, socio-cultural and ecological considerations as key for a joint policy approach, with some of them even achieving a legal framework of a “mountain law” as backdrop of support (e.g. France, Italy, Bulgaria and Georgia). In general, integrative concepts turned into a widely used buzzword and concept (Kotsios 2016), even taken up at EU-level (EC 2009) but with limited implications for policy. Focus on local schemes and implementation remained the rule (McAreavey 2006) and was referred to through the LEADER programme as a “magic” instrument of social innovation in local development (Slee et al. 2023).
- Due to difficult market access and structural obstacles for product elaboration, concepts in mountain areas focused on “niches”, “quality-production”, “geographical indication” (Santini et al. 2013) or enhancing use of place-linked assets through enhancing specific mountain value chains (Smith et al 2026).
- In view of balanced and sustainable development, concern for the multitude of challenges, pressures, and traps of mountain regions is sensible (MARGISTAR COST Action; Klein et al 2019; Sarkki et al. 2025). Mountain regions can only cope with these overwhelming challenges if opportunities are addressed explicitly and functional exchange with lowlands becomes balanced in the sense that non-market services are valued appropriately.

The current predicament is the increasing complexity of challenges due to climate change and the ensuing increase of pressures, risks, and visibility of traps for mountain socio-ecological systems. Building on redesigned narratives that overcome the failures and lock-ins of previous primarily growth-oriented approaches, future action needs to go beyond the nature/society divide and accommodate ecological trends in mountain development patterns. The kind of changes alluded to by this narrative shift intends to overcome failures in theoretical and conceptual considerations based on severe “hidden biases” on primarily economic valuation and quantified estimation of outcomes (Cherif et al. 2024). These ongoing changes



have substantial repercussions also on areas outside mountains, amplifying the perception and need to cope with detrimental ecological and socio-economic changes in mountain regions. One of the strongest examples of the tight interlinkages of mountain and lowland areas is water management of many mountain ranges and the rising threats experienced in lowland areas due to higher fluctuations in run-off, extended periods of drought and, on the other hand, a much higher probability for extraordinarily intensive flood events. It is of outstanding urgency to address the complexity of issues with negative implications for biodiversity, ecological resilience and habitability of mountain areas (Schneiderbauer et al. 2024) to attain sustainable mountain development pathways, and ensure socio-ecological functions for both mountain areas themselves and lowland areas depending on their provision.

The thrust of messages on mountain futures is still characterized by severe challenges of land management and peripheralization processes. Land abandonment (Dax et al. 2021) and out-migration (Copus et al. 2020) are considerable ongoing threats for the majority of mountain areas. Yet, in recent years, a great number of studies have highlighted that a turn in perspective is essential in achieving sustainability goals. Examples of recent EC Horizon research projects underpin the emerging new perspectives on mobility issues, including a rising interest of newcomers in mountain regions (e.g. EC projects MATILDE and PREMIUM_EU), on the crucial role of social innovation in marginal areas (e.g. EC-project SIMRA), the increasing awareness of opportunities of rural regions (e.g. EC-project SHERPA) the potential of new views on shaping mountain value chains (e.g. EC-project MOVING), and the capacity to adapt to climate change and to sustainable and resilient transitions (e.g. EC-projects MOUNTRESILIENCE and RUSTIK). Even if policy support to enhance the provision of public goods and to compensate for the consecutive market failures remains crucial, the recognition and valuation of opportunities for mountain regions becomes ever more decisive. Focus on inherent assets and products and services of mountain areas made available for lowland areas underpins the enormous potential of mountain features for society. Remoteness is thus no longer just a development trap but can become an asset if embedded in adjusted narratives (Dax et al. 2022). Recent narrative considerations put priority on local involvement, fruitful communication, transformative exchange, strengthening of community capacities, awareness and recognition of upland-lowland interrelations, and long-term commitment appreciating place-sensitive assets in mountain areas.

6. Discussion of enabling narratives for mountain regions

As underpinned by the above review of research trajectories, policies impacting on mountain regions primarily first addressed land management schemes (protective forest management and mountain farming support) in order to sustain the viability of sectors and ensure the habitability of these areas, and later on were extended to include more balanced options. Thus, mountain policies are increasingly based on an understanding of extended strategies (Dax 2020, 10ff.) integrating:

- Inter-related biophysical and socio-economic changes
- Importance of linked scales to cope with threats of fragmentation at local scale
- Neither exaggerate multidimensional views of hostile environments, lagging and “backward” societal and economic features, nor idealize pristine nature and tranquility
- Seeing rural amenities as “a wide range of natural and man-made features” (OECD 1999) with potential to divert from growth paradigm (Bina 2013)
- Accepting nature-human inter-linkages as pivotal drivers of desired sustainable development trajectories
- Complementing “endogenous” views with complex inter-related perspectives, encapsulated in ideas of “neo-endogenous development”



- Commitment to inter- and multi-sector policy coordination, multi-level governance arrangements, based on strong institutions and recognition of local specificities and strengths.

An improved understanding of spatial integration of mountain-lowland linkages (water; energy; tourism; climate change effects etc.) is particularly expressed in comprehensive assessments of the complexity of drivers, actors and discussion of opposing scenarios for sustainable futures, as available for the best resourced mountain ranges of the Alps (Chilla et al. 2018) or the Himalayas (Wester et al. 2019).

Considering mainstream narratives and related policy failure and conceiving the desired shift towards perspectives that guide action of sustainable development necessitates an “open” mind for comprehensive assessment of mountain places’ potentials. This implies a deliberate decision to engage in action to change mainstream narratives (Novikova 2025) by carrying out a process that harnesses the “power” of narratives, including their power for socio-cultural changes (Plough 2020). It should be remembered that useful narratives should not be seen as closed systems of strategic views but enhance the intensive exchange of perspectives and views geared towards beneficial local action and provision of public goods for communities at large. The danger of rigid rules of opposing narratives must be avoided. Hence, the following criteria supportive of the envisaged shift would be essential:

- All relevant sectors and local and regional activities have to be addressed and their inter-relations considered in shaping strategies, programmes and future trajectories of mountain regions (Dax 2023). This requires inter-and trans-disciplinary research approaches that combine different viewpoints and research visions (Otero et al. 2020).
- An assessment of the various spatial scales and specific roles and linkages is crucial in assigning particular place-sensitive roles to actors. Any spatial assessment on mountain areas alone should be avoided, and interrelation and exchange aspects with lowlands need to be taken into account comprehensively (Klein et al. 2019).
- Spatial specificities should not be viewed as immutable but contingent on a series of short- and long-term drivers. For mountain regions, many of those influences would deploy over long periods and thus might easily be overlooked; nevertheless, strategic considerations should take account of the dynamic nature of local endowments and interconnectedness of socio-economic evolution (Suitner et al. 2025).
- The focus of addressees should be placed on both internal actors and the wider “audience” of national communities and global structures, implying that the provision of essential goods and services at cross-boundary scales has to be conveyed so as to achieve approval to changed conceptual frameworks, shifts in (support) policies and exchange relations, and implications on influential regulations as well as large-scale value structures (Tucker et al. 2021). Shaping institutional change is hence fundamental to bring about the respective shifts in thinking, theorizing and explaining worldviews of mountain contexts.
- So far, predominant storylines describe spatial relationships as polarized, and mountain regions as dependent areas to be supported “against” general (neoliberal) market forces favouring central locations. This “defensive” notion is deeply enshrined in the consciousness of mountain and lowland populations, hampering visionary concepts and forward-looking activities in mountain areas. A strong embedding of concepts in neo-endogenous approaches might be useful to overcome this lock-in and circumvent action lines that often lead into dead ends (Dax 2020).
- Narratives have to be assessed against balanced views on options for mountain regions. This includes a realistic perspective on structural conditions and institutional bottlenecks, with a wide range of persisting problems and inherent challenges due to particular spatial contexts. Assertions of a technologically neutral playing field between different types of spatial categories seem misleading and hamper any improvement to negative development trajectories. On the contrary, it is essential to expose these structural deficiencies explicitly. However, at the same time, renewed narratives should emphasize the overlooked aspects of place-specific opportunities for mountain regions, in particular



highlighting nature-based assets, amenities of remote areas and all aspects of intrinsic capital linked to these specific areas (Kristensen et al. 2019)

7. Conclusion

This paper starts from the premise that “(t)here is a consensus by both scientific and nonscientific experts that healthy and sustainably managed mountain social–ecological systems play a critical role in contributing to the well-being of both highland and lowland populations” (Schneiderbauer et al 2024, Vol.2, 1). No doubt, public goods and ecosystem services provided by such systems to areas and communities beyond the mountains themselves is widely recognized in all parts of the world as a growing number of studies in different mountain contexts and global institutions underline (Schirpke et al. 2022). Relevant examples range from the great role in providing freshwater and biodiversity hotspots, natural resources and amenities to increasing attractiveness for sustainable tourism experiences.

The core role of mountains in safeguarding nature, ecosystems and sustainable land use is a mantra increasingly diffused by international institutions, taken up by science and evolved over thematic research programmes, deepening findings on long-term societal, cultural and ecological effects. In particular, with climate change challenges, studies on mountain regions' contribution to mitigating the impending threats gained particular global relevance (Adler et al. 2022). The changes required for mountain agency imply a shift in conceptualizing mountains not primarily as defensive places but as places inherently endowed with place-specific options and alternative development pathways. Emerging narratives in this direction should be strengthened to emphasize this potential and provide the underlying foundations for beneficial action and the long-desired turn of downward-spiraling processes.

The review of mountain studies and policies reveals very clearly that policies so far predominantly addressed productivity obstacles of land management schemes (protective forest management and mountain farming support) in order to compensate disparities, relieve sector production weaknesses, and contribute to the habitability of these areas. However, with ongoing market integration and the effects of climate change, the effects of those policies were limited, and threats due to climate change challenges increased both for mountain areas and interrelated lowland areas. Narratives for mountain policy and agency hence require a reconstruction of the notion of place-specific functions and roles of mountain areas. Such a rearrangement would be oriented at extended strategies that would consider the numerous aspects to be kept in mind when shaping frameworks for spatial action of mountain regions (Dax 2020, 10ff.). The most important issues are:

- Assess local impacts as inter-related drivers of both biophysical and socioeconomic changes
- Cope with the superficial view of the double face of mountains, either as “idyllic” places or as “barriers” and hostile environments
- Appreciate “rural amenities” in mountains, through a wide set of natural elements, including wilderness, cultivated landscapes, but also historical monuments and cultural traditions
- Shape understanding of nature–human inter-linkages, to become a pivotal driver of future environmental and socio-economic development
- Complement “endogenous” frameworks through the inclusion of exogenous drivers and the complex role of innovation processes
- And raise commitment and establish consensus for inter-sectoral policy coordination, multi-level governance arrangements, and trans-disciplinary research approaches.

Concluding from this complex array of fundamental issues, narratives for mountain regions do not represent a rigid framework of fixed strategic tools and activities or just extended policy support, but prosper from the discourse of inhabitants of these places and people beyond mountains. Increasing awareness on the different perspectives and views on mountain agency would lead to alternative scenarios and raise the scope of potentials available. The task of conveying the ideas of functional exchange, provision



of essential public goods and services, and hence the specific role in climate change mitigation is at the outset of creating new potent perceptions, convincing narratives and strategic programmes that differ from growth-centered unilateral trajectories that won't change harmful decision patterns and policies. Such a renewed perspective leaves scope for elaborating new explanations, visions and paradigms encouraging the values of remote locations and facilitating mountain development.

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Current Directions and Prospects for Domestic Tourism Development in Azerbaijan

Safar Purhani ✉  and Turay Abbasov ✉

Department of Tourism and Sectoral Economics, Western Caspian University, Baku, Azerbaijan

Abstract. Domestic tourism has become one of the strategic priorities of Azerbaijan's socio-economic development due to its significant contribution to regional development, employment, and the sustainable use of tourism resources. This study examines the current directions of domestic tourism development in Azerbaijan, with particular emphasis on mountain tourism, ecotourism, cultural tourism, and regional tourism potential. The research is based on the analysis of statistical data, official reports, and relevant scientific literature to evaluate recent trends in domestic tourist flows and tourism expenditures across different regions of the country. The findings indicate that domestic tourism has experienced substantial growth over the past decade, despite the temporary decline caused by the COVID-19 pandemic. The analysis demonstrates that regions such as Guba–Khachmaz, Shaki–Zagatala, Lankaran–Astara, and Ganja–Dashkasan have become leading domestic tourism destinations owing to their natural landscapes, cultural heritage, and improving tourism infrastructure. The study also highlights the importance of government support, infrastructure development, service quality improvement, and digital transformation in strengthening the competitiveness of the national tourism sector. The results suggest that the sustainable development of domestic tourism can contribute significantly to economic diversification, regional prosperity, employment generation, and the preservation of Azerbaijan's cultural and natural heritage. The study concludes that continued investment in tourism infrastructure, effective destination management, and the promotion of sustainable tourism practices are essential for ensuring the long-term growth and international competitiveness of Azerbaijan's domestic tourism sector.

Keywords: tourism, regions, mountain, ecotourism, Azerbaijan, digital

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1. Introduction

Recent years have witnessed increasing interest in the development of domestic tourism in Azerbaijan due to its significance as a significant contribution to socio-economic growth. Azerbaijan is known for its natural beauty and culture, landmarks, historical sites, and unique geographical location. Notably, the development of domestic tourism has now become one of the government's priority areas, and several measures have been taken to improve tourism infrastructure, diversify tourism routes, and promote local tourism. Such a sector's growth has also contributed positively to the economy by providing new jobs, triggering local economic growth, and raising living standards throughout the country. Domestic tourism serves as an effective means of utilizing the country's tourism potential within the national market and offers an important alternative to outbound tourism. Azerbaijan's diverse natural resources, varied climatic zones, and rich cultural heritage provide favorable conditions for the development of different tourism segments (Ricapito, 2015). Mountain tourism, ecotourism, cultural tourism, historical tourism, and



recreational tourism are among the principal directions of domestic tourism development (Goeldner & Ritchie, 2012). In recent years, destinations such as Quba, Qusar, Shaki, Lahij, Gabala, and Zagatala have attracted increasing numbers of domestic tourists owing to their unique natural landscapes, historical monuments, and cultural attractions.

The development of domestic tourism in Azerbaijan has brought significant social and economic changes to the region. This sector not only celebrates and disseminates local culture, traditions, and cuisine, but it also stimulates local economies (Page, 2019). The promotion and expansion of domestic tourism create new opportunities and income sources for local communities (Weaver & Weaver, 2006). These are the main determinants for the socio-economic growth of the regions, ranging from tourism infrastructure and hotel and accommodation development to new jobs in the service industry (Hall, 2008).” The Government of Azerbaijan has carried out numerous reforms to promote the growth of this field. By way of this, not only the tourism sector, but also the broader international promotion of Azerbaijan is advancing, as a result of these reforms. In addition to economic development, the domestic tourism sector is becoming an important sector in introducing Azerbaijan’s culture and natural resources to the world and strengthening Azerbaijan’s position in the global tourism market (Telfer & Sharpley, 2002). Tourism activities that promote Azerbaijani culture, language, music, cuisine, and local traditions also play a central role in forming the country’s tourism brand (Swarbrooke, 2002). Therefore, all measures to promote domestic tourism would be of social, cultural, and economic significance

Several critical determinants must be considered to fully understand the expansion of domestic tourism. On the one hand, local people’s attitude toward tourism, the effect of tourism on the regional economies, the presence of modern tourism infrastructure, and the quality of tourism service are very essential aspects. Conversely, the promotion of tourism and the establishment of educational and operational activities for different tourism segments must also be increased. The diversification of various types of tourism, the development of mountain tourism, ecotourism, and cultural tourism, the educational promotion of tourism in local communities, and the education of locals regarding tourism also play a significant role in the sustainable development of the industry (Fennell & Cooper, 2020). While there are unique qualities of each type of tourism and each type of tourism sector has its own distinctive features, domestic tourism as a whole is important to the diversification and development of the economy of Azerbaijan. Accordingly, the analysis of directions in domestic tourism of Azerbaijan reveals that it can be a relatively productive economic, social and cultural sector in the country. Promotion of national tourism as a means of bolstering the country’s status in the international tourism sector is welcome. Any effort in this direction will be favorable to the national economy along with general cultural awareness and social development of the citizens.

2. Analysis

The development of domestic tourism has become one of the priority areas of Azerbaijan's tourism policy in recent years. The continued expansion of this sector contributes to the growth of the tourism industry, increases domestic tourist flows, promotes economic diversification, and improves the socio-economic well-being of local communities. Azerbaijan's rich natural and cultural heritage, favorable geographical location, and diverse tourism routes provide a solid foundation for the sustainable development of domestic tourism. The country's mountainous regions, coastal areas, historical and cultural monuments, and rural tourism destinations possess considerable tourism potential. The continuous development of tourism infrastructure in regions such as Quba, Qusar, Shaki, and Ismayilli has created new opportunities for domestic tourism. These destinations attract visitors seeking to experience natural landscapes, cultural heritage, and authentic local traditions.

Furthermore, state-led initiatives play a pivotal role in fostering the growth of domestic tourism. The Government of Azerbaijan has promoted its tourism and tourism promotion legislation, along with an impressive list of tax holidays, to stimulate the sector. Meanwhile, several projects are being put in place



via public-private partnerships to modernize the nation's tourist facilities and develop new tourist routes. In the past few years, Azerbaijani domestic tourism has advanced significantly. From the statistics displayed in Table 1, the figures show that the tourist industry is taking on a more and more serious part in the national economy. From 2016 to 2020, domestic tourism in Azerbaijan experienced the dual crises of record growth and a severe drop-off due to the global pandemic.

Year	Number of People Traveling for Domestic Tourism Purposes (persons)	Expenditures for Domestic Tourism Purposes (AZN)
2016	3,5 million	2,5 billion
2017	3,7 million	2,8 billion
2018	3,8 million	3 billion
2019	4,5 million	3,5 billion
2020	1,3 million	813 million

Table 1. Domestic Tourism Indicators of Azerbaijan (2016–2020). Compiled by the author

In recent years, domestic tourism in Azerbaijan has developed rapidly. The statistical data presented in Table 1 demonstrate that the tourism sector has come to play an increasingly significant role in the national economy. Between 2016 and 2020, Azerbaijan's domestic tourism market experienced both record growth and a sharp decline as a result of the global pandemic. Azerbaijan experienced the dual crises of record growth and a severe drop-off due to the global pandemic. National tourism numbers show that it started growing from 2016 onwards. In 2016, the number of domestic tourists jumped from 3.5 million to 4.5 million, reaching a record 4.5 million. This is about a 28 per cent rise in the total number of domestic travelers over the four years. It is evident economically as well from even more numbers. The amount of domestic tourism increased from 2.5 billion Azerbaijani manats in 2016 to 3.5 billion manats in 2019 (State Statistical Committee of the Republic of Azerbaijan, 2025). This expansion had been directly attributed to small and medium-sized enterprises' growth in areas such as hotels, restaurants, and transport services (World Bank, 2023).

The year 2020 is considered to be one of the toughest years in the course of tourism in Azerbaijan. Tight quarantine measures, interregional travel restrictions, and health fears were among the main reasons why the domestic tourism industry suffered. Travelers are down 71 percent from 2019 to 1.3 million. Simultaneously, domestic tourism expenditure dropped hugely from 3.5 billion manats to only 813 million manats. This precipitous drop affected thousands of income-earning employees from the sector and highlighted the importance of government support packages for the tourism sector.

Regions	2021	2022	2023	2024	2025
Lankaran-Astara	180,492	238,225	194,198	247,898	255,612
Guba-Khachmaz	176,971	544,623	449,373	604,760	533,763
Shaki-Zagatala	238,201	413,950	435,271	555,399	530,355
Ganja-Dashkasan	128,559	196,236	221,849	234,725	255,336
Mountainous Shirvan	99,856	140,233	153,067	148,462	148,217

Table 2. Source: State Tourism Agency of the Republic of Azerbaijan. Comparative analysis of domestic tourism indicators by year.

Table 2 presents a summary of the most recent statistics regarding the patterns in tourist flow in the regions of Azerbaijan. Rather than looking at each area in isolation, this work is dedicated to analyzing general trends, the growth of patterns, and variations over time.

Tourist flow over the entire region of Azerbaijan from 2021 to 2025 indicates upward growth and the recovery and expansion of the tourism industry (United Nations World Tourism Organization, 2024). The numbers start at moderate levels in 2021, after the pandemic recovery conditions, presumably affected by the impact, and dramatically increase in 2022. This trend was stable in the years 2023 and 2024, but a mild



oscillating pattern was observed in 2025. Homegrown tourists flocked to the Southern area over the years because of the South's subtropical climate and unique beauty. As a significant increase from 180,492 tourists in 2021 to 238,225 in 2022 (a 32% increase). From 194,198 visitors in 2023, which fell back in 2023, it returned to growth by 2024, when a record 255,612 tourists reached the region in 2025. This surge is largely caused by infrastructure projects, recreation, and ecotourism development in the region.

The Quba-Khachmaz region has maintained a leading position with respect to tourist arrivals. Visitor numbers jumped from 176,971 in 2021 to 544,623 in 2022—over three times as many as a year earlier—showing how attractive its environment is to domestic tourism. The region peaked at 604,760 visitors in 2024. In 2025, the total number of tourists decreased to 533,763. Despite the somewhat stable figure in 2025, the region was still the most visited tourism zone in Azerbaijan. This performance is mainly attributed to the coastal tourism prospects of Khachmaz and the mountain tourism prospects of Quba. Shaki-Zagatala region has been showing reliable and resilient growth year-over-year in respect of both its historical and contemporary significance, from 2021-2025. Tourist numbers also grew, from 238,201 in 2021 to 555,399 in 2024. Growth has been more balanced and consistent than in other regions. With an anticipated intake of over 530,000 visitors in 2025, the region continues to demonstrate substantial tourism potential. The Ganja and Dashkasan area also saw quite an increase. During the same period, the number of visitors increased from 128,559 in 2021 to 255,336 in 2025, which was almost double in numbers. The development has been linked to Ganja's status as a cultural center, as well as the growing interest in the Goygol-Maralgol area as a natural tourism attraction. In the Upper Shirvan region — Shamakhi and Ismayilli included — the rise in tourist arrivals was more moderate yet was not markedly different from the rest. In the years since, visitor numbers increased from 99,856 in 2021 to 153,067 in 2023 and stabilized at around 148,000 in the following years.

Encouraging local tourists to perform more cultural and ecotourism activities could enhance domestic tourism. Some of the statistics reveal that the number of people interested in ecotourism increased by more than 40% in 2022. Among people travelling, 47% were meant to visit relatives and friends, and 29% were for leisure and entertainment. According to the 2022 domestic tourism summary report, tourism revenues reached 17.7 million manats, representing a 30% increase compared with 2021. Most of the domestic tourism activities in Quba, Qusar, Gabala, Lankaran, Khachmaz, and Shaki had a recreation/entertainment focus, as of 2023. Statistics indicated that the new tourist flows have allowed these areas to more effectively exploit their recreational potential. In 2024, the domestic tourism data in Azerbaijan showed relatively slower growth compared to previous years. From statistical information, the overall growth rate of domestic tourism stood at 9%, reflecting a stabilization phase for the development dynamics of the sector compared with 2023. A regional analysis, in particular, shows sharp upsurges in tourism in the areas of Ismayilli, Shamakhi, Astara, and Zagatala. As shown in the statistics of January–June 2025, total domestic tourism spend in Azerbaijan was approximately 2.5 billion manats, which is an increase of 13.6 percent from the same period of the previous year. This growth is in line with both rising demand for tourism services and the strengthening of economic turnover in this sector.

Tourism infrastructure covers all the material, technical, and service parts of a destination, and it is essential for the movement, accommodation, and overall comfort of tourists in the nation. These consist of accommodation (hotels, guesthouses, inns), food and beverage (restaurants and cafés), transport systems, and essential utilities such as water, electricity, and internet services. Significant financial investments have been directed toward this sector, yielding substantial potential for further development. While currently in the growth phase, tourism infrastructure modernization is still needed for durable and competitive growth. Specifically, the construction of high-quality accommodation facilities and food service establishments that meet international standards, in conjunction with the development of favorable conditions for tourists in the regions, should be key matters of future development. For that purpose, investor incentives and public & private investment are paramount. Second in line is service quality. The level of services offered in the tourism industry has a direct impact on tourist satisfaction and is critically important in defining the



country's tourism image (Mason, 2012). Hence, enhancement of such service quality entails more well-structured labor training, development programs, and the implementation of advanced education for the professionals in the field.

3. Conclusion

The development of domestic tourism in Azerbaijan is paramount for economic diversification, social welfare improvement, and the maintenance of cultural heritage. Its beauty and diversity, natural vistas, and historical buildings of the country will be attractive to both local and foreign tourists. The domestic tourism sector has been growing at a rapid rate, primarily with the backing of the state, and provides the opportunity for the establishment of new tourist routes, the enhancement of the infrastructure, and the enlargement of employment for the local population in the tourism industry. The homecoming of tourism in general, and the three types of tourism, mountain tourism, ecotourism, and cultural tourism, are some of the main sectors that have considerable potential to rejuvenate tourism, economic development, and social development in the various regions of the country. Besides stimulating socio-economic development in surrounding regions, this sector provides great potential to raise the level of regional development by providing opportunities for local people to showcase their culture and traditions, open up the international marketplace, and improve Azerbaijan's reputation.

The full potential of Azerbaijani domestic tourism is not exploited to date, despite a huge capacity to promote tourism in the country. Effective cooperation between the government, the local tourism corporations, and communities, through practical application of the right concepts and actions, will bring about further progress in the growth of domestic tourism and enhancement of national competitiveness in the world tourism market.

The development of domestic tourism should be recommended and advertised before it is finally presented to the global community and the media, because a full range of positive economic impacts and socio-welfare aspects, as well as showing an evidence of Azerbaijan's tourism potential to the world.

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Characteristics of Vegetation and GIS-Based Terrain Morphometric Analysis in the Beshbarmag State Historical, Cultural and Natural Reserve, Azerbaijan

Narmin Sadigova¹ , Rena Abdiyeva² , Arzu Mustafayev¹ , Vatan Mustafayev¹ ,
Sama Mammadli¹ , Tarlan Huseynli¹ , and Leman Suleymanova¹ 

¹Laboratory of Vegetation Transformation, Ecology and Mapping, Institute of Botany, Baku, Azerbaijan

²Laboratory of Geobotany, Institute of Botany, Baku, Azerbaijan

Abstract. This study aimed to assess the geobotanical characteristics of the vegetation cover of the Beshbarmag State Historical-Cultural and Nature Reserve and the impact of morphometric indicators of the relief on the spatial distribution of plant groups based on Geographic Information Systems (GIS). During the study, geobotanical field observations were conducted, the main plant groupings were identified, and the cenopopulation characteristics of the species *Pyrus salicifolia* Pall., *Ophrys caucasica* Woronow ex Grossh., which are included in the Red Book of Azerbaijan, were assessed. Based on the digital relief model (DEM), slope and aspect maps were prepared in the ArcGIS Pro program, and the impact of these indicators on the spatial distribution of vegetation was analyzed. As a result of the study, ephemeral, arid sparse forest and petrophyte plant groups were distinguished in the area. It was determined that the northern and northeastern exposed slopes, which constitute the majority of the reserve area, create relatively favorable microclimatic conditions for the preservation of arid sparse forest groups characterized by the dominance of *Pyrus salicifolia*. On the rocky slopes with southern exposure, mainly xerophytic and petrophytic plant groups are widespread. The obtained results indicate that the integration of geobotanical data with GIS-based morphometric analyses is important for explaining the spatial differentiation of vegetation cover, assessing the habitat of rare plant species, and monitoring biodiversity in mountainous protected areas.

Keywords: Beshbarmag State Historical, Cultural and Natural Reserve; vegetation communities; slope; aspect; biodiversity; plant conservation

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1.Introduction

Beshbarmag State Historical-Cultural and Nature Reserve is one of the protected natural areas established by the Decree of the President of the Republic of Azerbaijan dated June 8, 2020 (president.az, 2020). The territory of the reserve encompasses the natural monument of Beshbarmag Mountain, located in the village of Qalashikhi, Siyazan district, and currently operates under the jurisdiction of the Reserves Management Center of the State Tourism Agency of the Republic of Azerbaijan (Heritage.org.az). Beshbarmag Mountain, one of the rare natural monuments of Azerbaijan, is distinguished by its rich biodiversity, complex relief, and important historical and cultural heritage (Heritage.org.az; UNESCO Preslib.az). These features make the protection and scientific study of the area's natural ecosystems particularly relevant.



The formation and spatial distribution of vegetation cover in mountain ecosystems is closely related to the morphometric characteristics of the relief. In particular, the slope and aspect of the slopes are considered important ecological factors that affect the distribution of solar radiation, microclimate conditions, and humidity regime, determining the distribution of various plant groups and rare plant species (Singh, 2018; Yang et al., 2020). Since Mount Beshbarmag is located at the junction of semi-desert and mountain landscapes, it has favorable natural conditions for the formation of plant groups adapted to various ecological conditions. The distribution of rare plant species such as *Pyrus salicifolia* and *Ophrys caucasica*, which are included in the Red Book of Azerbaijan, in the area necessitates a comprehensive assessment of their cenopopulation status and habitat (Red Book of Azerbaijan, 2023). The application of Geographic Information Systems (GIS) creates broad opportunities for analyzing morphometric indicators of relief, assessing the spatial distribution of plant groups, and monitoring biodiversity. Slope and aspect maps prepared based on a digital relief model are of great importance in determining the impact of relief factors on the formation of vegetation cover.

The purpose of this study is to study the geobotanical characteristics of the vegetation cover of the Beshbarmag State Historical-Cultural and Nature Reserve, to assess the main plant groups and the cenopopulation status of rare plant species, and to determine the effect of morphometric indicators of the relief (slope and aspect) on the spatial distribution of plant groups based on Geographic Information Systems.

2. Study Area

Beshbarmag Mountain is located approximately 90–95 km from Baku, on the 95th kilometer of the Baku-Siyazan (Baku-Guba) highway, in the Siyazan district (president.az, 2020). From an orographic point of view, Beshbarmag Mountain is the eastern continuation of the Greater Caucasus Range. The lateral ridge extends approximately 20 km north of the Bashsuayreci ridge, parallel to it in a northwest-southeast direction for a distance of 115 km from the Shahdag massif to Mount Beshbarmag, and ends in the Bosphorus plain near Zarat (Museyibov, 1998). The eastern continuation of the side ridge is formed by the Yerfi, Tekla and Beshbarmag ridges (881–522 m east of Gilgilchay) (Museyibov, 1998). In the approximately 110 km distance from Shahdag to Beshbarmag, the absolute height of the ridge decreases by 3700 m.

One of the important features of Beshbarmag Mountain is its favorable strategic-geographical position. The area is located in the narrowest part of the natural passage along the western coast of the Caspian Sea, which has been considered one of the main factors determining its strategic and defensive importance since ancient times (Hüseynova, 2025). Geologically, the Beshbarmag area is mainly represented by sediments belonging to the Triassic system, and large rock fragments of these sediments are traced in a southeasterly direction to the Beshbarmag rocks (Museyibov, 1998). Structurally and tectonically, the area is related to the Tengi-Beshbarmag anticlinorium, located south of the zone extending from the Samur River valley towards Siyazan (Museyibov, 1998). Exogenous geological processes have played an important role in the formation of the relief. Large avalanche processes are observed on the eastern slopes of the Beshbarmag ridge, and their formation is associated with similar avalanche processes that developed in limestone layers on the northern coast of the Absheron Peninsula (Museyibov, 1998). In addition, traces of transgressions and regressions of the Caspian Sea during the Quaternary period are clearly observed around the city of Siyazan and along the coastline stretching from Beshbarmag to Alat. This feature indicates that Beshbarmag is one of the reference areas in terms of studying the ancient coastlines of the Caspian Sea (Museyibov, 1998).



3. Materials and Methods

Taking into account the significant impact of the geological and orographic features of the study area on the spatial differentiation of vegetation, geobotanical field surveys and morphometric analyses of the relief were conducted based on a comprehensive approach.

3.1. Geobotanical methods

In terms of botanical-geographical zoning, the territory belongs to the "Caspian Lowland" botanical-geographical region (Флора Азербайджана, 1950), and according to the new classification, to the Guba-Shabran botanical-geographical region (İbadullayeva & Əsgərov, 2025).

- Semi-desert ephemeral, ephemeral-grassland groupings — a type widespread at the foot of Mount Beshbarmag and in the lower parts of the slopes;
- Arid sparse woodland — a type that covers slopes and interslope areas located above sea level;
- Petrophyte assemblages — a type characteristic of rocky habitats, bedrock outcrops, and rocky ravines.

A vertical zonal sequence (ephemeral → arid sparse woodland → petrophyte) was observed in the distribution of these three types in the area.

From a methodological point of view, the term "arid sparse forest" is defined based on the following criteria: the above-ground distribution of the tree layer (sparse, isolated arrangement of trees), the presence of drought-resistant tree and shrub species, the presence of open grass-meadow type cover between the trees, development mainly on gravelly and gray-brown soils, and high dependence on the amount of precipitation and temperature regime. When studying the ontogenetic state of rare and protected species (Red Book of Azerbaijan 2023) (*Pyrus salicifolia* Pall., *Ophrys caucasica* Woronow ex Grossh.), the following structural indicators were taken as a basis: ontogenetic (age) state of individuals (p, im, v, g1, g2, g3, ss, s.); distribution pattern of terrestrial mammals (solitary, group, diffuse-group, diffuse-solitary); percentage of projective cover; interindividual distance indicators.

3.2. Methodology for analyzing morphometric characteristics of relief (slope and exposure)

The digital elevation model (DEM) of the study area (Beşbarmaq Mountain, within the boundaries of the "Beşbarmaq Mountain" State Historical-Cultural and Nature Reserve) was prepared based on Shuttle Radar Topography Mission (SRTM) data obtained from the OpenTopography open data platform (Farr et al., 2007; OpenTopography, 2025). All geospatial operations were performed in Esri ArcGIS Pro software, at a scale of 1:15,000 (Esri, 2025).

The slope and aspect of the terrain were calculated from the DEM using the corresponding "Slope" and "Aspect" tools of the Spatial Analyst module of ArcGIS Pro. The result for both indicators was obtained in a continuous raster format, then divided into discrete classes using the Reclassify tool. The slope was divided into seven classes: 1°–5°, 6°–10°, 11°–15°, 16°–20°, 21°–30°, 31°–40°, and 41°–53°.

Aspect is divided into 9 classes corresponding to the 8 traditional compass directions (North, Northeast, East, Southeast, South, Southwest, West, Northwest) (the North category is calculated as 2 separate classes, since it consists of the sum of the intervals 0°–22.5° and 337.5°–360°, and is later combined with the same color in the visual presentation) and an additional "Flat" (flat, unsloped areas, value -1) category (Esri, 2025).

The area (ha) of each class and its ratio to the total area (%) were calculated, and the results were presented only within the reserve area, masked by the official boundary of the reserve. A hillshade relief model, inset map, north axis, and scale bar were used as background during the preparation of the maps.



4. Results

4.1. Geobotanical Research

As a result of the research, ephemeral, arid sparse forest, and petrophyte plant groupings were distinguished in the Beshbarmag State Historical-Cultural and Nature Reserve.

Semi-desert groupings. At the foot of Mount Beshbarmag, wormwood-ephemeral and ephemeral (variegated, cereal-ephemeral) groupings were recorded with the participation of representatives of the families Poaceae Barnhart, Asteraceae Martinov., Brassicaceae Burnett, and Fabaceae Lindl. These groups are mainly spread at the foot of Mount Beshbarmag and on the lower slopes. In spring, the following species of the genus *Veronica amoena* M.Bieb., *Tragopogon graminifolius* DC., *Calendula persica* C.A.Mey, *Adonis aestivalis* L., *Senecio vernalis* Waldst. et Kit., *Bromus japonicus* Thunb., *Capsella bursa-pastoris* (L.)Medik., *Cardaria draba* (L.) Desv. and *Papaver* L. play an important role in the composition of the grass cover.

Petrofit groupings. In rocky areas and rock crevices, *Rosa sanguineus* Friv., *Rhamnus pallasii* Fisch. & C.A.Mey., *Ficus carica* L., *Punica granatum* L., *Jasminum fruticans* and *Sternbergia fischeriana* were recorded singly or in small groups.

Arid sparse woodland (dominated by *Pyrus salicifolia*) clusters. The main tree species of this type was *Pyrus salicifolia* (willow-leaf pear), which is included in the Red Book of Azerbaijan. The tree layer of the grouping was mainly represented by *Pyrus salicifolia*. A xerophyte-mesoxerophyte herbaceous layer consisting of *Ophrys caucasica* Woronow ex Grossh., *Centaurea Iberica* Trev. ex Spreng., *Poa bulbosa* L., *Salvia verticillata* L., and other species was observed to form under the canopy of the trees. When analyzing the age structure of the *Pyrus salicifolia* cenopopulation, a predominance of mature generative individuals (g1–g3) and a slight presence of pregenerative individuals were revealed. The spatial distribution of individuals is diffuse and solitary, with trees located at a distance of approximately 1 m from each other and occupying an area of approximately 1 ha (Fig. 1).

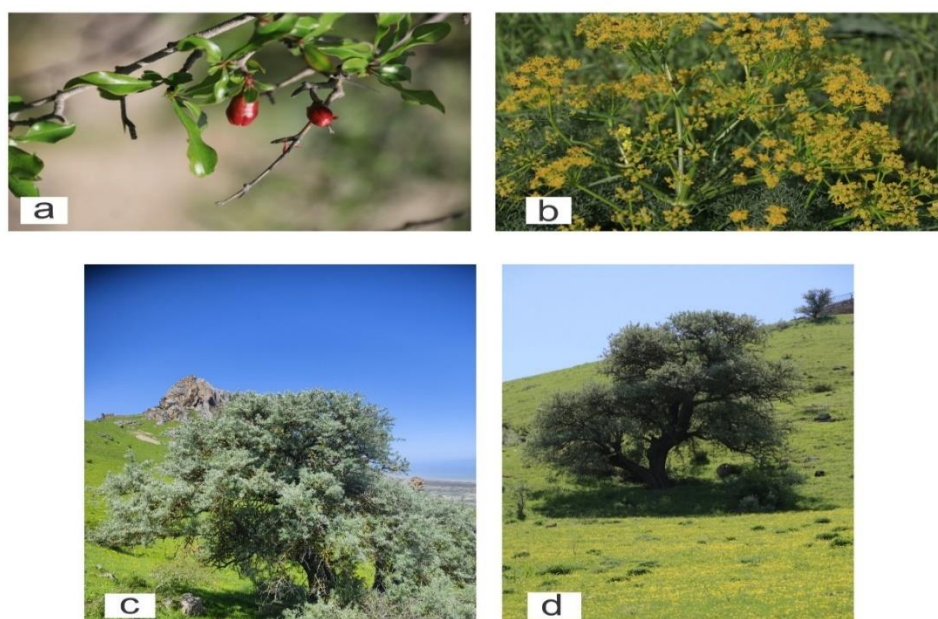


Figure 1. Representative plant species recorded in the Beshbarmag State Historical, Cultural and Natural Reserve: (a) *Punica granatum* L.; (b) *Ferula orientalis* L.; (c–d) *Pyrus salicifolia* Pall.

Ferula orientalis L., listed in the Red Book of Azerbaijan, has been recorded on rocky and gravelly slopes. Considering the limited local distribution of the species only around Beshbarmag and the impact of future global climate change, there is a possibility of a threat of population decline in this area. The species forms associations with cereals, *Centaurea iberica* L., and other species, preferring petrophyte habitats. The most typical settlement pattern is compact groups of 5–10 individuals, forming up to 90% projective cover over an area of about 2 m². However, single specimens located 2–3 m apart have also been recorded.

Another rare protected species, *Ophrys caucasica* Woronow ex Grossh., has been recorded under and around the canopy of *Pyrus salicifolia*. The xenopopulation shows satisfactory natural regeneration with the presence of individuals in different ontogenetic states. Individuals are grouped in small microgroups of 3–4 individuals per 1 m² area; the distance between them varies between 1.5–3 m. In the herbaceous layer, together with *Ophrys caucasica*, representatives of the genera *Plantago ovata* Forssk., *Veronica amoena* M.Bieb., *Salvia verticillata* L., *Ornithogalum ponticum* Zahar., *Anisantha rubens* (L.) Nevsi, *Poa bulbosa* L., *Hordeum leporinum* Link, *Geranium molle* L., and *Ranunculus* L. were recorded.

Thus, ephemeral-wormwood semi-desert, petrophyte, and arid sparse forest groupings have been identified as the main plant communities in the Beshbarmag State Historical-Cultural and Nature Reserve.

4.2. Morphometric relief indicators of the Beshbarmag Mountain area

As a result of GIS analysis, the following quantitative results were obtained on the exposure (Aspect) and slope (Slope) indicators of the Beshbarmag Mountain area: According to the exposure analysis (Fig. 2), the largest share of the area is occupied by slopes facing northeast — 124.4 ha (45.57%).

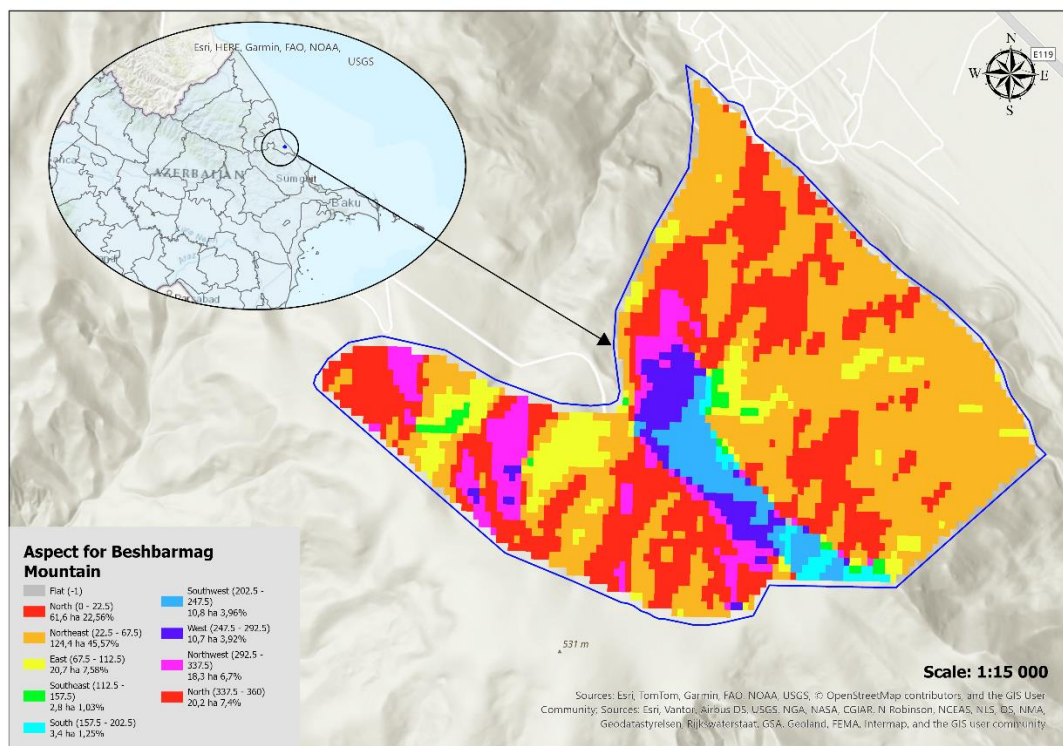


Figure 2. Exposure (Aspect) indicators of the Beshbarmag Mountain area

Areas facing north (sum of intervals 0°–22.5° and 337.5°–360°) occupy the second place with 81.8 ha (29.96%). Eastern exposure covers 20.7 ha (7.58%), western exposure 10.7 ha (3.92%), and north-western exposure 18.3 ha (6.7%). The least common exposures are southeast (2.8 ha, 1.03%) and south (3.4 ha,

1.25%), while southwest exposure accounts for 10.8 ha (3.96%). No flat areas were recorded in the study area.

Analysis of slope indicators (Fig. 3) reveals that the terrain of the area consists mainly of medium-steep slopes.

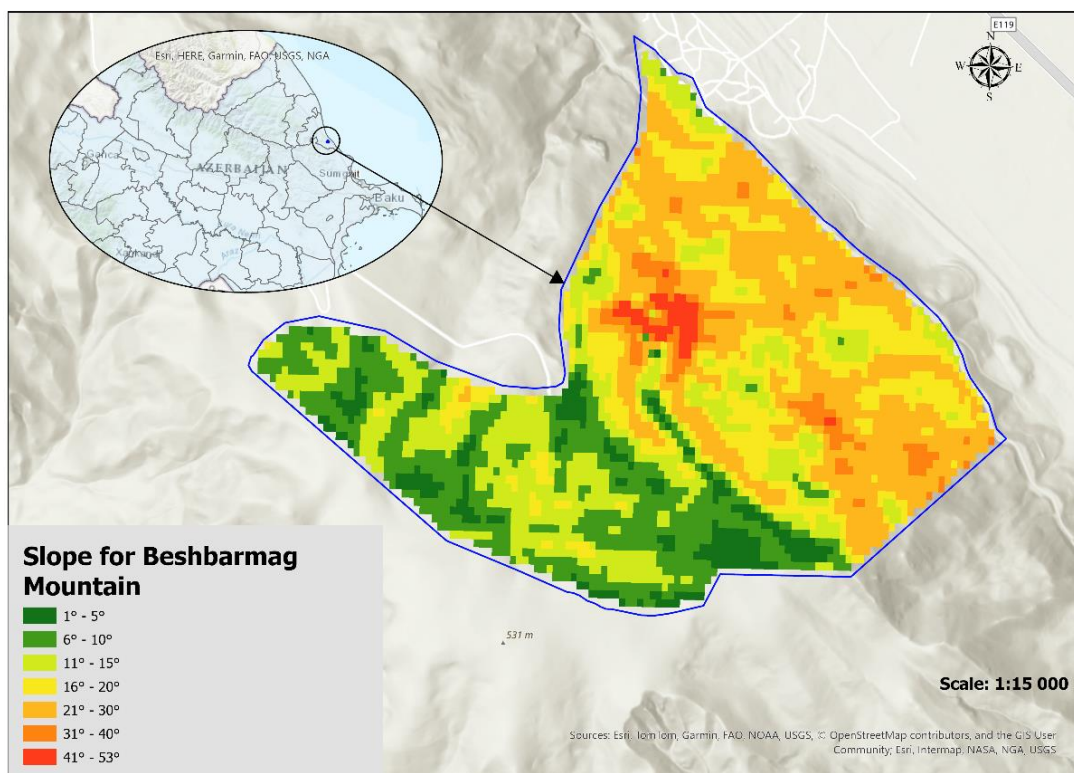


Figure 3. Slope indicators of the Beshbarmag Mountain area

The category with the largest share is the 21–30 slope interval — 77.9 ha (28.6%). This is followed by the 11–15° (57.8 ha, 21.2%), 6–10° (54.2 ha, 19.9%), and 16–20° (52.9 ha, 19.4%). The most gentle slopes (1°–5°) occupy 15.8 ha (5.8%), while the steepest slopes are divided into two categories: the 31°–40° range accounts for 10.3 ha (3.8%), and the 41°–53° range accounts for the smallest share with only 3.8 ha (1.4%). Overall, 67.1% of the area consists of gentle (0°–20°) slopes, and 33.8% consists of steep to very steep (21°–53°) slopes. The areas with the highest slope, although small in quantity (1.4%), are spatially concentrated mainly in the northeastern part of the reserve, around the main rock massif of the mountain.

Thus, as a result of morphometric analysis, it was determined that slopes with northern and northeastern exposure, as well as moderate slopes, predominate in the Beshbarmag State Historical-Cultural and Nature Reserve.

5. Discussion

Geobotanical observations and morphometric analysis of the relief conducted in the Beshbarmag State Historical-Cultural and Nature Reserve have shown that the spatial differentiation of plant groups is mainly closely related to exposure and slope indicators. These results are consistent with modern research showing that relief factors play a crucial role in the formation of vegetation in mountain ecosystems. Various authors



have evaluated slope exposure and inclination as key topographic factors determining the spatial structure, species composition, and biodiversity of plant communities (Singh, 2018; Yang et al., 2020).

Morphometric indicators of relief act as not only indirect but also direct ecological factors in the spatial organization of vegetation. The exposure of the slope changes the distribution of solar radiation, temperature and humidity regime, and the slope affects soil formation processes, surface runoff and water infiltration. As a result of the interaction of these factors, various ecological niches are formed, and spatial differentiation of plant groups occurs, which is consistent with the results obtained in the Beshbarmag area (Singh, 2018; Yang et al., 2020). The dominant groupings in the area are xerophytic plant groups formed on rocky and gravelly slopes, and high insolation and lack of humidity act as important ecological factors in their spread. This feature is especially evident on the southern and southwestern slopes of Mount Beshbarmag. The vegetation period in ephemeral plant groups is closely related to the seasonal humidity regime. Although a high diversity and projective cover of ephemeral species is observed in the spring season, most of them complete their vegetation during the summer months as a result of the decrease in humidity, and *Artemisia fragrans* takes a dominant position in the herbaceous cover.

These phenological changes, characteristic of semi-desert and arid ecosystems, demonstrate that seasonal moisture dynamics have a direct impact on the structure of the vegetation cover. The species recorded in the petrophyte groups demonstrate high ecological specialization, adapted to conditions of hard rock substrate, poor soil development, and water scarcity. These characteristics cause petrophyte groups to form mainly in limited areas on rocky slopes and rock crevices. The predominance of generative individuals and the scarcity of pregenerative individuals in the age structure of the *Pyrus salicifolia* cenopopulation indicate that the natural regeneration process is weak. In addition, the spatial structure of *Pyrus salicifolia* and *Ophrys caucasica* cenopopulations reflects the adaptation strategies of these species to arid conditions. The limited number of pregenerative individuals in the *Pyrus salicifolia* cenopopulation necessitates a more detailed study of natural regeneration processes. Therefore, it is considered appropriate to conduct long-term monitoring to assess possible changes in the age structure of the population.

Exposure analysis has shown that the majority of the reserve area consists of north- and northeast-facing slopes. These exposures create relatively cool and humid microclimate conditions, creating favorable conditions for the preservation of arid sparse forest groups characterized by the dominance of *Pyrus salicifolia*. Conversely, xerophyte and petrophyte plant groups dominate on rocky slopes with southern exposure that receive higher solar radiation.

A similar pattern has been observed in studies conducted in arid mountainous areas. It has been found that while north-facing slopes are characterized by lower temperatures, higher soil moisture, and richer vegetation, high solar radiation and drought conditions on south-facing slopes lead to a predominance of xerophytic plant communities (Yang et al., 2020; Singh, 2018). Slope indicators also play an important role in the spatial differentiation of vegetation. While the relatively developed soil layer on gentle slopes allows for the formation of various herbaceous and arid sparse forest groups, steep and very steep rocky slopes constitute ecotopes where mainly petrophyte plant groups are distributed. These observations are consistent with modern research showing that morphometric indicators of relief affect not only the distribution of vegetation, but also the formation of ecological diversity of habitats (Singh, 2018).

The digital elevation model (DEM) used in the study and the slope and exposure indicators calculated from it created a reliable basis for spatial analysis of geobotanical data. The application of modern GIS technologies allows for highly accurate assessment of the morphometric characteristics of the relief and objective determination of their relationship with the spatial structure of vegetation. This approach is considered one of the widely used methodological directions in the study of mountain ecosystems (Guth et al., 2021).



The research results show that the integration of geobotanical observations with morphometric indicators allows not only to explain the spatial structure of existing plant groups, but also to identify potential habitats of rare species. This feature is of particular practical importance in terms of monitoring biodiversity in protected areas, mapping sensitive ecotopes, and prioritizing conservation measures.

The results obtained show that the integration of geobotanical field studies with GIS-based morphometric analyses is an effective scientific approach for explaining the spatial structure of plant assemblages, assessing the habitat of rare species, and monitoring biodiversity in the reserve area. This approach is also consistent with recent research showing that the integration of morphometric indicators calculated based on digital elevation models (DEMs) with geobotanical data has important methodological advantages in assessing relief-vegetation relationships (Guth et al. 2021).

In this regard, the geobotanical-GIS approach applied in the Beshbarmag State Historical-Cultural and Nature Reserve creates a scientific basis not only for assessing the current state of the area's vegetation, but also for developing future monitoring programs, tracking the dynamics of the habitat of rare species, and adaptive management of reserve areas. The integrated methodological approach applied in the study can also be applied to assess biodiversity and plan conservation measures in other mountainous and semi-arid ecosystems.

6. Conclusion

The conducted research showed that the spatial distribution of plant groups in the Beshbarmag State Historical-Cultural and Nature Reserve is related to the morphometric characteristics of the relief. The application of geobotanical field surveys in conjunction with GIS-based relief analyses has allowed for a more complete assessment of the main plant groups formed in the area, their distribution patterns, and habitat characteristics.

It has been determined that the northern and northeastern-facing slopes that predominate in the reserve create relatively favorable microclimatic conditions, enabling the preservation of arid sparse forest groups characterized by the dominance of *Pyrus salicifolia*. Conversely, on rocky slopes with southern exposure, xerophytic and petrophytic plant groups predominated under conditions of high insolation and lack of moisture. In addition, the conducted cenopopulation assessment allowed us to characterize the current status of the *Pyrus salicifolia* and *Ophrys caucasica* species and form an initial scientific database for their future monitoring. The main advantage of this study is the comprehensive assessment of the spatial differentiation of plant groupings as a result of the integration of geobotanical field observations with morphometric analyses based on a digital relief model (DEM).

Overall, the integration of geobotanical surveys with GIS technologies can be considered a reliable methodological approach for a comprehensive assessment of vegetation and habitat in mountainous protected areas. This approach is of practical importance in terms of biodiversity monitoring, habitat assessment of rare species, and scientific justification of conservation measures. The results obtained create an important scientific basis for protecting biodiversity, organizing ecological monitoring, and making scientifically based management decisions in the Beshbarmag State Historical-Cultural and Nature Reserve.

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Mud Volcanoes of Azerbaijan as a Geological Heritage: Geoconservation, Geotourism, and the Prerequisites for the Creation of a Geopark

Elnur Baloglanov¹ , Jeyhun Pashayev² , Ruslan Akhundov¹ , Elmar Samedov¹ 
, and Anar Jafarov² 

¹Institute of Geology of the Ministry of Science and Education of the Republic of Azerbaijan, Baku, Azerbaijan;

² Mud Volcanoes Group of Baku and Absheron Peninsula State Nature Reserve, Ministry of Ecology and Natural Resources, Baku, Azerbaijan.

Abstract. The mud volcanoes of eastern Azerbaijan and the adjacent South Caspian Basin form one of the most dense and morphologically diverse mud volcanic provinces in the world. This paper summarizes data on their distribution, typology, scientific and educational value, the current legal protection system, and the potential for geotourism development. Ayrantoken, Arzani, Gelenderakhtarma, and the island volcano Garasu are examined separately as examples of various morphological and spatial types. The analysis shows that the combination of active fluid manifestations, varied topography, and connections to deep petroleum systems determines the high potential of mud volcanoes as geological heritage sites. The state nature reserve, national regulation of geological parks, and emerging tourism infrastructure provide the foundation for the development of a geopark initiative. However, preparing a potential nomination for the UNESCO Global Geoparks program requires defining a single territory, establishing a specialized management body, developing a long-term geoconservation and security plan, and documenting the participation of local communities. The study concludes that Azerbaijan possesses the essential geological and institutional prerequisites for a future geopark, although systematic geosite assessment, integrated management, and community participation remain necessary before a UNESCO Global Geoparks application can be considered.

Keywords: mud volcanism; geological heritage; geoconservation; geosites; geotourism; South Caspian Basin; UNESCO Global Geoparks

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1. Introduction

Mud volcanism is a form of sedimentary volcanism in which overcompacted and fluid-saturated sediments, water, and gases migrate to the surface through zones of increased permeability (Aliyev et al., 2015; Baldermann et al., 2020; Baloglanov, 2023; Bayramova et al. 2023; Mazzini & Etiope 2017). The depth of fluid sources and the structure of feeder channels vary between individual systems and are estimated based on geochemical, geophysical, and structural-geological data. Breccias brought to the surface and associated fluids provide indirect information about deep sedimentary complexes, petroleum systems, and degassing processes (Aliyev, 1992).

The global number of mud volcanoes remains uncertain and depends on the terminology used, the scale of mapping, and the completeness of the accounting of underwater manifestations (Baloglanov, Abbasov, & Akhundov, 2018). Different inventories may account for large volcanic edifices, individual gryphons, salses, and deep-sea structures differently.

According to the inventory data used in this work, 353 mud volcanoes have been recorded in eastern Azerbaijan and the adjacent waters of the South Caspian Sea, including 199 land-based and 154 offshore objects (Aliyev et al., 2015; Baloglanov, Abbasov, & Akhundov, 2018). Their high concentration and morphological diversity determine the special position of the region in the system of global mud volcanism (Fig 1).

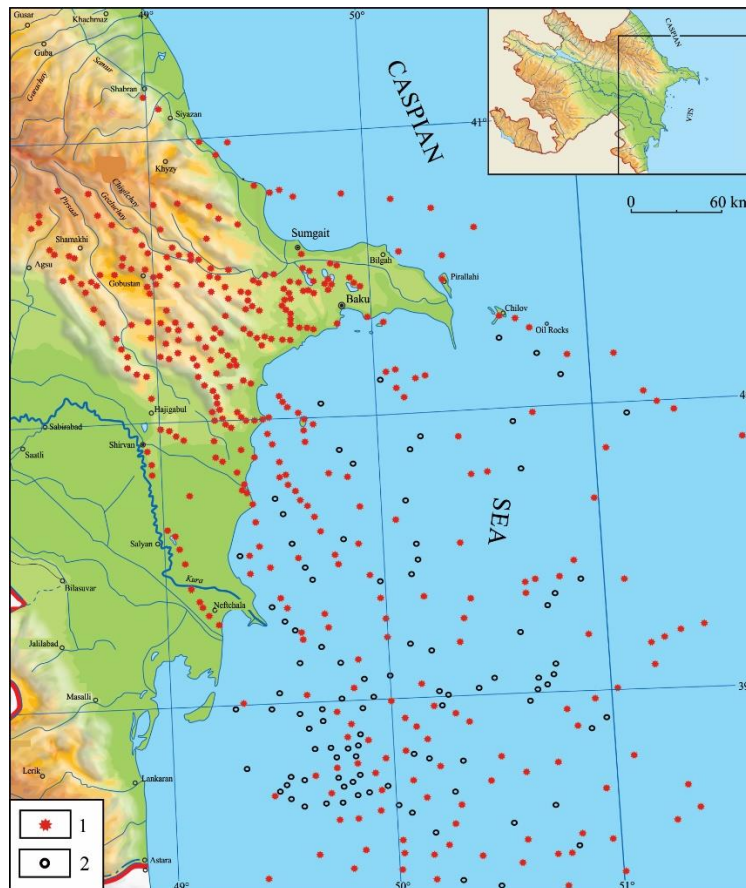


Figure 1. Map of the location of mud volcanoes in Azerbaijan.
Mud volcanoes: 1 – identified; 2 – supposed [3].

Mud volcanoes of Azerbaijan are of interest for the study of petroleum systems, deep fluid migration, methane emission and transformation, microbiological processes, as well as the links between mud volcanic activity, tectonics, and seismicity (Baloglanov et al., 2017; Etiope et al., 2004; Imbert et al., 2019; Liu et al., 2024; Mellors et al., 2007). Their landscape appearance is formed by erosional relief, mud cones, salses, gryphons, and areas of active fluid release. Historical eruptions, including cases of gas ignition, simultaneously increase the scientific significance of the sites and necessitate the consideration of natural risks (Aliyev et al., 2015; Aliyev, Guliyev, & Belov, 2002)

The concept of geological heritage has received significant development thanks to international and national initiatives in the field of geoconservation. The UNESCO Global Geoparks Programme, established in 2015, integrates the conservation of geological heritage with education, sustainable development,



geotourism, and local community participation (Aliyev et al., 2024). Lokbatan has been included by Azerbaijan on the UNESCO World Heritage Tentative List since 30 September 1998 (UNESCO 1998). This designation is under the World Heritage Convention and does not constitute a nomination or recognition under the UNESCO Global Geoparks Programme.

Although numerous studies have examined the geology, geochemistry, and eruptive activity of Azerbaijan's mud volcanoes, relatively few have evaluated them comprehensively from the perspective of geological heritage, geoconservation, geotourism, and geopark development. This review aims to bridge that gap by integrating these aspects within a single analytical framework.

The aim of this study is to assess the geological legacy of mud volcanic landscapes in Azerbaijan and the prerequisites for their development within the framework of the Geopark model. To achieve this goal, data on the distribution and typology of mud volcanoes are summarized, four representative sites are examined, and the current legal protection system, tourism infrastructure, and key management constraints are analyzed. Special attention is given to delineating the value of individual geosites and the requirements for the UNESCO Global Geopark.

2. Materials and methods

This work is presented in the format of a narrative review. The source base consists of scientific articles, monographs, and informational materials presented in the bibliography. The sources were selected based on their relevance to the main research areas: the distribution and classification of mud volcanoes, their geological structure and activity, geological heritage, legal protection, geotourism, and geopark management.

The analysis was conducted at two levels. At the individual site level, scientific, educational, aesthetic, and tourist value, accessibility, natural hazards, and the current protection regime were considered. At the territorial level, the prerequisites for establishing a geopark were assessed, including the legal and institutional framework, geoconservation opportunities, tourism infrastructure, and local community participation. The analysis was qualitative in nature and did not involve a rating system for the sites.

Instead, the assessment relied on a comparative synthesis of published geological, environmental, legal, and tourism-related information to identify the strengths, limitations, and development potential of representative mud volcano sites.

3. Global distribution and morphological diversity of mud volcanoes

3.1. Global distribution

According to the inventory (Baloglanov, Abbasov, & Akhundov, 2018), which includes terrestrial and underwater manifestations, 2,508 objects were recorded in 42 geographic regions. Their main areas of distribution are confined to the Alpine-Himalayan, Pacific, and Central Asian orogenic belts, as well as the deep-water parts of the Caspian, Black, and Mediterranean seas. Of the total number of recorded objects, 1,107 are terrestrial, and 1,401 are underwater mud volcanic structures. These values characterize a specific inventory base and are not considered a final estimate of their global number.

3.2. Morphological diversity of mud volcanoes in Azerbaijan

Mud volcanoes in Azerbaijan include terrestrial, island, and underwater forms. Based on their general morphology, cone-shaped, dome-shaped, ridge-shaped, and plateau-shaped structures are distinguished; shield-shaped, caldera-shaped, and other varieties are distinguished based on the structure of the crater region. Modern activity is manifested by periodic eruptions, the activity of gryphons and salses, as well as relatively weak fluid manifestations (Aliyev et al., 2015). The combination of various morphological types, activity regimes, and fluid composition makes the region an important natural platform for the comparative study of mud volcanic processes (Fig. 2) (Aliyev et al, 2024; Odonne et al., 2020; Odonne et al., 2021)



Figure 2. Examples of morphological types of mud volcanoes in Azerbaijan: a) Shorbulag, b) Sengi-Mugan, c) Toraghay, d) Durovdagh.

4. The value of Azerbaijan's mud volcanoes as geological heritage sites

4.1. Key components of geological heritage value

Based on the approach outlined in Section 2, the value of mud volcanoes is considered across scientific, educational, aesthetic, and cultural-historical dimensions. Available data indicate their high potential as geological heritage sites. However, the lack of a unified quantitative assessment limits the ability to compare sites and prioritize conservation.

Scientific significance: Breccia, water, and gases brought to the surface contain information about sedimentary complexes and fluid systems intersected by feeder channels. Their study allows us to investigate hydrocarbon migration, the origin and transformation of methane, interactions in the water-rock-gas system, the structure of mud volcanic channels, and the relationship of volcanic activity to regional tectonics (Etiope et al., 2004; Liu et al., 2024; Mazzini & Etiope 2017).

Educational value: Gryphons, salses, breccia blankets, and erosional features can be used for fieldwork in geology, geochemistry, and environmental science. Educational routes should consider gas release, surface instability, conservation regimes, and permissible recreational loads (Aliyev et al., 2024; Kopf et al., 2010; Kopf et al., 2009).

Aesthetic qualities: The contrast between the mud volcanic landforms and the surrounding semi-desert landscape determines the high visual expressiveness of the objects. Their aesthetic potential is due to the diversity of forms, the openness of geological processes for observation, and the possibility of panoramic perception of the landscape.



Cultural and historical value: Mud volcanoes are mentioned in ancient Greek, Roman, and medieval Arabic sources (Aliyev et al., 2015). Their cultural significance is also reflected in local toponymy, legends, and traditional perceptions of the landscape. One example is the name Lokbatan, the origin of which is associated with local historical and cultural beliefs (UNESCO, 1998).

4.2. Legal protection and international recognition

Legal protection of Azerbaijan's mud volcanoes is developing at the national level and is complemented by initiatives aimed at their international recognition.

National legal protection: In 1982, Lokbatan, Ayrantoken, Boyuk Kenizadagh and Dashgil were included in the list of geological sites taken under state protection (Aliyev et al., 2024). By the Decree of the President of the Republic of Azerbaijan No. 2315 dated August 15, 2007, the State Nature Reserve of the Baku and Absheron Peninsula Mud Volcanoes Group was established. The reserve, with an area of 12,322.84 hectares, ensures the protection of 43 mud volcanoes, including Toraghay, characterized as one of the largest mud volcanoes in the world. The main objectives of the reserve are to limit anthropogenic impact, prevent development, and ensure the protection of potentially hazardous areas.

International recognition: On 30 September 1998, Lokbatan was inscribed by Azerbaijan on the UNESCO World Heritage Tentative List as a natural property under criteria (vii), (viii) and (ix) (UNESCO, 1998). This status reflects the State's intention to consider the property as a candidate for future nomination, but does not imply recognition of its outstanding universal value by the World Heritage Committee.

Current initiatives: In 2020, the Ministry of Ecology and Natural Resources, together with local and international experts, began studying areas promising for the creation of geoparks. That same year, the General Regulation on Geoparks was approved, defining the legal and organizational framework for their creation and management in Azerbaijan. This document forms the national regulatory framework, but preparing an application for the UNESCO Global Geoparks program requires independent compliance with international requirements.

5. Representative objects

To characterize the diversity of mud volcanic heritage, four sites are considered: Ayrantoken, Arzani, and Gelenderakhtarma in the Shamakhi-Gobustan Province, as well as the island volcano Garasu in the Baku Archipelago. They represent different morphological and spatial types and are characterized by well-documented fluid manifestations. The selection of sites is illustrative and does not constitute a definitive ranking of Azerbaijan's mud volcanoes.

The Ayrantoken mud volcano is located at 39°59'21.67" N, 49°18'38.87" E, approximately 65 km southwest of Baku. It is an active plateau-like structure with a relative height of about 190 m. The volcanic edifice includes a breccia field with an area of 805 hectares and a volume of up to 500 million m³. The length of individual breccia flows reaches 1.5 km, and faults – 800 m. Oil-showing gryphons and mud cones 5-10 m high are developed on the territory of the volcano (Fig. 3). Eruptions during periods of high activity could be accompanied by gas ignition and the formation of flame columns up to 500 m high (Aliyev et al., 2015).

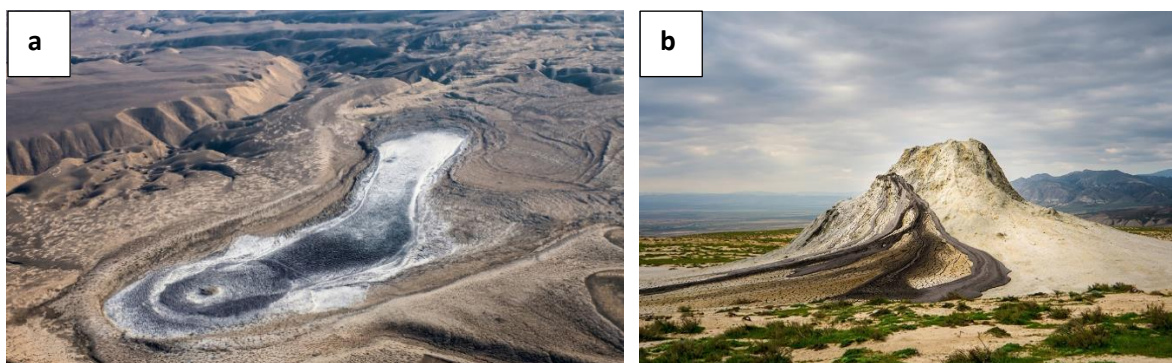


Figure 3. Ayrantoken mud volcano: a) aerial photograph from a helicopter, b) an active mud cone (sopka) on the territory of the volcano.

The scale of the breccia field, active oil and gas manifestations, and traces of past eruptions determine the scientific and educational value of Ayrantoken. Its tourist use requires taking into account the security regime, gas danger, surface stability, the condition of access roads and the possibility of organizing controlled routes.

The Arzani mud volcano is located at 40°10'49.41" N, 49°11'24.34" E, approximately 63 km southwest of Baku and 20 km northwest of the village of Gobustan. It is a plateau-like elevation with an area of approximately 50 hectares. The volcano's western slope faces the Toragay Plain, and to the north, it is bordered by Mount Galandarakhtarma and the Shirgobu River. Its geological structure includes deposits of the productive strata and the Upper Maykopian.

Three distinct microform distribution areas are identified within Arzani. The first area, over 4.5 hectares in area, contains over 30 mudflats and griffins, including oil-producing forms and a large mudflat with a hardened bitumen cover. The second area, approximately 1 hectare in area, is located approximately 300 meters to the southeast and contains approximately 15 griffins. The third area, approximately 470 meters to the east, is an eruptive field covering 16.5 hectares (Fig. 4) (Aliyev et al., 2015).

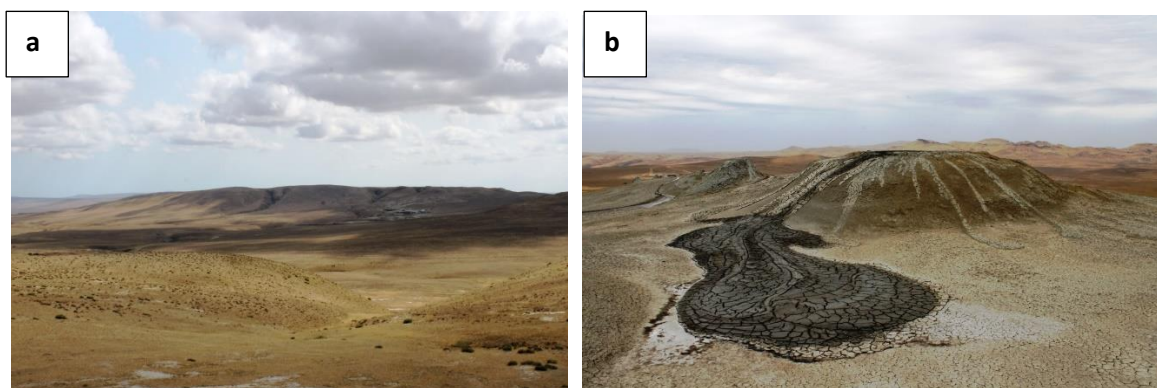


Figure 4. Arzani mud volcano: a) general view, b) mud cone.

The high concentration and diversity of microforms define Arzani's scientific and educational potential. Assessing its tourism potential requires data on the safety of oil and gas seeps, surface stability, accessibility, and acceptable visitor numbers.

The Gelenderakhtarma mud volcano is located at coordinates 40°15'3.31" N, 49°14'45.52" E and is confined to the eastern pericline of the Umbakinskaya anticline, composed of Miocene deposits. The structure, elongated in the latitudinal direction, has a relative height of about 160 m and a steep eastern slope. The crater field, which extends for more than 1 km, includes numerous active gryphons, saline lakes,

and mud cones more than 15 m high. The area of the breccia cover reaches 562 hectares, and its thickness, according to drilling data, is up to 30 m (Fig. 5) (Aliyev et al., 2015).



Figure 5. General view of the Gelenderakhtarma mud volcano.

The large size of the volcanic edifice and the high density of active microforms determine the scientific, educational, and aesthetic value of the site. Its potential for tourism use should be assessed taking into account accessibility, natural risks, and the protection regime.

Garasu is located at 39°50'7.16" N, 49°31'55.73" E and is a large island mud volcano in the Baku Archipelago. It is located in the Hamamdagh–Dashly Island anticline zone. The island is approximately 1.2 km long, up to 0.6 km wide, and reaches a height of 14 m in its northern part. The relief includes active gryphons, saline lakes, areas of gas, water, and mud emission, cracks, and coastal deformations (Fig. 6).

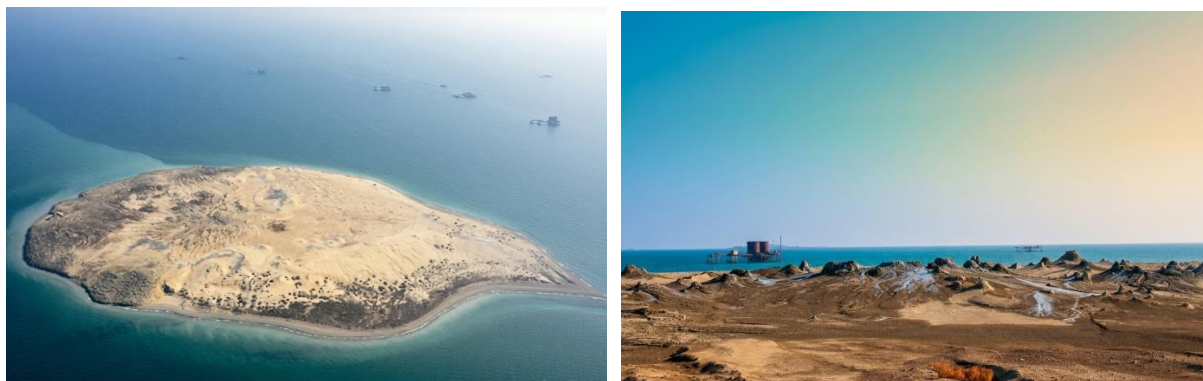


Figure 6. Garasu mud volcano: a) aerial photograph from a helicopter, b) the crater field of the volcano.

The 1977 eruption, accompanied by gas ignition, lasted for more than two days and resulted in the release of over 1.5 million m³ of breccia. The 1993 eruption did not involve intense combustion or massive breccia release, but was accompanied by surface subsidence, the formation of sinkholes, and the development of fissures. These events reflect the volcanic variability (Aliyev et al., 2015).

Garasu's island location, coastal instability, fracture formation, and constant fluid release enhance its scientific value but limit public access. Until a marine access and risk management plan is developed, the site should be used primarily for remote monitoring, specialized scientific expeditions, and digital interpretation.



6. Prerequisites for the development of the geopark

Azerbaijan has established important legal, environmental, and institutional foundations that support the future development of geoparks. These include the activities of the State Nature Reserve, national regulation of geological parks, and the creation of specialized tourism infrastructure. The reserve's experience can be used to organize geoconservation and monitoring of future geopark territories. However, preparing an international nomination requires defining uniform boundaries, establishing a specialized governing body, developing an integrated development plan, and establishing a mechanism for the participation of municipalities, local communities, and entrepreneurs.

A UNESCO Global Geopark should integrate geological heritage of international significance with long-term management, geoconservation, education, sustainable development, geotourism, and local community participation (Aliyev et al., 2024). Available data allow us to identify certain prerequisites for meeting these requirements, but do not confirm the site's full readiness.

The scientific significance of Azerbaijan's mud volcanoes is determined by their high concentration, morphological diversity, and the geological conditions of the South Caspian Basin, whose sedimentary cover exceeds 30 km (Aliyev et al., 2015). Designating the area as a state nature reserve ensures its legal protection and creates a reliable basis for regular monitoring. At the same time, establishing a geopark requires a unified territory, a specialized management system, a long-term development plan, and documented participation of local communities.

Preparing a geopark designation requires addressing several interrelated issues. Key constraints include the fragmentation of protected areas, the lack of a comparative geosite inventory, surface instability, gas emission, fracturing, subsidence, erosion of breccia blankets, and unregulated off-road vehicle traffic. Additional challenges include the proximity of individual sites to development zones, limited accessibility of island volcanoes, and insufficient community engagement. For the most visited sites, plans for safety, security, and recreational load management are required. Addressing these constraints should be regarded as a priority before initiating an application to the UNESCO Global Geoparks Programme.

At the same time, conditions exist that facilitate the development of a geopark initiative. The state nature reserve forms the institutional basis for geoconservation, and the existing tourist infrastructure increases accessibility to individual sites. Their distinctive geomorphology provides an opportunity to develop a unique geotourism identity that differs from traditional mountain- and cave-based geoparks.

7. Geotourism and sustainable development

Specialized geotourism infrastructure related to mud volcanoes is currently under development. Geotourism provides an opportunity to promote geological heritage while supporting environmental education, regional economic development, and public awareness of geoconservation. A key feature of this development is the availability of tourist infrastructure, including information and exhibition spaces, observation platforms, and visitor services. Tour programs often combine visits to mud volcanoes with the Gobustan rock art and other archaeological and cultural sites. Such integrated routes increase the educational value of excursions and encourage visitors to explore both the geological and cultural heritage of the region. The proximity of some volcanoes to Baku creates opportunities for one-day itineraries, while more distant sites can be included in specialized multi-day programs. However, a unified geotourism network encompassing these sites has not yet been established.

Interpretation of mud volcanoes for visitors should be based on safe observation of passive fluid manifestations, landforms, and geological processes in the South Caspian Basin. Eruptions are unpredictable and may be accompanied by the release of breccia, gases, and ignition, so they should not be considered a tourist product. Consequently, visitor management should prioritize safety, environmental protection, and scientifically guided interpretation rather than direct observation of hazardous volcanic



activity. The use of mud volcanic material for health purposes also requires separate mineralogical, geochemical, microbiological, toxicological, and clinical studies and is not assessed in this paper.

Geopark development can contribute to local economic diversification, employment, and support for small businesses. To achieve this, tourist flows must be regulated with due regard for environmental constraints, and local communities must participate in the provision of services and the distribution of economic benefits. The effectiveness of this approach can be assessed by the level of local employment, the participation of local providers, the condition of geosites, the satisfaction of residents and visitors, and the number of protection violations.

8. Practical priorities

1. Complete an inventory of mud volcanic geosites and conduct a comparative qualitative assessment.
2. Define the boundaries of the proposed geopark area and develop a specialized management system.
3. Develop geoconservation, monitoring, and safety plans for the most active and visited sites.
4. Develop a unified system of educational routes, information materials, and guide training.
5. Ensure the participation of local communities, municipalities, and entrepreneurs in the planning and implementation of the geopark initiative.
6. Prepare the official international application after a sustainable management system has been established and the key requirements of the UNESCO Global Geoparks program have been met.

9. Conclusions

The mud volcanic landscapes of Azerbaijan form a diverse complex of geological heritage sites. Their scientific value stems from active fluid manifestations, the morphology of volcanic edifices, and the opportunity to study deep sedimentary and petroleum systems. The accessibility of some sites and the distinctiveness of their topography create additional opportunities for field education and geotourism.

A state nature reserve, national regulation of geological parks, and developing tourism infrastructure form the foundation for the geopark initiative. The inclusion of Lokbatan on the UNESCO World Heritage Tentative List demonstrates the international interest in the country's mud volcanic heritage. However, existing forms of protection and recognition do not replace the specialized management system of a UNESCO Global Geopark.

Ayrantoken, Arzani, Gelenderakhtarma, and Garasu exhibit differences in morphology, activity patterns, accessibility, and natural risks. Further development of the geopark initiative should be based on an inventory of geosites, the definition of a unified territory, the development of geoconservation and safety plans, and the participation of local communities. Achieving these objectives will allow for the integration of geological heritage protection, scientific research, education, and sustainable geotourism within a single strategy. This review is based on published scientific literature and official sources and does not include original field investigations or quantitative geosite assessment. Future research should apply standardized geosite evaluation methods, GIS-based spatial analysis, and field-based investigations to support evidence-based geopark planning and sustainable management.

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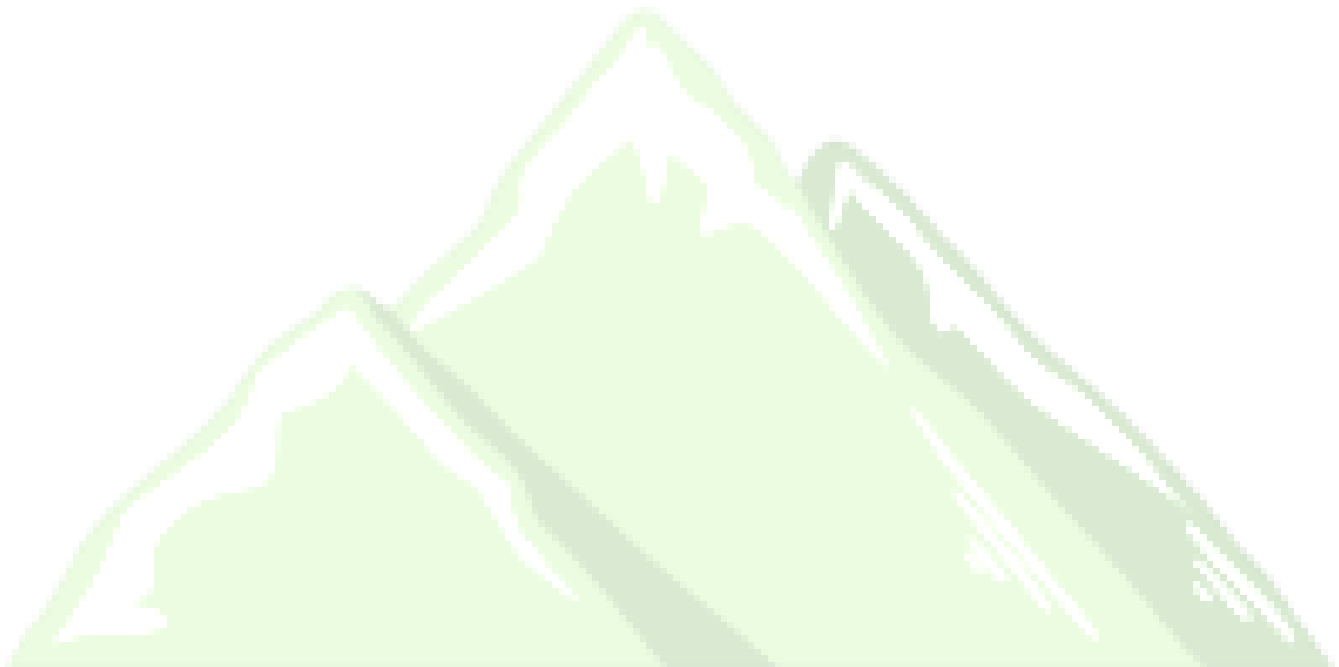
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Current Status and Classification of Vegetation Cover in the Gunnut–Gapicik Region of the Nakhchivan Highlands

Turan Mammadli ✉ 

Department of Biology, Nakhchivan State University, Nakhchivan, Azerbaijan.

Abstract. Vegetation cover plays a fundamental role in maintaining ecosystem stability, biodiversity conservation, and the sustainable use of natural forage resources in mountainous regions. This study investigates the current status, distribution patterns, and classification of vegetation cover in the Gunnut–Gapicik region of the Nakhchivan Highlands. Field investigations were conducted during 2017–2024 using standard geobotanical survey methods. Vegetation types were identified and classified according to classical and modern geobotanical approaches based on field observations and phytocenological analyses. The results revealed that the vegetation of the study area is represented by eight major vegetation types comprising 33 formation classes, 94 formations, and 137 associations. Mountain-xerophytic, steppe, shrub, forest, meadow, swamp, rock-scrub, and oasis vegetation communities were distinguished, while subalpine, alpine, tugay, and wetland ecosystems occupy significant ecological niches within the region. The distribution of vegetation was found to be closely associated with altitudinal gradients and environmental conditions, reflecting the high ecological diversity of the area. The obtained results contribute to a better understanding of the vegetation structure of the Gunnut–Gapicik region and provide an important scientific basis for biodiversity conservation, sustainable pasture management, and future ecological monitoring in the Nakhchivan Highlands.

Keywords: vegetation cover, Gunnut–Gapicik region, vegetation classification, plant communities, geobotany

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1. Introduction

The Nakhchivan Highlands represent one of the most ecologically diverse regions of Azerbaijan due to their complex relief, wide altitudinal range, and diverse climatic conditions. These environmental characteristics have contributed to the formation of a rich and highly heterogeneous vegetation cover. There are approximately 2.5 million hectares of fodder areas in our republic, of which up to 30% falls on the Nakhchivan Autonomous Republic. The fodder plants of the Nakhchivan plain and low mountainous areas have been partially studied in the area (Movsumova, 2005). The present study focuses on the investigation of forb forage plants in the Gunnut–Gapicik region. This covers an altitude of 1200 - 3906 m above sea level.

Numerous studies have investigated the vegetation of the Nakhchivan Autonomous Republic, providing valuable information on its vegetation classification, floristic diversity, and phytogeographical characteristics. L.I. Prilipko (Lavrenko, E. M., & Korchagin, 1960) divided the territory of the AR into semi-desert, mountain-xerophyte (phrygana), mountain-steppe (gariga), rock-scrub, meadow, forest, swamp, and oasis vegetation types. At the same time, the researcher divided the vegetation types into plant groups and geobotanical regions that form formations and associations. E.M. Gurbanov (Gurbanov, 1984) noted that the Nakhchivan basin belongs to 6 vegetation types; S.Y. Babayev (Babayev, 1999) shows that there are 4 vegetation zones in the Nakhchivan AR: semi-desert, mountain-xerophyte, high mountain steppes,



and alpine meadows. T.H. Talibov inspected the territory only for Cormobionta (Talibov, 2003: 6) according to A.Sh. Ibrahimov (Ibragimov, 2005) the territory of the AR is represented by 17 vegetation types, 16 subtypes, 21 formation classes, 310 formation groups, 13 formation subgroups, 430 formations, 1700 associations and microgroups; in addition, 4 botanical-geographical regions, 16 flora regions and 62 geobotanical regions are distinguished in the region.

The distribution of Apiaceae and Polygonaceae in vegetation types and their formation of tall herbaceous phytocenoses was studied by S.J. Ibadullayeva (Ibadullayeva, 2004; Ibadullaeva et al., 2008) and others. A.H. Ismayilov (Ismayilov, 2007) showed that semi-desert, mountain-xerophyte (phrygana), steppe, shrub, meadow, forest, water-swamp, petrophilous, and oasis vegetation types are distributed in the Gilanchay basin based on vertical zonation. However, the role of forage plants in the Gunnut-Gapicik region in the vegetation type has not been studied. Therefore, we set the goal of studying forb forage plants in the Gunnut-Gapicik region.

2. Materials and Methods

This study was conducted to investigate the composition and distribution of forb forage plants (excluding grasses and legumes) in the mountainous areas of the Nakhchivan Autonomous Republic during 2017–2024. In this regard, the forb forage plants of the flora of the area were studied in detail in the spring, summer, autumn, and winter seasons, and their role in vegetation types was determined.

Field expeditions were conducted in the upper mountainous areas of the Sadarak, Sharur, Kangarli, Shahbuz, Julfa, and Ordubad districts within the Gunnut–Gapicik physiographic region of the Nakhchivan Autonomous Republic.

During the geobotanical research, generally accepted methods were used: “Programs for geobotanical research” (Prilipko, 1939). “Methodology of field geobotanical research” (Haciyev, 2004; Gorodkov, 1938). The forage areas were determined according to the “Research methodology of natural forage areas” (Haciyev et al., 1995), and the classification of vegetation was determined using classical and modern geobotanical methods (Alekhin, 1950; Iljinski, 1935).

3. Results

The vegetation of the forage areas of the region is characterized by diverse phytocenological features and taxonomic composition. The historical development of the vegetation cover of the Gunnut-Gapicig region is determined by a number of factors. We have determined that the vegetation of the spring-summer and winter pastures of the Gunnut-Gapicig region is concentrated in 8 vegetation types, which include 33 formation classes, 94 formations, and 137 associations. Subalpine, alpine, water-swamp, to a lesser extent semi-desert and tugay groupings are also found in its vast areas, which are also included in the above-mentioned vegetation types. The separated vegetation types and their formations are characterized below.

Mountain-xerophyte (phrygana) vegetation. This vegetation type is zonal in nature and is mainly distributed in the region at 1200–1500 m above sea level. Phrygana type is represented by 5 formation classes, 12 formations, and 21 associations. The vegetation classification is as follows. (F-formation; A-association)

Formation class: Thorny bushes

F: *Zygophylleta atriplicoides*

A: 1. *Zygophyllum atriplicoides* + *Peganum harmala*; 2. *Zygophyllum atriplicoides* + *Reaumuria persica* + *Atraphax spinosa*

F: (*Rhamnus pallasii*)

A: *Rhamnus pallasii* + *Cerasus microcarpa* + *Amygdalus fenzliana*



F: Caraganea grandiflorae

A: 1. *Caragana grandiflora*: 2. *Caragana grandiflora* + *Zygophyllum atriplicoides*

Formation class: Tragacanth

F: (*Astragaleta lagurus*

A: 1. *Astragalus lagurus* + *A. regelli*: 2. *Astragalus euoplus* + *Festuca sclerophylla*: 3. *Astragalus euoplus* + *Acantholimon karelinii*

Formation class: Cushion-form

F: *Acantholimoneta karelinii*

A: *Acantholimon karelinii* + *A. araxanum*

F: *Astracantha microcephalae*

A: *Astracantha microcephalae*

F: *Onobrycheta cornutae*

A: 1. *Onobrychis cornuta*: 2. *Onobrychis cornuta* + *Artemisia lerchiana* + *Eremostachys macrophylla*

Formation class: Subshrub and semi-subshrub friganas

F: *Thymeta kotschyanus*

A: 1. *Thymus kotschyanus*: 2. *Thymus kotschyanus* + *Stipa capillata*: 3. *Thymus colinus* + *Astragalus lagurus* + *Acantholimon karelinii*

F: *Stachyeta inflatae*

A: 1. *Stachys inflata*: 2. *Stachys inflata* + *Thymus colinus* + *Acantholimon karelinii* : 3. *Stachys inflata* + *Capparis herbacea*

Formation class: Woody-stemmed perennial herbs

F: *Euphorbieta seguierianae*

A: *Euphorbia seguieriana*

F: *Eryngieta billardieri*

A: *Eryngium billardieri* + *Rosa canina* + *Phlomis pungens* + *Herbosa*

F: *Prangoeta ferulaceae*

A: *Prangoseta ferulaceae* + *P. acaulis*

Steppe vegetation. The steppe vegetation of the region covers 1500- 2300 m a.s.l. Three formation classes, 10 formations, and 17 associations have been identified in the steppe vegetation. The classification is as follows:

Formation class: Grass-forb mountain-xerophytic steppes

F: *Stipeta capillatae*

A: 1. *Stipa capillata*: 2. *Stipa capillata* + *Festuca valesiaca*: 3. *Stipa capillata* + *Atraphax spinosa* + *Herbosae*: 4. *Stipa capillata* + *Stachys inflata* + *Thymus kotschyanus* + *Kochia prostrata*

Formation class: Gariga-type steppes

F: *Atraphaxeta spinosae*

A: 1. *Atraphaxis spinosa*: 2. *Atraphaxis spinosa* + *Caragana grandiflora*

F: *Spiraea crenata*

A: 1. *Spiraea crenata* + *S. hypericifolia*: 2. *Spiraea crenata* + *Rhamnus pallasii*

Formation class: High mountain-meadow steppes



F: *Festuceta valesiaca*

A:1. *Festuca valesiaca* + *F.sclerophylla*: 2. *F.sclerophylla* + *Festuca valesiaca* : 3. *Festuca valesiaca* + *Thymus kotschyanus* + *Astragalus euoplus* + *A.cicer*

F: *Bothriochloa ischaemum*

A:1. *Bothriochloa ischaemum* + *Trifolium pratense* + *Lotus corniculatus* + *Herbosa*: 2. *Bothriochloa ischaemum* + *Ephedra procera*

F: *Brometa racemosus*

A:1. *Bromus racemosus* + *Festuca valesiaca* + *Herbosa*: 2. *Bromus racemosus* + *Filipendula vulgaris*

F: *Koeleria kurdicum*

A: *Koeleria kurdicum* + *Amoria hybrida* + *Trifolium pratense* + *T.canescens*

F: *Poa bulbosa*

A:1. *Poa bulbosa* + *P. trivalis* + *P. pratensis*; 2. *Poa bulbosa* + *Hordeum violaceum* + *H.bulbosum* + *Festuca pratensis* + *Herbosa*

F: *Seseli peucedanoides*

A: *Seseli peucedanoides* + *Stipa capillata* + *Filipendula vulgaris* + *Thymus collinus*

F: *Hedypneta cretica*

A: *Hedypnois cretica* + *Thymus collinus* + *Ziziphora tenuior* + *Z.capitata*

Shrub vegetation. The bushes spread in the areas of the villages of Gilanchay, Paragha, Tivi, Nasirvaz and Nurgut of the basin at altitudes of 1200-3200 m above sea level, rising to the borders of the subalpine and alpine belts. This vegetation is divided into 2 formation classes, 9 formations and 14 associations.

Formation class: Evergreen shrubs

F: *Juniperata foetidissimum*

A:1. *Juniperus foetidissimum*+*J.polycarpus*+ *J.hemispheriaca* + *Astracantha microcephala* + *Herbosa*; 2. *Juniperus foetidissimum* + *J.polycarpus* + *Ephedra procera* + *E.aurantica* + *Fruticosus*; 3. *Juniperus foetidissimum* + *J.hemispheriaca* + *J.polycarpus* + *Atrophax spinosa*

F: *Ephedra procera*

A: *Ephedra procera* + *Astracantha microcephala*

F: *Tamariceta meyeri*

A: *Tamarix meyeri* + *T.kotschy*

Formation class: Deciduous shrubs

F: *Amygdaleta fenzlianae*

A: 1. *Amygdalus fenzliana* + *Atrophax spinosa* + *Rhamnus pallasii*; 2. *Rosa canina* + *Lonicera iberica* + *Amygdalus fenzliana*

F: *Rhueta coriariae*

A: *Rhus coriaria*

F: *Berberieta vulgaretum*

A: 1. *Berberis vulgaris*+*Rosa canina*+*Acer ibericum*; 2. *Berberis vulgaris* + *B.densiflora* + *Cotonoaster melanocarpus* + *Spiraea crenata* + *S.hypericifolia*

F: *Roseta rapinietum*

A: 1. *Rosa rapinii* + *Rosa canina* + *R.nisami*; 2. *Rosa rapinii* + *Rosa canina* + *R.nisami* + *J.hemispheriaca* + *J.polycarpus* + *Crataegus meyeri* + *C.caucasica*

F: *Cotonoaster melanocarpus*

A: *Cotonoaster melanocarpus* + *Cerasus incana* + *C.integerrimus* + *Astracantha gudrath* + *A.insidios*



F: *Sorbueta persicae*

A: *Sorbus persica* + *S.boissieri* + *Viburnum lantana* + *Crataegus orientalis* + *C.pseudoheterophylla*

Forest vegetation. The natural forests of the basin consist of Tillak, Palidlidere, Talalar, Gevik, Ashagi, Yukhari Jalil (117 ha) and Nasirvaz forests (350 ha), spreading around the villages of Nurgut, Alahi, Khurs, Bist, Tivi, Paragha and Nasrivaz at altitudes of 1500-2700 m a.s.l. This vegetation type is divided into 3 formation classes, 8 formations and 17 associations.

The region's tugay forests are spread in narrow strips along the river banks. Species such as *Populus canescens*, *Ulmus minor*, *Pyrus caucasica*, *Berberis iberica*, *Tamarix meyeri*, etc. are found here. *Saliceta albaetum* formation has few components and is mainly located in narrow gorges along the valleys. In the basin areas, willow forests are represented by *Salix aeduptiaca*, *S.triandra*, *S. alba*, and shrubby *S.caprea*.

Tugay forests have great economic and phytocenological importance. These forests limit the excessive expansion of river channels, prevent erosion, and increase soil fertility. In recent years, as a result of direct human activity, tugay forests have undergone changes, and their areas have shrunk significantly. If necessary measures are not taken to protect these forests, they are in danger of complete destruction. Their classification is as follows.

Formation class: Tugay forests

F: *Saliceta albaetum*

A: 1. *Salix alba* + *S.triandra* + *S.caprea*; 2. *Salix alba* + *Elaeagnus angustifolia* + *Tamarix meyeri*

F: *Populeta gracilis*

A: 1. *Populus gracilis* + *P.euphratica* + *P.nigra*; 2. *P.nigra* + *S.triandra*

F: *Ulmua minoretum*

A: *Ulmus minor* + *Populus gracilis* + *Salix alba*

Formation class: Broad-leaved mountain forests

F: *Querceta macrantheretum*

A:1 *Quercus macranthera*; 2. *Quercus macranthera* + *Fraxinus excelsior* + *Acer bericum*; 3. *Quercus macranthera* + *Crataegus meyeri* + *C.orientalis*

F: *Crataegus meyeretum*

A:1. *Crataegus meyeri* + *Pyrus salicifolia*; 2. *Crataegus meyeri* + *Pyrus salicifolia* + *Malus orientalis* + *Quercus macranthera*

F: *Betuleta penduletum*

A:1. *Betula pendula* + *Sorbus greaca*; 2. *Betula pendula* + *Quercus macranthera* + *Fraxinus excelsior*; 3. *Betula pendula* + *S.caprea* + *Altherbosa*

Formation class: Sparse arid forests

F: *Pyrus salicifolietum*

A:1. *Pyrus salicifolia* + *P.caucasica* + *Cotonoaster melonacarpus* + *Rosa canina* + *R.rapinii* + *R.nisami*; 2. *Pyrus salicifolia* + *P.caucasica* + *Crataegus meyeri* + *Malus orientalis*; 3. *Pyrus salicifolia* + *Juniperus polycarpus* + *Quercus macranthera*

F: *Celtiseta tournefortietum*

A: *Celtis tournefortii* + *C.caucasica*

Meadow vegetation. This type covers almost all altitudinal zones in terms of vertical zonation. It is distributed in 14 formation classes, 42 formations, and 52 associations in the floodplain, sinkhole-meadow, forest understorey, post-forest meadow-shrub, subalpine, alpine, and alpine carpet meadow subtypes.



The floodplain and sinkhole-meadow subtype is mostly found in the areas of the Gilanchay River that pass through the villages Bist and Bash Diza. This subtype is divided into 2 formation classes, 6 formations, and 10 associations.

The alpine meadows subtype begins with the gradual disappearance of subalpine meadows in the basin, so that sometimes it is difficult to trace the boundaries of this transition. However, in some areas the transition is quite abrupt, or one of these meadows disappears and is replaced by another. This subtype is divided into 2 formation classes, 3 formations and 5 associations.

Alpine carpets subtype is distributed in the northern slopes of the basin, where the tundra climate prevails, in the rocky, stony-gravelly, subnival and nival zones characterized by snow and glaciers. This subtype is divided into 2 formation classes, 11 formations and 11 associations.

Semitype: Floodplains and meadows

Formation class: Floodplain meadows

F: *Lotuseta corniculatusetum*

A:1. *Lotus corniculatus*; 2. *Lotus corniculatus* + *Carex vesicaria* + *Cynodon dactylon* + *Phleum pratense* + *Herbosa*

F: *Trifolium pratensis*

A: *Trifolium pratensis*

F: *Elitrigia caespitosaetum*

A:*Elitrigia caespitosa* + *Dactylis glomerata* + *Cynodon dactylon* + *Alopecurus ventricosus* + *Phleum pratense*

F: *Filipendula ulmaria*

A: *Filipendula ulmaria* + *Hordeum bulbosum* + *H.violaceum*

Formation class: Hole meadows

F:(*Cynodoeta dactylon*

A:1. *Cynodon dactylon*; 2. *Cynodon dactylon* + *Alhagi pseudalhagi*; 3. *Cynodon dactylon* + *Tamarix meyeri*; 4. *Cynodon dactylon* + *Glycyrrhiza glabra*

F: *Aeluropeta repens*

A: *Aeluropus repens*

Semitype: Understorey, post-forest meadows and meadow-shrubs

Formation class: Grass-sedge-forb understorey meadows

F: *Poterieta lasiocarpum*

A: *Poterium lasiocarpum* + *Bromus racemosus*

F: *Potentilla recta*

A: *Potentilla recta* + *Poa araratica* + *Artemisia absinthum*

F: *Carixeta tristisae*

A: *Carex tristis* + *Echenochloa crusgalli* + *Aeluropus repens*

Formation class: Grass- legume- forb meadow shrubs

F: *Amorieta bordzilowskiae*

A: 1. *Amoria bordzilowskyi* + *Cephalaria procera*; 2. *Vicia elegans* + *Poa bulbosa* + *Galium verum*

Formation class: Post-forest dry meadows

F: *Agrostieta capillaris*

A: *Agrostis capillaris* + *Vicia variabilis* + *Herbosa*

Semi-type: Subalpine meadows of the high mountains



Formation class: Tall-grass subalpine meadows

- F: *Chaerophylleta bulbosum*
- A: *Chaerophyllum bulbosum* + *Ch.aureum*
- F: *Thalictrueta minus*
- A: *Thalictrum minus*
- F: *Heracleta trachylomae*
- A: *Heracleum trachylomae*
- F: *Aconiteta nasutum*
- A: *Aconitum nasutum*+*Heracleum trachyloma* + *Rumex alpestris* + *R.acetosa*
- F: (*Rumceta alpestris*
- A: *Rumex alpestris*
- F: *Doroniceta macrophyllum*
- A: *Doronicum macrophyllum*
- F: *Cirsieteta arvensae*
- A: *Cirsium arvense*

Formation class: Legume-forb subalpine meadows

- F: *Cicereta anatolicum*
- A: *Cicer anatolicum* + *Pulsatilla violacea* + *Hypericum perforatum*

Formation class: Dry grass subalpine meadows

- F: *Nardueta strictae*
- A: *Nardurus stricta* + *Festuca valesiaca*)
- F: *Festuceta sclerophyllae*
- A: 1. *Festuca sclerophyllae*+*Alchemilla sericea*; 2. *Festuca sclerophyllae*+*Bromus racemosus*
- F: *Poa compressa*
- A: *Poa compressa* + *Stipa capillata* + *Alchemilla epipsila*

Formation class: Humid (mesophilic) subalpine meadows

- F: *Hordeta violaceum*
- A: *Hordeum violaceum*+*H.bulbosum*+*Amoria ambigua*+*Trifolium montana*
- F: *Gentianeta anglosae*
- A: *Gentiana anglosa*
- F: *Geranieta collinum*
- A: *Geranieta collinum*+*G.divaricatum*+*Trifolium trichocephalum* + *T.canescens*

Formation class: Geophyte subalpine meadows

- F: *Allieta atrovioleum*
- A: *Allium atrovioleum* + *A.kunthianum* + *A.akaka* + *A.mariae*
- F: *Irieta imbricata*
- A: 1. *Iris imbricata*; 2. *Iris imbricata*+*I.lycotis*+ *Herbosa*
- F: *Gageta chloranthae*
- A: *Gagetum chloranthae*
- F: *Eremurus spectabilis*
- A: *Astragalus szowitsii* +*Eremurus spectabilis*
- Semi-type: Alpine meadows of high mountains

Formation class: Mixed grass alpine meadows

- F: *Alopecureta textilis*



A: *Alopecurum textilis* + *Phleum pratense*

F: *Agrosteta lazicae*

A: *Agrostis lazicae* + *Festuca valesiaca*

Formation class: Sedge-grass-legume-forb alpine meadows

F: *Carexeta tristis*

A: 1. *Carexetum tristiae*; 2. *Carex tristis* + *Festuca sclerophyllae* + *Astragalus alpinus*; 3. *Carex tristis* + *Festuca sclerophyllae* + *Alchemilla sericea*

Semi type: Alpine meadows of the tundra-type subnival and nival zones of the high mountains

Formation class: Humid alpine carpets

F: *Veroniceta gentianoides*

A: *Veronica gentianoides* + *V. anagallis-aquatica* + *Myosotis alpestris*

F: *Junceta alpigenus*

A: *Juncetum alpigenae*

F: *Ficarieta ficarioides*

A: (*Ficarietum ficarioides*)

Formation class: Rocky, gravelly alpine carpets

F: *Sibbaldieta parviflorae*

A: *Sibbaldia parviflorae* + *S. semiglabra*

F: *Campanuleta tridentata*

A: *Campanula tridentata*

F: *Minuartiteta aizoides*

A: *Minuartia aizoides* + *Plantago atrata*

F: *Pedicularieta crassirostris*

A: *Pedicularis crassirostris* + *Physioptychis caspica*

F: *Carumeta caucasicum*

A: *Carumetum caucasicae*

F: *Alchemileta sericeae*

A: *Alchemilletum sericeae*

F: *Plantageta saxatilis*

A: *Plantagetum saxatilis*

F: *Taraxaceta stevenii*

A: *Taraxacetum stevenii*

Swamp vegetation. This vegetation type is not very widespread in the study area. Swamps are mainly formed in plains where rainwater collects, and groundwater is close to the surface. Swamps are found in high mountain belts, near springs, natural and artificial lakes. Species such as *Veronica anagallis-aquatica*, *Mentha langifolia*, *Rumex acetosa*, *Carex vesicaria*, *Juncus compressus*, etc. are found here.

Formation class: True aquatic plants that are above water, floating on water, and submerged

F: *Typha laxmannii*

A: 1. *Typha laxmannii* + *T. minima* + *T. latifolia*; 2. *Typha laxmannii* + *Phragmites australis*; 3. *Typha laxmannii* + *Poa trivialis*

F: *Lemneta minor*

A: *Lemna minor* + *L. trisulcata*

F: *Persicarieta hydropiper*

A: *Persicarietum hydropiper*

F: *Potamogeta nodosus*



A: 1. *Potamogetonum nodosae*; 2. *Potamogetonum crispusae*

Formation class: Amphibious wetland plants

F: *Bolboschoeneta maritimus*

A: *Bolboschoenus maritimus*+*Typha laxmannii*+*Phragmites australis*

F: *Eleochareta palustris*

A: (*Eleocharietum palustris*

F: *Cypereta longus*

A: *Cyperus longus*

Formation class: Coastal wetland plants

F: *Junceta effusus*

A: *Juncus effusus* +*J.bufo*

F: *Phragmiteta australis*

A: *Phragmites australis*+*Carexeta vesicariae*

Formation class: Subalpine and alpine wetland plants

F: *Senecieta racemosus*

A: *Senecio racemosus*

F: *Luzuleta spicatae*

A: *Luzula spicatae*+*Carex canescens*+*Elitrigia caespitosa*

F: *Saginetum procumbens*

A: *Saginetum procumbens*

F: *Caltheta polypetalae*

A: *Calthaetum polypetalaea*

Rock and scree vegetation. This vegetation type covers all mountainous zones. It is distributed in 2 formation classes (rock and scree vegetation). Genera and species such as *Saxifraga pontica*, *Sedum tanellum*, *Erysimum pulchellum*, *Dianthus orientalis*, *Campanula bayerniana*, *Ephedra procera*, *Juniperus*, *Crataegus* and *Rosa* are found here. Stable scree compositions include particularly prominent species such as *Vicia ciceroidea*, *Nepeta buschii*, *Cirsium tomentosum*, *Jurinella subacsulis*, *Ranunculus caucasicus*, whereas the partially mobile part includes *Vicia varia*, *Oxyria digyna*, *Sibbaldia semiglabra*, *Nonea pulla*, etc.

Oasis vegetation. This vegetation type covers the areas of gardens and irrigated cultivated fields in the residential plains and mid-mountainous belt. They include trees and shrubs such as *Platanus orientalis*, *Juglans regia*, *Populus gracilis*, *Fraxinus exelsior*, *Salix alba*, *Ulmus scabra*, etc., perennial plants *Onobrychis transcaucasica*, *Hordeum bulbosum*, *Falcaria vulgaris*, *Melilotus*, *Agrimonia eupatoria*, etc., as well as harmful and poisonous species.

4. Conclusion

The vegetation cover of the Gunnut–Gapıcık region is characterized by high phytocenological diversity and includes eight major vegetation types comprising 33 formation classes, 94 formations, and 137 associations. The obtained results improve the understanding of vegetation structure in the Nakhchivan Highlands and provide a scientific basis for biodiversity conservation, sustainable pasture management, and future ecological studies.

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Geopolitics and Strategic Importance of Mountainous Regions: An Analytical Approach in the Context of International Relations, Security, and Military Strategy

Ayten Heydarli ✉ 

Department of Political Science and International Relations, Western Caspian University, Baku, Azerbaijan

Abstract. Geographical elements have long been considered among the most important factors influencing state strategy in international relations. But it is important to note that mountainous regions have mostly been described as either geographical barriers or regions that are difficult to traverse during military campaigns. In this paper, we present a fresh outlook on mountainous regions by examining them not just as passive geographical elements but also as active geostrategic elements that influence the state's security policy and military-strategic position. The research finds new conceptual frameworks, such as "vertical sovereignty," the "mountain security paradox," and "space-time strategic asymmetry." We also use historical-analytical, theoretical-conceptual, comparative-analytical, and empirical methods; the research shows that mountainous regions are not merely defensive lines but essential components of strategic resilience and asymmetric power balance in modern international relations.

Keywords: mountainous areas, geopolitics, security, military strategy, international relations

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1. Introduction

Spatial factors have long been regarded as one of the principal determinants shaping state behaviour in international relations. Traditional schools of geopolitics have primarily focused on maritime access, plains, and transportation infrastructure as the main sources of state power, while comparatively little attention has been paid to mountainous regions. Mountains have been largely depicted in the existing body of literature as either a natural boundary of states or as a geographical feature that hinders military movements (Mackinder, 1904; Ratzel, 1897).

Recent studies have increasingly approached this issue from a broader geostrategic perspective. This study argues that, within the contemporary international security environment, mountainous regions perform a far more complex and strategic role than has traditionally been assumed. The paper contends that mountainous regions should not be treated as passive geographical entities but as active geostrategic spaces that impact the state's security system and strategic actions. Mountains are not only used as a platform for defense or operational action but also as a determinant that fundamentally shapes a state's sovereignty, strategic security concerns, and even temporal planning (Kaplan, 2012; Dalby, 2002).

Geography is one of the most important factors that continues to influence the actions of states in international relations. More specifically, mountainous border areas create a specific environment that directly impacts the security and military plans of states. In addition to their role as barriers, mountains are important determinants of political-strategic decisions. High-altitude terrain and mountain passes provide



significant strategic advantages by strengthening defensive positions while, in some cases, limiting effective state control and creating opportunities for non-state actors.

The conduct of military activities in mountainous areas is associated with considerable logistical and strategic challenges. Strategic issues such as time management, logistics, and relations with the local population become important in mountainous areas. In a broader context, mountains can affect the balance of power in a region and the allocation of strategic advantage. The strategic and geostrategic significance of mountainous areas has increased in modern conflict, thus emphasizing the need to assess mountainous areas not only as geographical features but also as essential components of complex security and military strategy frameworks.

2. Mountainous Areas as Geostrategic Spaces

Previous studies suggest that in geostrategic concepts, space is not only a territory on the map but a social and strategic construct in which the relationship of power is created (Agnew, 2003). Compared with plains, mountainous regions are characterized by a more complex manifestation of state sovereignty. While the border on the plain is considered a horizontal line, sovereignty in mountainous regions has a vertical aspect. In this regard, the concept of “vertical sovereignty” can be introduced (Haggett, 2001). Vertical sovereignty is the focus of the state not only on its land territory but also on highlands, passes, and control points.

Mountains both shield and endanger the state. This can be explained by the “mountain security paradox,” whereby mountains are a positive factor in defense, but they are a negative factor in the control of peripheral regions by the central authority (Brunet-Jailly, 2012). In addition, mountainous regions influence the diplomatic and strategic actions of states, especially in border areas. For instance, in the South Caucasus, mountainous borders have had a considerable impact on the security and military strategies of Armenia and Azerbaijan (Cornell, 2001). Therefore, mountains have both geographic and diplomatic-strategic importance.

Mountains are not only physical barriers but also geostrategic spaces that influence state decision-making. The concept of *vertical sovereignty* emphasizes that states must exercise effective control not only over territorial boundaries but also over highlands, mountain passes, and other strategic elevations. Although mountains strengthen state borders, they may simultaneously reduce central authority over peripheral areas, creating a security paradox that requires comprehensive long-term strategic planning. Mountain passes and mountainous areas enhance diplomatic flexibility. Mountainous regions also need a special mechanism to monitor and control the actions of non-state actors. Mountains are also responsible for shaping the security culture of a state. Military activities and defense strategies in mountainous regions require longer-term planning. Border posts and strategic sites in highlands improve a state's influence in the region. Mountainous regions face geographical obstacles that increase logistical difficulties, which require modifications in military strategy. Each peak and pass is a strategic location for both offense and defense.

Because of these features, mountain ranges are very important areas from the perspective of international security. They also represent geostrategic balancing elements that determine the state's diplomatic and military strategies. The strategic importance of mountainous areas differs from one region to another, but they always affect the balance of power and defense. The control of these areas is maintained not only by military means but also by relations with the local population and social policies, forcing states to build their strategies on both military and social foundations. Mountain ranges increase the possibilities of asymmetric power in border conflicts. Military activities in mountainous areas are often extended over time, which accelerates resource depletion. These areas are usually considered the standards for both the state's defense policy and strategic resilience in international relations. Additionally, mountainous areas represent complex geostrategic factors influencing both state security and military strategy.



3. Strategic Significance of Mountainous Areas and State Power

Mountainous regions expand the notion of state power beyond the traditional boundaries of measurement. Although power in the plains is essentially grounded in speed, technology, and mass maneuvers, in mountainous regions, it is based on endurance, control, and the time factor (Van Evera, 1999). Mountain ranges are strategic buffer zones that prevent attacks while at the same time extending conflicts and draining the resources of the enemy. This particular feature of mountain ranges turns them into instruments of asymmetric power, thereby changing the principles of balance in international relations

Mountain passes and high ground in mountainous terrain increase the strategic strength of a state. For instance, the border disputes between China and India in the Himalayan region are directly affected by the mountainous terrain, thereby having a profound effect on the military strategy of both countries (Kaplan, 2010).

Mountains upset traditional concepts of state power and require new strategic challenges. Unlike the plains, in mountainous areas, military superiority is not just a matter of numbers and technology. Endurance, positional advantage, and time management are the decisive factors. Mountainous areas are strategic buffers that prevent attacks and wars. This allows states to create asymmetric strategies, as war exhausts the enemy's resources and gives a temporal advantage to the defenders. Highlands and mountain passes are areas that easily allow the creation of strategic positions, which are advantageous for both offense and defense. Mountains are not just geographical obstacles but geostrategic tools that increase the state's power and influence. Asymmetric offensive and defensive strategies are more easily implemented in mountainous areas. Military logistics and resource transportation are more complicated in these areas, requiring strategic thinking. States need to optimally use both technological and human resources. Strategic passes in mountainous areas are of great importance in regional and international politics and are important factors in border conflict analysis.

The mountainous environment is a complex space that combines defense and diplomacy strategies. Relations with local populations and social policies are taken into account in strategic planning. Mountainous regions are also crucial for the preservation of international security balance. Each mountain and pass is an additional factor that enhances the strategic superiority of the state. Therefore, mountains are not only geographical features but geostrategic spaces that reshape the scale and character of state power.

4. Security Challenges in Mountainous Areas

The mountainous terrain is conducive to non-state actors because of the lack of state control (Fearon & Laitin, 2003). This offers strategic advantages to separatist movements, armed groups, and terrorist outfits. Security in mountainous terrain is a complex phenomenon that involves military, social, and economic considerations. Logistics, communication, and local population relations are essential for security. Therefore, the definition of security in mountainous terrain is much more complex than mere defense. Mountains are often corridors where the state has limited control, and non-state actors, including separatists and armed groups, enjoy greater flexibility. Topography makes military planning difficult, and dominance is not solely dependent on technology and numbers; time and position management are critical.

Security is not only dependent on military factors but also on social and economic elements. Interaction with the local population, winning their loyalty, and support are fundamental determinants. Mountainous terrain logistics and supply chains are major security challenges. Every mountain and narrow pass is of prime importance to security. Countries are forced to develop sophisticated intelligence and information networks. Air transport and drones provide novel security features, but their efficiency is not possible in mountainous regions. Mountain passes along the borders in mountainous regions are of prime significance for both legal and illegal purposes. The location of non-state actors can weaken a state's defensive position, leading to the formation of new security structures. Surveillance systems need to be strengthened to avoid



any incidents. Although new technology provides military superiority, its efficiency in mountainous regions is still limited. Therefore, asymmetric security policies are adopted. Mountains are a source of strength for defense but limit the control of the state, leading to a paradox that requires long-term strategic planning.

Strategic locations in mountains determine regional policies. Mountains are of prime importance in the global balance of power. Military missions in mountains are protracted, and resources are depleted quickly, compelling states to formulate contingency plans. Security is maintained not only by military power but also by diplomatic and economic policies. The complexity of border conflicts heightens security threats. Local population intelligence and cooperation are crucial for mission success. Mountainous region infrastructure protection is a vital security component. Every mountainous location offers strategic superiority for defense and offense. Non-state actors' locations may be military and political challenges for states. Mountainous regions also include humanitarian and environmental issues that influence security. States must formulate comprehensive security policies, taking into account these considerations. Integrating military technology with local knowledge multiplies strategic superiority. Security policies in mountainous regions must be dynamic and flexible. Military, police, and intelligence agencies must coordinate to control borders. Non-state actors' behavior is a crucial indicator in security analysis. Military missions are inherently unpredictable and demand innovative tactical solutions. Spatial and temporal considerations are vital in planning military missions. Mountain passes are both a source of threats and opportunities. States should build infrastructure in mountainous areas. Intelligence and information are key to success in operations, and the movement of non-state actors increases security threats. Operational plans must incorporate both short-term and long-term goals. Technological and strategic advancements are essential for security. The mountainous terrain enhances the strategic power of a state, utilizing both human resources and local knowledge as strategic instruments. Security can be guaranteed by both state and regional/international efforts. Asymmetric security strategies are successfully applied in modern-day scenarios. Military and security planning in mountainous areas should be multidisciplinary, incorporating geostrategic and local social aspects into decision-making.

5. Military Strategy in Mountainous Regions: Space-Time Asymmetry

The hallmark of mountain warfare is the space-time asymmetry in military strategy. Mountain warfare involves protracted time periods and positional defense, which are not beneficial in plain warfare but are instead crucial in mountain warfare (Boot, 2002). Mountain warfare military strategy is not only about passive defense but also facilitates active defense and asymmetric offensive attacks. This aspect calls for a paradigm shift in the importance of technology in modern warfare. Advanced technology may not produce the desired results in mountain warfare, thus challenging traditional notions of military dominance (Echevarria, 2007).

Mountain warfare does not involve swift attacks; instead, it involves long-term positional dominance. Mountain warfare restricts the speed of combat and combat maneuverability. The space-time asymmetry in mountain warfare is a critical factor in operational strategy. Every hill is of immense strategic and surveillance importance, and mountain passes change offensive and defensive strategies. Resource deployment in mountainous regions involves protracted periods, making it difficult to plan operations. Weather and terrain often affect the pace of combat. Technological application could be less effective, and experience is essential. Asymmetric attacks and guerrilla tactics are more successful in mountainous terrain. Defensive positions must be extensive and strong, and military command must display flexibility in decision-making. The strategic value of heights must be taken into account in long-term planning. Military bases in mountainous regions are essential, and intelligence and information gathering are vital for success.

The mountainous terrain limits the use of modern technology, thus underlining the need for local knowledge. Logistics play a crucial role in sustaining a strategic advantage, and resource constraints may impair the sustainability of operations. Defense strategies must factor in possible asymmetric strikes. High



ground is vital for both offense and defense. Mountainous terrain operations are protracted, offering a temporal advantage to the defender, and the attacker must factor in resource exhaustion. Border posts are of strategic value, and aerial reconnaissance, including drones, helps in operational planning. To succeed, operations must be coordinated not only among the military but also among the local population. Tactical intentions can fluctuate rapidly, and the attacker may need a long time to cover short distances.

Position control needs both physical presence and intelligence gathering. The imbalance between offense and defense directly affects battle results. Defense tactics need to achieve a balance between strength and mobility. Loss of position in mountainous terrain is a strategic setback. Operational planning needs to take into account the constantly changing air and ground conditions. Mountainous terrain is conducive to asymmetric operations, where small forces can achieve a big advantage. Long-term defense in such regions increases state resilience. Space and time asymmetry is a strategic advantage for both offense and defense. Military strategy in mountainous terrain needs a multidisciplinary approach.

6. Consequences of the Mountain Factor in Regional Settings

The geostrategic significance of mountains differs in various settings:

- Caucasus region: Mountains accentuate ethnic and political divisions, leading to prolonged border conflicts (Cornell, 2001).
- Himalayan region: In the India-China-Pakistan setting, mountains facilitate prolonged strategic confrontations (Kaplan, 2010).
- Afghanistan: Mountains have turned into strategic traps for great powers (Grau, 2006).
- Andes and South America: Mountains restrict state power and improve the status of non-state actors.

These examples illustrate that mountainous regions are not only local factors but also global geostrategic variables that directly affect the international security system. Mountains are strategic and geostrategic factors in regional politics. In the Caucasus, mountains directly affect state security policies, extend border conflicts, and restrict diplomatic possibilities. Strategic passes and mountainous terrain offer strategic advantages, as in the Armenia-Azerbaijan border conflict. In the Himalayas, mountainous terrain in the China-India border area provides a strategic opportunity for long-term confrontation, with military presence and mountainous terrain offering a great advantage. Mountainous terrain extends conflicts. In Afghanistan, mountains have become strategic traps for international powers, necessitating complex long-term strategies. Mountains make non-state actors strong and reduce state power. In the Andes, local factors and terrain shape the security balance. Mountains are not only physical obstacles but also regional factors of influence and power. Military, diplomatic, and economic factors are closely interwoven in the strategic planning of mountainous regions. In the Himalayan and Afghan regions, mountains impede operational speed and efficiency, whereas in the Caucasus region, mountains directly influence the balance of interstate power. Mountains influence both defense strategy and international relations in a regional setting. Mountains are vital for states to gain strategic superiority and improve diplomatic flexibility. Hence, mountainous regions are identified as crucial strategic and geostrategic factors, rather than simple geographical features.

7. Conclusion

Mountainous regions are not secondary geographical features in international relations. They are fundamental geostrategic regions that define a state's security culture, military strategy, and sovereignty concept. Mountains change not only the size but also the character of power in the modern international system.



The geopolitical and strategic study of mountainous regions provides new perspectives on international relations theory and alternative approaches in security studies (Kaplan, 2012; Van Evera, 1999). Mountains cannot be considered secondary geographical features; they have a vital role in defining security and military strategies. The mountainous environment changes defense and attack capabilities, which demand strategies based on time and space management. The idea of vertical sovereignty is vital to ensure state control in mountainous areas. Mountains enhance or constrain diplomatic capabilities, forcing states to adopt long-term strategies and asymmetric approaches. They extend border disputes and change the power balance in the regions. In regions like the Caucasus, Himalayas, and Afghanistan, the role of mountains shapes the future of conflicts. Mountains offer ideal conditions to non-state actors and are difficult to control by states, and hence, a complete security strategy is required. Every mountain and pass offers an advantage.

Conducting military operations in mountains is more complex than in other regions. Weather and terrain conditions impact the success of operations, and logistics and resource mobilization are big challenges. Asymmetric attacks are more effective in mountainous areas. The defense lines have to be long and strong. The mountainous terrain forces states to take a multidisciplinary approach to military planning. Security is not only ensured by military means but also by diplomatic, economic, and social instruments. Interaction with the local population is an essential part of planning. Passes are sources of threats as well as opportunities. Intelligence and reconnaissance missions offer a critical advantage. The mountain terrain demands perfect synchronization of military resources, technology, and human capabilities. Operations may be extended, and resource depletion may be hastened, necessitating the need for contingency planning. Mountains provide a balance between offense and defense from a strategic perspective. Dominating and securing mountain heights provides long-term strategic sustainability. Border disputes in mountainous regions provide an integration of diplomatic and military strategies. Decision-making is complex and multi-dimensional. Strategic security planning needs to take into account local, regional, and global considerations. The mountainous terrain requires the application of asymmetric power, which enhances the strategic position of a state. Military superiority is not only measured in terms of quantity and quality but also in terms of time and space superiority. Long-term operational planning in mountainous terrain needs to take into account military, diplomatic, and social factors. Strategic decision-making includes both defensive and offensive intentions.

Mountain heights and passes are of prime strategic importance. Mountainous terrain requires a paradigm shift in military and strategic planning, which emphasizes flexibility and agility. These areas shape the power dynamic in international relations. Mountains raise the level of complexity of regional conflicts. Security policies need to be flexible and adaptive. Mountains are essential parameters for strategic planning. They pose challenges and opportunities for non-state actors. Countries need to develop long-term strategies to secure borders and strategic locations. Military dominance in mountains is both offensive and defensive. Mountainous regions have a direct impact on international policy and politics. It requires multidisciplinary and quick decision-making. The mountainous environment reshapes the scale and character of state power. Therefore, mountainous regions in international relations need to be defined not only as geographical but also as strategic, military, and geostrategic factors.

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