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Polytraps in European rural mountainous regions: an expert view

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ABSTRACT

Many territorial and development policies in the European Union recognize that rural mountainous regions suffer from enduring natural and demographic disadvantages. These regions frequently face undesirable, persistent and self-reinforcing challenges, often conceptualized as traps. Through engagement with a panel of experts on mountainous regions, we examined whether the trap concept effectively explains the development challenges in European mountainous areas. We find that the distinguishing feature of these challenges is their multidimensional interrelatedness, which can give rise to multiple, simultaneously occurring traps (e.g. rigidity traps, poverty traps, lock-in traps, and regional development traps). In effect, we find that mountainous regions experience a polytrap – a complex of concurrent traps,

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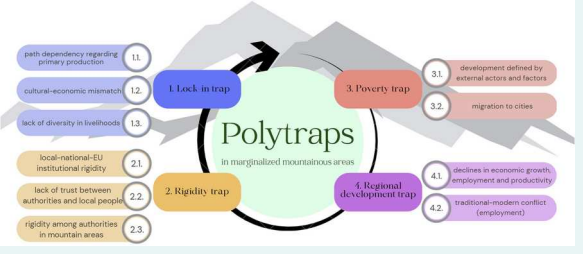
maladaptive processes, an absence or severe limitation of bounce-back resilience, and difficulties in achieving bounce-forward resilience, largely due to dependence on external actors and factors. This polytrap concept emphasizes the need for rural policies to acknowledge these multifaceted challenges and both enable and promote place-based approaches for revitalizing left-behind places.



1. Introduction

Rural mountainous regions face regional disparities and inequalities. Depopulation has led to rural shrinkage, a demographic and economic phenomenon that is part of a wider trend of territorial restructuring characterized by fewer jobs in primary production and greater urban economic growth (Espon 2017; EC 2021). European rural policies, dating back to the post-WWII period, have repeatedly tried to boost rural development through a variety of initiatives and associated measures e.g. the Common Agricultural Policy (CAP) (EC 2024a) and the Cohesion Policy (EC 2024b). Despite this, regional inequalities continue to pose a persistent challenge in Europe (EPRS 2023).

The resilience of rural mountainous regions has been a focus of scholarly research and policymaking for over forty years (Wyss et al. 2022). It continues to be a significant feature of rural policy today. For example, the vision for the EU's rural areas up to 2040 (EC 2021) promotes resilience and inclusive development:

> The preservation of natural resources, the restoration of landscapes, including cultural ones, the greening of farming activities and supply chains will make rural areas more resilient to climate change, natural hazards, and economic crises. Making rural areas more socially resilient requires tapping into the full breadth of talents and diversity in our society

Despite its prominence, resilience as a concept is multidimensional. Wyss et al. (2022) note a wide range of perspectives related to mountain resilience including physical, ecological, psychological, and social resilience. Historically, these definitions, often based on the physical sciences, focused on the capacity of a region or community to reduce the effect, absorb and bounce back to an equilibrium after some disturbance or adversity e.g. a natural disaster or an economic shock (see for example, Adger 2000; Bertocchi et al. 2016). More recent literature couched in social-ecological theories, recognizes that community resilience not only includes recovery and renewal, but transformation and adaptation to or anticipation of future or slowly developing changes (sometimes referred to as 'slow burns') (Gong and Hassink 2017; Magis 2010). This more modern perspective aligns with the evolutionary (or bounce-forward) approach to resilience, which emphasizes adaptive capacity and the transformation of rural regions rather

than bounce back resilience, which focuses on recovering to a previous system state after a disturbance (Scott 2013).

Recently, the bounce back interpretation of resilience has faced increasing criticism (e.g. Béné et al. 2014; Dornelles et al. 2020; Mahdiani and Ungar 2021). For example, Lyytimäki et al. (2023) highlight numerous cases that simultaneously exhibit resilience while engaging in unsustainable or undesirable practices, particularly with respect to economically lucrative but environmentally harmful activities. Bounce-back resilience has also been criticized for its bias toward persistence, its limited analytical power for studying sustainability transformations, and its neglect of social justice issues (Smith and Stirling 2010). Similarly, Scordato and Gulbrandsen (2024) argue that bounce-back resilience may be problematic due to its strong resistance to transformation, silo thinking', and lack of integration.

To better understand the multidimensional aspects of resilience and the relationship to persistent challenges in rural mountainous regions, we draw on the concept of traps (Barrett, Alexander, and Dasgupta 2011; Carpenter and Brock 2008; Cinner 2011; Dornelles et al. 2020; Eriksson et al. 2021; Haider et al. 2018; Méndez, Fajardo-Ortiz, and Holzer 2022; Polterovich 2008; Tidball, Frantzeskaki, and Elmqvist 2016). Traps are characterized by persistence, undesirability, and self-reinforcement (Haider et al. 2018). They are typically difficult to escape from and incremental change is often insufficient to break out of such traps (Tidball, Frantzeskaki, and Elmqvist 2016). Persistence links to a strand of resilience literature based on equilibrium thinking where the ability to 'bounce-back' to a state before the disturbance is the preferred goal (Scott 2013). Self-reinforcement in a trap situation has been connected to different types of feedback (e.g. social and ecological), which reinforce each other and maintain or push a social-ecological system towards an undesirable state (Stockholm Resilience Center 2016). Feedback between external drivers and key variables within the studied system can contribute to the creation and persistence of a trap (Enfors 2013). Traps are also often dynamic as they change over time representing persistent maladaptive states (Carpenter and Brock 2008). Others have noted that traps are path-dependent processes instead of conditions of systems (Boonstra and de Boer 2014).

The existing literature on traps includes poverty (Haider et al. 2018), rigidity (Gunderson and Holling 2002), lock-in (Allison and Hobbs 2004), isolation (Gunderson, Holling, and Craig 2010), and regional development traps (Rodríguez-Pose, Dijkstra, and Poelman 2023). Extant literature identifies sharply adverse situations that focus on one aspect e.g. institutions (Gunderson and Holling 2002), economic and regional development (Rodríguez-Pose, Dijkstra, and Poelman 2023), or opportunities for people (Haider et al. 2018). For instance, the lock-in trap highlights the difficulty of changing industrial or sectoral trajectories due to having invested significantly in the existing ways of doing things (Allison and Hobbs 2004). The rigidity trap concerns inflexible and self-reinforcing institutions that limit certain kinds of action opportunities (Gunderson and Holling 2002). The poverty trap highlights that people are impoverished by circumstances that are not in their control (Haider et al. 2018). The regional development trap focuses on declining and persistent trends in economic growth, employment and productivity (Rodríguez-Pose, Dijkstra, and Poelman 2023). While all these conceptualizations of traps have a clear merit, they often overlook the complexity of a multi-faceted perspective where social, political, economic, environmental, and demographic challenges are intertwined. A holistic,

place-based approach to addressing challenges is essential for ensuring stronger, connected, resilient and prosperous rural areas and communities in Europe (Barca 2009). Furthermore, focusing solely on one dynamic makes it difficult to envision a holistic solution. For example, Wieliczko, Kurdyś-Kujawska, and Floriańczyk (2021) argue that CAP and the Cohesion Policy lack comprehensive approaches to rural development. The place-based approach to rural development has also been emphasized in the Territorial Agenda 2030 (Evrard and Schmitt 2024). Understanding the mechanisms which shape the environments of 'left-behind places' (Pike et al. 2023) is crucial for advancing Europe's goals of inclusivity and justice (Evrard and Schmitt 2024).

To contribute to the literature on traps and related policy issues, we focus on European mountainous regions. Mountainous regions, other isolated areas, and areas with extreme environments (e.g. deserts, Arctic, and Antarctic regions) may accumulate adverse conditions across time and space. The combination of geographic isolation, climate harshness, limited connectivity, historical neglect, and weak local governance makes it hard to overcome persistent problems. We begin with the premise that mountainous regions face interconnected development locks, which mutually reinforce each other leading to significant socio-economic inequalities, environmental issues, and economic marginalization – 'left-behind' places.

The objective of the present paper is to explore current developmental challenges in European rural mountainous regions through the lens of the concept of traps. We aim to: (i) assess the potential of using concept of traps for capturing the challenges and dynamics occurring in the European mountainous regions, and (ii) reflect on the findings from this assessment to derive a robust definition for the concept of a polytrap, which combines economic, social, political, and environmental factors that reinforce each other, and helps to explain why some regions tend to be 'left-behind'. The polytrap concept builds upon and complements the general concept of a 'monotrap' in complex social-ecological systems.

2. Methodology

2.1. Traps in rural mountainous regions

Mountains have been given specific attention in agricultural and rural development policies of the EU. Since 1975, mountains have been designated as 'less favored areas' and more recently as 'areas with natural or other specific constraints' (Price 2016). The European Treaty on the Functioning of the EU notes that 'particular attention' shall be paid to mountainous regions, as they suffer from severe and permanent natural or demographic challenges that hinder development (EU Cap Network 2023; Opinion of the European Committee of the Regions 2019). Although there are many definitions of mountains (Körner, Urbach, and Paulsen 2021), there is no widely accepted interdisciplinary characterization of the traps that rural mountainous regions face. Rural mountainous regions share four key features that support the assumption that they are subject to a distinct kind of trap, which we provisionally term a 'periphery trap':

Geographical isolation from urban centres: Rural mountainous regions are often geographically isolated or remote due to their rugged terrain and challenging access.

Consequently, transportation and communication networks are typically less developed compared to more accessible regions. Mountainous regions are connected to lowland areas by inter-regional flows, which should be acknowledged in development strategies and governance frameworks (Dax 2020). However, political and economic developments predominantly generate centre–periphery dynamics, which can result in rural alienation and economic inequality in these areas (Vik, Fuglestad, and Øversveen 2022). Mountainous regions, in particular, face locational disadvantages, with peripheralization emerging as a consequence of macro-scale processes such as spatial reorganization of economic activity and globalization. This peripheralization occurs at different spatial scales, often compounding and amplifying the effects of pre-existing locational disadvantages (ESPON 2020).

Diversity and vulnerability: Rural mountainous regions are widely appreciated for their biodiversity, geodiversity, species richness, high endemism, and association with various essential ecosystem services and cultural heritage (see Payne et al. 2020). At the same time, they are particularly vulnerable to both incremental and rapid changes such as climate change and economic development that are driven by external factors (Chakraborty 2021). This makes mountainous regions particularly susceptible to adverse impacts. This vulnerability is further trapping mountainous regions into cycles of ecological and social-economic instability.

Policies enhancing resilience: Rural policies (e.g. CAP and the EU Cohesion Policy) often emphasize the need to build resilience (EC 2024b; Gaudron 2024). While this focus can foster adaptations in production sectors, it can also hinder transformative change by locking the development trajectory with status quo. A policy focus on agriculture and more recently on the environment (Lowe, Feindt, and Vihinen 2010) often fails to address the unique and evolving challenges of mountainous regions. Furthermore, the strict focus on growth and jobs in the 2014–2020 Cohesion programming period has been found too narrow to capture the full potential of endogenous rural development, which links also to softer issues like symbolic, identity, and catalyst functions having indirect positive effects on rural development (Harfst, Wirth, and Marot 2020).

Multi-dimensional drivers of change: These drivers (e.g. Dragonetti, Daskalova, and Marco 2024) include various factors such as climate change (e.g. treeline shifts, the emergence of new species, changes in snow cover duration etc.), land use pressures (e.g. tourism, forestry, nature conservation, pastoralism, agriculture, mining, land abandonment etc.), demographic trends (outmigration; immigration by refugees and internally displaced persons), policy influences and drivers (e.g. the Habitats Directive, EU Nature Restoration Law etc.), social-cultural shifts (e.g. urbanization, declining traditional values etc.), and economic factors (e.g. regional disparities in economic development and innovation). These interconnected drivers often lead to undesirable situations for mountainous regions, making them difficult to address effectively.

2.2. Material and methods

The data for this study was obtained through two expert meetings and four surveys conducted as part of MARGISTAR COST Action (https://margistar.eu/). The

MARGISTAR consortium's key areas of expertise include political science (institutions and governance), earth and related environmental sciences (terrestrial ecology, forest management and land cover change), social and economic geography (spatial development, land use, regional planning), as well as economics and business (microeconomics, institutional economics, digitalization). The MARGISTAR consortium consists of over 200 experts on European mountainous regions from 31 European countries.

Our work started with a preliminary assumption that the European mountainous regions are facing particular kind of development challenges, which we initially captured by the umbrella idea of periphery traps. The development and revision of the periphery trap idea was methodologically done in sequence of steps, leading eventually replacing it by robust definition of the concept of 'polytraps'.

We first conducted an online survey (Questionnaire 1) to identify key challenges that experts considered potential components of these traps. We then convened a workshop in Utsjoki, Finland, where small-group discussions examined the relevance and dynamics of traps in the mountainous context. A second online survey (Questionnaire 2) was conducted to gather expert insights on the potential conceptualizations of periphery traps that the diverse European marginalized mountain regions are facing. This was followed by a second workshop in Düzce, Türkiye, where 30 experts discussed the nature of traps and potential solutions, supplemented by a third online survey (Questionnaire 3). A final survey (Questionnaire 4) was distributed to the MARGISTAR consortium to collect insights into traps, visions and potential solutions (Table 1; Annex 1).

We employed a qualitative inductive approach to analyse the materials and to explore how our preliminary assumption on the general idea of periphery traps might apply to the challenges of mountainous regions. Our study design process involved following phases. First, we drew on insights from Questionnaire 1 and Workshop 1 to gauge the applicability of the periphery trap idea in various contexts, and its acceptance among experts. During conceptual validation, we performed an inductive cluster analysis of the expert definitions of periphery traps gathered via Questionnaire 2. This analysis

Table 1. Sources of data.

Method	Date	No. of participants/ respondents	Focus
Online Survey (Questionnaire 1)	November 2022	69	A general questionnaire on key challenges in European mountainous regions.
Workshop 1 (Utsjoki, Finland)	May 2023	28	Small groups of experts discuss the idea of periphery traps in European mountainous regions.
Online Survey (Questionnaire 2)	May 2023	30	Open questions on plausible definitions of periphery traps in connection to specific mountainous regions.
Workshop 2 (Düzce, Türkiye)	September 2023	30	Small groups of experts discuss idea of periphery traps in mountainous areas and their potential solutions.
Online Survey (Questionnaire 3)	September 2023	14	Open questions to identify challenges / traps that a mountainous region is facing and potential solutions to these challenges.
Online Survey (Questionnaire 4)	February 2024	38 respondents / 26 cases	In-depth case study questionnaire including questions on traps, solutions and visions regarding European mountainous regions.

allowed us to categorize responses into distinct clusters representing distinct aspects of traps as perceived by the experts, which we then compared against established literature on traps in social-ecological systems to refine the concept's theoretical foundation. By differentiating traps faced by mountainous areas from previously identified ones, we revealed how these challenges may form unique constellations of disadvantage. Additional insights from small-group discussions conducted during hybrid meetings in Finland and Türkiye, as well as supplementary data from Questionnaires 1 and 3, enabled us to triangulate diverse perspectives and refine the details of each cluster. Feedback from an online survey (Questionnaire 4) provided practical relevance and empirical validation for our findings. Through this iterative process, we observe that the salient feature of the traps affecting European mountainous areas lies not merely in their peripherality, but rather in the simultaneous occurrence of several types of traps – a phenomenon we refer to as 'polytraps'. This major finding is discussed in Section 4.

3. Results

3.1. Challenges faced by mountainous regions

Our work started with Questionnaire 1, through which we identified the specific challenges faced by European mountainous regions and found that the key issue is demographic decline, primarily depopulation (Figure 1). This is driven by a lack of services, employment, and education opportunities. While some mountainous regions are thriving, many were found to be technologically, politically, socially, and politically disconnected. Furthermore, these disconnected regions were perceived to be politically marginalized, often regarded as non-priority areas in mainstream political agendas. Compared to urban areas, mountainous regions are perceived to suffer from factors associated with peripherality (e.g. lack of innovation, powerlessness, distance from core areas, and poor accessibility) and marginality (e.g. remoteness, cultural marginality,

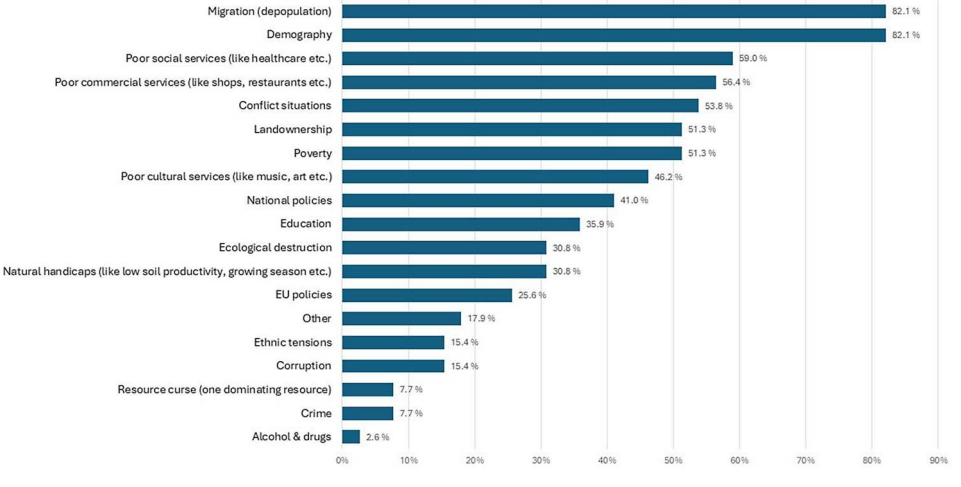


Figure 1. Challenges faced by European mountainous regions identified by experts in the MARGISTAR consortium ($n = 69$).

economic disparities, and political exclusion). These findings align with existing understandings of the structural disadvantages faced by mountainous areas (see Annex 2).

Our initial idea on the periphery traps included an assumption that European mountainous regions experience marginalization as part of dynamic process of entrapment. During the Utsjoki meeting, the concept of marginalized mountainous areas was further discussed:

> Marginalized mountain areas would be mountainous regions fallen outside of general trends of societal development, and thus exposed to abandonment, depopulation, inappropriate exploitation of their resources and overall degradation and devastation of the landscape, natural richness, cultural-historical heritage and the life of local population in general. (Expert 28)

> Regions or communities that experience socio-economic disadvantages, limited access to basic services and infrastructure, isolation, poverty, inadequate healthcare and education, and face challenges in terms of economic development, often due to geographical constraints, loss of traditional activities, land abandonment and historical marginalisation. (Expert 4)

These quotations highlight the simultaneous occurrence of several development challenges. An example of the multifaceted challenges faced by mountainous areas was provided in Workshop 1. In Utsjoki, Finland, Atlantic salmon fishing in the Teno river is both culturally and economically important for indigenous Sámi people. However, it is currently under threat due to a dramatic decline in the number of salmon returning to spawn in this river. This decline is driven by a complex set of factors beyond the control of the Sámi people, including intensive fishing at sea. Despite this, a salmon fishing ban has been imposed by the Finnish and Norwegian governments, restricting not only commercial fishing but the traditional fishing practices of indigenous Sámi at the Teno river. The significance of salmon fishing to the Sámi people is not only cultural but also economic, as it contributes to subsistence and tourism, particularly salmon fishing tourism. In this remote area, the lack of livelihood opportunities further underscores the importance of the relatively few existing economic activities. However, environmental policies primarily focus on science-based salmon conservation through fishing restrictions aimed at strengthening salmon populations and preserving Atlantic salmon biodiversity in the Teno river. These policies largely overlook local indigenous traditional ecological knowledge, cultural heritage and practices, and economic potential, as well as the Sami's place-based understanding of the environment – one deeply tied to their culture, social relations, and rights.

This example highlights the limitations of analytical approaches that isolate discrete institutional, sectoral, population or economic units. Such approaches may hinder the holistic perspective necessary to develop place-based strategies for advancing regional development.

3.2. Characteristics of the traps in mountainous regions

The results of Questionnaire 1 and Workshop 1 presented above suggest that the mountainous regions are facing multiple intertwined development challenges. To further develop a definition for the traps these regions are facing, we use Questionnaire 2

where we asked experts how they would concretely define such traps in the context of remote and peripheral mountainous regions on which they are experts. The proposed definitions from Questionnaire 2 were inductively clustered into five general categories (Annex 3). Three of these categories align with existing characteristics of traps identified in the literature: (i) undesirability of development, (ii) persistence, and (iii) self-reinforcement (Haider et al. 2018). Undesirability refers to various challenges faced by mountainous areas (Figure 1, Section 3.1). Persistence reflects the strong resilience of the status quo within the political economy, while self-reinforcement arises from disadvantageous and maladaptive processes, where short-term individual gains often outweigh longer-term collectively sustainable alternatives (Bertana et al. 2022). The results from Questionnaire 2 suggest a fourth characteristic of such traps: they emerge from a combination of simultaneous and interacting processes. This multifaceted nature of the traps is also supported by the Utsjoki example described earlier. Finally, the fifth category reflects critical perspectives on the idea of traps based on peripherality and marginalized regions.

3.2.1. Persistent traps explained by resilient status quo in political economy

The existing institutional setting (e.g. laws, policies, governance schemes) and economic development agendas tend to reinforce, rather than help overcome, the problems faced by the mountainous regions. Workshop 2 emphasized that mountainous regions are often low on political agendas, with a notable absence of specific policies to meet the unique requirements and needs of these regions. Furthermore, a lack of trust in authorities emerged as a key challenge, particularly in relationships between local actors and authorities across multiple levels, from local authorities to EU policymakers. On the one hand, the benevolence and integrity of authorities was seen to be compromised by unnecessary bureaucracy, perceived corruption, and a lack of appreciation and understanding of local perspectives by government. On the other hand, issues such as misuse of subsidies and inadequate collaboration were also highlighted. This lack of trust is particularly difficult to overcome because collaboration is often hindered by actors prioritizing their own interests, and because local authorities may lack the necessary competence.

Illustrative cases include Serbia and Türkiye. In the former, a combination of weak local government structures and insufficient government competence have further exacerbated distrust in authorities (Živojinović, Ludvig, and Hogl 2019). This distrust often manifests in conflicts between stakeholders. For instance, in the Kardüz Upland region of Türkiye, the use of forest resources by forest villagers – for pastoralism, grazing, (illegal) logging, and residential occupation, – has led to disputes with regional forestry directorates.

3.2.2. Self-reinforcing traps explained by maladaptive processes

Maladaptive practices are any actions, both deliberate and inadvertent, that may increase the risk of adverse outcomes, vulnerability, or diminished welfare, either now or in the future (Bertana et al. 2022). An example of maladaptation is seen in the demographic development of mountainous regions. Moving to cities is often appealing for individuals, as mountainous regions frequently lack adequate social, education and employment opportunities, which clash with the educational aspirations and professional ambitions of young local people. Furthermore, these regions typically lack jobs that could attract

new, educated workers and at the same time struggle to attract back those who have already left. At a regional level, this amplifies rural shrinkage and results in land abandonment, which adversely impacts local livelihoods and the preservation of cultural landscapes in the long term. For example, the Dinaric mountains of Croatia have experienced decades of depopulation, aging populations, land abandonment and limited development opportunities. Low employment and education opportunities force young people to leave the region, perpetuating the cycle of decline. This challenge is particularly difficult to overcome because, as expressed by one expert in the Türkiye workshop, '*people do not want to live in mountains due to change in cultural values*' (Expert 63). Together these point toward intertwined challenges that constitute polytraps.

Another example of maladaptive processes is linked to the recent institutional changes in the protected mountainous national park, the Tatras, in Slovakia. In this case, the management of the national park was transferred from the Ministry of Agriculture and Rural Development to the Ministry of the Environment, resulting in uncertainty in national park management and unnecessary challenges stemming from the ineffective integration of nature conservation and the economic development of the forest sector. Maladaptation can also be associated with poor land management practices that prioritize short-term (economic) gains, often at the expense of long-term environmental and social sustainability. Additionally, focusing on a single resource can create vulnerabilities to change. For example, high dependence on forest resources (e.g. in Skolivski Beskydy, western Ukraine) and mining (e.g. in the Western Carpathians) has led to the marginalization of actors who rely strongly on these resources for their income and livelihoods.

3.2.3. Multifaceted traps

The qualitative content analysis of expert definitions on the idea of periphery traps (Questionnaire 2) helped differentiate traps faced by mountainous areas from previously identified ones and revealed an additional characteristic beyond undesirability, persistence and self-reinforcing dynamics: their multifaceted nature. Results from Questionnaire 3 highlight how the depopulation of mountainous areas represents a key challenge, tightly coupled with other challenges and reinforced by concurrent processes, which together complicate potential solutions (Figure 2).

3.2.4. Critical views on the periphery traps

While our results show strong alignment among experts on the relevance of traps in mountainous regions, some alternative views were also presented in Questionnaire 2. The fifth cluster of responses to Questionnaire 2 emphasized that mountainous regions are 'rich in resources', suggesting that discussions on traps should also acknowledge strengths such as natural resources, ecosystem services, and local cultures. Additionally, some experts challenged the use of the periphery trap concept, arguing that it may frame certain areas as structurally disadvantaged rather than focusing on their potential and resilience. For example, Expert 63 noted that the periphery trap '*… sets out to place certain areas/groups in an underdog position, rather than focusing on their assets, capacity and capabilities*'. However, if the purpose of identifying traps is to understand systemic constraints, acknowledging their presence does not necessarily negate the existence of valuable regional assets.

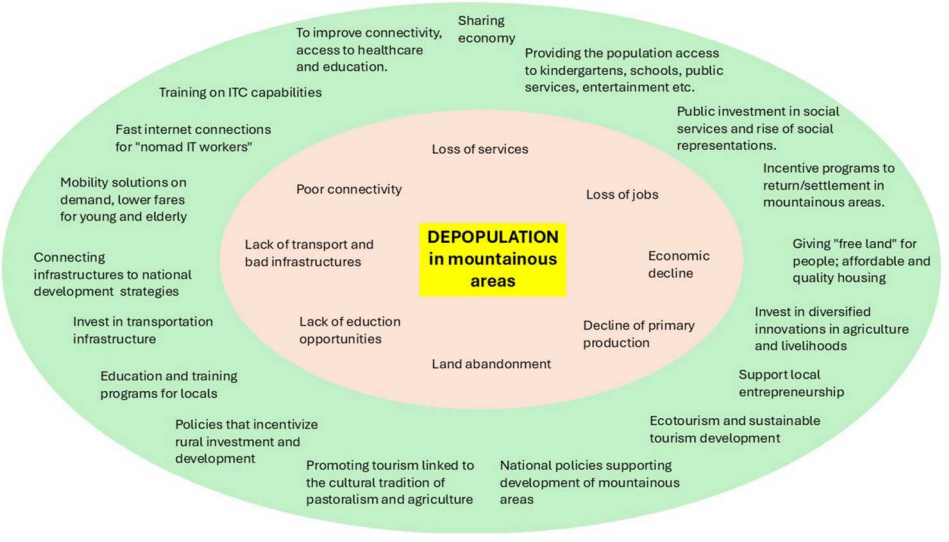


Figure 2. Depopulation in mountainous areas is a central element of a multifaceted trap. The items in the red circle refer to processes that exacerbate the demographic depopulation challenge in these areas, while the items in green indicate possible solutions. The figure is a synthesis of responses from Questionnaire 3.

Despite the pressing challenges associated with development traps in mountainous regions, solutions remain possible. Workshop 2 discussions emphasized that while the marginalization concept in existing literature (e.g. Chand and Leimgruber 2016) focuses often on structural disadvantages and negative feedback loops, mountain actors may not perceive themselves or their areas as marginalized. During Workshop 2, a crucial question was posed: '*are the people in mountainous areas feeling marginalized or recognizing that their home areas are marginalized?*' (Expert 54). Participants also noted that while external assessments often highlight the peripheral status and limited economic and other opportunities in mountainous regions, the subjective experience of marginalization often does not always align with these findings. This perspective suggests that mountain regions should not be viewed solely through a deficit-based lens but also in terms of their inherent strengths and adaptive capacities. This critique, therefore, highlights the need to reconceptualize traps not simply as a result of peripheral status but as unique combinations of challenges that together constitute a polytrap.

3.2. Potential solutions to polytraps

Workshop 2 also sought to discuss potential solutions to the challenges faced by mountainous regions. The following approaches to unlocking the potential of these regions were discussed during the workshop.

In terms of governance, actors in mountainous areas are often perceived as having a relatively weak voice in decision-making and limited opportunities to participate in decisions affecting their lives. However, a positive example from Portugal was shared during Workshop 2. Historically, there was an adversarial relationship between those

responsible for managing and conserving the Gerês National Park and the local stakeholders. However, when the local actors were included in the co-management of the park, the dynamic shifted. As a result, attitudes improved, and the park administration and local stakeholders now collaborate effectively to preserve the area's biocultural landscapes.

Examples of successful economic activities in mountainous areas were also discussed during the workshops. Greater economic diversity, including tourism and agro-forestry, was highlighted as a solution from the Irish experience. Meanwhile, non-wood forest products were identified as having significant potential to provide viable livelihood alternatives to industrial forestry in Northern Italy. Furthermore, new models of work, based on the so-called 'sharing economy' and 'gig economy', may offer new income-generation opportunities for individuals often excluded from traditional industries in mountain areas, such as women and older people.

Connectivity within mountainous regions, as well as between the mountainous and urban areas, has been enhanced through the concept of rural hubs (e.g. Vrmdza in Eastern Serbia). This approach is based on a sustainable eco-village model and functions as an open platform for exchanging ideas, information, and experiences among different initiatives and individuals seeking to integrate rural and urban knowledge and experience, and co-create social innovations (Živojinović, Ludvig, and Hogl 2019). In addition, initiatives aimed at attracting remote workers – sometimes referred to as 'digital mountain nomads' – to live in and repopulate declining mountain communities were identified as potential solutions. These initiatives include upgrading local infrastructure for connectivity, provision of off-season accommodation, and establishing rural digital hubs for co-working (Euro News Travel 2023; Global News Travel 2023).

While solutions were discussed, a critical tension between modernity and tradition was also identified. Many mountainous regions have already undergone, and will likely continue to undergo, a process of transformation from a focus on primary production to services, as well as a transition to becoming residential areas – particularly for second homeowners, seasonal visitors, and older members of the population. Unfortunately, while some benefit from these changes, opportunities for others diminish. An illustrative example is the Triglav National Park in north-west Slovenia. In this case, touristic areas are livable, with well-developed infrastructure and a vibrant cultural and social life. However, increased tourism has led to pressures on the environment and abandonment of traditional agriculture practices. This, in turn, has caused a shift in the mountainous cultural landscape, including a loss of biodiversity due to the decline of transhumance. Ironically, these cultural landscapes, shaped by traditional practices, also serve as key tourist attractions. This underscores the tension between modern development and the preservation of traditional culture and practice.

4. Discussion

4.1. Conceptual advancements on traps

As discussed, our initial assumption was that mountainous regions experience a specific type of development lock, a trap stemming from their peripheral status. However, our findings suggest that the intertwined challenges in the mountainous areas are better

captured by a concept of polytraps, which we will further discuss and define. Our concept of 'polytrap' adds complexity to the traditional understanding of developmental traps. While the literature on traps is extensive (Barrett, Alexander, and Dasgupta 2011; Carpenter and Brock 2008; Cinner 2011; Eriksson et al. 2021; Haider et al. 2018; Méndez, Fajardo-Ortiz, and Holzer 2022; Polterovich 2008; Tidball, Frantzeskaki, and Elmqvist 2016), studies addressing multiple, simultaneous traps at the local level are notably absent. At the global level, several concurrent Anthropocene traps have been identified in relation to polycrisis (Søgaard Jørgensen et al. 2024). We propose that polytraps include the characteristics of regional development traps, rigidity traps, lock-in traps, and poverty traps. Specifically:

- **Rigidity traps** manifest within polytraps as a form of institutional inadaptability (Gunderson and Holling 2002).
- **Poverty traps** are present due to a lack of livelihood opportunities (Haider et al. 2018).
- **Regional development traps** are reflected by the limited economic provision potential (Rodríguez-Pose, Dijkstra, and Poelman 2023).
- **Lock-in traps** emerge as weak problem-solving capability and capacity (Allison and Hobbs 2004).

While discussions of individual traps offer valuable insights, they often fail to recognize the underlying complexity of their interactions. Furthermore, these four traps manifest in distinct domains: institutions (rigidity trap), regions (regional development trap), sectors (lock-in trap), and people (poverty trap). We argue that mountainous regions are not confronting an entirely new type of development lock that prevents societies from escaping unsustainability. Instead, the areas face a convergence of dynamics across distinct domains, forming a polytrap. We define a polytrap as a condition where multiple, interlinked social, ecological, and economic traps coexist and interact, creating a compounded, self-reinforcing state of entrapment.

These traps may span various dimensions – economic, environmental, social, and institutional – and collectively exacerbate the challenges faced by a region or community. The interplay among these diverse traps intensifies the difficulty of achieving sustainable development and bounce forward resilience. As such, breaking the cycle of entrapment requires comprehensive, multi-faceted interventions (see Table 2).

It is important to note that we share the perspective that viewing resilience as a combination of persistence and bounce-back dynamics can lead to the creation of development traps (Gunderson and Holling 2002; Lyytimäki et al. 2023). In mountainous regions, resilience exhibited by industries and primary production policy sectors, and institutions at local, national, and European levels, may inadvertently foster dependencies, thereby obstructing or retarding transitions to new forms of livelihoods and economic diversification in mountainous regions. Our findings also suggest that there is a lack of trust among local stakeholders, which may fuel suspicion towards EU, national, and local administrations, resulting in a form of bounce back resilience characterized by persistent institutional and economic rigidity that fails to address local needs. Furthermore, mountainous regions often lack the bounce forward resilience – the capacity to adapt and transform – that is essential for overcoming challenges such as unemployment, limited educational opportunities, and economic decline.

Table 2. Key findings and novelties linked to polytraps compared against previous main conceptualizations of traps.

The trap concepts	Insights from existing literature	Key findings linked to traps in rural mountainous areas
Lock-in trap	Industries and / or sectors have invested so much in existing systems that their capacity for change is low (Allison and Hobbs 2004).	**Lock-in appears because of tensions between old and new livelihoods:** Dependence on primary production in some areas and on tourism and new livelihoods in other areas creates tension between mountainous cultures and economic development.
Rigidity trap	Institutions are highly connected, self-reinforcing, and inflexible (Gunderson and Holling 2002), and enable and reward only a controlled set of actions.	**Rigidity is apparent simultaneously in vertically connected institutions:** Institutional rigidity is apparent at multiple levels (e.g. local, national, EU authorities), and creates a divide and mistrust between inhabitants of mountainous areas and authorities.
Poverty trap	People are impoverished by circumstances beyond their control (Haider et al. 2018).	**Maladaptation is tempting in periphery traps:** Often individual efforts to enhance economic situations (e.g. moving to cities) lead to negative collective impacts and downgrade future opportunities (e.g. decline of opportunities in remote areas).
Regional development trap	Regions face decline in economic growth, employment, and productivity in relation to their neighbours and to their own past economic trajectories (Çınar 2023; Rodríguez-Pose, Dijkstra, and Poelman 2023).	**Escaping regional development traps may lead often to new problems:** Transition from primary production to services and being designed for seasonal visitors, second homeowners, and elderly people radically change the employment structure and leave many inhabitants behind from the transition.
Polytraps	Undesirable, persistent, self-reinforcing (Haider et al. 2018).	**Traps in mountainous areas function as polytraps:** Polytraps represent conditions where multiple, interlinked social-ecological and economic traps coexist and interact, creating a compounded and self-reinforcing state of entrapment.

4.2. Generalizing the polytraps to other regions

We found that European remote mountainous regions are caught in a 'polytrap'. These mountainous regions can also serve as representative examples of other remote rural areas in Europe that are experiencing rural shrinkage (Espon 2017; 2020). Furthermore, rural decline is recognized as a global issue, affecting countries such as the US, Canada, Australia, China and Japan, where rural decline has either occurred or is ongoing (Li, Westlund, and Liu 2019). Consequently, the polytrap concept may have relevance beyond Europe, particularly in rural regions undergoing processes of peripheralization. Peripheralization operates across multiple geographical scales and involves phenomena such as '*selective out-migration, disconnection from infrastructure and knowledge networks, increasing dependence upon larger cities for decision-making, funding and services, and discursive marginalization*' (Pike et al. 2023, 1174). Thus, our key assumption is that the polytrap concept is especially pertinent to rural regions and sparsely populated areas that are also experienced processes of peripheralization.

Another way to generalize our findings is by examining the conceptual assumptions underlying polytraps and compare them with assumptions underpinning other key concepts. Table 3 outlines four key assumptions related to the dimensions of a polytrap within a trap – resilience matrix.

Table 3. The dimensions of a polytrap in a trap – resilience matrix.

	Resilience and traps as persisting systemic states	Resilience and traps as processes
Traps	Simultaneously occurring traps: Polytraps are holistic and include interacting aspects of many traps (e.g. rigidity, poverty, regional development, and lock-in traps) which sustain the undesirable situation.	Maladaptive processes that make the situation even worse: Actions that are rational and beneficial for individuals or specific groups are causing collective harm and compromising desirable future states.
Lack of resilience	Lack of bounce-back resilience: Polytraps refer to situations where bouncing back to a previous system state is difficult or even impossible (e.g. an inability to go back to a situation where flourishing primary production was the main driver of rural well-being).	Bounce-forward resilience is difficult to realize. Solutions to escape the polytrap are difficult due to cross-sectoral, complex and intertwined challenges, and over dependent on external actors and factors.

4.3. How to escape the polytrap?

Polytraps pose a significant challenge for policy and planning in rural mountainous regions at European, national and subnational levels. A major obstacle in implementing effective solutions for reducing regional disparities and enhancing equality lies in the fact that European rural policies are often part of the polytrap itself. One critical issue sustaining these polytraps is that the specificities of mountainous areas are insufficiently addressed by EU policies, which heavily emphasize the development of the primary sector and the agri-environmental schemes (Copus and Dax 2010; Zasada et al. 2018).

A place-based approach to rural development has the potential to reduce regional disparities and can help areas escape polytraps. Barca (2009) defines a place-based approach as one that goes beyond the centralization vs. decentralization debate by allocating responsibility of policy making '*among different levels of government supported by both contractual relations and trust, with a role being played by special-purpose institutions (agencies, public-private partnerships, etc.)*' (Barca 2009, XI). However, even with the adoption of a place-based approach that incorporates a broad range of stakeholders in policy development and implementation, regional disparities are likely to remain (EC 2024b).

Discussions in Workshop 2 underscored the need to view mountainous regions not through the lens of individual sectors, actors, or livelihoods but as interconnected places requiring holistic approaches to planning and economic development. The place-based approach acknowledges not only the environmental, livelihood, and economic conditions of these areas (De Toni, Martino, and Dax 2021) but also their institutional and social-cultural characteristics, necessitating tailored solutions. This understanding informs the paradox inherent in the neo-endogenous approach to rural development, where top-down policies are needed to support local bottom-up development (Ahlmeyer and Volgmann 2023; Dax 2020). By being more adaptable to the diverse needs of different places, EU-wide policy approaches may resolve this paradox and create the conditions for the revitalization of these diverse and remote regions.

The complexity of polytraps makes resolution difficult. Our analysis of European mountainous areas reveals a key tension between, on the one hand, persistent traps, maladaptive processes, and a lack of bounce-back resilience, and on the other, self-organized and adaptive efforts to revitalize these areas and build bounce-forward resilience. To address this tension, we propose three potential solutions. First, there must be policy support, incentives and investments for local initiatives to catalyze self-organization and adaptation.

This implies that achieving bounce-forward resilience in trapped regions cannot rest solely on the shoulders of local inhabitants. Second, the systemic factors that make maladaptive choices easy and tempting for individuals while leading to rural shrinkage – such as migration to urban centres due to limited local opportunities – must be addressed. The aim is to ensure that people have viable local alternatives to leaving the area, by cultivating and promoting conditions that make staying in or returning to these areas attractive and sustainable. Third, the persistence of traps, including simultaneous rigidity, poverty, lock-in, and regional development traps, needs to be disrupted.

While all three proposals are challenging to implement, there is evidence of progress. Existing policies, such as the Territorial Agenda 2030 and the EU Rural Vision 2040, demonstrate a commitment to revitalizing remote rural areas. However, these efforts risk failure if they do not adequately address maladaptation and break persistent traps. The priority should be to make maladaptive choices more difficult, as maladaptation not only sustains polytraps, but also worsens the situation – for instance, by contributing to the loss of services, employment, and education opportunities. Once a situation stabilizes, the focus can shift to dismantling the traps, potentially through place-based approaches.

4.4. Limitations

Our study is not without limitations. First, our analysis remained at a conceptual level, focusing broadly on the notion of traps. While this provides a foundational understanding, a comprehensive framework for studying development traps should also include the quantitative methods to diagnose and assess such situations. For instance, Wang et al. (2023) provide a quantitative method to illustrate the state and development trajectory of a social-ecological system over time, which can help to measure whether and how such systems become trapped. Second, our study relies on expert perspectives, drawing on their knowledge of the mountainous regions with which they are familiar. While expert knowledge is valuable, it can be diverse, and harmonizing these diverse opinions requires robust quantitative methodologies. Such methodologies could achieve consensus on scientific concepts, while also measuring the level of consensus and diversity among experts. Future research should engage local stakeholders to incorporate their perspectives on traps. Third, this paper primarily focuses on grounding and defining the concept of a polytrap. In our future work, we intend to shift focus toward solutions to such traps through detailed case studies.

5. Conclusion

We have introduced the concept of polytraps, which can help in understanding the complex and pressing challenges faced by European mountainous regions. We propose that the polytrap concept is also applicable beyond mountainous regions – for example, such as in rural and sparsely populated areas – and potentially in contexts outside Europe. Based on our analysis, polytraps can be characterized by the following features:

1. They consist of a set of interacting adverse dynamics (e.g. poverty, rigidity, lock-in and regional development traps) that converge in specific regions in a way that undermines the development and creates or exacerbates regional inequality and disparity.
2. They are rooted in the inherent resilience of existing political and economic systems, which resist place-based innovations, narrows local opportunities, and obstructs transformative change.
3. They manifest at both individual and collective levels, where regional and institutional disadvantages constrain the potential of those caught within these dynamics.

Further studies are needed to investigate how polytraps manifest in different locations, particularly regarding how their diverse elements interact and compound challenges for rural development. In addition, research is also needed to identify strategies for escaping these traps and breaking the cycle of maladaptive processes. Early indications suggest that rather than striving for fixed equilibria, managing the regimes that control various subsystems may offer a promising pathway forward. By shifting the focus from isolated, single-dimensional traps to the complex dynamics of polytraps, we can more effectively address the multifaceted obstacles that hinder development.

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