# Smart Metromountain:
# urban and mountain interdependence and physical-digital
# infrastructures as a tool for a new climate-resilient liveability.

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## ABSTRACT

*The contemporary climate challenges led mountain regions to face new and complex issues of liveability that must be resilient to the effects of climate change, which are even more evident in high-altitude areas, and adapt themselves to the new life and work habits emerging in these places. In this regard, the research aims to highlight how typically metromountain actions, based on the interdependence between cities and mountains, can serve as tools for re-inhabiting mountain territories, addressing both the effects of the climate crisis and the criticism, such as depopulation and marginalisation, that have plagued rural areas for decades. The essay demonstrates, through several examples, how relational practices have produced concrete and positive responses for the regeneration of high-altitude areas, countering the phenomena of gentrification and tourism-centric development typical of the late 20th century. These practices also became an experimental field for crisis management, which can be useful in urban areas as well. Studying actions and projects working in this direction, it emerges that the role of space, whether physical or digital, is central to regenerative urban-mountain relations. Infrastructure, particularly those linked to welfare, become hubs of exchange and connection capable of reversing trends and providing resilient responses to the effects of the contemporary polycrisis.*

**KEYWORDS:** metromountain, climate resilience, re-liveability, inner areas, welfare

## 1    INTRODUCTION

In recent decades, both climate changes and socioeconomic transformations have brought to light a series of complex challenges that now redefine housing paradigms in mountain areas. These territories, historically considered marginal places where compared to the large, productive, and advanced urban centers under the metaphor of *'the pulp and the bone'* [1], are now experiencing an acceleration of the climate crisis effects; these include the extreme weather conditions in an already fragile environment, the decrease in biodiversity, and the increase in the frequency of extreme weather events.

Long-standing social dynamics that have long weakened mountain areas (such as depopulation, aging phenomena, economic marginalization, and neglect of the territory) combined with these environmental issues have made highlands particularly vulnerable.

After almost two centuries in which mountain areas were seen as places to be saved through targeted policies and actions, recently, for the first time, these territories have started to be seen as an opportunity rather than a problem. Some profound cultural [2] and institutional changes, which treat these regions as experimental grounds for a new form of re-inhabitation, alongside a shift in political perspective, in which the *'places that do not matter'* [3] have begun to gain relevance in international political debates, have laid the foundation for a novel rethinking of life in mountain areas in response to the challenges of the 21st century.

The challenges of our times also offer new opportunities to rethink and redesign the liveability of inner areas [4]. In particular, there is a growing need for approaches that promote territorial resilience, considered not only as the ability to withstand the impacts of climate change but also as the capacity to transform vulnerabilities into resources for sustainable and innovative development. In this context of highlands' reconsideration, the concept of 'metromountain' [5] has emerged for the first time, theorizing the functional interdependence between cities and mountains. The term conceives urban and mountain entities not as separate worlds but as elements profoundly connected to each other through the flows of people, ideas, resources, and experiences.

From a design perspective, the metromountain [6] represents a dynamic and complex response to the climate and social crisis that offers a sustainable way to reinhabit and regenerate mountain regions. This model goes beyond the imagination of mountains as mere natural reserves or tourist playgrounds, recognizing them as laboratories for social and environmental innovation, capable of generating forward-thinking practices that can also be applied in urban areas. The interaction between cities and mountains thus offers a way to counteract gentrification phenomena and tourist-centered development [7], which dominated the 20th century and often accelerated the critical issues previously described.

The core of this perspective is the role of connective and relational spaces, both physical and digital. The places where cities and mountains interact become the focal point of regenerative processes, where infrastructures play a strategic role, especially welfare-related ones. In particular, creating shared spaces and fostering trans-territorial collaboration networks can help reverse negative trends, activating virtuous cycles of local development. Through examples of initiatives that engage in different forms of metromountain exchange, this paper aims to demonstrate how these actions can produce positive outcomes by countering depopulation and promoting new economic and social models that leverage local resources, culture, community, and technological innovation.

Furthermore, metromountain practices provide not only those practical solutions for mountain regions but also act as experimental grounds for crisis management, which can also be applied in urban areas. By managing natural, social, and economic resources in an integrated and resilient way, mountain territories can become protagonists in a new development phase, contributing actively to the construction of a sustainable and inclusive future for society.

In conclusion, it emerges that the regeneration of mountain regions can no longer be achieved through general or standardized solutions; instead, it requires a nuanced and participatory approach that values the distinctive characteristics of each territory from a place-based perspective. The success of these actions hinges on the ability to forge deep connections between cities and mountains, that foster reciprocal exchanges and mutual benefit. In this way, responses to the climate crisis are closely tied to addressing the needs of local communities through collective action oriented towards common well-being and long-term sustainability.

## 2 THE CONCEPT OF METROMOUNTAIN BETWEEN COGNITIVE, PRESCRIPTIVE, AND PRACTICAL OBJECTIVES

The long-standing debate on the potential interconnections and interdependencies between urban and rural areas has recently been enriched by the concept of *'metromountain'*. This term, introduced into the academic discourse through the works of Giuseppe Dematteis [5] and the volume edited by Filippo Barbera and Antonio De Rossi [6], provides an interpretative framework that highlights how city and mountain can mutually influence each other, fostering a dual territorial development.

The introduction of a specific term like *'metromountain'* significantly impacts both conceptual and practical levels; naming a specific phenomenon creates a common language that enables a more precise representation of reality and fosters a shared imagination. This process of naming and spatial codification not only aids in the self-representation of territories but also serves as a solid foundation for developing targeted policies and operational strategies. In the case of metromountain, the term has gradually gained a political and project-oriented dimension, becoming a practical tool for promoting initiatives that aim to rebalance the relationships between metropolitan areas and high-altitude regions [8].

In the scientific and cultural debate, the metromountain is regarded as a 'quasi-concept' [6]. It, therefore, not only describes an existing reality but also bridges cognitive, prescriptive, and practical objectives. Consequently, the term does not carry a singular definition; rather it embodies a range of meanings that capture both the interactions between urban and mountain areas and the proposals of concrete solutions for territorial development. This semantic versatility makes the concept particularly valuable for categorizing projects and initiatives that, although they are different, have maintained a core of shared meanings that ensures their coherence.

Examining the territory through the metromountain lens makes it possible to understand the critical issues that local development shows today more clearly. Frequently, regions that are both physically and functionally interconnected are hindered by administrative boundaries that impede integrated and synergistic management. These artificial divisions cause in territorial fragmentation that limits the development of common strategies, often also obstructing them. In this context, the concept of metromountain provides an innovative framework for reimagining territorial governance and fostering, through new forms of institutional cooperation, those enhanced interdependencies among urban, intermediate, and mountain areas.

The term is evolving beyond mere theory becoming a political and strategic framework that places the urban-mountain relationship at the forefront of addressing contemporary challenges. Various institutions, such as the municipalities of Turin and Cuneo, have created official positions dedicated to metromountain policy; others are developing plans explicitly based on city-mountain cooperation, like the Città Metropolitana di Firenze with its plan 'Firenze città metro-montana. Indicazioni strategiche per le politiche pubbliche locali' and the Città Metropolitana di Torino, which named its 2024-2026 Metropolitan Strategic Plan 'Torino Metro(poli)montana'.

The political and institutional initiatives described below have occurred mainly in mountain urban centers that increasingly look beyond their borders to foster cooperation and ensure sustainable and shared development. At the same time, grassroots experiences translate these theoretical ideas into practical action. In mountain areas, citizen-led initiatives, third-sector organizations, and small municipalities implement metromountain principles through hands-on projects to revitalize these territories and foster a new re-inhabitation model.

This context highlights a dual inter-scalar dynamic: on one side, we find those envision large-scale development scenarios involving key institutional actors who can deploy significant public resources and drive changes in the management of local institutions and services. Conversely, individuals and small community groups tackle immediate, personal challenges through innovative, small-scale solutions.

In the next chapter, the essay will explore individual metromountain initiatives with a pioneering spirit, becoming part of broader, well-established processes by converging around similar methods and types of interventions. These common trends have increasingly attracted the attention of political and institutional actors, particularly within national strategies for territorial development (SNAI) and the forward-thinking concept of smart villages promoted by the European Commission.
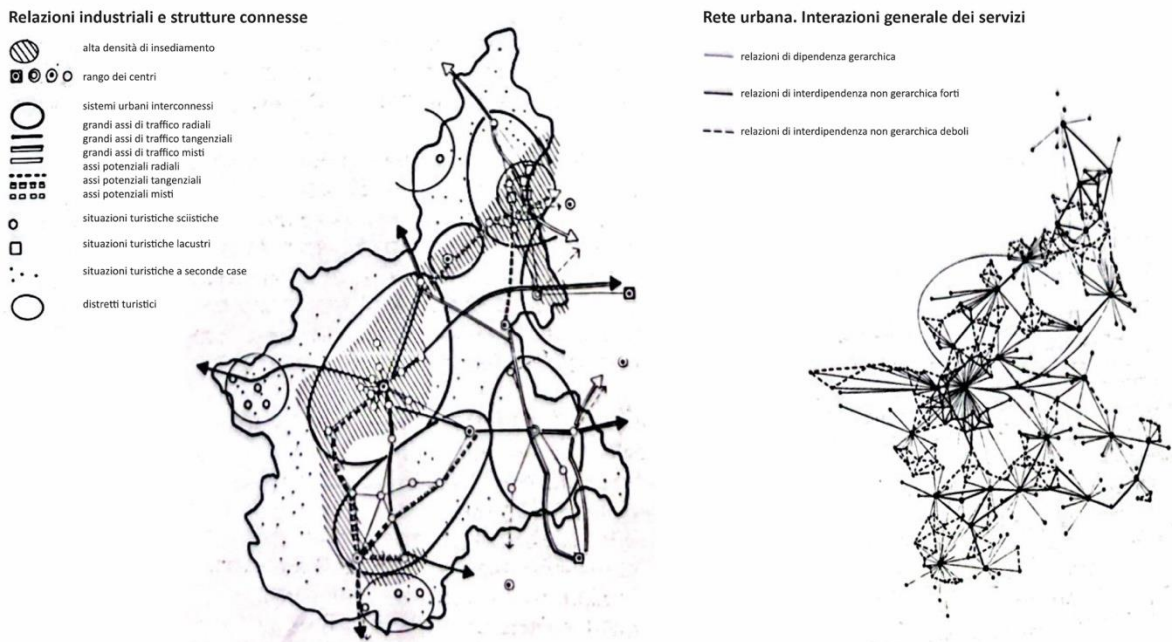


Figure 1: Diagram of metromountain phenomenon – Dematteis, G. (1989) [9]

## 3    METROMOUNTAIN EXPERIENCES FOR RE-INHABITING INNER AREAS

In exploring actions oriented to creating a new form of liveability for inner areas resilient to climate change and grounded in strengthening urban-mountain connections, it is essential to develop a classification framework. This framework should focus on a select number of experiences while situating them within a broader, ongoing discussion.

In this regard, the investigation into metromountain experiences related to climate will follow the four areas of intervention outlined by the European Commission in 2021 in the document *'A long-term vision for the EU's rural areas: Towards stronger, connected, resilient, and prosperous rural areas by 2040'*. These areas have been repeatedly referenced in the assessments of intelligent solutions proposed within the Smart Rural 21 and Smart Rural 27 projects, the 'preparatory actions on smart rural areas in the 21st century', which contributed to the practical application of the theoretical definition of smart villages in authentic contexts.

Two primary criteria will guide the selection of practices: firstly, identifying examples that are based on a metromountain exchange [10], regardless of what is being exchanged (whether people, goods, resources, data, practices, or models) and the type of exchange infrastructure (whether physical or digital). Secondly, the selection focuses on climate resilience, particularly those exchanges addressing climate change's causes (such as reducing emissions), those shaped by climate effects, or those that work to mitigate them.

## 3.1 Stronger rural areas

The first block of actions *'Stronger rural areas'* includes all those actions that offer innovative solutions for services provision, leveraging digital tools and promoting social innovation [10], particularly in elderly care, youth engagement, and in the usage of data and digital platforms to enhance local services [12].

The achievement of these goals is possible only by empowering local communities to become more dynamic and self-sufficient. Revitalizing communities in depopulated areas requires the reduction of migration to cities—especially among younger populations—and the encouragement of 'vertical migrations' to mountain areas, which is made feasible by ensuring access to physical and digital essential services.

In this context, the connection between urban and mountain areas and the fight against climate change becomes clear on several levels. Firstly e-medicine and e-care play a critical role by bridging the gap between service providers and users reducing unnecessary long-distance travel and minimizing environmental impact. Investments in these areas, supported by Mission 6 of Italy's National Recovery and Resilience Plan (PNRR), are part of a broader vision of strengthening community-based healthcare through a structured network of welfare infrastructure and an expansion of local and digital services.

Secondly, climate-related migration [13], in particular among those over 65, is becoming an increasingly relevant issue. Extreme urban climates, often unsuited to the lifestyles of an even more aged population [13], are pushing individuals to relocate permanently or seasonally to more climate-friendly regions creating new opportunities for the development of new services tailored to the elderly and vulnerable populations, such as e-care.

Finally, within urban-mountain exchanges that transfer models and practices, the adaptation of co-housing models, typically found in urban settings, to mountain environments has significant climate benefits such as shared services and communal spaces that help reduce waste and energy consumption, fostering more sustainable living practices.

## 3.2 Connected rural areas

The European Commission's definition of *'Connected rural areas'* emphasizes the importance of links between mountain, urban, and peri-urban areas, but the concept is mainly limited to transportation and digital infrastructure [11]. Envisioning mountain areas connected to cities shifts the focus of the metromountain relationship to urban centers, positioning them as the starting or ending point for which such infrastructure is designed.

Actions in this domain are also interwoven with climate change on two fronts: On the one hand, physical transportation must transition to more sustainable and slower forms of mobility, reducing reliance on private vehicles in favor of innovative, efficient public transport and smart mobility solutions like car-sharing and electric vehicles. On the other hand, digital infrastructure could significantly reduce transportation needs, particularly for commuting, by enabling remote work and flexible working arrangements for a wide range of professions.

Implicitly, a more connected mountain region could not only facilitate daily and periodic urban-mountain exchanges but also attract permanent migration, especially those in the emerging

professional category of digital nomads. These working-age people, known as amenity migrants, are those who could easily live in urban settings but decide to move to the mountains motivated by the desire to reside in a pleasant, natural environment, particularly one free from climate challenges (such as pollution and urban heat islands) common in metropolitan areas [15].

### 3.3 Resilient rural areas

The third mission, *'Resilient rural areas'*, is based on the concept of resilience, a key term in contemporary discourse, mainly when applied to inner, marginalized, and vulnerable territories. In the European Commission's framework, resilience is primarily addressed from an environmental perspective, with some focus on social factors. It highlights key actions such as 'the conservation of natural resources, the restoration of landscapes - including cultural ones, the greening of agricultural activities, and the shortening of supply chains' as essential to making rural areas resilient to climate change and economic crises [11].

In contrast to the previous block of actions, in this case the focus of the metromountain dynamic shifts toward mountain regions, their resources, and their unique characteristics. The exchange flow involves a 'downward flow' of environmental resources and products integrated into nested markets [16][17] alongside an 'upward flow' of financial resources, often tied to ecosystem service taxation or contributions for environmental maintenance.

On the one hand, urban-mountain exchanges in this area encourage the use of renewable energy and the strengthening of short supply chains, helping to minimize the environmental impact and the increasing rarity and intensity of precipitation caused by climate change; on the other hand, they inflict severe damage on unmanaged mountain ecosystems. Among the new forms of liveability in mountain areas that are resilient to climate change it is crucial to mention policies that encourage resettlement or stewardship of fragile territories, often through community-based resource management practices.

### 3.4 Prosperous rural areas

Finally, within the scope of 'Prosperous rural areas', all experiences linked to the economic fabric come into focus. The central idea is the diversification of economic activities into new sectors, driven by local, sustainable strategies that, on the one hand, make the area attractive for businesses and on the other encourage the development of new skills to support entrepreneurial ventures [11].

Metromountain relations in this context, as well as their connection to climate change, are varied and depend on the specific economic sector. Tourism is one example: over the past century, it was seen as the key to the Alpine revival [18], especially during winter. The movement of people, including tourists and seasonal workers from cities to mountain areas, alongside the development of large infrastructures for sports and leisure, created a dependency of the mountains on the city, reinforcing the seasonality of visits and reducing year-round activities. However, the impact of climate change and decreasing snowfall has prompted a shift in approach with tourism being reimagined through a more sustainable lens. This shift has also sparked interest in integrated forms of territorial development beyond just tourism. While urban visitors continue to flock to mountain regions, more sustainable choices and efforts to reduce seasonality have mitigated the environmental impact of infrastructure and promoted a broader, though temporary, presence across larger areas, not limited to ski resorts.

These new forms of slow tourism are also aligned with innovative methods of artisanal and agricultural production of local goods. Small businesses, often networked and supported by business development training and local funding - such as that provided by Local Action Groups (GALs) - serve as important drivers of territorial growth and foster a new model of livability in

mountain areas. Investing in local supply chains, bringing work and home closer together and reducing long-range exports all contribute to lowering environmental pollution. At the same time, the proximity of high-quality, locally sourced agricultural products to urban areas increases urban demand for mountain goods, spurring economic exchanges that are often carried out sustainably, including through collective purchasing groups.

The effects of climate change on mountain agriculture and metromountain exchanges can also be seen in the upward shift of production zones for many products. In this context, the ability to form networks with cities and peri-urban areas for the transfer of raw materials, as well as production technologies and know-how, becomes essential for both rural and urban regions.

Finally, transferring skills and professional expertise, facilitated by digital infrastructures and online training, is another crucial aspect of the relationship between metropolitan areas and mountain regions. The latter often become testing grounds for innovative entrepreneurial practices especially for younger generations which can also benefit urban areas.

## 4    THE ROLE OF SPACE BETWEEN PHYSICAL AND DIGITAL INFRASTRUCTURES

In outlining a fragmented yet significant picture of metromountain practices that foster climate-resilient livability in mountain areas, it becomes evident that the role of space, whether physical or digital, is central to promoting and enhancing these diverse experiences. By revisiting the categories proposed by the European Commission through the perspectives of architects and urban planners we can classify these exchanges based on the infrastructure/space facilitating them.

A broad initial division distinguishes between physical and digital spaces; however, it is essential to note that the latter still depend on physical infrastructures to function, such as ultra-broadband and 5G networks. A second division separates long infrastructures (or networks) from performative spaces [19]. Economic exchanges (such as goods, energy resources, tourists, and data) typically unfold along long infrastructures that connect producers and consumers, while welfare-related exchanges tend to focus on specific, often community-centered spaces that facilitate regenerative practices [20].

Contemporary welfare spaces in mountain areas serve as hubs of exchange rather than mere service delivery points. They are often undefined and interconnected where functional specificity is overshadowed by innovative management approaches that leverage community engagement, local resources, and proximity [21][22][23]. In this context, digital tools are crucial in enabling innovative governance models and new professional roles (such as community nurses, social facilitators, educators, and community cooperatives) to interact effectively with traditional welfare professions, typically based in urban centers.

As highlighted in the review of various experiences climate change does not merely impact the physical dimensions of these exchanges; instead, it creates connections that shape their structures. The emerging forms of livability promoted by a multitude of policies—focused on specific aspects through various funding avenues—are inherently linked to the climatic challenges of our time. Therefore, there can be no relationships or infrastructures aimed at regenerating highland areas that do not address the impacts of climate change, are not influenced by it, or do not actively seek to mitigate its effects.

### 4.1    Ostana case study

A noteworthy case that exemplifies the intertwining of regenerative practices, repopulation efforts, metromountain experimentation and smart-sustainable solutions is Ostana, a small village located in the province of Cuneo that has successfully reversed the depopulation trend

characteristic of alpine valleys during the 20th century. In 1921 Ostana had around 1.200 residents, but over the following decades, this number sharply declined, ultimately dwindling to just five permanent inhabitants by the end of the last century. Today, the population stands at 88 residents [Web-2].

The revitalization project in Ostana began in 1985 when a group of former villagers led by then-mayor Giacomo Lombardo initiated a redevelopment program focused on enhancing and promoting local culture. Despite early efforts to restore the building heritage and improve the area's appeal the population continued to decline. A turning point occurred in 2003 marking the start of a new phase aimed at creating welfare infrastructures and fostering new local microeconomies. Collaborations with the Politecnico di Torino and various institutions led to the realization of several key projects including the cultural center *Lou Pourtoun*, a significant welfare infrastructure known as *Mizoun de la Villo* and a cohousing initiative. These developments, alongside other efforts in sustainable agriculture and responsible tourism, have transformed Ostana into a vibrant and attractive location for new families, particularly young people [24].

In 2020, the municipality applied for the *"Smart Rural 2021"* program [Web-3] and emerged victorious among 185 applications despite having the smallest population (only 85 residents). The proposed strategy, shared within an international network of similar initiatives, focuses on three specific objectives: firstly, promoting sustainable environmental development, particularly in terms of sustainable mobility and natural resource management; secondly, addressing residency issues by regenerating unused buildings and exploring new financial management approaches; and finally, enhancing culture and social innovation by implementing culturally oriented actions and new services for a broader population. The community cooperative "Viso a Viso" has played a pivotal role in managing services and promoting local well-being ensuring social cohesion and facilitating new job opportunities.

The innovative aspect of this case study lies in the community-driven approach that permeates every facet of regeneration. Activities that connect urban and mountain areas and address climate change, such as cultural and educational programs organized at the cultural center and temporary residency initiatives for migrants, including climate migrants, arise from a cohesive network of relationships among public stakeholders, entrepreneurs, research institutions, local economic activities, third sector organizations, and innovative governance models.

In conclusion, Ostana illustrates how public-private cooperation aimed at enhancing the welfare of local communities while remaining open to external influences can foster new forms of livability that are resilient to climate change. This example encapsulates many of the virtuous experiences highlighted in the previous chapter.

Figure 2: The Cultural Centre Lou Pourtoun (2015)
design: M. Crotti, A. De Rossi, M.P. Forsans, Studio GSP - photo: L. Cantarella



Figure 2: Mizoun de la Villo - Welfare alpine house (2019)
design: M. Crotti, A. De Rossi, L. Dutto - photo: L. Cantarella

Figure 3: Social Housing Valentin (2023)
design: A. De Rossi, L. Mascino, M. Tempestini, S. Costamagna - photo: L. Cantarella

## 5    CONCLUSION

From the research and case study presented it becomes evident that the urban-mountain relationship plays a significant role in rethinking the livability of highland areas. While territorial institutions have begun to gradually acknowledge themselves as "metromountain" by initiating practices to enhance the connections between cities and mountain regions the individual experiences discussed in this essay do not explicitly pursue this goal. However, they naturally align with it by establishing, for practical reasons, a climate-resilient form of livability that is deeply intertwined with metromountain dynamics.

When considering smart regenerative models for rural areas [25], it is clear that integration with cities goes beyond the simple replication of the smart city concept in rural settings like *smart villages* and *smart rural*. Instead, it aligns more closely with the concept of *smart territory* [26][27] which broadens the perspective by identifying actions that foster synergies between rural and urban areas. This approach enables both regions to respond more resiliently to the effects of the contemporary polycrisis, impacting them both.

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