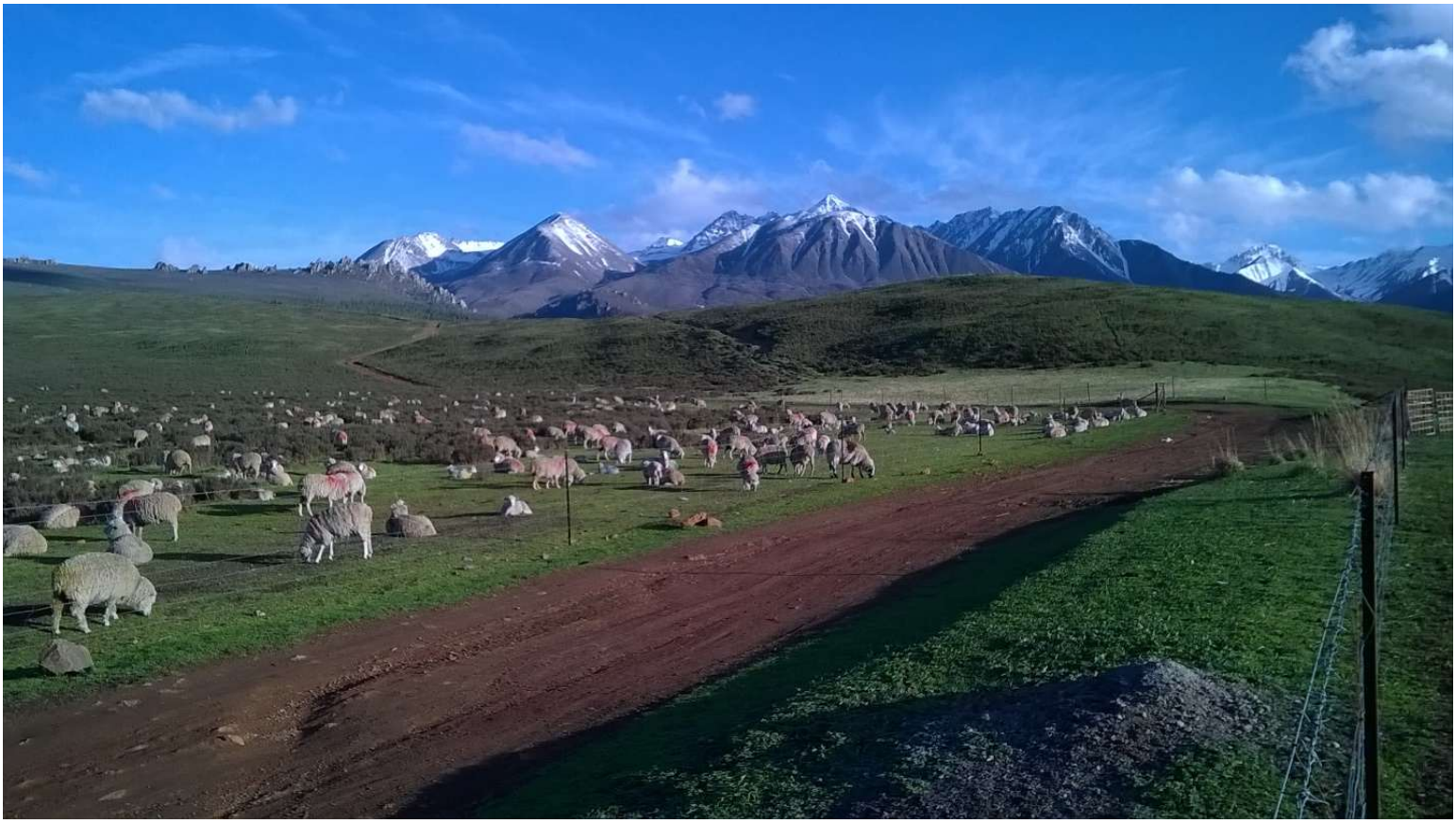

Past, Present and Future Challenges in Mountain Transhumance

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TLS - The Livestock Sustainability LiFLoD Livestock Farming and Local Development

CIRAD / French Agricultural Research Centre for International Development

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Past, Present and Future Challenges in Mountain Transhumance

Abstract

This book, through historical and forward-looking analysis carried out across various study sites by around fifty researchers and stakeholders involved in Mountain Transhumance, aims to anticipate the major changes and challenges facing this pastoral activity, in order to inform policymakers at the local, regional, national, and even global levels. The findings presented in this book are based on research conducted in the early 2020s across twenty case studies on four continents: Asia (Qilian Mountains in the northeast of the Tibetan Plateau, China; Kazakhstan; and Mount Lebanon), Africa (Green Mountains in Libya; Eastern Atlas in Algeria; High Atlas in Morocco; Tigray in Northern Ethiopia; and Kamiesberg Mountains in South Africa), Americas (Canadian Rockies; Chimborazo Watershed in Ecuador; Cordillera Blanca and Altiplano in Peru; Malargüe and Southern Patagonian Andes in Argentina), and Europe (Serra da Estrela in Portugal; Cévennes and Upper Tarentaise/Alps in France; Pindos Mountains in Greece; Romania; and Scandinavian Alps in Norway).

From a methodological standpoint, the research sought to combine approaches from the human and social sciences—particularly interviews and text analysis involving stakeholders recommended by local transhumance actors—with tools from life and natural sciences, such as forage balance assessments and factorial analyses. In terms of results, the research confirmed and refined the key functions of transhumance, which were found in nearly all the case studies. These functions—listed in no particular order—include: i) making use of a seasonal pastoral resource essential to the forage balance of herds, while maintaining landscapes across altitudinal gradients (one of the key ecosystem services provided by livestock farming); ii) freeing up labour for other important agricultural tasks while protecting cultivated areas from grazing; iii) strengthening food security and livelihoods for pastoral families, villages, and mountain regions; iv) preserving skills and providing remunerative employment opportunities for both young and older generations; v) maintaining social networks and relationships among pastoral communities on opposite sides of the same mountain—networks that support not only tourism development, but also, as in the past, the exchange of techniques, practices, equipment, and genetic material; and more.

Another major finding, consistent across most case studies, is the critical role of public policy at the local and territorial levels. Moreover, addressing the immense challenges posed by climate change is a significant issue in most study areas. This is particularly due to the uncertainty surrounding climate evolution and local policy decisions, both of which strongly affect pastoral resource management and the lives of families and communities. Climate change intensifies the uncertainty that pastoral systems have always faced, and it exacerbates the effects of market price volatility, which these systems must increasingly learn to navigate.

Acknowledgment

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Foreword

Bernard HUBERT (INRAE, EHESS)

Why not choose transhumance as the archetype of pastoralism? In any case, that is the choice made by the authors of this book, and we congratulate them on the wealth of information it contains from different parts of the world. Congratulations also to the coordinators who succeeded in mobilizing authors to write twenty relevant and well-chosen case studies to illustrate the diversity of what is referred to as "transhumance" through its variability but also its commonalities.

This book provides a remarkable overview of transhumance today in different parts of the world and raises questions about the future of such pastoral practices. Its coordinators invited me to write this preface to encourage readers to read it. I gladly accepted because I believe that this work deserves to be read and known by a wide audience concerned about the transformations taking place on our planet as a result of climate change, political developments, and a dominant trend over the past few decades to believe that technology will save us from the threats that lie ahead. But here we can clearly see that it is not that simple...

Isn't transhumance a remarkable socio-technical model, built up over time and in different regions of the world around an alliance between human societies and animals to transform elements of the environment into resources for living and developing, even in situations considered extreme? But rather than being about the ability to adapt to difficult conditions, aren't these forms of pastoralism actually ways of making the most of diverse, contrasting, and uncertain environments? And maybe these are models that could inspire us to face the threats looming in an increasingly uncertain world?

I find this relevant to my own reflections and questions about the relationship between humans and animals through the process of domestication: dogs, horses, but also cattle, zebu, yaks, sheep, goats and others no longer exist in the wild, yet they constitute the largest animal biomass on Earth! This is indeed a process that began in the Neolithic era, shaping living beings at the interface between their more primitive stage and the needs of generations of herding populations, organized into pastoral societies or otherwise, in order to allow these animals to develop new skills based on their behavior but going beyond it to generate new and original living entities. These skills are new and adapted to the expectations of those who have shaped them: an aptitude for new activities, which can be associated with forms of work, an ability to understand what is expected of them, partly through language (without necessarily being fluent in Sumerian, Pulaar, or Tibetan...) but above all through gestures, postures, and looks. For me, these are indeed skills, acquired from interactions between individuals of the same species, used for interspecies communication through a process of mutual learning between animals and humans...

A unique adventure that illustrates what Catherine and Raphaël Larrère[*] have described as "making do" or "doing with", which they distinguish from "making" (in place of nature) by creating artifacts using a range of technologies, as encouraged by the "modern" thinking that has framed the relationship to

[*]Larrère C. et Larrère R., 2015. Penser et agir avec la nature. Une enquête philosophique. La Découverte, 374 p.

knowledge in the Western world for just over three centuries. For them, it is a question of distinguishing between two visions of the relationship with the living world:

• as an industrial process that transforms inputs into outputs ("doing"): this is the world of *tékhnē* (*τέχνη*), of artifacts, aimed at stabilizing and homogenizing the living world in order to reduce the uncertainties associated with its dynamics; resources are considered as a given stock that must be managed with varying degrees of care depending on its level and capacity for renewal; it is marked by the power of technology and judged on its technical and economic performance in terms of productivity (per animal, per worker, per hectare, etc.) to the detriment of the unique components of the situations to be addressed;

• as a transformative dynamic to be guided and nurtured ("doing with"): this is the world of *physis* (*φύσις*), of evolving, unpredictable behaviors that must be supported; resources are not given, they emerge from interactions, provided that we know how to take advantage of the complexity of these interaction systems; however, it is confronted with the limits of knowledge, the difficult reproduction of tacit knowledge, the ambitious choice to take complexity into account without seeking to reduce it, and, as a result, is unfortunately judged on its shortcomings... But, conversely, it is also through rigorous and systematic work describing the practices implemented in different parts of the world by a diversity of pastoral societies that this approach is legitimized, as does the book that follows these few lines focusing on transhumance as an outstanding illustration of this position.

This distinction refers to two practices of Nature/Culture relations: (1) dualism: based on the separation of Nature/Culture, i.e. naturalism, which leads to normative dispositions, such as the approach to biodiversity that distinguishes between hierarchical values ("remarkable," "ordinary," etc.); (2) duality: the focus is no longer on what separates, but on what connects, on the interactions that determine how we situate ourselves in an environment, as the two faces of the same coin. Biodiversity as a whole is then considered to be the expression of the diversity of life and the product of its dynamics of differentiation; domestication is one of the most exemplary illustrations of this, creating new species over time and the diverse expectations of the human groups that shaped them in their daily shared lives... like transhumance! Here too we are talking about practices and techniques that have developed pragmatically from experience, on animals as well as plants, in a historical continuity that is distinct and independent from the development of theoretical frameworks and related technologies...

This is not a trivial question, as it touches on the values we assign to living beings, their unlikely dynamics, and the way we view them, as well as the ways we interact with these living beings in all their diversity and complexity. Indeed, beyond these profound changes in our relationship with living beings, it is a question of fundamentally rethinking the way in which techniques have been conceived in "modern" thinking, in order to recognize that dealing with living beings does not mean reducing them to simplified and stabilized artifacts in order to control them better. It is a question of learning to manage their diversity and dynamics, which are also those of human societies, i.e. learning to look at nature from the inside and no longer from the outside, as modern thinking has encouraged us to do. And how the latter has relied on the eminently reductive vision of the "animal machine," on which contemporary zootechnics is largely based, which, incidentally, likes to call itself "Animal Production"... which is quite a program!

The two visions of *tékhnē* and *physis* recall Thompson's[†] philosophical approaches to sustainability in agriculture, centred respectively on the principles of '*resource sufficiency*' and '*functional integrity*'. *Resource sufficiency* considers resources as a given stock and focuses on managing the rate of their consumption. Sustainability is pursued either by using the resource more efficiently or by finding an alternative resource. The current organization of the agricultural sciences favors this approach. Technical recommendations regarding rangeland management from this perspective have focused on matching stocking rates with 'carrying capacity' (more or less based on appropriate evidence) and the introduction of improved pasture, mastered through practices that are valued *a priori*, as part of 'modern agriculture' which could put transhumance in danger, only valued as "folklore" or "cultural heritage" for tourism… For how long?

On the other hand, *functional integrity* represents resources not as given stocks of objects but as relationships emerging from matching practices of production and social and ecological processes, while acknowledging that both sides are in continuous transformation. Within this perspective the focus is on monitoring systemic interactions, preserving the capacity for resilience, and avoiding unintended consequences, especially those generating irreversible changes in the agroecosystem, i.e. the kingdom of transhumance!

Extensive livestock farming, and particularly transhumance, is illustrative, where stocking rates depend on herd mobility–itself resting on social organization and institution for land tenure–, animals' feeding competence, local configurations of terrain and biodiversity, herd composition, specific breeds, seasonal changes in ecosystems and in the metabolism of animals, and of course herders' management skills.

The dominant theoretical framework for agricultural research and development is hinged on *tékhnē*/resource efficiency as if it were the only option. However, an alternative does exist. As argued by Hubert[‡] and Hubert and Ison[§], climate change and biodiversity loss impose a reconsideration of our trajectory in agriculture. Even more importantly, they call for a shift from *tékhnē* to *physis*, a move out of the present tunnel vision on resource efficiency and towards an approach to sustainability finally capable of understanding and respecting the functional integrity of the living world, including humans.

Livestock husbandry has to be considered as a socio-technical object embedded in complex networks. These networks combine interests, rationales and practices by a multitude of actors (breeders, policymakers, extension services, local communities, territorial institutions, private companies…) as it is well illustrated in the following pages wherever it is reported. To match this complexity in a changing world, simultaneous patterns of change have to be conceived. We are not operating in a stable or predictable environment. Crucially, the range of possible futures has to be enlarged so as to match the global diversity of local production systems: people, cultures, food systems and habits, infrastructures,

[†]Thompson, P.B. 1997. Sustainabilty as a norm. *Philosophy and Technology* **2** (2) :75–93.

[‡]Hubert, B. 2020. The need for a conceptual paradigm shift. In H.R. Herren, B. Haerlin, IAASTD+10 Advisory Group (eds) *Transformation of our Food Systems*. Berlin/Zurich, ZukunftsstiftungLandwirtschaft/Biovision. p. 131–133.

[§]Hubert, B. and R. Ison. 2011. Institutionalising understandings: from resource sufficiencyto functional integrity. In T. Kammili, B. Hubert and J.-F. Tourrand (eds). *A Paradigm Shift in Livestock Management: From Resource Sufficiency to Functional Integrity*. Avignon: Cardère. p. 11–16.

diversity of territorial structures, arrangements, land ownership and use, bundles of rights, complementarities of supply chains, and involved stakeholders.

In this context, which is the one in which we live and which shapes our future, transhumance practices have much to teach us about the careful management of complex, diverse, and changing environments, in order to make use of the elements of the environment, which are themselves variable, diverse, and dynamic, i.e. transforming them into so called resources... In short, it is an art of living in one's environment, and now is not the time to lose it in the midst of the profound changes we are experiencing and those that lie ahead.

Introductory Chapter

Past, current and future challenges in mountain transhumance

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Abstract

Transhumance in mountain areas is defined as a seasonal movement of herds to take advantage of pastures in the summer that will no longer be usable in winter due to the cold. But that's not all! Indeed, transhumance has other functions at the level of the herd, the farm, and the territory. These functions will be described successively, along with their historical evolutions, from a global perspective, based on information drawn from twenty case studies spread across four continents, which make up the chapters of this book. The general methodology adopted for this work will then be presented. Special attention was paid, on one hand, to the structural model of the chapters to which the authors agreed to adhere and, on the other hand, to the combination of close reading of the chapters with factorial analyses conducted on the data from the case studies presented in the different chapters. The results are organized into those obtained from the detailed readings and those from the factorial analyses. A large portion of the latter confirm the former. Moreover, new questions have emerged from the comparison of the two types of results. The discussion first addresses the historical evolution of transhumance in livestock farming and its effects on the agricultural holdings involved. It then moves on to consider transhumance and livestock farming in the face of the major current global challenges, and finally, the public policy measures needed to keep mountain livestock farming—and especially transhumance—viable, given its vital contributions to the planet's overall balance.

Keywords: Ubiquity of mountain transhumance; Pastoral and agropastoral ecosystem; Impacts and amenities of livestock farming; Public policy; Factorial analyses

Introduction

Transhumance is a seasonal movement of domestic animals, but also of wild ones. Who hasn't heard of the great seasonal migration of wildebeest in Africa? Transhumance, as thus defined, exists on every continent. It is primarily driven by the search for food, which is available during a specific period or season of the year in one or more designated areas. Transhumance therefore becomes a key element in the feeding of animals. One could also mention the transhumance of fish and marine mammals in the oceans—their periodic, almost always seasonal movements are also related to the search for and tracking of food. The same applies to bird migrations depending on the season, although in that specific case, temperature becomes a significant factor, bringing it closer to mountain transhumance.

Indeed, mountain transhumance is generally perceived as the movement of domestic herds to high altitudes during the summer season to utilize pastures that become inaccessible in winter due to cold and snow, and more critically due to frost. These conditions are unsuitable for both animal life and the humans who care for them, and they also compromise the nutritional quality of forage. Altitude and temperature thus appear to be essential factors in mountain transhumance.

However, among the case studies presented in this volume, we will see that although altitude is almost always a factor, temperature is less decisive in certain contexts—especially in areas near the equator. This is the case with transhumance in the Chimborazo River watershed (Lat. 1°28'S) in the central Andes of Ecuador. Temperature is also less determining in tropical zones close to the equator, as shown by the case study in Tigray (Lat. ~13°N) in Northern Ethiopia, on the highlands of East Africa, and the two Peruvian case studies—one in the Cordillera Blanca (Lat. ~9°S) and the other in the Rio Ramis watershed (Lat. ~14°S) on the Altiplano. Alongside altitude and temperature, the seasonal nature of mountain transhumance appears to be an omnipresent factor, linked to the availability—or seasonal accessibility—of specific food resources. Furthermore, looking to the future, since temperature is directly affected by climate change, changes in transhumance patterns are expected in the coming decades, as several stakeholders in the sector already note.

We will also see that summer transhumance is—and will remain—a livestock management technique whose various practical forms contribute in multiple ways to the viability of pastoral, agropastoral, and silvo-agropastoral agricultural systems. Transhumance provides numerous contributions, essential to maintaining the territories where it is practiced and ensuring the sustainability of the agricultural production systems it supports—in the broadest sense of the term. These contributions include ecosystem services, such as the transfer of soil fertility through the return of organic manure to fields via the spreading of animal droppings at certain times of the year, control of invasive species, and management of cellulose biomass that could otherwise fuel wildfires. These contributions are also critical to the agronomic and even economic balance of cultivated areas: optimizing crop by-products through animal use, reducing labour needs to limit potential crop damage by herds, ensuring family food security through the consumption or sale of various animal products (meat, milk/cheese, wool, hides, leather), and diversifying pastoralists' incomes.

Simply listing the geographic locations of the case studies gives a sense of the weight of social, economic, and political factors in shaping the past, present, and future of mountain transhumance. Indeed, we observe that transhumance has been affected by one or more historical events in the regions concerned. However, these impacts have often been mitigated by the sociocultural continuity—or even resilience—of mountain societies in the face of change. Notably, this resilience operates on time scales vastly different from the events themselves. By "events," we mean revolutions such as the Chinese Revolution of 1949 or the collapse of the USSR in the 1990s, which affected the case studies of the Qilian Mountains on the Tibetan Plateau and Kazakhstan, respectively. Armed conflicts, such as the war in Syria (which directly impacts the Lebanese case study), the current conflicts with Israel, and the civil war in Ethiopia, also fall into this category. Additionally, older events such as French colonization in the Maghreb—particularly in Algeria, where the consequences are still felt more than 60 years after independence—are relevant. Natural disasters, such as Hurricane Daniel, which severely impacted the Green Mountains in Libya in September 2023, are also included. A summary of the 20 case studies (geographic location, climatic characteristics, etc.) is provided in Table 1**.**

Moreover, transhumance involves a range of social and cultural factors, the similarity of which across the case studies is striking—particularly a clear collective dimension that contrasts sharply with the global rise of individualism. This collective aspect is likely linked to the necessity of mutual assistance in challenging conditions, as well as the need for coordination in both time and space for managing pastoral resources that are often remote from major communication infrastructures (roads, urban centres, telephone networks, etc.) and for defining the routes to be taken.

Table 1. Characteristics of 20 mountain transhumance case studies across the world

Case Study	Region and Country	Altitude (m)	Climate characteristics
Qilian Mountains	Tibetan Plateau, China	2000-3500	Cold and semi-arid
Kazakhstan	Kazakhstan	1000-3500	Continental, semi-arid
Mount Lebanon	Lebanon	500-3000	Mediterranean, semi-arid
Aït Bougmez	Central Atlas, Morocco	1800-2400	Mediterranean, semi-arid
Beni Salah Forest	Eastern Atlas, Algeria	800-2000	Mediterranean, semi-arid
Green Mountains	Libya	300-900	Mediterranean, semi-arid
Tigray	East Africa Plateau, Ethiopia	700-2000	Tropical
Namaqualand	South Africa	500-1000	Temperate, arid
Canadian Rockies	Rocky Mountains, Canada	300-2000	Cold and semi-arid
Chimborazo Rio Basin	Central Andes, Ecuador	2500-4000	Equatorial, humid
Cordillera Blanca	Central Andes, Peru	2000-3500	Tropical, humid
Altiplano	Central Andes, Peru	3500-4500	Cold, semi-arid
Southern Patagonia	Southern Andes, Argentina	300-1500m	Cold, dry
Malargüe	Sout-Central Andes, Argentina	1500-3000	Temperate, arid
Serra da Estrela	Portugal	500-2000	Atlantic and temperate
Cévennes	Massif Central, France	500-1500	Mediterranean
Pindos Mountains	Greece	500-2500	Mediterranean
Romania	Romania	500-2000	Mediterranean and temperate
High-Tarentaise	Alps, France	1000-2500	Temperate
Norway	Scandinavian Alps, Norway	300-1000	Cold, humid

All of this calls for essential coordination in the practices implemented during transhumance—for example, setting the departure dates for herds and the necessary preparations, jointly managing high-altitude grazing routes, supplying herders and livestock with necessary inputs during this period, and organizing emergency interventions in case of accidents.

Other sets of factors appear to be common to nearly all the case studies. While these are crucial for identifying similarities and anticipating future trends, they seem less useful for distinguishing between individual cases. Among these are new technologies, particularly ICTs (Information and Communication Technologies), as well as transportation of people and animals, which was done on foot until quite recently and is now largely mechanized for both humans and livestock.

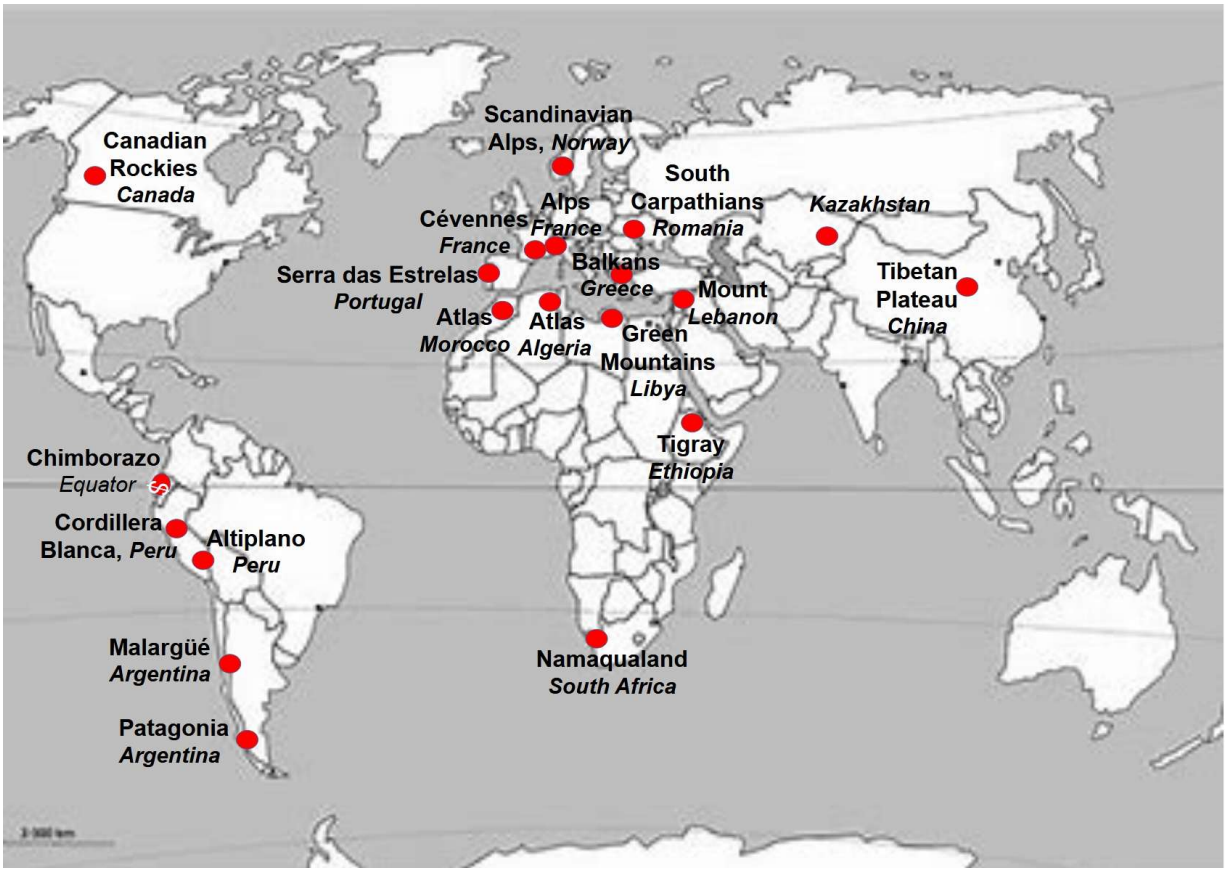
Another shared element across all case studies is the need to share the mountain space with other stakeholders—such as tourism operators, mining groups (it's worth recalling that, after the ocean floor, mountains are the world's second-largest reserve of minerals), environmental NGOs, various stakeholders, and policymakers. We also include in this group—though to a lesser extent—the demands of the new generations who are expected to take over

agricultural activities, including transhumance. These aspirations are closely tied to environmental concerns and to living and working conditions that differ from those experienced by their parents and grandparents.

The collected and analysed material, along with the methods of data collection and analysis used, will be presented in turn. We will then examine the main findings on what transhumance in mountain regions has been, is today, and will be in the future, based on a comparative analysis drawing on both a qualitative understanding of the processes in each case study and the results of the factorial analyses. Finally, we will attempt to define, explain, and model the major changes or challenges—past, present, and future—facing mountain transhumance.

I. Materials & Methods

The geographical locations of the twenty case studies are shown in Map. 1, form the foundation of this work. In selecting the case studies, we prioritized diversity, based on both the existing literature and our own knowledge of mountain transhumance practices, as well as their geographical distribution—considering both latitude and longitude—while aiming to cover the main mountain ranges. Furthermore, all chapters were co-authored by small teams of two, three, or four regionally recognized experts, each with a solid understanding of the specific case study and its developments over several decades. However, due to the often-considerable diversity in forms of mountain transhumance—even within the same region, country, or mountain range—each of the case studies presented should be understood as representative of its own specific context and does not necessarily reflect broader trends at the regional, national, or range-wide level.



Map. 1. Location of the 20 case studies of mountain transhumance and their countries

In terms of methodology, a chapter template was first developed, which the authors/experts were asked to follow in order to ensure the presence of comparable elements across the twenty chapters, making it easier to highlight similarities and differences between the case studies. A historical overview was thus included in all case studies, reviewing key elements that have influenced transhumance practices over recent decades—or even centuries, in some instances. Multivariate factor analysis quickly emerged as a relevant and preferred tool, both to account for the multifactorial origins of the evolution of mountain transhumance and to bring together a diverse and contrasting set of data—collected and compiled by the authors in their respective chapters—into a unified analytical framework. Furthermore, conducting the factor analysis required identifying and defining relevant variables, and assigning each of them two contrasting modalities. Each case study was then coded by attributing one modality for each of the selected variables. Given the limited number of case studies and the goal of ensuring robust factor analyses using qualitative variables, we chose to retain only two modalities per variable, as shown in Table 2. Based on this dataset, a Multiple Factor Analysis (MFA) was conducted using the R software. The results made it possible to construct a global typology of transhumance practices. This typology, based on three distinct groups, is then discussed in order To understand better the differences in practices implemented and their effects on resource management.

Table 2. The two modalities for each variable selected for the factorial analyses of the case studies

Variables	Variable Names	Modality 1	Modality 2
LA	Latitude	< 20° N & S (or 23.5)	> 20° S & N (or 23.5)
AT	Altitude	<1000-1500m	>1000-1500m
Tm	Temp. min.	> 10-15°C	< 10-15°C
TM	Temp. Max.	>25-30°C	<25-30°C
SP	Agrarian System	Pastoral	Agro(sylvo)pastoral
TY	Transhumance Type	Seasonal	Permanent
RA	Annual Rainfall	<800-1000mm	>800-1000mm
LD	Land Status	Common & Contract	Private & Contract
TI	Transhumance Time	Summer	Diverse
AN	Animals	Local species & breeds	~ sheep & cattle
BN	Farm headquater bioma	Natural	Transformed
BT	Transhumance bioma	Natural	Transformed
EV	Past of current strong Event	NO	YES
PP	Public policy efficiency	NO	YES
NT	NTICs	NO	YES
TU	Tourism effects & Impacts	NO	YES
PK	Policymakers Influence	NO	YES
MI	Current emigration	NO	YES

A careful reading of the various chapters by the authors of this introduction was also a crucial step in the comparative analysis, preceding the factor analyses. This approach allowed each of the present chapter's authors to reflect individually on each chapter, thereby fostering a cross-analysis of the various past, present, and future changes in mountain transhumance. Once these initial perspectives were broadly defined, the results of the factor analyses helped to refine this cross-analysis and to identify new research hypotheses—or confirm those that had emerged from the close reading of the chapters—regarding the past, current, and future changes and challenges of mountain transhumance.

II. Results

As previously mentioned, a close reading of the twenty chapters—although structured by the authors according to a predefined template, but without any formal analysis—already reveals the main similarities and significant differences between the case studies. This careful reading was used to select both the variables included in the factor analyses and their two respective modalities. In the first part, we therefore present the cross-analyses of transhumance practices that emerged from this reading, beginning with a deeper examination of the functions of transhumance. We then address what these cross-analyses reveal about the past, present, and future changes in mountain transhumance. In the second part, we show how the conducted factor analyses have, on one hand, confirmed several of the insights gained from the cross-readings—without invalidating any of them—and, on the other hand, brought to light new research hypotheses.

1. Reassessing the functions of transhumance through cross-analysis

First and foremost, as outlined in the introduction, transhumance is not merely about moving livestock to high-altitude pastures during the summer season to take advantage of food resources available only at that time of year. Indeed, while transhumance helps maintain the year-round production of animal products (milk, meat, wool, hides, and leather), it also serves other essential—sometimes secondary—functions, depending on the agricultural production systems involved. Transhumance, as a form of pastoralism, is consistently associated with strengthening the resilience of livestock farming in the face of various risks—climatic, political, economic, etc. (Nori and Scoones, 2023). By enabling herd mobility and leveraging the advantages of diverse environments (cultivated valley forages, wild Alpine grasses, purchased feed when needed, etc.), transhumance offers economic opportunities to herders, reducing their dependency on a single feed source throughout the year. It also allows for the marketing of animal products in different markets and at varying seasons. Despite its high labour demands and the difficult working conditions it often entails (isolation, cold nights, intense sun exposure, etc.), transhumance reduces the need for constant herd supervision near cultivated fields, preventing livestock from entering them before harvest and thereby protecting the broader farming system. This applies not only to agropastoral systems but also to pastoral systems with small-scale subsistence farming, where it is necessary to protect crops from roaming animals during the growing season. In both pastoral and agropastoral contexts, transhumance also contributes to soil fertility, as animals graze and fertilize fallow or uncultivated plots—particularly at night—or their manure is collected for later use on lower-altitude cultivated lands. Several case studies mention the establishment of fertilization agreements, even if they are almost always informal in nature.

On another note, historically, mountain transhumance was a valuable opportunity for encounters, enabling the exchange of information, techniques, practices, and even genetic material (mainly male breeders) between both sides—or even multiple sides—of a mountain range, depending on the geography of the Alpine zones. Transhumance also served as an occasion for organizing festivals and communal celebrations which, over time, became fundamental to shaping the identities of mountain communities. This is closely linked to the collective nature of transhumance, which still endures today and has even been revived through the promotion of mountain tourism.

2. Cross-analysis of past, present, and future drivers of change in mountain transhumance

To begin with, the reading of the various chapters clearly shows that climate change is an unavoidable issue, mentioned in the vast majority of the study areas. A noticeable decrease in rainfall, with prolonged droughts—especially in already arid or semi-arid regions—and a more erratic distribution of precipitation during the rainy season are major contributors

to an increasingly uncertain future for agriculture, particularly for livestock farming and transhumance in their current forms. In response to this shift, some herders are adopting new, often much more intensive, livestock systems, in which the use of natural rangelands—and therefore transhumance—plays a far less central role, given the demanding nature of transhumant practices: long-distance movements, harsh weather conditions, isolation in high-altitude areas with limited access to basic services, etc. On the other hand, changes in minimum or maximum temperatures are cited only in a few cases and do not appear to have major effects on transhumance, even if temperature remains an important criterion for distinguishing between case studies.

The societal demand and the aspirations of younger generations regarding transhumance, as mentioned in several chapters, are closely tied to technological change—not only information and communication technologies (ICTs). Significant transformations have occurred over the past four to five decades, partly due to the actions of young people at the time—many of whom are now questioning what future generations will expect. Indeed, it seems unimaginable for many current stakeholders to undertake transhumance under the same conditions as 30 or 40 years ago, or even longer. The major changes already observed mostly relate to logistics, particularly the transportation of animals, goods, and people, as well as the supply of provisions for transhumant teams. Security—both for people and livestock—has also improved dramatically: today, in case of an emergency, one can easily get in touch via mobile phone, internet, or road access with public safety services or with those who remain at the farm to ask for help. The discussion will explore why this major change, despite being a true revolution for transhumance, is often under-emphasized.

Several chapters report major past or more recent events that have significantly disrupted society—and therefore livestock farming and transhumance. The authors observe that some of these past fractures have not healed and/or may resurface years or even decades later. For example, the Chinese Revolution of 1949 profoundly altered livestock farming on the Tibetan Plateau, redefining land tenure and herd ownership by dismantling pre-existing structures. Interestingly, the new management systems resulting from the Chinese Revolution were based on a community model in which private ownership of land and herds was no longer prohibited. Over the following decades, however, new management approaches adapted to the harsh bioclimatic context emerged again—particularly land-use systems aimed at avoiding the "Tragedy of the Commons" (Hardin, 1972). Although these systems did not fully privatize the land, they strongly resembled privatization. In contrast, livestock farming and transhumance in Kazakhstan were severely disrupted by the collapse of the USSR in the early 1990s, in a somewhat opposite direction to what occurred on the Tibetan Plateau. Starting in the mid-1990s, new systems for utilizing pastures and managing herds emerged, based on private ownership of land and animals, whereas under the communist regime, these had been collectively managed to a large extent. In contrast, current events—such as the wars in Ethiopia and Syria (and thus Lebanon), Hurricane Daniel in Libya's Green Mountains, or the September 2023 earthquake in Morocco's Atlas Mountains—are too recent to fully evaluate their impact on livestock and transhumance. However, their long-term consequences will likely be significant. The Algerian case is more instructive when examining the potential pastoral consequences of major historical events. The authors note the significant impact of the approximately 130 years of French colonization—from the mid-19th century to the 1960s—which dismantled traditional land tenure systems in Favour of settlers. Algeria's independence only partially restored these systems in the half-century that followed. Clearly, some historical fractures have not fully healed—and may even re-emerge.

Several chapters highlight the emergence of new actors in mountain areas who now interact—more or less—with herders, who, for centuries, shared the landscape mainly with foresters, smugglers, and small-scale miners. These new actors—mostly from the worlds of leisure, tourism, environmental conservation, and the growing large-scale mining sector since the late 20th century—reflect the global rethinking of the role of mountain regions in tomorrow's world.

Public policy in mountain regions is addressed in every chapter—either by its absence, by proposed improvements, or, less frequently, by its effectiveness. As one author notes, "we often fail to highlight what works, focusing only on what doesn't," making it a key criterion for differentiating case studies. The discussion will show that public policy plays an essential role in ensuring the proper functioning of mountain systems, maintaining territorial balance at the national level, and encouraging greater participation of local stakeholders in decision-making—potentially contributing to democratic progress.

A strong contrast between the chapters relates to migration: emigration in some cases, immigration in others. This also proves to be an important criterion for differentiating the case studies, with historical perspectives offering particularly interesting insights to be explored further in the discussion.

3. Results of the factor analysis: dendrogram and factorial maps

The dendrogram in Figure 1 shows the result of the hierarchical ascendant classification (HAC) based on data from the MFA conducted on around twenty case studies, using variables with two modalities as defined in Table 2. It can be observed from the second level of subdivision that three groups of case studies emerge represented in the dendrogram in black for the first group, red for the second, and green for the third.

The Black group consists of the following five case studies: Green Mountains/Libya, Tigray/Ethiopia, Namaqualand/South Africa, Chimborazo/Ecuador, and Cordillera Blanca/Peru. The Red group consists of the following nine case studies: Tibetan Plateau/China, Kazakhstan, Mount Lebanon/Lebanon, Aït Bouguemez in the Western Atlas/Morocco, Beni Salah Forest in the Eastern Atlas/Algeria, Altiplano/Peru, Southern Patagonia-Andes/Argentina, Malargüe - Central-Southern Andes/Argentina, and Carpathians/Romania. Finally, the Green group includes the following six case studies: Canadian Rockies/Canada, Serra da Estrela/Portugal, Cévennes/France, High Tarentaise - Alps/France, Pindos Mountains/Greece, and Scandinavian Alps/Norway. These three groups will be described and characterized in greater detail later on.

Figure 2 presents the factorial plane 1x2 resulting from the MFA and HAC, accounting for approximately 25% of the diversity among the case studies. It clearly highlights the three groups of the case studies (Black, Red, and Green) described previously.

4. Characterization of the three case studies groups

The five case studies in the Black Group (Green Mountains/Libya, Tigray/Ethiopia, Namaqualand/South Africa, Chimborazo/Ecuador, and Cordillera Blanca/Peru) correspond to regions where:

- Winters are not very harsh and summers are hot, with average temperatures above 10–15°C in winter and 25–30°C in summer;
- Production systems are mostly agropastoral or agro-silvo-pastoral in nature;
- The biomes in which the farm headquarters are located have been transformed and no longer represent their natural state.

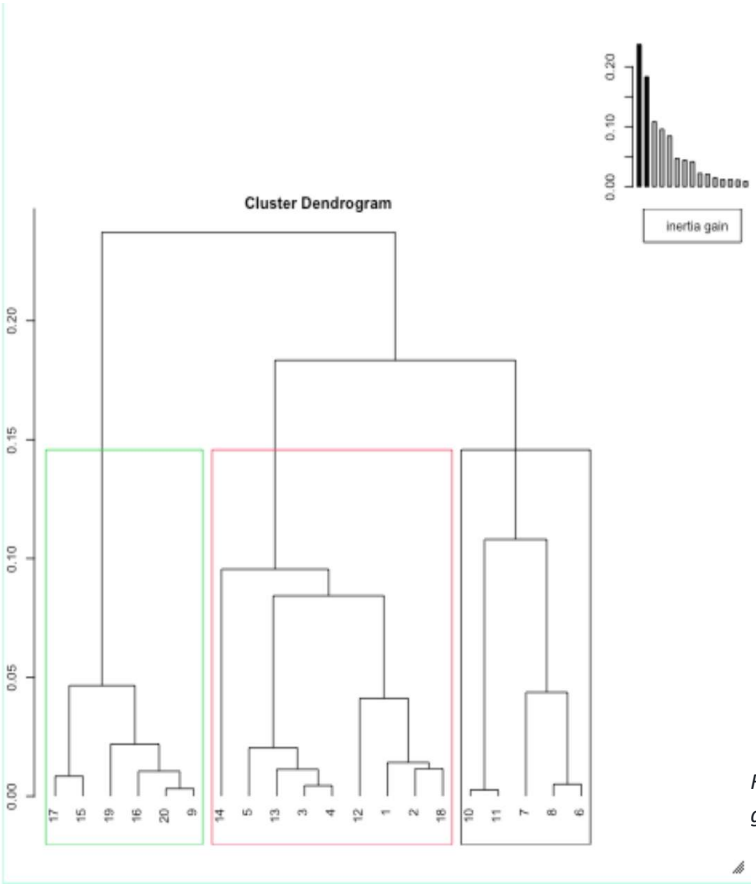


Figure 1. Dendrogram showing the three main groups of case studies (Black, Red, Green)

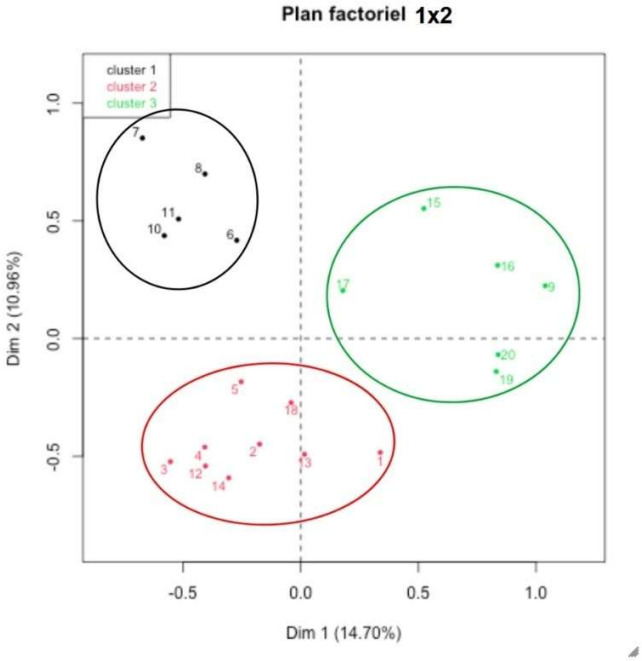


Figure 2. Factorial plan 1x2 resulting from the CAH et AFM showing the three case studies groups (Black, Red, Green)

The nine case studies in the Red Group (Tibetan Plateau/China, Kazakhstan, Mount Lebanon/Lebanon, Aït Bouguemez in the Western Atlas/Morocco, Beni Salah Forest in the Eastern Atlas/Algeria, Altiplano/Peru, Southern Patagonia-Andes/Argentina, Malargüe–Central-Southern Andes/Argentina, Carpathians/Romania) correspond to regions where:

- The majority of systems are pastoral;
- Winters are harsh, with average temperatures below 10°C and often below zero;
- Natural rangeland biomes are present both in transhumance areas and where farm headquarters are located.

The case studies in the Green Group correspond to regions where:

- Public policy is considered efficient, with policymakers and local stakeholders having strong influence on those policies and the ongoing dynamics;
- Tourism is well developed and constitutes a major economic activity;
- There is little to no emigration, and instead, immigration is observed.

The results of the factorial analyses thus largely confirm the relevance of a detailed reading of the chapters concerning the variables, as well as the modalities that differentiate the case studies. Both minimum and maximum temperatures, whether in transhumance areas or at the location of farm headquarters, appear to be key variables in distinguishing among the case studies, separating, on one hand, tropical and intertropical areas and those south of the Mediterranean. Additionally, low temperatures seem to condition the presence of pastoral systems and therefore natural rangeland biomes, while milder temperatures allow for the development of agropastoral systems, including agro-silvo-pastoral ones, and thus transformed rangeland biomes into cultivated land. The efficiency of public policy and the significance of tourism stand out as major differentiating variables among the case studies, separating, on one side, developed countries (Western Europe and North America), where public policies are assumed to be more effective, from emerging (China, Morocco, Argentina) and developing regions, where such policies may be less efficient.

III. Discussion

It seemed appropriate to divide the discussion points raised by previous results concerning past, present, and future changes in mountain transhumance into two groups. The first group addresses transhumance at the scale of the agricultural holding. The second focuses on transhumance and livestock farming in the face of the planet's major challenges. We will then turn to the topic of public policy as the main tool to both meet the expectations of local stakeholders and consider the well-being of the high-altitude ecosystems—namely the Alpine pastures—used for transhumance and, by extension, livestock farming.

1. Transhumance at farm scale

Transhumance, regardless of climate or altitude, has allowed, continues to allow, and should continue to allow in the future the valorisation of cellulosic resources that are unsuitable for human consumption. In doing so, it gives livestock a central role in social and economic sustainability, starting with pastoral systems but also within agropastoral farms, where

the integration of crop and livestock production is vital for broader economic and environmental balance (Moyo et al., 2010; Wang et al., 2019; Serra, 2021).

In addition to producing goods from the consumption of mountain pasture forage, livestock contribute through transhumance to the viability of many pastoral and agropastoral systems via manure fertilization. These systems, in turn, support animal diets through crop residues. This is a far cry from the traditional and ongoing conflict between farmers and herders over crop damage caused by herds. Perhaps this is because transhumance, as practiced today, fosters better collaboration between crop and herd management.

Lastly, the cultural, even identity-based, dimension of transhumance persists—and may even be growing stronger—with all that it implies for animals, but also in terms of the exchange of zootechnical knowledge and genetic material between human groups (Fernández-Giménez and Wilmer, 2024), occasionally giving rise to new economic activities. This is also linked to tourism, territorial events, local celebrations, and a variety of alliances, including marriages between communities from different sides of mountain ranges. Far from being a barrier, the mountain—through transhumance—acts as a bridge between valleys.

2. Transhumance and livestock farming in the face of global challenges

Alongside the major challenge of feeding the world's population through the valorization of Alpine forage resources that are not directly consumable by humans, livestock farming and transhumance also contribute through a variety of ecosystem services, as highlighted by several authors including Opplert et al. (2020), Wang et al. (2021), and Scoones (2023). While many of these services existed in the past, their fundamental roles were not always explicitly acknowledged. Today, they are increasingly recognized by stakeholders and policymakers, and even the general public is becoming more aware of them. These services should be considered essential in the future and therefore more fully integrated into the development of public policies related to the environment, as well as agriculture and livestock (Gerber et al., 2010; Scoones, 2023).

According to Opplert et al. (2020), livestock farming—and by extension, transhumance—delivers ecosystem services across four key domains: soil, air, water, and landscape. Before addressing each domain in detail, it is important to highlight the ecosystem service of maintaining open areas that are more resistant to the spread of wildfires—a threat that is already significant and likely to intensify in the near future, endangering both rural and urban environments. Recent wildfires in the U.S., Algeria, Greece, and Portugal underscore the critical role of rangeland maintenance, for which grazing is indispensable.

Soil: Through the exclusive use of grazing in rangelands—natural biomes, especially at high altitudes—well-managed transhumance protects soils by (i) maintaining permanent vegetative cover that promotes biological activity, and (ii) avoiding soil tillage and chemical inputs. This leads to limited erosion, improved soil structure, and richer nutrient content.

Air: Grazing-based livestock farming and transhumance are often criticized for methane (CH_4) emissions from ruminants, which significantly impact the environment (FAO, 2006). While methane output can be reduced through dietary additives, grazing also stimulates photosynthesis through forage consumption, which sequesters carbon dioxide (CO_2). Additionally, pasture-based livestock systems consume less fossil fuel and fewer synthetic inputs, which themselves require CO_2 and N_2O to produce. Moreover, some CO_2 is sequestered in soils through grazing.

Water: Livestock and transhumance (i) utilize rainfall and snowmelt that nourish rangelands and generate forage, and (ii) enhance water infiltration and reduce both flooding and erratic runoff due to their effects on soil structure.

Landscape: Livestock farming and transhumance (i) help mitigate risks of floods, wildfires, and avalanches, as mentioned earlier, (ii) sequester carbon, nitrogen, and phosphorus in soils through photosynthesis and other biological processes, and (iii) support biological control of invasive plants and certain diseases.

However, these ecosystem functions only produce positive externalities when management practices are sustainable—that is, when they respect the life and long-term viability of rangeland ecosystems. Unfortunately, this is not always, or even often, the case. Many chapters point to frequent situations of overgrazing and advanced or even irreversible degradation of natural pastures. One might wonder: has rangeland degradation become the unofficial norm, and is it destined to worsen globally?

The official narrative, often driven by livestock industry lobbies and some researchers specializing in rangelands, claims that sustainable rangeland management experiences do exist, can be replicated, but should not necessarily become the universal standard. In reality, rangelands—especially Alpine pastures—are in a poor state worldwide, and the means to change this trajectory appear insufficient.

Under growing pressure on resources, particularly land, and in light of agricultural intensification, new forms of intensive livestock production are driving profound changes in techniques, practices, and strategies. Add to this soil, air, and water pollution (e.g. from large-scale mining, as mentioned in several chapters), and transhumant livestock farming—despite its somewhat outdated image—could represent a viable alternative. But in light of the degradation discussed earlier, is this not merely a researcher's hopeful illusion?

On a more optimistic note, young people have driven many of the recent changes in transhumance, as seen in previous analyses. Transhumance has adapted to the needs of its practitioners across nearly all study areas, thanks in part to advances in transportation logistics and digital technologies. For the near future, a growing demand among youth for greater environmental consideration seems to be emerging—though this is mostly a trend in urban areas, especially in mountain regions, and it has yet to be widely shared by older generations, including climate sceptics who still dominate public policy in this second decade of the 21st century.

It is worth remembering that, nearly two decades ago, the livestock sector was severely criticized by the FAO's influential report *Livestock's Long Shadow* (2006), which demonstrated that livestock production was far less "natural" than previously believed and contributed to approximately 15% of global greenhouse gas emissions—a major factor in climate change. This criticism extended to all forms of livestock, including extensive grass-fed systems, particularly in mountainous areas, which had previously been considered environmentally beneficial and prominently featured in advertising and public communications.

However, current models for assessing greenhouse gas emissions are not well suited to pastoral systems, as they rely on assumptions designed for high-yield animals and significantly underestimate the carbon sequestration capacity of grazing systems (Houzer & Scoones, 2021; Nori & Scoones, 2023; Scoones, 2023).

Thus, depending on how environmental concerns are prioritized in the 21st-century agenda, the question remains: how will the transition unfold between the older generations—still in charge of livestock policy and deeply convinced of the benefits of mountain livestock farming and transhumance—and the new generations, increasingly aware of environmental well-being, and ready to challenge the assumptions promoted by livestock stakeholders? Will they push research to find efficient alternatives to the few stopgaps used thus far?

Lastly, no discussion of global challenges is complete without addressing climate change. As we've seen, mountain livestock farming—and therefore transhumance—should play a central role in human efforts to confront this challenge, given the critical importance of mountain regions in environmental issues. This includes the role of mountain livestock farming alongside water management, biodiversity preservation, and large-scale forestry and mining operations.

3. Public policy and government action in mountain areas

The case studies reveal a wide variety of public action in mountain regions, particularly regarding livestock farming, which remains a major activity in these areas. However, the central question remains: *by whom* and *for whom* are these public policies designed?

To support our argument, we will draw on comparative examples of migration in several of the case studies. In the mid-19th century, the Scandinavian mountains—especially in Norway—experienced a significant wave of emigration to the United States, as local populations struggled to meet their basic needs, especially survival. Similar dynamics occurred in mountain regions such as the Cévennes and the Alpine Savoie in France, where migratory flows developed respectively towards mining industries and long-distance maritime transport. A century later, starting in the second half of the 20th century, these former lands of emigration had become socially and economically developed territories, thanks to successive public policies. Eventually, they even became regions of immigration.

A similar process unfolded on the Tibetan Plateau, where the traditional social and economic structures were dismantled by the Chinese Revolution of 1949. After a period of uncertainty and trial, public policies were implemented to support agricultural operations—especially targeting ethnic minority populations—with the goal of achieving economic parity with other Chinese regions. These efforts aimed to satisfy the demands and aspirations of local ethnic groups, thus preventing resistance to the exploitation of their lands' natural resources for the benefit of the entire country—a strategy viewed as a form of fair compensation. While this strategy has not succeeded everywhere on the plateau—particularly in the former Chinese Turkestan, homeland of the Uyghurs—other regions have become attractive destinations. In fact, young people from neighbouring ethnic groups, such as Kazakhs, Mongols, and Gobi populations, now migrate to the Chinese Tibetan Plateau seeking naturalization and access to the benefits of state-led development in the region.

Comparable examples can also be found in North Africa, particularly Morocco. During the second half of the 20th century, emigration from high mountain areas became frequent—driven by population growth, pressure on scarce resources, and the search for additional income or better access to quality social services like healthcare and education. Interestingly, however, these migrants often maintain strong ties to their regions of origin, contributing investments in kind and introducing technical and even institutional innovations (Rignall, 2017). This is especially evident in mountain oases in Morocco, where livestock farming—in sedentary and/or transhumant forms—continues despite the constraints of a structurally arid climate.

These historical perspectives from Europe, China, and North Africa on migration in mountain regions demonstrate the effectiveness of public policy—*when* it responds to the legitimate aspirations and coherent demands of local actors. But should we necessarily interpret these cases as progress in terms of public participation—especially in the design, implementation, and/or evaluation of public policy—and, more broadly, as democratic advances?

Regardless of the answer, these cases remain major examples of how public action can slow emigration and promote development in mountain regions—an aspiration shared by several case studies in our sample. This is particularly important considering that emigration primarily affects young people. Yet, a territory that fails to take care of its youth is a territory with little or no future.

Conclusion

To conclude our analysis of past, present, and future transformations in mountain transhumance, we first established the near impossibility of separating transhumance from livestock farming, from the pastoral or agro-pastoral systems

in which it is embedded, and from the territories themselves—particularly high-altitude ecosystems such as Alpine pastures. We then noted the strong influence of natural parameters—such as minimum and maximum temperatures or elevation—on the feasibility of change.

Yet, despite these constraints, significant transformations have taken place, particularly in terms of technique, thanks to innovations driven by the demands of younger local actors. These younger generations are poised to succeed their elders, continuing the practice of transhumance, sustaining livestock farming, and contributing to the broader territorial development dynamics. Similarly, in recent decades, there has been a profound shift in how high-altitude environments—and even lowland rangelands converted into agricultural, urban, or industrial land—are perceived and managed. These changes have often been initiated by the younger generation.

Public policy, for its part, has emerged as the principal tool to initiate, guide, and fund change in mountain territories. However, this can only be effective if such regions are truly prioritized in the minds of local and national stakeholders. Change is often feared, particularly by decision-makers and policymakers preoccupied with a wide array of interests—interests that are too often poorly aligned or not shared with local actors. In all the case studies, climate change is clearly a present concern—even if it is not always explicitly cited as the main driver of transformation, largely because its multiple facets are difficult to characterize both for local actors and for stakeholders and policymakers alike.

Ultimately, just as in the past and present, the future of mountain transhumance and livestock farming will depend on their ability to adapt their goals, strategies, and practices to evolving contexts. Crucially, they will help shape that future—provided public action continues to support and enable them. It is exactly this philosophical approach to the multiple contributions of transhumance and the challenges that await in the near future that has led international bodies such as the International Council on Monuments and Sites (ICOMOS) and the International Mountain Conference (IMC) to select the presentation of this book in renowned conferences (ICOMOS Initiative to Highlight the Heritage Value of Transhumance Cultural Landscapes, Baku – Azerbajan, June 2025; International Mountain Conference, Innsbruck – Austria, September 2025) (Sraïri et al., 2025a; Sraïri et al., 2025b), with a view to disseminating at a global scale the messages it promotes to the scientific community, to decision makers and even to the public opinion.

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Chapter 1

Change in transhumance in the Qilian Mountains, Tibetan Plateau, China*

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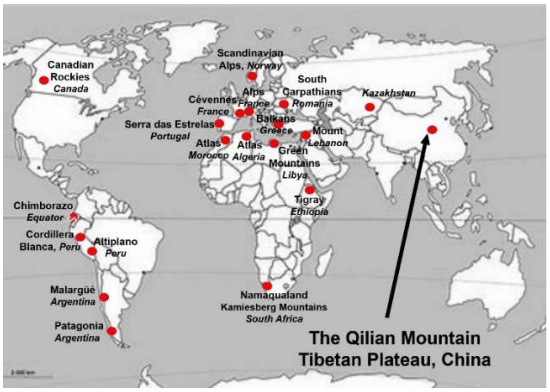
Abstract

The Qilian Mountains are a mountain range located in the northeastern part of the Tibetan Plateau. The region is home to several ethnic minorities who benefit from specific public policies. Due to the high altitude and harsh climatic conditions, livestock farming is almost the only viable activity in rural areas. Transhumance is a traditional livestock farming practice that enables the use of Alpine meadows during the summer, which remain frozen or snow-covered in winter. This practice involves various livestock species, including yaks, sheep, goats, donkeys, and/or horses, and, when present, cattle—as well as, of course, the herders' families. Major changes in transhumance are closely tied to developments in livestock farming. These changes have primarily been driven by agricultural and public policies, particularly land tenure reforms following the 1949 revolution. Subsequent major public initiatives included market liberalization in the 1980s and the introduction of the Household Contract Responsibility System (HCRS) in the early 2000s. Other factors influencing transhumance—beyond those specific to the Tibetan context—include the expectations and aspirations of younger generations regarding agricultural investment, the rapid development of new technologies that are transforming livestock practices, and, more recently, climate change.

Keywords: Harsh climatic conditions; Land tenure change; New technologies; Public policies; Youth expectation



* Photo credits: the authors

Introduction

Livestock breeding has long been the main activity in the rural areas of the Tibetan Plateau, primarily due to the harsh winter climate. As a result, the transhumance of yaks, sheep, and goats—accompanied by donkeys and/or horses—has been an essential practice for centuries, perhaps dating back to the very origins of livestock breeding. This practice enables the use of vast pastoral resources during the summer, which remain frozen and often snow-covered from mid-autumn to mid-spring.

In recent decades, the Tibetan Plateau—and China as a whole—has undergone significant transformations, profoundly reshaping the national livestock sector and, by extension, that of the Tibetan Plateau. Key historical events include the Chinese Revolution in 1949 and the transition to a market economy, overseen and regulated by public authorities, beginning in the 1980s. Additionally, national rangelands—particularly those on the Tibetan Plateau—have become a priority for Chinese public authorities for several reasons, which will be discussed later in this chapter.

The livestock sector has experienced profound changes—sometimes abrupt and dramatic, other times gradual and subtle—affecting various structural aspects of herds, pastures, and the people involved in these activities. The organization of livestock farming has been significantly impacted, especially in terms of rural community leadership, land tenure and livestock ownership, rangeland and herd management, and the supply chains for inputs, outputs, and market distribution.

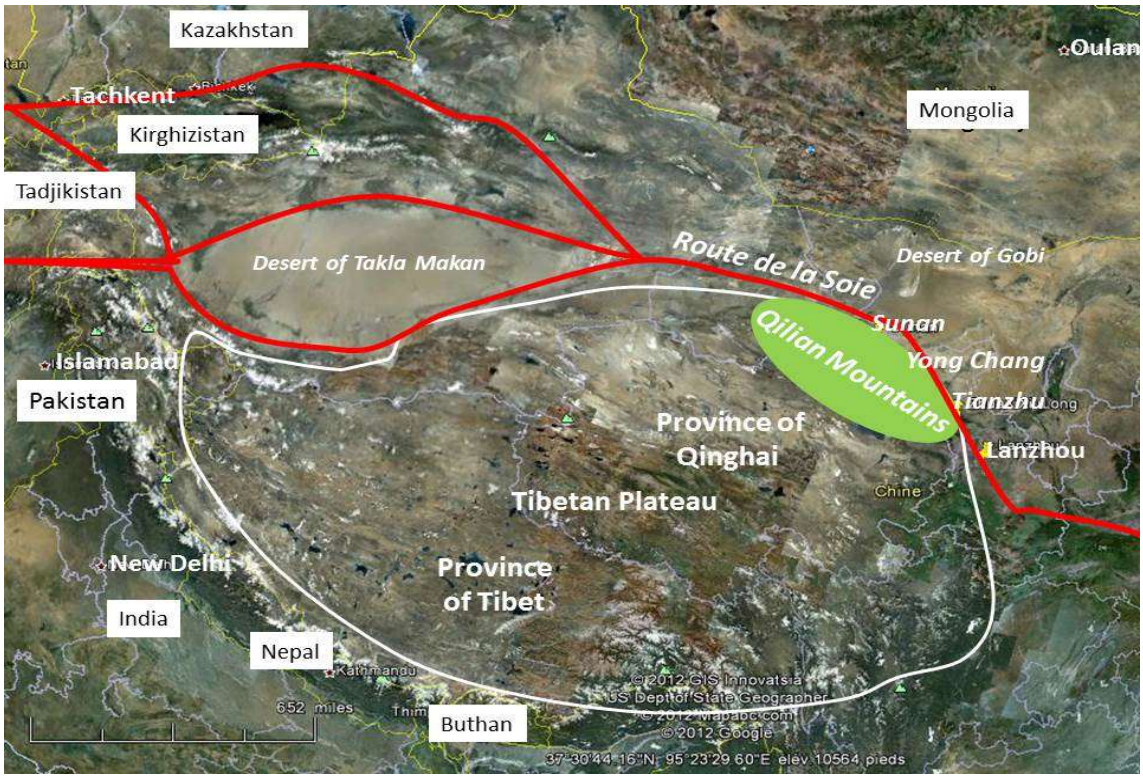
This chapter draws on data and findings from an international research project conducted between 2009 and 2014, coordinated by the International Centre of Tibetan Plateau Ecosystem Management (ICTPEM) under the leadership of Lanzhou University. It explores transhumance within the livestock breeding system and its ongoing transformations, through a case study of Sunan County in the Qilian Mountains on the Tibetan Plateau.

The chapter begins with an overview of livestock breeding, which remains the dominant rural activity due to the extreme geographical and climatic conditions of the Tibetan Plateau in general, and the Qilian Mountains in particular. It then examines the recent history of livestock breeding and agricultural production systems in the region, with a focus on the transformations initiated by the Chinese Revolution of 1949 and their subsequent developments in the 1980s.

Next, using the example of Sunan County in the Qilian Mountains, the chapter describes rural life, emphasizing the central role of livestock breeding and transhumance in the livelihoods of local communities. Special attention is given to land tenure—an issue of critical importance for herders as they navigate the challenges of future local development. Finally, building on these successive analyses, the chapter presents and explains the main changes that have affected livestock breeding and transhumance over time.

I. Breeding and the harsh climate in the Qilian Mountains

From a geographical perspective, the Qilian Mountains are crossed by the Hexi Corridor—an ancient trade route of the Silk Road—which has historically served as an economic axis for the region. This corridor connects Gansu Province, and thus the heart of China, to Western China and the Middle East. It also forms part of the eastern and northern boundaries of the Tibetan Plateau (Map 1).



Map. 1. Location of the Qilian Mountains in the northeast of the Tibetan Plateau, China

As with caravans up until the mid-20th century, the Hexi Corridor remains the primary route for transporting people and goods between Eastern and Western China. Administratively, the Qilian Mountains fall under the jurisdiction of both Qinghai Province—located entirely on the Tibetan Plateau—and Gansu Province, which lies partly on the Tibetan Plateau, partly in Central China.

The elevation of the Qilian Mountains ranges from 2,500 to 5,000 metres, slightly lower on average than much of the Tibetan Plateau, where altitudes typically range between 4,000 and 5,000 metres above sea level in the West. The Hexi Corridor crosses the Qilian Mountains at elevations between 1,500 and 2,000 metres, with mountain passes in the North rising above 3,000 metres.

Due to their inland location and position behind the Himalayan range, the Qilian Mountains experience a harsh continental climate characterized by four distinct seasons. Winter, lasting from December to February, is cold and dry, with average sub-zero temperatures from November to March. Nighttime lows can reach -30°C, and winter precipitation is minimal, typically less than 20 mm. Summer, from June to September, is cool and wetter, with afternoon highs ranging from 15 to 20°C. Summer precipitation varies between 150 and 250 mm annually, though some areas may receive as much as 500–600 mm (Tabouret, 2009).

With regard to pastures, Long (2003) notes that due to low temperatures, the growing season for forage biomass in Alpine meadows is relatively short, spanning from late May or early June to late October or early November. Peak biomass production, averaging 3,000–3,500 kg of dry matter per hectare (DM/ha), occurs in August and September (Photos 1 & 2).

Photo 1. Winter landscape in the Qilian Mountains

Photo 2. Summer landscape in the Qilian Mountains

The harsh weather conditions in the Qilian Mountains—except along the Hexi Corridor—strongly support livestock breeding as the primary agricultural activity in rural areas. Crop diversification is limited, consisting mainly of oat hay, which is used to feed herds from mid-autumn to mid-spring. Furthermore, due to the extreme climate, Alpine meadows cannot be grazed before mid-June. Herders must bring their animals—particularly small ruminants—back to the farm headquarters before the first snowfall, typically between mid- and late September, depending on the year. Yaks (*Bos grunniens*, a local bovine species) are more resilient and can remain on mid-altitude pastures until mid-November.

In mid-June, herds and herding families gradually move to higher-altitude pastures, where they remain until mid-September. This marks the beginning of their return from transhumance to the villages, where they spend late autumn, winter, and early spring. During these six coldest months, herds graze near the villages and are fed oat hay cultivated in nearby croplands during the summer, sometimes supplemented with off-farm concentrate feeds.

Covering approximately 2.5 million km², the Tibetan Plateau accounts for nearly one-quarter of China's total land area (10 million km²). It also represents the country's largest rangeland region. According to scientific sources, rangelands cover between 40% and 65% of China's land area—equivalent to 4 to 6.5 million km²—primarily located in the North (Inner Mongolia) and West (Tibetan Plateau) (Hu & Zhang, 2001; Ren et al., 2008). The Tibetan Plateau's rangelands serve as vast pastoral zones, mainly used by ethnic minority groups, including Tibetans, Uyghurs, Gobis, and Mongols, alongside Han Chinese—the country's dominant ethnic group, comprising 92% of the population—who also engage in livestock breeding and farming in the Qilian Mountains (Long et al., 2008).

For Chinese public authorities, these rangelands hold major strategic importance. They function as a crucial "water tower," supporting irrigated agriculture, industrial activities, and the growing needs of urban populations. Additionally, they are rich in valuable mineral resources—including uranium, lithium, and hydrocarbons—that are vital to China's rapid industrial, agricultural, and economic development.

II. Livestock in the history of the Qilian Mountains

As previously mentioned, the Tibetan Plateau has undergone a turbulent recent history, particularly following the Chinese Revolution of 1949. This major political shift primarily impacted the social organization of both urban and rural areas, with significant implications for land tenure and livestock ownership.

Before the Revolution, monasteries were the main landowners of the rangelands across the Tibetan Plateau. For pastoral tribes, these rangelands—used for grazing their herds—formed the cornerstone of their livelihoods. Access to and use of these lands were governed by complex, long-standing agreements between the tribes and the monasteries (Long et al., 2008). Moreover, Wang et al. (2010) highlight the balance that existed between natural resources and their use by herders, likely due to low stocking rates and relatively small herd sizes at the time—particularly in comparison to the current situation.

The 1949 Revolution brought about a dramatic change in land ownership. Monasteries were stripped of their landholdings, which were transferred to rural communities. These communities became responsible for allocating land use equitably among households, based on population and specific needs. This transition also affected livestock ownership and management, which shifted from pastoral tribes to the community level. The collectivization of rangelands and herds led to significant degradation of pastures, especially around villages, where animals were concentrated.

Signs of rangeland degradation became evident in the mid-1950s, following a pattern similar to the "Tragedy of the Commons" described by Hardin (1968). In response, specific policies were introduced and, a decade later, a national program for sustainable rangeland management was implemented—mirroring the National Agricultural Development Program launched in 1958 for cropland. Recognizing the vital role of rangelands in the water cycle, the program aimed to curb unsustainable grazing practices, which had intensified due to a doubling of herd sizes, resulting in widespread soil erosion and land degradation (Longworth & Williamson, 1993; Huang, 1996).

By the mid-1970s, rangeland management remained problematic, particularly in severely overgrazed areas. As a result, a new approach was adopted: usage rights were allocated directly to individual households, while ownership of the land remained collective and was overseen by local administrative authorities (Wang et al., 2010). This approach took shape through the Household Contract Responsibility System (HCRS), a key policy tool for sustainable rangeland management. The system introduced various incentives for households, formalized in contracts between the household, the community, and the local government. These contracts granted households the right to use specific rangelands and set a maximum number of livestock that could be supported. The HCRS marked a significant transformation in pastoral society: although land ownership remained collective, households assumed responsibility for managing their herds and rangelands (Wang et al., 2010). As a result, the HCRS had a direct impact on transhumance practices, as families now relied on individually contracted land rather than collectively shared grazing areas.

Further policies were introduced to reinforce the HCRS, notably the 1985 Grassland Law, which aimed to protect rangelands by penalizing their conversion to cropland or forest clearance. In the mid-1990s, following catastrophic flooding along the Yellow and Yangtze rivers, the government launched the Natural Forest Protection Program—a large-scale initiative to preserve forests and encourage afforestation (Liu et al., 2001; World Bank, 2001). At the same time, the Great Western Development Strategy, also introduced in the mid-1990s, set the framework for rural development and poverty alleviation. It provided incentives for local economic initiatives and environmental conservation. These policies significantly affected livestock breeding—the mainstay of rural economies—and, by extension, transhumance practices.

However, Wang et al. (2010) argue that the initial implementation of the HCRS was largely ineffective due to its top-down approach, mirroring earlier agricultural policies. According to these authors, the system only began to show results in the early 2000s, when a new form of rangeland governance emerged. This model was also based on contracts negotiated among households, communities, and local authorities—a model that will be further discussed below.

III. Rural life based on animal breeding

1. Settlement, housing, family, and herds

Nowadays, within the county—typically structured around a central town—rural settlements are organized into a few villages, several hamlets, and some more isolated farms (Photos 3).

Photos 3. Two isolated farms in winter (left) and in summer (right) in the Qilian Mountains, Tibetan Plateau, China

Regarding local administration, each village is led by two leaders: one elected by the households and another, called the manager, appointed by the local administration. The appointed manager is typically not a member of a village household. Villages are connected to a nearby town or city, where residents have access to essential services such as health centres, primary schools, post offices, and other administrative facilities. Similarly, towns are governed by two leaders—one elected by the households and the other designated by the public authorities. The shared official objective of these leaders is to coordinate the local community by balancing household demands with administrative requirements.

A typical rural household in Sunan County consists of a couple and two children. As members of an ethnic minority (Uyghurs), families are allowed to have more than one child. However, many households choose to have only two children due to financial constraints, as their income —primarily from livestock farming— did not overcome approximately €6,000 per year in 2014. The cost of education, particularly high school and university fees (~€2,000 per year in 2014), is a significant consideration in family planning decisions. Each household resides in its own home (Photos 4 & 5), either within or near a village, with access to basic social services such as electricity and, in many cases, running water. Recently, a government policy has supported farmers in constructing modern and more comfortable houses equipped with greenhouse heaters (Photo 4).

Photo 4. The old (left) and the new (right) houses

Photo 5. inside a rural house with its equipment

The furniture in a typical household is simple and functional, including a bed, a table, one or two small cupboards for storage, a few chairs and stools, and the essential stove, which burns dried yak dung as fuel (requiring 5 to 15 kg per day, depending on the temperature). Upon retirement, most farmers migrate to the nearest town, where they live in apartments that are often slightly more comfortable and well-furnished.

The size and composition of a family's herd vary depending on the household. A typical family herd consists of 25–40 yaks and 80–100 small ruminants, including sheep and goats (Photos 6).

Photos 6. Typical family herd with yaks (left) and sheep (right) receiving oat hay during winter

However, some families raise only small ruminants, primarily Tibetan sheep, with herd sizes sometimes reaching 200–300 head. While some households prefer the native Tibetan sheep breed, known for its adaptability to the local environment, others opt for crossbreeds with Merino sheep. These so-called fine wool sheep produce higher-quality wool but have greater nutritional requirements than the hardy Tibetan breed.

2. Family labour, the key factor in livestock farming

Family labour is primarily focused on three key tasks: (i) supervising animals during grazing, (ii) producing oats' hay for winter feed on cultivated plots, and (iii) caring for the animals, particularly newborns, their mothers, and young livestock, which require daily monitoring. The late afternoon is usually dedicated to small ruminants, as they are penned for the night to protect them from predators such as wolves and foxes. The flocks are often checked again in the morning when they leave the enclosure, and sometimes even on pasture, to identify animals needing special attention.

Managing more than 60–80 yaks, especially dairy yaks, or 300 sheep and goats requires more labour than a typical household couple can provide, particularly during the late winter and early spring (mid-February to mid-April) calving and lambing season. Additionally, from late autumn to mid-spring, small ruminants receive supplemental feeding

with oat hay produced during the summer, given either when they return to the farm or before they leave for grazing in the morning (Photos 6). Yaks, being more resilient, only receive hay toward the end of winter and early spring, a period considered by breeders as being the most difficult for both people and animals.

Calving and lambing typically occur without human intervention. However, due to extreme cold, especially at night, breeders sometimes need to warm newborns by rubbing them, wrapping them in blankets, lighting a fire, or even bringing weaker ones into their homes. For this reason, breeders in the Qilian Mountains, like those in many other mountain regions, prefer to keep pregnant females close to their headquarters.

Recently, this challenge of cold temperatures during calving and lambing has been mitigated by the subsidized construction of greenhouses for vegetable production in spring, summer, and autumn, which are then converted into sheepfolds and stables in winter (Photos 7 & 8). These greenhouses, depending on the case, have roofs made of either glass or plastic.

Photo 7. Building a greenhouse near a troglodyte stable

Photo 8. House with two new greenhouses

A significant advantage of greenhouses is their natural "disinfection" effect due to sunlight exposure and improved ventilation. In contrast, traditional stables and sheepfolds (Photo 7) often pose challenges related to infectious diseases and parasites. According to breeders, using greenhouses for calving and lambing results in an estimated 10% net increase in herd productivity and significantly improves working conditions for households.

Milking yak females is also a labour-intensive task, particularly because it requires preparing and distributing supplementary feed such as flour, while other yaks and small ruminants either receive only hay or nothing at all, their dietary ration consisting in resources grazed.

Beyond direct animal care, the available labour force must also handle other essential activities related to livestock farming, including: (i) Cultivating and storing hay for winter feeding; (ii) Selling and purchasing livestock and necessary inputs; and (iii) General agricultural tasks such as equipment and building maintenance, as well as household-related purchases.

The effective management of family labour is therefore one of the key factors in livestock farming in the Qilian Mountains. Children often assist with farm work outside school hours and during holidays, which fortunately coincide with transhumance. However, most of the workload, especially night work during calving and lambing, falls on the couple managing the farm.

3. Livestock supports rural households' livelihoods in Sunan County

Livestock breeding serves as the backbone of rural family income and livelihoods in the Qilian Mountains, primarily through the sale of live animals and secondary products such as wool, leather, and yak dung used for heating. The following techno-economic and financial data, sourced from Long et al. (2014), Bracquiès (2014), and Bossuette et al. (2015), provide a clearer picture of the economic role of livestock farming in this region.

Lambs are sold aged 6 months (June-July) at 15−17 kg live weight for a market value of €55−75, depending on size and fat cover. Male yaks are sold aged 4-5 years, weighing 200−250 kg, for €450−700. Culled female yaks are sold between 12-18 years old for €250−350. From a 100-head sheep flock, breeders can sell 75−80 lambs per year, keeping around 20 lambs for flock renewal. In a 50-yak herd, with 12−15 breeding females and an equal number of heifers, around 4−6 yaks can be sold annually. A female yak typically gives birth every two years, or two calves every three years, though shorter intervals are sometimes observed. Heifers generally calve for the first time at 5−6 years old.

In terms of income from livestock products, a farm with 80 sheep and 40 yaks can generate around €5,000 from live animals' sales. Wool sales increase income by 5−10%, rising to 15% for Merino sheep and 20−25% for white yaks (highly valued for their wool and tails). A Merino sheep produces 3−4 kg of wool per year, sold for €3−4/kg. Leather is sold at slaughterhouses for €10−12 per hide. Subsidies from the HCRS and other government programs add approximately 10% to household income, excluding further subsidies for transhumance tents, farm repairs, or urban apartment purchases.

Regarding the additional income sources, some pastoralists engage in tourism, offering traditional meals and lodging in tents. Others collect and sell yarsagumbu mushrooms (*Ophiocordyceps sinensis*), a valuable traditional remedy. Trade and service-related work can supplement income but often require long absences, increasing labour demands on family members. In such cases, households form associative agreements with close relatives for labour-sharing.

The major livestock farming expenses are (i) fodder and forage rental (sometimes including concentrate feed); (ii) stable and sheepfold construction, previously a major investment, is now largely offset by higher productivity and lower mortality, with significant government subsidies covering construction costs; and (iii) families can also earn rental income from rangelands: summer and autumn rangelands (€20/ha), winter rangelands (€45/ha), forage plots, particularly for elderly farmers who can no longer engage in pastoral work.

This economic model highlights the delicate balance between traditional livestock farming, government support, and diversification strategies that sustain rural families in the Qilian Mountains.

IV. Transhumance as a strategic practice in pasture management and feeding

Transhumance in the mountains of the Tibetan Plateau varies from region to region and even within the same region, depending on factors such as geography, topography, climate, local traditions, and available opportunities. An example of mountain transhumance can be seen in rangeland and herd management in Sunan County, located in the Qilian Mountains (Photo 9)

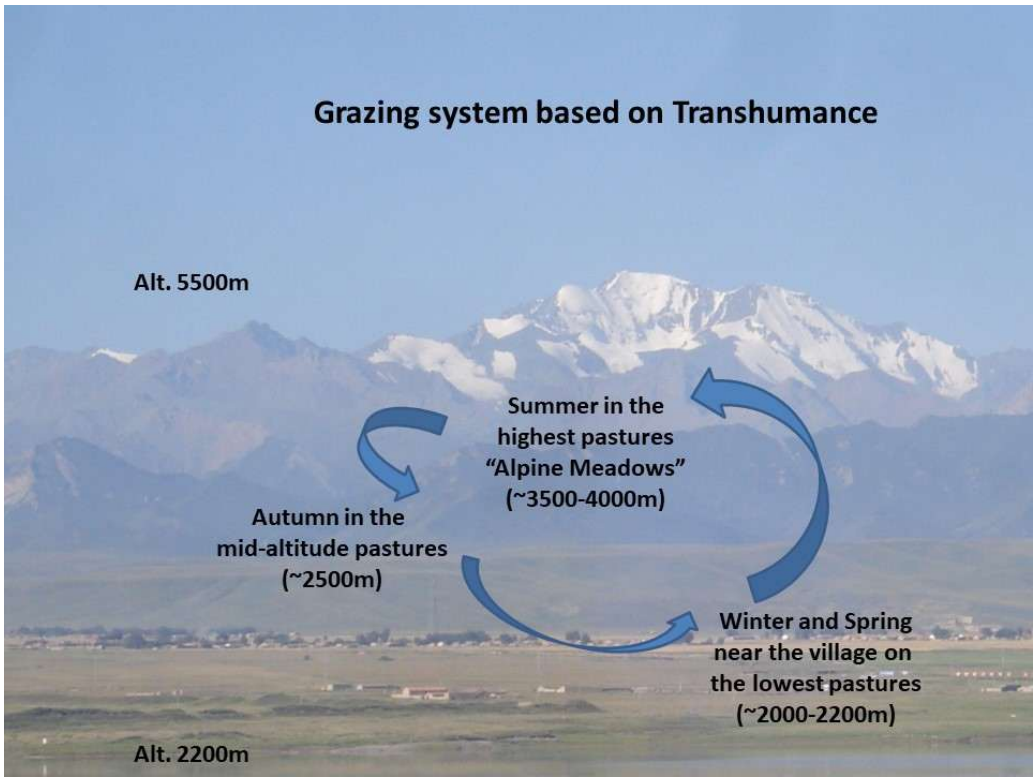


Photo 9. Rangeland management and transhumance in Sunan County, the Qilian Mountains

Transhumance to the high pastures, at elevations of around 3,500–4,000 metres, generally begins in mid-June, when the Alpine meadows have thawed, are no longer covered in snow, and the grass has grown sufficiently to be grazed without the risk of permanent degradation. This late spring to early summer departure allows herders to cultivate oat plots in the spring, ensuring a supply of hay to feed their livestock during the winter. The descent from the Alpine meadows takes place at the end of summer, around mid-September. Part of the flocks move to mid-altitude pastures, where they graze until the first frost, while the rest return to the villages and graze on nearby pastures.

In Sunan County, almost all pastoralist households move with their herds. A few families travel together, as reaching the high pastures can require covering several kilometres to a few dozen kilometres, depending on the location of the farms. The time needed to reach the transhumance sites depends logically on the distance to be covered and the means of transport. Until now, transhumance in Sunan County has been carried out on foot, both for the flocks and the shepherds, with typically one person per flock or household accompanying them. Households travel with pack animals— sometimes horses but more often donkeys— carrying various equipment as well as materials, and food needed to live three months away from the villages.

However, an increasing number of households or groups of households now use motorized vehicles (motorcycles, cars, or even small trucks) to facilitate trips between villages and transhumance sites. As in most regions of the world where transhumance is practiced, households in Sunan County return each year to the same transhumance site, following established routines. In spring, the couple typically sets up their camp there (Photo 10), usually consisting of a tent for living and sleeping, with an annex for the kitchen.

Today, nearly all households have at least solar panels for energy, a satellite antenna, and sometimes a Wi-Fi connection. A specific public policy aims to improve the living conditions of transhumant herders, offering subsidies

for acquiring a tent (a former army tent costs around €450) or building a hut (Photo 11). Additionally, efforts are made to maintain access roads to transhumance sites and improve communication infrastructure.

Photo 10. Tent and hut with their equipment

Photo 11. Old and new huts for transhumance

During the day, flocks graze in the Alpine meadows around the camps, following protocols specific to each household or household group. They are usually inspected at least once or twice per half-day. At night, small ruminants are kept in enclosures near the tents to protect them better from predators. This also facilitates thorough inspections in the morning and evening when they enter and exit the night enclosure. Yaks, on the other hand, are granted more freedom to roam both day and night, as they require less supervision and control. They also remain longer on the high pastures since the grass remains sufficient, and they are more resistant to frost and snow-covered pastures than small ruminants. As a result, part of the flocks is moved to mid-altitude pastures (~2,500 m, Photo 12), which are less affected by frost and snowfall, where families set up their tents. The other part returns with their owners to the villages and grazes on surrounding pastures at an altitude of around 2,000 to 2,200 m (Photo 13).

Photo 12. Flock grazing on mid-altitude pasture

Photo 13. Flock grazing on lowest pasture

From November to May, all flocks are brought back during the day to the winter rangelands near the villages. The yaks join them later, when they leave the mid-altitude rangelands in mid to late winter. When the lowest pastures become insufficient or snow-covered, small ruminants —and later, the yaks— receive supplemental feed made from oat fodder harvested from forage plots, as previously mentioned. As also noted, in winter and early spring, supplemental fodder is provided to all animal categories, with special attention to the most vulnerable: newborns, lactating and milking females, and young animals. Some breeders also purchase concentrates feed made from cereal

grains and oilseed meal. Most of the oat hay fed to livestock in late autumn, winter, and early spring is produced on the farm. Each household is allocated one or more agricultural plots in the village's croplands, where they cultivate oats, usually with supplementary irrigation.

Oats' cultivation begins in spring when temperatures rise above freezing and the ground thaws. The process continues until the hay is ready for harvest. Sometimes, a family member returns to the village during transhumance to oversee hay production, which is crucial for ensuring winter feed for the herds. Once harvested, the hay is typically stored on the farm in the form of stacks.

V. Past, current, and future changes in transhumance

1. Overriding importance of public policies for almost a century

The discussion above clearly illustrates the impact of socio-political and macroeconomic events on transhumance over the past 70–80 years. First, the Chinese Revolution of 1949 significantly disrupted the social, economic, political, and cultural structures of livestock breeding —and consequently, transhumance— by stripping monasteries of land control and tribes of herd management.

The ecological disaster following years of poor rangeland management, along with its direct and indirect consequences —such as severe famines and deadly floods— forced public authorities to reassess their approach. By the mid-1980s, policy shifts led to new strategies for managing rangelands, much like those previously introduced for agricultural land.

Over time, this new approach gradually took shape, ultimately resulting in the establishment of the Household Contract Responsibility System (HCRS). Today, according to herders and stakeholders, the HCRS plays a major role in shaping livestock dynamics and, by extension, transhumance, which remains an essential practice in the Qilian Mountains. This influence has been further reinforced by various government measures aimed at supporting transhumance, such as subsidies for purchasing tents and essential equipment for energy and communication, the construction of Alpine huts, and the allocation of usage rights for Alpine plots, as seen in Sunan County.

Additionally, as previously mentioned, authorities have introduced various initiatives to strengthen the resilience of livestock farming in rangelands. These include land reforms, rural housing renovations, new production models such as feedlots, and the development of social and economic services for rural populations.

It is highly likely that this territorial policy, launched in the late 20th century and pursued by public authorities in the Eastern Tibetan Plateau—where the Qilian Mountains are located—will continue in the coming years. As a result, transhumance will likely evolve, benefiting from advancements in infrastructure for transporting people and animals, improvements in Alpine housing, enhanced social and technical services, scientific research, and ongoing innovations.

2. New expectations and demands of young people in rural areas

The socio-demographic changes that Chinese society has undergone in recent decades have had a significant impact on livestock breeding in rangelands and, consequently, on transhumance as a fundamental practice in this sector. As previously mentioned, while ethnic minority couples in the Qilian Mountains are not subject to the one-child policy, they typically have no more than two children, a decision they attribute to the high cost of raising children. Additionally, livestock productivity remains highly dependent on intensive labour uses due to the low level of

mechanization in breeding techniques and practices, though this may change in the future, as discussed further on. In traditional rangeland society, before the revolution, young people married early, around the age of 20. Newlywed couples integrated into the extended family, participating in both social and economic life, contributing to the joint management of family herds while also raising their own animals—livestock they had received since birth, forming the foundation of their own herd.

After the revolution, social norms in the rangelands gradually evolved with the introduction of an education system, first in urban centres and later in local communities. Over time, the integration of ethnic minority groups, including those in the Qilian Mountains, into broader Chinese society led more parents to prioritize their children's education—primary school, secondary school, high school, and potentially university—to provide them with opportunities beyond livestock breeding. Young people have increasingly embraced this shift, becoming urban dwellers with rural roots, returning home for weekends and vacations.

As a result, for these young people transhumance remains a culturally significant and festive event in which they participate for a few weekends or up to one or two weeks, both to assist their parents and to stay connected to their traditions. Some traditional aspects and social ties persist, such as communal departures for transhumance or mutual aid for labour-intensive fieldwork. Additionally, they sometimes bring urban friends along, introducing them to the rural way of life. However, few envision themselves taking over their parents' breeding activities, primarily due to the demanding workload, which extends year-round, 24/7. That said, some may develop an interest in alternative forms of livestock breeding, as we will now explore.

3. New technologies, practices, and forms of livestock breeding

Throughout this chapter, we have seen that new breeding techniques and practices have emerged in recent years, largely driven by public policies, particularly those directly or indirectly linked to the HCRS. Notable developments include the introduction of greenhouses for birthing and caring for vulnerable animals, the construction of new houses to improve living conditions, and the establishment of mountain huts. Additionally, significant efforts have been made in transport and communication infrastructure —including television, mobile networks, and internet access— as well as in social services such as healthcare, education, and postal services at the village level. Breeders also benefit from subsidies and retirement pensions, further shaping the evolution of livestock farming.

Another key policy measure is the allocation of land for livestock farming. Initially intended for hay cultivation to provide winter feed in villages, land allocation has now been extended to mountain pastures, promoting better management of pastoral resources, particularly during transhumance in Sunan County.

It is evident that this dynamic, rooted in the HCRS policy, will continue and likely expand to include new forms of livestock farming. For instance, feedlots for fattening young lambs or bulls, as well as culled females, could become more widespread, alongside the development of dairy barns. Similarly, alternative herd management strategies could be explored, such as breeders pooling their animals for transhumance or even hiring shepherds under contract, as seen in other regions worldwide. Directly related to transhumance, some actors plan to harvest fodder from mountain pastures for feeding their herds and/or storing it for later distribution.

Moreover, new marketing and supply chains could be implemented, alongside expanded production of meat, dairy, cheese, leather, and wool, sectors that already exist to some extent, often linked to the specific characteristics of animal production in rangelands. These transformations will inevitably impact transhumance in various ways, particularly as they intersect with production diversification and the rise of tourism.

4. High tourism potential

Upon arriving in the Qilian Mountains, and particularly in Sunan County, both Chinese and foreign visitors are often struck by the beauty, vastness, and diversity of the landscapes. The region also offers an array of sporting activities almost year-round, including various forms of skiing (downhill, cross-country, and ski touring), cycling, hiking, and canyoning.

The potential for tourism development appears vast, extending beyond livestock farming to encompass broader aspects of rangeland and Chinese society, including education related to nature and biodiversity, as well as religious and cultural heritage. However, since tourism in the region is still in its early stages, several challenges must be addressed: structuring and organizing the sector, attracting and training the necessary workforce, and securing funding to initiate development.

A key question remains: What role will transhumance, livestock breeding, and agriculture play in the future of tourism in this region? Will tourism be developed sustainably, showcasing the unique aspects of local society and its environment? Or will mass tourism take precedence, sidelining local communities and limiting their benefits from this growth?

Given the stunning landscapes, the cultural richness of ethnic minority groups, and the distinctive aspects of rural life, transhumance and livestock farming in the Qilian Mountains present significant opportunities for agro-tourism. If managed properly, tourism could highlight these unique elements while ensuring that local community's benefit from its development.

5. Climate change

Climate change is becoming an increasingly serious concern for breeders, stakeholders, and policymakers in the Qilian Mountains. Although its current effects are not yet alarming and are often attributed to annual climate variability, its long-term impact cannot be overlooked.

However, in the downstream regions of the Tibetan Plateau —where China's agricultural, urban, and industrial hubs are located— some effects that scientists link to climate change are already evident. In particular, heavy rainfall has led to severe flooding, a phenomenon that previously prompted the implementation of soil and rangeland management programs. These past measures highlight the interconnectedness of climate change, land use policies, and sustainable resource management in the region.

Conclusion

Starting in the early 1980s, during the post-revolutionary period, several public policy measures were introduced to simultaneously improve the livelihoods of pastoralists and address the environmental challenges facing rangeland socio-ecosystems. A key environmental concern driving these policies was the degradation of rangelands, which was seen as a major contributor to water loss and soil erosion, exacerbating flooding with catastrophic downstream consequences that affected both the environment and the Chinese economy.

Over the past 30 years, the socio-ecosystem of the Qilian Mountains has shown noticeable improvement, reflected in better living conditions for pastoralists, their families, and communities, as well as in more sustainable rangeland management practices.

Livestock breeding remains the primary rural activity on the Tibetan Plateau, and transhumance continues to play a crucial role in utilizing high- and mid-altitude rangelands. However, transhumance is highly labour-intensive, adding to the already demanding workload of livestock farming. This heavy labour requirement, combined with relatively low economic returns, has led many young people to lose interest in livestock farming—especially as their parents increasingly encourage them to pursue careers in urban areas.

Alternatives to enhance the rangeland socio-ecosystem do exist, including new forms of livestock farming such as feedlots and dairy operations, as well as crafts directly or indirectly linked to livestock production. Additionally, innovations in transhumance practices—such as collective herding managed by salaried shepherds—could help sustain the tradition. Furthermore, as in many other parts of the world, tourism could offer valuable opportunities for both livestock farming and transhumance, given the region's vast tourism potential and its appeal to both domestic and international visitors.

In conclusion, transhumance remains a fundamental component of livestock breeding, with significant technical, economic, cultural, and social implications—particularly in ensuring herd feeding for three months. However, adapting transhumance to evolving contexts will be essential, and its continued viability will depend on well-designed public policies that support its sustainable development.

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Chapter 2

Transhumances in Kazakhstan

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Abstract

Kazakhstan is a Central Asian country that was part of the Soviet Empire throughout the 20th century, gaining independence following the collapse of the Soviet Union in 1991. Prior to the Bolshevik Revolution, the majority of the population led a nomadic lifestyle, primarily herding horses, sheep, and camels—species more suited to mobility than cattle. Beginning in 1927, Stalinist policies—including the fight against the *kulaks*, the forced sedentarisation of nomads, and the collectivization of agriculture—completely dismantled this traditional way of life. These measures led to a devastating famine and a significant loss of livestock. Although this policy was somewhat relaxed after the Second World War, herd mobility remained severely restricted. Following independence, a rapid and harsh privatization process resulted in another dramatic decline in livestock populations and animal production, a trend that continued until the early 2000s. Since then, agricultural modernization policies have revitalized the livestock sector, encouraging a partial return to herd mobility. This renewed mobility is based on the seasonal availability of resources—either through longitudinal movements across the steppe or altitudinal transhumance in the foothills of the Alatau Mountains.

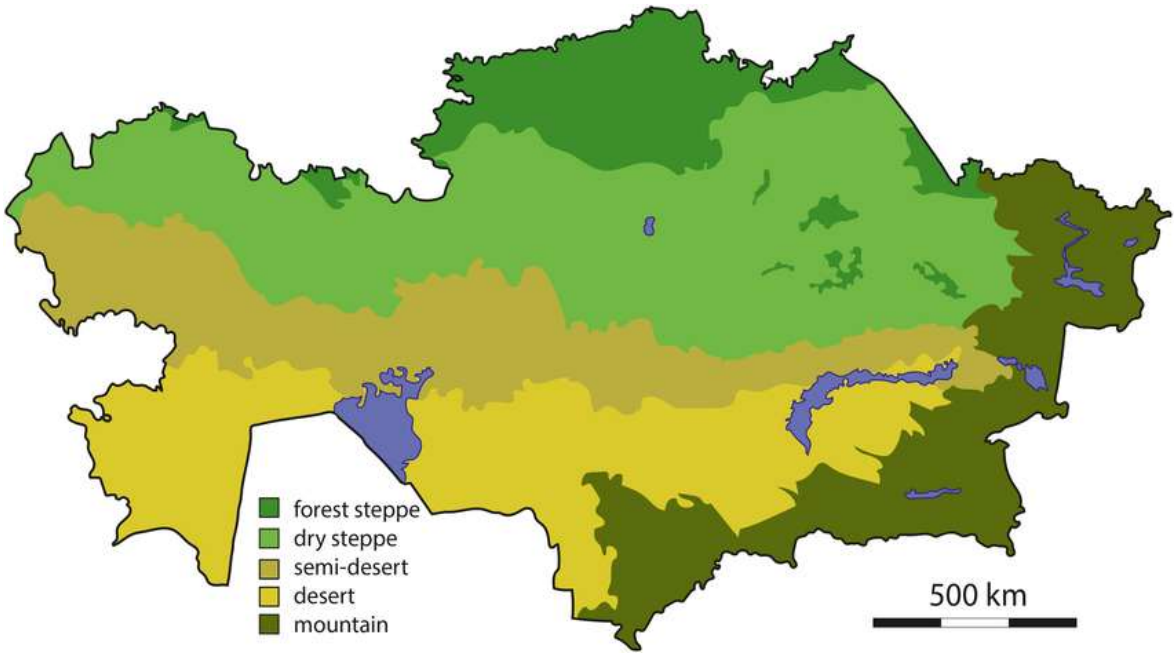
Keywords: Central Asia; Collectivization; Forced sedentarisation; Privatization; Mobility; Horse; Camel

Introduction

Kazakhstan, which spans 2,717,300 km² (ranking 9th largest in the world), is characterized by a wide range of ecosystems. These include icy deserts in winter and scorching deserts in summer in the central and eastern regions (such as the Kyzylkum and Muyunkum deserts), some of which are located in depressions—like Karagiye, which lies at 132 metres below sea level. In contrast, the country is also home to several major mountain ranges (Altai, Sauyr, Tarbagatai, Dzungarian Alatau, and the Tian Shan Mountains), culminating in Mount Khan Tengri, which rises to 6,995 metres above sea level. Between these extremes, semi-arid steppe zones occupy more than a third of the country's central territory. Wetter regions lie in the north along the Russian border, while a quasi-Mediterranean zone is found in the south, along the borders with Kyrgyzstan and Uzbekistan. The steppes, deserts, and mountainous areas have historically supported livestock farming, particularly pastoral practices based on herd mobility. However, political transformations during and after the Bolshevik Revolution in the early 20th century profoundly altered the role and structure of the livestock sector in the country.

I. Kazakhstan, historically a country of nomads

Throughout its history, Kazakhstan has been a land of nomadism, particularly in the steppe and semi-arid zones, which together covered nearly 80% of its vast territory (Map 1).



Map 1. Ecosystems in Kazakhstan (©Ventresca Miller et al., 2020)

There is archaeological evidence that mountain agro-pastoral practices, including vertical transhumance, were already present during the Bronze Age and Early Iron Age (Ventresca-Miller et al., 2020). At that time, herds were

relatively small, and the main domestic animals were small ruminants, especially sheep. Investigations conducted at various sites across the steppe, foothills, and mountains have shown that, even 2,500 years ago, sheep were fed with valley-grown millet during the winter (in steppe sites) and fresh grasses from high-altitude pastures during the summer (in mountain sites).

Two large animal species have historically supported human mobility with their herds in Central Asia: horses and camels. The region was an important centre for horse domestication. One of the earliest archaeological evidences of horse domestication—specifically the ancestor of the modern Przewalski's horse (*Equus przewalskii*)—dates back to 3,500 BC in the northern Kazakh steppe (Outram et al., 2009). However, the domestic horse (*Equus caballus*) was introduced to Kazakhstan by early nomadic groups such as the Scythians and Sarmatians, between the 8th and 4th centuries BC. These people were exceptional horsemen, and their nomadic lifestyle greatly contributed to the cultural and practical importance of horses in Kazakh society.

Later, with the migration of Turko-Mongol groups—ancestors of today's Kazakh population—horses came to be used not only for transport, but also for meat and milk production, with the latter traditionally consumed in its fermented form, known as *qymyz* (Konuspayeva et al., 2023). This long-standing cohabitation between humans and horses has shaped the exceptional equestrian skills of Kazakh riders, still showcased today in traditional games like *Kokpar*, where two teams on horseback compete for control of a goat carcass.

The harsh conditions of the steppe—freezing winters and scorching summers—also explain why the ancestors of the Kazakh people adopted the double-humped camel (*Camelus bactrianus*). This species proved to be perfectly suited for the desert regions of the country, such as the Kyzylkum and Aral-Kum. Likely domesticated between the Caspian Sea and the Aral Sea around 3000 BC (Sala, 2022), the Bactrian camel was quickly integrated into pastoral practices. It was also widely used as a pack animal, contributing to the efficiency of the Silk Road trade routes that connected China to the West for centuries, spreading the Bactrian camel across Central Asia (Barisitz and Barisitz, 2017).

Like horses, camels were not only used for transport but also for meat, milk, and wool. Hybridization between the Bactrian camel and the dromedary began early on, especially in regions where their ranges overlapped along the Silk Road. Today in Kazakhstan, this crossbreeding is primarily aimed at improving milk yields (as the Bactrian camel is a relatively poor milk producer compared to the dromedary), while in Turkey, it is often used for camel wrestling festivals (Faye, 2022). As with horse milk, camel milk is traditionally consumed in fermented form, known as *shubat* (Konuspayeva et al., 2023).

Thus, until the end of the 19th century, Kazakh pastoralism was primarily based on the rearing of horses, camels, and sheep. Although goats and cattle were also present, they played a less central role in both cultural practices and production systems. Even today, in urban settings, horse meat and mutton are regarded as more prestigious than beef, while camel meat is consumed mainly in rural areas.

II. Pastoralism in Kazakhstan before the Bolshevik revolution

The management of pastoral spaces in Kazakhstan was traditionally based on tribal rules, where the wealth of families and tribes was measured by the number of livestock they owned. Tribal social organization operated under the traditional authority of a chief known as a *Bai*, typically designated through family or clan affiliations. Each tribe had its own defined territory, although conflicts over pasture could arise. The resolution of such conflicts, along with herd management, was overseen by a *Bek*, another figure of authority within the tribe.

Animal herding was primarily the responsibility of men, while women managed domestic tasks and processed dairy products (such as butter, cheese, and fermented milk). Although the nomadic lifestyle fostered a certain degree of household self-sufficiency, trade activities did exist. Surplus animals, wool, hides, and even dairy products were sold or exchanged, though dairy was largely consumed within the household or shared through a gift economy (Faye and Corniaux, 2024).

Unlike neighbouring regions inhabited by Uzbeks and Turkmens, Kazakhstan lacked large oases, which limited the development of crop-livestock systems. As a result, urbanization remained low, and nomadism and transhumance continued to dominate Kazakh society throughout its history until the radical transformations brought by the Bolshevik revolution (Konuspayeva and Faye, 2020).

This nomadic lifestyle was reflected in both the traditional diet—largely based on meat and dairy products—and in the portable dwellings used by pastoralists: yurts made of felt and removable wooden frames (Vuillemenot, 2009). In near-constant motion, herds were fed exclusively on natural grasses of the steppe or desert, without supplementation—even during winter.

Several types of mobility could be observed (Ferret, 2018):

- Strict nomadism, where the entire group moved year-round along established routes, rarely staying in one place for more than three months and covering distances of several hundred to over a thousand kilometres.

- Quasi-nomadism, where the group maintained a fixed settlement for at least one season (often winter), with or without permanent structures.

- Semi-nomadism, where part of the group remained in a permanent location year-round while others moved with the livestock.

- Semi-sedentarism, essentially transhumance, in which the group alternated between two seasonal settlements—one for winter and one for summer. Movements could be longitudinal (within the steppe for horses and sheep, or the desert for camels) or altitudinal (between the steppe and mountain zones for horses, sheep, and cattle) (Kerven et al., 2009).

- Quasi-sedentarism, where most of the group stayed in the village year-round with a small number of productive animals (especially lactating ones), while a minority of families moved seasonally with the herds.

- Sedentarism, in which the entire group remained in a single location year-round, although herders still accompanied the livestock during transhumance.

Under Tsarist administration at the end of the 19th century, increased Russian pressure—such as the imposition of taxes on pastoral activities—pushed Kazakh communities toward more sedentary livelihoods. Additionally, Russian colonization led to the appropriation of the most fertile pastures for cattle farming (Olcott, 1981). Russian settlers also introduced forage crops, which increased pressure on pastoral resources, although this impact was geographically limited to the northern regions of the country.

At the beginning of the 20th century, the Stolypin agrarian reforms, aimed at “modernizing” agriculture and integrating Kazakhs into a sedentary farming economy, caused significant tensions and disrupted the traditional pastoral system. These tensions culminated in the 1916 uprising, which was violently suppressed and marked a pivotal moment in Kazakhstan’s history (Pallot, 1999). Nonetheless, on the eve of the Bolshevik Revolution, nearly 70% of the population across the territory still practiced nomadism (Kerven et al., 2009).

III. Upheaval of the Bolshevik revolution

At its outset, the Bolshevik revolution initially appeared beneficial to Kazakh herders, who regained some of the land previously occupied by Russian settlers. Support from the new state even enabled them to establish small agricultural enterprises. However, this positive trend was short-lived. Stalin's ideology, which viewed the nomadic way of life as incompatible with the modernization of the rural economy in a socialist society, led to the complete dismantling of pastoralism based on herd mobility and tribal organization.

This eradication was implemented in three major phases (Ohayon, 2006):

- The 'dekulakization' of society, i.e. the elimination of traditional tribal authority, particularly targeting the *Bai*, who were equated with wealthy landowners or "kulaks", even though their livestock wealth varied widely. This policy led to the arrest, deportation, or even execution of many *Bai*, while others fled to neighbouring countries, notably China and Afghanistan.

- The forced settlement of the nomadic population, which included the banning of seasonal herd movements—despite the fact that this policy ran counter to ecological realities and was later partially reversed due to environmental constraints.

- The collectivization of production systems, carried out with extreme violence, echoing the previous phases.

Between 1927 and 1932, this policy not only caused the death of nearly one-third of the Kazakh population and a total dismantling of traditional spatial organization, but also led to a catastrophic drop in livestock numbers—particularly among the species most associated with nomadic life: sheep, horses, and camels. In a society heavily dependent on animal products, this inevitably resulted in a famine worsened by collectivization. More than 1.3 million people, primarily from the steppe regions, perished during this dark period (Konuspayeva and Faye, 2020).

In terms of livestock:

- The sheep population dropped from 18 million to 12 million;
- Horses declined from 3.5 million to just 800,000;
- Camels suffered the most, losing 90% of their population—from 1.2 million in 1927 to only 120,000 in 1940 (Faye and Konuspayeva, 2020).

Camels, seen as relics of the past in contrast to cows—considered symbols of socialist modernity—were especially impacted by the constraints on mobility. Although some adjustments were introduced as early as the 1930s and intensified after World War II (such as partial restoration of seasonal movement, pasture regeneration, and forage storage for winter), the devastating effects of Stalin's policies persisted throughout the Soviet period, despite significant growth in agronomic research.

However, Soviet agronomy followed a strictly top-down model, where science was tasked with applying solutions formulated in laboratories or administrative offices, with little input from the field. Livestock management under the Soviet system took two main institutional forms:

- The sovkhoz (state farm), where all peasants were salaried workers and agriculture was meant to reflect a proletarian ideal;
- The kolkhoz (collective farm), a peasant cooperative in which members shared profits and could retain a private plot of 4,000 m² for household use.

Although presented as modern versions of the traditional Russian *Mir*, these new structures were ill-suited to mobile livestock systems. While such collectivization occasionally coincided with real productivity gains—especially in Russia (Grigg, 1985)—in Kazakhstan, it deeply disrupted traditional pastoral structures and led to long-term declines in livestock productivity, with lasting effects even after independence.

Notable consequences include:

- The Taylorisation of agricultural work, which created highly specialized roles (e.g. tractor driver, milker, harvester) but eliminated the multi-functional nature of the traditional peasant role;

- A centrally administered management system, driven more by five-year planning targets than by local needs;

- The degradation of pastoral resources—initially through overgrazing caused by restrictions on herd movement, and later (1960–1980) through large-scale conversion of pastures into cropland under the ambitious *Virgin Lands Campaign* launched in 1953, which aimed to turn Kazakhstan into the Soviet Union's wheat granary.

This environmental degradation was further exacerbated by falling groundwater levels and, in some areas, complete depletion—especially near rivers and streams feeding into the Aral Sea. Large-scale irrigation projects, particularly for cotton along the Syr Darya River, led to a drastic reduction in water flow, contributing to desertification and soil salinization. These areas became increasingly unsuitable for pastoralism.

The reduction in the scale and seasonal rhythm of traditional mobility fragmented the pastoral landscape (Kerven et al., 2006), concentrating livestock around limited resources such as watering points, and increasing pressure on those areas. By the time of the Soviet Union's collapse and Kazakhstan's independence, pastoral systems were not only ecologically degraded (Schillhorn van Veen, 1995), but also suffering from industrial and agricultural pollution (Kenesariyev, 2008; Konuspayeva et al., 2011).

IV. Upheaval of Soviet Union collapse

The independence of the Republic of Kazakhstan following the collapse of the Soviet Union in 1991 once again profoundly transformed the country's agricultural landscape, particularly the livestock sector. Three key factors played a pivotal role in this restructuring: privatization, the fragmentation of large collective structures, and the emergence of large-scale agricultural enterprises in the context of modernization.

The dismantling of collective farms was triggered by the land reform initiated in 1991, which led to the privatization of land, equipment, and livestock. These assets were redistributed to cooperative members. In practice, however, the process was marked by significant inequalities and regional disparities. In many cases, it resulted in the looting of former collective assets—including infrastructure such as schools, health clinics, and cultural centres—since cooperatives and state farms had functioned as integrated systems. Livestock privatization followed the same path as other assets, contributing to a dramatic reduction in animal numbers reminiscent of the decline witnessed during the forced collectivization of the 1930s.

While part of this decline can be attributed to statistical distortions—exaggerated livestock counts during Soviet times to meet state planning targets, followed by underreporting after independence to avoid taxation on privately owned animals—the primary causes were economic. Breeders, now responsible for covering input costs themselves, were compelled to reduce herd sizes. Moreover, former specialists had to assume the diverse responsibilities of a traditional peasant, often without the necessary skills. This led to widespread management errors, with serious

consequences for animal health and nutrition, resulting in increased mortality rates (Delehanty and Rasmussen, 1995).

The lack of cash flow further accelerated the reduction in herd size, with sheep—once a staple of Kazakh pastoralism—often used as a currency for barter. Between 1991 and 1996, the sheep population declined from 33 million to 13 million head. Cattle numbers fell from 9 million to under 5 million by 1997. The decline was somewhat less pronounced for horses (from 1.6 million to 1.3 million) and camels (from 145,000 to 111,000) over the same period. By 2014, only camels and horses had surpassed their 1991 population levels.

Between 1992 and 1997–1998, the livestock population decreased by 53% for cattle, 60% for small ruminants, 46% for horses, and 44% for camels. This decline, coupled with a drop in productivity—for instance, the average bovine carcass weight fell from 185 kg in 1992 to 150 kg in 1997—led to a marked decrease in output: beef production declined by over 50%, mutton by 36%, and cow milk by 40%. Agricultural production reached its lowest levels since independence in 2001.

During this period, the economic downturn also caused a significant drop in consumer demand due to falling living standards. Meat consumption declined by 14%, and milk consumption by 12%.

V. Changes in farming systems and pastoralism

A major consequence of the dismantling of collective structures was the transformation in farm sizes, leading to a significant increase in the number of agricultural production units. From approximately 5,000 farms in 1990, the number had risen to 188,616 by 2012 (OECD, 2013). However, this “atomization” of farm structures resulted in an unstable status for many of the “new” farmers, particularly small family-based farms, which were more prevalent in the southern regions of the country. A significant proportion of these farms failed to achieve profitability and were subsequently purchased by investors. These investors established larger operations with varying legal statuses and degrees of specialization, often by consolidating bankrupt family farms.

Additionally, some large enterprises were directly inherited from Soviet-era collective farms and maintained under the form of private cooperatives. These operations, however, were generally less specialized, engaging in the rearing of multiple livestock species, crop cultivation, and, in some cases, product processing. In 2014, such large-scale structures accounted for only 7.6% of the national cattle population and 4.3% of small ruminants. Conversely, they were significantly more dominant in pig farming (29.6%) and poultry production (65.2%).

Aside from the poultry sector, small family farms remained the primary holders of livestock. Despite limited investment—both public and private—these farms were responsible for more than 80% of milk production and 67% of total meat output (across all species). They played a critical role in ensuring the supply of animal protein to the broader population, and were especially important for food security in rural areas, where self-consumption still accounted for a considerable portion of production.

These family farms operated within short, often unstructured supply chains relying primarily on direct sales to consumers or through local bazaars. As a result, product quality—especially in the camel and horse sectors—was highly variable. Productivity in these small-scale enterprises was also lower than large operations, which benefited from more substantial public support. For instance, in 2014, the average annual milk yield per dairy cow in family farms did not exceed 1,770 liters, compared to 4,250 liters in large farms equipped with imported high-genetic-merit breeds such as Holsteins, and supported by improved feeding regimes and veterinary services.

Moreover, research institutions and technical support services were ill-equipped to respond to the needs of these small-scale enterprises. These institutions were historically oriented toward top-down approaches tailored to large-scale operations, leaving a gap in appropriate technical assistance for the dominant segment of Kazakhstan's livestock sector.

VI. Modernization policy of the agriculture

With the improvement of living standards—particularly two decades after independence, driven by rising global oil and gas prices, in which Kazakhstan plays a major producing role—the population's demand for a more diversified and higher-quality diet increased significantly. This shift in consumption patterns contributed to a decline in the country's self-sufficiency in food production. For instance, the export-import balance for beef remained negative (with the exception of 2022); for sheep meat, a positive trade balance was only achieved starting in 2016; and for cow milk, the trade balance remained negative, except for a brief period between 2018 and 2021 (Figure 1).

In response to this situation and in an effort to meet the growing domestic demand, the government implemented a policy aimed at modernizing the agricultural sector—including livestock production—with the objectives of increasing both output and productivity, and ultimately achieving national self-sufficiency.

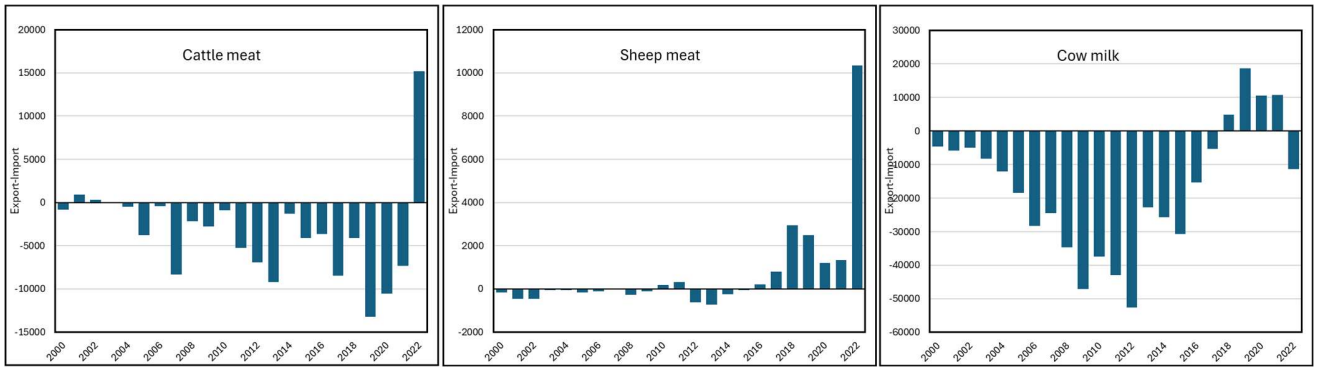


Figure 1. Balance (in volume) export-import of cattle meat, sheep meat and cow milk in Kazakhstan from 2000 (source FAOSTAT, 2024).

To address the challenges facing the livestock sector, the State allocated 600 billion tenge (KZT)—equivalent to approximately 4.6 billion USD at the time—for the years 2003 to 2005. This investment marked the beginning of a broader effort toward sustainable agricultural development, formalized through the 2005–2010 development program (Act No. 184-185 of 12 July 2005). Agriculture was identified as a key priority under the government's "Kazakhstan 2030" strategy, which aimed to reduce the country's dependency on oil and to diversify its export base. In the years that followed, annual state aid to agriculture averaged 200 billion KZT (around 1.36 billion USD), amounting to approximately 11% of farmers' gross revenues. This level of support was relatively modest compared to the average of 21% provided to farmers in OECD countries (OECD, 2013).

However, 82% of these public subsidies were directed toward measures linked to production and prices, which created a disconnect between producers and market signals, potentially distorting production decisions (OECD, 2013). Moreover, the distribution of support was unequal. Despite their predominance, family farms received comparatively little assistance and remained largely excluded from technical innovation.

In an effort to modernize the agricultural sector, public investment was also channelled into agronomic research, stakeholder training, technical innovation, transport infrastructure, and protective systems. Nonetheless, producers

—particularly in remote areas of Kazakhstan, a vast and sparsely populated country with only 20 million inhabitants—continue to face significant challenges. The geographic dispersion and remoteness from major consumption centres contribute to high transaction costs and limit agricultural development. Consequently, the government prioritized the construction of rural roads, infrastructure, and logistics systems to support the cold chain and enhance market access.

VII. Back to transhumances?

In this context, sedentary pastoralism remains the dominant mode of livestock management throughout Kazakhstan. However, despite the twentieth-century crises that led to a shift from quasi-nomadism to quasi-sedentarism, systems of seasonal pasture use have persisted in certain regions. In particular, the Almaty Province, characterized partly by mountainous terrain, continues to practice vertical transhumance, capitalizing on the altitudinal variations in vegetation and climate. While historically only the coercive policies of the Stalinist era succeeded in enforcing the sedentarisation of traditionally nomadic populations, the catastrophic famine that followed prompted a partial policy reversal in the 1940s. Since Kazakhstan's independence in 1991, there has been a resurgence, not of full nomadism, but of mobility practices that emphasize transhumance as a central component of livestock management.

Currently, two main forms of transhumance can be observed, varying by ecosystem and the species involved (Vuillemenot, 2009). These are:

- Altitudinal transhumance, which typically involves seasonal movements between the foothills or steppe and the mountain pastures (locally referred to as *jalaw*), situated above 2000 metres in elevation. This traditional mobility system—where herds winter in the lowlands, which are more climatically stable, and migrate to mountain pastures between June and September—primarily involves dairy mares as well as sheep and, to a lesser extent, cows (Ferret, 2018). The mares are milked five to six times a day (Photos 1 & 2), being tethered during milking and allowed to graze freely nearby the yurts where the herders reside.

Photos *1 & 2. Milking mare in Jalaw close to Almaty (left), dairy mares and sheep in Jalaw above Almaty (right) (© Bernard Faye)*

Sheep are kept in pens overnight and grazed during the day under the supervision of mounted shepherds accompanied by dogs. Cattle, mainly beef breeds, are less common and usually graze freely. It is also typical to find a few goats mixed into sheep herds. Although yaks are rare in Kazakhstan, the neighbouring country of Kyrgyzstan sees widespread yak transhumance under similar practices (Faye, 2010).

Since the independence of Kazakhstan and the dissolution of the Soviet Union, the privatization of land and its redistribution to former collective farm workers have significantly altered the dynamics of transhumance. In the post-Soviet context, seasonal mobility now requires specific agreements between landowners and mobile livestock keepers, unless the *jalaw* (summer pasture) lands are directly owned by the herders themselves. In peri-urban areas, particularly around major cities such as Almaty, tourism-related developments—most notably ski resorts—have contributed to a reduction in available grazing land. Nonetheless, arrangements are sometimes made with sheep owners to use these slopes for grazing during the summer months, thereby maintaining the vegetation and reducing fire risks.

- Longitudinal transhumance, primarily practiced in the steppe regions (Yespolov et al., 2018), involves horizontal seasonal movements and mainly concerns horses, which hold significant cultural and nutritional value in Kazakhstan. Mare's milk is widely consumed, and horse meat is considered the finest red meat. In southern regions bordering desert zones, this form of transhumance also includes camels (see photo 3). Kazakhstan is unique in hosting both Bactrian (two-humped) and dromedary (one-humped) camels, which may be managed together within the same farming systems. While the precise distribution between the two species is not well documented, it is estimated that dromedaries make up approximately 15% of the national camel population. Crossbreeding between the two species is common, aimed at enhancing the milk yield of the typically hardier Bactrian camels.

Transhumant movements often span several hundred kilometres, typically involving shifts from winter pastures near villages—where animals are kept in enclosed barns to withstand the extreme cold—to summer pastures characterized by open grazing and traditional yurt-based herder accommodation. These migrations may also include spring and autumn intermediate grazing grounds. In the Caspian Sea region, shorter transhumance routes for camels (Photo 3) are often prompted by the need to escape seasonal mosquito infestations near the coast. In large-scale camel enterprises, comprising several thousand head, seasonal movement typically occurs entirely within the vast landholdings of a single owner, which can span thousands of hectares. In contrast, cattle—especially prevalent in the more humid northern regions—tend to follow sedentary systems. Similarly, sheep raised in steppe environments are subject to more limited mobility and are generally moved over shorter distances.

Photo 3. Departure in summer transhumance of a camel herd around the Caspian Sea, Kazakhstan (© Bernard Faye)

Conclusion

The mobility of livestock in Kazakhstan underwent profound transformations throughout the 20th century, shifting from widespread nomadism to a near total cessation of herd movements under Soviet rule. However, since the country's independence and the privatization of land, a cautious revival of pendular mobility has emerged, particularly in mountainous regions of the South and in the arid zones of the steppe. This partial return to seasonal movement reflects both a cultural resurgence and an ecological necessity. Moreover, the state's broader agricultural modernization policies appear increasingly compatible with this renewed mobility, especially in light of heightened seasonal variability and the growing need to optimize the use of limited and fragmented pastoral resources.

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Chapter 3

Outlook on sustainability of transhumant systems in Mount Lebanon*

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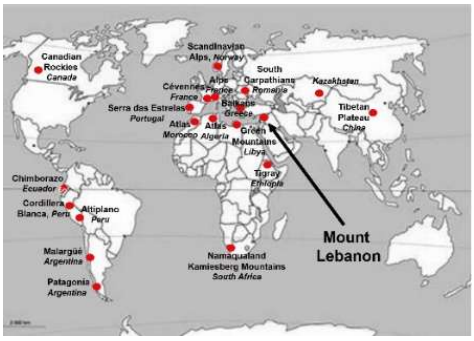
Abstract

Small ruminant production has always played a vital role in Lebanon's economy and the livelihoods and food security of rural communities. Goats and sheep which are mainly raised in agro-pastoral systems, help maintain biodiversity and support sustainable land management practices. This chapter describes the small ruminant production systems in Lebanon, with a special focus on goat production in Mount Lebanon. To understand better the changes occurring in the pastoral systems, and in an attempt to identify the prospects of their sustainability, a SWOT analysis was done to pinpoint the strengths, weaknesses, opportunities, and threats of small ruminant production. The analysis was based on data collected from available literature and unpublished data of the authors. It provided a comprehensive overview of the various aspects influencing the sustainability of small ruminant farming covering the economic, environmental, and sociocultural pillars of sustainability, and other relevant factors such as health and technology. The analysis offers a brief outlook on transhumance as a main feature of small ruminant systems in Mount Lebanon, and provides a foundation for strategic planning and targeted interventions to enhance this dynamic sector in adapting to current challenges while preserving its cultural and traditional features and its contributions to rural livelihoods.

Keywords: Lebanon; Small ruminants; Mount Lebanon; Pastoral systems; Sustainability



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Introduction

This chapter describes the small ruminant production systems in one of the smallest countries in the Middle East and Mediterranean region—Lebanon. Throughout Lebanon's history, small ruminants have been integral to the country's rural and cultural fabric. Dating back centuries, the rearing of sheep and goats has been intertwined with traditional farming practices, serving as a cornerstone of rural livelihoods and economic activity for many farming families (Sader and Akl, 2005; Serhan and Mattar, 2017; Chedid et al., 2019).

Since ancient times, small ruminants have been valued for their adaptability and utility, providing meat, milk, wool, and manure, while also serving as valuable assets for Lebanese farmers. Both nomadic tribes and settled communities relied on these animals for sustenance, trade, and cultural practices, fostering a deep-rooted bond between people and their livestock (Serhan and Mattar, 2017; Hosri and Nehme, 2006). These practices also helped maintain strong intergenerational social ties and preserve the livelihoods of pastoral societies (Chedid et al., 2019).

The traditional importance of small ruminants in Lebanon extends beyond economics to encompass cultural and culinary traditions. Sheep and goat meat remain staples in Lebanese cuisine, featured in dishes such as grilled meats and slow-cooked stews that are central to local gastronomy. Small ruminants have also played prominent roles in Lebanese folklore, literature, and art, symbolizing resilience, fertility, and abundance (Hosri et al., 2016).

It is worth noting that cattle in Lebanon are not subject to transhumance, as they are raised in intensive systems. For this reason, they are not addressed in this chapter, which focuses exclusively on sheep and goats.

Small ruminant farming has long been a pillar of Lebanon's agricultural sector, significantly influencing both the economy and traditional practices. According to the latest statistics, Lebanon is home to approximately 434,209 sheep and 523,669 goats, underscoring the country's substantial small ruminant population (FAOSTAT, 2023). Over time, advances in farming techniques and agricultural technologies have shaped small ruminant management and production in Lebanon. Traditional practices have evolved alongside modern methods, enabling farmers to boost productivity while preserving long-standing traditions such as transhumance, flock management, and milk processing (Hosri et al., 2016).

Production systems have adapted to meet the needs of a growing population and shifting market demands. Nasr and Helou (2000) highlighted the diversity of approaches used in small ruminant farming, ranging from extensive grazing systems to more intensive production models.

Despite ongoing challenges such as climate change and resource scarcity, small ruminant farming in Lebanon continues to thrive—thanks in part to active research and development efforts, especially from the private sector. Organizations like the Food and Agriculture Organization (FAO) of the United Nations offer valuable insights and recommendations for sustainable livestock management in the region (FAO, 2017).

In light of Lebanon's rich historical legacy and the enduring significance of small ruminants, it is clear that these animals remain foundational to the country's agricultural heritage and play a vital role in shaping its rural economy and cultural identity (Serhan and Mattar, 2017).

This chapter focuses more particularly on pastoral goat production in "Mount Lebanon" chains. It describes the economic, social, and environmental sustainability of the existing systems and their evolution using a SWOT analysis methodology, underlining their strengths and weaknesses, the threats they face, and the opportunities for their growth and sustainability for the future. Data collection was based on a literature review including scientific reports and peer-reviewed publications, in addition to original and unpublished data from the authors.

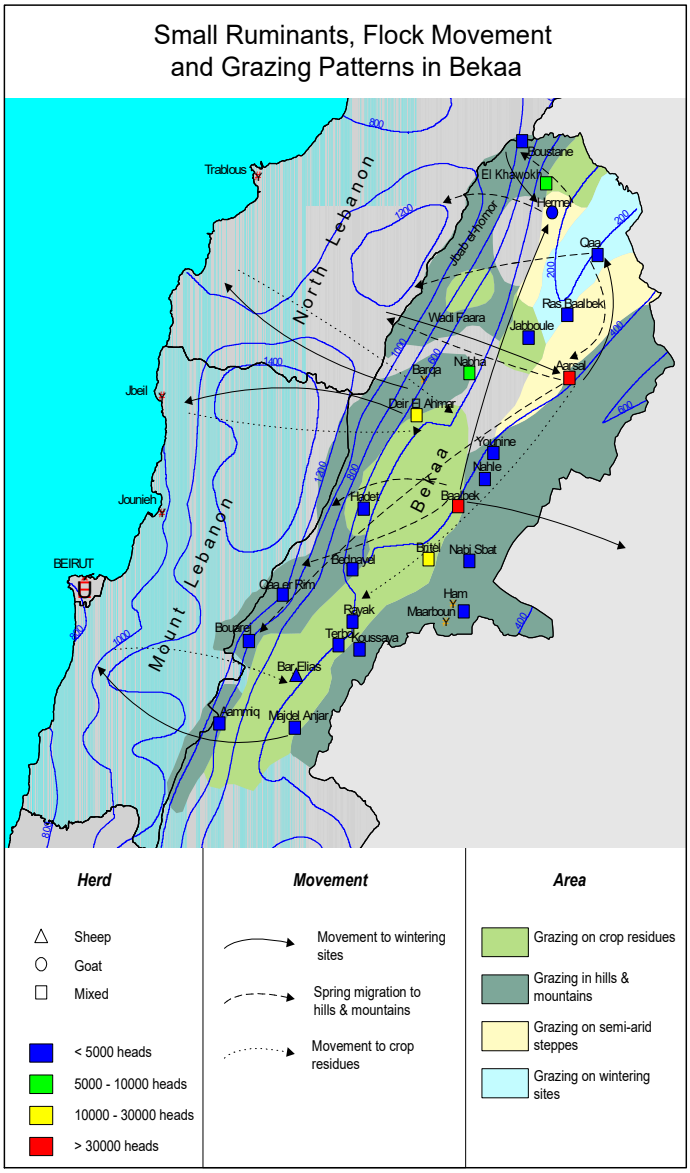

Figure 1: Small ruminant flock movement and grazing patterns in the Bekaa region of Lebanon

I. Pastoral systems in Mount Lebanon chains

Historically, Mount Lebanon was mentioned in the Old Testament 71 times (Horn, 1998). Its majestic cedar forests (*Cedrus libani*) were cut and used to build the temple of Salomon in Jerusalem, and the Phoenicians also used their wood to build their ships. Today, the remnants of these forests are found in the northern part of the mountain chain and are known as the Cedars of God, a UNESCO World Heritage Site. On the other hand, the largest Cedar Forest lies on the southern part of Mount Lebanon and is called the Shouf Biosphere Reserve (Hamadeh et al., 2005), which used to provide seasonal grazing sites for many flocks coming from nearby and distant villages, before the establishment of the natural reserve in 1997 (Chedid, 2019).

Overall, Mount Lebanon is distinguished by an Alpine climate, all year long, and by snow-covered tops during five to seven months, receiving 50 and 67% of the total annual precipitation as snow (Fayad et al., 2017). It is characterised by mountains of an average of 2200 m of altitude above sea level (Fayad et al., 2017); its highest peak reaching up to 3087 m in the north of the country, and up to 1941 m towards the south (peaks of Barouk Mountains). Mount Lebanon chains stretch along the whole country, over 150 km, parallel to the Mediterranean shoreline from the west and to the Anti-Lebanon mountain chains from the east. The fertile Bekaa valley, home of large flocks of local Awassi sheep and Baladi goats, separates the two mountain chains (Figure 1). The steep slopes of Mount Lebanon provide spring and summer rangelands to the goat flocks which rely on mobility to range the most marginal and difficult natural pastures that no other ruminants can value. The local *baladi* breed constitutes the majority of local herds (MoA, 2012) which are raised in semi-sedentary systems with vertical transhumance, seeking feed and water resources during the different seasons of the year. They spend the spring and summer seasons on the high slopes of Mount Lebanon, benefitting from the fresh grass and multiple resources after the snow has melted. In October, they move either to the coastal zones or to the Bekaa Valley where winter is less harsh, and crop residues constitute a major source of feed. According to Srour (2006), transhumance routes of landless flocks in the Hermel region, Northern Bekaa, may reach up to 300 km. In Southern Bekaa, however, shorter routes of 51 km only were reported by Mitri et al. (2022) across grasslands, forests, and croplands and between low and highlands, alternating between private and public lands. In Keserwan region, Fahed et al. (2023) reported drove roads of 26.21 km divided into 14.72 km of natural paths and 11.49 km of built public roads over five villages

Most of the shepherds are landless and exploit marginal lands to feed their animals. Land tenure systems in Lebanon is a major problem facing shepherds, disrupting their mobility, causing pasture segmentation, and consequently leading to the breakdown of the traditional agro-pastoral system in the country. The land tenure issue is discussed later in this chapter.

II. Small ruminant systems in Mount Lebanon sustainability perspective

Small ruminant production in Lebanon is distributed to different systems. These range from transhumant to semi-nomadic and semi-sedentary systems, and vary in the mobility of their flocks, use of rangelands, size, composition and feed supplementation patterns (Hamadeh et al., 1996; Hosri and Nehme, 2006). However, a trend toward more sedentary systems has been noted, similar to other countries around the Mediterranean and semi-arid regions (Hamadeh et al., 1999; Alary et al., 2016; Chedid et al., 2019; Bistanji et al., 2000). This shift is caused by various factors, namely limited access to pastures due to the expansion of agricultural lands, establishment of natural reserves, as well as lack of supportive services (financial, veterinary, etc.) experienced labour and targeted policies.

To understand better the changes occurring in the pastoral systems in Lebanon, and to identify the prospects of their sustainability, a SWOT analysis was done to pinpoint the strengths, weaknesses, opportunities, and threats of small ruminant production (Table 1). The analysis was based on data collected from available literature as well as unpublished data of the authors. It provides a comprehensive overview of the various aspects influencing the sustainability of small ruminant farming covering the economic, environmental, and sociocultural pillars of sustainability, including other relevant factors such as health and technology, and ending with a brief outlook on transhumance as a main feature of small ruminant systems in Mount Lebanon.

Table 1. Brief SWOT analysis of the Lebanese small ruminant sector from the economic perspective

Strength	**Weaknesses**	**Opportunities**	**Threats**
Traditional source of steady income	Increasing costs of production	Opening urban market for local goat dairy product and international markets through "designation of origin" and similar labels	Economic and political instability
Persistent demand for sheep meat	Unfair pricing through the value chain	Potential for farmers organisation into cooperatives for a more effective role un price and market	
Increasing demand for goat milk	Limited market access	Role in agri-tourism	smuggled animals and products

Compilation based on references mentioned in the above paragraph and authors' personal observations and unpublished data

From an economic standpoint, the tradition of livestock farming has long provided a steady income stream for many Lebanese families living in rural and mountainous regions (Khafagy et al., 2022). This consistent market is based on traditional local demand linked to Lebanese culinary traditions and dishes based in part on small ruminant meat and dairy. The seasonality in milk production, which is considered a challenge in the sector, is addressed through adding value to dairy products and diversifying the products and the preservation methods. Although bovine meat and dairy have greatly gained a share in the market, important staple dishes still rely on the traditional sheep and goat raw ingredients. On the production side, the sector shows signs of economic weaknesses, particularly linked to increasing costs of production (feed, access to land and services) thus affecting the livelihoods of the farmers (Chedid et al., 2019; Dal et al., 2021). Furthermore, unfair pricing along the goat dairy value chain is observed with milk collectors (middlemen) controlling milk prices at the expense of the farmers (Khairallah et al., 2023). Added to that, traditional farmers based in remote rural areas have difficulties accessing wider markets and meeting urban customers' expectations (Hughes, 2023). Economic hardships are often cited as the main reason for farmers to reduce their herd sizes or even sell out to move to another activity (Hosri et al., 2016; Chedid et al., 2019).

On the other hand, this resilient sector is witnessing promising opportunities that offer hope for a better future. Investment in the goat dairy industry has shown an important increase in the last decade. New brands have emerged servicing the urban market with local type products (yoghourt and strained yoghourt) as well as European types (bûche, bûche cendrée, etc). A quick overview of the main supermarkets in Beirut shows at least five main brands, with farms based in the Bekaa valley or Mount Lebanon, that are catering to the capital (authors' unpublished data). These brands also report exporting part of their products to foreign markets. The top producers rely mostly on modern dairies with large processing facilities as opposed to the traditional setup of the small-scale producers, which helps them ensure better quality standards. Goat dairy products and sheep meat are sold at competitive prices reaching 1.5 to 2 times more than similar counterparts from bovine sources. The increased demand for small ruminant products, particularly in urban markets, may be linked to increased health awareness and the appeal of goat products as healthier alternatives especially since many are marketed as "organic" or "natural" products as well (Serhan and Mattar, 2017; Dal et al., 2021). Mount Lebanon serves as an interesting setting for these new dairies since it offers natural wild pastures at no or minimal land cost and with minimal existing environmental

contamination since such rugged terrains are often inaccessible for other uses. Another opportunity for the small ruminant sector appears in the emerging eco/agri-tourism business where this activity helps offer better direct sales options for the farmers as well as increasing marketing opportunities (Ghadban et al., 2013; Dal et al., 2021). Furthermore, local and international markets may be opened through protected labelling and "terroir" product listing of traditional Lebanese small ruminant products which can increase their visibility and market penetration, provided they meet the needed quality standards (Zurayk and Abu Ghyda, 2009). Despite these opportunities, economic instability, volatile security, and lack of governmental support continue to threaten the livelihoods of shepherds and hence the sustainability of the sector (Chedid et al., 2020; Ushakov and Shatila, 2022). From lack of financial services to unconducive policies and land access laws, to lack of border control and smuggling, small ruminant farmers are often neglected from receiving tailored national support for their sustainability.

Environmentally, pastoral systems benefit from available natural resources such as rangelands, and land-owning shepherds have an agricultural background that allows them to cultivate feed, namely hay, to supplement their herds (Chedid et al., 2019; Zurayk et al., 2001). Furthermore, shepherds often have access to crop residues (vegetable residues, cereal stubbles and straws) through arrangements with local farmers, thus providing a sustainable circular solution where they can use cheap feed, and in return, the farmer receives direct animal manure on his field for improved soil quality. Traditional knowledge of grazing routes and rangeland management is still considered as a strength although this knowledge is at risk of disappearing with time. However, issues such as overgrazing, land degradation, limited water resources, and degrading soil fertility pose significant challenges to grazing practices (Zurayk et al., 2001; Darwish and Faour, 2008; Chedid et al., 2018). In the absence of a clear national strategy for rangeland management, the available pastures, fragmented by inadequate land use laws which do not clarify the role of local authorities and other stakeholders in managing rangelands, are often subject to overgrazing by animal numbers exceeding their carrying capacity. Agricultural encroachment, urbanisation, and natural reserves designated areas constitute a major challenge to the rangeland's areas. Added to the degradation of the rangelands, in area and quality, is the unavailability of affordable quality feed alternatives leaving the herds with sub-optimal nutrition and productivity (Tami et al., 2005). Moreover, a recent trend is noted of increased reliance on imported high-producing breeds such as Saanen and Alpine, especially in newly emerging big dairies. Imported goat breeds often lack resistance to local climate conditions and prevalent diseases, resulting in increased veterinary costs and higher mortality rates, and they also have specific nutritional needs that, when not met, may negatively impact their productivity (Nair et al., 2021). Nevertheless, owning imported breeds is still limited to a few farmers.

The development of eco-friendly grazing initiatives and sustainable grazing practices offers promising opportunities for environmental restoration and conservation (Jabbour et al., 2023). Projects to that end, supported by local and international entities, have emerged in recent years although they may not replace a well-implemented national rangeland strategy that's still lacking.

Finally, one cannot forget the omnipresent environmental threat which is climate change and climate variability. With Lebanon's rangelands mostly falling under a semi-arid climate, except for those in the highlands, the threat of climate change is rapidly being reflected through lower vegetation cover and productivity as well as a decrease in water source availability, thus limiting the grazing potential of the lands and flocks' mobility (Darwish et al., 2011; Chedid et al., 2018). With increased restrictions on mobility due to environmental, economic, and social factors, sedentarism is increasing as a production system and, with it, increased reliance on supplemental feed, which in turn constitutes an economic challenge as mentioned earlier.

Photo 1. Shepherd with his goats in the Matn district of Mount Lebanon

III. Case study

In a brief survey within a small mountainous village (Mresty, Photo 2) in Lebanon covering most of the livestock owners of that village, farmers shared their views on the most common environmental challenge they face due to climate variability and their reported strategy to respond to these changes. The below unpublished data were collected under the Collaborating for Rural Sustainability (CORUSUS) project funded by the Foundation to Promote Open Society (OSUN). Tables 2 and 3 summarise these findings.

Table 2: The four environmental challenges most commonly reported by livestock owners in a mountainous Lebanese village (Mresty) are listed in order from most to least common.

	Common environmental challenges
1.	Change in temperature (mostly increase)
2.	Change in rainfall (mostly decrease)
3.	Increase in diseases
4.	Decrease in forage quality and quantity

Table 3: The four strategies to respond to environmental challenges most commonly reported by livestock owners in a mountainous Lebanese village (Mresty) are listed in order from most to least common.

	Common adaptation strategies
5.	Increased reliance on rangeland
6.	Improved veterinary care and vaccination
7.	Cultivating own feed
8.	Increased supplemental and alternative feeding

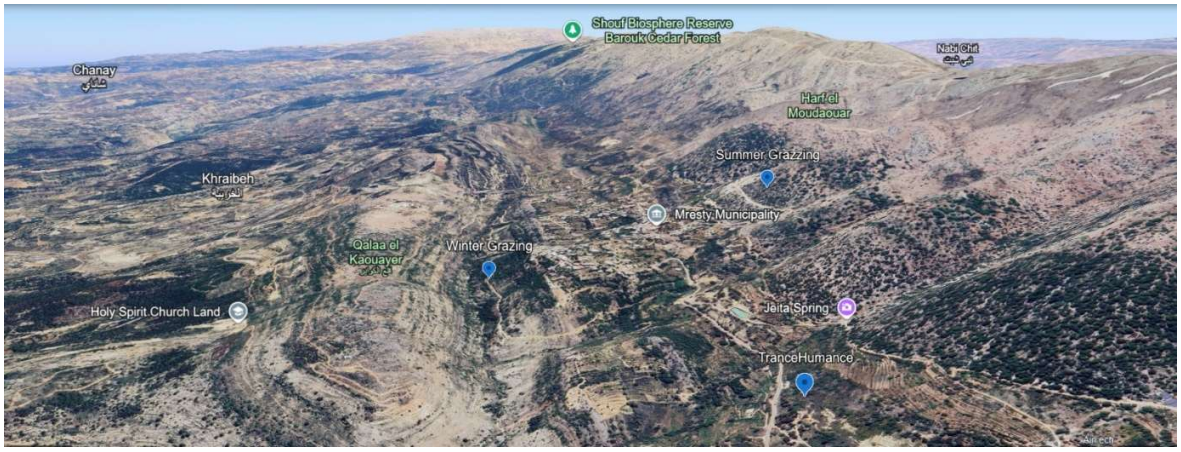

Photo 2. Location of the village of Mresty with its summer and winter grazing sites

It can be noted from this brief overview of a typical Lebanese village that rangelands still constitute the ultimate resource for their livelihood. Although environmental challenges may not be the sole drivers for heavy reliance on the rangelands, it is still nevertheless the most resorted to solution in the absence of other readily available and/or affordable options.

The socio-cultural context of Lebanese small ruminant farmers features strong community bonds and support networks among shepherds which are vital for sustaining the pastoral lifestyle (Obeid, 2006). Deep cultural heritage ties to pastoralism, particularly in Mount Lebanon, further reinforce these social structures (Chedid et al., 2020). However, challenges such as an aging shepherd population, lack of interest of young people in farming, marginalisation in policymaking, and the loss of traditional heritage threaten the social fabric of these communities (Obeid, 2006; Chedid et al., 2020; DeQuero-Navarro et al., 2020). The herds are owned and managed by families. Community-driven initiatives and cultural preservation programs are essential to attract younger generations and maintain pastoral traditions (Al-hagla, 2010; Rinaudo et al., 2021). In addition, there is an opportunity to tap into innovation and technology in production and marketing as attractive features for bringing youth back into the sector. Adapted small-scale technologies at the farm, processing, or market level, can help in retaining a well-trained and skilled new generation in the sector, putting their modern education at the service of improving a traditional industry.

In addition to attracting a skilled and young labour force, adapted and affordable technology can play a role in improving efficiency, productivity, and quality thus leading to a better marketing and economic outlook (Duboeuf, 2011; Toro-Mujica et al., 2015). In contrast, unconditional modernization introducing new technologies and practices can threaten to replace traditional methods and ancestral knowledge, leading to a loss of unique cultural practices (Thompson and Scoones, 2009). Added to that, globalisation brings in foreign products and ideas that can also displace local traditions.

Cultural preservation efforts are critical for maintaining the rich heritage associated with pastoralism, artisanal dairy products, and the knowledge passed down through generations. This heritage includes traditional farming practices (transhumance, nomadism, etc.), methods of small ruminant cheese-making (*serdali, ambaris, darfieh, kishk*, etc.) (Table 4), and other dairy production techniques, and even local recipes that have been refined over centuries. These practices contribute to communities' cultural identity and offer valuable insights into sustainable agriculture and food production (FAO, 2012), predating the modern energy-intensive society with naturally low energy, climate-smart practices and products. To control these threats, promoting cultural heritage through various means is essential. Documentation and research of traditional knowledge, through written records, videos, and other media, helps preserve these practices for future generations (Al-hagla, 2010). The Food Heritage Foundation is a Lebanese NGO, founded with the vision of documenting, preserving and supporting this cultural heritage and the rural communities (https://food-heritage.org/). Furthermore, tourism can be a powerful tool, where visitors are introduced to traditional practices and products, generating income for local communities and increasing awareness and appreciation of their heritage (Richards, 2009). With Lebanon having a widespread diaspora largely outnumbering the resident population, targeted cultural tourism and educational activities catering to Lebanese expatriates can be an interesting approach for ensuring that the younger expatriate generations learn and value their cultural roots.

Other factors

As mentioned earlier, the small ruminant sector is largely underserved, and this extends to the availability and efficacy of health and veterinary services. The adaptation of local breeds to the prevailing environment, their resilience to various diseases, and the traditional knowledge of animal health are significant strengths of the system (Chedid et al., 2020; Dankar et al., 2022). Nevertheless, limited access to modern veterinary care, exposure to harsh and unusual weather conditions, and zoonotic diseases and parasites (*Cystic echinococcosis*) pose serious health risks (Paz et al., 2021; Al-Kilani and Meyer, 2022). Small ruminant farmers in Lebanon suffer from the lack of proper veterinary support and incentives. Private veterinary services are too costly, and the limited public provisions such as vaccines may be of questionable quality due to bad handling and storage. In 2010, following the Syrian crisis, the uncontrolled flux of unvaccinated livestock crossing the Syrian-Lebanese border created further health risks to local flocks (FAO, 2017). Training programs for better animal health management, breeding, and improved healthcare infrastructure in rural areas are necessary to address these challenges (Chedid et al., 2018; Youssef et al., 2023).

Technology is an important emerging factor that can provide solutions to the sector. The adoption of basic mobile technology for communication and market information as well as digitalization for data gathering and rapid treatment, in addition to milking machines, cooling tanks, and the use of motorcycles and trucks for transportation, reinforce the sector's adaptability (El-Hajj et al., 2024; Al-Kilani and Meyer, 2022). Nevertheless, there is a significant gap in the use of advanced technology for livestock management and monitoring, which hinders progress (Chedid et al., 2018). The gap is most noticeable when comparing the different production systems with increasing use from the transhumant traditional farms to the more intensive and sedentary systems. The main weaknesses preventing wider technology adoption can be summarised as high cost, low skills, and lacking infrastructure. For instance, trucks were used to transport flocks between winter and summer pastures, and vice-versa. However, due to the continuously increasing fuel prices, farmers reported ceasing this practice, and looking for closer pastures instead. This has

consequently affected the mobility of flocks and shortened the transhumance distances. The introduction of modern technologies like GPS tracking for flocks and mobile health applications for veterinary support, along with solar-powered solutions for remote areas, could revolutionise the sector (Holmstrom and Beckham, 2017; Kassem et al., 2023). However, the chronic disruptions in electricity and internet connection in Lebanon may constitute a challenge in adopting such solutions, even in the presence of willing and well-trained farmers.

Table 4: Traditional Lebanese small ruminant dairy products (Semaan et al., 2011; Khairallah et al., 2023)

Product	**Milk Type**	**Region**	**Production Technique**
Labneh Moukaazale (*labneh* balls)	Goat or sheep	All Lebanese rural areas	Strained yoghourt made by draining it in a cloth to remove the whey, resulting in a thicker consistency. The final product is rolled into small balls and stored in closed glass jars immersed in olive oil.
Serdalli, or *Ambaris* or *Labneh Jarra* (depending on the Region)	Goat traditionally	Mount Lebanon, Bekaa Valley, and North Lebanon	Clay jars are soaked in whey, washed, then filled with salted raw milk. The whey is drained and the mold is removed every two weeks. This is repeated 3-4 times before sealing the jar. Fermentation lasts 4-6 months. The resulting curd is collected and dried in cloth bags for 24-48 hours. The final product is preserved in olive oil.
Kishk	Cow or goat	All Lebanese rural areas	Made from fermented yoghurt and burghul (cracked wheat). Cracked wheat is soaked in milk or yoghurt for about a week with periodic milk and salt additions to control fermentation. The resulting dough, *kishk akhdar*, can be preserved in olive oil or dried on rooftops until hard and dry. The dried *kishk* is then ground into a fine powder, and used in cooking a nutritious soup during winter.
Darfiyeh cheese	Goat or sheep	North of Lebanon	Raw milk is filtered and left at room temperature for 24-48 hours, then coagulated with rennet. The curd is moulded, drained, salted, and placed into a goat skin (*daref*). Heated whey extracts coagulated solids (*Arichi*), are salted and layered with the cheese in the *daref*. The sealed skin is salted on the outside and aged in a humid cellar with periodic salting.
Baladi cheese	Cow or goat or sheep	All Lebanese rural areas	Fresh white cheese made by heating milk and adding rennet to curdle it. The curds are then cut, drained, and pressed into molds. Often salted and sometimes stored in brine.
Kawarma (meat and fat preserve)	Goat or sheep	All Lebanese rural areas	Prepared by cooking meat with fat (from the fat-tail of local sheep) and spices, then preserved in its own fat. Often stored in jars and used as a flavouring or topping for other dishes and stews adding high energy and protein content to the dish.

Although land tenure can be considered as a socio-cultural issue, it is worth discussing it separately, given its significant impact on transhumance. Overall, the land sector in Lebanon is regulated by ancient laws and characterised by legal ambiguity causing overlapping land rights. Rangelands are owned by the government which gives the local communities the right to use them. This tenure system is regulated by the Ottoman Land Code dating from 1858 (Chenini F. and Darwish T., 2012). However, in the absence of a clear definition of land use rights, conflicts often arise between the land users and the owners, which also affect the land exploitation (Chedid et al., 2020). The expansion of agriculture and the decrease in rangelands surface and quality result in overstocking and consequently in overgrazing and rangeland degradation. The establishment of rangeland-focused policies, with the inclusion of relevant stakeholders (shepherds, associations involved in rangeland rehabilitation, representatives of municipalities and the ministry of agriculture, etc.), is imperative for the preservation of pastoral activities and land resources.

Rangeland rehabilitation in Lebanon also requires joint efforts to address various environmental challenges, such as overgrazing, land degradation, and climate change, and to support agro-pastoral communities and their traditional practices. Several projects are underway to restore and manage rangelands. For instance, the Forest and Landscape Restoration Mechanism (FLRM) of the FAO are working with the Lebanese Ministry of Agriculture to implement rangeland management plans. These plans include detailed information on grazing periods, rotation among rangeland management units (RMUs), and supporting initiatives like water facilities and feed supply. Local communities and organizations are also involved in rangeland rehabilitation. The Shouf Mountain Landscape project, for example, is a project implemented by a consortium of local organizations like The Society for the Protection of Nature in Lebanon (SPNL) and the Shouf Biosphere Reserve (SBR), aims to restore mountain pastures and strengthen the socio-cultural fabric that sustains biodiversity and cultural values. R&D projects are also undertaken to study the challenges faced by the small-ruminants holders, learn about the transhumance routes, explore community-based solutions and enhance the sustainability of the traditional systems and practices by building the capacity of shepherds and animal keepers (Chedid et al., 2020; Hamadeh et al., 1996; Hamadeh et al., 2015; Fahed et al., 2024). The Environment and Sustainable Development Unit at the American University of Beirut was a pioneer in researching these agropastoral systems helping in their classification and following their adaptation trends over time as well as working for their development through multiple interventions such as introducing feed alternatives, breeding management, grazing and rangeland management plans. These initiatives, among others, aim to enhance both the ecological and socio-economic resilience of Lebanon's rangelands, ensuring sustainable land use and improved livelihoods for local communities.

A word on the special security situation in Lebanon is warranted when discussing the small ruminant sector. Lebanon has been significantly impacted by the Syrian war, leading to conflicts affecting various sectors, including small ruminant production systems. Many Syrian refugees, including pastoralists, have moved to Lebanon, leading to more competition for limited grazing land, which has caused conflicts between local farmers and the new arrivals (FAO, 2017). This competition extends to market dynamics, where an oversupply of livestock and their products has driven prices down, hurting the livelihoods of Lebanese farmers (Tawk et al., 2019). Disputes over land use and resources have become more common, leading to social conflicts (UNDP, 2018). Additionally, the traditional practice of transhumance between Syria and Lebanon has been disrupted, further hurting the pastoral systems (ESCWA, 2017). This instability has necessitated adaptive strategies among herders, and there's a clear need for strategies that consider these conflicts and support agricultural practices in these challenging times (FAO, 2020). Farmers on the Southern border face similar challenges in moving their animals, where many fields are still land-mined posing a significant risk to farmers and their animals, and other fields are often destroyed by the ongoing conflict. In addition, animal movement along the volatile Lebanese Southern border often leads to unintentional cross border trespassing into hostile territories with serious repercussions on the farmers. The escalating events between Lebanon and Israel in the autumn of 2024, resulted in significant losses in the agricultural sector in Southern Lebanon estimated to 176,600 USD in livestock and animal production losses (FAO, 2024).

IV. Discussion of future outlooks on transhumance in Mount Lebanon

As can be clearly seen, flocks' mobility has been disrupted on many levels, and the animals are becoming more sedentary. The shift to sedentarism in the Bekaa valley, for example, has been noted over a span of ten years (Chedid et al., 2018). Traditional transhumance has become a privilege to a limited number of farmers with access to pastures or with enough financial means to move the flocks by trucks. The practice of seasonal livestock migration is integral to maintaining ecosystem diversity and resource management (Jobbins et al., 2022). Despite the economic, ecological, and socio-cultural benefits of transhumance, logistical challenges, land use conflicts, natural reserves, encroachment on traditional migration routes, economic threats, climate change and lack of adequate policies threaten this practice (Aryal et al., 2014; Khechen and Samaha, 2022; Fahed et al., 2024).

Pastoralism, a form of local food systems, is considered as one of the world's most sustainable food systems. Hence preserving this lifestyle and its associated practices, including transhumance, is vital to securing food and livelihoods for the communities relying on this system. Efforts to preserve transhumance and increase the resilience of small ruminant production systems in Lebanon should be based on the numerous (and interrelated) opportunities and strengths that characterise these systems and which were described in this chapter. The increasing demand for goat dairy products, for instance, is a great opportunity to grasp and improve the quality of these products and develop agro-tourism activities. Nevertheless, preservation efforts should not fail to tackle the weaknesses and the threats, mostly related to the market (increasing costs of production, unfair pricing through the value chain, limited market access) and weak governmental presence/support (economic and political instability, lack of adapted financial services and supportive policies, smuggled animals and products), respectively.

Small ruminant production systems in Mount Lebanon have proved to be resilient in spite of all challenges; this is reflected in the increasing number of flocks and dairy production units, as well as in the adaptation mechanisms that the farmers have adopted (use of supplements, changing transhumance routes, spending more time on the pastures, integration of other activities, etc.).

While prospects for the full intensification of the pastoral system are still unlikely, the revival of transhumance in Mount Lebanon would be seen as a means to fortify pastoralism, contribute to its sustainability, and restore natural pastures and their ecosystems. Nevertheless, some factors related to the complicated land tenure system in the country, characterized by outdated laws and an overlap of authorities over the lands, would inhibit the reinforcement of transhumance. Religious endowment lands, for instance, account for 30% of private land and would offer, if well managed, many possibilities to be rented for grazing. A holistic approach taking into consideration land tenure and (range)land use and management policies, capacity building of stakeholders, rangeland ecosystems investigations and listening to the voice of the herders, shepherds and other stakeholders should hence be applied to restore transhumance (Sattout, 2014; Chedid, 2018).

Conclusion

The insights gathered from Lebanese farmers underscore the complexity and richness of the livestock farming sector in Lebanon. This sector is a tapestry of traditional knowledge, cultural heritage, and economic practices interlaced with modern challenges and opportunities. Addressing the weaknesses and threats, while leveraging the strengths and opportunities, will require coordinated efforts from policymakers, communities, research and education

institutes, and development organisations. Sustainable practices, technological advancements, and cultural preservation initiatives must be prioritised to ensure the resilience and prosperity of Lebanese livestock farming. This comprehensive understanding provides a foundation for strategic planning and targeted interventions to support this vital sector in adapting to contemporary challenges while preserving its rich heritage and essential contributions to rural livelihoods.

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Chapter 4

Past, current, and future transhumance in the Green Mountains, Libya*

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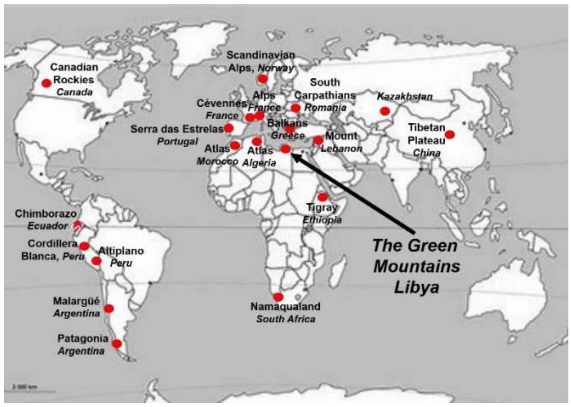
Abstract

Animal husbandry is a major rural activity in Libya, accounting for approximately 20% of agricultural domestic products and serving as a cornerstone of rural livelihoods. The Green Mountains are located in the eastern part of Libya, near the Mediterranean coast. They span 160 km from east to west and over 60 km from north to south. Historically and even currently, the Green Mountains have been a strategic agricultural region, particularly for crops, fruits, and livestock. Agriculture relies on complementary irrigation, since the average annual rainfall is about 400−500 mm, and this helps sustain the natural rangeland productivity. Settled by Bedouin tribes, the area has long been characterized by seasonal animal movements. Traditionally, flocks migrate southward from October to March, during the cropping period. Many families also travel to neighbouring Egypt, where a significant portion of their livestock production is sold. However, animal husbandry in the region is facing challenges due to climate change, particularly the increasing frequency of droughts in recent decades, as well as changing aspirations among youth, ineffective policies, and urban and agricultural expansion onto natural rangelands. In response to these challenges, breeders are adopting more intensive feeding systems, primarily relying on imported concentrates feedstuffs, cultivated forages, and a reduction in transhumance practices.

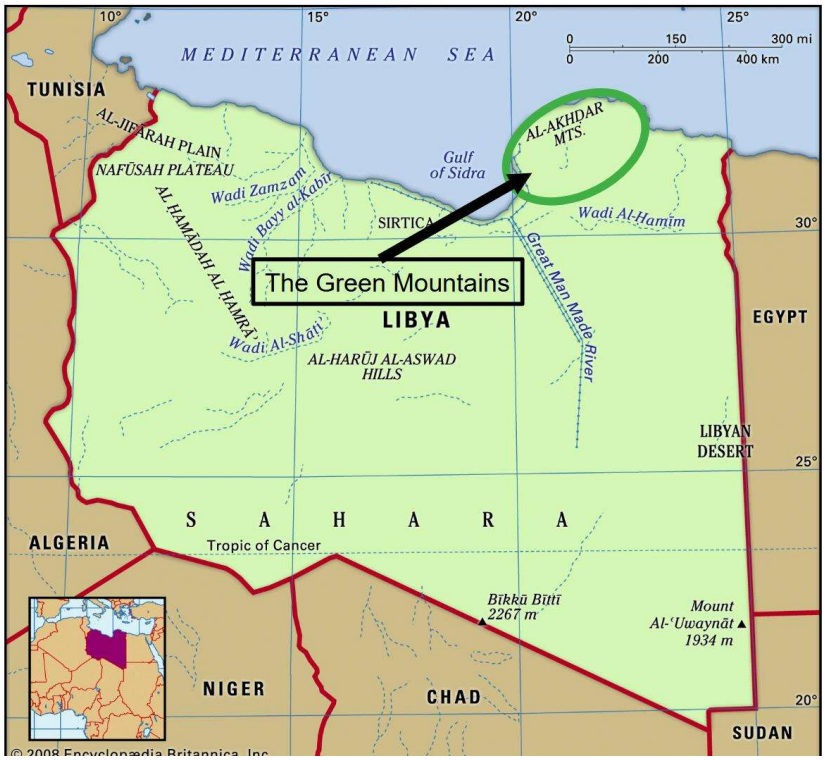
Keywords: Agropastoral farming; Intensification; Overgrazing; Sheep and goat breeding; Bedouin area



* Photo credits: the authors

Introduction

The agricultural sector is considered one of the most important components of the Libyan national economy. It serves as a crucial source of food and clothing for the population and raw materials for various industries. Additionally, agriculture and its supply chains employ a significant portion of the workforce and contribute directly to the gross domestic product (GDP). Animal production represents one of the key economic activities, with an annual budget of approximately €70 million, accounting for about 20% of the total value of agricultural output in 2012. In the same year, red meat contributed 60% of the value of livestock production in Libya. Livestock in Libya is estimated to include 6 million sheep and 1.5 million goats, both of which primarily depend on open grazing systems, with natural pastures meeting around 30% of their fodder needs. The remaining requirements are supplemented with concentrates. Additionally, there are about 60,000 camels, whose nutritional needs are also met through open grazing and fodder, and approximately 100,000 cattle raised for both meat and dairy production. According to FAOSTAT (2023), cattle nutrition relies on green fodder, coarse feed, and concentrates, collectively meeting 60% of the local market's demand for meat and milk. The Libyan Green Mountains are located in Northeastern Libya (Map 1), specifically along the Mediterranean coast, spanning 160 kilometres in an east-northeast direction between the cities of Al-Marj and Derna.

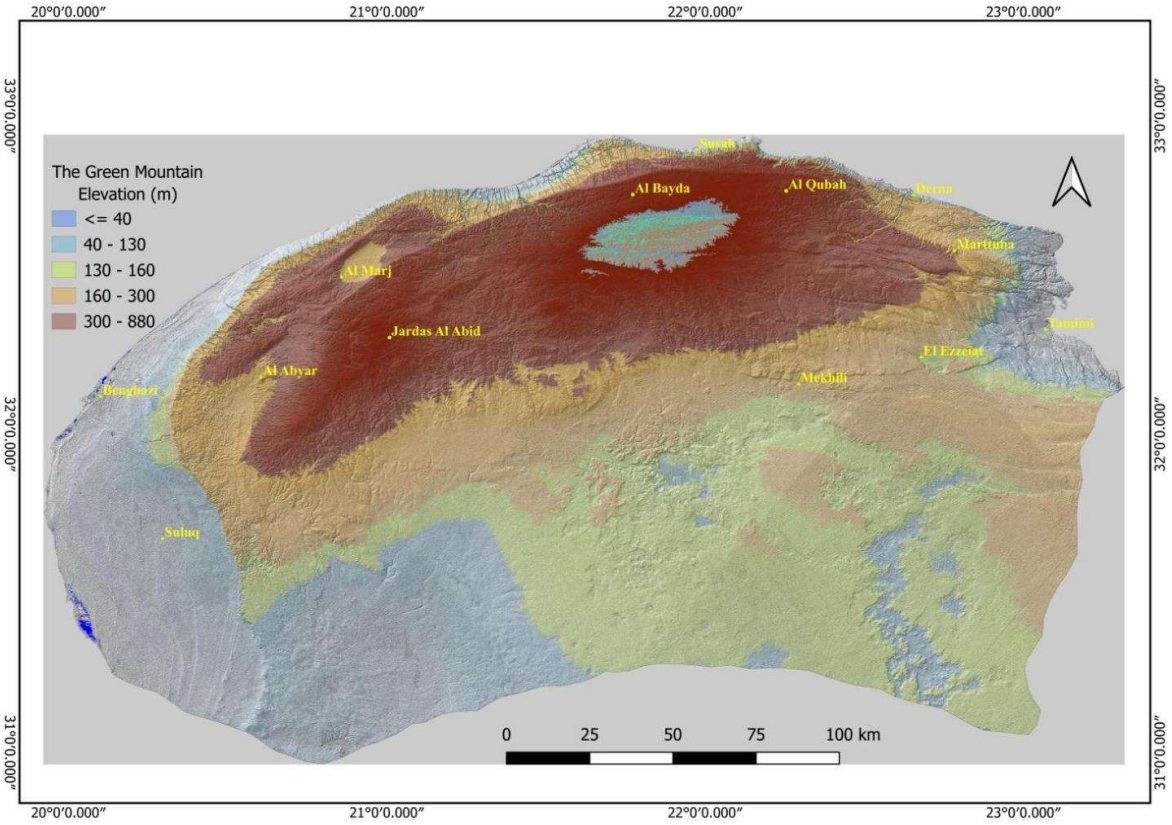


Map 1. Location of the Green Mountains (Al Akhdar Mountains) near the Mediterranean Sea in Northeastern Libya

The mountains feature two prominent peaks: one rises to about 300 metres, the other to about 880 metres above sea level. The Green Mountains have long been and continue to be a strategic area for agriculture in Libya, particularly for crops, fruits, and animal husbandry. This chapter begins with an overview of the historical, geographical, and climatic context of the Green Mountains. It then describes the development of agriculture in the region, with a focus on livestock farming and transhumance practices that are essential for utilizing natural pastoral resources and ensuring the proper functioning of the agricultural production systems in place. Finally, it examines the various drivers of agriculture and livestock farming in these mountains, as well as their impacts and consequences on transhumance.

I. Geographical, historical, and climatic context

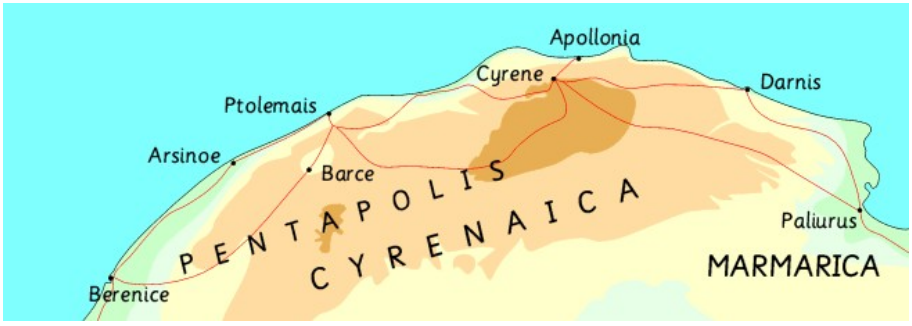
The Green Mountains extends from the Libyan-Egyptian border in the east to the Red Valley near the city of Sirte in the west, and face the Mediterranean Sea to the north at a latitude of about 31-33°N (Map 1). Its mountainous part covers around 855 square kilometres and is inhabited by approximately 1.7 million people. These mountains form a plateau parallel to the Mediterranean Sea (Map 2), with two main terraces (Map 3). The height of the first terrace is about 250−300 metres, and the second reaches about 550−600 metres. The highest peak stands at 880 metres.



Map 2. Elevation in the Green Mountains (Al Akhdar Mountain), Libya

From a historical point of view, the Green Mountains correspond to the northern part of Cyrenaica (Map 3), an ancient Greek colony where a school of philosophy closely aligned with hedonism was founded in the 4th century BC in the city of Cyrene (Map 3) by Aristippus, one of Socrates' disciples. This school of philosophy regarded voluptuousness as the necessary foundation of morality. As a result, the Green Mountains hold significant historical importance due to the ancient Greek settlement. Numerous archaeological and historical sites can still be found there, including the village of Slonta, a notable historical landmark. For example, there is a small museum housing ancient shipwrecks, as well as various remains of both ancient Greek and Roman civilizations, particularly the remnants of irrigation systems, which include cisterns dug into the ground and connected by irrigation canals. Like much of this southern Mediterranean region, the Green Mountains are inhabited by Bedouin tribes who practice livestock farming and transhumance to make the most of natural pastoral resources, while also cultivating crops for their own consumption, as we will explore below.

Regarding the climate, the Green Mountains are characterized by a relatively high level of rainfall, ranging between 375 and 500 mm annually. January is the rainiest month, whereas July is the driest one. Additionally, the area experiences high humidity due to its proximity to the Mediterranean Sea, despite the recurring dry summers and periodic droughts. The average temperature varies with altitude but is generally around 15−20°C, with periods of frost in winter (January and February), especially during the night, and heat waves exceeding 30−35°C in the summer (July and August).



Map 3. The Green Mountains corresponding to the antic-Greek Cyrenaica and its two main terraces

In relation to this Mediterranean climate, the Green Mountains stretches out from the valleys and rivers that run throughout the region. Their natural rangelands were once covered by a herbaceous carpet of annual grasses (Photo 1), various groups of shrubs, both isolated and in clusters, and small patches of forests. This environment supported the traditional transhumance practiced by the breeders and their flocks. From March to October, they settled in the Green Mountains, grazing the natural rangeland (Photos 1, 2 & 3). From October to March, they moved south to warmer lowlands or east to the neighbouring Egyptian North Western Coast Zone (NWCZ), where they marketed much of their animal products.

Photo 1. Natural rangeland on the Green Mountains

Photo 2. Sheep grazing natural rangeland on a plateau

↑ *Photo 4. Cattle grazing natural range land on the plateau*

← *Photo 3. Goat grazing natural rangeland on the plateau*

Rainfall and its annual distribution in the Green Mountains have always allowed local farming families to cultivate cereals, such as wheat and barley, which were harvested in late spring (May-June) and early summer (July) for family consumption. In dry years, non-harvested crops were used as pasture for livestock. Similarly, in favourable years, with abundant rainfall, both in terms of quantity and distribution, cereal stubbles were grazed by livestock. In line with the Mediterranean climate, some orchards with fruit trees, particularly figs, olives, almonds, and pistachios, were a constant presence in the valley lands where runoff water accumulated.

II. The Green Mountains in the current Libyan socioeconomic context

Firstly, due to their location on the border with Egypt, the Green Mountains are a strategic region in relation to the socio-political challenges that Libya has been facing for several decades. This is especially true since the Egyptian market has historically been, and still is, a crucial outlet for Libyan agricultural products and a key source of supplies, connected to the strong social ties between the Bedouin tribes of the Green Mountains and those in the NWCZ in Western Egypt.

Secondly, agriculture, which had been the economic foundation of North Africa since Antiquity—particularly in supplying cereals to the Roman Empire— has lost its leading role to oil production over several decades. In the 1950s, agriculture accounted for one-quarter of Libya's GDP, but by the 1960s, it had dropped to 10%, and by the 1980s, it only represented 3-4%. By the end of the 20th century, it had risen slightly to 5-6%. This sharp decline in agricultural production highlights the dominance of fossil energy production in Libya's national economy. For example, in 1977, food imports were approximately 37 times greater than they had been 20 years earlier, in 1958. Agriculture, however, remained the primary source of livelihood for rural populations, especially the most vulnerable ones. Despite oil wealth being spent on imported food, this had a minimal impact on the national economy and did little to alleviate rural poverty, as public policies mainly focused on large, often grandiose, development projects. Furthermore, oil revenues created employment opportunities in urban areas, fuelling high rates of rural-urban migration.

Moreover, the Green Mountains possess significant untapped tourism potential. From a cultural perspective, the region is rich in historical sites scattered across various towns and villages. Its proximity to the Mediterranean Sea

and its beaches add value for summer tourism, similar to the tourism boom along the nearby Egyptian coast in recent decades. Additionally, the remaining natural rangelands in the Green Mountains, particularly the wooded areas, present opportunities for tourism activities such as leisure, hiking, and trekking.

The Green Mountains are therefore considered one of Libya's most important and productive agricultural areas due to several key factors. Notably, as a cultural crossroad from ancient times to the present, along with their proximity to the Mediterranean, especially the cities of Derna and Benghazi, they play a significant role in the region's development. The Mediterranean climate—characterized by favourable rainfall and humidity levels due to the closeness of the sea—supports a variety of annual and perennial crops, despite frequent droughts. This climate was a key factor in the implementation of major agricultural development projects funded by oil revenues, particularly since the Green Mountains have vast natural rangelands, often regarded as free land for development. However, the land of the Green Mountains is not "free" in the sense of the Libyan government, as Bedouin society holds traditional land rights that extend across much of North Africa. Moreover, they are often the same tribes who own land on both sides of the border, such as in the case of the NWCZ in Egypt. Thus, in addition to being traditionally used by their transhumant herds of sheep, goats, and some camels from March-April to October, the rangelands of the Green Mountains are also cultivated for cereals, vegetables, and fruit. Far from opposing the establishment of large-scale agricultural projects, Bedouin tribes have sought to integrate these projects to benefit from them while maintaining control over their lands. As a result, when these major projects were gradually abandoned, the Bedouin tribes reclaimed full ancestral rights to the lands of the Green Mountains.

Another key factor of the Green Mountains is their proximity to the NWCZ and the large Egyptian market in the Nile Delta and Valley, home to about 100 million consumers—15 times the population of Libya. This market provides a significant outlet for agricultural products and a source of inputs.

In conclusion, a combination of factors has made the Green Mountains a region of great agricultural and strategic importance. Their location, cultural significance, and proximity to key Mediterranean markets have all contributed to the region's role in Libya's agricultural and socio-economic history. Despite the political challenges of recent decades, the Bedouin tribes living in the Green Mountains have effectively navigated these factors and continue to shape the region's agricultural landscape.

III. Historical perspective of livestock and transhumance

For many centuries, the nomadic Bedouin tribes of the Green Mountains primarily relied on livestock rearing, as their lives were based on livestock activities and the seasonal movement of their flocks in search of water and natural pastures. The mobility of the animals in the Green Mountains followed specific patterns that allowed for freedom of movement over time. At both the local and regional levels, herds could move interchangeably between the Cyrenaica region and the South, and/or the Egyptian NWCZ, depending on the annual rainfall, the abundance of rangeland resources, and the demand for market products. Sown fodder did almost not exist in those times; only natural pastures and crop residues were available. These transhumance movements lasted several centuries and continued until the mid-1960s.

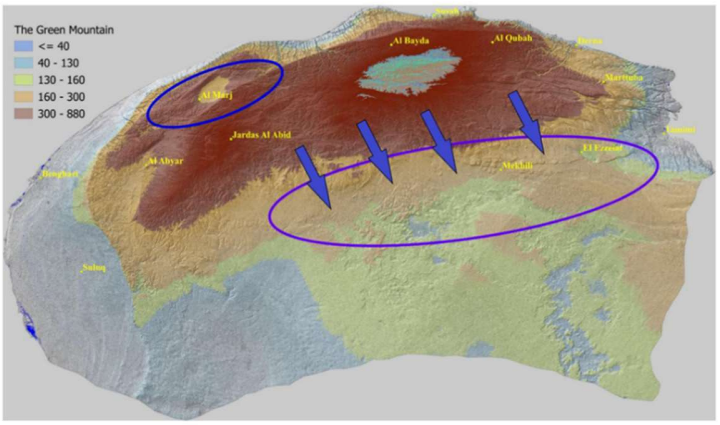
Firstly, there was a seasonal movement of sheep flocks from the Green Mountains to the southern areas. The herds would remain in the Green Mountains from early March/April to the end of September or the beginning of October, when they would return south to spend the winter. This seasonal migration was due to the cold temperatures (sometimes below 0°C) in the Green Mountains during the winter months (October-April), which posed a real constraint for sheep. Flocks then moved south to flat desert areas with milder temperatures, such as Al-Uzziyat,

Al-Mukhaili, and other desert regions south of the Green Mountains. In these areas, flocks benefitted from more moderate weather, as well as the natural pastures, which were characterized by an early spring season. When the animals returned to the Green Mountains in March/April, they enjoyed a late spring season due to the altitude, which lasted longer than the Southern areas.

Secondly, as mentioned earlier, transhumance to the NWCZ was also driven by the search for markets, particularly in the Al-Hamam area, which was a major trading hub for sheep, goats, and camels. Official documents confirm a long-lasting transfer of live animals between Egypt and Libya, especially through the Salloum crossing point, the last border point on the Egyptian frontier. In 1894, for example, around 1,200 camels and horses, 53,000 sheep, and 3,600 kg of butter were transferred from Libya to Egypt. In 1908, approximately 34,000 sheep were moved, and in 1922, about 80,000 sheep and 75,500 kg of butter were transported (cited by Daoud, 2015). This shows the significant complementarities between the Green Mountains in Libya and the NWCZ in Egypt, with both areas inhabited by the same tribes. These exchanges and connections have existed since ancient times, strengthening over the years. Historically, the Green Mountains served as a good pasture for Egyptian flocks, whereas the NWCZ and Egypt represented a strategic market for Libyan animal products, especially meat and butter.

In conclusion, there was traditionally a double transhumance: on one hand, flocks spent the spring and summer in the Green Mountains, and on the other hand, they spent the autumn and winter in the southern lowlands and the NWCZ, where they grazed in warm conditions and provided the primary Bedouin products, particularly meat and milk, to supply the market.

At present, the movement of herds across the Libyan-Egyptian border has almost completely ceased. This change is due to several factors, the most important one being the settlement of Bedouin tribes in both Egypt and Libya as part of public policies. As a result, movements across the Libyan-Egyptian border no longer exist. Additionally, with advancements in transportation and the growing population in Libya, there are now more opportunities to market Green Mountains animal products within Libya itself, even though the national market is not as lucrative as the Egyptian one for sheep, goats, camels, and butter. Consequently, livestock farming has evolved over the past few decades in response to changes in the national context. Bedouin families now migrate with their flocks to the south, but no longer to the east, starting from October (Map 4).



Map 4. Transhumance in the Green Mountains, going to the south in October and coming back in March-April

Until the second half of the 20th century, only a few members of each family or tribe remained in the Green Mountains to prepare food crops (Photo 5), which were sown at the beginning of the rainy season. The orchards were usually located at the bottom of the wadis, where rainfall accumulated (Photo 6). Families and their flocks would return in

March-April to spend spring and summer grazing the rangelands, where vegetation had grown due to the winter and spring rainfalls. Flocks also grazed on the cereal stubbles by the end of spring and the beginning of summer.

Photo 5. Cereal plot in a wadi bottom

Photo 6. Orchard with fig and olive trees in a wadi bottom

In the past, flocks (small ruminants with some dromedaries) followed the movements of transhumant families between spring-summer pastures in the Green Mountains and autumn-winter pastures located further south or east in the neighbouring Egyptian NWCZ. It should be noted that families generally settled on the land of their tribes, knowing that the tribes owned land in various areas. Every Bedouin knew the lands of his tribe and neighbouring tribes, the boundaries of which were indicated by simple small piles of stones (Photo 7). Grazing is relatively simple as the flocks remained close to the barns. In cases where the barns are close to cultivated plots, guarding was necessary (Photo 8). Flocks spend the night in pens to limit losses due to predators and theft. This does not concern dromedaries.

Photo 7. Pile of stones indicating the tribe's land limit

Photo 8. A shepherd guarding a flock near a crop plot

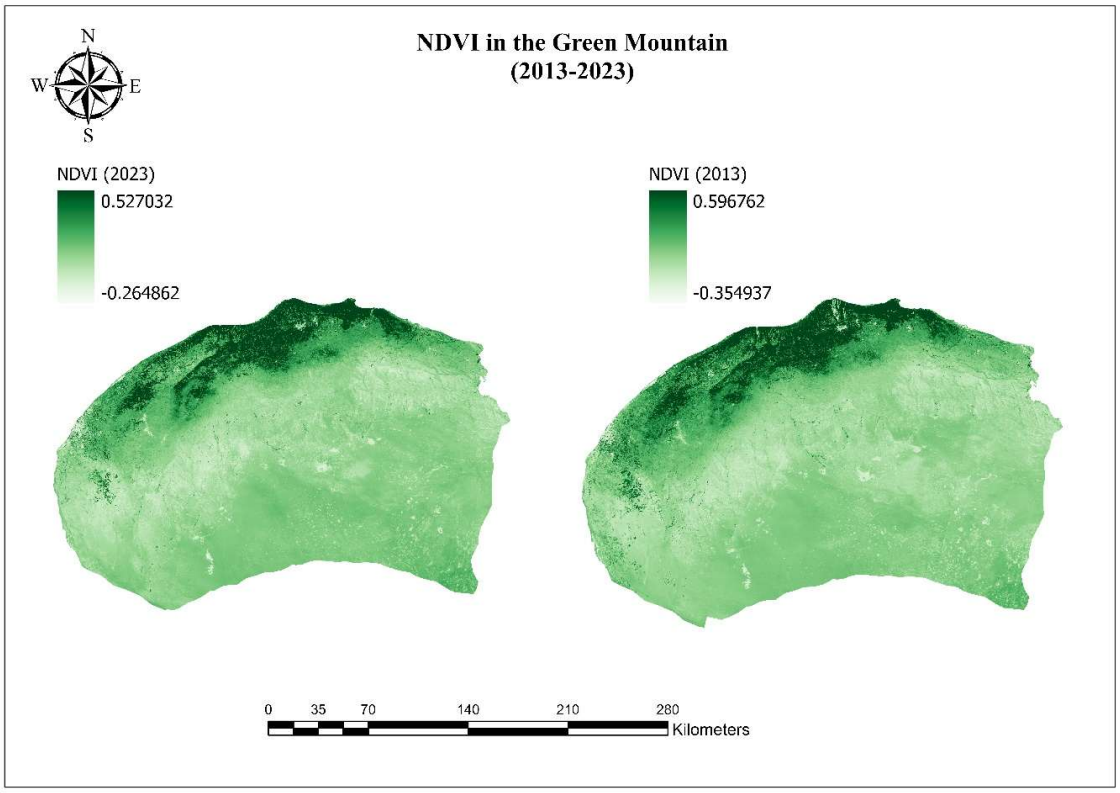
Furthermore, in current times, herding livestock (camels, goats, and sheep) in the Green Mountains always involves the practice of transhumance, since the new agricultural development projects are mainly concentrated in the Marj Plain and around Derna. Regarding the Marj Plain, in addition to the seasonal movements south and north, there is another transhumance of flocks toward the west, to the outskirts of the western Jebel Akhdar region. This particularly concerns the Marj region, which is an agricultural area characterized by flat and fertile lands and the spread of dense crops and vegetables that provide feed resources for animals, mainly in the form of crop residues.

IV. Main past and present stages of sheep transhumance

Many natural and human factors have greatly affected the practice of raising livestock and transhumance in the Green Mountains. Some of these are natural and largely beyond human control, whereas others are anthropogenic. These human-related factors are tied to local resource exploitation practices or specific policies that have a direct impact on livestock, rangelands and, consequently, on transhumance. The following is a review of the factors that have led to these changes.

1. Climate change, natural disasters, degradation of natural pastures

There is no doubt that the Green Mountains, like other regions of the world, are suffering from the negative effects of climate change—a global issue. For example, they have experienced severe droughts in recent decades, with rainfall amounts decreasing over consecutive years, leading to deterioration in the natural vegetation cover, which is an important source of animal nutrition. Additionally, soil degradation has occurred due to the decline in vegetation cover. In this context, statistics indicate a significant decrease in livestock in the Green Mountains, though official data on this decline are unavailable. Moreover, rangelands have decreased both in quantity and quality. Certain plant species, which were once of quantitative importance, are disappearing. Studies also show the disappearance of some key plant species in the Green Mountains. For instance, the Map 5 illustrates the changes in vegetation cover from 2013 to 2023, using the vegetation change index (NDVI), which highlights a decline in vegetation spread and density, particularly in the Marj area. Consequently, breeders are forced to rely on compound feed, the price of which has recently increased significantly due to the global inflation episode. This prompts them to reduce their herds or abandon animal breeding.



Map 5. Change in vegetation cover between 2013 and 2023 in the rangelands of the Green Mountains

Additionally, as a result of the negative effects of climate change, the region of Derna was hit by Hurricane Daniel in September 2023. The hurricane severely impacted the city, leading to the death of thousands of residents. According to government statistics, approximately 40% of the region's livestock was lost. Moreover, significant damage was inflicted to infrastructure and equipment. The hurricane also affected the roads leading to pastures in the Green Mountains. Around 85% of the croplands were damaged, resulting in a major loss of the seasonal vegetables and fruit harvests. Furthermore, the strong floods and torrents caused by Hurricane Daniel had a severe impact on the Jabal al-Akhdar region, located in the heart of the Green Mountains. More specifically, various archaeological sites were destroyed, including some that were listed as UNESCO World Heritage sites.

From an environmental perspective, fires constitute also a major factor contributing to the deterioration of forests and natural rangelands' vegetation. One of the largest fires occurred in the summer of 1988, spreading across the eastern part of the Green Mountains along the northern slopes facing the sea. Around 30,000 hectares of natural forest were destroyed. Another fire broke out in 1990 in a neighbouring area, destroying approximately 7,200 hectares. Forest fires in the Green Mountains are usually caused either by lightning or human activity, whether intentional or accidental. Among human activities, charcoal production and slash-and-burn farming before planting crops are common causes. Tourists also contribute to forest fires, especially during outdoor picnics in forested areas, where they light cooking fires and leave them unattended. Additionally, some forested areas are sometimes used to burn urban waste, which can lead to the spread of fires.

2. Change in animal husbandry patterns

There is no doubt that animal husbandry patterns in the Green Mountains have undergone a major transformation due to the shift from a transhumant/nomadic lifestyle to a more sedentary one. As a result, transhumance is no longer a necessity for breeders, as the main source of animal nutrition now relies on manufactured feed and imported grains. Many breeders no longer prefer to move their animals over long distances to remote natural rangelands due to several factors. For instance, a significant portion of today's breeders, particularly young people, have adopted alternative methods of animal husbandry, such as lamb fattening operations. These operations take place over short, specific periods and are characterized by a rapid capital turnover and a lower risk rate.

3. Local and global social and political changes

The Green Mountains, like much of the Near East and North Africa (NENA) region, have been significantly impacted by social and political changes over the past two decades, particularly the Arab Spring and the rise of several dictatorships. These events have led to social instability, security issues, and a weakening of national policies. In Libya, this instability resulted in the leakage of a large portion of the livestock population to neighbouring countries, as breeders feared losing their animals. It also made breeders more inclined to keep their livestock close to their homes, thereby reducing livestock movements.

Additionally, most young people today are reluctant to engage in animal husbandry as it was practiced in the past. Modern technologies and evolving lifestyles are far more appealing to the younger generations of the Green Mountains than the traditional Bedouin way of life. Furthermore, Libya experienced a prolonged period of unstable government policies. Several decades ago, specific policies were implemented to support breeders, which had a significant positive impact on animal husbandry. However, in the past five years, new policies to support livestock breeders have been introduced, but their impact is not yet clearly evident and requires more time for proper evaluation.

4. Urbanization and human practices leading to the degradation of natural rangelands

Libya's two decades of turmoil have resulted in a lack of control over the protection of natural resources, particularly in the Green Mountains, affecting both forests and rangelands. As a consequence, much of the region's natural vegetation has been severely degraded or has disappeared.

The process of land urbanization in the Green Mountains is historically rooted. It began with the Greeks, who established cities in the most fertile agricultural areas, such as Kyrene, Barka, and Apollonia, which are now known as Shahat, Al-Marj, and Sousse, respectively. The discovery of oil in the 1950s triggered a rural exodus, leading to the expansion of these cities beyond their original urban plans. This expansion resulted in the destruction of surrounding forests and pasturelands, thereby diminishing available grazing resources for livestock.

The Green Mountains are home to six major cities—Al-Abyar, Al-Bayda, Al-Marj, Al-Qubba, Derna, and Shahat—as well as approximately 54 villages and various scattered population centres. A survey conducted by the Libyan National Authority for Documentation and Information in 2006 estimated the total population of these areas at around 530,000. By 2025, the population is expected to reach approximately 769,500, which poses significant pressure on the region's natural resources.

Urbanization in the Green Mountains is a primary driver of forest degradation. The destruction of surrounding forests has severely disrupted the natural flow of rainwater. For example, the expansion of cities like Al-Bayda and Al-Haniya, driven by population growth and industrial activities, has transformed surrounding forested lands into urban areas just a few kilometres from city centres. Moreover, urbanization has made the soil relatively impermeable, preventing rainwater from infiltrating and instead causing torrents to flow along roads.

In addition to animal husbandry, historical records indicate that several urban activities have been closely tied to the natural rangelands of the Green Mountains, especially near cities, towns, and villages. The region has long been a site for gathering wild fruits, flowers, and medicinal plants, as well as for apiculture, wood collection, and soil extraction for domestic or craft purposes. This exploitation of the Green Mountains' vegetation, soil, and subsoil has been carried out by both professionals engaged in these activities and by ordinary city dwellers and tourists during weekends or holidays.

5. Overgrazing linked to destroying grazing due to contextual changes

The Green Mountains are considered the second most important region in Libya in terms of natural pastureland. As previously mentioned, overgrazing has always been a major issue in the Green Mountains because, firstly, it significantly affects the quantity and quality of pastoral resources, and secondly, it often leads to soil erosion and degradation. The problem is further exacerbated by the decline of transhumance. Flocks remaining in the same location for an extended period severely hinder the regeneration of vegetation cover. In the past, autumn-winter transhumance allowed five to six full months for natural pastures to recover. Moreover, overgrazing does not only impact grasses and herbaceous vegetation, it is also a major cause of forest degradation in the Green Mountains. Due to the lack of forage, animals—including small ruminants, dromedaries, and cattle—feed on tree limbs, small shrubs, and green branches, leading to the degradation of forest vegetation. The deterioration of the vegetation cover is however less severe in areas along the sides of major valleys than in sites near urban areas.

In addition, changes in the specific composition of the animal wealth in the Green Mountains are gradually affecting natural vegetation. With the decline of winter transhumance among several small ruminant flocks, the few cattle that have been introduced to farms now remain in the Green Mountains year-round. They graze on the rangelands—often

the best pastures—preventing them from regenerating with the autumn and winter rains, as they once did when herds migrated seasonally.

6. Agricultural expansion and lack of policy for land-use management

In the 1960s and 1970s, driven by Libya's significant oil revenues, large-scale efforts were undertaken to reclaim agricultural land in the Green Mountains. The strategy involved slashing and burning forested areas to replace them with tree and crop plantations. Consequently, vast forest areas were cleared with technical assistance from consulting agencies in developed countries. These practices led to vegetation degradation, soil erosion, and land loss. Moreover, the expansion affected not only forested areas but also pastoral lands. These projects ultimately failed to achieve their intended goals due to the tribal ownership of the land. Unfortunately, without proper land-use control, this expansion continues today. It typically starts with the fencing of plots, followed by the clearing and burning of natural vegetation, including forests, shrubs, and grasses, to make way for cultivation.

Another important factor is that, despite Libya's prolonged social and political instability, Bedouin tribes appear to have maintained control over their lands, both in the Green Mountains and in the more southern regions where flocks historically migrated in autumn and winter. This control extends even to neighbouring Egypt's NWCZ. In the Green Mountains, Bedouin tribes continue to oversee urban expansion areas, rangelands, and sites where various agricultural projects have been established or are currently being developed.

Conclusion

The information presented above clearly illustrates that transhumance in the Green Mountains has changed significantly in recent decades due to multiple factors. Firstly, where transhumance still exists, it primarily concerns the movement of animals, whereas in the past, entire Bedouin families migrated. Secondly, the pattern of seasonal migration has shifted. Previously, families lived in the Green Mountains, where their flocks grazed during spring and summer, and migrated to the more arid southern rangelands during autumn and winter, including the neighbouring Egyptian NWCZ, where a significant portion of Bedouin livestock production—particularly meat and butter—was marketed.

Additionally, evidence suggests that rangelands in the Green Mountains are deteriorating due to population growth, rapid urbanization, agricultural expansion, and improper flocks and vegetation management. Public policies over past decades have strongly influenced these changes, further compounding the effects of climate change, which is particularly pronounced in this semi-arid Mediterranean region. Above all climate change amplifies the lack of pastoral resources in an already harsh context. The devastating impact of Hurricane Daniel is a clear example of how these environmental and policy-related factors intersect.

At the same time, it is evident that Bedouin tribes, who have controlled the Green Mountains for centuries, continue to hold significant influence over the land. Daoud (2015) highlighted a similar situation in Egypt's NWCZ, where land ownership conflicts primarily occur between the military (i.e. public authorities) and the tribes. Given recent events in the Green Mountains, it is logical to assume that Bedouin tribes will maintain control over the land, as they have in surrounding regions, even as new governance structures emerge with the advancement of democracy.

In the context of globalized agriculture and trade, more intensive forms of livestock farming are expected to develop. These may include poultry production and lamb fattening operations aimed at supplying local, national, and regional markets, similar to those established in recent years. At the same time, rangeland development will continue to provide opportunities for many farms, allowing them to sustain transhumance practices while adapting to new environmental and economic conditions.

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Chapter 5

Transhumant agro-sylvo-pastoralism in Algerian Atlas: the Beni Salah Forest

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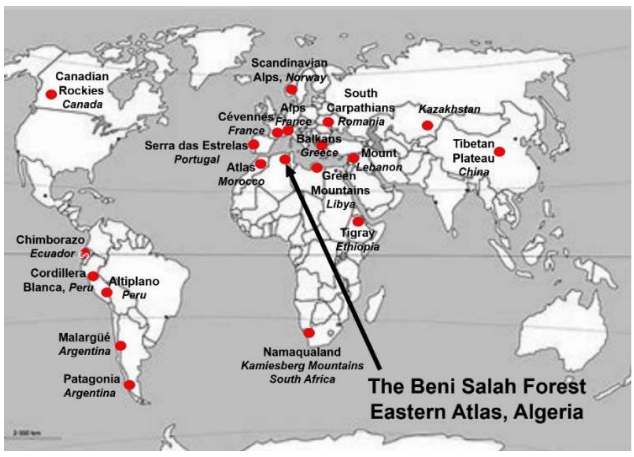
Abstract

In the forested highlands of Northern Algeria, local transhumance remains a key strategy for adapting to environmental and resource variability. This study was conducted in the mountainous region of Beni Salah (Northeastern Algeria), where winter transhumance of indigenous cattle was historically widespread. Our objectives were to characterize the long-term trends of transhumant farming systems and to identify their socioeconomic and environmental drivers. Findings revealed that transhumance of indigenous cattle was practiced by both pastoral and agro-pastoral systems to make use of available silvopastoral resources in the mountains and to compensate for the lack of pastoral resources in the lowlands during winter. However, herd movements are declining due to a complex interplay of multiple factors. Over the past forty years, the main forces shaping the evolution of the Beni Salah massif and driving changes in farming systems have included demographic shifts, urban expansion, the growth of food markets, public subsidies to farmers, wildfires, and cyclical droughts. These factors have collectively contributed to the intensification and diversification of farming systems, along with the decline of pastoralism and traditional transhumance. Although new small-scale pastoralists who raise indigenous cattle for local transhumance are helping to revive the practice, further research is needed to develop an integrated management strategy aimed at sustaining silvopastoral systems and protecting the forested ecosystem.

Keywords: Highlands; Local transhumance; Farming system; Drivers of change



Introduction

Transhumance and nomadism have long been widespread phenomena in Algeria, where pastoral resources have served as the primary source of livestock feed since the Neolithic period (Roubet, 2012). Livestock mobility has historically adapted to regions where natural resource availability is highly variable across both time and space (Niamir-Fuller, 1999; Little, 2015). In the Sahara Desert, located in Southern Algeria, adaptive strategies are mainly driven by rainfall patterns that influence forage availability and the mobility of dromedaries (Benaissa, 1989). In the central arid steppe regions, seasonal mobility of small ruminant flocks typically occurs in spring and summer, when herders move toward the northern high plains and the fringes of the Tell Atlas Mountains to graze on cereal fallows and stubble fields (Boukhobza, 1982; Bensouiah, 2005). When the climate in the cereal-producing high plains turns colder in autumn, flocks return to the steppes. During winter, some herds move further south to the milder pastures at the steppe–Sahara interface, known as *Azib* (Guillermou, 1990; Huguenin et al., 2021).

Transhumance is perceived by pastoral and agro-pastoral communities as a means to utilize and enhance pastoral resources, as a source of income, and as an effective and adaptive resilience strategy in arid and semi-arid regions (Boukhobza, 1982). However, high livestock densities have led to increased competition over natural resources, contributing to the degradation of pastoral lands in the steppe regions (Bencharif, 2011). As a result, pastoral and agro-pastoral systems, along with the transhumance model, are increasingly undergoing structural transformations (Huguenin et al., 2021), primarily driven by climate change, rangeland conversion, fragmentation and degradation, and socioeconomic pressures (Gaci et al., 2021).

According to Bencharif (2011), large-scale movements of small ruminants from the steppe to the cereal plains are gradually diminishing due to shifts in land use and livestock production systems. Nevertheless, localized livestock movement continues, particularly in the Tell Atlas forested areas, as noted by Madani (1993). Despite this ongoing practice, few studies have focused on understanding the historical evolution and current dynamics of short-distance livestock movements within agro-silvo-pastoral systems in Northern Algeria's mountainous regions.

Although forest fires represent the primary direct and indirect threat to deforestation and degradation in Algerian forests (World Bank, 2023), extensive livestock farming has had historically not only a positive economic and social impact on pastoral communities (Herrero et al., 2012) but also plays a critical role in controlling bush and forest fires by reducing fuel accumulation. This practice can have a direct beneficial effect on endemic forest ecosystems and biodiversity (Celaya et al., 2022), as well as on the conservation of indigenous livestock breeds and agro-biodiversity in Algeria's forested mountain regions (Madani, 1993). Using the Beni Salah forested massif, representative of the cork oak ecosystems in Northeastern Algeria, as a case study, we aim to describe the transformation of pastoral farming systems, identify key drivers of change, and assess their potential consequences on transhumant farming trends. Specifically, we focus on suckler cattle systems involving indigenous breeds, which play a vital role in the use and enhancement of agro-silvo-pastoral resources and serve as drivers for preserving wildlife habitats, biodiversity, and landscapes (Caballero et al., 2009; Nori and Farinella, 2020).

I. Case study

1. Data collection

We conducted field research as part of a broader study aimed at testing integrated management approaches as a key strategy for combining forest management, wildlife conservation, and pastoral resource use in the Beni Salah

massif forest. The central question was how to establish an integrated forest management system that balances cork and timber production, biodiversity conservation, and pastoral resource utilization, particularly under the growing threat of forest wildfires.

This forest is characterized by an agro-silvo-pastoral ecosystem primarily used by pastoral and agro-pastoral livestock farming systems. Field data on livestock and pastureland use were collected between 1989 and 1992. This included in-depth, semi-structured interviews with 120 farms, among which 12 were followed in greater detail over a two-year period. In 2024, additional interviews focused on transhumance practices were conducted with herders who had participated in the earlier survey.

2. Geographic and bio-climatic context

The study area is located in the Tell Atlas Mountain chain in Northeastern Algeria. The Beni Salah massif (36°31'6.59" N, 8°02'1.80" E) lies between the Mediterranean Sea and its coastal plains to the north, and the semi-arid continental high plains to the south. It spans the territories of three provinces: El Tarf, Guelma, and Souk Ahras (Map 1). This mountainous forest forms a continuous natural barrier covering approximately 35,000 hectares (BNEF, 1992), extending about 40 km in both north–south and east–west directions. It significantly influences living conditions within and around the massif.

The silvopastoral resources of the massif are utilized by herds belonging to three distinct communities: the Beni Salah tribe in the northwest, and the Ouled Bechih and Ouled Driss tribes in the southeast. Elevation in the massif peaks at 950 metres above sea level, gradually decreasing from southwest to northeast, with the most common altitudes ranging from 300 to 800 metres (Madani et al., 2001).

The average annual temperature is 18°C, fluctuating from 5°C in winter to 35°C in summer. The massif's relatively low summits are open to maritime influences, facilitating the flow of clouds into the forested areas. Rainfall averages 800 mm annually but can exceed 1500 mm on sea-facing summits, creating optimal conditions for traditional transhumance practices.

The climate is humid at the summits, transitioning to sub-humid and temperate conditions in the adjacent piedmont and high plains. Winters are typically cold and humid in the mountainous zones. Precipitation is concentrated in autumn, winter, and spring, but its amount, timing, and spatial distribution are highly variable. This climatic variability directly impacts the availability of natural resources and represents one of the key challenges for pastoral livestock farming systems (Madani, 1993).

Map 1. Location of the study area in the Eastern Atlas in Algeria

As in many Mediterranean forests (Quézel and Médail, 2003), the heterogeneity in the composition and structure of vegetation in the Beni Salah Forest plays a key role in shaping landscape diversity (Photos 1 & 2). The massif's ecosystems are highly complex, consisting of three main vegetation layers. These include a mosaic of small patches of open herbaceous communities, shrublands, and forest stands primarily composed of cork oak (*Quercus suber*), zeen oak (*Quercus faginea*), and mixed communities of both species (Photos 3 & 4).

Shrub communities are rich and diverse, comprising species such as heather (*Calluna vulgaris*), tree heath (*Erica arborea*), strawberry tree (*Arbutus unedo*), rockrose (*Cistus crispus*), calicotome (*Calicotome spinosa*), mastic tree (*Pistacia lentiscus*), and laburnum (*Laburnum anagyroides*). These are interspersed with herbaceous grassland mosaics, which are maintained as open areas by the grazing activities of both livestock and wild animals (Madani, 1993).

Lazli and Bouaicha (2022) recorded a total of 117 vascular plant species in the massif, including 87 herbaceous species and 21 shrubs. Of these, 61 species were identified as medicinal and aromatic plants. Additionally, the massif hosts a notable array of fauna, with 10 mammal and 25 bird species inventoried, reflecting significant wild biodiversity (Bouaicha and Lazli, 2022).

The massif also includes a protected natural reserve covering 2,000 hectares in its Northern section, situated at elevations between 600 and 900 metres (www.asal.dz). This reserve was established to protect the endangered Atlas deer (*Cervus elaphus barbarus*), a subspecies of the red deer and the only deer native to the African continent.

Photos 1 & 2. Settlement and landscape at the periphery of the massif (© T. Madani)

Photos 3 & 4. Forested areas dominated by zen oak and cork oak (© T. Madani)

3. Historic context

Since the Holocene, cyclical herd movements in Northern Algeria have occurred during spring and autumn, accompanied by the intergenerational transmission of environmental knowledge and pastoral practices (Roubet, 2021). Beginning in the Neolithic period, the lowlands and piedmont zones were gradually cleared and transformed into small plots of polyculture—primarily cereals and legumes—as well as open natural pastures. Orchards also partially occupied the alluvial soils adjacent to rivers. Over time, the combined effects of fire, deforestation, and the activity of domestic herbivores significantly altered the vegetation composition and structure in these areas, leading to the prevalence of low maquis and scrubland ecosystems (Quézel et al., 1980; Bendaradji et al., 2006).

Prior to French colonization, land tenure systems were diverse, encompassing private ownership (Melk), as well as collective and communal forms. During the colonial era, in an effort to legitimize land expropriation from indigenous populations, the French administration restructured these systems and imposed new land-management regulations, particularly within forested and agricultural areas. This included the introduction of a forest code specific to Algeria, which from 1851 onward reclassified forested lands as state property. These measures, coupled with ongoing fires and deforestation, led to a significant reduction in forest cover (Ford, 2008).

The Algerian War of Independence (1954–1962) brought about drastic changes in the Beni Salah massif: local settlements were destroyed, and populations were forcibly displaced. The withdrawal of livestock allowed for natural revegetation, but also led to the accumulation of underbrush and an increase in combustible biomass, making the area more vulnerable to wildfires, as observed by local farmers (Madani, 1993). In the post-independence period, only a few of the original settlers gradually returned to the mountains. At the same time, transhumance from neighbouring lowlands and piedmont zones to the forested areas of the massif resumed. This practice became an adaptive strategy to mitigate climatic risks and cope with the spatial and temporal variability of pastoral resources, particularly for emerging small-scale family farms (Madani et al., 2001).

A key driver of this mobility was the seasonal degradation of herbaceous resources in surrounding high plains below 500 metres during winter and spring, which pushed herders to seek better grazing conditions at higher altitudes. Conversely, the improvement of agro-pastoral resources in the lowlands in late spring triggered the return of herds to permanent settlements (Madani, 1993). These transhumant systems are inherently complex, involving various strategies and typically targeting one or more livestock species—cattle, sheep, and goats. Movements are closely tied to the fluctuating availability of herbaceous and woody vegetation across different elevations.

However, in recent decades, transhumance has undergone significant transformation. The practice now primarily involves the partial or complete seasonal movement of local cattle herds, whereas small ruminant transhumance has been largely abandoned due to socioeconomic changes such as sedentarisation, labour shortages, shifts in farming systems, and increased agricultural intensification. For cattle, seasonal mobility remains a complementary strategy within a broader sedentary pastoral livestock system, providing access to additional forage resources during specific times of the year (Madani, 1993).

4. Past and current changes in the farming system

Pastoral farming systems in the Beni Salah massif and its surrounding regions have historically evolved under the influence of a complex interplay between socioeconomic and biophysical factors (Madani et al., 2001). During the Algerian War of Independence (1954–1962), the French military imposed strict restrictions on access to and settlement within the massif, displacing most native inhabitants to newly established lowland settlements. Until 1962, the local population endured a harsh period marked by severe pressure, including forced cantonment in

isolated regroupment areas. This led to the systematic destruction of traditional livelihoods—primarily livestock and agriculture—and was accompanied by labour shortages, poverty, food insecurity, and low reproductive performance of livestock. Additional constraints such as grazing limitations enforced by the forest administration and prevalent livestock health issues further undermined pastoral productivity.

Following independence in 1962, settlers from the Ouled Bechih ethnic group reclaimed the forested highlands, reinitiating the practice of transhumance. Each autumn, they migrated from agro-pastoral lowland areas to the silvopastoral highlands, returning to their permanent settlements in the spring. From that point onward, three distinct and successive phases of transformation can be observed:

Phase 1: Reemergence of local farming systems (1963–1970)

This period marked the gradual revival of livestock rearing, beginning with the acquisition of small herds (typically 1–2 cows). After years of exclusion from grazing, the abundance of silvopastoral resources in the massif facilitated herd expansion and restocking efforts. Herds were mainly raised in open environments, capitalizing on the self-sufficiency of local cattle breeds, and a low-input; pastoral system emerged as the foundation of subsistence agriculture. During this phase, settlers cleared approximately 300 hectares of land, used individually as hay meadows and grazing areas. The remaining pastures, consisting of diverse and complex wooded zones, were collectively grazed. In adjacent agro-pastoral areas, farming systems rapidly integrated small ruminants to enhance the value of cereal residues and diversify agricultural outputs, resulting in households typically raising cattle, sheep, and goats.

Phase 2: Expansion and productivity-oriented strategies (1970–1983)

This phase saw an increase in the availability of pastoral resources, which supported the rise of larger cattle herds (ranging from 20 to 100 head). Small-scale, extensive integration of sheep and goats became common, even within the massif itself, leading to more diversified and productive farming strategies. Crossbreeding initiatives—particularly with French Tarine bulls—were introduced to improve local cattle morphology and dairy potential. Revenue from cattle sales was often invested in urban housing, as legal barriers prevented investment in forest lands. Meanwhile, income from small ruminants served as both daily cash flow and emergency financial buffers. The concurrent use of three ruminant species enabled efficient exploitation of rangelands where crop cultivation was limited, reinforcing the resilience and economic viability of the farming systems.

Phase 3: Resource degradation and structural transformation (since 1983)

From 1983 onward, recurrent wildfires and uncontrolled grazing by large numbers of cattle and small ruminants significantly degraded the massif's silvopastoral resources. Extensive cattle systems, heavily dependent on natural vegetation, encountered ecological limitations. The diminished quality of forage particularly challenged the adaptability of crossbred cattle, whereas local small ruminants proved more efficient in utilizing degraded pastures. These pressures initiated a broader transformation of livestock systems, necessitating new synergies among cattle, sheep, and goats to ensure diversification and stability. Over time, farms that failed to incorporate all three species increasingly collapsed.

Among the remaining farms, two distinct strategic orientations emerged:

a) Intensified agro-pastoral systems

Some farms began incorporating commercial concentrates into cattle diets to sustain intensification, while maintaining small ruminants under extensive systems. However, fluctuations in concentrate availability and price exposed these farms to significant economic vulnerability. In the massif periphery, land intensification and herd expansion contributed to the development of emerging agro-pastoral models. In contrast, forest-dwelling farms semi-intensified cattle operations by leveraging income from small ruminants to subsidize feed costs. In both

contexts, traditional transhumance was progressively abandoned in favour of integration into commercial value chains. These farms diversified activities, including bull and lamb fattening, with profitability increasingly shaped by market and climatic uncertainties.

b) Low-input, pastoral-based systems

Other households continued to rely on traditional low-capital systems, sustaining all livestock through pastoral-based practices. These farms remained highly vulnerable to climatic variability, experiencing high mortality rates and fluctuating productivity. With limited external inputs, their primary assets were labour and livestock. Compared to semi-intensive systems, their productivity and profitability remained lower. Climatic constraints limited transhumant movements, restricting the seasonal relocation of only part of the local cattle herd from lowland agricultural areas to forest pastures during winter and spring.

5. Transhumance dynamics

Since the Holocene, vertical transhumance in the Tellian mountainous regions of Algeria has involved the seasonal movement of livestock from lowland cereal-based pastures in the valleys to progressively higher elevations. This strategy, as Roubet (2021) notes, has been employed to capitalize on the spatial and temporal variability of pastoral and silvopastoral resources. The availability of these resources has been largely shaped by environmental factors, particularly the highly fluctuating rainfall patterns, both within and between seasons—a feature consistent with the broader Mediterranean climate and ecological systems.

In the Beni Salah massif, short-distance vertical transhumance has traditionally served as a core mechanism to synchronize agro-silvo-pastoral systems with grazing resource dynamics. Following Algeria's independence in 1962, emergent livestock farming systems were characterized by small herds of the indigenous Arbia cattle breed. These herds typically moved within a range of less than 50 kilometres between fixed locations to exploit seasonal pasture availability. This movement often occurred in autumn, coinciding with the depletion of agro-pastoral resources or their reallocation to livestock retained near the farmstead. Such mobility reflected a longstanding itinerant pastoral tradition.

Over time, some transhumant households permanently migrated to the massif. Systematic monitoring of livestock farming practices began in 1989 with a sample of 12 farms. Among them, only two continued practicing seasonal transhumance, illustrating the declining but persistent influence of this mobility on household livelihoods and livestock management. These herds utilized highland silvopastoral resources during winter and spring—precisely when agricultural zones faced fodder shortages and market feed prices were high. During this period, breeders increasingly prioritized their agricultural land for more productive livestock, such as crossbred and selected dairy cattle, whereas herds of native cattle were either managed extensively or sold.

Typically, transhumant cattle were left to graze freely in forested areas, requiring minimal supervision. However, the widespread wildfire of 1982 significantly disrupted this practice. In its aftermath, only a limited number of herds—mainly in the southern and southeastern areas of the massif—continued to migrate seasonally. Prior to the fire, indigenous cattle could graze extensively without supplementary feeding. Post-fire, the intricate link between vegetation dynamics and livestock management was reshaped by broader socioeconomic and environmental adaptations.

A significant shift occurred nationally with the expansion of urban markets, driving a transition towards more commercially integrated livestock systems. In the highlands of Beni Salah, extensive cattle and sheep systems began to adopt greater external inputs and household labour, notably through increased reliance on purchased concentrate feed. This transition anchored these systems to fixed locations, thereby reducing the feasibility of transhumance.

Simultaneously, agro-pastoral systems on the lowland fringes intensified and diversified. These systems increasingly integrated exotic cattle breeds and cash crops, fostering closer ties between livestock and sedentary agriculture. To enhance productivity and link farms to meat markets, the traditional Arbia breed was progressively replaced by crossbreeds from temperate regions, primarily the French Tarentaise and Montbéliarde. This transformation was facilitated by state subsidies for imported feed and investments in semi-intensive systems.

Despite these changes, goat herds have largely remained within an extensive-pastoral framework, subsisting solely on silvopastoral resources. Yet, as more household labour has been redirected toward cattle and crop production, and given the limited profitability of goats, seasonal mobility has steadily declined among fringe farms.

Today, the survival of seasonal transhumance depends on small-scale pasture-based herds owned by farmers from the southern and eastern regions of the massif. These areas suffer from limited agricultural and pastoral resources, prompting herders to relocate in late autumn to the Beni Salah Forest. There, resilient indigenous cattle graze unguarded with minimal labour inputs and experience low predator-related losses, thus preserving a legacy of transhumance in a transformed landscape.

II. Drivers of the systems and impacts

1. Environmental and ecological drivers

Most herders in the Beni Salah massif, informed by long-term observation of local climate trends, recognize that cyclic wildfires and droughts—driven by highly irregular seasonal and annual rainfall—have significantly impacted pasture resources in the forested highlands, thus influencing the viability of transhumance practices. The pattern of recurrent, large-scale wildfires in the massif mirrors trends observed in other Algerian forest ecosystems (World Bank, 2023). These fires have severely diminished both the quality and availability of silvopastoral resources, which are crucial to the pastoral systems operating in this region.

While the origins of wildfires in Algeria are acknowledged to be multifaceted and complex (Medour-Sahar and Bouisset, 2013), reflecting broader Mediterranean dynamics (Alexandrian et al., 1999; Arnould and Galugaru, 2008), local herders have identified a recurring cycle of intense fires approximately every 10 to 15 years. This cycle is attributed to factors such as rising summer temperatures, the accumulation of combustible shrubs, and changes in vegetation structure, all of which heighten the landscape's flammability. The resulting ecological degradation has threatened not only the environmental balance but also the socioeconomic sustainability of local communities.

In response to these challenges, farmers have adapted to the irregular availability of pastoral resources and broader shifts within the regional agroecological context. The formerly dominant cattle pastoral system—which leveraged transhumance to exploit highland silvopastoral resources and relied on increasing herd sizes—has come under pressure due to declining productivity and profitability. As a consequence of wildfire-induced pasture degradation, this technical model has collapsed, and its long-term resilience has been called into question.

One key adaptation strategy among farmers has been the integration of small ruminants into livestock systems, where labour availability permitted. This diversification has allowed for more efficient use of transformed rangeland resources and has fostered productive complementarities between livestock species. In doing so, herders have enhanced the resilience of their systems against environmental uncertainty and maintained a level of productivity despite adverse conditions.

These environmental pressures have also prompted a gradual shift away from transhumance toward more settled livestock practices. This evolution has influenced feeding regimes and broader farm management strategies. Farmers have increasingly adopted modern practices and technologies to boost livestock productivity—such as the use of concentrate feeds, improved breeds, and veterinary care—while also integrating cash crops in agricultural zones. The result has been a deepened synergy between cattle and small ruminants and a broader diversification of farm outputs.

However, the intensification of farming systems has introduced new dynamics, particularly heightened competition for land, labour, and financial resources. These trade-offs between intensive and extensive components of farming systems have redefined internal resource allocation and influenced long-term sustainability strategies. The intensified model, though more profitable, has further contributed to the decline of traditional cattle transhumance in the massif.

Nevertheless, this practice has not disappeared entirely. Approximately one in two herders continues to mobilize indigenous cattle to highland silvopastoral areas within the Beni Salah Forest, motivated in part by the absence of grazing fees. Furthermore, these same pastures are now frequented by new small-scale herders from the Southeastern regions, who are bringing their local cattle to the massif. This ongoing use of pastureland by transhumant and semi-transhumant systems underscores the resilience and adaptability of traditional livestock management practices in the face of evolving environmental and socioeconomic pressures.

2. Political and socioeconomic drivers

Among the multiple interconnected factors influencing the evolution of transhumance practices in the Beni Salah massif, demographic changes, urban expansion, food market development, and public policy interventions have played decisive roles in shaping its decline. At the national scale, Algeria has experienced a significant urbanization trajectory, with urban growth increasing from 2.5% prior to 1962 during the colonial period to 10.2% in the early years following independence (Saidi et al., 2023). Specifically, in the Beni Salah region, the Algerian War of Independence triggered a large-scale exodus from mountainous areas to emerging urban centres, driven by the disruption of rural livelihoods, widespread poverty, and the erosion of subsistence agriculture.

In the aftermath of independence, the abandonment of agricultural land led to spontaneous forest regeneration and, subsequently, an expansion in available pastoral biomass. This ecological change enabled herd formation and growth, temporarily revitalizing transhumance practices. However, the reemergence of cyclical wildfires soon posed new threats to silvopastoral resources, contributing to the gradual disruption of seasonal herd movements. At the same time, demographic expansion led to increased labour availability, supporting a trend of household-level diversification and intensification of agricultural activities. As traditional grazing strategies were integrated with more intensive farming practices, transhumance became less prevalent.

Concurrently, the structure of rural households evolved. The transformation from nuclear to extended and multi-parent households marked a shift towards more complex agri-family systems. This transformation often resulted in a decline of transhumance, as household labour and capital were reallocated toward more profitable and urban-oriented activities. The partitioning of landholdings and livestock assets, along with intra-family conflicts, further contributed to the abandonment of collective pastoral traditions.

Additionally, income from livestock production has increasingly been reinvested in housing and consumer infrastructure in urban areas. These trends have been influenced by regulatory constraints that limit agricultural development and settlement within forest zones, adding to the challenges of maintaining traditional pastoral

practices. Moreover, increased competition over winter pastures, difficult living conditions for shepherds, and security concerns—such as cattle theft—have further undermined the viability and profitability of transhumance.

Since independence, the Algerian government has implemented several agricultural policy measures to ensure food security and support the country's growing urban population. These policies have included subsidies on imported animal feed, price guarantees, and direct payments on staple food products such as cereals and milk. While these interventions initially supported livestock intensification, the sharp drop in oil and gas prices in 1986—Algeria's main source of revenue—prompted austerity measures and cuts to agricultural subsidies. This significantly weakened the resilience of intensive livestock systems, especially those dependent on purchased inputs.

The violent conflict of the 1990s further discouraged the use of forested areas and silvopastoral resources, effectively halting many transhumant practices in the region. Despite these challenges, low-intensity pastoralism remains a cornerstone of resilience and sustainability for extensive farming systems, particularly among small-scale or economically vulnerable households. For these rural communities, transhumance continues to offer a viable livelihood strategy when access to pasture is affordable and labour requirements remain low. Such systems depend largely on the use of hardy, native cattle breeds and free-range grazing in highland silvopastoral landscapes—highlighting the ongoing relevance of this traditional practice under conditions of economic and environmental constraint.

Conclusion

Transhumance in the forested Beni Salah massif has historically been a deeply rooted pastoral tradition. Predominantly involving cattle herds, this practice contributes positively to biodiversity conservation, ecosystem service provision, and the sustainability of silvopastoral livelihoods. The movement is characterized by short-distance vertical transhumance, whereby herds migrate from lowland agro-pastoral zones to highland forested areas to utilize silvopastoral resources during winter and spring seasons. This tradition has been sustained through the use of small, resilient indigenous cattle breeds—typically weighing between 150 and 350 kg live weight—adapted to the challenging conditions of dense shrubland and cork oak forests. Raised under an extensive, free-range grazing system, these native breeds are well-suited to the ecological constraints of the region and require minimal external inputs.

Our research has shown that environmental stressors—particularly recurrent large-scale wildfires and prolonged drought episodes—interact with socioeconomic pressures and evolving public policies to influence significantly the structure and evolution of local livestock farming systems. These dynamics have led to increasing complexity in both household strategies and farming systems. Intensification and market integration have gradually supplanted traditional mobility patterns, contributing to the progressive decline of transhumance.

Despite these shifts, seasonal cattle transhumance to the Beni Salah highlands during winter and spring remains active. Its continuation reflects the emergence of a new cohort of transhumant herders, differing in profile, origin, and herd size from previous generations. While further research is required to understand fully these evolving practices and their socioeconomic contexts, the role of transhumance in forest management is increasingly recognized.

As a low-cost and ecologically sound method, transhumance offers potential benefits for reducing wildfire risk, conserving biodiversity, and enhancing the resilience of pastoral resources. Its revival by a new generation of smallholder farmers presents an opportunity to develop an integrative strategy—one that links cork oak production, landscape conservation through managed grazing, and improved livelihoods for subsistence-based rural

communities. Ensuring the viability of transhumance is thus a shared challenge and opportunity for all stakeholders involved in the sustainable development of the Beni Salah massif.

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Chapter 6

Transhumance in the Central High Atlas of Morocco: from ancestral traditions to the current adaptations induced by global change

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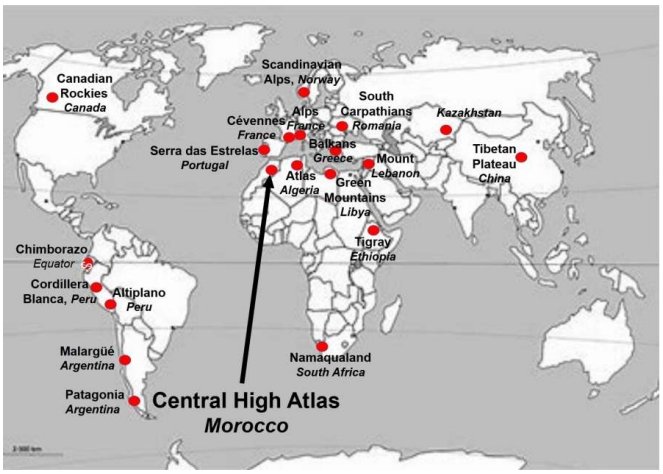
Abstract

The chapter explores transhumance in Morocco's Central High Atlas, particularly in the Aït Bouguemez Valley. This ancestral practice, vital for its ecosystem services and the economic security of herders, is based on the seasonal use of diverse pastoral resources, ranging from forested areas to high-altitude pastures. Primarily involving small ruminants (sheep and goats), and to a lesser extent camels, it enables the full utilization of pastoral resources across various ecological zones within harsh territories characterized by structural water scarcity. Faced with the impacts of climate change, increasing land pressure, and socio-economic transformations, herders are adapting their practices through mobility strategies and collective resource management. However, the erosion of natural resources and growing land-use conflicts—exacerbated by recent agricultural intensification initiatives aimed at expanding irrigated orchards—have undermined the viability of transhumance. The chapter underscores the importance of preserving this practice in the face of contemporary challenges, while integrating modern innovations such as improved pastoral infrastructure and financial support mechanisms. It concludes that the future of transhumance in the High Atlas hinges on blending traditional knowledge with sustainable development approaches to strengthen the resilience of pastoral systems in a rapidly changing environment.

Keywords: Climate change; Ecosystem services; Morocco; Transhumance; Work



Introduction

The mountainous regions of Morocco are characterized by a rich and diverse pastoral and silvopastoral flora. Due to conditions unfavourable to crop intensification, grazing has traditionally played a central role in these ecosystems. Despite the presence of small cultivated plots in valley areas and extensive sheep and goat farming at higher elevations, pastoral practices remain essential to maintaining the balance of production systems, notably through the transfer of nutrients (Auclair, 2005). Mobile small ruminant systems are of paramount importance in these marginal regions, generating income and supporting territorial control by local tribes (Sraïri, 2015). The High Atlas, a key pastoral zone that hosts over half of Morocco's small ruminant population (53%), is currently undergoing profound transformations (El Aayadi et al., 2021). These changes—affecting social organization, the economy, and ecosystems—are reflected in shifts in production systems, land use patterns, and the exploitation of natural resources.

Transhumance, an ancient practice, continues to play a critical role in maintaining ecological balance in these mountainous areas. It allows for the optimal use of high-altitude resources, where the primary constraint is the intense anthropogenic pressure on all resources, particularly agricultural land (Bourbouze, 2000). Over the years, numerous studies have examined these transformations and their effects on production systems in the High Atlas (Bourbouze, 1999; Mahdi and Domínguez, 2009; El Aayadi et al., 2020). These studies have documented evolving trends, characterized livestock systems, and analysed herders' adaptive capacities, providing a vital foundation for understanding resilience in the face of current challenges such as global inflation, climate change, and local aspirations for improved livelihoods.

Given the pace and scale of these changes, reassessing the prospects for pastoral practices—especially transhumance—is essential. In this context, the present study focuses on the Aït Bouguemez Valley in the Central High Atlas, a region steeped in the age-old traditions of herding and livestock mobility. The main objective is to understand the transformations that have occurred in transhumance practices and grazing land management over recent decades, considering the combined effects of environmental, socio-economic, and political dynamics. At the same time, the study examines the adaptation strategies employed by herders to ensure the sustainability of their production systems. From this analysis, the aim is to propose perspectives for the future of pastoral small ruminant systems in the High Atlas, which are directly affected by global change factors such as climate warming, societal transformation, and prices' volatility.

I. Study area

1. Aït Bouguemez social–agro-ecological system

The Aït Bouguemez Valley lies at the Eastern edge of Azilal Province, bordering Ouarzazate Province. Located within the Mgoun massif at elevations ranging from 1,800 to 2,400 metres, the valley is distinct from other High Atlas valleys due to its expansive flat floor, which spans approximately 1,500 hectares and extends over 25 kilometres in length (Figure 1). It is surrounded by peaks exceeding 2,900 metres, including Ighil N'Aït Ourat (2,915 m) to the north, Jbel Tizal (3,100 m) to the west, the Azourki Massif (3,667 m) to the east, and the ridges of Waougoulzar (3,763 m) and Igoudamen (3,500 m) to the south (El Amiri et al., 2007). The valley is home to around 15,000 inhabitants, predominantly Amazighs (Berbers), living across roughly thirty villages.

Enclosed by towering mountain ranges, the valley experiences a semi-arid to sub-humid climate, marked by harsh winters (2 to 6°C from December to February) and hot summers (up to 40°C in July and August). Annual precipitation averages around 600 mm, though it is highly variable from year to year. Snow represents a substantial portion of this total—between 20% and 30%. This climate variability includes recurrent droughts, approximately every ten years, which can persist over multiple years. The mountainous terrain and climatic constraints pose significant challenges to both the population and their resource base, prompting the development of adaptive and innovative strategies (DPA-Azilal, 2019).

Households in the valley have developed complementary agro-pastoral livelihoods through strategic use of territorial resources. These activities are organized across three bioclimatic zones: (1) the cultivated valley floor (between 1,800 and 2,200 m), managed at the family level; (2) forested massifs above the villages (2,200–2,700 m), collectively managed by village communities; and (3) high-altitude pastures (above 2,700 m), managed at the intervillage level. The valley's vertical stratification strongly influences access to and management of resources, which are overseen by customary institutions operating at both village and intervillage scales (Romagny et al., 2008).

It is also important to note that the intensive introduction of certain crops—particularly apple orchards, first introduced in 1995—into these high-altitude systems has contributed to a decline in the appeal of livestock farming, which is more labour-intensive and often perceived as less profitable (Sraïri and Amartini, 2024). Nonetheless, small ruminant husbandry—especially transhumant flocks—remains central to the valley's economy. According to official figures, transhumant households manage approximately 17,000 goats and 16,000 sheep (DPA-Azilal, 2019).

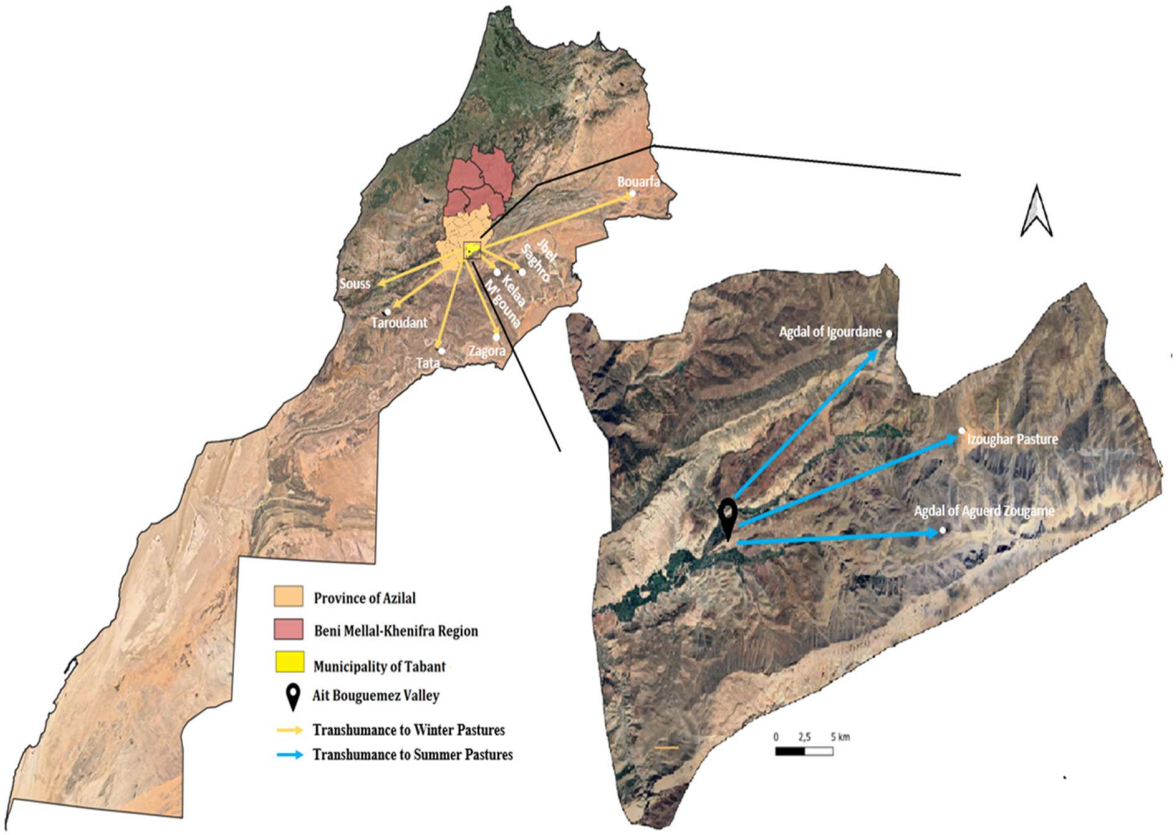


Figure 1. Study area in Morocco including winter and summer pastures

2. Pastoral and silvopastoral resources exploited by the Aït Bouguemez transhumants

Forage resources in sub-village silvopastoral spaces

Forest areas constitute a crucial source of forage, particularly during winter snow episodes (from November to April), when they can provide up to 50–60% of the animals' net energy intake. The availability of foliar forage from forest *Agdals*—a local term for seasonal grazing exclosures—is considered a key reason for their conservation, especially as these resources are increasingly under threat. Their proximity to villages offers residents a standing reserve that can be readily accessed when needed. In the Aït Bouguemez Valley, foliage from three tree species—*Juniperus oxycedrus*, *Juniperus thurifera*, and *Quercus rotundifolia*—is commonly harvested by women using axes. Typically, each tree is cut once every two years, with the number of branches removed depending on the tree's size and condition (Genin, 2006).

Forage resources in high-altitude pastures

High-altitude pastures, which extend over vast areas above the forest zone, are vital to the transhumant pastoral system. Although these pastures generally offer relatively low forage quality (ranging from 80 to 200 forage units [FU] per hectare), they remain integral to livestock farming. The botanical diversity of these rangelands enables animals to graze selectively palatable species, partially offsetting their low nutritive value. These areas—especially those designated as pastoral *Agdals*—are managed at various levels (village, intervillage, or intertribal), and provide herders with a reliable source of forage, supporting the year-round health and productivity of their herds. Climatic variability affects the availability of these resources, prompting herders to make strategic grazing decisions to prevent overexploitation by external flocks. Among these highland areas, Alpine meadows stand out for their higher nutritional potential, estimated between 600 and 1,000 FU per hectare (Genin, 2006), and are of particular importance in pastoral terms.

Pastoral resources in transhumance areas far from villages

Winter transhumance zones are highly diverse, although certain destinations are particularly favoured, such as the southeastern High Atlas (e.g. Kelaa M'gouna, Taroudant), Jbel Saghro, and, further east, the desert rangelands near Zagora. Other destinations may occasionally be chosen, including Northeastern areas such as Guercif and Bouarfa. The selection of a destination varies from year to year and is carefully made by the flock manager, who personally travels to the site in advance to assess pasture conditions.

II. Transhumance practices among Aït Bouguemez herders

Transhumance involves up to 60% of the flocks in the Aït Bouguemez Valley, depending on the year's climatic conditions, and generally occurs between October and March, when local conditions—particularly snow and cold temperatures—are too harsh for livestock to remain in the valley. Flock mobility is a cornerstone of the production system. As in most mountainous regions around the world, pastures serve as the primary feed resource for these animals. The use of these rangelands is enabled through various forms of flock and herder mobility (Figure 1). Flock movement depends on several factors, including the availability of pastoral resources, flock size, animal breeds, and the knowledge and expertise of herders. The two following types of transhumant farming systems have been identified (El Aayadi et al., 2021; Genin, 2006; Bourbouze, 1999): a) Livestock system with optional transhumance, and b) Small ruminants' systems with systematic transhumance.

a) Livestock system with optional transhumance

In this system, multi-species flocks of over 60 animals typically include Timahdite and Tirhaline sheep (the latter meaning 'transhumant' in Berber language), along with Noire de l'Atlas goats. Collective pastures serve as the primary forage resource. Decisions to undertake winter transhumance—toward the Southern High Atlas, the Saghro region, or Kelaa M'gouna—depend on the condition of the destination pastures. Herders gather information in advance and may visit the sites personally to assess pasture quality. If conditions are judged to be poor, the flock remains in place. In favourable years, some herders choose to stay near the Aït Bouguemez Valley, benefiting from extensive pastures with high-quality flora. According to these herders, livestock remain healthy and gain weight rapidly. Consequently, they opt for nearby grazing and short-range movements (under 50 km), avoiding costly migration to Jbel Saghro (located in the East).

In a 'transhumant' year, flocks begin their southward journey on foot in October as soon as the cold sets in. The migration typically lasts 7 to 10 days. Along the route, animals are sheltered at night in barns owned by acquaintances in villages they pass through. In return for use of the facilities, herders leave manure, which is later transported to cultivated downstream plots at the farmer's expense. Animals drink from natural water sources along the way. Once in the Southern collective pastures, flocks are housed at night in adapted caves known as *Azibs* (stone corrals) located near grazing areas. Water is provided via communal troughs, many of which were constructed by state technical services and supplied by springs.

Between April and May, the flocks return to the Aït Bouguemez Valley and are immediately directed to the summer pastures, where *Azibs* are already in place. From May to early July, they graze on village pastures. If accessible, they then move to the high-altitude *Agdal* of Igourdane/Tamda. Igourdane is an intertribal *Agdal* shared by the Aït M'Hamed, Aït Ali (a sub-group of the Aït Bouguemez), and parts of the Aït Atta tribes. Usage rules, grazing exclusion periods, and rights of access were formalized in the 1941 High Atlas Transhumance Charter, issued during the French Protectorate. Today, the Igourdane *Agdal* is closed annually from April 1st to May 17th. Each of the three tribes appoints a guardian to enforce access restrictions, with the Aït Atta delegating this task to the Aït M'Hamed.

In August, the flocks return to the Izoughar zone or nearby village pastures, where they remain until October. Izoughar is a vast, collectively used rangeland—covering approximately 10,000 hectares and ranging from 2,400 to 3,700 metres in altitude—without specific usage regulations. It is shared by multiple tribes, including the Aït Bouguemez, Aït Atta (Oussikis), and Imgoune. A colonial-era agreement included in the Transhumance Charter limits the number of livestock units permitted by the Imgoune to 3,500 small ruminants on this pasture.

In a 'non-transhumant' year, the flocks follow the same routes to high-altitude pastures between April and October. However, during winter, their management depends on climatic conditions:

- If heavy snow prevents any movement, animals are kept in village barns throughout the day and fed with stored or purchased feed (such as cereal straw, alfalfa hay, unsold apples), along with leaves and acorns from green oak forests.
- If only the highest pastures are snowbound, flocks are redirected to forested pastures closer to the villages.

Pasture use is intensive, with grazing durations ranging from 4 to 12 hours per day, depending on the season. In a 'transhumant' year, over 89% of the flock's net energy requirements are satisfied through pastoral resources. During dry years, these resources are exploited to their maximum. Whenever winter conditions permit, animals graze on nearby forest or high-altitude pastures, minimizing the need for distributed feed and optimizing the use of 'free' feed resources.

Transhumant herders evaluate pasture quality not only based on forage quantity but also on water availability and soil characteristics. They particularly seek out areas known as *Amskou*, which, despite modest vegetation, support fattening and improved animal performance. *Amskou* is considered the key indicator of high-quality grazing land, linked to favourable soil and climate conditions that enable livestock to rest and achieve optimal productivity in terms of fertility and fattening.

b) Small ruminants' systems with systematic transhumance

In these extensive livestock systems, flocks composed of over 200 Tirhaline sheep and Noire de l'Atlas goats primarily rely on pastoral resources to meet their nutritional requirements. In addition to local grazing areas, supplementary zones with varied ecological conditions are accessed through traditional, long-distance movements (>100 km). Transhumance is systematic and occurs annually, with animals transported by truck for both winter and summer migrations beginning in October. Along the route, flocks are hosted overnight on collective pastures, often in barns owned by acquaintances of the herders. The manure left behind benefits the barn owners as a form of compensation.

In March or April, the flock is transported back to the Aït Bouguemez Valley—either directly to village pastures or to the Izoughar zone, depending on snow conditions—until the opening of the *Agdals*, such as Igourdane or Aguerd Zougarne. Aguerd Zougarne is an *Agdal* covering approximately 3,300 hectares, used exclusively by herders from the Aït Hakim subgroup of the Aït Bouguemez tribe, which comprises ten villages. These herders hold recognized rights of access and exclusion, and the area is protected annually from April 20th to July 4th. In August, herds return to the Izoughar zone or village pastures depending on forage availability, where they remain until the next transhumance departure. Pasture use is intense, with 'free' forage resources providing up to 95% of the flock's net energy intake in an average year, thereby significantly reducing the need for purchased or stored feed.

In this system, forest *Agdals* are not utilized, as herders are absent from the valley between September and April. Unlike the previous system, winter transhumance is essential to the functioning of this livestock system and is practiced annually to escape the valley's cold, snow, and forage scarcity. Supplementary feeding is not systematic and is generally reserved for animals with specific physiological needs, such as pregnant or lactating females.

Since the 1990s, the range of movement for these obligatory transhumant herders has expanded in response to climate change—particularly drought conditions affecting traditional Southern transhumance zones such as Kelaa M'gouna and Ouarzazate. As a result, herders now often travel longer distances, by truck, in search of suitable grazing areas, including destinations in the Southwest (Souss, Tata), the North (Berkane), and the East (Bouarfa), covering distances of up to 700 km.

3. Management rules of the *Agdals* by transhumant herders

Tribal communities implement a randomized allocation system to distribute *Azibs* and water sources within the *Agdals* among their members on an annual basis. On the eve of the *Agdal* opening, the *Jmaa*—the traditional assembly composed of tribal elites representing all community members—convenes at a central location in the high mountain pastures to carry out the allocation. The process involves drawing lots to determine the sequential entry of families into the *Agdal* with their flocks, each moving along a designated route toward their assigned *Azib*.

The use of *Agdal* resources is governed by a comprehensive set of regulations, many of which date back centuries. Even prior to the colonial era, specific tribal customs established the order in which families could access local grazing lands and water points (Bourbouze, 1982). Each *Azib* is linked to a specific water source, and only the individuals assigned to that *Azib* are permitted to use the corresponding source. Water use is further regulated: upstream water is reserved for drinking and cooking, whereas downstream sections are designated for washing.

Additional spatial rules are in place: specific areas are designated for firewood collection, and gathering outside one's assigned zone is strictly prohibited. Defined routes are prescribed for the movement of flocks during both entry and exit from the *Agdal*, and families are required to adhere to their allocated paths. Obstructing another herder's movement is forbidden, and any breach of these regulations is subject to fines (Fernández-Giménez et al., 2021).

4. Justification for transhumance

For many pastoralists, transhumance is not only a livelihood but the only way of life they have ever known, with limited experience or training to pursue alternative occupations. A second major factor sustaining this practice is its relative profitability. Transhumant herders graze their flocks year-round on natural, 'free' resources, relying minimally on supplemental feed. Despite lower productivity levels than sedentary systems, the reduced costs associated with feed purchases often make transhumance more economically viable (Fernández-Giménez et al., 2021). Moreover, this system allows for the management of larger flock sizes.

Transhumant herders also acknowledge the ecological advantages of mobility. They argue that periodic movement helps pastures regenerate by providing rest periods, thereby preventing soil degradation caused by continuous grazing in a single location. According to a study conducted in the Central High Atlas (Fernández-Giménez et al., 2021), herders expressed a strong preference for the transhumant lifestyle, highlighting a sense of freedom and relief from daily pressures (Photo 1). Some transhumant women described this way of life as deeply fulfilling, noting the harmony they experience with animals and the satisfaction derived from completing their daily tasks.

However, it is important to recognize that not all herders wish to maintain this lifestyle. Some express a desire to reduce flock mobility and gradually transition away from transhumance due to the physical hardship involved, low financial returns, and increasingly frequent droughts linked to climate change. In recent years, this shift in attitude has even led to the suspension of *Agdal* openings, as fewer herders are willing to adhere to the strict collective management rules that govern access to high-altitude rangelands. These include rigid entry and exit dates, restrictions on using certain wells even when unoccupied, and other complex customary regulations.

Photo 1. A shepherd sunbathing after a snowy episode (© Mohamed Taher Sraïri, 2023)

III. Adaptation strategies in small ruminant farming systems: a major role of transhumance in the resilience of high-altitude systems

1. Resilience induced by the mobility of flocks

For transhumant herders, mobility is not merely a strategy for coping with uncertainty, but a fundamental means of adaptation enabling them to capitalize on the full range of spatiotemporal variability in forage availability. It is practiced even during climatically favourable years. Mobility functions as a mechanism for capital accumulation and savings, reducing the system's vulnerability to environmental fluctuations by improving animal health and minimizing reliance on purchased feed. As such, it constitutes a key strategy for building financial capital (Sall et al., 2011) and strengthening herders' decision-making autonomy and access to resources, thereby enhancing the overall resilience of the agricultural system.

For these pastoralists, the herd is considered a sacred asset—regardless of its productivity—that must be preserved through movement, as it is central to their livelihoods. In this context, increased mobility, particularly through motorized transport toward the Southwestern and Eastern regions from October to May, has emerged among wealthier herders. This enhanced mobility enables better adaptation to severe droughts, the exploitation of spatial and temporal diversity in rangeland conditions, and the creation of alternative transhumance routes that help avoid overgrazed areas used by the majority of herders.

2. Resilience induced by the 'collective'

Herders belonging to the same ethnic group often activate the 'collective' lever to implement strategies aimed at securing their production systems (Alary et al., 2022). In the Aït Bouguemez Valley, the use of certain high-altitude pastures remains governed by traditional *Agdal* practices imposed by the local communities. These practices facilitate pasture regeneration and extend the grazing season. As mentioned before the *Agdal* system is essential to rangeland management. Except through formal associations, it generally excludes outsiders. Each *Agdal* is overseen by a guardian, selected for his trustworthiness and compensated by the community. Violations of *Agdal* rules are sanctioned with fines, either monetary or in kind (Bourbouze, 1999).

Other forms of collective organization also characterize high-altitude livestock systems and reflect herders' capacity to mobilize external resources through sustainable alliances. During transhumance, social ties are established with other tribes, allowing access to their rangelands when local resources are insufficient due to drought. In these contexts, herders often pool their flocks and entrust them to a shared shepherd—either local or from another region—forming collective herds of up to 300 to 400 animals (Photo 2). This strategy not only fosters cooperation but also helps reduce the logistical and financial burdens associated with transporting and caring for animals at distant transhumance sites.

Photo 2. A collective flock departing to high altitude grazing areas (Aït Atta tribe, Tinghir province, Mesmrir village) (© Mohamed Taher Sraïri, 2023)

IV. Evolution of transhumance in the Central High Atlas: key factors and current issues

Transhumance, a deeply rooted livestock practice in the history of the Moroccan Atlas, has undergone a dynamic evolution shaped by internal pressures within the pastoral system—such as climatic and ecological changes—as well as broader socio-economic and political transformations.

1. Vulnerability to climate hazards

Prior to the 1970s and 1980s, according to elderly herders, pastoral resources were abundant, and livestock farming was primarily based on the collective use of grazing lands, supported by the traditional mobility of hardy local breeds. However, recurrent droughts—particularly from 1980 to 1995, and again from 2020 to 2024—combined with increased stocking rates encouraged by agricultural policies, have led to a marked decline in both the abundance and quality of pastoral resources. This has resulted in a noticeable reduction in palatable species.

Transhumant herders have observed significant changes in the condition of natural pastures, including a decrease in phytomass and in wooded areas near the valley, whereas high mountain zones have been increasingly affected by erosion. The degradation and reduced availability of these rangeland resources have emerged as a key driver in the transformation of transhumant livestock systems.

In response, herders have diversified their production strategies. These include the introduction of high-value cash crops—particularly apple orchards—the adoption of more productive sheep breeds, and the partial sedentarization of flocks. As a result, herd mobility has diminished, and the proportion of dietary energy derived from natural pastures has declined. These developments have compelled herders to adapt their feeding strategies, increasing their reliance on supplementary feed (Photo 3) and modifying movement patterns, thereby reshaping the foundational characteristics of transhumant livestock systems (El Aayadi et al., 2021).

Photo 3. Feed supplementation for Timahdite lambs reared in a transhumant system (© Mohamed Taher Sraïri, 2023)

2. Conflict of interests between agricultural development projects and transhumant herders

The coexistence of alluvial terrace agriculture in valley bottoms and extensive livestock farming at higher altitudes has historically supported the development of a circular bio-economic farming system in the Central High Atlas (Sraïri and Talebi, 2025; Auclair, 2005). However, recent development initiatives promoting the expansion of agriculture into pastoral areas—alongside the growing trend toward the privatization of agricultural plots—pose significant

challenges to the mobility of transhumant herders and to the nutrient recycling process (i.e. the return of manure from high-altitude barns to downstream cultivated fields).

This shift undermines an adaptive practice closely linked to livestock wealth, disrupting nutrient flows and encouraging the conversion of communal lands—often poorly suited for cultivation—into orchard plantations (Sraïri, 2015; Hamzaoui et al., 2024). Moreover, the weakness and limited effectiveness of current conservation policies further exacerbate the issue. For instance, Law 113-13, enacted in 2016 to regulate pastoral transhumance and manage pastoral spaces, has sparked contention among transhumant herders (Boubrik, 2022). The declining number of herders committed to transhumance raises concerns about the long-term viability of territorial maintenance, as practices diverge from collective, mobility-based land stewardship.

3. Challenges of knowledge transfer and the shepherding profession

The aging of the transhumant workforce, alongside a growing trend toward sedentarization, can largely be attributed to a breakdown in the intergenerational transmission of knowledge. This phenomenon is particularly pronounced in remote areas with limited resources, where the low profitability of transhumant livestock farming, its vulnerability to climate change, the persistence of patriarchal social structures, and the negative societal perception of shepherding in Moroccan society diminish the appeal of this livelihood.

At the same time, increased access to employment opportunities, migration to urban centres, and expanded educational pathways for younger generations have contributed to a labour shortage in pastoral communities. These factors also reflect a broader shift in values and aspirations, with many youths seeking less physically demanding and more socially recognized forms of work (Ait Hamza, 2012).

4. Isolation and physical constraints

The challenges of isolation and lack of access to essential services—agricultural, medical, commercial, educational, veterinary, and others—are frequently cited by transhumant herders, particularly in the remote summer pastures of the High Atlas. These conditions make the profession especially arduous. The inaccessibility of high altitude rangelands and the spatial dispersion of flocks across steep mountain slopes severely hinder the dissemination of technological innovations by agricultural extension and veterinary services. This results in increased input costs and higher animal mortality rates.

For many transhumant herders, isolation exacerbates both the physical fatigue and the inherent risks associated with long-distance travel on foot. They also report growing difficulties in accessing water and pasture along their transhumance routes—especially in areas affected by agricultural expansion and urbanization, which have, in some cases, obstructed traditional mobility corridors. Rising tensions with local residents in the traversed regions are also becoming more common.

While most herders recognize the infrastructure efforts made by public authorities over the past two decades—such as the development of rural roads and expanded electrification—they also express concern that the rugged, confined nature of high-altitude terrain severely limits their capacity to diversify income sources or improve their living conditions.

V. Future of the ‘transhumant profession’

The study conducted by El Aayadi et al. (2021) in the Central High Atlas reveals a predominant concern among Aït Bouguemez herders regarding the sustainability of transhumance. The perceived threat of its imminent

disappearance emerged as a central issue raised by all interviewees. According to their testimonies, transhumance appears to be facing an uncertain future, with many anticipating its complete extinction within the next 10 to 20 years. Some foresee a sharp decline in the number of active transhumant herders over the next 5 to 7 years, potentially marking the beginning of this traditional practice's irreversible decline.

One key factor driving this outlook is the declining profitability of transhumance, as rising transportation and feed supplementation costs increasingly undermine its economic viability. In light of these challenges, interviewees suggested several targeted measures to support the continuation of transhumant livelihoods:

- Financial support for animal feed and health
  - Subsidies for animal feed and veterinary medications were deemed essential to mitigate rising input costs, particularly in the face of more frequent extreme weather events (e.g. droughts and severe snowfall).
  - Climatic stressors have heightened the need for dietary supplementation, especially as herders shift from the low-input Tirahaline breed to the heavier Timahdite sheep, which require more feed.
- Development of pastoral infrastructure
  - Solar-powered wells in grazing areas were proposed to address increasing water scarcity caused by prolonged droughts.
  - Shelters for herders and flocks, especially during winter snow events, would improve safety and animal welfare.
  - Improved transportation routes would facilitate vehicular transhumance, reducing reliance on long-distance travel by foot.
- - Social services and livelihood sustainability
  - Access to healthcare was seen as crucial to improving living conditions for transhumant families, who are often isolated in remote high-altitude areas.
  - Educational access—particularly through the expansion of mobile schools—was highlighted as key to retaining youth in pastoralism and preventing forced sedentarization or urban migration driven by educational needs.
- - Environmental restoration and rangeland productivity
  - Reforestation of degraded rangelands was proposed as a means to improve forage availability. Examples cited include the heavily degraded grazing areas of Timitte and Almou N'edikel near Zaouiat Ahansal.
  - Restoration efforts aim to reverse declines in phytomass and palatable species due to overgrazing and erosion.
- - Tailored technical training
  - Specialized training in herd management was requested to address emerging challenges related to flock genetics, disease prevention, and reproductive health (e.g. managing diarrhea and abortions in goats).
  - Such training would help herders adapt to evolving environmental and economic conditions while maintaining productivity.
- - Diversification through tourism and local products
  - Pastoral tourism was viewed as a promising avenue for generating supplementary income, especially for young people. Interviewees expressed interest in sharing their traditional knowledge and way of life with visitors.

- Development of transhumance-related local products was also seen as an opportunity, though challenges remain due to (i) insufficient herd productivity and (ii) lack of skills in product development and marketing.

- - Recognition through ecosystem service payments
  - Interviewees unanimously emphasized the need for public subsidies as compensation for the ecosystem services they provide, such as wildfire prevention and biodiversity conservation.
  - Several warned that without continued grazing, high-altitude rangelands could become dangerously overgrown, increasing fire risk and potentially leading to social unrest in depopulated, neglected areas.

Conclusion

Transhumance in the Central High Atlas of Morocco, deeply rooted in history and culture, represents a pastoral way of life that has adapted over centuries to shifting environmental, climatic, and socio-economic conditions. In the Aït Bouguemez Valley, this ancestral practice continues to persist, thanks to its vital roles in sustaining local livelihoods, preserving soil fertility, and maintaining the viability of mountainous territories. Despite increasing pressures, its endurance stands as a compelling testament to the resilience of mobile herding communities.

However, the future of transhumance now hangs in the balance. Its continuity depends on the capacity of transhumant communities to confront and adapt to a host of contemporary challenges—global warming, extreme weather events, global inflation, and the declining attractiveness of shepherding among younger generations.

Preserving this centuries-old practice requires a comprehensive and inclusive approach—one that integrates traditional ecological knowledge, supports local initiatives, and aligns with global frameworks for sustainable development. Only by addressing these dimensions can a future be envisioned in which transhumance continues as a defining feature of pastoral life in the Central High Atlas, while evolving to meet modern realities.

Importantly, the current crisis in transhumant livelihoods should be seen not merely as a threat, but as an opportunity to rethink and reform public policies for mountain area development. This need has become even more urgent in the aftermath of the devastating earthquake that struck the Western High Atlas in September 2023, which destroyed critical infrastructure supporting transhumance—roads, electricity networks…—and wiped out in some areas the primary assets of herding families: their flocks. Addressing these challenges must become a priority on the national political agenda to ensure the survival and revitalization of pastoral systems in Morocco's mountainous regions.

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Chapter 7

Transhumance in Tigray, Northern Ethiopia*

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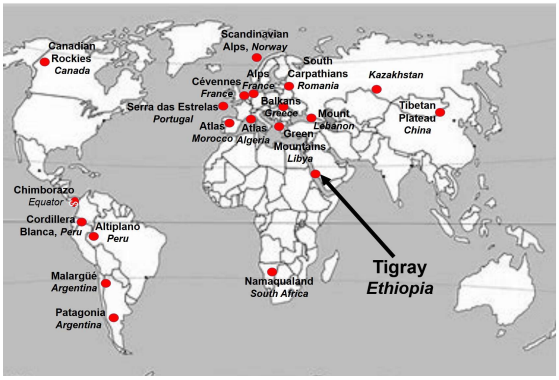
Abstract

Transhumance has long been practiced in Tigray, involving the seasonal movement of livestock in search of feed and water, especially toward the end of the dry season. This study focuses on the Northwestern and Western zones of Tigray, highlighting transhumance patterns, destination areas, livestock composition, economic importance, environmental impacts, and the challenges faced. Several animal species are transhumant. The practice typically takes place from May to December and plays a crucial role in sustaining livelihoods and strengthening community cohesion. While transhumance has positive effects on highland areas, it presents challenges in the lowlands, including overgrazing, environmental degradation, and a decline in biodiversity. The recent devastating war in Tigray significantly disrupted transhumance routes, leading to economic losses and social strain. Additionally, weak rule of law has contributed to environmental harm through activities such as unregulated gold mining and illegal wildlife hunting. These actions have resulted in wildlife migration, decreased biodiversity, and exacerbated potential climate change impacts. Despite government concerns about the environmental consequences of transhumance, efforts must be made to promote sustainable practices. These should include initiatives such as sustainable land management and community-driven natural resource conservation. Interventions should aim to enhance the resilience of transhumant systems while ensuring the well-being of local communities.

Keywords: Destination zone; Environment; Ethiopia; Livestock; Livelihood; Tigray War; Transhumance



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Introduction

Transhumance is a traditional livestock management system involving the cyclical, seasonal migration of livestock between two points along a specific route repeated annually (Nyssen et al., 2009). It refers to the yearly movement of livestock between two areas (Karatassiou et al., 2021) within a system that integrates seasonal livestock movement with permanent arable agriculture (Nyssen et al., 2009; Jones, 2005). This system has been widely practiced in various parts of the world, including Mediterranean countries (Ruiz & Ruiz, 1986), as one of the livelihood strategies of rural communities (Moktan et al., 2008). In Ethiopia, transhumance is common in regions where pastoralism—an economic activity primarily based on livestock rearing (Jones, 2005)—is prevalent, particularly in the Eastern, Northeastern, Western, and Southeastern parts of the country. This practice is classified based on the distance travelled, ranging from short to long distances (Nyssen et al., 2019). Azage et al. (2009) further classify transhumance into dry and wet season types. Dry season transhumance is primarily driven by the search for feed and water, whereas wet season transhumance aims to find areas free from livestock diseases such as trypanosomiasis.

The transhumant livestock production system represents a form of pastoralism and serves as an adaptation strategy to spatial and temporal climatic variability (Nyssen et al., 2009; Azage et al., 2009). It is also practiced in semi-arid regions where agro-pastoralism constitutes a key livelihood strategy (Azage et al., 2009). Similar to other regions, transhumance is widely practiced in the highlands of Northern Ethiopia, especially in the Tigray highlands (Nyssen et al., 2009; Azage et al., 2009; Nyssen et al., 2019), where natural pastures are inaccessible to livestock (Nyssen et al., 2019). The primary reason for transhumance is the search for feed and/or water due to the shortage of fodder in the highlands. Limited resources in these areas often lead to resource competition or conflicts between farmers and herders. The highlands are characterized by high human and livestock population densities (Alemu, 2015; Cecchi et al., 2010), leading to land scarcity and severe degradation of natural resources. Additionally, productive grazing lands are increasingly being converted into farmland for staple crop production (Gebremedhin et al., 2018; Gebremariam & Kebede, 2010). Low adoption rates of improved forage, degradation of natural pastures, and large livestock populations exacerbate the situation (Nyssen et al., 2019). As a result, livestock often lose body weight during the prolonged dry season (Abraha, 2016; Gebremariam & Belay, 2023). During the cropping season, transhumance becomes widespread in sedentary agricultural systems, as croplands are no longer accessible to livestock (Nyssen et al., 2009). It thus represents an opportunistic livestock production strategy that relies on available forage in the lowlands. In Tigray, transhumance involves the seasonal movement of livestock from the highlands to the lowlands and serves as a coping mechanism for resource limitations in the highlands (Azage et al., 2009). However, land grabbing by both local and international investors poses a significant threat to the Ethiopian lowlands (Lavers, 2012).

Despite existing knowledge on transhumance, no studies have assessed the impact of war on past, present, and future transhumance practices in the Northwestern and Western zones of Tigray, Ethiopia. This study therefore aims to assess the impact of war on transhumance and explores future opportunities for sustaining transhumance practices in Northern Tigray. These zones, and the Central Zone, are three of the seven administrative zones of Tigray Region.

I. Materials & Methods

1. Central Zone of Tigray

The Central Zone is located between latitudes 13°15′ and 14°39′, and longitudes 38°34′ and 39°25′ (Map 1). The majority of the zone receives an average annual rainfall ranging from 400 to 800 mm. The mean maximum and

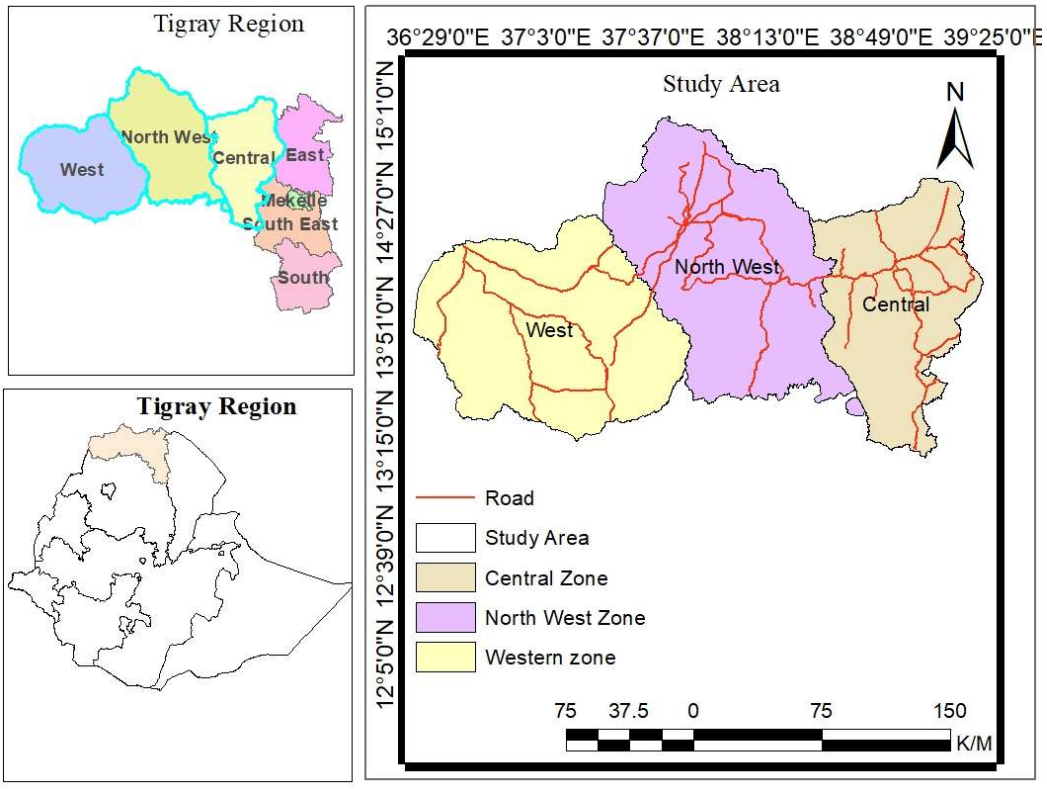
minimum temperatures are approximately 30°C and 10°C, respectively. The zone covers an area of 9,741 km² and has a population of 1,132,229 inhabitants (Fitsum et al., 2017). The population density is higher than that in the lowland areas of Tigray. Most of the land is cultivated, with scattered patches of grazing land in valley bottoms and degraded hilly areas (Gebremedhin and Dawit, 2013).

2. Northwestern Zone of Tigray

The Northwestern Zone is located between latitudes 13°38′ and 14°57′, and longitudes 37°40′ and 38°40′ (Map 1). It features both lowland and midland agro-ecological conditions, with an average temperature of 31°C (Tesfahunegn et al., 2019). It receives a mean annual rainfall of approximately 878 mm, while annual temperatures range from 18°C to 34.6°C. Elevation varies between 645 and 2,852 metres above sea level. The zone encompasses seven districts: Zana, Selekleka, Tahtay Koraro, Laelay Adyabo, Adi Hageray, Seyemti Adyabo, and Tahtay Adyabo. It is estimated that more than 40% of the area is covered by forest, and the zone also supports a high livestock population. Kafta Sheraro National Park, located within the zone, is home to a rich diversity of wildlife, including 95 avian species and 42 mammalian species (Gebru et al., 2019).

3. Western Zone of Tigray

The Western Zone is located between latitudes 13°42′ and 14°28′, and longitudes 36°23′ and 37°31′ (Map 1) (Mekonnen et al., 2011). The zone features both highland and midland agro-ecological conditions, with elevations ranging from 500 to 3,008 metres above sea level. Annual rainfall varies between 600 and 1,800 mm. Temperatures in the lowland areas are relatively high, ranging from 27°C to 45°C, whereas the highland areas experience cooler temperatures ranging from 10°C to 22°C. The zone comprises three districts: Welkait, Tsegede, and Asgede.



Map. 1. Study areas of mountain transhumance in Tigray, Ethiopia

4. Sampling method

The study was conducted in selected zones of Tigray where transhumance is practiced. The Central Western and Northwestern zones of Tigray were deliberately chosen. Farmers who own livestock and have experience with transhumance were selected with the assistance of local administrators. Key informant interviews were also conducted to gather valuable insights from experts and elders.

5. Methods of data collection and data analysis

Both primary and secondary data were collected from published and unpublished sources. Primary data were gathered through interviews with the transhumant community, agricultural experts, and local administrators using a semi-structured questionnaire to collect information on transhumance practices in the selected case studies. Qualitative data analysis was carried out to describe the collected data.

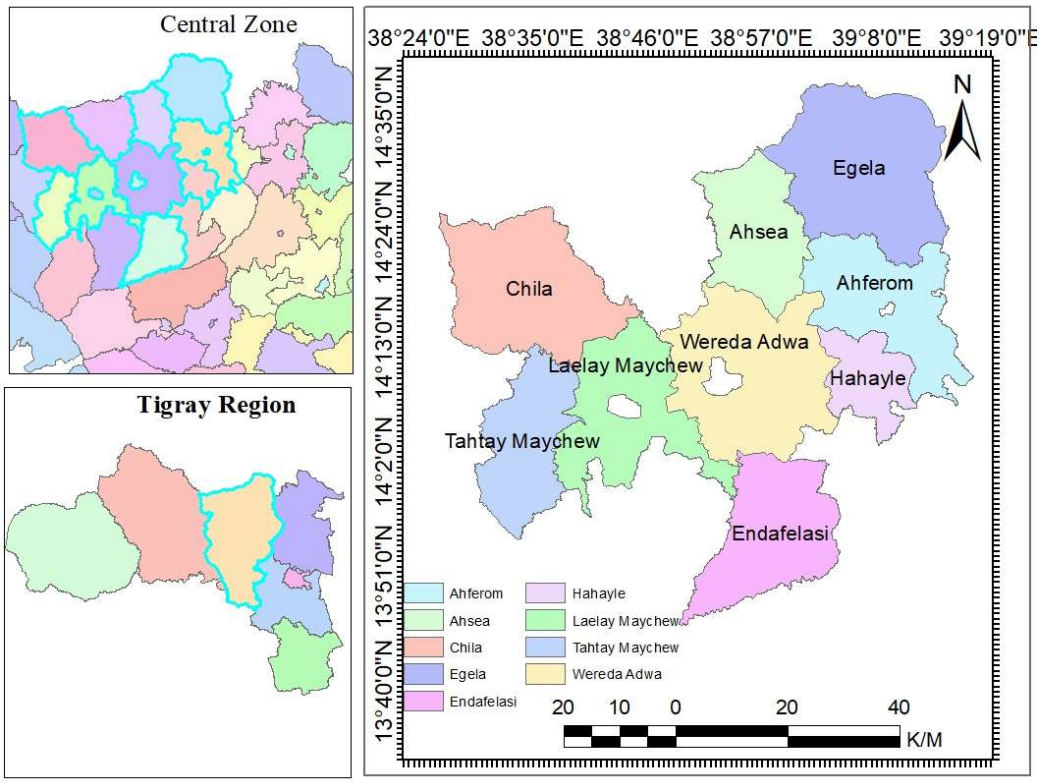
II. Results and Discussion

1. Case description of the Northwestern and Western zones of Tigray

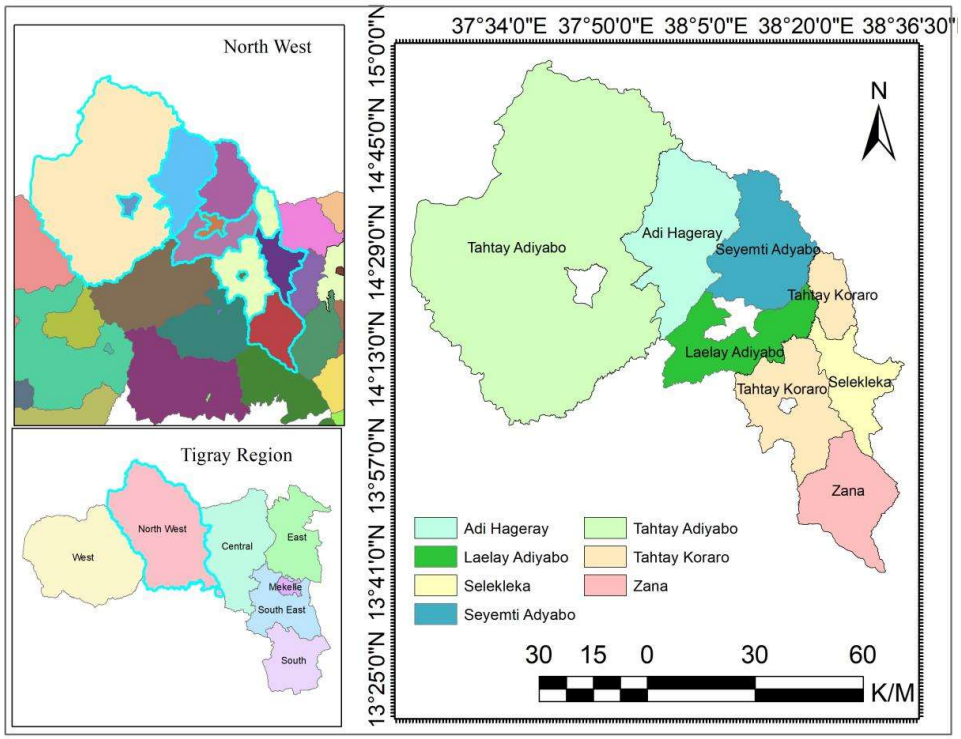
Although its exact origins are unknown, the practice of transhumance has a long history in Tigray. It involves the seasonal movement of livestock in search of feed and water, particularly during the long dry season, when animals face shortages of both in the highlands of Tigray.

The highland communities of Tigray have long relied on transhumance as a vital strategy for managing livestock and optimizing resource utilization in the lowland areas. Transhumance involves the annual seasonal migration of livestock from the highland districts of the Central, Northwestern, and Western zones of the region. Before the onset of transhumance, herders gather information through traditional means of communication. They meet during social gatherings, either at marketplaces or in churches. Sometimes, they also use mobile phones and radios to obtain reliable information about the onset of rainfall and the availability of pasture in the destination zones. The Central zone districts involved in transhumance (Map 2) include Adwa, Ahferom, Ahse'a, Chila, Egela, Enda Felasi, Hahayle, Laelay Maychew, and Tahtay Maychew. In the Northwestern zone (Map 3), the relevant districts are Zana, Selekleka, Tahtay Koraro, Laelay Adyabo, Adi Hageray, and Seyemti Adyabo. The highland areas of Welkait, Tsegede, and Asgede districts form part of the Western zone of Tigray (Map 4).

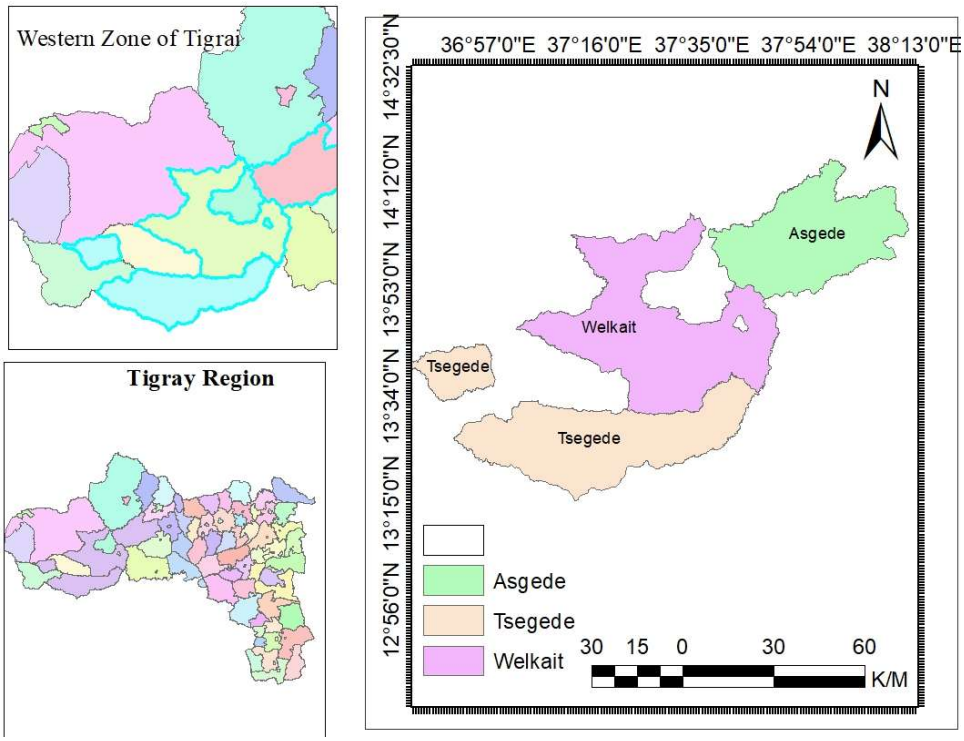
The transhumance destination zones include the extensive grazing lands located far from rural towns in the lowlands of the Tahtay Adyabo, Welkait, Kafta Humera, Asgede, and Tsegede districts. In Tahtay Adyabo, the *tabias* (the lowest administrative units or subdistricts) involved are Adi Aser (located in the Tekeze Valley), Adi Tsetser, Badme, Gemhalo, May Kuhli, May Hiwot, Shimbilina, and Fika Gebre. In Welkait district, the *tabias* include Korarit and Mogue. In Kafta Humera, they are Adi Goshu, Wihdet, Bereket, May Kadra (Bahr Selam), Ruwasa, and Shiglin. The relevant *tabias* in Asgede district are Dedebit, May Hanse, and Adi Mahameday. In Tsegede district, the key *tabias* are Gichew (specifically Silandi, May Bumba, and Shabmako) and May Delie.



Map. 2. Transhumance starting points from highlands of Central Tigray



Map. 3. Transhumance starting points from highlands of Northwestern Tigray



Map. 4. Transhumance starting points from highlands of Western Tigray

The transhumance journey includes several stopping points, where herders construct temporary shelters for their livestock before reaching their final destination (Photos 1 & 2). Groups of transhumant herders assist each other in building overnight shelters using thorny plants. These journeys extend over long routes from the starting points to the destination areas. The transhumance destination zones offer better feed resources, including herbaceous plants of natural pastures, forbs, and woody plants such as browse shrubs and trees. It typically takes one to two weeks to reach the final transhumance destination, covering an average distance of more than 100 km. This finding contrasts with the report by Nyssen et al. (2019), who indicated that annual transhumance herders travel an average distance of 8.1 km.

2. Reasons for transhumance

The primary reason for transhumance is the limited availability of livestock feed during the dry season, exacerbated by the depletion of existing feed resources and the use of croplands for cultivation at the onset of the wet season. This results in a lack of grazing areas for livestock during the crop growth period, necessitating the seasonal movement of herds to more suitable pastures in the lowlands. Additionally, the insufficient space for crop cultivation in the highlands—where the average landholding per household is less than one hectare (Tesfay et al., 2016)—also drives transhumance towards the extensive open lands in the lowland areas of Western and Northwestern Tigray. This practice is locally known as *Wefer Zemet* (the cultivation of forestland).

Photos 1 & 2. Two examples of temporary shade / overnight fence

3. Transhumance travel, livestock composition and purpose

Groups of transhumant herders travel long distances with their livestock (Photos 3 & 4), whereas the majority of non-herders use public transportation services. Transhumance is practiced exclusively by men, with women and children remaining at home to care for vulnerable and young livestock. Upon arrival, the transhumant herders gather in the destination zones of the Tahtay Adiyabo, Welkait, Kafta Humera, and Asgede districts. There are notable differences in the number and species of livestock among the transhumant groups. Herders from the Central Zone of Tigray typically have smaller herds and no goats, whereas those from the Northwestern and Western zones keep goats and maintain relatively larger herds. On average, a transhumant herder from the Central Zone owns four oxen, three heifers, one dry cow, one camel, and one donkey. In comparison, herders from the Western and Northwestern zones own significantly larger herds, averaging ten oxen, twenty heifers, twenty dry cows, fifty goats, one camel, and one donkey.

Photos 3 & 4. Herders walking along their transhumant livestock

The livestock species commonly involved in transhumance practices include heifers, draught oxen, goats, donkeys, and camels (Photos 5, 6, 7 & 8). In contrast, gravid cows are not moved. These animals are primarily indigenous breeds, valued for their resilience to harsh environmental conditions, their ability to travel long distances, and their capacity to survive periods of feed scarcity. Importantly, vulnerable young stock and recently born animals are excluded from transhumance movements.

Photo 5. Transhumant cattle herd

Photo 6. Transhumant small ruminants flock

Photo 7. Transhumant camel herds

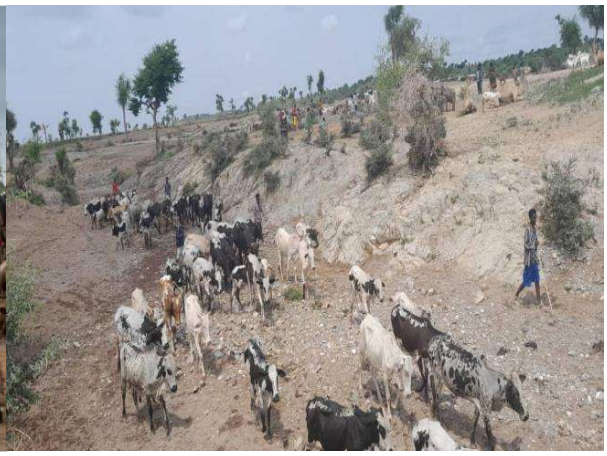


Photo 8. Transhumant mixed species - cattle and small ruminants

Different livestock species serve various purposes within the transhumant community. Draught oxen are used as a source of power for crop cultivation, from land preparation to threshing, either on the transhumants' own croplands or on land rented from sedentary farmers. Dairy animals, primarily cattle and goats, provide food sources such as milk and other dairy products, whereas donkeys and camels are used as pack animals to transport cooking utensils, flour, and farm implements.

Livestock are kept overnight on croplands for about a month to provide organic fertilizer, locally known as *Tsibra*, thereby naturally enhancing soil fertility (Photos 9 & 10). In addition, live animals, milk, dairy products (such as butter and buttermilk), and meat are sold to the local community in nearby markets, contributing to the stabilization of the livestock market.

Photos 9 & 10. Keeping livestock in cultivated plots, especially during the night, to enhance soil fertility (Tsibra)

In transhumance production systems, a contractual agreement is established between livestock owners and herders (referred to as cowboys). Each year, livestock owners entrust their best heifers to the herders. The herders are responsible for caring for the livestock and processing the abundant milk from lactating cows into butter during the autumn season, taking advantage of the availability of lush green pastures. They typically consume bread along with buttermilk and bring the butter back home for later sale.

The butter is stored without the addition of salt and is primarily used for food, though it is occasionally applied for hair care. The quantity of butter produced largely depends on the availability of green forage and the number of dairy cows under the herders' care.

4. Period of transhumance practices

Transhumance typically begins in early May and continues through the summer months until December, following the harvest of crops. During this period, animals are also fed crop by-products, allowing farmers to enhance the value of their livestock. The fattened animals are then sold in the transhumance destination zones. This cyclical practice extends for approximately six months each year and serves multiple purposes: accessing better pastures, utilizing communal lands, diversifying income sources, supporting crop cultivation, and meeting market demands.

5. Economic and social importance of transhumance

In economic terms, transhumance is vital for the livelihoods of communities, offering income diversification through the sale of livestock and livestock products, creating job opportunities, supporting local businesses, and driving trade in local markets. Livestock therefore constitute a key component of people's livelihoods in Ethiopia (Asresie and Zemedu, 2015). Furthermore, transhumance plays a crucial role in the economic activities of farmers by providing primary household income for younger generations without access to land for crop cultivation. It also serves as a supplementary or secondary income source for older individuals who possess agricultural land for growing crops. Additionally, it contributes to the overall food security and livelihoods of the community. Transhumant herders improve their livelihoods by cultivating croplands near grazing areas, either by renting land or by clearing nearby forests. This practice significantly boosts grain production, supporting their livelihoods through both the sale and consumption of grains.

Transhumance also supports local economies by contributing to summer agricultural tasks such as ploughing, weeding, harvesting, threshing, and gathering grains for human consumption and crop residues for animal feed. Furthermore, the supply of grains produced through transhumance activities to local markets contributes to market stabilization. This finding is consistent with Azage et al. (2009), who indicated that transhumance played a significant role in farmers' livelihoods in Northern Gonder. During their stay in destination areas, transhumant herders typically sell dry cows, oxen, heifers, young bullocks, and dairy products.

In addition, transhumance plays a vital role in promoting social values and ecosystem services. It strengthens relationships among transhumant herders and fosters community ties between highlanders and lowlanders. Transhumance also helps maintain soil fertility through the use of manure. The animals help control undesirable shrubs and bushes through grazing, thereby supporting a balanced ecosystem. They also practice a form of rotational grazing among natural pasturelands to prevent overgrazing.

6. Impact of transhumance on the environment

While the environmental impacts of transhumance in highland areas are generally positive—as it reduces livestock pressure and promotes rotational grazing—in the lowlands and along transit routes, negative consequences are observed due to high grazing intensity, leading to erosion, deforestation, and loss of wildlife habitat. This is consistent with previous findings by Tesfaye et al. (2010), who indicated that transit routes were exposed to continuous grazing and trampling by transhumant herders in Northern Gonder.

Forest fires and land clearing for crops contribute to controlling forest cover. However, excessive grazing and the deforestation of woody plants for purposes such as temporary traditional house construction, the making of farm implements, and wildlife habitat destruction in the lowlands result in the unsustainable exploitation of natural resources (Photos 11, 12, 13 & 14). These practices lead to long-term land degradation and present obstacles to biodiversity and ecosystem health (Alemu, 2015; Gebremariam & Kebede, 2010).

Livestock gatherings at watering points also have detrimental effects on the environment. The aggregation of livestock in these areas leads to water pollution from waste, the drying up of water points, trampling, and soil erosion. Additionally, the close proximity and movement of livestock result in uncontrolled breeding and the spread of communicable diseases such as brucellosis, anthrax, blackleg, lumpy skin disease, and *peste des petits ruminants* (PPR) among animals. This has also been reported by Berhe et al. (2007), who state that livestock movements aggravate the transmission of infectious diseases in Tigray. These issues not only impact the health of livestock but also have potential implications for human health.

Furthermore, the unsustainable use of natural resources, including water and land for livestock production, contributes to climate change through factors such as greenhouse gas emissions. It is therefore important to address these interconnected challenges to ensure the sustainability of livestock management practices for the health of both the environment and the community.

Photos 11 & 12. Cutting trees for diverse domestic uses

Photo 13. Deforestation for fuel wood and charcoal production

Photo 14. Grazing livestock in the national park

7. Mitigation strategies for environmental impact of transhumance

According to key informants, sedentary farmers in destination areas use traditional methods to mitigate adverse anthropogenic environmental impacts. Wildlife and forestry scouts are employed to limit the cutting of dead trees

and to implement traditional land management practices. These scouts are local residents who are recruited and paid by the local government for the services they provide.

8. Impact of devastating war on transhumance

A devastating war began in November 2020 between the Ethiopian National Defense Forces and their allies—namely, the Amhara militias and the Eritrean Defense Forces—against the regional government of Tigray in Northern Ethiopia. The root causes of the war were a constitutional crisis, the delay of elections, and the Amhara region's ambition to annex territories belonging to the Tigray Regional Government (Jima, 2023).

As a result of the war, transhumant communities were internally displaced to other parts of Tigray, leaving their livestock and belongings behind. The environmental consequences of the Tigray war included vegetation destruction for military purposes, soil erosion, the killing and looting of livestock, the destruction of animal feed, the devastation of vegetable and fruit farms, and water pollution from chemical releases caused by weaponry. These factors have led to wildlife migration, reduced biodiversity, and potential climate change impacts. Similar findings were reported by Meaza et al. (2024), who affirmed that the war in Tigray has negatively affected natural resources and undone decades of re-greening efforts.

Moreover, illegal large-scale gold mining and increased wildlife hunting, resulting from the weakened rule of law in the Tigray region (Photos 15 & 16), have placed additional pressure on the environment and its natural resources. The disruption of transhumance routes and practices has not only had social and economic repercussions but has also significantly altered the environmental landscape, posing serious challenges for both local communities and the broader ecosystem.

Photos 15 & 16. Impact of the war on the environment such as illegal wildlife hunting and gold mining activities

The impact of the war on transhumance practices in the Northwestern Zone of Tigray is significant and multifaceted. The conflict has disrupted traditional transhumance migration routes, creating major challenges for communities

that rely on this practice for their livelihoods. Furthermore, the presence of Eritrean troops and Amhara militias in transhumance destination areas has led to the halting or alteration of traditional migration paths. This disruption has severely affected herders' ability to move their livestock to lowland grazing areas. Access to critical inputs such as feed and veterinary services has also been interrupted.

The inability to practice transhumant livestock production due to the war has resulted in significant economic losses for transhumant communities. These losses include reduced income from livestock and livestock product sales, diminished revenues from renting draught animals, negative impacts on local businesses, increased poverty levels, a decline in market activities, and shifts in employment patterns. The economic benefits traditionally derived from transhumance, such as income diversification and local economic support, have been severely compromised. Overall, there has been an economic downturn among community members, a widening income gap, and decreased economic activity.

The disruption of transhumance practices due to the Tigray war has also had profound social consequences. These include strained community relationships, erosion of traditional knowledge, displacement, shifts in social roles, and, in some cases, ethnic cleansing and genocide. Civilian casualties were very high, with many transhumant herders among the victims. This finding agrees with that of Annys (2021), who reported high numbers of civilian casualties in Tigray. The social structures of communities that traditionally practiced transhumance have been significantly damaged by the war.

In conclusion, the Tigray war has had far-reaching and devastating effects on transhumance practices in the region, impacting not only the livelihoods of communities but also the environmental and social dynamics. The disruption of transhumance has upset the delicate balance between human activities and the natural environment, posing significant challenges to the sustainability and well-being of both communities and ecosystems.

9. Challenges of transhumance

At the onset of transhumance, livestock are vaccinated, but later they often encounter health problems. Livestock herders keep their animals without the assistance of dogs. Livestock theft is also a significant problem, similar to the findings of Aryal et al. (2018) and Azage et al. (2009), who noted that livestock loss and theft are disadvantages of transhumant livestock production. Although not common, conflicts can arise between transhumant herders and sedentary farmers, as well as between transhumant herders and park rangers. This finding is consistent with Tesfamariam et al. (2019), who found that conflicts occurred between highlanders and lowlanders in the marginal grabens of Northern Ethiopia.

River flooding causes food shortages for transhumant herders, and kidnappings by criminals in forested areas pose additional threats. This is also consistent with the findings of Nyssen et al. (2019), who identified human and livestock diseases and natural vegetation degradation as the main challenges to transhumance in the Degu'a Temben Southeastern zone of Tigray.

10. Future opportunities of transhumance

Government officials do not support transhumance due to its perceived negative environmental impact. This negative outlook may stem from the concept of the 'Tragedy of the Commons' proposed by Hardin (1968). Nevertheless, efforts should be made to explore sustainable transhumance practices as a long-term strategy to support the resilience of communities in Western and Northwestern Tigray. These initiatives should include strengthening sustainable land management, promoting community-driven natural resource management such as soil and water conservation, implementing afforestation programs, diversifying economic activities, and building the capacity of transhumant communities.

Transhumance should contribute to maintaining ecological balance through enhanced rotational grazing, strengthening forest monitoring, restricting tree cutting, prohibiting wildlife hunting, and using manure to improve soil fertility. Previous efforts based on similar recommendations—such as soil and water conservation practices and area enclosures in the highlands of Tigray—could be adapted and transferred to other parts of the region (Derakhshani, 2015).

It is also crucial to integrate these practices with traditional knowledge and to adopt inclusive approaches that involve transhumant communities in the decision-making process. Their participation is vital for the sustainable conservation of vegetation, as found also by Araya et al. (2023), who emphasized that local participation and ownership are key tools for sustainable rangeland rehabilitation.

Conclusion

Transhumance plays a vital role in the livelihoods and economies of communities in Tigray. However, the recent Tigray war has had significant negative impacts on transhumance practices, leading to economic losses, social strain, and environmental disruption. Efforts should be made by governmental and non-governmental organizations to promote and preserve transhumance practices through initiatives focused on sustainable land management and community-driven natural resource conservation. Research institutions and higher education establishments should raise awareness and support transhumance practices in a scientific manner. It is essential to balance the benefits of transhumance with environmental sustainability and community well-being to ensure the resilience of transhumant practices in the region.

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Chapter 8

Transhumance at the tipping point in the Kamiesberg Mountains, South Africa

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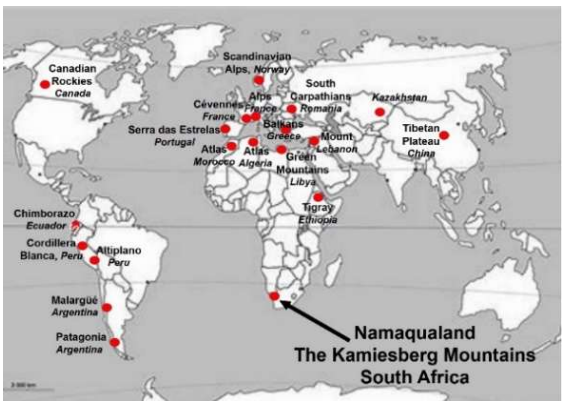
Abstract

The Kamiesberg Mountains in South Africa are home to indigenous Nama pastoralists, for whom altitudinal transhumance has been essential to the survival of their livestock. This study assessed the drivers of transhumance in the semi-arid Leliefontein Communal Area of the Kamiesberg Mountains by examining its ecological and agricultural significance as well as its most immediate threats. Altitudinal transhumance in Leliefontein continues to rely on traditional ecological knowledge, including weather and climate patterns, forage quality and quantity, and livestock behaviour, condition, and dietary needs. However, the transhumance system practiced by the Nama pastoralists is increasingly pressured by a complex interplay of factors: climate change, poor governance, socio-economic transformations, and the decline of traditional cropping systems. Rising minimum temperatures, greater rainfall variability, and more frequent and prolonged droughts are negatively affecting vegetation health and water availability. Simultaneously, weakened traditional and local authorities, deteriorating infrastructure, and elite capture of communal land have contributed to the contraction and fragmentation of grazing areas. The decline in skilled and experienced herders, along with youth disengagement, further threatens the sustainability of transhumance. The future of this practice in Leliefontein depends on the restoration of ecological infrastructure, herder training, preservation of traditional knowledge, and the implementation of policies that support herd mobility. Altitudinal transhumance remains fundamental to ecological integrity and the sustainability of Nama pastoralist livelihoods.

Keywords: Short-range mobility; Nama pastoralists; Kamiesberg Mountains; Herding; Dryland cropping



Introduction

About 54% of the world's terrestrial surface can be classified as rangeland, and these landscapes are largely characterized by variability in climate and resource availability (ILRI, 2021). Pastoralism is often the most suitable land use for such environments, and over centuries, pastoralists have developed knowledge and skills to master the art of managing variability through mobility (Fernandez-Gimenez, 2002). Pastoral mobility also serves to overcome socio-economic, political, security, and health challenges, ensuring sustainable land use (Behnke and Scoones, 1993; Mortimore and Tiffen, 1994).

Pastoralists employ various mobile strategies to manage their livestock, including nomadism, emigration, long-range transnational movements, short-range movements, and transhumance (Samuels et al., 2021). Mountain regions are typically characterized by harshly cold temperatures in the uplands during winter, necessitating seasonal altitudinal movements to warmer, lower-lying areas (Samuels et al., 2008). Livestock kept in mountainous regions are diverse and generally include both large and small stock, primarily ruminants.

The Kamiesberg Mountains, located in the arid Namaqualand region of South Africa and extending through the Leliefontein Communal Area, have been home to indigenous Nama pastoralists for millennia (Sadr, 1991). This chapter focuses on the short-range transhumant practices of the Nama pastoralists in the Leliefontein Communal Area, exploring the drivers behind these movements. It also examines the immediate threats to this livestock management strategy and outlines what is needed to ensure the survival of transhumance in the area.

I. Geographic and bioclimatic context of the study area

The Kamiesberg Mountains in South Africa present a diverse and rugged terrain that significantly influences the traditional livestock grazing practices of Nama pastoralists. The Leliefontein Communal Area spans approximately 192,000 hectares and features a range of elevations—from about 250 metres above sea level near the Atlantic coast in the West to 1,350 metres in the rocky uplands. The eastern plateau stands at roughly 800 metres above sea level (Samuels, 2013). The communal area is divided into ten villages, each with associated commons ranging in size from 12,000 to 31,000 hectares. Leliefontein, the oldest village in the communal area, has a grazing common of about 20,000 hectares, including 12,000 hectares of upland areas within the Kamiesberg Mountains.

Namaqualand is a semi-arid, winter-rainfall region situated between the Mediterranean-type climate of the southwest and the summer-rainfall regions to the east and north of South Africa. The climate is marked by hot, dry summers and cold, wet winters. Geographic features such as the escarpment mountains and the influence of the cold Benguela Ocean Current contribute to climatic variability, creating a diverse range of conditions across the region (Davis, 2013). Summer temperatures can exceed 40 °C, while winter temperatures, especially in the uplands, can fall below freezing (Samuels, 2013). Temperature records from 2002 to 2012 show average winter minimum temperatures ranging between 5 and 11.5 °C (Davis, 2013).

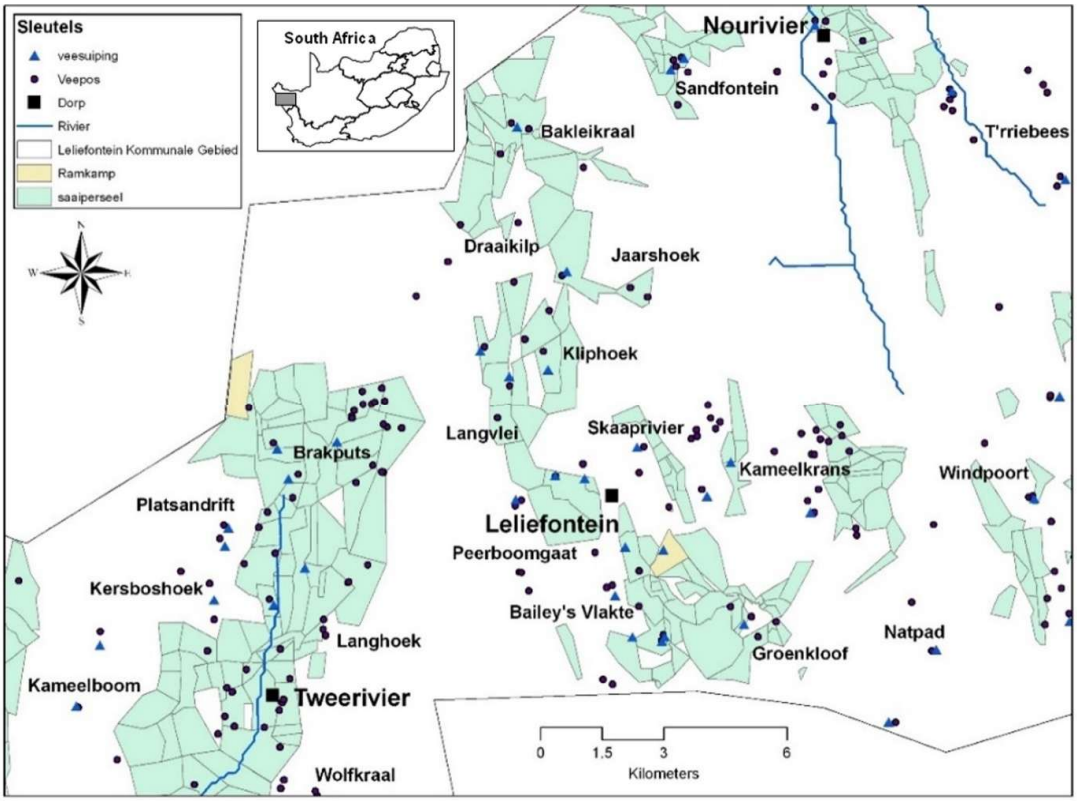
In the Leliefontein Communal Area, the eastern fringes receive summer rainfall, whereas the majority of the area experiences winter rains. Over the past century, Leliefontein village has recorded an average annual precipitation of 392 mm, with moderate variability (Samuels, 2013). Most rainfall occurs in winter, between June and August, due to cold westerly fronts bringing gentle showers. Occasionally, tropical thunderstorms occur in late summer (February to April), delivering intense and unpredictable downpours (Desmet, 2007). Winter frost is common above 1,000 metres elevation and lasts an average of 120 days, compared to 88 days in the lower areas where flocks are moved

during winter (South African Weather Service, unpublished data). Sporadic snowfall is typically observed above 1,200 metres (Helme and Desmet, 2006).

Leliefontein village, nestled in the mountains, benefits from higher rainfall and abundant water sources, including numerous springs and ephemeral wetlands scattered across the rangeland. These wetlands are especially valuable during dry seasons and droughts, providing essential forage for livestock (Samuels et al., 2016). Although they make up only 1.3% of the total area, wetlands have been significantly transformed. Intensive land use—including overgrazing, excessive burning, crop farming, water abstraction, and invasive vegetation—has led to the degradation of over 60% of the wetlands in the Kamiesberg uplands (Kotze et al., 2010; Helme and Desmet, 2006).

The Leliefontein Communal Area lies within the Succulent Karoo biome, one of only two arid biodiversity hotspots globally, renowned for its high concentration of endemic succulent species. The area includes nine distinct vegetation types, six of which cover 98.3% of the region. These are: Namaqualand Klipkoppe Shrubland, Namaqualand Blomveld, Namaqualand Heuweltjieveld, Namaqualand Granite Renosterveld, Kamiesberg Mountain Shrubland, and Kamiesberg Granite Fynbos (Mucina and Rutherford, 2006). Namaqualand Klipkoppe Shrubland is the most extensive, covering about 52% of the communal area. Namaqualand Granite Renosterveld, though occupying only 6.8%, makes up 65% of the vegetation around the high-lying Leliefontein village (Samuels, 2013).

Map 1 illustrates the Leliefontein Communal Area, showing grazing areas for Leliefontein village, cropping fields, water points, and stockpost locations. This map is essential for understanding the spatial distribution of resources and management practices.



Map 1: Leliefontein village commons and locations of the natural resources and stockposts

II. Historical context of the Kamiesberg Region

Namaqualand derives its name from the Nama-speaking Khoikhoi pastoralists, whose ancestors expanded into southern Africa approximately 2,000 years ago (Rohde & Hoffman, 2008). Historically, Namaqualand was divided into Little Namaqualand, which formed part of the Cape Colony, and Great Namaqualand, located north of the Gariep River in present-day Namibia. The pre-colonial Nama were both nomadic and transhumant pastoralists, optimizing production through seasonal exploitation of natural resources and movements aligned with climatic cycles (Penn, 1986). The Kamiesberg served as a summer gathering point for the Nama Khoikhoi due to its relatively abundant resources, and its name is derived from the Nama word *kamies*, meaning "to gather" (Price, 1976).

Colonial expansion by the Dutch and British, followed by Apartheid policies, confined the Nama Khoikhoi to small communal areas, severely limiting their transhumance practices (Samuels, 2013). These restrictions also led to insecure land tenure, high unemployment, and limited economic opportunities for the Nama people (Rohde et al., 2003). The arrival of missionaries further altered governance and land ownership in communal areas, affecting access to and management of resources, including grazing rights and land use (Samuels, 2013).

In 1816, Nama Chief Wildschutt and four elders traveled south to Cape Town to seek a missionary who could help protect their land from encroaching Dutch *trekboers* (Catling, 2008). Reverend Barnabas Shaw, a Wesleyan missionary, agreed to settle in Leliefontein to serve the Nama people under Captain Wildschutt (Shaw, 1970). By 1824, the Cape Governor had granted the resident missionary full authority to maintain order in the area (Swarts, 2014). In 1847, all of Little Namaqualand was declared British Crown land, and the Cape Colonial Government issued "tickets of occupation" to the Nama inhabitants, with missionaries stationed in their reserves (Rohde et al., 2003; Hoffman & Rohde, 2007). In 1854, a ticket of occupation was issued to the Nama-speaking Khoikhoi pastoralists in the Leliefontein Reserve (Rohde et al., 2003).

The Leliefontein Reserve subsequently became central to the pastoralist community, allowing them to continue their transhumance practices within a restricted area managed by the missionary and the local church council. Missionaries introduced dryland cultivation of winter crops such as wheat, barley, and oats, aiming in part to sedentarize the Nama's transhumant lifestyle. However, the resulting confinement led to overpopulation, overgrazing, and soil degradation (Price, 1976).

Following a fluctuating history of governance—from missionary control to a resident magistrate in the late 1800s—the Mission Stations and Communal Reserves Act 29 of 1909 placed Leliefontein under state control, formally separating church and state authority (Rohde et al., 2003). Within a century, land governed by Namaqua chiefs for generations had been expropriated, first by the church, and eventually by the colonial and apartheid State after 1948. In 1984, the apartheid government attempted to privatize parts of Leliefontein through the creation of "economic farming units," undermining the informal land rights of local inhabitants (Samuels, 2013). These fenced grazing paddocks were allocated to politically connected pastoralists and those who owned relatively large herds. Only 17 out of the 47 grazing units were designated as communal paddocks, expected to accommodate more than 200 pastoralists (Samuels et al., 2021). The communal tenure system was reinstated in 1987 after the abolition of the economic farming units.

Post-apartheid efforts to reform communal land tenure and transfer ownership to the inhabitants of former reserves, including Leliefontein, remain incomplete. The land is still held in trust by the State under the custodianship of the Minister of Agriculture, Land Reform and Rural Development. Since 2000, access and use of the land have been managed by local municipalities and elected committees, pending the official transfer of ownership to an entity selected by the community.

III. Agrarian context

The agrarian landscape of the Leliefontein Communal Area is shaped by traditional livestock farming practices that have persisted despite numerous environmental, socio-economic, and political challenges. Livestock farming remains a vital source of income and protein for the local population, who traditionally employ herders to move sheep and goats between different parts of the landscape (Samuels, 2006). The communal grazing areas are supported by essential infrastructure, such as stockposts and formal water points, but lack internal paddocks (Map 1). Overgrazing—primarily resulting from settlement and the limited mobility of livestock—has created tensions with conservation efforts aimed at preserving the region's rich biodiversity (Mucina and Rutherford, 2006). Climate change further intensifies these issues, with increasingly frequent and severe droughts reducing forage availability and straining water resources.

In response, sustainable livestock farming practices are being actively promoted. For example, grazing guidelines have been co-developed by pastoralists, community members, and a conservation agency to improve natural resource management and mitigate environmental impacts. These guidelines, tailored to the ecological and socio-economic contexts of the Nama pastoralists, aim to balance livestock farming needs with biodiversity conservation. They integrate both traditional ecological knowledge and scientific understanding. Key elements include the promotion of rotational grazing, seasonal resting of rangelands through herd mobility, and participatory rangeland monitoring. The guidelines also emphasize the protection of key ecological habitats, such as ephemeral wetlands, and the reduction of soil erosion through the prevention of overgrazing.

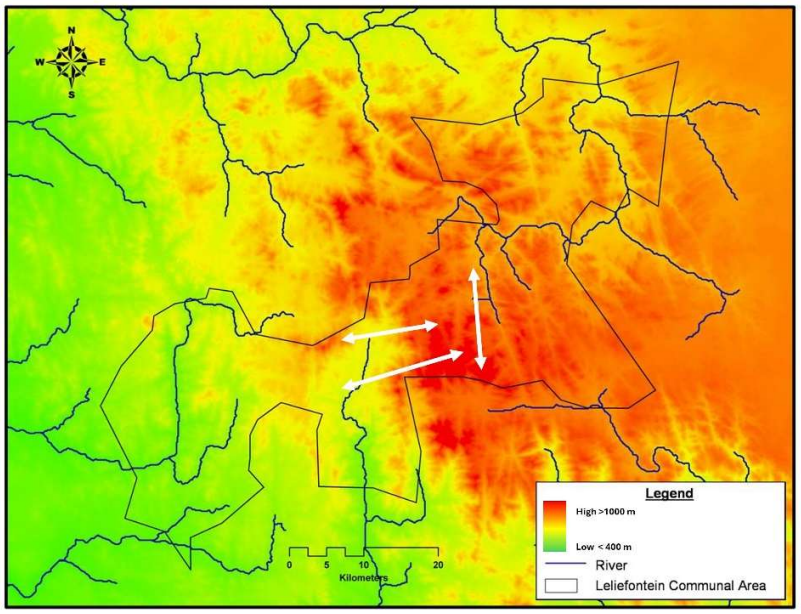
In addition to livestock farming, approximately 23,000 hectares of land within the communal area have been designated for dryland crop cultivation. This land is rented out to residents of the Leliefontein Communal Area. A total of 564 sowing plots of varying sizes (averaging 44 hectares) were surveyed, primarily located on flatter, sandier terrain. Agropastoralists grow winter cereal crops to supplement livestock feed during the dry summer season. Natural resources such as firewood, medicinal plants, and woody shrubs for construction are also used by the community. However, some traditional practices—such as harvesting reeds from wetlands to build reed mat houses—have declined or disappeared over time.

IV. Altitudinal transhumance in the Kamiesberg Mountains

Gradients in climate and topography support a system of altitudinal transhumance, whereby herders move livestock seasonally to avoid extreme weather conditions, protect growing crops, or exploit different grazing resources (Samuels, 2013). Leliefontein village has approximately 25,000 hectares of communal grazing land, of which about 5,000 hectares have been surveyed as sowing plots. Although only a small number and area of these plots are ploughed each year, their presence creates a clear need to relocate flocks during the growing season. This is particularly important given the limited size of the grazing commons and the associated risk of livestock damaging crops.

From June to September, herders move their flocks from the cold, higher-elevation uplands—where the average winter minimum temperature is approximately 2.6 °C—to the warmer, low-lying areas, where minimum temperatures average 3.9 °C. Temporary stockposts are erected in these lowland areas to support livestock during the winter months. The return to the uplands typically occurs in late spring or early summer, once crops have been harvested, temperatures have increased, water sources in the lowlands become scarce, or forage is depleted.

Each year, approximately 32 flocks undertake these seasonal altitudinal movements around Leliefontein village. Their three primary migration routes are illustrated in Map 2. The flocks range in size from 25 to 200 animals and consist exclusively of goats and/or sheep (Samuels, 2013). Cattle and equines are not herded; instead, they typically move downslope independently during winter.



Map 2. The transhumant routes of Nama pastoralists in the Leliefontein village commons

V. Herders' decision-making during transhumance

This seasonal movement of livestock between different elevations is a distinctive aspect of the Nama pastoralists' livelihood and is deeply intertwined with their cultural heritage. It is especially critical during the cold winter months when ewes give birth, as temperatures at higher elevations around Leliefontein village—located approximately 1,400 metres above sea level—frequently drop below freezing. However, increasing rainfall unpredictability and prolonged droughts driven by climate change have forced pastoralists to adapt their traditional migration schedules.

Movements between summer and winter stockposts are informed by a deep understanding of the landscape, weather patterns, and animal behaviour, drawing on generations of indigenous knowledge blended with contemporary insights. Cupido et al. (2024) describe the herders' knowledge system as a synthesis of indigenous and scientific knowledge, interwoven with 'idiosyncratic' practices. This syncretic knowledge is essential for decision-making in transhumance and demonstrates the herders' flexibility and resilience in adapting to environmental change.

An observational account of altitudinal transhumance in Kamiesberg Uplands

The traditional schedule for moving livestock to the lower-lying winter grazing areas is usually set for May 15th, following the first substantial rains typically expected in April each year. If adequate rainfall has not occurred by this date, herders delay relocation until two weeks after the first significant rainfall. The return to the summer grazing

areas is scheduled for November 15th. Herders and livestock owners maintain flexibility and coordinate movement dates within each village to ensure effective resting of the rangeland (Leliefontein Grazing Guidelines, 2023).

However, the multi-year drought that affected South Africa between 2015 and 2021 significantly disrupted pastoralist decision-making, to the point that many were unable to follow the traditional trekking calendar. In 2019, for instance, pastoralists in Leliefontein village faced a major challenge when they were effectively trapped at high elevation at their summer grazing stockposts. No significant rainfall had occurred to replenish vegetation in the winter grazing areas. It was only at the end of June—more than a month after the scheduled migration—that the first good winter rains finally arrived.

(First Photo) A livestock owner, his grandson, the herder, with their flock of sheep and goats, leave the summer grazing stockpost at Blokdrif, and (Last Photo) reach the winter stockpost at Jaarskloof. © Clement Cupido 29 June 2019

Our research team accompanied one of the Leliefontein livestock owners, his grandson, and their experienced herder on their seasonal journey from the summer grazing stockpost at Blokdrif to the winter stockpost at Jaarskloof (Cupido, 2020; *Walking the Ancient Livestock Paths of Namaqualand*).

At dawn, we set out with the flock, accompanied by three landrace dogs. The 70-year-old herder, a quiet and introspective man, carried only his *kierie* (a traditional club used as a walking stick) and a makeshift rucksack containing water bottles. His minimalist approach reflected a deep familiarity with the landscape. In an unusual touch, he had dressed formally for the occasion, wearing a blazer—something rarely seen in the daily life of a herder—indicating the significance of the journey.

As we walked, the livestock owner shared the historical context of their transhumant movements. The older ewes instinctively led the way, pausing often to sample fresh vegetation along the path. Our pace was steady, at approximately two kilometres per hour. After about two and a half hours, we reached the halfway point, marked by the turnoff to Leliefontein village. From there, the route descended into Jaarskloof, where the vegetation gradually shifted from renosterveld to succulent Karoo species—commonly understood as a transition from sourveld to sweetveld.

The trek covered approximately 10 kilometres, descending roughly 300 metres in elevation. Though the altitudinal difference may seem modest, it is ecologically significant, allowing the flock to cross a critical temperature threshold that influences vegetation types and forage quality. Such distances are common in the communal area, which has historically shrunk due to land encroachment during the colonial period.

Throughout the journey, the herder's calm demeanour and profound understanding of both landscape and livestock were evident. His expertise ensured a smooth and uneventful trek. The livestock owner highlighted the vital role of experienced herders, who possess not only practical knowledge but also a deep ecological intuition shaped by years of observation and adaptation.

Upon arrival at Jaarskloof, we were welcomed by the familiar setup of a traditional stockpost: a *khaya* (sleeping shelter), a *kookskerm* (cooking enclosure) built from local plant material, and a kraal (livestock corral). The atmosphere was rich with the sounds and smells of pastoral life—the bleating of animals, conversation in the cooking shelter, and the aroma of indigenous *taaibos* (*Searsia undulata*) smoke as coffee brewed. This tranquil scene captured the essence of life in the Kamiesberg Uplands: one of simplicity, community, and a deep-rooted connection to the land.

Yet, beneath this serenity lies growing concern for the sustainability of this way of life. These concerns stem from interconnected challenges: climate change, rural crime, youth disengagement from farming, and weak local governance, which has increasingly enabled elite capture of portions of communal land for private use.

VI. Drivers of abandonment of transhumance

1. Lack of herders

The average age of herders in the Leliefontein Communal Area is approximately 55 years, a demographic trend consistent with other Nama pastoral regions in the broader area (Samuels, 2006). This age profile is largely the result of former mine workers and individuals previously employed outside the communal area who returned to Leliefontein, acquired livestock, and resumed a Nama pastoral lifestyle as a means of income and cultural continuity (Samuels, 2006).

However, given that unemployment rates in South Africa—particularly among youth—are among the highest in the world, there is increasing pressure for younger individuals to enter the pastoral sector. Yet, several barriers hinder this transition. Young people often lack the financial capital to acquire livestock, and strained intergenerational relationships, perceptions of youth disinterest in farming, and the dominance of older men in decision-making structures make it difficult for younger people to participate meaningfully in pastoralism (Swarts & Aliber, 2013).

As the current population of herders ages, many no longer possess the physical strength or health required to move livestock along the demanding altitudinal routes. Hiring herders may offer a temporary solution, but wages in the sector remain below the national minimum wage, making the work unattractive to the younger generation. Moreover, many youth are not sufficiently immersed in Nama cultural practices to sustain the pastoral tradition. Processes of acculturation—intensified under colonial and apartheid regimes—have contributed significantly to the erosion of Nama identity, disconnecting younger generations from their cultural roots.

2. Poor governance by local authority

The historical breakdown of traditional Nama authority over natural resource management has led, to some extent, to uncertainty regarding how and when decisions should be made. As a result, decision-making today largely resides

with individual livestock owners, although consideration for others' rights to access and use communal land remains an important factor in herd movements. Attempts to establish new committees as extensions of local governance structures have largely failed. These failures are partly due to the dominance of modern, commercial livestock management models—such as fenced grazing paddocks—in grazing regulations, which often marginalize traditional pastoral practices like herding and mobility.

In the absence of strong communal authority, wealthier pastoralists have fenced off large sections of rangeland for exclusive use, with their livestock grazing in these enclosures year-round. Since there are no legal or social repercussions for this form of land appropriation, it risks setting a precedent for further privatization of communal land. Such fragmentation undermines the viability of transhumance, as herders must increasingly defend exclusive access rights rather than participate in collective land stewardship.

Moreover, poor governance has led to the decay of essential infrastructure. Parts of the winter grazing areas, such as Kameelkrans and Peerboomgat in the lowlands, have become inaccessible due to deteriorated and hazardous dirt roads that are no longer maintained. Similarly, critical water infrastructure—including boreholes, solar panels, and troughs—has fallen into disrepair, rendering some grazing areas unusable. This lack of reliable water access forces flocks to remain near the few functional water points, thereby promoting sedentarisation and overgrazing.

In addition, there has been a sharp rise in the poaching of dwarf succulent plants by organized syndicates with international connections. This illegal activity poses direct risks to herders, who may encounter poachers in remote grazing areas, raising serious safety concerns and further complicating herd mobility in the region.

3. Abandonment of dryland cropping

Dryland cropping in the Leliefontein Communal Area is highly constrained by climatic conditions. When rains are delayed, reduced, or fail entirely, agropastoralists often choose not to plough their fields. This is especially true during drought periods, which typically occur every 7 to 10 years (Kelso, 2010) and are expected to increase in frequency, duration, and intensity due to climate change (Fauchereau et al., 2003). Missed opportunities to sow crops mean that agropastoralists must rely on commercial livestock feed, which is often prohibitively expensive. To afford this feed, they may use social grants or sell a portion of their animals to ensure the survival of the remaining flock (Samuels, 2006).

The lack of functional farming implements further limits the ability of agropastoralists to cultivate their fields. In the past, some used tractors for ploughing, but all available machinery is now broken. Occasionally, implements were provided through interventions by local commercial farmer unions or rented from elsewhere, but these initiatives have since ended. Additionally, high fuel costs have made tractor use unsustainable. While donkeys were traditionally used for ploughing, not all households own donkeys or a plough, and alternative methods such as no-till cropping or conservation agriculture have yet to be introduced or adopted.

Traditional cropping practices require detailed knowledge of local conditions. For instance, during ploughing, the depth of the furrow is critical—ploughing too deeply can bury seeds in the sand, preventing germination. All harvesting is carried out manually using a sickle, though few people today retain these skills. After harvesting, chaff is separated from the grain using donkeys guided to walk in circular patterns over the harvest laid out on dung-coated threshing floors. This process also requires specific expertise, which is increasingly rare in the area.

Finally, another factor discouraging cultivation is the risk of crop damage by livestock. Many flocks are left unattended during the day and have not been moved away from cropping areas, leading agropastoralists to avoid planting altogether. Leliefontein also has a large population of stray donkeys, which frequently damage growing crops.

4. Climate change

Pastoralists move downslope during winter to escape cold conditions, as annual average minimum temperatures in the uplands often fall below thresholds that both livestock and herders can tolerate. However, observed increases in minimum temperatures over the past few decades (Davis, 2013) may, in time, push winter temperatures above these critical survival thresholds. Herd movement data indicate that the difference in minimum temperatures between upland and lowland stockpost locations during winter is only about 3 °C (Samuels et al., 2008).

Snowfall is another factor pastoralists seek to avoid, as livestock kraals in the uplands are not covered. After snowfall, wind chill conditions can be especially harsh and potentially deadly for livestock. These cold spells are particularly dangerous following drought periods, when weakened immune systems among animals make them more susceptible to illness and mortality. This vulnerability affects even robust breeds such as the Boer goat, which are otherwise well-adapted to high summer temperatures and arid conditions.

In addition, the lack of rainfall in some years has prevented herders from moving to traditional winter grazing locations such as the Twee River area, as the vegetation there has not regenerated sufficiently to support livestock.

Conclusion

There are several factors—such as poor governance, a shortage of herders, the abandonment of cropping, and climate change—that could signal the end of transhumance in the Kamiesberg upland areas. Therefore, for altitudinal transhumance to continue in the future, several obstacles must be overcome in order to realize the ecological and agronomic benefits of herd mobility.

Firstly, it would be in the interest of local government—through the implementation of the national Expanded Public Works Programme—to invest in training young people to become herders. This would help elevate the status of herders and make the profession more appealing to younger generations.

Additionally, providing network coverage across all communal areas would enable herders to stay in touch with others, including their families, and to access vital climate information while on the move with their herds. Digitization is also crucial—for example, to access real-time market price data, near-real-time vegetation condition maps, and emergency alerts and procedures.

The status of herders could also be improved through the enforcement of South Africa's national minimum wage. In other parts of the world, such as the United States, herders like cowboys enjoy widespread recognition for their lifestyle. Herders in Leliefontein could similarly gain acknowledgment, particularly if they are recognized as custodians of biodiversity in the world's richest arid biodiversity hotspot.

Implementing these initiatives would be an important step toward protecting transhumant herding in the Leliefontein Communal Area.

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Chapter 9

Transhumance in the Rocky Mountains of Western Alberta, Canada

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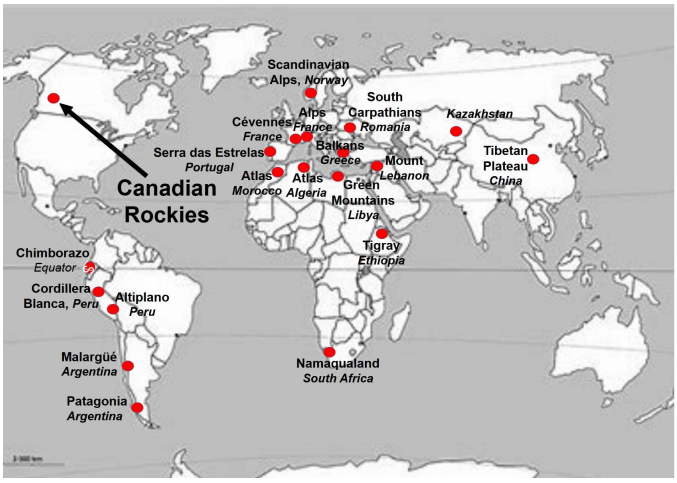
Abstract

In the Alberta Canadian Rocky Mountains, the transhumance occurs on a seasonal basis, from the end of the spring and the middle or end of autumn, almost exclusively with cattle. Herds spend the winter close to the home ranches, located in the lowlands, where they can be protected from predators and fed with stored forages when the snow is deep and prevents grazing. In southern Alberta province, the grasses in these lower areas maintain relatively high protein levels over the winter so are very palatable for cattle grazing. Periodically warm Chinook winds melt the snow exposing the hillsides for grazing. The number of farms in Canada and Alberta is decreasing, the size of the farms is increasing, the number of beef cattle per farm is increasing and number of farms with cattle is decreasing. Grazing in the highlands faces several challenges. The publicly owned landscapes are deemed to be multi-use and cattle grazing shares with recreation and wildlife habitat conservation. Predation by wolves, grizzlies and cougars is an issue. The rental rate framework calculates lease rents based on the profitability of operating a grazing lease, considering market prices, transportation, and operating and labour costs.

Keywords: Multi-use of mountain landscape; Public action (specific public policy); Transhumance; Canadian Rocky Mountains; Cattle grazing; Predators



Introduction

The Rocky Mountains are a large mountain range in Western North America, in the United States and Canada, stretching over 3,000 km from the New Mexico US state in the South to the Northern British Columbia Canadian province, in the North, where they are known as the Canadian Rockies (Map 1).

Map. 1. Rocky Mountains (left) in North America and Canadian Rockies (right) in Western Canada

A brief presentation of the geomorphological and bio-climatic characteristics of the Rocky Mountains sets a base for information about the human context of the area. This has had an impact on colonization of the area over the past centuries and consequences on the grazing management and the transhumance, currently and in the future. Although the Rocky Mountains have long been traversed and inhabited by indigenous populations, in the USA and Canada, they represented an obstacle for European American and Canadian immigrants as they settled in Western North American.

I. Geo-morphological and bio-climatic characteristics of the Rocky Mountains

The Rocky Mountains were formed during the Cretaceous, around 70 million years ago. However, certain Southern sectors date back to the Precambrian (i.e. between ~ 4.5 billion years and ~ 542 million years ago). The Rocky Mountains are the result of the collision between the North American plate and the Oceanic plate.

Rivers flowing from the Rockies empty into three of the world's five oceans: the Atlantic, Pacific, and Arctic. The region is a huge watershed. As a result, the Rockies are considered to be one of North America's water towers. As in other high-altitude mountains, vegetation in the Rocky Mountains depends on many factors: as the range stretches in latitude, geographical position largely determines the appearance of the flora (Photos 1 & 2). Other differentiating criteria are exposure to sun or wind and altitude. Vegetation is in fact layered. In the Alpine zone, for example, grassland replaces forest.

Photos 1 & 2. Mountain landscapes of the Canadian Rockies (© Debbie Webster)

II. The Rocky Mountains human history

Since the last Ice Age, the Rocky Mountains have been considered a sacred place by the Paleo-Indians. This distinctive character was later maintained by the Apache, Arapaho, Bannock, Blackfoot, Cheyenne, Crow, Flathead, Shoshone, Sioux, etc. The first inhabitants of these regions hunted mammoth and bison in the hills and valleys. They probably migrated to the plains in early autumn and wintered in less hostile areas. They returned to the mountains in spring and lived by fishing, hunting, and gathering. A form of transhumance therefore already existed, with indigenous communities travelling to find the resources they needed to survive. Some indigenous communities also practiced slash-and-burn agriculture, and consequently they have modified the natural environment, as in many other areas in the planet. The oldest archaeological evidence dates back 10,000 or 12,000 years.

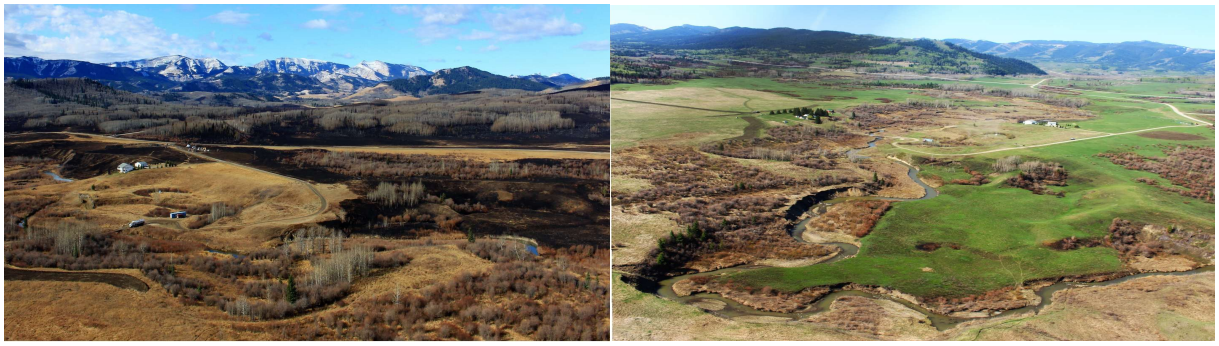
III. Specificities of the Canadian Rocky Mountains

The Canadian Rockies are the Eastern most part of the Canadian Cordillera, the collective name for the mountains of Western Canada. They are part of the American Cordillera, an almost continuous series of mountain ranges stretching from Alaska to the very tip of South America. The Cordillera is, in turn, the Eastern part of the Ring of Fire bordering the Pacific Ocean.

The Canadian Rockies are the Northern portion of the Rocky Mountains. Measuring 1,200 km in length, they begin at the Canada-U.S. border and end on the Liard River plain in British Columbia. They straddle the border between Alberta and British Columbia provinces.

The Canadian Rockies are bounded on the East by the Canadian Prairies, on the West by the Rocky Mountain Trench and on the North by the Liard River. The Southern limit corresponds to the border with the United States (49th parallel). This is, of course, an arbitrary boundary, as the mountain range continues into the United States. From an orogenic point of view, the Southern boundary could be considered to pass through the Marias Pass in Montana, which geologically separates the Canadian Rockies from the Rocky Mountains. The Canadian Rockies are different from the Rocky Mountains. They are older and were formed mainly by thrusting, whereas the Rocky Mountains were formed mainly by tectonic uplift. They are also almost exclusively sedimentary, whereas the Rocky Mountains have

a granitic core. Their physical appearance is different, since the Canadian Rockies were covered by glaciers, resulting in sharp-topped mountains (Photo 3) separated by wide, U-shaped glacial valleys (Photo 4), whereas the Rocky Mountains have more rounded peaks separated by river-carved V-shaped valleys.



Photos 3 & 4. Sharp-topped mountains separated by wide U-shaped glacial valleys (© Debbie Webster)

The average temperature is 6°C, with July the hottest month at 28°C and January at -2°C. Average annual snowfall is 36 cm. Precipitation averages 460 mm with considerable yearly variations. Snow is possible every month of the year with the most falling November to April (AAFRD, 2003).

The vegetation of the Canadian Rockies is highly diverse. It consists of Alpine meadows and meadows, as well as evergreen forests (Photos 5 & 6.). Subalpine forests dominate, covering the entire foothills from Alpine meadows to valleys (Photos 1, 2, 3 & 4). The Montane Natural Subregion (Whaleback, Livingston and Porcupine Hills) is valued for grazing, its important wildlife habitat, and recreational activities. The areas are characterised by 'mild summers, a summer-high precipitation pattern, frequent Chinook winds and warm winters" (Downing and Pettapiece, 2006).

Photos 5 & 6. Landscape of Alpine meadows in summer and autumn (© Debbie Webster)

The wildlife of the Canadian Rockies is easily observed in the national parks, and forestry reserves: moose, elk, mule deer, bighorn sheep, Rocky Mountain goat, black bear, and coyote. (Photos 7 & 8). Many trout species, such as bull, rainbow, cutthroat, and Dolly Varden, are native to Canada, whereas others, such as brown and brook, have been introduced for fishing.

Photos 7 & 8. Presence of diverse and numerous wildlife in the Canadian Rockies (© Debbie Webster)

One important event was the building of the Canadian Pacific Railway (CPR) which was founded to link the province of British Columbia with the Eastern provinces. The main difficulty was crossing the Canadian Rockies: mountain passes, swift rivers and dizzying waterfalls slowed construction of the line.

Currently, a significant activity in the Canadian Rockies is the five national parks, four of which are closely linked to form the UNESCO World Heritage Canadian Rocky Mountain Parks, since 1984, for their unique landscapes featuring peaks, glaciers, lakes, waterfalls, canyons, and caves, as well as fossils found in the Burgess Shale. These four parks are Banff National Park, Jasper National Park, Kootenay National Park, and Yoho National Park. The fifth park, Waterton Lakes National Park, is located further south, along the border. The Canadian Rocky Mountain Parks site also includes Alberta's and British Columbia's provincial parks.

IV. Early history of ranching in Southern Alberta

Open-range ranching in Southern Alberta began in the 1880's as cattle and ranchers moved up from Texas, Oklahoma and Montana USA, and Eastern Canada. It became a hybrid of Old and New World culture skill and expertise adapting to the harsh environment of the region. Brutal winters in 1886–87 and 1906–07 with big snows and no Chinooks killed the open-range approach to ranching with the realization that stored winter feed was needed. Many ranches lost entire herds (Andrews, 1970).

By 1912, open-range ranching was dead—as were many ranches, including some of the large corporate outfits. But the people that survived were tough, resilient, and innovative. They adapted expertise from American, British, and Eastern Canadian experience and made the rangelands their home. They learned the benefits of moving cattle from ranch home bases in the valley bottoms to the highlands for summer grazing. They established the base for the successful ranching industry that is seen today (Andrews. 1970).

"The influence ranchers had on southern Alberta can be seen in many examples, such as the Calgary Stampede, established in 1912 to honour the end of open-range ranching, and the preservation of vast swaths of Alberta's native rough fescue grasslands" (Andrews, 1970).

Women on these Southern Alberta ranches, as in other agricultural regions in the world, stepped into new unconventional roles to ensure the success of the ranch (Photos 9 & 10). These early women fed threshing crews, grew gardens, raised large families, trained horses, and moved cattle herds from the ranches to the highlands (Herbert, 2017).

Photos 9 & 10. Relevance of women in Canadian ranch managing the herds (© Debbie Webster)

V. Transhumance in Canadian Rockies: a complex land-herd-grazing system

In the case of the Canadian Rockies located in the Alberta province, the transhumance occurs on a seasonal basis, from the end of the spring and the middle or end of autumn, with some variations between the years, according to the availability of the grazing resources. Moreover, the transhumance deals almost exclusively with cattle. Herds spend the winter close to the home ranches, located in the lowlands, where they can be protected from predators and fed with stored forages when the snow is deep and prevents grazing. After calving in the spring, the herds are moved from the home ranches to the higher elevations. This cattle movement happens along the Rocky Mountain foothills of most of Western Alberta. During the transhumance, cattle graze freely over large areas loosely marked by fencing. In the autumn as temperatures fall and the grasses in the high areas become dry and decrease in protein content, the cattle are moved to the lower elevations and valley bottoms.

In Southern Alberta province, the grasses in these lower areas maintain relatively high protein levels over the winter so are very palatable for cattle grazing. The area is modified in the winter by warm Chinook winds that melt the snow exposing the hillsides for grazing. Ranchers owning or leasing these lands value this service very highly. These warm, dry Chinook winds originate from the Pacific Ocean and blow eastward over the Rockies. They cool on the mountainous slopes and then warm significantly as they blow downward onto the prairies. There may be 30–35 days in the winter affected by these winds.

The ranches have their home base at elevations from 1000 m, altitude of the Alberta plains, to as much as 1345 m (similar to Banff, Alberta townsite) and are identified as being in the foothills. Further into the mountains, summer grazing happens significantly higher, up to 2100 m where it is open enough for grazing, a difference around 1000 m.

The landownership in the highlands is a mix of private and Crown (public) with the higher elevations almost exclusively publicly owned. Predating the creation of the Alberta province in 1905 much of these lands were leased for grazing with current leaseholders holding the leases for more than a century.

The number of farms in Canada and Alberta is decreasing, and the size of the farms is increasing, but specific statistics for the region of interest are not available. This has been a trend over the past 125 years in all of Canada (Statistics Canada, 2023). The number of beef cows on cow-calf farms in Canada has decreased: from 4.5 million in January of 2008 to 3.3 million in January of 2023. The average number of Canadian cattle and calves per farm increased from 134 in January 2008 to 155 in January 2023. Those numbers went from 204 to 229 per farm in Alberta (CBC, 2023).

At the same time, Canada's domestic beef production in 2022 was the third largest on record after 2004 and 2005. Carcass weights are increasing. Canadian cow numbers are down. Off farm income is increasing (Canfax, 2023).

Producers are continually looking for efficiencies assisted by extension work and researchers: “Strategies to improve the efficiency of beef cattle are focusing on operational and breeding management, host genetics, functional efficiency of rumen and respiratory microbiomes, and the structure and composition of feed” (Terry et. al, 2021).

Grazing in the highlands faces several challenges. Firstly, at the highest elevations in the summer the publicly owned landscapes are deemed to be multi-use and cattle grazing shares with recreation and wildlife habitat conservation. Excessive/intense cattle watering in streams can damage banks and stream structure causing negative impacts on fish, especially, trout spawning. Secondly, predation by cougars, grizzlies and wolves is an ongoing challenge for ranchers. The latter two are protected by government legislation. In 2024 Alberta farmers made 48 compensation claims for lost livestock to predators. (Scheele, 2024). The Wildlife Predator Compensation Program provides compensation for those lost animals. In place for 45 years the program is funded by dedicated revenue from the sale of provincial recreational hunting and fishing licenses, and by the federal government (Scheele, 2024). Although there is a government compensation program the claims are often difficult to prove and take time from regular ranching activities. Controlling and monitoring herds on land far from headquarters is a constraint that compounds the previous two challenges.

At lowest elevations, where much of the land is privately owned, voluntary programs are available to assist ranchers with offsite watering to protect water quality and quantity (Cows and Fish Riparian Management Society, 2024). Extension programs also assist with grazing management to encourage increases in productivity for cattle grazing and wildlife habitat (ARECA, 2024). The grassland in the lowest elevations is also much sought after for acreages (small holdings) for retiring people or for summer/weekend homes. This fragments the landscape for grazing and wildlife habitat.

The Upper Foothills subregion is found below the Subalpine in elevation and above the Lower Foothills subregions, dominated by closed canopied lodge pole pine forests. It ranges in elevation from 1200−1500 m at lower latitudes and from 1000−1250 m at higher latitudes. The shrub and grassland community types in the valley bottoms provide important wildlife habitat, summer livestock grazing and recreation (Agriculture and Agri-Food Canada, 2007). There has been increasing discussion about how these lands are managed and what the management expectations are. Public concerns are being expressed about recreational access, leaseholder liability, environmental protection, rental rates, and lease tenure and transferability.

On all provincially owned Crown land, the province is paid a rental fee by producers for the grazing rights. According to Alberta Government (2024):

“The grazing rental framework is based on cattle markets and reflects the economic reality of managing a disposition, while ensuring Albertans get fair value for the use of the province’s resources. […]

The rental rate framework calculates lease rents based on the profitability of operating a grazing lease, considering market prices, transportation, and operating and labour costs.

To calculate rent we use a model based on: (i) the purchase of yearlings in the spring, (ii) weight gain on the lease during the grazing season, (iii) sale price in the fall.

Although there is considerable variability in how cattle operations and grazing leases are managed across the province, this standard was chosen to provide consistency.

Inputs to the model come from actual market reports (example: Canfax) and take into account long-standing cycles between spring and fall markets, as well as yearling and calf markets. Grazing lease cost surveys provide inputs to the model such as: weight gain on the lease and direct and indirect operating costs

The most recent survey in 2021 was funded by the province and delivered through contracted services. The grazing lease rental rate varies as net revenue from cattle (steers) minus additional input costs and grazing lease costs (example: profitability) either increases or decreases.

There are 3 key calculations used to determine rental rate under the grazing disposition rental rate framework:

Key calculation	Inputs	Output
Net revenue calculation	Canfax steer prices (Market prices: 850 lb sale weight minus 650 lb purchase weight) = Weight gain from purchase to sale	Net revenue earned by rancher from cattle grazing on lease
Operating cost calculation	Direct costs + Indirect costs	Operating costs incurred by rancher whose cattle graze on the lease Return on investment (ROI) is calculated for the lease
Rental rate calculation	Return on investment (ROI) + Rental rate tiers[1], including minimum rent	Public lands grazing lease rental payment

[1] Rental rate tiers' are found at: Ministerial Order 09/2024: Public Lands Fees, Rents and Other Amounts Payable Order

[…]The government supports rangeland sustainability and proactively invests 30% of grazing disposition rental revenue above $2.9 million into rangeland sustainability initiatives through the Rangeland Sustainability Program."

The grazing leaseholders receive an annual negotiated compensation amount for loss of use of the land and for the adverse effects by oil and gas operators. Periodically these arrangements are challenged by factions of the public for the fairness of the system (O'Malley et al. 2016).

VI. Labour and workers, serious challenge for ranching, including transhumance

The Canadian Agricultural Human Resource Council has identified the widening gap between the labour requirements and the available domestic workforce as a challenge to the Canadian agribusiness sector. The sector has increasingly relied on foreign workers to address these labour shortages. The domestic agricultural labour force is considerably older than the average with over 17% of agricultural workers being over the age of 65 (CAHRC).

There are challenges to attract labour. Hours are irregular. During certain times of the year like calving, seeding, harvest hours and transhumance are long and work often stressful. Wages are often not competitive. Locations are remote and social activities scarce. Although internet access is improving there are many areas where it is unreliable.

The average age of Canada's farmers in 2021 was 56, compared to an average age of 49.9 in 2001 according to the Census of Agriculture. The number of farm operators under 35 declined 43 per cent. If number of farmers continues to trend downward use of technology increases as a solution to the lack of skilled labour and ensures food security. Immigration of temporary foreign workers is also used as a solution to the lack of labour. In the cattle industry these workers are employed year-round and often are able to apply for landed immigrant status.

More technology such as larger equipment with GPS, automation in confined feeding systems, automated temperature measuring systems, also supports larger farms, fewer producers and declining population in many rural areas. Work is progressing in wearable devices that track vital signs, movement, and behaviour to detect health issues early. Artificial intelligence and genomic testing are used to select optimal breeding pairs, increasing herd quality and productivity. Drones and satellite imagery are used to monitor pasture health, detect overgrazing, and manage forage resources. There is research on using virtual fencing and GPS collars to control cattle movement without the need for physical fences. RFID and GPS Tags facilitate automated tracking of cattle, reducing the need for roundups. Data management platforms exist to aggregate data from individual animals to provide insights for herd management. Hydraulic chute systems assist in sorting and processing cattle for vaccinations, weight monitoring, or shipping with less manual labour. There are challenges to adopting this technology. There are high initial investment costs, training requirements for workers to operate and maintain technology and integration into existing workflows.

VII. Strong policymaking to support the Canadian cattle ranching

The Sustainable Canadian Agricultural Partnership (Sustainable CAP), formerly referred to as the Next Policy Framework, is a five-year (2023–2028) investment by federal, provincial, and territorial (FPT) governments to strengthen and grow Canada's agriculture and agri-food sector. It replaced the Canadian Agricultural Partnership (CAP), which ended March 31, 2023 (AAFC 2023). Some form of an agricultural framework has been in place since 2002. It is based on a sustainable agriculture approach which includes environmental, social, and economic considerations.

In Alberta, the Sustainable CAP provides funding to the agribusiness sector to enhance capacity and competitiveness in order to expand economic growth, drive domestic and export market activity, and enhance food security and local food capacity. Alberta producers, farmers, ranchers, processors, and organizations can apply for these cost-shared grant programs: Efficient Grain Handling, Emerging Opportunities, Farm Technology, On-Farm Value-Added, Resiliency and Public Trust, Resilient Agricultural Landscapes, Value-Added, Water, Business Risk Agricultural Programs and Accelerating Agricultural Innovations (AB AG, 2024). Alberta's Sustainable CAP is delivered by Results Driven Agriculture Research (RDAR), an arm length government agency. It enables Alberta producers to determine priorities and lead agriculture research.

RDAR supports producer-identified priorities that enhance productivity, profitability and competitiveness. Any research project needs to provide economic benefits that can be adopted by producers. Projects may include plant & animal health, production efficiency, feed utilization, pest & disease management, and genetic improvements, (RDAR, 2024).

VIII. Market forces

From January to December 2023, according to Statistics Canada the demand for Canadian beef remained robust in both domestic and U.S. markets. Consumers' appetite for high-quality beef drove prices higher. Rising input costs challenged the producers' margins.

Furthermore, in terms of market, according to the Canadian Agrifood Policy Institute (CAPI), the Canadian agriculture and agri-food sector faces competing pressures that threaten its future sustainable land use. "These include: Canada, being a major producer and net exporter of high-quality sustainable agriculture and agri-food products, will face pressures to produce more to meet the demands of countries experiencing population growth, urbanization, and increased food demand. Commodity shortages and price spikes due to food scarcity will also exert upward pressure on prices, costs, farm income and land values, putting pressure on land conversion. Biofuel mandates and current agriculture support measures are also exerting pressure on prices and land use and need to be reassessed to preserve land (and food security) for future generations. Climate change and extreme weather events are impacting productivity growth, risking insufficient food production. Investments in R&D, infrastructure, better data and knowledge and technology transfer are key for future sustainable productivity growth, which can help achieve food security while minimizing environmental impacts. However, regarding the environmental impacts and protecting land use, policies promoting land zoning and protection of sensitive ecosystems must become an important part of the toolbox, drawing from international examples like the EU, U.S., and traditional Indigenous knowledge."

IX. Promotion of sustainability for Canadian cattle ranching

"Consumers are increasingly interested in how their food is produced and are seeking reassurance about the practices used to raise beef in Canada. From land and water stewardship to supporting local communities, and from animal care to innovations that improve efficiency and productivity, certification provides producers with recognition for the sustainable practices they already employ on Canadian beef farms and ranches. Retail and foodservice companies want to satisfy consumer demand for responsibly raised products by sourcing beef that has been raised according to sustainability standards, and to tell the story of sustainable beef production to their customers." (CRSB, 2024) To address these issues and concerns The Canadian Roundtable for Sustainable Beef (CRSB) was formed in 2014 to promote, measure and communicate continuous improvement in environmental, social and economic sustainability of the Canadian beef value chain (CRSB, 2024)

The Alberta Environmental Farm Plan (EFP) provides a tool for producers to assess areas of strength and potential environmental risks on a farming operation: "Providing a farm with increased awareness of areas of potential environmental concern it helps outline site-specific, individualized plans to address risks. Voluntary and free, The EFP program began in 2003 and has been delivered by the Agricultural Research and Extension Council of Alberta (ARECA) since 2013 (AEFP 2024).

The cattle industry works with conservation organization with similar goals such as Alberta Cows and Fish. A non-profit stewardship organization that empowers people who live, work, and play in Alberta's riparian areas to take action to care for riparian areas They work with landowners, communities and local stewardship groups to access technical advice and educational materials, monitor the health of their riparian areas, and evaluate new management strategies (ARMP 2024).

Alternative Land Use Services (ALUS) is another group working with agricultural producers to provide important solutions to pressing environmental challenges including climate change and biodiversity loss. Solutions are based on sound scientific principles and verification guidelines, to deliver nature-based solutions. The ecological services produced by ALUS projects have potential economic value on the marketplace. Citizens, corporations, and philanthropists are able to invest directly in environmental stewardship through ALUS (ALUS, 2024).

X. Change in technology

An important technology development for grazing management has been the use of solar and wind power. Norm Ward, a leading-edge grazier in Southern Alberta province, developed the Power Grazer as an all-in-one portable electric fencing tool. The Range Ward and its Power Grazer fencing products is a tool to manage grazing animals. The system centres around the use and management of grazing animals for regenerative agriculture**.** This approach and tools help to regenerate above and below ground biodiversity, improve water cycles, improve carbon cycles, and help improve the vitality and resilience of the ecosystem and the people on the land.

The Canadian Cattle Association (CCA) states: “Regenerative practices are part of a sustainable Canadian beef production system. Because no two farms or ranches are the same, producers adopt principles and elements of regenerative practices that are appropriate for their environment and individual operation in order to achieve desirable outcomes.

Regenerative beef production recognizes the co-benefits of integrating the crop and livestock sectors, which supports nutrient recycling as well as soil health. This must be viewed from an agricultural systems or community perspective.

Principles:

1. Utilize a holistic approach that seeks to strengthen ecosystems and community resilience

2. Limits soil disturbance, maintain soil cover, keep living roots in the ground and active as much of the year as possible

3. Optimize plant biodiversity (e.g. manage crop rotations for the ecosystem/region, complex pasture mixtures) including forages, intercrops, polycultures and cover crops into rotations

4. Utilize grazing concepts including a focus on the grazing period to avoid overgrazing, suitable rest periods, animal impact to stimulate the soil, appropriate stock density, and preserve soil cover

5. Recycle nutrients with grazing and crop-livestock integration” (CCA, 2021)

In 1998 the Canadian Cattle Identification Agency was created to administer a national cattle identification program. Initially the intent of the system was to allow the trace back to herd of origin of any bovine for the purposes of animal health and food safety, (CCIA, 2024). “The core objective of the […] CCA National Cattle Identification program is to create a system whereby every bovine animal sold by its original owner, and leaving its herd of origin, bears a unique identification number. That unique identification number will remain with that animal until it is slaughtered and after slaughter will serve to identify the carcass and its products and will be maintained as an identifying number until 60 days post slaughter” (CCIA, 2024).

This unique animal identification program now supports a sustainable beef production value chain. Cattle can be certified and tracked through the ear tag program and move through the chain of custody to participate in the Cargill Chain of Custody program increasing value to the producers.

Statistics Canada's 2016 census data were analysed to determine the proportion of Canadian cow-calf producers who had adopted the use of seven different technologies and two different grazing/feeding management practices, collectively referred to as management tools. The four most commonly used management tools were rotational grazing, in-field winter grazing/feeding, smartphones/tablets, and computers/laptops. These technologies assist in data management. If you can measure it and track it, you can manage it.

Feed type and quality, additives, and husbandry practices affect greenhouse gas emissions (GHG). Reducing these emissions by implementing the following beneficial management practices on farm also often improves economic efficiencies: (i) Select livestock to improve genetically feed use efficiency; (ii) Feed high quality feeds and appropriately balanced rations; (iii) Feed livestock based on sex, age and stage of production matching diet to nutritional requirements; (iv) Increase the digestibility of feed by mechanical (i.e. chopping, grinding or pelleting feed), chemical or biological processing; (v) Reduce age to harvest; (vi) Improve forage quality; (vii) Implement strategies to improve fertility rates (i.e. pregnancy test cows, evaluate bulls breeding soundness and adopt a strict culling program).

Most GHG emissions from beef production occurs when cattle are grazing on pasture lands that are not well-suited for growing annual crops. These lands support a wide range of ecological services that improve climate adaptation. Practices that increase efficiency, reduce GHGs and enhance climate resiliency include: (i) converting marginal crop land to perennials to increase GHG removals by soil carbon storage; (ii) reducing or eliminating cultivation to lower soil carbon losses from tillage and CO_2 from use of fossil fuels; (iii) managing stocking rates to avoid overgrazing and high concentrations of manure; (iv) including non-bloating legumes to reduce amounts of added nitrogen; (v) extending grazing seasons with swaths or bales to lower CO_2 from fossil fuel use and save on feed costs (Alberta Government, 2025).

Conclusion

Regarding the "Past, Current and Future Change in the Canadian Rockies", the transhumance is only a classic, old and efficient practice of cattle breeding allowing profit from the highest pastures from the end of the spring to autumn, even given some constraints, such as predators and weak control due to the distance from the farms. So, transhumance, as an integrated practice in the cattle breeding in the Canadian Rockies, faces the same current and future challenges which could be defined as follows: The breeders (ranchers) must adapt and change. They profit from a supportive Canadian federal and Alberta provincial policymaking environment based on necessary maintenance of the breeders' livelihoods, research of sustainability, market analysis and consumers' demand.

An interesting point is the increasing importance of the environmental issue, especially in (i) the provincial parks and wilderness/forestry reserves as tourism, and consequently economical, and ecological drivers of the Canadian Rockies dynamic; (ii) the set of public policy focused on both environmental protection/conservation and agribusiness. Another point is the gradual and inescapable ageing of the rural population, or the lack of interest among young people to get involved in rural activities, for a variety of reasons.

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Chapter 10

Pastoralism and transhumance in Ecuador

Case study of the Rio Chimborazo watershed*

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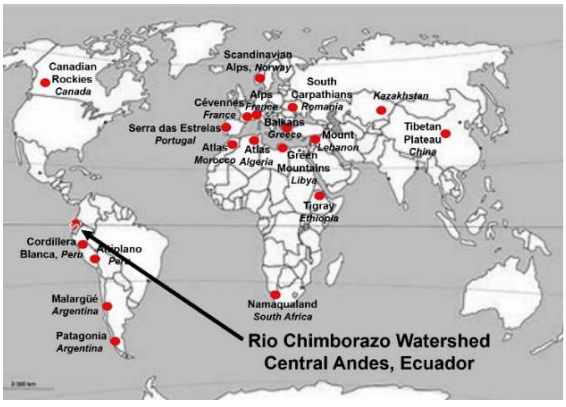
Abstract

Mountain transhumance in Ecuador differs from that in many other mountainous regions due to the equatorial climate, which allows grazing on high-altitude natural pastures year-round. As a result, access to Alpine meadows—known as *páramos* —is rarely a limiting factor for herders. Transhumance involves all herbivorous species, including small ruminants (sheep and goats), small camelids (llamas and alpacas), and cattle, and can be practiced almost throughout the entire year. The main drivers of transhumance are land access and the need to free up land for crop cultivation, which is essential for household food security. In recent years, economic migration has increased among rural community members as they seek to meet their needs, impacting the entire agrarian system but also opening up new opportunities. Historical analysis shows that livestock farming—and thus transhumance—has continuously evolved since the colonial period, influenced by numerous changes in national land policy. However, this evolution has not narrowed the gap between, on one hand, precarious subsistence-based village communities and, on the other, the descendants of settlers who possess larger landholdings, enabling them to generate substantial profits and invest in technology.

Keywords: Good climatic conditions; Policy; Land tenure; Livestock practices; *Páramo*



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Introduction

The productive transformation of the Ecuadorian Andes is part of a historical process tied to broader agrarian changes in the country and shaped by a series of significant social events over time. During the pre-Inca period, before the 13th–14th centuries, native communities managed their territories according to a system known as 'microverticality,' which organized land use perpendicularly to the mountain slope. This system was designed to adapt to variations in soil, water, and climate. Pastoralism, accordingly, followed a transhumant pattern, ranging from the highest rangelands —known as *páramo*, located at 3,500–4,000 metres above sea level— down to agropastoral lands at the base of the slopes and valley floors at 2,000–2,500 metres.

This traditional system remained largely intact during the Inca conquest in the 15th century. However, with Spanish colonization in the 16th century, a new land-use model was introduced to ensure political dominance, societal control, and the extraction of productive surpluses by colonial authorities. This led to major transformations in social organization, land use, landscapes, pastoralism, and the practice of transhumance. Many areas previously cultivated by local communities were converted into grazing lands for sheep, owned by a few large landowners connected to the Spanish elite. The wool from these sheep supplied raw materials for textile production, primarily for export.

Despite these shifts, traditional pastoralism and transhumance practices persisted in some smallholder communities. However, the wool crisis at the end of the 16th century led to a decline—and in some cases, abandonment—of sheep farming. Large estates transitioned to cereal agriculture, relying heavily on the labour of local peasants. Social tensions escalated and persisted through the formation of the Republic of Ecuador in 1830 and into the early 19th century.

To address issues related to land tenure, water access, and grazing rights, the government implemented several public policies. These included the Agrarian Reform Law of 1964 and accompanying support measures such as the promotion of technological modernization and agricultural credit, with an institutional focus on dairy farming. However, these policies had limited impact on local communities, who remained in precarious conditions and were often pushed onto marginal lands unsuited for sustainable agriculture or livestock.

In such conditions, resource-poor communities became increasingly marginalized and vulnerable to socio-environmental challenges. For over three centuries, traditional pastoralism practiced by local communities was constrained by an agrarian system imposed by Spanish colonization—one that prioritized large-scale production for urban supply, mining, and export, rather than the improvement of rural livelihoods.

I. Biophysical elements of Central Andes

The Ecuadorian Andes stretch from north to south, with altitudes ranging from 1,800 metres above sea level (asl) to 6,268 metres asl at Chimborazo Volcano. Their location within the neotropical belt of South America has fostered the development of numerous microclimates and highly variable soil types. In general, however, the region is characterized by deep, fertile soils that support productive agriculture. Despite the diversity of soils—shaped in large part by volcanic ash deposits—distinct patterns emerge, from the high-altitude *páramo* ecosystem to the inter-Andean valleys and the lower, drier basins. Most of these areas were traditionally covered by natural rangelands, giving rise to a range of pastoral practices and transhumance systems, adapted to the different farming methods used by local peasants.

From an agrarian perspective, two major ecosystems coexist in the Ecuadorian Andes. Firstly, the *páramos* serve as the primary rangelands for transhumant herds (Photo 1). Located mostly above 3,000 metres asl and extending up to around 4,000 metres asl, these areas are part of a cold, humid climate zone, with temperatures generally ranging from 2°C to 10°C. This climatic context strongly influences soil formation and conditions. In the *páramo*, organic material—composed of aluminum-silicate and organic carbon compounds—has accumulated over thousands of years, resulting in black, soft, deep, and highly humid soils that are extremely fragile. Although the *páramo* provides excellent natural pasture for livestock, it must be carefully managed to prevent environmental degradation.

And secondly, the inter-Andean valley features a mosaic of landscapes—including small plains (Photo 2), hilly valleys, and steep slopes—that, while prone to erosion, are highly fertile. In these areas, where agriculture and livestock farming are intensively developed, Andisol soils dominate much of the land used for crop production. The clay fraction of these soils is rich in amorphous minerals such as allophane, imogolite, and halloysite, which originate from the weathering of pyroclastic materials derived from volcanic ash.

Photo 1. Paramo in the Rio Chimborazo watershed

Photo 2. Landscape of the inter-Andean valley floor

These two primary biomes—the *páramo* and the inter-Andean valleys—offer a wide range of possibilities for agro-pastoral feeding systems, combining natural rangelands, cultivated grasslands, and agricultural by-products. For centuries, various forms of transhumance have existed between the *páramo*, the slopes, and the valley floors, depending on the farming systems in place. The chemical composition of the soils in these regions is highly variable, reflecting a complex nutrient profile (Table 1).

Table 1. Chemical composition of soils focused on sheep and cattle breeding in the Andean watersheds (Source: Palate 2022)

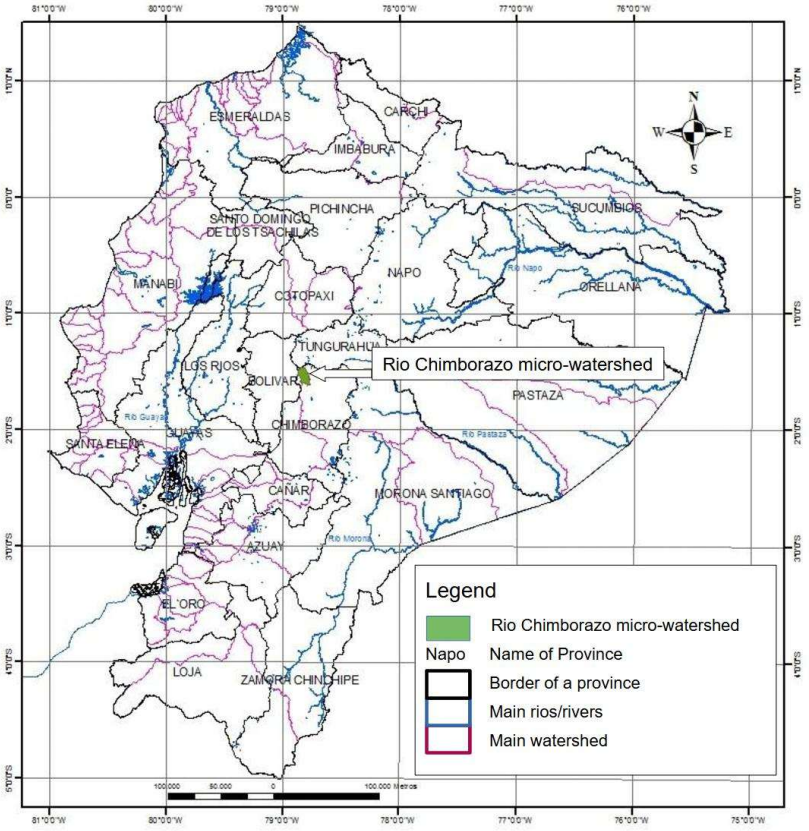
Variable	**High altitude (metres asl)**	**Low altitude (metres asl)**
	3.500–3.700 Natural grassland (*páramo*)	**3.000–3.400 Natural or cultivated pastures**
pH	6.10 ± 0.126	6.28 ± 0.450
Organic matter (%)	5.13 ± 2.192	7.35 ± 2.475
Total nitrogen (%)	0.25 ± 0.110	0.37 ± 0.123
Phosphorus (ppm)	2.97 ± 1.051	26.21 ± 11.624
Potassium (cmol/kg)	0.27 ± 0.124	0.37 ± 0.275
Calcium (cmol/kg)	8.62 ± 1.682	13.26 ± 1.738
Magnesium (cmol/kg)	2.18 ± 0.748	3.47 ± 0.699

According to Varela and Ron (2018), Ecuador's climate varies significantly with altitude, with transitional zones extending westward toward the coast and eastward toward the Amazon. The climate ranges from very humid tropical conditions in the Amazon to humid temperate in the inter-Andean region, warm and dry in certain valleys, and cold at high elevations in the *páramo* above 3,000 metres. The study area experiences two rainy seasons, typically from March to April and from October to November. Average annual rainfall ranges between 800 and 1,500 mm.

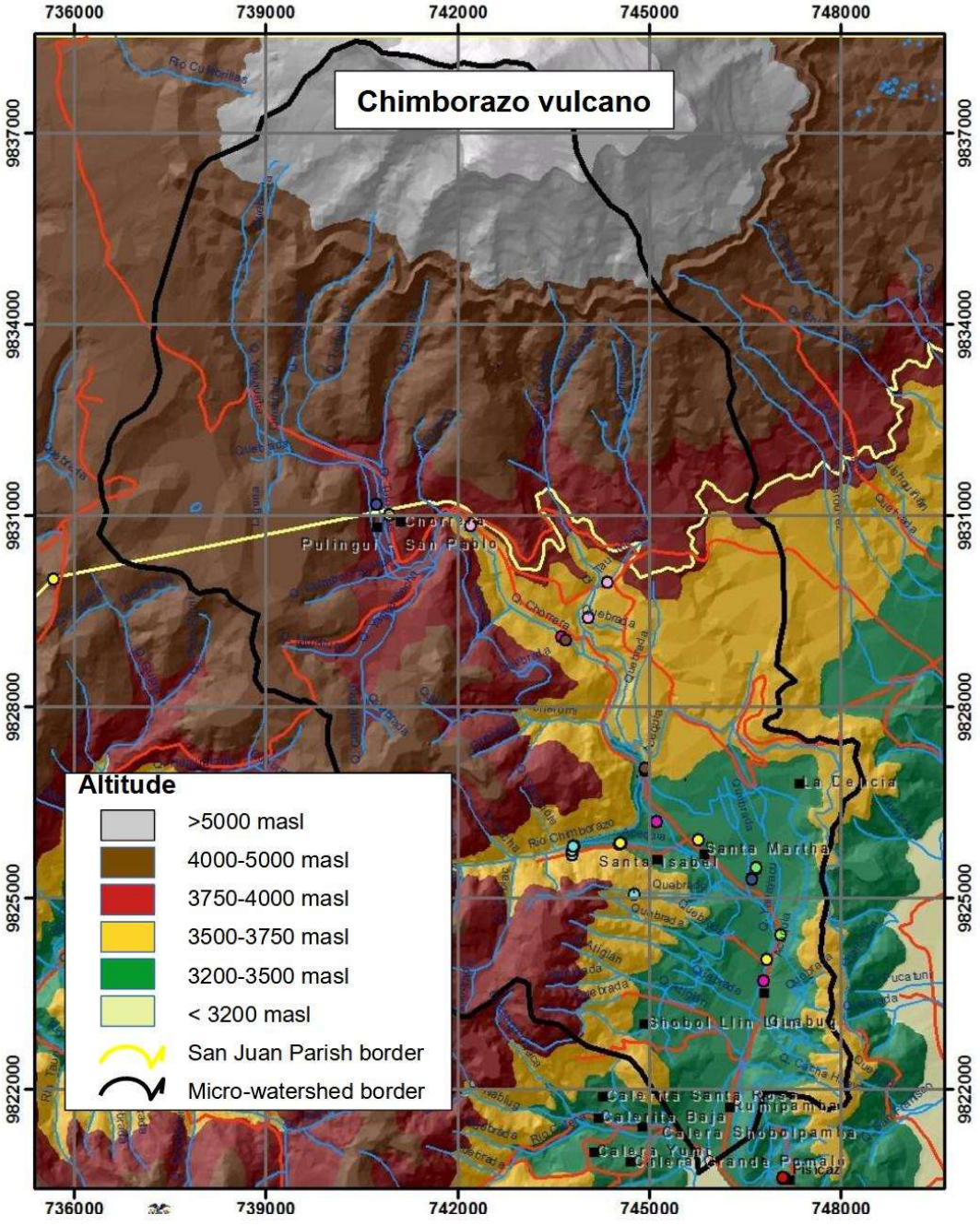
Temperature is closely linked to altitude, ranging from approximately 20°C at 1,500 metres asl to 8°C at 3,000 metres asl, with an average gradient of about 5°C per 1,000 metres of elevation. This consistently positive temperature throughout the year allows for continuous access to various types of pasture. As a result, transhumance is not strictly seasonal, and a variety of transhumance practices and strategies are employed depending on the specific farming systems.

II. Rio Chimborazo Watershed: a biocultural region in the Equatorian Andes

The Chimborazo River originates in the parish of San Juan, located in the central Ecuadorian Andes, within the canton of Riobamba, in the northeastern part of Chimborazo Province—named after the river itself (Maps 1 & 2). The San Juan Parish spans an area of 22,111 hectares, with elevations ranging from 3,200 to 6,300 metres asl.



Map 1. Chimborazo micro-watershed in the Ecuador national context



Map 2. Rio Chimborazo micro-watershed

III. Local communities: history and diversity of productive systems

Until the 15th century, before the Inca conquest, the region was inhabited by the native nation of the Puruhá. Their socio-spatial organization was based on Cacicazgos, or ethnic lordships, which led networks of communities. These communities were structured within Llactacunas, themselves embedded in Ayllus. This social system was intricately linked to the ecological characteristics of the Andean region. Territorial management followed what Salomón (1985) defined as Andean 'microverticality': in each village, households cultivated and managed land across different ecological zones. They carried out a wide range of activities—residential, agricultural, commercial, ritual, and recreational—at varying altitudes (Oberem, 1981; Moreno, 1996; Ontaneda & Fresco, 2002; Andricain & Osorio, 2006).

The *páramo* zone near Chimborazo Volcano was used for gathering straw from native grasses and for hunting; the sub-*páramo* zone supported potato cultivation and other Andean crops such as oca (*Oxalis tuberosa*), quinoa (*Chenopodium quinoa*), and *melloco* (*Ullucus tuberosus*). Temperate valleys were used for intensive maize production and the cultivation of crops like *zambo* (*Cucurbita ficifolia*), beans, and *chocho* (*Lupinus mutabilis*). In the hotter valleys of the larger river basins, cotton, chili, and coca were grown (Holm & Crespo, 1980). In this context, transhumance between the *páramo*, cultivated pastures, and post-harvest crop residues was an effective year-round strategy for livestock feeding within the agro-pastoral system.

With the Inca conquest in the 15th century, self-sufficiency and the use of diverse ecological niches were maintained. The system of microverticality persisted (Ramón, 1995), as Inca rule aimed more at integrating local systems into the empire than dismantling them. Rather than imposing structural changes, the Incas adapted local sociopolitical structures to be compatible with state control while preserving significant local autonomy (Andricain & Osorio, 2006).

In contrast, the Spanish conquest in the 16th century brought a radical reorganization of land occupation and settlement. Beginning in 1570, four interrelated mechanisms were implemented to ensure the colonial appropriation of productive surpluses, political dominance, and social control (Andricain & Osorio, 2006). The province of Puruhá was particularly affected due to its dense population, abundant agricultural and grazing lands, and the colonial perception that its inhabitants had relatively advanced customs (Haro, 1977). The traditional ethnic lordships were dismantled, and their territories were usurped to establish large estates (haciendas) under Spanish control. Native populations were forcibly relocated to 'Indian towns' to facilitate religious indoctrination and social oversight.

This colonial transformation drastically altered the landscape of Chimborazo. A formerly diverse agropastoral region was converted into a livestock-oriented zone, focused on high-volume wool production for the textile industry. This wool, exported to Lima, then to European industrial centres, was sourced primarily from sheep raised on *páramo* pastures. Indigenous communities—once self-sufficient—were heavily exploited as labour for both sheep raising and textile manufacturing.

The emphasis on sheep farming in native communities was no coincidence. From the 16th century onward, Spanish landowners were already major sheep producers. The Spanish Crown also promoted and enforced sheep rearing among indigenous populations using low-input systems based on grazing natural highland pastures. Cattle, by contrast, were not commonly raised by native communities. Instead, they were kept on haciendas located in temperate valleys with more favourable climates. Ecuador's livestock history thus dates back to the 16th and 17th centuries, when haciendas began specializing in sheep and cattle, including pack animals.

However, the colonial sheep industry soon faced challenges. The textile crisis of the late 16th century led to a decline in wool demand. Consequently, even within the haciendas, crop production began to take precedence over sheep farming. In the early 19th century, cattle production underwent significant modernization, driven by the expansion of the domestic market and the construction of railway infrastructure in the Andean region (Barsky, 1981).

The creation of the independent Republic of Ecuador after 1830 brought only limited changes to the dominant political and economic structures. Instead, it accelerated the fragmentation of indigenous communities and their ancestral territories (Andricain & Osorio, 2006). At the same time, the expansion of haciendas into high-altitude areas began to disrupt environmental conditions, particularly through increased water scarcity, which further fuelled social tensions. The growing number of estates and *obrajes* (textile workshops) also contributed to declining soil water retention capacity (Ramón, 2004; Carlosama, 2000).

Starting in the late 1930s, the Ecuadorian government attempted to address social conflicts related to access to land, water, and other resources—conflicts largely rooted in hacienda practices (Bretón, 1997). Over time, the indigenous population had become a semi-servile labour force, which dismantled traditional social structures. Unfortunately, the agrarian reform and land redistribution that followed had limited success. Much of the land redistributed was unsuitable for cultivation: only 3% was arable, 17% was pasture, 61% was forest, and the remaining 19% was unused.

IV. Local arrangements as strategy to access resources and agro-pastoral development

Inhabitants of the watershed are descendants of *huasipungueros*, for many become workers in the large haciendas. The families are organized in communities, and also in cooperatives and associations, which respond to their local demands, needs and decisions (Photos 3 & 4). Collective work is usual, especially for agriculture. Consequently, the communities are generally grouped in bigger organizations, as the two more important are the Union of Peasant Communities of San Juan (UCASAJ), made up of 17 communities located in medium-low territories, and the Federation of Indigenous Organizations of the Chimborazo Foothills (FOCIFCH), made up of 5 grassroots communities, located in the highest areas. In addition, there are several agricultural workers' associations and women's organizations, the latter created after the enactment of the Chimborazo Fauna Production Reserve Zone, which forced the affected communities to negotiate natural resource management with the Ministry of the Environment.

Photos 3 & 4. Woman spinning wool (3), collective work (4). Source: Comunidad La Delicia, rio Chimborazo watershed

V. Socioeconomic characteristics of local population and access to basic services

Households are typically composed of a father, mother, and children, with an average family size of 5.2 members. Most adults and young people are primarily engaged in agricultural work, while livestock-related activities are mainly carried out by women. Although most children attend school, the quality of education is low, largely due to the prevalence of multi-grade teaching by a single teacher.

The communities are served by a health sub-centre that provides basic healthcare and rural social assistance. They have access to piped water, latrines for waste disposal, public telephone services, radio, and television. Families generally own their homes and are connected by a primary road and secondary roads that provide access to each community (Plan de Desarrollo Local UCASAJ, 1999).

Chronic child malnutrition remains a serious public health concern in rural Andean communities, affecting over 27% of children under the age of two. This situation has remained largely unchanged in recent decades and is attributed to poor nutrition, disease, limited access to basic services, and inadequate hygiene and sanitation (UNESCO-Ecuador, 2022).

VI. Characteristics of the farming systems

Since the enactment of the 1964 Agrarian Reform Law, two main mechanisms of land access and use have been practiced within the communities: family-based and community-based forms. These two systems complement each other, linking individual (family) ownership with collective (community or county) property. Inheritance remains a key means of land transfer, but is increasingly challenged by land fragmentation and declining soil fertility.

Community or county land is collectively managed, primarily in the higher *páramo* zones. The use of these communal lands is regulated by local organizational structures to ensure sustainability (Andricain & Osorio, 2006). Recent environmental regulations promoting *páramo* conservation have also affected livestock activities. For instance, the number of sheep in the micro-basin dropped from approximately 7,000 in 2000 to just 350 a few years later (Andricain & Osorio, 2006).

Land use in the region reflects a true mosaic of small, family-owned cultivated plots, especially on moderately sloped terrain. These plots are used for short-cycle crops such as potatoes, carrots, barley, beans, and *melloco*, often organized within systems known as ‘home gardens’ (Photo 5).

Photo 5: Family ‘home garden’. Source: Comunidad La Delicia, rio Chimborazo watershed

On steeper slopes and at higher elevations, livestock raising—primarily cattle and sheep—is the dominant activity, relying mostly on natural grasslands (Photo 6), and to a lesser extent, on cultivated pastures located on the few flatter plots (Photo 7). Depending on management strategies, herds are moved through transhumance between the high-altitude pastures and the villages (Photo 8).

Photos 6, 7 & 8. Sheep on natural grassland (6), Dairy cattle on planted pasture (7,) Sheep going to páramo (8)

Furthermore, large plots of land are still owned by private haciendas. At present, there are only a few areas under community ownership, where only part of the land is cultivated while the rest remains fallow or is used as natural rangeland, particularly in the *páramo* and sub-*páramo* zones. There are no native forests, but all communities have small areas with planted trees.

San Juan Parish covers approximately 22,100 hectares, of which about 12,600 hectares (~58%) consist of natural rangeland. Of the 3,100 hectares (14%) designated as cultivated land, only 19% is used for food crops, while 82%—nearly 2,500 hectares—is dedicated to fodder production, primarily for dairy cattle. The remaining area—around 6,000 hectares or 30%—is composed of non-productive land, including sand, rocks, snow, eroded soils, and ice (GAD San Juan, 2021).

The dominant farming system in the Chimborazo River watershed is mixed crop-livestock farming. A rotational system between crops and pastures serves a dual purpose: maintaining soil fertility through manure application and providing feed from crop by-products. The lower and middle elevation lands are typically planted with potatoes, beans, barley, and carrots, followed by maize, quinoa, oats, wheat, rye, and various vegetables. These crops are primarily consumed by the household, with any surplus sold in local markets.

In terms of livestock, dairy production is the most significant activity. Average milk yield is eight litres per cow per day, totalling approximately 28,680 litres of milk produced daily across the San Juan Parish. Around 88% of this milk is sold—mainly to an industrial dairy processor—whereas the remaining 12% is reserved for self-consumption. The current livestock inventory in the parish includes approximately 325 sheep, 125 pigs, and 190 small camelids (llamas and alpacas), making these species relatively marginal.

The integration of native and introduced forage species, such as ryegrass (*Lolium* sp.), combined with rotational cycles—primarily with potatoes—has fostered a moderate level of livestock intensification. This is partly due to the fact that livestock farming typically requires less labour than crop production and is less vulnerable to weather-related risks.

Grazing practices involving cattle, sheep, and small camelids are also part of a broader soil fertilization strategy. Animals are brought to sleep in corrals near family homes—called *chacras*—where their manure can be collected

and used as fertilizer. These techniques, known locally as *sogueo* (Photo 9) and *corraleo* (Photo 10), are an essential part of the system. Traditionally, women and children are primarily responsible for animal care and herding.

Photo 9. Sogueo *system for dairy cattle*

Photo 10. Corral system for sheep, lamas and alpacas

Sheep, small camelids (llamas and alpacas), pigs (approximately 4,600 in the parish), and poultry play an important role in the food security of smallholder families in the communities. This is largely due to the lack of irrigation infrastructure and limited access to land ownership, which restricts the ability of many households to engage in cattle farming—particularly dairy production, which requires cultivated fodder (GAD Parroquial San Juan, 2021).

Within family plots or *chacras*, two main cropping systems can be observed: intensive monocultures for market-oriented production, and traditional crops and techniques aimed at self-consumption. Both systems contribute to household food security. In addition, many families maintain small plots in different parts of the community as a strategy to reduce climatic risks such as frost, hailstorms, or pest outbreaks (Andricain & Osorio, 2006).

The replacement of traditional crops by pastures for dairy and beef production is a relatively recent trend. This shift is partly driven by the low productivity of traditional agriculture, increasing soil erosion, and the scarcity of arable land. As a result, many families have turned to cattle and milk production as a source of daily income and food, relying on dairy breeds of medium to low genetic crossbreeding (Andricain & Osorio, 2006).

However, the current state of livestock production reveals troubling indicators, as it reflects the cumulative effects of environmental degradation, economic constraints, social pressures, and even the limited effectiveness of public policies aimed at supporting production (Table 2).

Table 2. Stocking rate and capacity for dairy production in two scenarios of pasture intensification in the Rio Chimborazo watershed

Scenarios of pasture intensification	**Frequency of grazing (day)**	**Capacity (animal unit/ha)**	**Stocking rate (animal unit/ha)**	**Milk production (kg/ha/day)**
Natural grassland (*páramo*s & sub-*páramos*)	60–75	0.23–0.30	0.1–0.50	< 1.0–2.3
Mixed pastures with pay-grass and white clover	45–60	2.1	1.2	7.0–11.0

VII. Where are the farming products going?

A portion of the potato production, as well as all of the broad bean and carrot production, is intended for sale. Another portion is used for family consumption and seed. Barley is used within the household. Milk production is both sold and used to make fresh cheese. Livestock such as cattle, sheep, and pigs are sold occasionally, usually when there is a financial need or for social events. The small amount of wool produced is sold, with minimal use for spinning, and hides are generally sold as well.

Agricultural products are sold at the Condamine, San Alfonso, and Plaza Dávalos markets in the city of Riobamba, mainly to intermediaries, wholesalers, and retailers. Riobamba's *camal* (slaughterhouse) is the main marketing channel, followed by sales at town fairs and to wholesalers and retailers within the communities themselves. In the case of raw milk, most of it is sold in the communities or directly from farms to intermediaries, who then process it into cheese.

VIII. Pastoralism, a socio-environmental challenge for local communities

Several political, economic, social, organizational, and environmental factors influence land-use decisions and shape the future of the communities.

1. Migration as social process of impact

Poverty and a lack of job opportunities lead some family members to migrate. Over a quarter (26%) of the population migrates either temporarily or permanently, within or outside the region, and their income significantly contributes to the household budget. Temporary local migration is most common in the lower and middle zone communities, where people work in the provincial capital in construction and domestic services. Permanent migration, both within the country and abroad, mostly involves young men and boys who work as drivers, construction workers, contractors, bricklayers, carpenters, and bakers. Women often work as domestic helpers or in factories. As a result, caregiving responsibilities fall primarily on women, who look after the children and also perform tasks such as cooking, sewing, farming, herding, spinning, fetching water, and collecting firewood.

In the Río Chimborazo watershed, there is also migration within the parish, involving both agricultural and non-agricultural activities. The ongoing subdivision of land has led to an increase in properties smaller than 2.0 hectares. In the lower zone plots range from 0.1 to 0.2 hectare, in the middle zone from 1.0 to 2.0 hectares, and in the upper zone they are typically larger than 2.0 hectares (PDA-UOCIC, 2006). The possession of such small plots hinders the productive use of family labour in both crop and livestock systems, limiting employment generation and thus driving migration. Families that own between 1.0 and 2.0 hectares use their production primarily for food security, selling any surplus in local markets, where intermediary chains significantly affect prices and family income.

2. Weak access to technology

The level of technology used in dairy herd management is very low. This is due to the use of poor-quality naturalized pastures, low soil fertility, a lack of chemical fertilization, minimal or no use of feed concentrates and mineral supplements, the absence of a veterinary care schedule, and poor calf-rearing practices. Additionally, government

institutions provide very limited technical assistance. In the *páramo* region, the practice of raising llamas and alpacas is being promoted with the support of the Curia of Riobamba (Sinchiguano, 2006). As for crops, the National Institute for Agricultural Research (INIAP) has encouraged the adoption of new varieties—particularly potatoes and other Andean crops—that offer better yields and greater resistance to pests and diseases.

Concerning irrigation water availability, most communities have access to irrigation canals or ditches that draw from various sources within the watershed. However, this infrastructure does not meet the needs of all communities, thereby delaying improvements in agricultural productivity. Rainfed agriculture is still common, even though the management of water resources began well before the 1964 Agrarian Reform Law. In fact, it predates the hacienda system, as community members (former *huasipungueros* and *yanaperos*) were traditionally responsible for building and maintaining the irrigation systems that supplied water to the haciendas and their crops (Ramón, 2004; Andricain and Osorio, 2006).

3. Importance of the family

All family members participate to on-farm tasks. When the man is permanently at home, he has the greatest decision-making power over what is to be cultivated. When he migrates, the responsibility falls to the wife or children, who are in charge of farming activities. Women actively participate in agricultural work such as planting, irrigation and harvesting. In livestock activities, they participate in the care of animals during grazing and milking cows. Despite this role, women often lack the power to acquire land ownership rights or have access to credit, training and project implementation, or management on behalf of the organization's assembly.

4. Point of view of local community about management and conservation of soil and water

In the Río Chimborazo watershed, the local population generally supports the conservation of natural resources. As a result, various soil conservation practices are in place, including the planting of windbreaks, reforestation, and the construction of slow-forming terraces. Tree plantations—often incorrectly referred to as 'forestation' and 'reforestation'—have been promoted, with the support of governmental and non-governmental organizations, to combat soil erosion on both community and family lands. These initiatives have encouraged the use of timber species such as eucalyptus and pine. Additionally, native species have been promoted for the development of agroforestry systems. Examples include *Quishuar* (*Buddleja incana*), *Yagual* (*Polylepis racemosa*), *Lupina* (*Genista monspessulana*), *Tilo* (*Sambucus nigra*), and *Llin-llin* (*Senna multiglandulosa*).

5. Access to loan for farming

Production is financed through savings, credit—either in kind or in cash—and a simultaneous savings and credit system. These resources are used to purchase agricultural inputs such as seeds, fertilizers, livestock, tools, and other necessities. The main formal sources of financing are the province's Savings and Credit Cooperatives, and to a lesser extent, the Banco de Fomento and Banco Solidario (Sinchiguano, 2006). However, families face two major limitations: lack of technology and insufficient capital—both of which are key factors contributing to low agricultural productivity. From a political standpoint, improving access to credit could significantly support community development, particularly through low-interest, long-term loans that are accessible to most families. Some non-governmental organizations, such as FEEP, have addressed these needs by supporting land and livestock acquisition. While this contributes in part to development, it remains insufficient to revitalize the entire micro-watershed.

6. Climate change as an additional challenge

Throughout the central highlands of Ecuador, populations are severely impacted—and therefore more vulnerable—by the effects of climate variability, soil erosion, land degradation, and the loss of biodiversity in both natural and cultivated plant species. These challenges directly affect traditional farming and pastoralist practices, particularly transhumance. Food security is seriously threatened, given that peasant agriculture supplies 80% of the basic food basket.

Furthermore, climate change modelling projections for 2050 indicate an expected rise in average temperatures by 1–2°C and a 30% decrease in average rainfall. These two factors are likely to negatively impact crop yields and milk production, further endangering the food security of the local population (Grijalva & Riofrío, 2010).

Conclusion about change in pastoralism and transhumance

Due to its equatorial climate and its steep altitudinal gradient—from nearly 2,000 metres to over 4,500 metres above sea level—the upper Río Chimborazo watershed is home to diverse transhumance practices, particularly among small-scale herders. These movements occur between the *páramo* or high-altitude rangelands located on the upper slopes, and cultivated or fallow plots situated lower down the slopes and in valley bottoms.

Since pre-Inca times, pastoralism and transhumance have continuously evolved, as both livestock and crop production have adapted to changing contexts. Above all, traditional farming systems have capitalized on favourable climatic conditions, allowing for a variety of agricultural and pastoral techniques based on access to land and water, as well as the availability of financial resources.

However, over the centuries, successive public policies have primarily benefited the most advantaged segments of rural society—particularly settler populations—by granting them land and providing technical, economic, and political support. Meanwhile, smallholders in traditional rural communities have been progressively marginalized, despite some well-meaning policies aimed in their direction. These communities, however, have shown remarkable adaptive capacity, especially in terms of pastoralism and transhumance, thanks to the inherent flexibility of their livestock systems.

In the face of future climate change—bringing biodiversity loss, soil degradation, and the deterioration of natural ecosystems, particularly the *páramo*—it is essential to recognize that traditional rural communities are the most directly affected. These communities urgently need access to land, financial support, and training resources to enable them to engage in sustainable development. This must be done through participatory and collaborative approaches involving public authorities.

Given the high adaptability of livestock systems, especially among small herders, and the overall favourable climatic conditions for agriculture and livestock, transhumance practices will likely continue to evolve in response to new challenges, just as they have done for centuries. Nonetheless, several interacting factors continue to influence livestock farming and transhumance—particularly the persistent issue of land tenure in Ecuador and the ongoing migration of young people away from agricultural work.

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Chapter 11

Transhumance in Ancash, White Cordillera, Central Andes, Peru*

Territorial Strategies of Traditional Grazing in High Andean Ecosystems

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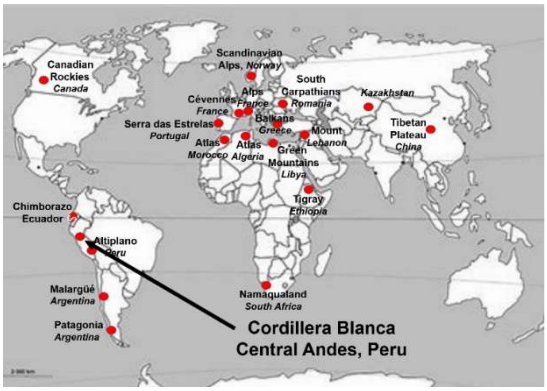
Abstract

Transhumance in Ancash, Peru, is an ancestral practice that links livestock farming with the sustainable management of the Andean landscape, enabling the strategic use of natural grasslands according to seasonal and altitudinal variations. This study examines the role of transhumance in conserving high Andean grasslands, emphasizing its ecological and socioeconomic benefits, such as the promotion of biodiversity and the sustainability of grazing systems. Using field data, interviews, and both historical and current analyses, the study assesses the impacts of climate change and mining on this traditional practice. The findings show that the altitudinal and bioclimatic diversity of Ancash—particularly within the Huascarán Biosphere Reserve—supports transhumant grazing by offering access to diverse microclimates and vital water resources. Rooted in a system of vertical territorial control, this ancestral model integrates livestock and agriculture into a sustainable agroecological approach. However, its continuity is threatened by challenges such as mining expansion, sheep overpopulation, and the absence of grassland restoration plans. If unaddressed, these issues could jeopardize the future of transhumance, endangering the conservation of Andean ecosystems and the livelihoods of local communities.

Keywords: Pastoralism; Land-use management; Cordillera Blanca; Ancash; Peru



* Photo credits: the authors

Introduction

The relevance of transhumance in the Puna lies in its ability to ensure the sustainability of grassland ecosystems located at extreme altitudes, between 3,500 and 4,800 metres above sea level. Through the seasonal movement of herds, communities are able to avoid the overexploitation of natural resources, effectively managing land use, water resources, and a diversity of species. However, increasing pressures from climate change and advancing desertification have placed the sustainability of these systems at risk, underscoring the need for more adaptive management strategies.

This chapter also explores how the integration of livestock, agriculture, and forest resource use within transhumant agro-silvo-pastoral systems fosters dynamic interactions between economic activities and the ecological environment. In this context, rangeland management contributes not only to agricultural productivity, but also to water and ecological balance, by controlling the accumulation of organic matter that could otherwise trigger natural fires. The chapter analyses how these practices promote more efficient resource use, preventing land degradation and loss of biodiversity.

Beyond its economic significance, transhumance holds deep cultural and social meaning for high Andean communities, forming an integral part of their identity and worldview. It is not only a strategy for environmental adaptation but also a reflection of traditional knowledge passed down through generations. This chapter emphasizes the importance of valuing this ancestral knowledge and explores how collaboration with academic and development programs can enhance its implementation, ensuring the long-term sustainability of agro-silvo-pastoralism.

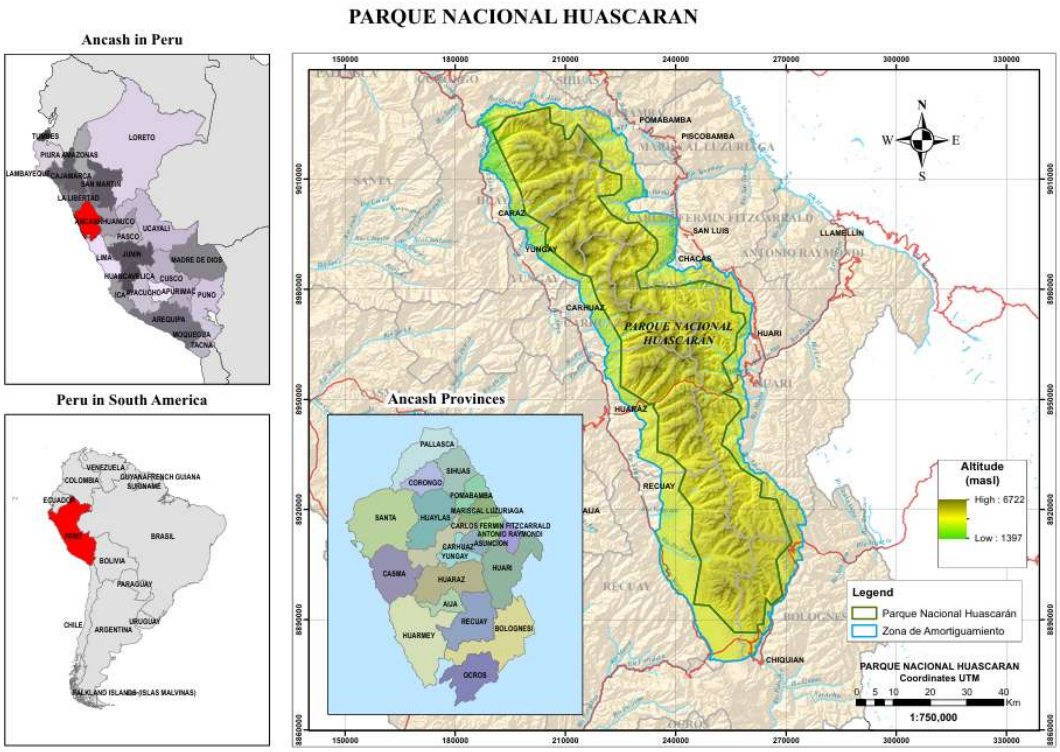
The main objective of this chapter is to show how transhumant agro-silvo-pastoralism in the high Andean grasslands of Peru represents a key productive strategy that integrates livestock, agriculture, and forest resource management in response to the environmental and atmospheric conditions of the Andean Mountain range. Over time, this practice has enabled high Andean communities not only to secure their livelihoods, but also to play a critical role in the conservation of fragile high-altitude ecosystems. This analysis highlights how the productive activities of pastoral communities have evolved to meet the complex challenges of the Andean environment.

I. Geographical and bioclimatic context

From a bioclimatic perspective, the Ancash region in Northern Peru spans a territory extending from the South Pacific coast to the Marañón River, covering approximately 36,000 km². Two prominent Andean ranges—the Cordillera Blanca and the Cordillera Negra—run through the region, generating significant altitudinal variation, from coastal plains to snow-capped peaks reaching 6,768 metres above sea level (Monsalvo & Asunción, 2005). This geographical diversity fosters the development of various microclimates, with the Santa River serving as the region's most important hydrological axis. Originating in the Andes, the Santa River flows through inter-Andean valleys before reaching the Pacific Ocean, supporting regional biodiversity and moderating climatic contrasts between the highlands and the coast (Map 1).

The Huascarán Biosphere Reserve is a Protected Natural Area, with Huascarán National Park—established in 1975—as its core (Map 2). It encompasses the entire Cordillera Blanca, along with buffer and transition zones where unique ecological systems are preserved (SERNANP, 2016). The reserve is home to 663 glaciers, 296 lakes, and 41 rivers and creeks, making it a region of significant ecological importance and high vulnerability to climate change. Accelerated glacier retreat due to global warming is disrupting these fragile ecosystems, affecting biodiversity, and threatening the livelihoods of peasant communities who depend on agriculture and livestock (Ministerio del Ambiente, 2021).

Map 1. Administrative map of Peru



Map 2. National Park Huascaran, Peru

According to Holdridge's ecosystem classification, the Huascarán Biosphere Reserve is primarily a humid montane region covered by mountain forests. The climate is characterized by a rainy season from December to March, with monthly precipitation ranging from 110 to 160 mm and relative humidity between 70% and 73% (Sabino, 2019). During the dry season, from May to August, daytime temperatures fluctuate between 0°C and 22°C, accompanied by a notable increase in sunshine hours. In recent years, however, the dry season has lengthened, now often extending into October. This shift has shortened the rainy season and increased the frequency of droughts (Steven, 2019).

Hailstorms occur mainly in February and May, though in recent years they have persisted into June. Frosts, typically confined to the June–August period, have increasingly been observed as early as January and February. These frosts are characteristic of the dry season, during which strong winds are also common, particularly in July, August, and September. The coldest period aligns with the dry season—from June to August—marked by low temperatures and frequent frosts. Paradoxically, the warmest daytime temperatures also occur between May and August. Lightning is frequent during the rainy season, which now spans approximately from October to April. Water resources, sustained by glacial melt from the Cordillera Blanca, seasonal rains, and high-altitude lagoons, provide a continuous flow to the region's rivers.

II. Historical and agrarian context of the Puna, Ancash

The Ancash region is one of the oldest inhabited areas in Peru, with evidence of human settlements dating back to approximately 12,560 B.C. at the Cueva de Guitarreros in Yungay. By the seventh millennium B.C., Ancash had

become one of the earliest centres of agriculture, where the domestication of plants first occurred. Later, important cultural centres emerged, such as Chavín de Huántar in Huari, an archaeological site of great ceremonial importance dating back over 3,000 years. Another significant site is Sechín, located in the province of Santa, which reflects the cultural development of the Northern coast. These sites highlight advancements in agriculture, architecture, pottery, and religious practices, with a significance comparable to Pachacamac in ancient Peru.

The region's pastoral tradition dates back to the Archaic Period (7000–4000 B.C.), when the domestication of herding animals began, giving rise to the first pastoral societies. This trend expanded during the Early Intermediate Period (2nd century B.C. to 6th century A.D.), when strategies for managing different ecological zones for agricultural production were developed. The practice of vertical control of ecological levels—a response to the complex Andean geography—was already taking shape in these early cultures. Highland settlements provided alpaca fibre and llama meat to pre-Andean and forest-edge communities, which in turn supplied products from warmer climates and salt (Amat, 2004).

According to a study by the Urpichallay Association in the Huascarán Biosphere Reserve, the corn and potato agro-ecological zone, located between 2,700 and 3,200 metres above sea level, is characterized by irrigation-based agriculture. In this zone, commercial corn varieties such as White Urubamba and Velvet are widely cultivated for the market and require high levels of agrochemical inputs. Potatoes (*Solanum tuberosum*) are also a key crop, with market-oriented hybrid varieties like Yungay, Renacimiento, and Canchán being most prominent. Other crops such as peas, beans, squash, onions, carrots, and cabbages are cultivated on a smaller scale, often in association with the main crops.

In the grains and tubers agro-ecological zone (3,200–3,600 metres), as described by Álvarez (2002) in his study of the Vicos–Marcará micro-basin within the Huascarán Biosphere Reserve, agriculture is largely rain-fed and relies on rotational land management. Potatoes are generally planted first, followed by broad beans, peas, or other Andean tubers. Cereal crops such as wheat, barley, and oats are commonly grown after potatoes. Following these cycles, the land is left fallow to regenerate naturally and is used as pasture for livestock, enabling integrated and sustainable use of resources.

The native tubers agro-ecological zone, located between 3,500 and 4,000 metres, is characterized by diversified, low-intensity agriculture grounded in traditional knowledge. In addition to potatoes, Andean crops such as oca (*Oxalis tuberosa*), olluco (*Ullucus tuberosus*), and mashua (*Tropaeolum tuberosum*) are cultivated—vital for local food security. Native cereals like quinoa (*Chenopodium quinoa*) and kiwicha (*Amaranthus caudatus*) are also grown, adapted to high altitudes and harsh conditions. This traditional system not only preserves genetic crop diversity but also ensures ecological sustainability through agroecological practices suited to local environments.

The natural pasture zone, or *jallqa*, lies between 4,000 and 5,000 metres above sea level, marking the transition to permanent snow. These areas have moderate slopes and undulating terrain with surface rock outcrops. The pastures are highly diverse, dominated by grasses such as *Festuca* sp., *Stipa* sp., *Bromus* sp., and *Scirpus* sp., along with palatable herbs like native clovers. In wetlands, pasture growth is enhanced by constant water availability. During the rainy season, livestock graze at higher elevations, whereas in the dry season, they are moved to lower, flatter areas to optimize grazing resources.

According to PRATEC (2006), the Andean agro-festive calendar harmoniously integrates agricultural activities with cultural celebrations, aligned with natural and celestial cycles. Potato planting begins in October with the onset of rains and is harvested in May, coinciding with astronomical events such as the zenith of the sun and the movement of the Andean Cross. Maize is planted in September and harvested in February, whereas wheat and barley are typically sown in January. The "mishka potato," irrigated in July and harvested in November, along with vegetables and fruit trees in lower altitudes, extend the agricultural cycle through early and late campaigns. This calendar not

only structures agricultural work but also reflects the profound relationship between Andean communities and their environment, blending productivity with tradition (Amat, 2004).

In the Andes, livestock breeding is deeply intertwined with agriculture, forming an integrated subsistence system. At higher altitudes, herding becomes the dominant activity, with sheep and cattle being most common, followed by alpacas (*Vicugna pacos*) and llamas (*Lama glama*) in specific areas (Photo 1). Horses also play a role, facilitating herding and transportation. This agricultural-livestock synergy enables peasant families to make efficient use of natural resources, adapting to ecological conditions. Herding in the highlands is not only an economic activity but also a cultural pillar, essential to the identity and resilience of Andean communities.

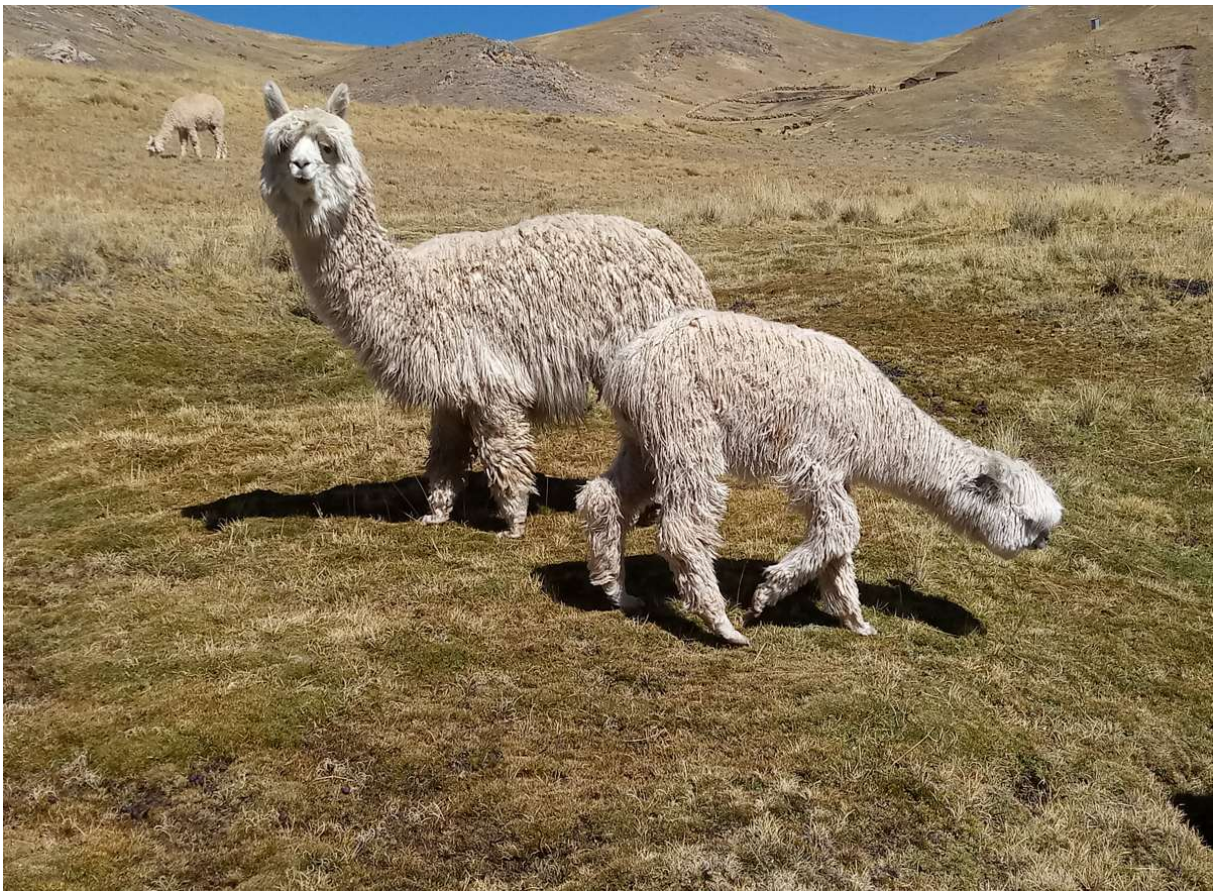


*Photo 1. Alpacas (*Vicugna pacos*) grazing on natural pastures*

Mining, the economic backbone of the Andean region, is categorized into small, medium, and large-scale operations, with the latter exerting the greatest economic and environmental impact. While it remains the primary source of income, mining activities have had detrimental effects on mountain ecosystems, particularly impacting traditional livestock farming. Water pollution, degradation of grasslands, and competition for land use have undermined the livelihoods and well-being of high-altitude pastoralist communities. This situation has sparked ongoing tensions between economic development and environmental preservation, threatening the delicate balance of life in the Andes and raising serious concerns about the long-term sustainability of extractive practices in a region of profound ecological and cultural significance.

III. Transhumance case studies in Huaylas and Conchucos

Transhumance in the Huaylas and Conchucos valleys is closely tied to the grazing systems practiced in the Ancash region. It depends on factors such as herd location, land ownership, and altitude. Access to key resources—particularly pastures and water—is critical and significantly influences herd mobility. Additionally, external actors, including the State and private enterprises, often intervene in ways that reshape local practices and pasture management.

In the Southern part of the region, genetically improved breeds of cattle, sheep, and alpacas are raised to enhance the production of wool, meat, milk, and breeding stock. The grazing cycle alternates between native highland pastures during the rainy season and improved pastures in the lowlands during the dry season, particularly for dairy and fattening cattle. Extensive native grasslands are managed under communal administration, with designated areas allocated for collective grazing. During the dry season, community members often rent lowland plots to feed their herds. Grazing is carried out by families or hired herders, providing a critical source of income and resilience against harsh climatic conditions. This system, finely adapted to the region's extreme environment, remains vital for rural livelihoods.

In the Northern part of the region, grazing systems are diverse and span the Huaylas and Conchucos valleys. Livestock breeding primarily involves family-owned herds of Creole cattle that utilize varied pasture types. Cattle and horses typically roam freely in the highlands, whereas sheep are raised in mid- and low-altitude areas (Photo 2). Community-owned alpacas are concentrated in the Cordillera Negra, whereas llamas—introduced mainly for tourism—are more common in the Cordillera Blanca. Livestock practices include branding of young animals and selective selling, with seasonal herd movements between higher and lower elevations. Mutual assistance among families and local associations enables the management of large herds through shared responsibilities and the construction of temporary shelters, ensuring that livestock practices remain well adapted to both economic demands and climatic variability.

The community of Vicos, located in the province of Carhuaz, district of Marcará, within the Huascarán Biosphere Reserve, provides a representative example of transhumance in the region (Montes, 2002). The communal territory extends from 2,400 to 4,800 metres above sea level, allowing the community to benefit from a range of ecological zones for subsistence. Its economy integrates crop cultivation for self-consumption in the lower areas with extensive livestock breeding in the highlands. Sheep and cattle, primarily of Creole breeds, are moved seasonally in response to rainfall patterns and the availability and quality of pastures (Photo 3). This practice illustrates the community's deep ecological adaptation, blending farming and herding into a sustainable model of natural resource management.

In the Vicos community, located at the source of the Marcará River, a high-altitude plateau supports an ecosystem based on natural pastures in both flooded and lowland areas. Cattle and horses graze freely for most of the year, whereas sheep are kept in the lower zones from December to March, where their manure is used to fertilize crop fields. Families periodically travel to the highlands to monitor the herds, care for vulnerable animals, and carry out tasks such as branding. In August, young animals are moved to the lowlands for fattening, sale, or use in agricultural labour. Livestock management is closely aligned with the crop calendar, particularly with the cereal harvest in June and July, and the onset of rains in September and October, when pasture becomes abundant in the lower zones. During the rainy season, cattle are typically grazed in the highlands.

Photo 2. Sheep grazing on natural pastures

Photo 3. Cattle grazing post-harvest areas

A different situation is observed in San Antonio de Juprog, located in the jurisdiction of Huari, district of San Marcos, within the Callejón de los Conchucos. Unlike Vicos, Juprog is composed of dispersed individual farms situated at higher altitudes (Valle, 2022). This geographical distinction has shaped the community's focus on sheep herding and high-altitude agriculture. The territory is divided into two main sectors and 47 sub-sectors, nine of which are dedicated exclusively to grazing, as shown in the accompanying maps. These areas primarily support sheep, which graze on native pastures in accordance with seasonal cycles that govern herd mobility.

In San Antonio de Juprog, sheep make up approximately 95% of the total livestock population, followed by horses, goats, and small camelids (4.5%). Cattle account for just 0.5%, largely due to the limited availability of pasture—an issue worsened by the overpopulation of sheep. Some farmers mitigate this by relocating cattle to lower elevations and supplementing sheep diets with cultivated fodder and harvest residues, especially during the dry season (May to July). Studies of Juprog's grasslands indicate a critical deterioration in pasture quality, primarily caused by overgrazing. As a result, residents have increasingly relied on feed supplementation, rotational grazing, and more frequent livestock sales. However, the absence of structured pasture recovery plans poses a significant threat to the long-term sustainability of the region's pastoral system.

IV. Past, current and future impacts of drivers of change

With regard to the evolving drivers of livestock movement in the Huaylas and Conchucos regions, a prospective approach has been used to identify the key factors shaping the long-term trends of transhumance. These drivers are defined as variables that, on the one hand, have a significant impact on transhumance practices, and on the other, involve a high degree of uncertainty regarding their future trajectories—thus requiring ongoing monitoring. Among the most influential drivers, three stand out: (i) socio-cultural dynamics, encompassing shifts in traditions, values, and lifestyles; (ii) environmental and conservation policies, which regulate the sustainable management of ecosystems; and (iii) extractive activities, particularly mining, which directly affect grazing areas and land availability.

1. Socio-cultural and economical dynamics

The Andean pastoral tradition, originally centred on the breeding of small camelids such as llamas and alpacas and organized through *ayllus*—kinship-based family and ethnic units—underwent a profound transformation following the Spanish conquest. Under colonial rule, the indigenous population was reorganized into centralized communities, facilitating greater administrative control. European livestock, particularly cattle, were introduced and gradually displaced native camelid species. At the same time, haciendas—large agricultural estates—emerged, concentrating land ownership in the hands of Creoles and Spaniards. Although Peru eventually gained independence, this land tenure model persisted for decades. A notable example is the community of Vicos, where the State leased both land and its population to private landowners, effectively maintaining a system of servitude well into the late twentieth century.

Within these haciendas, the most fertile lands were reserved for the landowners' cattle, whereas indigenous labourers, operating under a system of enforced service, were tasked with tending the herds in exchange for limited access to land for their own grazing and cultivation (Photo 4). This economic model triggered significant shifts in Andean grazing systems, including the progressive replacement of native camelids with European species such as cattle, sheep, goats, and horses. As the most productive lands were appropriated, indigenous herders were pushed into higher, less hospitable terrains, requiring the adaptation of European livestock to the extreme conditions of the *puna* (high-altitude grasslands). Over time, this led to the emergence of Creole breeds—smaller and less productive than their European ancestors but better suited to the harsh Andean climate and altitude.

Photo 4. Farmer replanting natural pastures

Transhumance, an ancestral livestock practice in the Andes, underwent major transformations in twentieth-century Peru. Peasant uprisings—most notably the rebellion led by Pedro Pablo Atusparia—highlighted the urgent need for land redistribution, which culminated in the Agrarian Reform of 1968. Spearheaded by the government of General Juan Velasco Alvarado, this reform dismantled the hacienda system and promoted the formation of peasant cooperatives. In Vicos, the community regained control of its land as early as 1966, anticipating the broader reform process and establishing autonomous self-governance. This transition enabled communities to access better lands, expand their herds, and facilitate transhumance to more accessible areas. Additionally, agricultural production increasingly integrated with urban markets, surpassing the former model of self-sufficiency.

In recent decades, however, evolving social dynamics have weakened communal structures related to grazing and livestock management. New generations have increasingly turned away from family-based pastoral traditions in pursuit of education and employment in urban areas. As a result, youth migration has left herding responsibilities primarily to older community members, reducing the viability of transhumance due to labour shortages. When elders age or pass away, many of their children opt to sell the livestock, with few choosing to continue the practice. The

COVID-19 pandemic, however, temporarily reversed this trend, prompting a return of young people to rural communities, where they once again engaged in herding activities. At the same time, the livestock market has begun to influence family decisions, transforming animals into a form of savings and capital accumulation. While production largely remains oriented toward self-consumption, the rising market value of cattle and sheep has strengthened their economic role.

Looking ahead, emigration is expected to remain a dominant trend, as many young people continue to seek education and employment opportunities in urban centres. Nevertheless, in times of crisis—such as pandemics, economic downturns, or challenges to urban sustainability—land and agriculture often re-emerge as viable alternatives. Young migrants are beginning to view agricultural entrepreneurship not only as a source of income but also as a way to maintain cultural ties with their communities. However, their approach tends to favour more intensive practices, including the use of improved pastures and the replacement of Creole cattle with more productive breeds. Increased income from urban employment enables investment in improved livestock, thereby strengthening the family's agricultural assets. These evolving dynamics suggest a future in which livestock production becomes more productive and market-oriented, as communities explore more equitable relationships with the market and potential pathways for offering organic or value-added products.

2. Environmental and conservation policies

Elder members of Andean communities often assert that "past times were better," nostalgically recalling periods of abundant and predictable rainfall, fertile soils, and more numerous and resilient livestock. This sentiment reflects a profound and intimate relationship between the Andean population and its natural environment, where the "language of nature" was once closely observed and respected. In earlier times, communities could anticipate a rainy or dry year based on environmental cues such as animal behaviour, the flowering of specific plants, and the position of stars. This ancestral knowledge—transmitted orally across generations—was vital for maintaining a harmonious coexistence with nature and contributed to the conservation of both domestic and wild biodiversity in the Andes (Hirsh, 2016).

The 1980s marked a turning point in the environmental governance of Peru's high Andean regions. As the State's presence diminished, non-governmental organizations (NGOs) began to lead conservation and production initiatives. These organizations provided crucial financial, logistical, and technological resources, supporting the preservation of grasslands and water sources while also promoting the introduction of cultivated pastures, often with the active participation of local communities. The establishment of Huascarán National Park (HNP) in 1975 initiated a renewed State presence, which expanded in the 1990s through agricultural mechanization and programs like Sierra Verde, aimed at livestock expansion. However, these efforts often emphasized the delivery of resources over comprehensive training, limiting their long-term impact on the sustainability of transhumance practices.

Within Huascarán National Park, conservation was prioritized, resulting in restrictions on human activity within protected zones. This directly impacted herd mobility and traditional transhumance routes, leading to tensions between local populations and park authorities, as communities continued to view these lands as part of their ancestral territory. In response, Pasture User Committees (CUPs) were established to regulate grazing within the park. However, in Vicos, strong community resistance prevented the full consolidation of these committees. By contrast, in Juprog—located outside the park—CUPs became a tool for negotiation, particularly in dealings with the expanding presence of a mining company. These committees helped protect community land-use rights and pasture access.

In Vicos, changes in transhumance have occurred autonomously, without direct intervention from the State or HNP. This independence has allowed the community to preserve traditional grazing systems to the present day. Similarly,

grazing patterns in Juprog have remained relatively stable, with the exception of adaptations related to the mining company's presence. However, in both communities, the degradation of native grasslands has persisted, compromising ecological sustainability. Despite the known vulnerability of high-altitude ecosystems, there is a notable lack of coherent climate change adaptation policies. Conservation efforts, when they exist, tend to focus on water sources and artificial lagoons in the Cordillera Negra, under the assumption that the Cordillera Blanca still has sufficient water reserves due to glacial melt.

Looking ahead, the contrasting experiences of Vicos and Juprog reflect two distinct community strategies. In Vicos, the community has rejected environmental negotiations with the State, largely due to longstanding tensions with HNP, and remains committed to maintaining its ancestral highland grazing practices. In contrast, Juprog has chosen to engage with contemporary legal and environmental frameworks, using environmental legislation to negotiate with the mining company for compensation and ecological protection. While Vicos emphasizes cultural preservation and autonomy, Juprog seeks a pragmatic balance between environmental stewardship and economic opportunity, adapting traditional systems to meet the demands of modern challenges.

3. Extractive activities

Transhumance in the Huaylas and Conchucos regions has long been an ancestral tradition, sustained in territories rich in mineral resources. In these areas, artisanal and small-scale mining has historically complemented the income of herders and farmers.

This activity has also reinforced community cohesion by increasing the demand for family labour and influencing the timing and duration of stays in the highlands. However, the arrival of private capital and the expansion of large-scale mining have profoundly disrupted these traditional ways of life (Gobierno Regional de Áncash, 2016). Industrial mining developments have led to the loss of key grazing territories, triggering a crisis in agricultural and pastoral practices. This shift has impacted both the economic base and the cultural identity of peasant communities, whose livelihoods are deeply tied to these highland resources.

Conflicts between mining operations and Andean peasant communities have a long and complex history, shaped by highly localized dynamics. The lack of adequate regulatory frameworks to safeguard mountain ecosystems has exacerbated the degradation of rangelands and water sources, which are vital for transhumance and livestock management (Instituto Peruano de Economía, 2018). In Vicos, small-scale mining in the Quebrada Honda did not significantly affect grazing areas; however, studies conducted between 2000 and 2002 revealed the presence of toxic metallic elements in water sources, although their precise origin could not be determined. In contrast, in Juprog, the advent of large-scale mining in the 1990s drastically altered the local environment, disrupting ecosystems and reshaping relationships between residents and their land. While communities received economic and material benefits, these came at a high environmental cost, underscoring the ongoing tensions between economic development and ecological preservation.

These transformations have shaped current grazing conditions in both communities. In Vicos, change has been minimal; traditional highland grazing of cattle and horses continues with little disruption, despite the increasing presence of mining operations and mineral transportation. These extractive activities have brought jobs and income to the community, but they have also diverted attention from environmental concerns. The limited oversight from Huascarán National Park authorities has meant that no systematic monitoring of environmental impacts is in place, raising concerns about the long-term sustainability of both mining and pastoral practices.

In Juprog, large-scale mining has significantly reshaped community dynamics. The income generated has spurred youth migration to urban areas, leaving a largely elderly population behind. Despite their physical absence, many migrants maintain ties to their community, preserving the economic benefits associated with mining revenues.

Nonetheless, this shift has led to serious challenges, including pasture degradation caused by livestock overstocking. Compounding the issue is the lack of effective recovery programs for these degraded grasslands and insufficient efforts to secure water availability during the dry season. These shortcomings further undermine the sustainability of local agricultural and transhumance systems.

Looking ahead, Vicos appears poised to maintain its current patterns of highland–lowland grazing, with no major changes anticipated. Juprog, on the other hand, faces a more complex scenario. While youth migration continues due to economic opportunities tied to mining and urban development, the remaining population still relies heavily on agriculture. This reliance is essential not only to sustain household livelihoods but also to uphold eligibility for mining-related support programs. As a result, Juprog must navigate a dual reality: adapting to the opportunities presented by modernization and mining, while striving to preserve its traditional agricultural practices and environmental resilience.

Conclusion

Mountain transhumance in the Puna of Áncash—particularly in the regions of the Callejón de Huaylas and Conchucos—remains a vital strategy for subsistence and natural resource management in high Andean ecosystems. Despite variations in the management of different livestock species, both areas share a system rooted in seasonal adaptability and family-based ownership. While these characteristics have shown resilience over time, they are increasingly challenged by evolving social, economic, and environmental conditions.

The influence of State-led environmental policies and the expansion of mining operations in mountain territories have altered grazing and transhumance dynamics. These developments have contributed to the declining participation of younger generations in herding activities, weakening the intergenerational transmission of traditional ecological knowledge. In Huaylas, these changes stem mainly from broader social transformations, whereas in Conchucos, the economic allure of mining has accelerated youth migration and reduced engagement in livestock practices. This trend raises significant concerns about the continuity of traditional transhumance in the coming decades.

At the same time, shifts in the role of the State in conserving high-altitude ecosystems have redefined relationships between farming communities and NGOs, which previously played a leading role in implementing environmental management initiatives. Tensions surrounding land-use regulations within Huascarán National Park underscore the need for a more balanced approach—one that both honours ancestral practices and promotes ecological sustainability. Current negotiations between park authorities and local herders reflect ongoing efforts to reconcile ecosystem preservation with community livelihoods.

Looking forward, it is essential to conduct more comprehensive studies on the emerging social and ecological dynamics that are reshaping grazing and transhumance. The emigration of youth and their detachment from pastoral traditions pose serious risks to both the continuity of agropastoral systems and the resilience of high-mountain ecosystems. Decisions related to land management, market integration, and territory governance will be critical in determining whether grazing practices evolve toward greater sustainability—or continue to erode—in the Puna of Ancash.

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Chapter 12

Transhumance in the Ramis River Basin, Puno, Altiplano, Peru*

Traditional grazing strategies in high-Andean/Altiplano ecosystems

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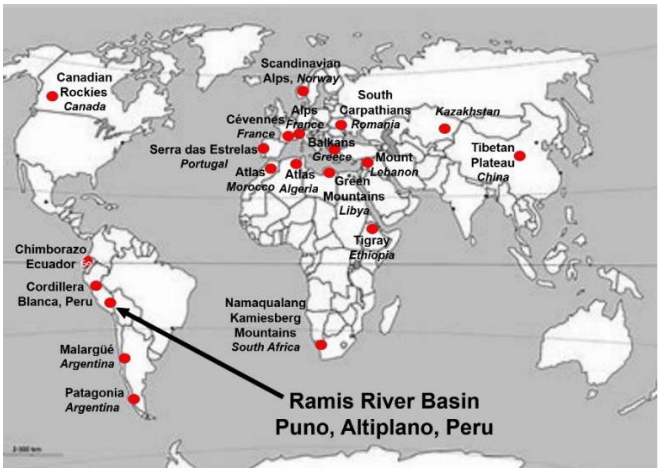
Abstract

Transhumance in the Ramis Basin of Puno, Peru, is an ancestral grazing practice that contributes to the sustainable management of grasslands in the Altiplano. A qualitative and ethnographic study, based on interviews with professionals and the analysis of secondary data, explored the socio-ecological dynamics that support this practice in the region. The research revealed that the Agrarian Reform significantly transformed transhumance in the Titicaca Basin by altering land tenure and traditional grazing routes. While these changes strengthened local identity, they also introduced challenges for coordinating grassland management. At the same time, the Federation of Peasants of Melgar (FUCAM), through the Kunurana Rural Social Production Enterprise (ERPS), promoted access to land with communal autonomy, entrusting communities with the responsibility of managing their territories amid development pressures and climate change. The study concludes that transhumance is an adaptable and resilient practice that optimizes forage resources and reduces pressure on high-Andean ecosystems. Strengthening this practice as a strategy for ecological conservation and integrating traditional knowledge with new territorial governance policies is essential to ensure its sustainability in the current context.

Keywords: Ramis Basin; Transhumance; Territorial dynamics; High-Andean ecosystem



* Photo credits: the authors

Introduction

The Ramis River Basin, located in the Peruvian highlands, represents a confluence of natural wealth, cultural worldviews, and agricultural traditions. This tributary, which flows into Lake Titicaca, runs through an area where livestock farming stands out as one of the main sources of livelihood. In this context, transhumance—or mobile grazing—emerges as an adaptive strategy to cope with the region's extreme climatic and geographical conditions. It predominantly involves sheep, cattle, camelids, and pigs, each contributing to the area's economic diversity (Giraldo, 2017).

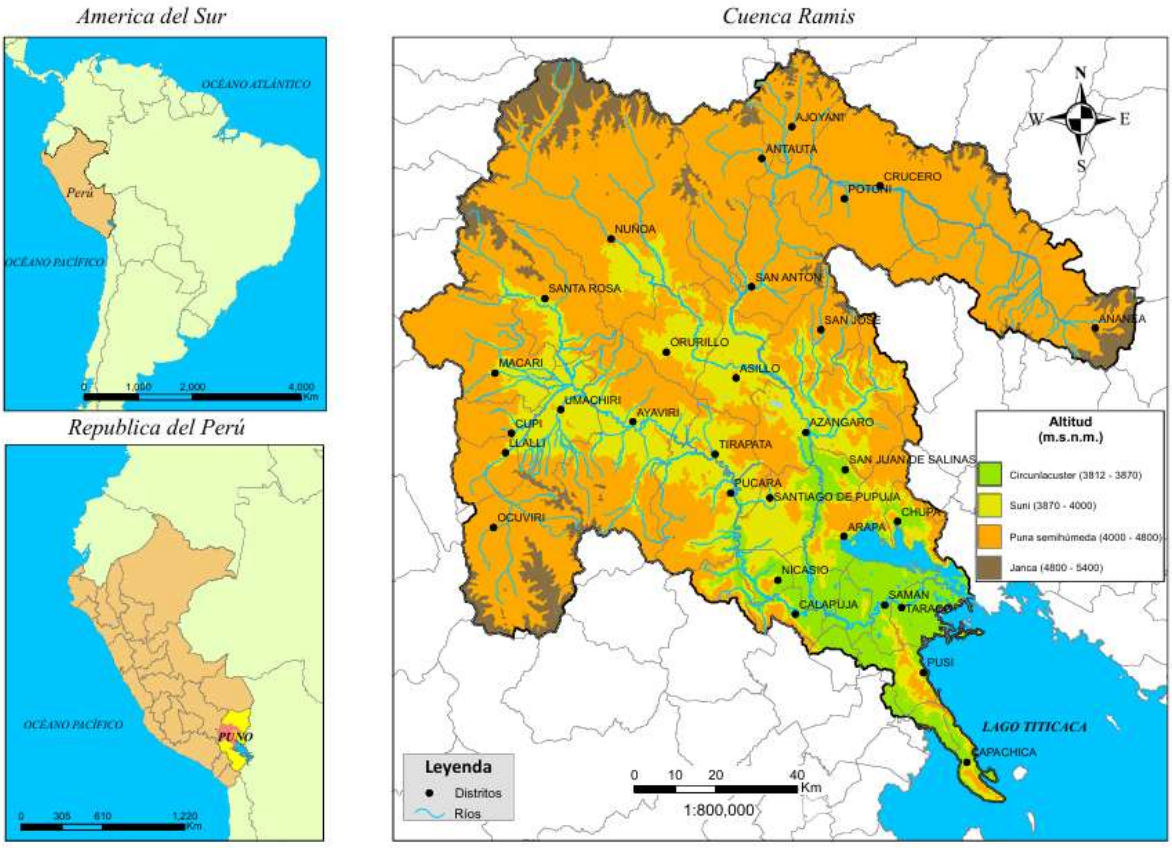
Access to water is crucial for transhumant livestock farming, as animals must move in search of fresh pastures and water sources. Rivers serve as vital supply points, but upstream mining activities have disrupted the delicate hydrological balance. These extractive operations have raised concerns about water quality, adversely affecting both agricultural and livestock productivity. Cheese production—an emerging activity supporting the local economy (Aubron et al., 2009)—also relies on this threatened resource, underscoring the urgency of implementing sustainable, eco-hydrological water management practices.

The challenges facing transhumant livestock farming in the Ramis Basin are varied and complex. Grassland degradation, water scarcity, and the displacement of alpaca herding to marginal lands of low ecological quality are among the key issues impacting local producers. These factors weaken the resilience of productive systems and reduce food availability for high-Andean communities, which heavily depend on livestock and its by-products. A comprehensive and holistic approach that addresses both environmental and socioeconomic dimensions is essential to safeguard the future of this ancestral practice.

The situation in the Ramis River Basin highlights the tensions between economic development and environmental sustainability. The interdependence between transhumant livestock farming and natural resources calls for immediate action from both authorities and local communities. To preserve tradition and ensure economic viability, it is essential to implement practical solutions that promote ecosystem protection and responsible water management. Only through a collective, coordinated, and knowledge-based effort can the continuity of transhumance be secured in this emblematic region of the Peruvian Andes.

I. Geographical and bioclimatic context

Within the endorheic system of Lake Titicaca, the Ramis River Basin stands out as one of the most significant on the Peruvian side, in contrast to the seven adjacent basins located in Bolivia (Map 1). This vital hydrological system in the Puno region spans eight provinces, covering an area of 14,706 km² and ranging in elevation from 3,812 to 5,750 metres above sea level (asl). The Ramis River, extending 363.49 kilometres with an average slope of 1.13%, shapes the mountainous terrain of the basin. Variations in average annual precipitation—ranging from 575.2 mm in Taraco to 855 mm in Crucero—reflect a climatic pattern characterized by heavier rainfall at higher elevations and near the lake. The region experiences a marked dry season in June and July, accompanied by lower temperatures, in contrast to the warm and humid period from November to March, when the Ramis River flows more vigorously, sustaining ecosystems and livelihoods along its course (INRENA, 2008).



Map 1. Ramis River Basin, Puno, Altiplano, Peru

The lower Ramis River Basin features varied topography that supports diverse productive uses. In the lower areas, flat terrain facilitates agriculture and livestock farming, whereas in the middle section, the land rises toward the Carabaya Mountain Range, marking a transition to steeper slopes. To the south, the basin borders Lake Titicaca, forming a circum-lacustrine region between 3,812 and 3,900 metres asl, where seasonal grasslands serve as vital resources for transhumance. Hydrologically, the Ramis and Nuñoa Rivers, along with their tributaries and lagoons, provide essential water sources for transhumant grazing, forming a dynamic and interdependent ecosystem. These geographical and ecological characteristics enable adaptive transhumance, in which herders move based on seasonal climatic and ecological conditions. This approach promotes sustainability and balance in the basin's resource use.

The lower Ramis River Basin also hosts a rich diversity of mountainous ecosystems, ranging from subtropical mountain rainforests to Alpine meadows, each offering a variety of microhabitats and endemic species. These ecosystems, highly sensitive to human activity, face increasing risks that threaten their ecological integrity. At lower elevations, subtropical forests—home to iconic species such as *quinual* (*Polylepis* spp.) and *ulcumano* (*Retrophyllum rospigliosii*)—have been heavily fragmented by human intervention, leaving only remnants of their original biodiversity (Winkel, 2013). Between 3,900 and 4,500 metres asl, subtropical moors known locally as *páramos*, adapted to harsh conditions, offer temporary grasslands that support seasonal transhumant livestock grazing. At the highest elevations, Alpine meadows and glaciers provide crucial water resources to the lower regions, maintaining a delicate balance that supports both wildlife and traditional grazing practices (Giraldo, 2017).

II. Region’s history

The history of the Peruvian highlands—particularly the region of Puno—reflects how territorial and administrative changes during the Viceroyalty of Peru influenced its socioeconomic dynamics. The Viceroyalty of Peru, established by Charles V in 1542 to administer the Spanish Crown's holdings in South America, extended from Panama to Patagonia and from the Andes to the Atlantic Ocean. Alongside New Spain, centred in Mexico, it was one of the two major colonial entities created to govern Spanish America. Notably, Brazil remained under Portuguese control. According to Luque (1999), the creation of the Viceroyalty of the Río de la Plata in 1776 fragmented the Intendancy of Puno, leading to tensions among local authorities and weakening judicial and religious oversight. However, Puno's reincorporation into the Viceroyalty of Peru in 1796 restored its territorial unity and reaffirmed its importance as a centre of transhumance. This practice—fundamental to the seasonal management of high-Andean grasslands—has long been essential to the region’s sustainability. In this way, Puno not only regained its political cohesion but also reinforced its role in preserving traditional livestock grazing practices, many of which continue to this day.

III. Agrarian context

The Ramis River Basin, situated in the Andean highlands, is characterized by its vast plains that enable agricultural and livestock activities from 3,812 to 5,750 metres above sea level, with Mount Kunurana, in the province of Melgar, serving as a reference point at 4,894 metres asl. In the lower areas of this Peruvian basin, agriculture focuses on staple crops such as potatoes, quinoa, beans, barley, and forage oats, up to 3,970 metres asl. Beyond that altitude, family farming centres on grain crops like quinoa and cañihua, as well as high-value tubers such as oca (*Oxalis tuberosa*) and *mashua* (*Tropaelum tuberosa*) (Photos 1 & 2). Moreover, livestock farming plays a significant role, particularly the raising of cattle, sheep, alpacas, and llamas.

Photos 1 & 2. Livestock activities in farms located in the Ramis River Basin, Puno, Altiplano, Peru

This sector is currently grappling with persistent social issues stemming from an almost abandonment by public action of traditional agricultural and pastoralist communities living in poverty. This reality is exacerbated by recent climatic factors, such as rising temperatures that have shortened the growing period for crops, and the scarcity of rainfall. Over the last 20 years, there has been an irregular decline in precipitation, directly affecting agricultural production and significantly reducing crop yields. This, in turn, increases the risk for the survival of these populations, which depend on agriculture and livestock for livelihoods (Belizario, 2015).

The Pucará architectural complex, located near the Puno-Cuzco highway at an altitude of 3,950 metres asl, is one of the most important complex societies in the Northern Altiplano, flourishing between 250 BC and 380 AD. This site covers an area of six square kilometres and is renowned for its finely crafted ceramics and ceremonial complex. Today, its population continues traditional artisanal and ceramic practices, with the Torito de Pucará as its most iconic expression.

On the other hand, there are various hypotheses regarding the domestication of alpacas in the Titicaca Basin. Some teams of researchers suggest a late domestication of these species to improve fibre quality and production. Alpaca farming has played a crucial role in the economic situation of rural families in the highlands, as evidenced by archaeological and ethno-historical records (Photos 3 & 4). The development of grazing-based livestock farming and agriculture has enabled the region to overcome natural limitations, facilitating settlement and the growth of major civilizations, with Lake Titicaca serving as a fundamental agro-economic element (Quina, 2015).

Photos 3 & 4. Alpaca herd grazing on natural rangeland in the Ramis River Basin, Puna, Altiplano, Peru

1. Transhumant grazing in Ramis Basin

Land, as a vital foundation for the development of civilizations, has played a transformative role in the Lake Titicaca region, bearing witness to profound shifts in its social and economic structures. The Agrarian Reform of the 1970s, led by General Juan Velasco Alvarado, brought significant changes to land ownership, reshaping its organization and control. These transformations reflect not only the region's local history but also the broader tensions surrounding the reform's implementation, which varied across regions. They have had a lasting impact on land tenure and use—an essential factor in understanding the area's territorial evolution (Photos 5 & 6).

Transhumant grazing in the Ramis Basin represents an ancestral livestock management system deeply rooted in the region, though it faced significant disruption following the Agrarian Reform of 1969. This practice is based on the seasonal migration of herds between highland and lowland areas, adapting to the geography and climatic conditions of the Andes. The conflicting relationship between herders and other land users underscores the complexities of access rights to grasslands, particularly in the context of weakened traditional economies caused by declining wool and fibre prices. The government's establishment of organizations such as agrarian social interest societies (SAIS) and rural social production enterprises (ERPS) transformed patterns of land access and control, sparking resistance from communities concerned about losing sovereignty over pasture management. Despite these challenges, transhumant

practices have persisted, demonstrating the resilience and ongoing relevance of this adaptive, subsistence-based strategy in the Peruvian highlands.

Photos 5 & 6. Seasonal cropping system and alpacas grazing on natural rangeland in Ramis River Basin

The first act of popular justice concerning land occurred in the Kunurana ERPS, in Melgar Province—now part of the Ramis Basin—and was led by the Unitary Federation of Peasants of Melgar (FUCAM). This event, promoted through the 'communal path', helped increase the number of officially registered peasant communities in Peru from 500 in the 1980s to 1,240 today. At the same time, many associative organizations in the Puno region disbanded. During the 1990s, a process of internal land parcelling began in many communities, leading to the creation of new population centres and districts. This parcelling facilitated land access for community members and supported transhumant grazing, as herders could move between parcelled and communal lands across different locations, sustaining their pastoral livelihoods.

Andean residents practice mobile grazing, rotating their livestock—cattle, sheep, alpacas, and llamas—across pastures depending on the season. During the rainy season, springs are recharged, streams flow, small lagoons fill, and native grasslands regenerate rapidly. Various high-Andean grasses, such as *chilliguas*, *crespillo*, and *cebadilla*, flourish in the moist conditions, producing fresh, tender forage. This season is also optimal for reproduction, as ewes and she-alpacas give birth and can adequately nurse their young. In contrast, during the dry season, residents must move their herds to areas with more reliable water and pasture availability to maintain productivity. This rotational grazing system enables the sustainable use of forage resources throughout the year.

Tapia and Felipe-Morales (2024) emphasize that transhumance in the Ramis River Basin is an ancestral practice that facilitates seasonal exploitation of forage resources while adapting to the region's geographical and climatic realities. In this basin, transhumant grazing primarily occurs in the *suni* and semi-humid *puna* zones, where natural grasslands offer temporary feeding grounds. In the circum-lacustrine area, agricultural activities such as potato and quinoa cultivation complement dairy cattle farming. In the humid *puna*, at elevations between 4,000 and 4,800 metres asl, rain-fed pastures support the cultivation of bitter potatoes and the raising of sheep, alpacas, and llamas—species well-adapted to the harsh environment. Livestock mobility is thus highly compatible with the sustainable use of the region's diverse natural resources.

2. Historical and current impacts

The Agrarian Reform transformed transhumance practices in the Lake Titicaca region by redefining land ownership and disrupting grazing routes that had been used for generations. With the conversion of large-scale estates, or

haciendas, into peasant communities, herder organization shifted to a collective management model. While this change strengthened communal identity, it also created challenges in coordinating land use across diverse stakeholders. This reorganization introduced new mobility dynamics aligned with communal regulations. Today, transhumance faces additional pressures from development and climate change, compelling communities to adapt their practices to safeguard both the sustainability of grazing systems and the ecological balance of high-Andean ecosystems.

New agro-associative enterprises—such as agrarian cooperatives (CAP), SAIS, and ERPS—introduced systems of collective property. However, these reforms met resistance from communities that perceived a threat to their territorial autonomy. In the 1980s, economic hardship, exacerbated by declining fibre and wool prices, intensified conflicts among landowners, Indigenous peoples, and other land users. These tensions disrupted traditional transhumance routes amid uncertainty about future land status—whether private, public, communal, or otherwise. These historical changes continue to shape contemporary transhumance, which must now balance sustainability with adaptation to ongoing socio-economic and climatic pressures in a region where pastoral mobility remains vital for grassland management.

As a form of public action tied to the Agrarian Reform, the FUCAM movement, based in the Kunurana ERPS, played a pivotal role. It contributed to an increase in the number of officially registered rural communities in Peru from around 500 in 1980 to approximately 1,250 today. This marked a turning point for transhumance in the Ramis Basin, particularly in Melgar Province, by promoting greater community autonomy and facilitating access to both communal and parcelled lands. This shift enabled herders to establish more flexible routes and seasonally adapt to the variations of the high-Andean ecosystem. However, the later dissolution of many associative organizations left a gap in collective resource management, requiring each community to independently manage its grazing territories. While this historical process reinforced communal identity and highlighted the centrality of land in transhumance, it also introduced challenges related to sustainability and coordination. Today, communities must balance autonomous land use with sustainable practices to ensure the resilience of both ecosystems and traditional livelihoods.

IV. Projected impacts of major drivers of change

In the future, transhumance in the Lake Titicaca region will be shaped by key drivers such as socioeconomic development and climate change, both of which are already affecting the sustainability of these practices. The land reorganization that followed the Agrarian Reform strengthened communal identity, but as regional development advances, communities must reconcile their traditional ways of life with emerging economic and infrastructural demands. Climate change, in particular, is altering the availability of pastures and disrupting seasonal cycles, necessitating greater flexibility in transhumance routes. Additionally, increasing pressure on natural resources—vegetation, soil, air, and water—will require more effective coordination to manage herd mobility and ensure ecosystem conservation. These evolving conditions call for a model of ‘adaptive transhumance’ that integrates ancestral knowledge with innovative practices to support the resilience of high-Andean communities.

Moreover, the legacy of agro-associative enterprises such as CAP, SAIS, and ERPS continues to influence transhumance in the Lake Titicaca region. Historical tensions between collective ownership and communal autonomy have left a persistent pattern of land management conflicts. These issues, now compounded by economic uncertainty and climate pressures, challenge the long-term viability of transhumant practices. The continued decline in fibre prices and fluctuations in global markets have weakened the pastoral economy, pushing communities to diversify their livelihoods. Meanwhile, climate change threatens the consistency of pastures and the seasonal rhythm of herd movements, requiring new routes and adaptive techniques. Ensuring the sustainability of transhumance will depend

on effectively combining traditional ecological knowledge with modern approaches to resource management and communal governance.

Finally, the role of the FUCAM movement within the Kunurana ERPS—by promoting communal autonomy and more flexible access to land—points toward a future where transhumance in the Ramis Basin increasingly relies on self-managed practices. The capacity for seasonal adaptation fostered in this context has been critical. However, the dissolution of many associative organizations has created a void in collective resource management, leaving individual communities to oversee independently their grazing territories. This situation presents sustainability challenges, particularly in managing shared ecosystems. Looking ahead, the continuation of transhumance in this region will require intercommunal collaboration and the development of sustainable, locally driven strategies. Such efforts will be essential to ensure that pastoral mobility contributes not only to ecological resilience but also to the preservation of the cultural identity and traditional livelihoods of high-Andean communities.

Conclusion

The Ramis River Basin, located between 3,800 and 5,700 metres asl, encompasses a variety of mountainous ecosystems vital to the practice of transhumance. However, increasing fragmentation of these ecosystems due to human activities highlights the urgent need for conservation strategies. Despite a complex colonial history, these high-altitude rangelands remain essential for transhumance—particularly for herd feeding—even as livestock systems have evolved, with dairy production now playing a growing role in local consumption and markets. Alongside Puno's continuing role as a transhumance hub, its livestock traditions remain a valuable cultural and economic legacy. Climate change, however, has exacerbated subsistence challenges by shortening crop-growing periods and affecting water availability. In this context, transhumance plays a critical role by enabling seasonal management of grazing resources at extreme altitudes, securing livestock-based livelihoods, and supporting income diversification for local communities. These realities underscore the need to protect both the rangelands and the cultural traditions that depend on them, especially in the face of current environmental challenges.

The Agrarian Reform of the 1970s serves as an emblematic example of the resilience of transhumance. Although initially met with resistance, the reform did not eliminate traditional herding practices; rather, the adaptive capacity of herders allowed transhumance to endure. Later, the land parcelling processes of the 1990s did not hinder transhumance but instead fostered a new articulation between communal and private land use. This evolution shows that traditional grazing systems can adapt to new socioeconomic frameworks without losing their core identity. The experience of the Titicaca region shows that transhumance is not merely a productive activity, but a dynamic cultural practice capable of reinventing itself in the face of agrarian modernization.

The continued survival of transhumance will depend on the ability of communities to reimagine their mobility strategies in response to disrupted natural cycles. The dissolution of previous associative structures has left each community with the critical responsibility of managing its resources sustainably, in coordination with emerging models of territorial governance. Ultimately, transhumance in the Ramis River Basin remains a cornerstone of sustainable forage management in a landscape defined by sharp seasonal and geographical variations. The integration of agricultural and livestock activities reinforces local livelihoods, while the seasonal movement of herds optimizes pasture use, reduces pressure on ecosystems, and promotes ecological balance. As such, transhumance stands out as a vital practice for resilience and adaptation among high-Andean communities in the Ramis Basin.

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Chapter 13

Challenges for transhumance in Malargüe, Argentina, under global change

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Abstract

This study focuses on transhumance in the Malargüe department in the Central Argentinian Andes and the challenges it currently faces. Transhumance is a recurring and functional livestock movement that allows the use of pastures resources at different altitudinal ecological levels and also its protection. It yields an organic product of high social and cultural value in the region. In this chapter, we describe the typical characteristics of this activity, as well as its historical and cultural implications, which are similar to the rest of Central-Western Argentina where dryland goat herding is practiced. The text questions the conditions for the persistence of this activity in the face of the environmental, economic, and socio-demographic changes observed in rural territories globally. We conclude by highlighting the importance of transhumance as adaptation strategies to face the current scenario of global socio-ecological transformations.

Keywords: Argentina; Goats; Life trajectories; Andes

Introduction

Pastoralism, a widespread practice around the world, is closely linked to specific forms of territorial appropriation. At the same time, it offers insights into the relationships between peasant communities and their natural environments. Transhumance involves a seasonal, pendulum-like movement between winter and summer pastures (Bendini et al., 2005). This chapter argues that the cyclical rhythm of seasonality inherent in transhumance evokes a form of symbolic and cultural appropriation of rural spaces. What makes this type of grazing distinctive is that it is an ecological approach that enables the rotation of grazing areas, optimizing the use of available resources while protecting both plains and mountains from overgrazing.

In the context of debates on socio-ecological transformations (Turnheim et al., 2015; Kern et al., 2019), this work begins with the assumption that transhumant activity is not a natural given, dictated by a predefined order; rather, it results from socio-ecological relationships that have developed over long periods of time and can contribute to the preservation of natural grasslands through a low-intervention form of production.

This chapter presents a description of transhumant activity in the Malargüe Department, Mendoza Province, in western Argentina (Map 1). Firstly, we describe the activity, highlighting the specific features of this form of pastoralism, the summer pasture areas, and the elements that constitute the transhumance cycle. Secondly, we outline a series of factors that help explain the historical evolution and dynamics of this practice in the region. As a result, the advantages and disadvantages of this extensive livestock farming system are listed. To encourage reflection on the current state of transhumance, the text then discusses demographic shifts and climate change, both of which are threatening the viability of this activity.

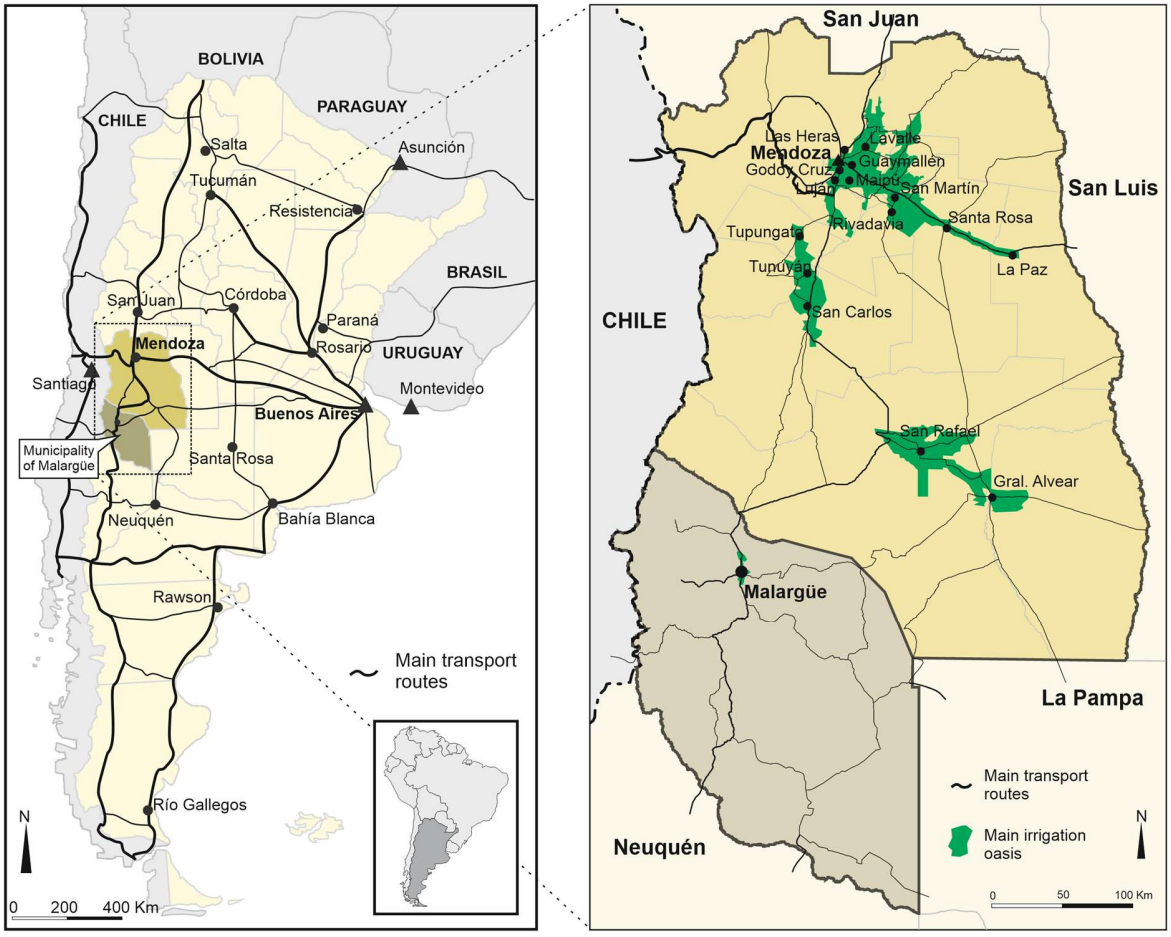
I. Description of transhumance in Malargüe

Transhumance is an ancestral practice involving the seasonal migration of livestock and herders between diverse agroecological zones (Byers, 1996). This form of extensive livestock farming is practiced in many mountainous regions around the world (Rota & Sperandini, 2010). It entails raising livestock by moving them across different environments and managing the pastures that sustain them (Manzano et al., 2021; Scoones, 2023). This rural labour dynamic enhances the resources available to herders who traverse grasslands across the globe (Roe, 2020).

Rural areas dominated by shrubland and steppe—where pastoralism thrives—exhibit diverse characteristics. These vast grasslands are sustained by seasonal rains and snowfalls. One of their most distinctive features is the reliance on traditional knowledge to navigate harsh climates and environments, where humidity and altitude are often the only factors ensuring adequate forage for livestock. It is estimated that between 100 and 200 million people in more than 100 countries engage in this practice (Quiroga Mendiola et al., 2021).

This traditional livestock management system dates back to between 2000 and 4000 BC in mountainous regions such as Central and Northern Europe. By the 10th century, large-scale transhumance had expanded through grazing concessions granted by Aragonese and Castilian monarchs (Castán Esteban, 1994). This marked a transition from pastoralism as a subsidiary activity of agriculture to a more dynamic and commercially oriented form of livestock farming. In the Americas, this few millennium-old practice is believed to be at least 2,000 years old and spans over 30 million square kilometres—twice the area dedicated to agriculture. Its defining characteristic is the seasonal movement of livestock to high-altitude pastures in summer and lower-altitude pastures in winter (Liechti & Biber, 2016).

Malargüe (Map 1) is one of the regions where extensive transhumant livestock farming is practiced. Its geography is marked by a west–east topographic and climatic gradient. The Western sector features a mountainous landscape with elevations reaching 4,000 metres above sea level, cold winters, warm summers, and average annual precipitation of up to 900 mm. In contrast, the Eastern zone has a dry steppe climate, with annual precipitation in some areas falling below 300 mm (Forte et al., 2021). Malargüe is characterized by its vast territory and low population density (0.79 inhabitant/km²), which is lower than the provincial average. The area spans 41,317 km² and is home to 32,717 inhabitants (INDEC, 2023).



Map 1: Location of Malargüe (Ruiz Peyré, 2012)

Nearly 80% of the local population is concentrated in the city of Malargüe. In the department's rural areas, two-thirds of the inhabitants live in so-called *puestos*—the typical productive and domestic units of rural Western Argentina—usually inhabited by extended families spanning several generations (Ruiz Peyré, 2013). The family groups occupying these units identify themselves as *puesteros* (Soto, 2021). The spatial settlement pattern in the department is highly dispersed, except in the capital city. It consists of large natural rangelands managed extensively, relying primarily on native vegetation as the main source of livestock feed, with little or no supplementary feeding (Ramires, 2013; Ruiz Peyré, 2013). The territory is composed of three well-defined sectors: the Payunia, a volcanic plateau dotted with numerous cones; the main Andean Cordillera, with high peaks and steep valleys; and the Huarpes Depression, characterized by closed-basin hydrology and salt flats.

Since the early 20th century, transhumant pastoralist families have moved across the vast Western margins of Malargüe. Due to the aridity of the region and the resulting sparse vegetation, families undertake seasonal migrations to their high-altitude production units, known as *veranadas*, primarily from December to March. This seasonal movement allows lower-altitude pastures to recover while ensuring livestock—mainly goats, but also cattle and sheep—have adequate feed for the winter. The *veranadas* are located along the Andes Mountains, particularly in the valleys of the upper basin of the Río Grande. This migration defines the transhumant pastoralism practiced in the department. The term *arreo* is used by the *puesteros* to describe the movement of their herds and families in search of better pastures for subsistence (Photo 1).

Photo 1. Transhumance of a flock of goats (© Ricardo Curie, Malargüe)

In the highlands, *veranada* areas are characterized by numerous ravines and streams that support lush, tender pastures (Ramires, 2013). There are usually no permanent houses; instead, simple mountain shelters are constructed from stone, mud, wood, and other natural materials to provide protection from sun and rain (Ruiz Peyré, 2013; Ovando, 2011). The stay in the *veranada* lasts from three to five months, depending on distance and weather conditions. During this period, living conditions are often extremely basic, with diets typically consisting of goat meat and a limited range of products that can be transported with the animals. In some areas with road access and improved transportation, supply deliveries are more regular and food options more diverse (Bocco de Abeyá, 1988).

Transhumant pastoralists continue to be part of livestock systems with flexible boundaries in dryland regions, while becoming increasingly integrated into conventional agricultural systems (Beinart, 2007; Scoones, 2020). Each December, pastoralist families set out with their animals toward the highlands. Between March and April, after spending the grazing season along the Andes, these families return to their homes. This practice, established

throughout the South American Andes (Hevilla, 2014)—from Northern Argentina (Quiroga Mendiola, 2013) to Southern Mendoza and Northern Patagonia—also takes place in the Biobío and Araucanía regions of Chile (Contreras & Castro, 2005).

1. Historical evolution. How did the activity reach the region? What dynamics has it experienced?

The historical roots of what we now recognize as transhumant pastoralist families can be traced back to the cross-border movements between Ngulumapu (west of the Andes) and Puelmapu (east of the Andes), carried out by the Mapuche-Pehuenche people during the 19th and early 20th centuries (Marchant, 2019). Today, as in the past, transhumance reflects the necessity for pastoralist families to manage various ecological zones effectively. In other words, these groups must access and utilize resources from different altitudinal levels—coastal areas, valleys, mountain ranges, and plains—in order to survive. This necessity underpins their control over both lowland and highland territories. Transhumance shares many similarities with the model of vertical archipelagos, as it involves seasonal and altitudinal mobility to meet the animals' nutritional needs.

In September, corrals are repaired and *rodeos* are organized to separate livestock belonging to different owners, as herds often intermingle due to the absence of fencing (Agüero Blanch, 2014). The Malargüe department displays a diverse set of transhumant movements across the basins of the Grande, Malargüe, and Barrancas rivers. Notably, 80% of seasonal migrations occur along the banks of the Río Grande (Map 2).

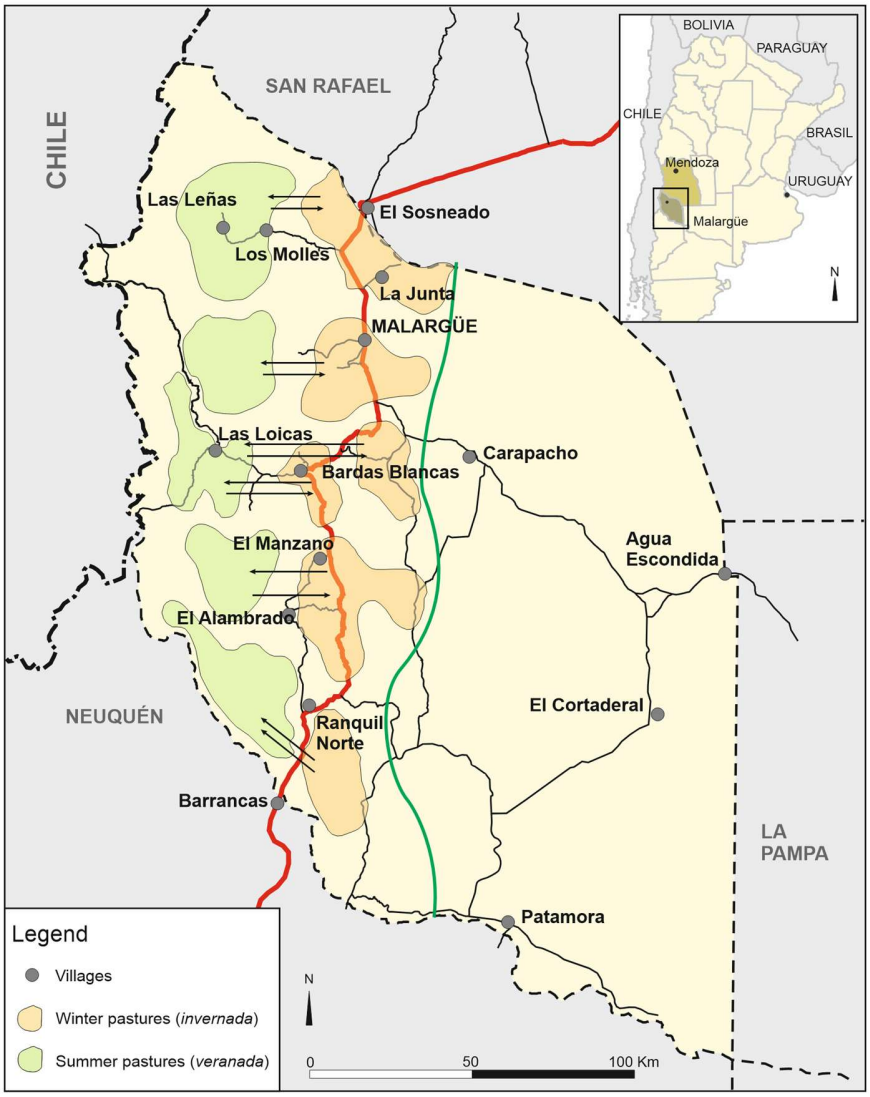
Following the birth and nursing of kids in the winter pastures, the long journey to the summer grazing grounds begins between September and November. Transhumance is sustained by the duality of winter and summer pastures. The mobility of rural families in Malargüe, tied to caprine herding and oriented toward the high-altitude valleys of the Andes, is recognized as an ancestral practice. It represents not only a seasonal migration but also a form of spatial appropriation of nature by rural communities.

2. Advantages and disadvantages. What are the strengths of the activity and what general problems does it face?

Both the winter and summer pastures used by pastoralist families provide resources based on their geographic characteristics. Ridges, valleys, and ravines are particularly well-suited to the needs of livestock breeding. For this reason, animals typically remain in the *puestos* between May and September or November. During this period, births take place. This cycle presupposes appropriate land management, beginning with residence in areas with abundant forage, thereby allowing winter pastures to rest. The descent of breeding males in May initiates the reproductive process, with gestation occurring between June and October. This entire winter–summer cycle enables the specific management of livestock production—especially goat farming—while helping to avoid contact with neighboring herds (known as *piños*). Such contact could result in out-of-season reproduction (particularly in winter), which would jeopardize the survival of the offspring (Ramires, 2013).

Transhumant pastoralism provides pastoralist families with the means to acquire clothing, everyday items, and storable food (Rivarola, 2005). Additionally, the existence and transmission of traditional knowledge support the production of natural, additive-free, and organic goods, distinguishing this practice from similar ones in other regions.

However, this advantage in producing healthy food remains largely unrecognized. Furthermore, the seasonal rotation from winter to summer pastures helps protect the soil from overgrazing and erosion.



Map 2. Summer and winter pasture areas in Western Malargüe (Ruiz Peyré, 2012)

Nevertheless, this system has certain disadvantages, chief among them being the high dependency on natural resources, which directly impacts productivity. The availability of water and natural forage is crucial to the livelihoods of transhumant families. In recent years, this has been affected by extreme weather events—such as intense snowfalls (Segade, 2023) and, conversely, prolonged droughts (Rojas et al., 2023). Predation by wildlife, including pumas and foxes, is another major issue threatening this model of livestock production. In addition, the aging of rural pastoralist populations (Ruiz Peyré, 2019a; Soto & Martínez, 2020), along with the limited capital accumulation possible under such precarious conditions, poses further challenges to the sustainability of this practice.

II. Current and future challenges for transhumance in Malargüe

Under current conditions, transhumance in Malargüe—much like in other parts of the world—faces challenges that threaten or hinder its continuity. While these challenges are diverse and complex, this section focuses on key demographic and environmental shifts, as well as difficulties in land access, which remains one of the most persistent issues in the region.

1. Demographic changes and their impact on transhumance

As in many rural areas globally, Malargüe is experiencing a marked exodus of rural youth (Barés et al., 2024; Ruiz Peyré, 2019b). In this context, peasant communities and families in the study area are particularly affected by conditions of marginalization and exclusion that characterize their territories. Each family adopts its own strategies to maintain their *puestos*, with varying degrees of success.

An analysis of life trajectories (Figure 1) highlights the challenges of generational renewal within the *puestos*. A biographical approach reveals that critical decisions about whether to remain in the countryside are often made

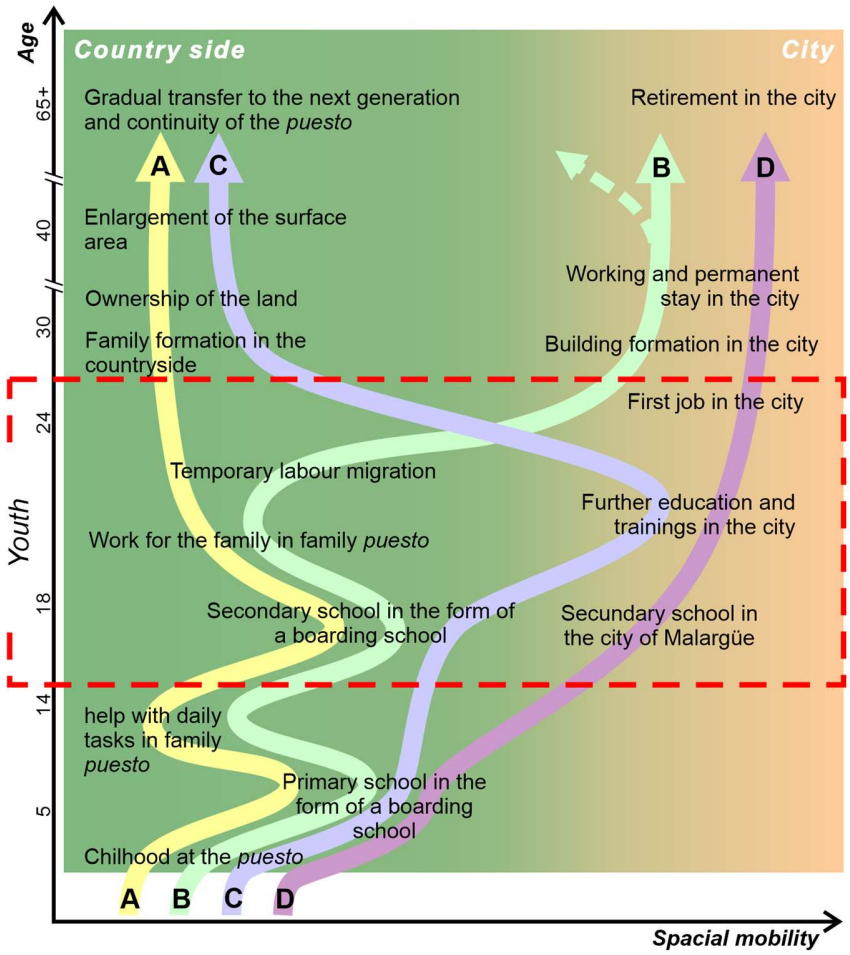


Figure 1: Life trajectories (Ruiz Peyré, 2019b)

during young adulthood, between the ages of 15 and 25 (Ruiz Peyré, 2019b). These decisions result from a combination of factors, both internal and external to young individuals. These include household variables such as property size, land tenure arrangements, social capital, overall economic status, and the number of siblings. Personal interests, individual abilities, and young people's social relationships also significantly influence their choices.

As a result of the rural youth exodus, generational renewal is no longer guaranteed, leading to many *puestos* being managed by elderly individuals until they are eventually abandoned. Consequently, the proportion of elderly heads of household in Malargüe is increasing at a faster rate than the provincial average. Our observations indicate that this trend is becoming even more pronounced in rural areas over time.

It is also important to consider significant gender differences, particularly the greater vulnerability and higher tendency of young women to emigrate. Moreover, the growth of other economic sectors in the region—especially mining and the oil industry—has shifted the preferences and territorial distribution of young *puesteros* (Spacapan et al., 2020). These industries not only compete with traditional rural livelihoods but also have negative environmental impacts: they contaminate and alter watercourses and springs, disrupt watersheds, and cause irreversible damage to vegetation, all of which directly affect livestock farming.

2. Climate change and environmental conflicts

Central-western Argentina is characterized by a mountainous landscape, with altitudes reaching up to 4,000 metres above sea level, a cold climate, and annual precipitation of up to 900 mm. In contrast, the Eastern part of the Malargüe department features a dry steppe climate, with precipitation in some areas not exceeding 300 mm annually (Forte et al., 2022). As highlighted by the Intergovernmental Panel on Climate Change (IPCC), mountainous regions are more affected by climate change than other areas. One of the most significant impacts is the reduction in snowfall, which severely affects water availability (Trasorras, 2023). Paradoxically, this occurs alongside increasing climatic instability, which has had a dramatic impact on the lives of local populations. In August and September 2023, *puesteros* in Malargüe were affected by unusual snowfalls that left them isolated and in need of emergency assistance (Chacón, 2023). In a semi-arid region like Malargüe, such events have a severe impact on agricultural activities and life on mountain farms.

For the Malalweche Mapuche community, water scarcity is a pressing issue, with many settlements facing moderate to severe shortages of irrigation or even drinking water. This situation has worsened in recent years, prompting the community to adopt various adaptive strategies: relocating or abandoning certain settlements, constructing new canals, building water reservoirs, and installing pumps to ensure water supply.

In parallel, climate change has also affected the transhumance cycle itself, with increasingly frequent long droughts alternating with periods of intense snowfall. These shifts have, in some cases, forced transhumant families to concentrate the reproductive cycle at the winter *puestos* (Chillo & Ojeda, 2015). One of the most pressing issues currently affecting livestock farming in Malargüe is the growing conflict with wild carnivores such as pumas and foxes.

The impact of wildlife predation has become so severe that it now threatens the survival of the *puestero* way of life (Corradetti, 2021). This has prompted government agencies to acknowledge the urgency of developing effective responses. One such initiative is the provincial law establishing a “Special Compensation Fund for Sheep and Goat Producers Affected by Wild Carnivore Predation” (Law 8846), implemented under the Provincial Directorate of Livestock (DGP). Although passed in March 2016, the law was not officially regulated until 2019 (Trasorras, 2019).

With diminishing water availability and the cumulative degradation of ecosystems over the years, livestock production in Malargüe—traditionally marked by a single kidding season per year—has declined. These challenges

underscore the vulnerability of this traditional form of livestock farming, as practiced by transhumant families in Central-Western Argentina.

Conclusion

Transhumance is an ancestral practice of grazing livestock on natural pastures along the Andes Mountain range. In central-western Argentina, it refers to a cyclical pattern of livestock mobility that follows seasonal rhythms and supports the social reproduction of the *puestero* way of life. Summer pastures, winter pastures, and the transhumant journey (*arreo*) together constitute a production circuit shaped by the harsh conditions of arid and semi-arid environments that challenge both peasant and Indigenous subsistence.

This peasant reproductive dynamic makes a significant material and ecological contribution to both the regional and global economy. The seasonal preservation of natural grasslands is paired with a distinctive form of organic production in arid zones. However, precarious land tenure—prevalent in both winter and summer grazing areas—creates adverse conditions for families who must dedicate a significant portion of their limited capital to renting grazing land.

Moreover, the intensification of an extractive economy—driven by oil and mining activities—has led to the displacement of transhumant households, directly threatening the continuity of transhumance in the Malargüe department. The gradual abandonment of transhumant systems has triggered a shift in the use of mountain pastures. Combined with the effects of climate change and the lack of effective regulation regarding wildlife predation, the sustainability of this socio-ecological form of mobility is increasingly at risk.

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Chapter 14

Transhumance in Patagonia, Argentina*

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Abstract

Argentinean Patagonia is an arid and cold plateau in the south of South America, located between the Andes Mountains and the Atlantic Ocean. Colonization began at the end of the 19th century and was primarily based on sheep farming. Due to the low stocking rates allowed by the arid steppe, pioneer ranches were large—some spanning several thousand hectares. As a result, transhumance almost always occurs within the same ranch, depending on the terrain and the season. This seasonal movement involves both sheep and cattle. Ranch headquarters are usually located in valleys, at altitudes of 200–400 metres above sea level, while the highest rangelands exceed 1,000 metres. Herds graze on high, mid, and low pastures depending on rainfall, snow cover, and—above all—pasture productivity. Breeders believe that both ranching practices and transhumance have changed significantly in recent decades. Climate change, particularly the decrease in annual rainfall and snowfall, is seen as a major driver of this change. Ranch abandonment—ranging from 30% to 70% depending on the area—is another critical factor. This is largely due to poor financial returns, stemming from a lack of effective public policy and competition from mining, tourism, and urban employment. Furthermore, the abandonment of ranches has reduced predator control (e.g. pumas and foxes) and allowed wild llamas to graze freely on the pastures. While alternative solutions exist, their implementation requires appropriate and supportive policies.

Keywords: Cattle and sheep breeding; Desert; Climate change; Ranch abandonment; Livestock predators

* Photo credits: the authors

Introduction

The chapter begins with a description of the geographical context, which is essential for understanding the dynamics of transhumance in Argentinean Patagonia and, more broadly, livestock breeding in the region. From a geographical perspective, Argentinean Patagonia is unique in the world as an arid region located at mid-latitudes on the Eastern coast of a continent. The harsh and relatively homogeneous ecological conditions across the region significantly diminish the contrasts in geological substrate, particularly between the Andean foothills, the barren Atlantic Coast, and the Patagonian Central Plateau.

Complementing this, the historical context is presented, as it is key to understanding both the past and current state of livestock breeding in Northern Argentinean Patagonia. Colonization in this area is relatively recent, having started at the end of the 19th century, led by the Argentine army advancing from the north. Breeders followed this advance with their flocks of sheep. In Southern Argentinean Patagonia, the situation was slightly more complex, with pioneers and their flocks arriving from the Malvinas/Falkland Islands and the Tierra del Fuego Province.

Next, the chapter details ranching practices, particularly the main livestock breeding techniques used in the area, with a focus on those that enable the efficient use of limited rangeland biomass and help breeders cope with the cold and arid conditions. Chief among these is the systematic practice of transhumance. This description is based on a large sample of ranches analysed and monitored by the authors over the past 25 to 30 years.

Finally, the chapter examines past and current changes, as well as the challenges affecting transhumance and livestock breeding more broadly. Indeed, it is difficult to discuss transhumance in isolation from other practices and techniques. The conclusion outlines future scenarios, developed from the authors' experience and discussions with local stakeholders, and situates transhumance within the historical and prospective context of Argentinean Patagonia.

I. Geographical context of the Argentinean Patagonia

Patagonia covers approximately one million square kilometres at the Southern tip of South America, stretching from the 39th parallel to Cape Horn at 56° South latitude (Map 1). It extends over more than 1,800 kilometres in length, with an average width of around 600 kilometres between the Atlantic and Pacific oceans, narrowing toward the south (Coronato, 2010). The Andes Cordillera divides Patagonia between Chile to the west and Argentina to the east. The 40th parallel South is generally recognized as the Northern boundary of Patagonia. As for the Southern limit, some authors consider the Strait of Magellan as the dividing line between Patagonia and Tierra del Fuego, while others include Tierra del Fuego within Patagonia.

Argentinean Patagonia covers approximately 670,000 square kilometres, bounded by the Andes Cordillera to the west, the Atlantic Ocean to the east, the Colorado River to the north (~40° S latitude), and either the Strait of Magellan (~50° S latitude) or Cape Horn, if Tierra del Fuego is included, to the south. Between the Andes and the Atlantic Ocean, Argentinean Patagonia is composed of an arid plateau with a mean altitude ranging from about 1,000 metres above sea level in the Andean foothills to 200–300 metres near the Atlantic Coast (Map 2). This plateau is intersected by large and deep valleys carved by ancient glaciers, now occupied by wadis, creeks, lakes, and rivers that originate in the Andes, where glaciers and ice fields still persist today.

Map 1. Location of Patagonia in the World and South America, divided between Argentina and Chile

Map 2. Patagonia

Due to its latitude, Patagonia lies within the zone of prevailing westerly winds, which, in the Southern Hemisphere, are stronger and more frequent than in the Northern Hemisphere. The Andes, oriented north to south along the Pacific Coast, stand perpendicular to this westerly airflow and thus create a significant rain shadow on the downwind side—that is over Argentinean Patagonia. As a result, a semi-desert climate dominates the vast plateau on the Argentinean side, which is covered by steppes that starkly contrast with the forested, high-rainfall mountains on the Pacific side. On the windward side of the Andes (West), average annual precipitation is about 2,000 mm, whereas on the leeward side (East), over the Argentinean plateau, it is ten times lower—or even less.

Annual rainfall on the Argentinean side reaches 200–300 mm near the Andean foothills and in the Southernmost areas, but drops to as little as 80–100 mm in Central Patagonia. Rangelands closer to the Atlantic benefit slightly from oceanic humidity and receive somewhat higher rainfall, which allows for slightly greater biomass production than in the more arid interior.

As for temperature, the annual average is relatively cool for this latitude—around 13°C in the North and 6°C in the South—likely due to the influence of the two cold oceans surrounding the region. However, the elevation of the plateau and the rain shadow effect give the climate distinctly continental characteristics. In the South, winter temperatures of -20°C are not uncommon, whereas in the North, summer temperatures can reach up to 40°C. These extreme temperature variations, combined with low annual precipitation and strong winds, explain why herbaceous or shrub steppe is the dominant vegetation type (Photos 1 & 2). Primary productivity is typically around 100–200 kg of dry matter per hectare, providing a forage availability of about 350 kcal/ha/year—though it can fall to zero in wind-eroded areas (Coronato, 2010).

Photo 1. Steppe in high altitude rangeland in summer

Photo 2. Steppe in low altitude rangeland in spring

In terms of grazing capacity, the average stocking rate on the Patagonian steppe is around 5–10 hectares per ewe and 25–50 hectares per head of cattle, depending on location and annual rainfall or snowfall. The literature (Léon et al., 1998; Oliva et al., 2002; Peri & Ormaechea, 2013) mentions the following species present in the region: *Acaena poeppigiana*; *Armeria maritima*; *Berberis microphylla*, *B. heterophylla* and *B. buxifolia*; *Calceolaria uniflora* and *C. biflora*; *Carex andina* and *C. argentina*; *Chiliotrichum diffusum*; *Hordeum pubiflorum* and *H. comosum*; *Erodium cicutarium*; *Mulguraea tridens*; *Mulinum spinosum* and other *Mulinum* sp.; *Poa dusenii*; *Senecio filaginoides* and other *Senecio* sp.; as well as introduced species such as *Capsella bursa-pastoris*; *Cerastium arvense* and *C. fontanum*; *Taraxacum officinale*; and *Trifolium repens*, *T. pratense*, and other *Trifolium* sp.

Another environmental factor that underscores the uniqueness of Patagonia—already mentioned—is the strength, persistence, and predominance of westerly winds, which play a major bioclimatic role. Prohaska (1976) noted that "in few parts of the world is the climate of a region and its life so determined by a single meteorological element, as

is the climate of Patagonia by the constancy and strength of the wind." The impact of wind is significant both mechanically—causing soil erosion and inhibiting plant growth—and physiologically, by accelerating heat loss and evapotranspiration (Weischet, 1985). The strong, persistent winds across the Patagonian steppe significantly reduce productivity by desiccating vegetation and rapidly degrading the quality and palatability of pastures (Photos 3 & 4). Moreover, Morales et al. (2016) identified wind-induced desiccation as a key factor in land abandonment, due to the poor regenerative capacity of degraded pastures, particularly when the ground is partially bare.

Photo 3. Grass growth improves as shrubs protect from wind

Photo 4. Stronger wind erosion without shrub protection

In conclusion, despite clear geological differences—ranging from the Precambrian to the Holocene—the biogeographical landscape remains relatively uniform, characterized by an arid plateau (except in areas close to the Andes Cordillera) and a cold climate, resulting in harsh living conditions and complex livestock breeding challenges.

II. Historical context of the Argentinean Patagonia

According to Coronato (2010), the harsh climate previously described was likely one of the reasons for the low Native American population in the region. It is estimated that only around ten thousand people lived in all of Patagonia at the beginning of colonization in the late 19th century. These populations were nomadic hunter-gatherers, with the earliest groups believed to have settled in the region shortly after the last ice age, approximately 12,000 years ago (McEwan et al., 1997). Patagonia was first revealed to Europeans during Magellan's expedition in 1520. This expedition is thought to have given the region its name, Patagonia, due to a supposed resemblance between the faces of the Tehuelche people (the native inhabitants) and the dog-headed monsters featured in 16th-century Spanish chivalric romances.

Over the following two and a half centuries, there were some local settlement initiatives. However, with the exception of the Welsh colony in Chubut Province and the colony of Carmen de Patagones in the North, most settlements were confined to the Atlantic Coast and had minimal impact on the interior (Coronato, 2010). Until the late 19th century, Patagonia remained a kind of no-man's land, with no formal authority controlling it. According to Coronato (2017), drawing on analyses by Colton (1856), Martin de Moussy (1860), and Walther (1934), Argentina considered its southern border to be the frontier between the Pampas and Patagonia. The same held true for Chile.

In the absence of formal national control, British stakeholders based in Punta Arenas (a Chilean colony on the Strait of Magellan) and in the Falkland Islands acted as unofficial stewards of Patagonia. Furthermore, the British embassies

in both Argentina and Chile encouraged these recently independent nations to colonize their respective Patagonian territories (Coronato, 2010). British interest was particularly strong, as overgrazing in the Falklands had begun to degrade local rangelands. The relocation of part of the sheep flocks to the mainland, and their subsequent expansion across Patagonia's vast steppe, was seen as an opportunity—a potential boom already noted by British explorers who had travelled through the region (Coronato, 2010).

The Argentine army conducted the "Conquest of the Desert" between 1879 and 1884. The colonization of Patagonia by shepherds and their sheep flocks followed the military pacification of the area. Colonization advanced from two pioneer fronts: flocks arrived from the north, from the Pampas (then increasingly populated by European migrants of diverse origins), and from the south, through the Falklands, under British control (Coronato, 2010). Land occupation typically progressed from east to west—that is, from the Atlantic Coast toward the Andes (Figure 1).

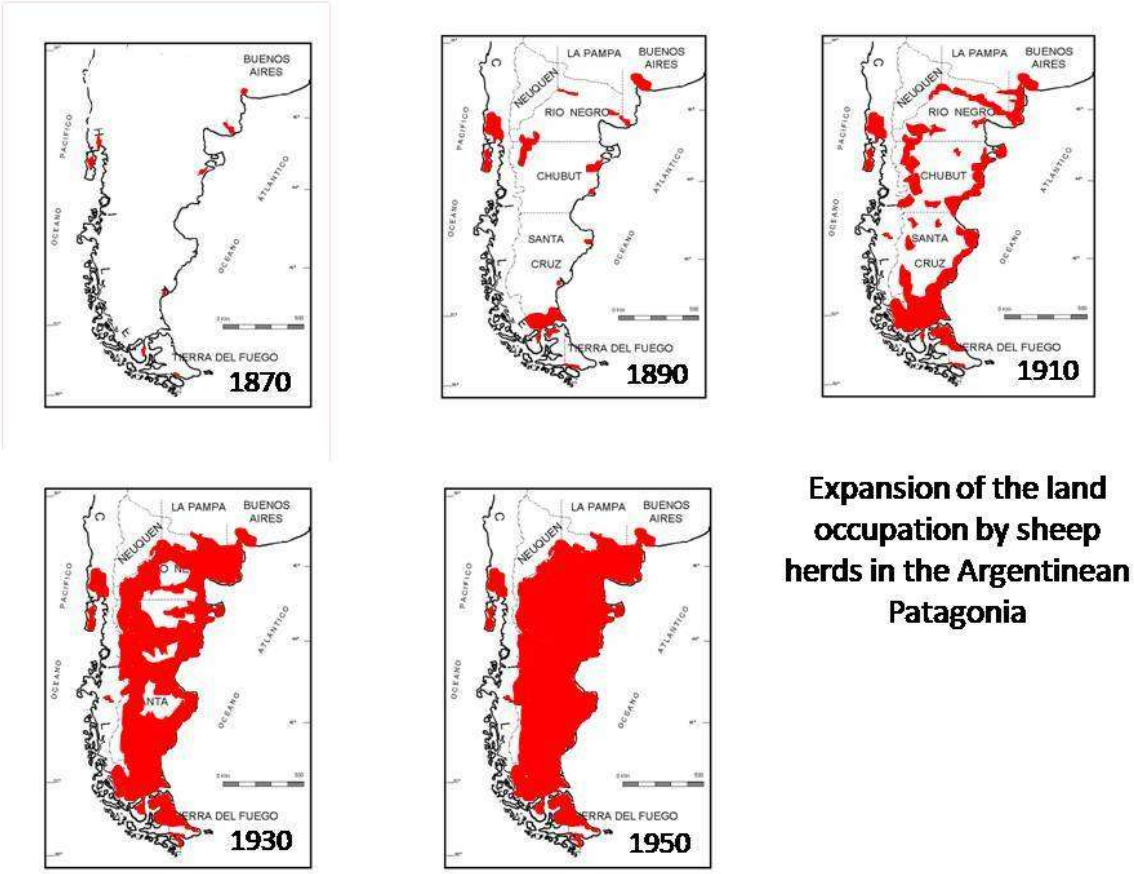


Figure 1. Expansion of the land occupation by the sheep flocks in the Argentinean Patagonia (Coronato, 2010)

Due to the low stocking rates imposed by the arid steppe, pioneer settlements were established as large farms, often covering several thousand hectares—each theoretically sufficient to provide a decent livelihood for a single family. For this reason, sheep farming was adopted as the primary activity. Cattle rearing was introduced only later, in areas with higher rainfall, such as those near the Andes and in the far South. Wool was the main product (Photos 5 & 6), and nearly all of it was destined for export. Furthermore, wool production shaped both the supply chains and the rural and urban landscapes, with various wool traders strategically located to provide livestock farms with necessary inputs and to market their products.

Photo 5. Flock in a farm at the middle of the 20th century

Photo 6. Wool transport in Patagonia late 19th or early 20th century

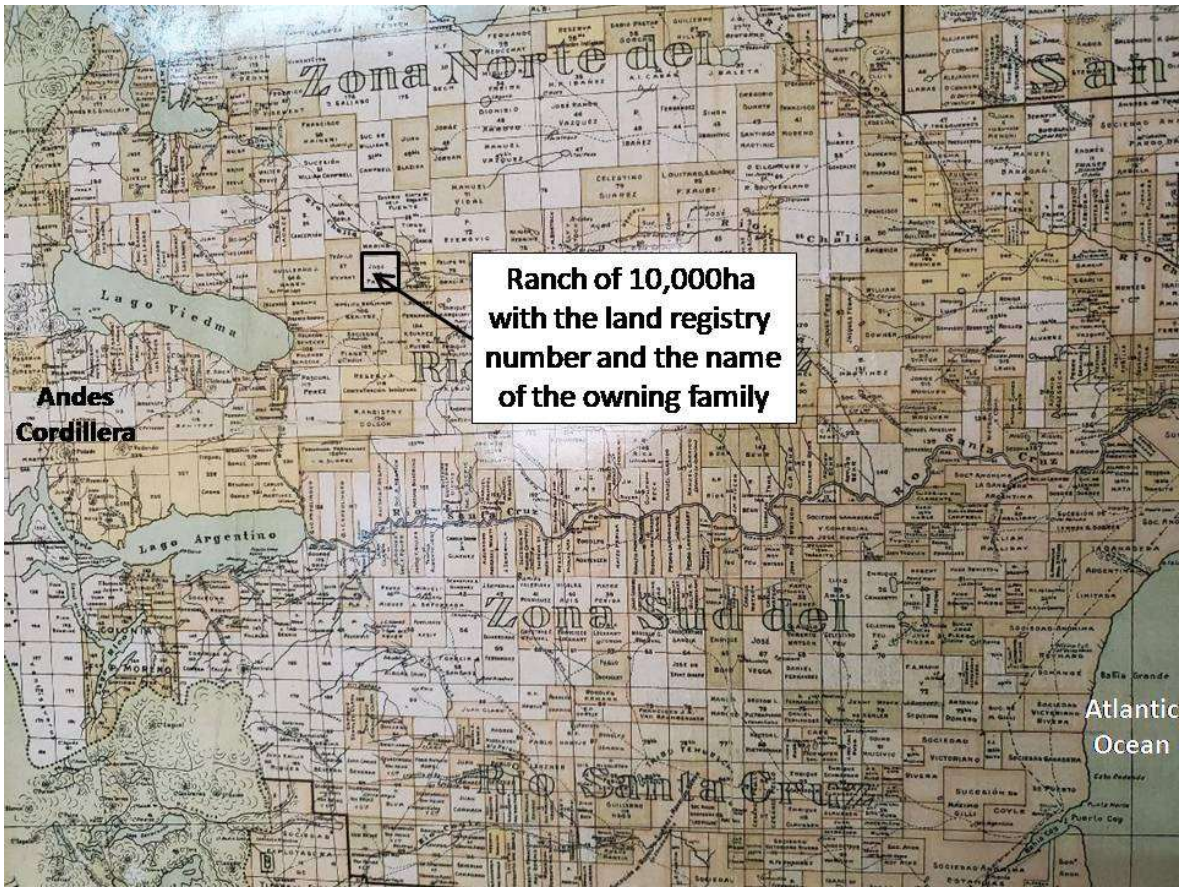
Coronato (2017) highlights the great diversity of migrant origins in Patagonia, mainly from Europe and the Eastern Mediterranean, representing at least twenty different nationalities. This diversity contrasted with the regional dominance of the city of Punta Arenas, strategically located on the Strait of Magellan—a mandatory stopover on the inter-oceanic route between North America's West and East coasts or between Europe and the Pacific. Thanks to its position, Punta Arenas was already a thriving town and economic hub, even before the rise of sheep farming in Patagonia, notably as a port for ship repairs and whaling, the export of minerals, and the trade of goods produced by native communities (Luiz & Schillat, 1997; Martinic, 2002). However, the city greatly benefited from the development of sheep farming, becoming a key starting and convergence point for the main wool and sheep supply chains associated with this industry.

The opening of the Panama Canal in 1914 drastically altered the situation. Patagonia once again became a remote periphery in the context of international trade. From that point onward, sheep production entered a long and gradual decline. Unlike other major sheep- and wool-producing countries, Argentina did not implement public policies to restructure or modernize the sector. Instead, the country shifted its economic focus to other areas, notably fossil fuels and the many minerals found in Patagonia's subsoil, as well as fishing along the Atlantic coast. Only more recently has tourism emerged as a relatively significant economic activity in the region.

III. Ranch management context in Argentinean Patagonia

Before discussing transhumance in the strict sense, it is important to describe the overall farming system and the practices within which it operates. We therefore address, in sequence, ranch assets and investments, land tenure, land structure, and labour organization on the ranch. Next, we present the main principles of herd management, as the type and physiological stage of the animals are key factors in transhumance. Finally, we examine seasonal rangeland management, the context in which transhumance takes place.

Regarding land, we have seen that each pioneer family was granted a vast tract of land—several thousand hectares—by the Argentinean government for settlement. The family became the private owner of the land and could raise sheep there. Map 3 shows the land registry map of Santa Cruz Province, in Southern Patagonia, as it appeared in 1913, with plot numbers and owners' names. Almost all ranches ranged in size from 5,000 to 20,000 hectares.



Map 3. Land register map of the Santa Cruz Province, Southern Patagonia in 1913

Due to the large size of the ranches, they often extend from the valley floor—typically at an altitude of around 200–300 metres, where permanent water sources are found—up to the plateau, corresponding to ancient glacial moraines (Photo 7). In some cases, a single ranch covers both sides of the valley. Ranch headquarters are usually located at the foot of a leeward slope, at mid-altitude—neither on the plateau, where weather conditions are harsher, nor at the bottom of the valley near the creek or river, which is often frozen and muddy in winter, or nearly inaccessible after rainfall in spring and autumn.

On ranches that span varied topography with significant altitude differences, herds are moved up to higher-altitude grazing areas in summer (*campos de veranada*), and brought back down in late autumn to spend the winter in less severe conditions (*campos de invernada*). These winter pastures are, in fact, the limiting factor for the ranches, as supplemental feeding during winter is extremely rare, and—given the size of the flocks—stabling is not feasible. In other cases, transhumance takes place between neighbouring ranches owned by the same family or arranged through systems of rangeland rental or lending. In such cases, herds may move along roads to more distant grazing lands, and transhumance can extend into public spaces, as seen in many other mountain regions around the world, with both positive and negative consequences. Land rental costs vary widely depending on the context, typically ranging from 5% to 25% of the expected production, payable in wool, meat, live animals, or cash.

Photo 7. Flock on the valley floor, with the ranch headquarters in the background and the plateau rising behind.

However, transhumance mainly concerns Southern Patagonia and areas along the Andean Cordillera. In fact, in the Central and Northern regions of Patagonia, transhumance is generally unnecessary due to milder climatic conditions and the vast size of ranches, which provide pastures of low nutritional quality but can be grazed year-round. While the ability to avoid transhumance is certainly a convenience for breeders, it can become detrimental to the rangelands if they are not allowed a rest period—even when the climate doesn't impose one.

A typical family consisted of a couple—usually landowners—their children (if any), and possibly their parents. Sometimes, one or two farmhands were also part of the household. These workers, locally called *gauchos*, were often young men waiting to get married and establish their own ranch further west, or older, often single men whose lives were closely tied to the ranch and the family they worked with and had become part of. Flock size varied greatly, ranging from 500 to 3,000 ewes, depending on several factors: how long the family had occupied the land, the initial capital invested, their level of expertise in sheep breeding, and the inherent risks of farming in such harsh environmental conditions.

As in many frontier regions, the success of certain ranches enabled their owners to acquire additional land—either nearby or farther afield—leading to the creation of large *latifundia* spanning several hundred thousand hectares. Some successful families also invested in the sheep farming supply chains, a sector with attractive financial returns due to the export-oriented nature of wool production. Nevertheless, in most cases, the largest ranches belonged to foreign-based joint-stock companies—primarily British—which had been involved in the international wool trade even before colonization, whether through operations in the Falklands, the Pampas, Australia, or elsewhere (Coronato, 2015).

Since the beginning of settlement, four key groups of techniques have been consistently applied in Patagonian sheep farming for wool production, and they remain relevant today:

- Priority given to lambing — This involves careful selection of efficient ewes—those sufficiently well-fed to avoid undernutrition and reduce mortality during the coldest winters—and appropriate rams. Rams are typically replaced each year, often exchanged with other farms, to avoid inbreeding. The two most commonly used breeds are the Merino, which produces fine wool, and the Corriedale, whose wool is coarser but which is hardier and requires less feed.
- Ewe-lamb management — Ewe-lambs are raised to replace aging ewes. Additional ewe-lambs may be kept to expand the flock's reproductive capacity if rangeland resources allow; otherwise, they are sold.
- Male-lamb management — Male lambs are castrated to become more productive wool producers as adults. Others are sold off.
- Animal care — High priority is placed on animal care, including frequent visits to the flocks—once or twice daily—especially around lambing time. This includes monitoring ewes and lambs, and managing predator threats.

Two additional longstanding practices are still observed on ranches today:

- Maintenance of infrastructure — This includes fences, barns, and corrals. It is essential for ensuring optimal production conditions.
- Meat consumption on the ranch — It involves the older ewes that can no longer reproduce, typically after three to five lambing—due to the tough forage, which prematurely wears down their teeth.

Cattle ranching, by contrast, is generally easier and more flexible. This explains the frequent shift from sheep to cattle in several ranches. Cattle are equally well adapted to the region's cold, dry climate and require less labour—especially in caring for young animals and managing predators.

IV. Past and current change in transhumance and animal husbandry in Patagonia

In addition to considering the application of this set of rules, transhumance must be adapted to both the local climate conditions and the pastoral structure of the ranch. Firstly, regarding the local climate conditions, as already mentioned, except wetter areas near the Andes or the Strait of Magellan, the Argentinean Patagonia presents a fairly uniform climate, at least in terms of rainfall, with a slight decreasing of temperature from north to south. Secondly, regarding the pastoral structure, each ranch has its own pattern. However, it is possible to define relatively simple models of pastoral structures that can be found in almost every ranch, with very few exceptions. Thus, a ranch usually has three types of rangelands:

- The higher rangelands, which can be snow-covered during part of the winter (mid-June to mid-August) and are equipped with windmills for flocks' watering;
- The lowest rangelands located at the bottom of the valley, near the creeks and rivers, which are also frozen during the winter and not easily accessible during rainy weather due to their muddy ground;

- The intermediate-altitude rangelands on the valley slopes or on small hills, which can be pastured all year round.

This means that in terms of transhumance, in late spring or early summer, after a snowy winter and a rainy spring, the flock—including rams and ewes which have already been weaned, as well as castrated males—moves to the highest plateaus in order to graze in good pastures (Photo 8). However, since the animals stay far from the ranch headquarters, some adjustments are required: either a shepherd stays near the flock all the time (dwelling in an only-summer hut), or someone has to go up frequently to monitor the flock and check the watering system. However, in the last two or three decades, farmers have noticed successions of dry years, interspersed with only one or two rainy and snowy years. Under these conditions, the production of the plateau pasture, which has been already low, diminishes even more (Photo 9), and consequently breeders have become sceptical about the interest of transhumance to highlands, except in summers following a rainy and/or snowy autumn, winter and spring.

Photo 8. Plateau pasture after a snowy winter and rainy spring

Photo 9. Plateau pasture after some dry years

The guanaco, or wild llama, has long been a favoured source of meat for Patagonia's indigenous communities and is still widely consumed in rural areas today. It is also commonly used to feed the dogs that are always present on ranches—whether for herding, guarding, or even hunting predators such as pumas and foxes. Additionally, the dog holds symbolic importance, alongside the horse, as an emblem of the *gaucho* (cowboy), and is often considered the *gaucho*'s pet.

It is likely that when Patagonia was fully occupied (Fig. 1 & Map 3), hunting pressure helped to keep guanaco populations in check, likely reducing their original numbers. However, in recent decades, guanaco populations have increased significantly due to the abandonment of many ranches. In Santa Cruz Province, the abandonment rate is estimated at 25–40%, depending on the area, and rises to two-thirds if we include near-abandoned ranches—i.e. those where only a minimal presence is maintained, usually by an elderly *gaucho*, but without livestock. As a result, guanaco herds now graze these abandoned lands and compete heavily with domestic livestock on operational ranches. Fences—usually 1.00 to 1.20 metre high—designed for sheep management are easily jumped by guanacos. On a 10,000-hectare ranch capable of supporting about 500 sheep or 100 cattle, several hundred guanacos may be present. They are hunted for local meat consumption—especially on ranches and in small urban centres—alongside sheep and cull cattle. While there have been attempts to exploit commercially guanacos for their meat and wool, such ventures require substantial investment, particularly in fencing and corrals, and have yet to yield proven results.

Like domestic herds, guanacos migrate seasonally to take advantage of the best grazing areas and water sources, including those developed for livestock. If driven off a ranch, they often take refuge on nearby abandoned lands—simply jumping the fences—and return once the threat has passed. Ranchers are therefore convinced that the decline in pasture productivity caused by climate change is significantly worsened by the presence of guanaco herds.

Moreover, due to their constant presence, it is nearly impossible to implement pasture fallow periods that would allow vegetation to recover.

One might assume that the proliferation of guanacos would reduce predation on livestock by pumas and foxes. However, this is not the case, at least for sheep, as they remain much an easier prey, especially since they are unable to escape by jumping fences. This is one of the main reasons many ranchers have shifted from sheep to cattle, as the latter are not targeted by small predators like foxes and are rarely attacked by pumas.

The growing presence of guanacos has reinforced ranchers' scepticism not only about the benefits of transhumance but also about the future of livestock farming altogether. As a result, certain adjustments have been made, such as avoiding high pastures far from the ranch headquarters or sending only part of the flock—such as castrated males, which are less vulnerable to predators—and only for part of the summer.

Another major challenge for Patagonian ranching is the lack of available labour. As mentioned earlier, many ranches today are maintained by a single person—rarely a couple—living in isolation and responsible for all herd management. According to local ranchers, the main reason for this labour shortage is the stark contrast in quality of life between rural and urban areas, with isolation being particularly discouraging. There are no official data on ranch budgets or owner incomes, but according to our estimates, a well-maintained 10,000-hectare ranch with about 500 sheep and 100 cattle has an annual operating budget of around USD 25,000–30,000. To operate such a ranch, at least two people are needed—for example, the owner and a *gaucho*. If the *gaucho* is paid the minimum monthly wage (around USD 400) plus social charges (approximately 45% of the wage), the owner can expect to pay themselves a monthly salary of USD 750–800, plus social charges. These earnings must be considered in light of the ranch's estimated value—USD 250,000–300,000 (roughly half in land and half in infrastructure)—resulting in a return of about 3% for an owner-operator. If the owner cannot work the land themselves, returns drop to around 1%, and losses are common, since—except in rare cases—a hired manager is less effective at overseeing operations, maintaining pastures, and upkeeping infrastructure and equipment.

While wages in urban areas are not necessarily higher, living conditions are vastly superior in terms of social life, access to healthcare and education, and communication infrastructure. For instance, telephone and internet service are still unavailable on many ranches in Argentine Patagonia. Internet access is limited to one antenna for every 1,000 to 2,000 km², mostly located along main roads—forcing some residents to travel dozens of kilometres just to get a signal. Towns with a small hospital and a full educational system are often located 100 to 200 kilometres away.

Conclusion

Because of the harsh geo-climatic conditions of Argentinean Patagonia, the region remained largely excluded from the broader colonization of the South American continent for over two and a half centuries. Once the "Amerindian question" was definitively resolved by force of arms, pioneers began settling the region with sheep farming. The initial impetus largely came from Scottish shepherds arriving from the nearby Falkland Islands, which share similar geo-climatic conditions. Thanks to the high quality of the Patagonian steppe pastures—which had never before been grazed by domestic ruminants—and the vast size of the farms, pioneering families were able to utilize fully their land, especially as they had sufficient labour to do so. They developed a set of techniques and practices specific to wool and sheep production, including transhumance, to take advantage of different grazing areas within their own ranches and/or neighbouring properties, based on altitude and season.

In recent decades, however, rangeland management has increasingly failed to adapt to shifting bioclimatic conditions—especially declining rainfall—largely due to the effects of climate change. This has led to overgrazing in

many areas. In addition, the relative decline of livestock production is also linked to a lack of effective and supportive public policies, particularly over several decades at the national level.

As a result, a significant proportion of ranches today are either abandoned or no longer commercially productive—estimated at around 25–30% across the region, and reaching nearly two-thirds in the hardest-hit areas. Transhumance, perhaps more than any other livestock farming technique, has suffered under this downturn, as it depends not only on seasonal variations in rangeland productivity—which are increasingly diminished—but also on an increasingly scarce labour force.

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Chapter 15

Past, present and future of the Portuguese transhumance*

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Abstract

Transhumance is an ancient practice of seasonal livestock management that dates back to the Neolithic era. It has been widely practiced in the mountainous regions of the Iberian Peninsula, particularly in Spain and Portugal, where hot, dry summers favour livestock grazing. In Portugal, records of transhumance date back to prehistoric times and peaked during the favourable medieval period. Evidence of this practice can be found throughout all Portuguese mountain ranges, from north to south, where sheep, goats, cattle, and pigs were moved seasonally. Although long-distance transhumant routes disappeared in the late 20th century, the practice still exists in mountainous areas in the form of short-distance movements of small flocks of sheep and goats, known as transterminance. The last long-distance journey by transhumant shepherds was recorded in 1999, to the Serra de Montemuro. The decline of transhumance has been mainly due to political changes and land policies—both in terms of ownership and land use—as well as improved accessibility and rural depopulation. The future of transhumance in Portugal now depends on tourism and initiatives funded by European projects, supported by municipalities seeking to integrate traditional practices into modern land management through identity-based strategies that evoke the collective memory of mountain communities.

Keywords: Transhumance; Transterminance; Portuguese transhumance routes; Heritage

* Photo credits: the authors

Introduction

Transhumance is an ancient practice of seasonal livestock management that dates back to the Neolithic era. It has been widely practiced in the mountainous regions of the Iberian Peninsula, particularly in Spain and Portugal, where hot, dry summers favour livestock grazing. In Portugal, records of transhumance date back to prehistoric times and peaked during the favourable medieval period. Evidence of this practice can be found throughout all Portuguese mountain ranges, from north to south, where sheep, goats, cattle, and pigs were moved seasonally.

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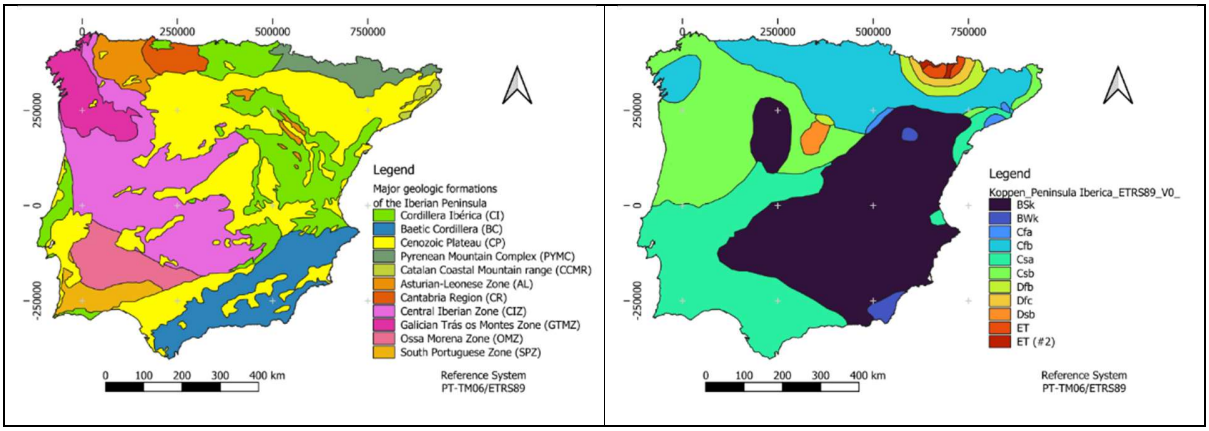
The decline of transhumance has been mainly due to political changes and land policies—both in terms of ownership and land use—as well as improved accessibility and rural depopulation. The future of transhumance in Portugal now depends on tourism and initiatives funded by European projects, supported by municipalities seeking to integrate traditional practices into modern land management through identity-based strategies that evoke the collective memory of mountain communities.

As a characteristic of Mediterranean climates, transhumance also depends on the altitudinal gradient, which provides greener pastures in mountainous regions. The Iberian Massif was formed approximately 310 million years ago when several geological fragments merged to create a single block. This complex formation explains the region's diverse geology and morphology, making it one of the most mountainous areas in Europe (Map 1, left) (Fullea et al., 2021).

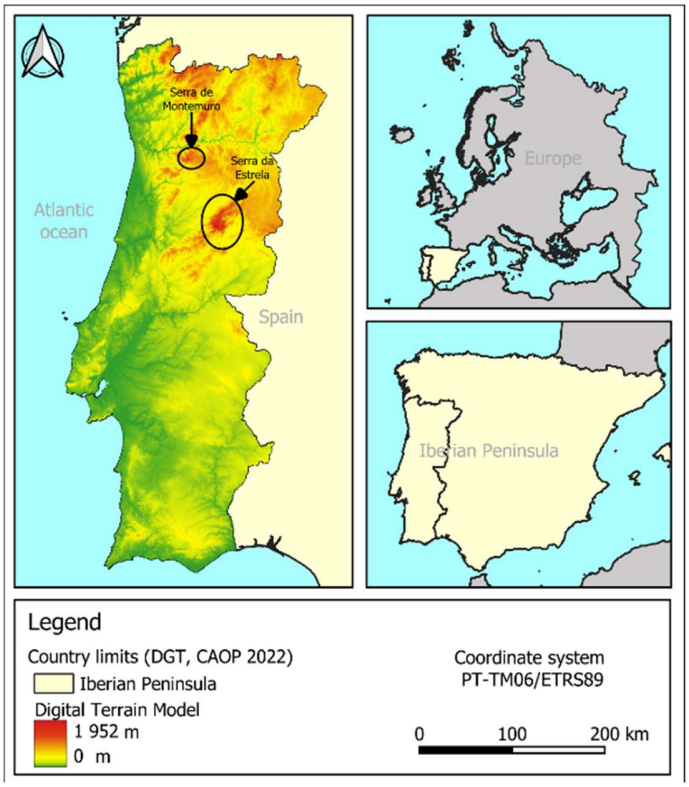


Map 1. Left: Geologic characteristics of the Iberian Peninsula, adapted from the Geological Map of Spain and Portugal, scale 1:1,000,000, Portuguese National Laboratory of Energy and Geology (LNEG). Right: Climatic variability of the Iberian Peninsula according to Koppen-Geiger, adapted from the European Environment Agency

In the northeast of the peninsula lies the Pyrenean Mountain Complex (PYMC), with the Cantabrian region to the west, followed by the Asturian-Leonese Zone and the Galician–Trás-os-Montes Zone (GTMZ)—a bean-shaped structural unit that extends inland from the coast. Southeast of the Pyrenees is the Catalan Coastal Mountain Range, followed by the Cordillera Ibérica (CI), which stretches into the interior and borders the north of the Central Iberian Zone (CIZ), extending from Coruña through Northern Portugal. The Ossa-Morena Zone (OMZ) spans from east of Lisbon to the boundaries of the Baetic Cordillera (BC) in the southeastern part of the peninsula. Finally, the South Portuguese Zone (SPZ), an exotic geological formation, lies at the southernmost end (Torne et al., 2015).

The climatic variability of the Iberian Peninsula (Map 1, right) is strongly influenced by its geology and the altitudinal gradients created by its geomorphology (Fullea et al., 2021). According to Köppen's classification, four major climatic zones can be identified, ranging from cold to semi-arid climates (Peel et al., 2007): the 'BSk' climate is found in elevated areas of temperate zones; 'Csa' occurs south of the central mountain systems in both Portugal and Spain; 'Csb' appears in regions north of the Montejunto–Estrela Mountain system, extending into the northern interior of the peninsula and the coastal areas of Northern and Eastern Spain; the 'Cfb' oceanic/Atlantic climate dominates the northern coastal areas; whereas the 'Dsb' (Mediterranean-influenced warm-summer humid continental), 'Dfc' (subarctic), and 'ET' (tundra) climates are restricted to the higher elevations of the central and northern parts of the peninsula (Pérez & García, 2023).

The Estrela Mountain Complex (Map 2) is an ideal destination for summer transhumance due to its unique climatic conditions. This specific climate is influenced by two main factors: the mountain's altitude (around 2,000 metres) and its proximity to the sea (approximately 100 kilometres). As a result, oceanic westerly winds bring precipitation—mostly rain and snow—especially on the western and northwestern slopes (Monsanto et al., 2005). Precipitation peaks between November and March, predominantly falling as snow.



Map 2. Location of the main transhumance hotspots in Portugal, Estrela and Montemuro

This climate has a dual impact on vegetation: it is beneficial in promoting spring herbaceous growth and enhancing soil water storage, but also detrimental, as ice can deform woody plants at higher altitudes. The Estrela Mountain displays three distinct vegetation zones along its altitudinal gradient: the basal zone, the intermediate zone, and the upper zone (Batista, 1990). The basal zone, located between 800 and 900 metres, is influenced by the Mediterranean climate. Its southern and eastern slopes feature olive groves and vineyards, whereas the northern and western slopes—exposed to humid Atlantic winds—are characterized by maize fields, pine forests, and chestnut groves. The intermediate zone, ranging from 900 to 1,600 metres, supports rye cultivation and wild meadows. Finally, the upper

zone, above 1,600 metres, is dominated by juniper (*Juniperus communis*, locally known as *zimbro*), Pyrenean broom (*Cytisus oromediterraneus* or *piornos*), and matgrass (*Nardus stricta* or *servus*). This upper area is particularly valuable for livestock due to the abundance of these forage resources (Meireles, 2021).

In Portugal, geomorphology has strongly shaped transhumance practices, especially summer (ascending) and winter (descending) transhumance. Although the regular pattern involves ascending movements during summer, some mid-altitude karstic mountain regions (such as the Serras d'Aire and Candeeiros) present a reversal. In these calcareous zones, water scarcity in summer forces flocks to descend toward the coast or to riverine floodplains.

Winter transhumance primarily involves the seasonal movement of flocks from mountain areas, with the Estrela and Montemuro mountains most often cited in the literature (Map 2). Flocks historically moved from villages in the Estrela region to grazing lands in Idanha, the lowlands of Ourique in Alentejo, Baixo Mondego, and the Alto Douro region (Chambino, 2013). Summer (ascending) transhumance refers to the movement of flocks from the lowlands of Alentejo, Idanha, and Baixo Mondego to highland pastures in Estrela and Montemuro, typically occurring on June 24th—St. John's Day—with Estrela being the primary destination (Ferreira & Cunha, 2006).

In addition to these long-distance routes, transhumance can also follow a pendular or oscillating pattern. This occurs when flocks are based at mid-altitudes, in forested areas sheltered from snow, particularly in villages situated between the highlands and the plains (Figure 1). This ancestral practice reflects a rational use of available grazing spaces, seeking complementary pastures either nearby or in more distant territories. Generally, transhumant flocks—mainly of sheep—were primarily raised for wool production, unlike flocks that remained in towns and their surroundings, which were oriented toward meat and milk production (Carvalho & Tente, 2023; Carvalho & Marques, 2020).

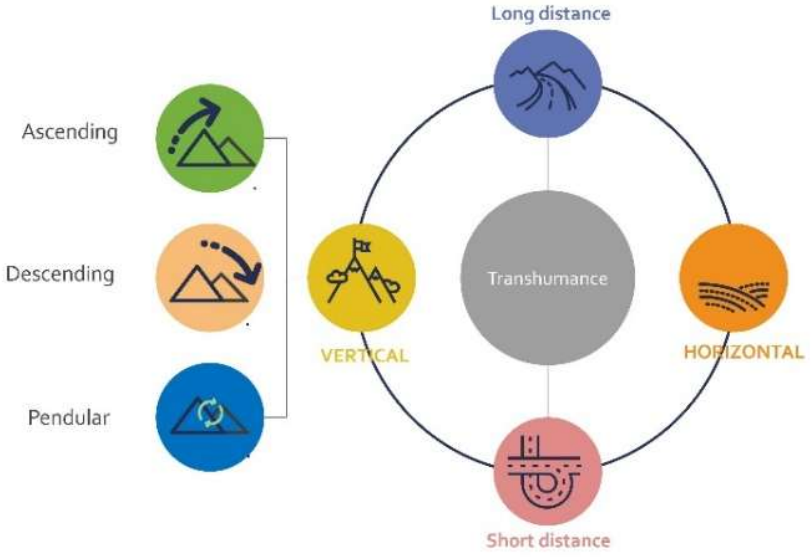


Figure 1. Iberian transhumance variability scheme (© Luís Carreira dos Santos)

Transhumance was once a highly significant phenomenon, particularly in Portugal's mountainous regions, which relied heavily on grazing. Today, however, there are very few places where this form of seasonal migration still occurs. Apart from small transterminance routes—still practiced by some shepherds in villages near the Serra da Estrela—this tradition is virtually extinct. The last recorded long-distance route followed by transhumant shepherds' dates back to 1999, involving migration to the Serra de Montemuro (Oliveira & Silva, 1999; Oliveira et al., 1999). In the Estrela region, long-distance transhumance came to an end more than three decades ago.

In the town of Manteigas, located in the heart of the Serra da Estrela Natural Park, small-scale transhumant movements persist during both winter and summer, still regulated and practiced by elder shepherds. It is therefore essential to document the historical memory of long-distance transhumance, not only to preserve this cultural heritage but also to construct a framework for understanding current practices and envisioning future possibilities.

I. Historical milestones of Portuguese transhumance

Transhumance movements are, in essence, a human adaptation of one of nature's most fundamental phenomena: the migration of thousands of animals across great distances in search of suitable habitats, food sources, and breeding grounds. These natural migrations were followed by Palaeolithic tribes and, after Neolithic settlement and the domestication of animals, transformed into systematic practices crucial for human survival.

The Iberian Peninsula experienced a diverse and complex history of occupation—by Celts, Lusitanians, Phoenicians, Greeks, and Carthaginians—until Roman conquest (218 B.C.–19 A.D.), when the territory became known as Hispania. Although transhumance was likely practiced by earlier peoples, reliable records begin with the Romans. The importance the Romans attributed to grazing became evident with the enactment of the Licinian Law in 367 B.C., which regulated the use of public pastures by private individuals.

During the Visigothic period in Iberia (409–711 A.D.), the presence of large herds is confirmed, along with regulations concerning pasture rights and obligations, as noted in the *Fuero Juzgo*—a document later referenced in the codex of Castilian transhumance laws enacted by Ferdinand III in 1241 (Oliveira & Silva, 1999). Under Arab rule, particularly during the Almohad period (12th century), the introduction of sheep highly suited to wool production (Munro, 2004) by Moroccan tribes significantly boosted transhumance across the Peninsula, especially in Castile (Miguel Gil Morgado, 2013).

Transhumance flourished during the Reconquista (8th–15th centuries). In the 13th century, King Alfonso X of Castile institutionalized it by establishing the Honrado Concejo de la Mesta de Pastores. Founded in 1273, the Mesta became a powerful royal institution that governed pastoral activity throughout medieval and early modern Spain. Its leaders represented not merely a shepherds' confederation, but rather an organized legal framework that sought the State's recognition and protection for transhumance (Rei, 2013).

Portugal shared many legal and cultural developments with Spain, and transhumance was no exception. However, while Spain developed a comprehensive legal structure prioritizing transhumant activity, Portugal did not establish an institution equivalent to the Mesta. Instead, Portuguese transhumance remained under royal authority and municipal oversight. Flocks represented a vital economic resource—for shepherds, landowners, municipalities, the Crown, and the Church—through taxes such as the *montádigo*, which applied wherever transhumant herds moved.

Though mentioned in the *Alfonsine Ordinances*, transhumance was only clearly regulated in Portugal in the 16th century, particularly in the *Manueline* charters of towns like Guarda and Covilhã (Miguel Gil Morgado, 2013). In contrast to Spain, where legislation empowered pastoral institutions, Portugal centralized authority in the hands of the king and local municipalities, which adjudicated conflicts related to transhumance (José Lagos Trindade, 1965).

Long-distance transhumance, involving journeys of several hundred kilometres, only became viable after the Reconquista established safer conditions. These migrations included sheep, goats, cattle, and pigs. In Castile, transhumance expanded significantly with the introduction of high-yield wool-producing sheep, culminating in the development of the Merina breed—later brought to Portugal for use in Estrela pastures (Morais, 1998).

However, these large-scale movements often sparked conflict with local farmers. Such tensions contributed to the creation of the Mesta and the definition of official transhumance routes (*cañadas*). Castilian flocks frequently passed through Portuguese territories, especially to Estrela in summer and Alentejo in winter. This incursion provoked resistance from Portuguese herders, particularly in regions like Monsaraz. In response to mounting protests, King João III of Portugal banned the entry of foreign transhumant livestock in 1538 (José Lagos Trindade, 1965; Silva Nunes, 2010).

The period of Spanish rule over Portugal (1580–1640) marked the height of transhumance protection and regulation (Morgado, 2013). Historical analyses of *montádigo* tax records and other sources confirm that Portuguese transhumant herds primarily migrated from the Serra da Estrela to the plains of Idanha, the Mondego basin, the Douro valley, and Alentejo in winter, returning to mountain pastures during summer. The Montemuro mountain range also became a notable transhumance area, and the site of the last recorded route in 1999—possibly used as an alternative to Estrela due to intense grazing pressure (Oliveira & Silva, 1999).

Looking ahead, the remaining historical periods is discussed in terms of the evolving routes and structural changes that ultimately led to the decline of transhumance. This ancestral practice covered vast areas and persisted over centuries, leaving a profound mark on the history and economy of the Iberian Peninsula. In Portugal especially, transhumance was a vital component of life in mountainous regions, where pastoralism formed the backbone of local livelihoods.

II. The Portuguese transhumance routes

The practice of transhumance in Portugal never developed to the same extent as it did in Spain, where the highly organized Mesta, which was established in the 13th century, played a central role. A similar institution in Portugal, known as the Rafalas, differed in structure: while in Castile the flocks belonged to the Honrado Concejo de la Mesta, in Portugal they were primarily under the ownership of the king and municipal authorities.

Nonetheless, due to its wide geographical scope and long historical duration, the ancestral practice of transhumance significantly shaped cultural identity throughout the Beira Interior region, particularly in mountainous areas. The regular movement of shepherds and livestock fostered economic, social, and cultural exchanges, and gave rise to an extensive network of paths known as the Portuguese Canadas. These transhumant routes shaped the landscape and remain embedded in the collective memory of the region, serving as enduring cultural and identity markers.

Transhumance in Portugal was undoubtedly supported by the monarchy. Extensive landowners and flock masters under the Crown, along with municipal authorities, regulated herd movements and granted rights of passage across properties. Although disputes over passage did occur—especially since Portuguese legislation on transhumance was enacted much later than in Spain—the system of municipal communal flocks and the *montádigo* tax served as an effective form of regulation.

In addition to many short-range routes, Portugal's primary long-distance transhumance routes extended from the Serra da Estrela highlands to the southern regions of Campos de Idanha and Baixo Alentejo, and to the northern areas of Baixo Mondego and Alto Douro. These migrations occurred twice a year: flocks descended to the lowlands in winter and returned to the highlands in summer.

Long-distance transhumance in Portugal was a complex, multifaceted practice involving far more than the movement of flocks and shepherds. It required meticulous planning and logistical coordination to ensure safe and efficient migrations. This included the strategic selection of routes, precise timing of departures, and careful management of the animals' welfare throughout the journey.

Mountain villages welcomed these seasonal visitors with enthusiasm. Often, the arrival and departure of the herds were marked by celebrations that featured music, dance, and traditional food, reinforcing community bonds and preserving regional customs. These events highlighted the deep cultural significance of transhumance and offered moments of joy and unity amid the hardships of rural life.

Flocks followed well-defined Canadas—walled paths typically running between cultivated fields, vineyards, and olive groves (García Martín & Sánchez Benito, 1996; Carvalho & Marques, 2020). These paths were used not only by livestock but also for the transport of goods and people, often overlapping with ancient Roman roads (Miguel Gil Morgado, 2013).

In addition to shepherds, transhumance involved several key roles, most notably the *patrons*—individuals responsible for organizing and managing the flocks in regions traditionally known for cattle breeding. The *patron* selected the herders, notified them of departure dates, appointed a lead shepherd (*maioral*), and recruited others, including cooks and a cart driver (*almocreve*), who typically used draught oxen. When there was a shortage of herders, additional help was recruited from mountain villages.

Before April 25th, 1974—the date of the Portuguese Revolution—municipal permission was required for flocks to travel on public roads (Oliveira & Silva, 1999). Pastures, both municipal and private, were rented annually by the *patrons*. These rental agreements were often negotiated after Sunday mass, with competition among landlords sometimes driving up prices, which were then divided among the landowners based on plot size.

Transhumance routes included regular resting points, especially near the final destinations. Notable examples include Tortosendo (before Estrela) and Cruz do Rossão (before Montemuro). At these locations, the *maioral* would divide the flocks according to their designated grazing zones—symbolically significant, as they marked the 'gateway' to the mountains. Before moving into Alpine pastures, the herds would graze overnight on small, hand-dug plots called *alquebres*, sown with rye. This practice fertilized the soil with manure, ensuring the land's future productivity.

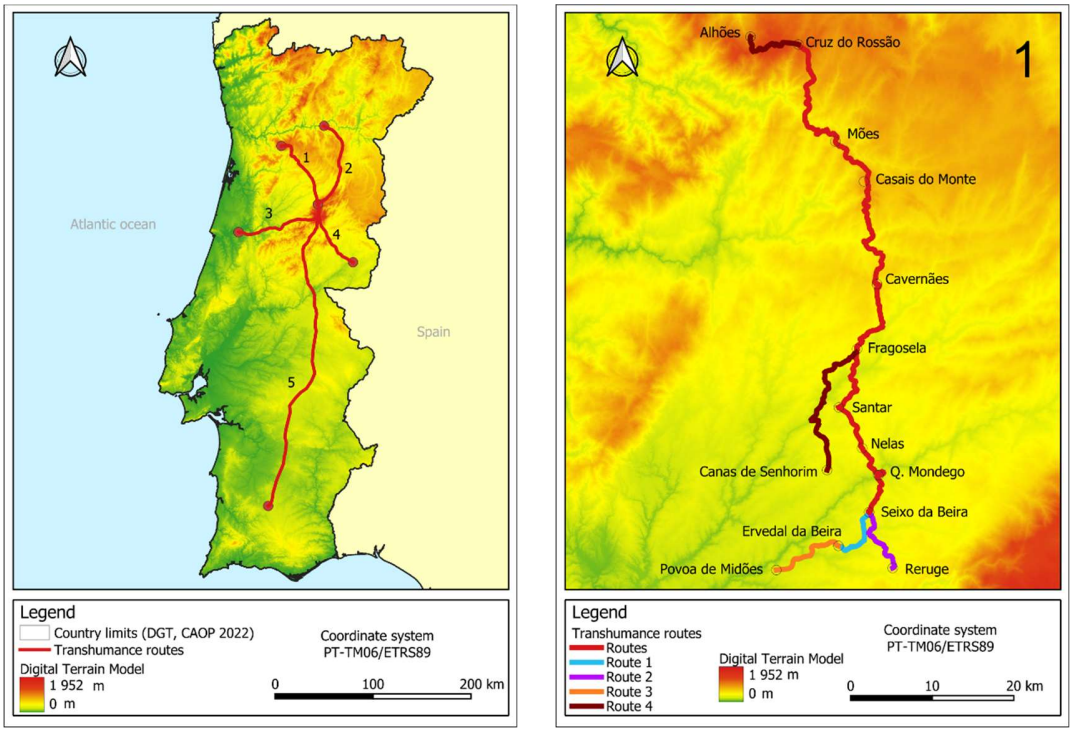
The arrival of the shepherds in mountain regions was a moment of celebration for local villagers. Life was difficult, with limited income and food, but the return of the transhumant flocks brought festive spirit. As twilight fell over the mountains, the sounds of laughter and music echoed through the valleys. Young men and women danced, and the transhumant community revived the villages' social life (Ferreira & Cunha, 2006; Rei, 2013).

Departure day for the highland pastures was another occasion for celebration (Photo 1). Bucks with horns adorned with multi-coloured wool pom-poms, and decorative head collars with bells, gave the procession a solemn and striking appearance. Behind them followed the goats—some also decorated—and the rest of the herd, parading through narrow village paths to the delight of locals and visitors alike.

Photo 1. Departure of the flocks to the mountains, celebration reconstructed in 2023 (© Paula Pires). Left: People watch the parade, the flocks passing by the church, a mandatory passage point; Right: Wool and bells adorn goats and bucks leading the flocks.

Since the advent of Christianity, transhumance has been closely linked to religious celebrations. The traditional day of summer departure is June 24th, St. John's Day, while the return from the highlands usually begins around August 24th, St. Bartholomew's Day, depending on weather conditions and pasture availability.

Among the various transhumance destinations cited in the literature, two mountain ranges stand out: Serra da Estrela (Map 3 left) and Serra de Montemuro (Map 3 right). Due to its vast area and proximity to the Spanish border, Serra da Estrela was particularly favoured for transhumance. Key entry points to Estrela included Seia, Gouveia, and Celorico da Beira for flocks arriving from the north, whereas Guarda, Belmonte, Tortosendo, and Unhais da Serra served as entry routes for those coming from the east (Spain) and the south. Additionally, the village of Manteigas played a central role as a strategic hub within the mountain.



Map 3. Left: Transhumance routes from Estrela Mountain; Right: Detail of the Montemuro transhumance routes starting on the northern foothills of Estrela Mountain

Serra de Montemuro also emerged as a notable and intriguing destination, particularly after the extinction of the long-distance cattle route to Mira, on the coast, in the 16th century. Many flocks that once followed that route began departing instead from the northern slopes of the majestic Estrela Mountain (Chambino, 2014) (Table 1). This shift was likely driven by fierce competition among Southern Estrela herders for access to the sun-drenched slopes, where rich and fertile pastures offered ideal conditions for grazing.

The landscape of Montemuro—with its varied topography and vibrant vegetation—offered a compelling setting for these movements. It highlighted the deep interdependence between geography and the pastoral economy, emphasizing how terrain shaped the rhythms and sustainability of transhumant life.

The works of Orlando Ribeiro (1941) and Alberto Martinho (1978) (cited in Carvalho & Tente, 2023) are foundational references in the literature on Portuguese transhumance. These studies have been used here to identify and highlight the main transhumance routes, with particular emphasis on the Serra da Estrela region (Table 1*;* Map 3 left).

Table1. Main Portuguese transhumance routes to and from Estrela Mountain

Route 1	Route 2	Route 3	Route 4	Route 5
Estrela – Ourique – Beja (extinct in the 17th century)	Estrela to Marão	Estrela to Trás os Montes & Alto Douro	Estrela to Idanha	Estrela to Baixo Mondego

The last long-distance transhumance route, to Montemuro in 1999, has been extensively documented in modern academic literature (Carvalho & Tente, 2023; Oliveira et al., 1999). These works provide detailed descriptions of the routes originating from the lowlands north of Serra da Estrela, which are transcribed in Table 2 and illustrated in Map 3 right.

Table 2. Routes to Montemuro Mountain, adapted from Oliveira et al., 1999

	Route 1	Route 2	Route 3	Route 4
Day 1	Ervedal – Seixo da Beira – Mondego	Meruge – Seixo – Mondego	Póvoa de Midões – Ervedal – Mondego	Canas de Senhorim – Fragosela
Day 2	Mondego – Vale do Gato – Nelas	Mondego - Folhadal – Caldas de Alcafache	Mondego – Fragosela	Fragosela – Cavernães
Day 3	Nelas – Santar – Fragosela – Cavernães	Caldas de Alcafache – Cavernães	Fragosela – Cavernães	Cavernães – Vouga – Casais do Monte
Day 4	Cavernães – Capadouro (Vouga) – Pedras Negras	Cavernães – Vouga – Casais do Monte	Cavernães – Vouga – Pedras Negras	Casais do Monte – Mões – Castro Daire (feira)
Day 5	Pedras Negras – Mões – Castro Daire (feira)	Casais do Monte – Mões – Castro Daire (feira)	Pedras Negras – Mões – Castro Daire (feira)	Castro Daire – Vilar – Cruz do Rossão
Day 6	Castro Daire – Vilar – Cruz do Rossão	Castro Daire – Vilar – Cruz do Rossão	Castro Daire (feira) – Cruz do Rossão	Cruz do Rossão – Alhões (Cambo e Montinho)

Transhumance is not merely the movement of animals—it also involves people. It is therefore important to recognize that this activity was primarily driven by the subsistence needs of flock owners, herders, associated industries, and the communities that supported these routes. Transhumant flocks were primarily raised for wool production, in contrast to sedentary flocks—those that remained in villages and surrounding areas—which were mainly intended for meat and milk production.

In Manteigas and throughout the Serra da Estrela region, livestock breeding has long been a cornerstone of the local economy, even serving as a motivating factor for the region's repopulation. Given the prevalence of poor-quality, stony soil, grazing provided a practical means to utilize the land. This was often done in combination with cereal cultivation—especially rye—to meet the basic subsistence needs of local inhabitants (Batista, 1990).

III. Decline of transhumance up to present

To understand the decline of transhumance, one must first examine Spain at the end of the 18th century, when Jovellanos proposed a new agrarian reform policy that became constitutionalized in 1812. This policy called for the dissolution of the Mesta, which he described as an institution ruled by "a council of lords and monks disguised as shepherds" (Mohíno-Cruz, 2019). The privileges enjoyed by the Mesta had generated widespread resentment, with common pastures and open land increasingly seen as impediments to agricultural progress. These sentiments were echoed in Portugal, where similar criticisms were levelled against the Rafala.

In the 19th century, liberal ideas regarding property rights brought dramatic changes to the landscape. Agricultural expansion and the planting of olive groves became dominant. The abolition of common pasture rights, codified in the Civil Code of 1867, contributed significantly to the decline of transhumance, rendering obsolete many of the major routes to Alentejo. The so-called *baldios*—common uncultivated lands—were increasingly viewed as obstacles to economic development and were subjected to State-led policies encouraging their sale or lease for farming.

In 1886, the creation of the Forestry Services marked a turning point. Initially focused on afforesting the Gerês and Estrela mountains, these services expanded under the Forestry Regime, which directed attention to Portugal's interior. Gradually, many *baldios* were incorporated into this regime. As transhumance diminished, these once-grazed public lands became overgrown with vegetation, a condition disliked by shepherds, who prefer open grasslands (AFFORNORD Conference, 2005).

In 1936, the Junta de Colonização Interna (Internal Colonisation Board) was established to promote agricultural and forestry development in *baldios*. The Forest Planting Law of 1938 gave new momentum to afforestation, aligning Portugal with broader European and North American movements in forestry conservation. The result was the widespread planting of *Pinus pinaster* and *Eucalyptus globulus*, which further reduced land available for grazing (Fernández et al., 2018; Miguel Gil Morgado, 2013). The designation of many highland regions as Protected Areas introduced new restrictions, creating conflict between pastoral communities and authorities, with only a few customary grazing rights remaining intact.

During the 20th century, the establishment of the Portuguese Republic and the disruptions of World War I accelerated transformations in the mountain landscapes. Three key factors drove these changes: the redefinition of *baldio* use, the expansion of afforestation, and the internal colonisation policies, which promoted reforestation even in the last remaining grazing lands (Carvalho & Marques, 2020).

In the second half of the 20th century, industrialization, urbanization, and mass emigration—especially during the 1960s—further altered the social fabric. Rural populations dwindled and aged. With fewer young people taking up shepherding, herds declined and transhumance gave way to more individualistic forms of livestock keeping. This collapse of the traditional rural trilogy—agriculture, forestry, and livestock breeding—led to the decline of the agro-silvo-pastoral way of life.

Based on subsistence economies and characterized by low agricultural yields, the pastoral lifestyle struggled to generate wealth. The shepherd's profession—physically demanding and poorly paid—lost its appeal among younger generations. Meanwhile, technological advancements, improved transportation, and modern communications offered alternative livelihoods, making traditional pastoralism increasingly obsolete. Cattle are now transported by truck or train under strict European regulations, and are fed on fodder and cultivated pastures. The fencing of land parcels not only allowed for better livestock control but also led to the destruction of most traditional transhumance routes (Canadas), further marginalizing shepherds (García Martín & Sánchez Benito, 1996).

With smaller herds, local pastures were sufficient to meet feeding needs, rendering long migrations unnecessary. Even the traditional Estrela Mountain dog breed lost its relevance as predators disappeared. The introduction of chemical fertilizers weakened the traditional link between livestock and crop production. Additionally, the adoption of the Common Agricultural Policy (CAP) in the 1980s—geared more toward supporting agriculture than pastoralism—accelerated the sector's decline (Viegas et al., 2023).

Together, these sweeping political, economic, social, and environmental changes brought about the near-total extinction of transhumance in Portugal.

Conclusion: rethinking the future of transhumance in Portugal

Times have changed significantly. The traditional transhumant journeys to places such as Campos da Idanha, the Douro, and the Mondego fields have largely vanished. Today, only a few solitary shepherds—like José Borges (Photo 2)—continue to practice what once defined the rhythm of rural life.

Photo 2. One of the last Estrela shepherds, José Marvão Borges, Gouveia, 2023

Transhumance, which once shaped local economic, social, cultural, and environmental relationships, has now become almost a relic of the past. A combination of factors—including pasture scarcity, the disappearance of predators, increasingly extreme and unpredictable climate conditions, restrictions imposed by protected conservation areas, forest fires in afforested regions, and the emergence of highly contagious livestock diseases—has discouraged breeders from maintaining these ancestral practices.

In their place, intensive livestock production, driven and regulated by capitalist and industrial models, has taken hold. This shift has replaced the quality and sustainability of traditional, artisanal methods with efficiency-oriented practices, compelling shepherds and breeders to adapt to a fundamentally different system (Sousa et al., 2005).

Today, transhumance in the Estrela and Montemuro mountains has been largely reduced to folkloric and touristic celebrations. These events evoke the memory of this ancestral practice, re-enacting portions of the original routes in educational, recreational, and religious contexts. In doing so, they help preserve the region's vernacular heritage and capitalize on tourism as a new economic engine (García Martín & Sánchez Benito, 1996; Javier & Burgos, 2007).

The future points to increasing forest fire risks and continued expansion of intensive livestock farming to meet the demands of a growing global population. However, there is hope in re-examining the complementarity and sustainability inherent in traditional agro-silvopastoral systems. Encouraging signs are emerging among conservationists and in animal welfare trends, where transhumance is increasingly recognized as a sustainable alternative to intensive breeding.

By enabling extensive grazing in lowland pastures during the winter—when these areas are wet but free of snow—and shifting herds to mountain pastures in the summer—when lowlands are planted with crops—this practice can enhance animal welfare, increase biodiversity and ecosystem services (Manzano & Malo, 2006), and help reduce wildfire risk (Chergui et al., 2018). Such a model promotes the sustainable use of landscapes, offering higher resilience to climate change (Pérez & García, 2023; Tofan & Niţă, 2021).

To address economic stagnation in mountain regions, sustainable tourism can serve as a powerful development tool. With its prime location for mountain sports, nature tourism, and proximity to iconic sites such as Torre and the Penhas Douradas winter resorts, Serra da Estrela also boasts rich cultural products, notably wool and cheese. These elements present promising opportunities for a revitalized local economy.

A strategic investment plan promoting sustainable mountain tourism could integrate transhumance as a key feature—especially through the establishment of ecological corridors aligned with Natura 2000 conservation principles. Such corridors would support farmers, conservationists, local communities, and the tourism sector, offering a model of shared benefit.

Ultimately, the future of transhumance in Portugal depends on policy decisions, especially those tied to the European Common Agricultural Policy, as well as tourism strategy. While this practice may never return to its historical prominence, its revival—rooted in sustainable principles and cultural identity—aligns with local aspirations for greater tourist engagement, regional development, and the preservation of communal herding traditions.

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Chapter 16

Past, current and future changes in transhumance in the Cévennes, France*

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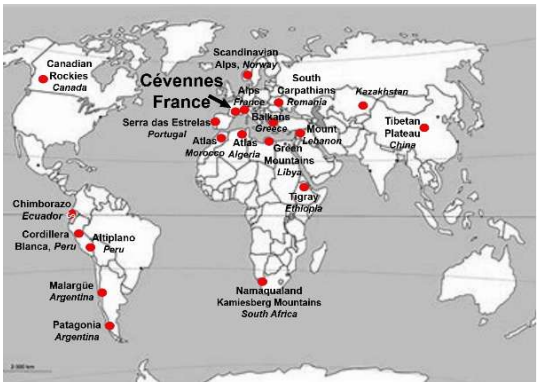
Abstract

The Cévennes are a mountainous region located in the southeast of the Massif Central in France, near the Mediterranean coast, from which they benefit from a climatic influence. The Cévennes have a turbulent history, particularly for religious reasons. Transhumance in the Cévennes is a traditional livestock farming practice, developed over several centuries, that enables the use of high-altitude pastures, at elevations of 1,000 to 1,500 metres above sea level, from mid-June to mid-September. It primarily involves sheep and goats, with fewer cattle and horses. Transhumance is part of an agropastoral system that, over the past two to three centuries, has evolved in an agro-industrial context, notably driven by wool and silkworm production, as well as mining. This particularity has led to pressure on the local labour force, which has been offered various employment opportunities in this industrial setting, and more recently, in tourism along the Mediterranean coast. The main changes that have taken place in recent decades—and are expected to continue—appear to have multiple causes, particularly linked to the evolving role of breeders in society, new agricultural and environmental policies, technological advances, and climate change.

Keywords: Agropastoral system; Industrial context; Demand of youth; Workforce; Climate change



* Photo credits: the authors

Introduction

This chapter on past, present, and future changes in transhumance in the Cévennes massif draws largely on the experience, knowledge, and perspectives of a retired couple of sheep farmers. Originally from urban areas, they returned as young adults to their ancestral land in the Cévennes to take over the farms from their grandparents, great-grandparents and earlier ancestors, and have run these farms for nearly four decades. The couple refers primarily to their own history in the region and, to a lesser extent, to that of their neighbours. This is a particular case study in which Cévennes livestock farmers may recognize themselves to varying degrees. Rather than attempting to present the full range and diversity of past, present, and future changes in transhumance in the area, the authors have chosen to highlight the changes they believe most effectively explain and characterize the ongoing evolution in the region.

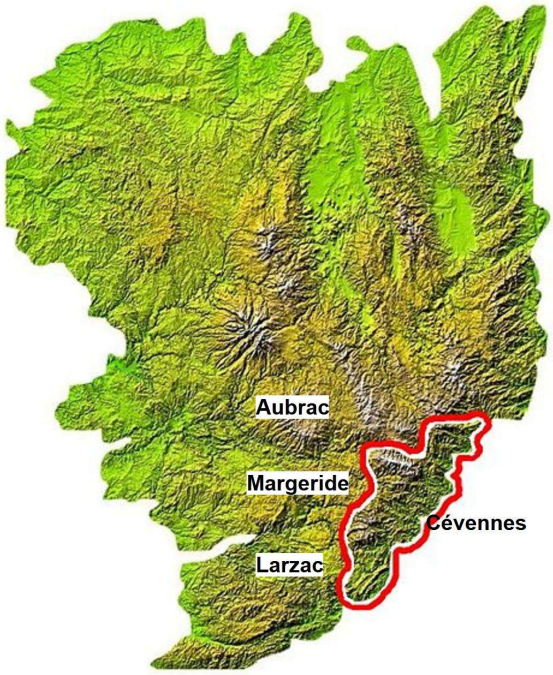
The chapter begins with a general overview of the Cévennes, a mountain range in Southern France. This overview starts with key geographical features of the Cévennes, including its geomorphological and bioclimatic characteristics, followed by a historical account focusing on major events since the Middle Ages that have shaped the region's development, particularly those related to livestock farming and transhumance (Clément, 1983; Duran, 1991; Stevenson, 2007). To conclude this section, we outline the region's agricultural and pastoral activities. The following section presents transhumance in the Cévennes, using our case study of seasonal livestock migration to the Alpine pastures of Mont Aigoual as an example. Finally, the chapter analyses and synthesizes the various past and ongoing changes in transhumance to Mont Aigoual, most of which have been discussed in earlier sections. In conclusion, several plausible future scenarios for livestock farming and transhumance in the region are proposed.

I. Geography of the Cevennes

The Cevennes form a group of low- and mid-range mountains, located in the south-east of the Massif Central (Maps 1 & 2), which, as its name suggests, is in the centre of France. The surface area of the Cevennes is about 5,000 to 6,000 km². This varies widely depending on whether several peripheral zones are included, with the maximum perimeter going as far as to encompass one-fifth of the Massif Central, i.e. around 35,000 km². The Cevennes are dominated by the two peaks of Mont Lozère and Mont Aigoual, culminating at 1,699 m and 1,565 m, respectively. The Cevennes are composed mainly of schist and granite. Like its perimeter, the Cevennes appellation has evolved over time. Administratively, the Cevennes straddle the three departments of Gard, Lozère and Ardèche, and the two regions of Occitanie and Auvergne-Rhône-Alpes. The Cevennes are centred on the institutional, administrative and ecological entity that is the Parc National des Cévennes (PNC). This national park is inhabited year-round. It has a population of around 70,000 to 75,000, of whom almost 600 live permanently in the heart of the park, mainly agro-pastoralists.

From a geomorphological perspective, the Cévennes—like the Massif Central as a whole—consist of a 300–500-million-year-old Hercynian basement composed of schist and granite, which was heavily eroded to form a vast peneplain around 250 million years ago. Then, less than 200 million years ago, subsidence of this peneplain followed by a prolonged marine period led to significant limestone deposits, reaching up to 2,000 metres in thickness. Finally, the Pyrenean and later the Alpine orogenies, occurring between 50 and 30 million years ago, caused the uplift of the Massif Central, shaping its current form as a plateau tilted toward the northwest, marking the divide between the Atlantic and Mediterranean watersheds. The Cévennes Fault also formed a coal basin, the exploitation of which played a major role in the region's history, particularly from the early 19th century onward, as will be discussed further below.

Map 1. Location of the Cévennes in France



Map 2. Relief of Cévennes and Massif Central

The Cévennes are characterized by deeply incised valleys—approximately twenty main ones—running in a northwest-southeast direction (Photo 1). The region exhibits steep altitudinal gradients, with average slopes around 40% and vertical drops reaching 800–1,000 metres. Until the construction of roads, access from the valley floors was difficult, often relying on ridge-top paths known as *drailles* (Photo 2). Additionally, the Cévennes are geographically isolated, making them an ecologically, climatically, socioeconomically, and even politically and culturally marginal region. This has contributed to a strong local identity among Cévenol inhabitants.

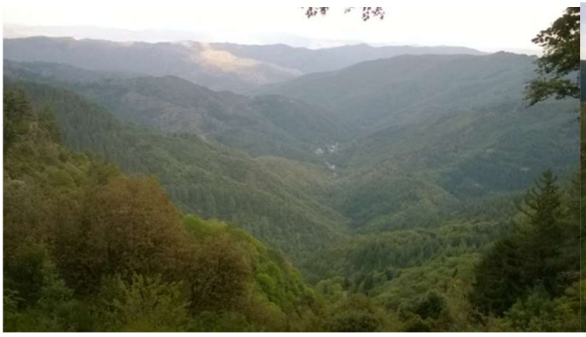


Photo 1. A typical landscape of the Cevennes

Photo 2. Transhumant sheep flock on a draille *(track)*

The Cévennes climate is Mediterranean, with four distinct seasons, and in the highest areas, it takes on more mountainous characteristics. Typically, transhumance takes place in summer, from June to August, when the weather is hot and dry. At an altitude of 1,000 metres, daytime temperatures generally stay below 20°C, although in recent years, due to climate change, they frequently exceed 25°C. The sound of cicadas is common. Winter, from December

to February, is cold, especially at higher altitudes. Frost occurs regularly, even in the valley bottoms, particularly at night. As in much of the Mediterranean, winters are usually dry. Snowfall—once frequent and sometimes heavy—has become increasingly rare. Rain mainly falls in spring (March to May) and especially in autumn (September to November). Average annual rainfall reaches about 2,000 mm at Mont Aigoual and Mont Lozère, and about 800–1,200 mm in the valleys—over a third to half the annual rainfall observed on the Mediterranean coastal plain. Recent decades have seen a decline in annual rainfall on both the plains and in the mountains, with consequences for pasture productivity, groundwater levels, and, subsequently, livestock feed and water availability.

Rainfall in the Cévennes originates from the Mediterranean, carried inland by the sea breeze known as Le Marin. Intense rainfall events, sometimes accumulating 100 to 300 mm in a week and known as *épisodes cévenols*, have been documented since at least the Middle Ages. These episodes result from hot, dry Saharan air—driven by the Libyan anticyclone—absorbing moisture over the Mediterranean and releasing it as heavy rainfall upon reaching the Cévennes, where rapid elevation gain and contact with cold Atlantic air trigger precipitation.

According to the Parc National des Cévennes (PNC, 2023), the region's natural vegetation varies with altitude, soil type, and underlying geology (granite, schist, or limestone), as well as Mediterranean or oceanic climatic influence. Above 1,500 metres, the subalpine zone consists of heathland with juniper, bilberry, *Calluna*, and spikenard. Although limited in area, it is significant as a transhumance zone, given the absence of a true Alpine level due to the region's relatively low elevation. Between 800 and 1,500 metres, the montane zone is dominated by beech forests, interspersed with fir at higher elevations and deciduous species such as oak at lower elevations (Photo 3). Between 500 and 800 metres, the collinear or supra-Mediterranean zone features boxwood and oak stands on limestone under Atlantic influence, whereas chestnut and Scots pine dominate siliceous soils, particularly under Mediterranean conditions (Photo 4). Below 500 metres, holm oak prevails, although chestnut is increasingly replacing it.

Photos 3 & 4. Transhumant flock on a draille *(track) going to Mont Aigoual. Sheep flock grazing on chestnut pasture*

In fact, the natural vegetation of the Cévennes has been deeply changed over centuries by agricultural and pastoral activity, including transhumance, as will be further explained. In the already narrow valley bottoms—wedged between roads and rivers—a few small plots of cultivated grassland or cereal crops can still be found.

II. Key events in the history of the Cevennes

Key factors have shaped the development and use of land and resources in the Cévennes. At the beginning of the 18th century, the Southern Massif Central and nearby Mediterranean-bordering regions were the scene of a religious conflict known as the Camisards' War. This uprising of numerous Reformed (Protestant) believers—supported by a portion of the local population—against the Catholic monarchy's armed forces (backed by another part of society) was, at its core, a civil war. While religion was the primary cause, the conflict also reflected deeper tensions, including the oppression of the rural population under centralized royal authority and its beneficiaries. The roots of this conflict date back to the 16th century and it only came to an end with the French Revolution at the close of the 18th century. Throughout this period, the Cévennes—partly controlled by Protestants and covered in vast forests—served as a regional refuge for many persecuted Protestants, especially during the height of the Camisards' War (1702–1705).

In addition, many wealthy Protestant families, particularly those involved in sericulture (silkworm rearing, silk spinning, and weaving), fled abroad. This harmed an industry that had existed in the region since the late 13th century and had once produced between one-third and half of France's silk. With the return of the monarchy in 1815, the Cévennes again fell victim to state repression during the period known as the White Terror, due to their perceived sympathy for revolutionary and Napoleonic ideals. While these recurring religious and social conflicts significantly impacted the regional economy, they also helped forge a strong Cévenol identity—an image of a rebellious region willing to question the authority of central power, which endures to this day.

Another major historical factor in the Cévennes is the significance of textile production, particularly wool and silk, including spinning and weaving. Already established in the Middle Ages, these industries expanded during early industrialization, helped in part by the hydraulic power of rivers and streams in this well-watered mountainous region. Sericulture, in particular, benefited from favourable bioclimatic conditions for mulberry trees, as well as a socio-economic and political context conducive to silkworm farming. This included the availability of large family workforces to manage silkworm farms and processing workshops, and subsidies provided by the monarchy as early as in the 15th century—extended in the 16th century under King Henri IV and in the 17th century by Minister Colbert—to reduce costly silk imports. However, the spread of silkworm diseases and, later, the advent of synthetic fibres such as nylon in the mid-20th century led to the gradual disappearance of this industry.

Wool was also a key material in the region's textile industry and for a long time was the main product of sheep farming in the Cévennes—alongside meat, dairy for local consumption, and manure used to fertilize local and regional cropland. Sheep flocks were primarily composed of rams or castrated males, whose wool yield is higher than that of ewes or lambs. Like silk, wool production declined with the introduction of synthetic materials. In recent years, wool has even become a net cost, as shearing expenses now exceed the market value of the wool. Nonetheless, some initiatives have shown the potential for adding value to wool through short supply chains and targeted marketing—for instance, by creating handcrafted goods such as socks, scarves, gloves, or laptop sleeves sold in farm shops or local markets.

The presence of a coal basin—though limited to areas along the Cévennes fault—is another key element of regional history. Coal mining in the Cévennes dates back to the 13th century, concurrent with the development of other coal sites in the Massif Central. However, religious conflict disrupted production throughout the 16th to early 18th

centuries. It was not until the second half of the 18th century that production stabilized, contributing significantly to the local economy. Coal mining created jobs and attracted local and regional migration, fuelling the rural exodus and creating a consumer base for food and mining-related materials and equipment—including timber for mine construction and draft animals for hauling coal to ports for distribution.

The building of one of France's earliest railway lines in the mid-19th century further boosted coal production, especially after long-standing disputes over mining rights and subsoil ownership were resolved through the introduction of concessions. The nationalization of the Cévennes mines in 1946, after World War II, triggered another production boom, with a record output of 3.3 million tons in 1958 and a workforce of around 20,000.

Rural depopulation accelerated throughout the 20th century, due to a combination of factors: the growing labour needs of the mining industry, conscription during World War I—as evidenced by long lists of fallen soldiers on village monuments—and, more recently, the rise of Mediterranean coastal tourism starting in the 1960s. Today, the rural population is a fraction of its former size. Many young people have left, only returning occasionally—during vacations or for a few weekends a year—as long as older family members still reside in the villages. As a result, many houses in villages and hamlets now remain closed for most of the year.

At the dawn of the third millennium, the Cévennes have been undergoing a new transformation. The current economy is largely based on green tourism and small-scale mixed farming and livestock breeding, sustained by local food production and commerce, much of it stimulated by tourism. Efforts are underway to revive traditional crops in some valleys, such as the Cévennes sweet onion (AOC), known as *raïolette*, and the *reinette du Vigan* apple. Meanwhile, the gradual decline of traditional pastoralism is disrupting local ecosystems and reshaping the landscape, as will be explored further below.

Tourism in the Cévennes is not only environmentally oriented, thanks to the region's ecological richness, but also cultural, driven by its historical depth and the vitality of segments of its population. While summer remains the high season, tourism is present year-round. In winter, although not the only attraction, the Prat Peyrot – Mont Aigoual ski resort offers downhill and cross-country skiing. Weekend tourism is also active in spring and autumn, when the weather is pleasant. Created in 1970, the Cévennes National Park plays a central role in regional tourism—not only because of its extensive land presence across the massif, but also due to the range and quality of activities it offers, alongside its primary role in environmental protection.

III. Rural and pastoral activities in the Cevennes

As in many low- and mid-mountain regions, farming in the Cévennes has traditionally been family-based, that is, farms were managed by individual families, sometimes extended to a few close relatives, and more rarely at the community level. Today, most farms remain family-run, though often with only one permanent member. In many cases, the second member of a couple works off-farm. Since the late 20th century, some family-style farming groups have emerged, bringing together one or two parents with one or two children, or two siblings. This section does not address the forest plantations established in the second half of the 19th century to reduce erosion on steep slopes, which are now managed by the National Forestry Office (ONF) under concession agreements.

This form of family farming has typically been, and largely remains, a mixed crop-livestock system. It includes a few annual crops (such as cereals, legumes, tubers, and vegetables) for household consumption and local trade, alongside perennial crops (grapes, olive trees, mulberry trees, chestnut trees, and other fruit trees). Livestock—mainly sheep and/or goats—are favoured due to the region's terrain and grazing conditions. Grapes and olives, like mulberries, are now marginal crops in the Cévennes agrarian system, though they were once central to household food security.

Chestnuts, on the other hand, remain important. Historically, chestnuts were so valuable that flocks were not allowed to graze under chestnut trees until the harvest was completed by landowners—and then by those in need. Today, chestnuts still play a vital role in local agriculture. Flocks are often driven into chestnut-rich woods and undergrowth to feed directly on fallen nuts (Photo 4).

The Cévennes landscape retains clear traces of its agricultural past, particularly the terracing that once covered the lower mountain slopes. Today, active terraced farming is limited to areas near villages and hamlets, but remnants of abandoned terraces and rural dwellings can still be found scattered through the forests and underbrush that have overtaken former farmland. The landscape also preserves the old communication and transhumance routes—*drailles*—which followed ridge lines and are still used today by migrating flocks and hikers (Photos 2 & 3).

The presence of a mixed crop-livestock system in the Cévennes explains the importance of transhumance during the three summer months, from mid-June to mid-September. On the one hand, the growth cycle of both annual and perennial crops requires that fields be left undisturbed and available labour focus on key agricultural tasks such as haymaking and cereal harvesting. On the other hand, while transhumance also requires shepherding, it demands less labour overall and poses less risk to crops.

Not all animals take part in transhumance. In the case study presented here, only ewes that lambed early in the year and are no longer lactating are sent to the mountain pastures. Breeding occurs after their return, starting in mid-September, so lambing takes place at the end of winter or the beginning of spring—timed to coincide with the emergence of fresh grass for optimal offspring development. In general, farmers believe that Alpine pastures do not provide sufficient nutritional quality to properly fatten lambs to meet local market standards. For this reason, lambs are either kept on lower pastures with their mothers during spring or supplemented with feed in the morning before grazing, or in the evening when they return to the fold. Moreover, pastures around Mont Aigoual do not offer any particular advantage in terms of meat quality.

Some farmers choose to sell their lean lambs to feedlots, many of which are located in Catalonia, Spain (Map 1), where lambs are fattened using by-products from irrigated agriculture. Like the lambs, rams do not go on transhumance—they remain on the farm and are fed either at troughs or in grass pens. Other breeders prefer to send pregnant ewes to the mountain pastures, timing lambing for their return in the autumn so the lambs can be sold for the end-of-year holiday market. In this case too, only the females are sent to Mont Aigoual.

IV. To Mont Aigoual: one of the transhumance routes in the Cevennes

The ascent of Mont Aigoual is one of several forms of transhumance practiced in the Massif Central. In fact, various types of transhumances coexist in the region, depending on local customs, the season, and the availability of mountain pastures for feeding livestock. One form involves transhumance within the Massif Central itself, with animals moving from the coastal plain, foothills, or valley bottoms to higher elevations—such as in the case of transhumance to Mont Aigoual, the example examined here. Other forms include movements from the southwestern plateaus of the Massif Central, such as the Larzac or Margeride, or northward to Aubrac (Map 2). Transhumance also occurs to pastures outside the Massif Central, such as those in the Pyrenees or Alps. Additionally, winter transhumance routes lead to Mediterranean-bordering massifs—such as the Southern Alps or the hinterland of the Côte d'Azur (Map 1)—where livestock graze in forest undergrowth to reduce fire risk for the following summer, benefiting from subsidies granted for this service.

Transhumance to Mont Aigoual was traditionally integrated into the agricultural cycle and pastoral calendar specific to the Cévennes, though similar systems can be found in other regions. Moving the flock to mountain pastures in summer reduced the cost and labour of guarding animals near cultivated plots, freeing up the same workforce for fieldwork. Even if a shepherd had to be hired to oversee multiple flocks in the mountains, the benefits were clear. Since Alpine pastures were only available during the summer, the three-month transhumance period ensured that flocks were fed for about a quarter of the year, thereby alleviating grazing pressure on farmland pastures.

Transhumance to Mont Aigoual primarily involved sheep, occasionally accompanied by a few goats. A small number of transhumant cattle would also benefit from the best high-altitude pastures. In the past, transhumant sheep flocks to Mont Aigoual, Mont Lozère, or the Corniche des Cévennes, were far more numerous and significantly larger—often numbering several hundred to several thousand head. Older residents recall flocks so large that their passage through villages spanned several days. Today, such movements typically last no more than a weekend or three to four days.

It also appears that flocks once came from farther afield than they do today, including from the piedmont and even the Mediterranean coastal plain—areas where sheep and goat farming have now largely disappeared. In earlier times, flocks would travel several days to reach the high Cévennes meadows, while nowadays the longest transhumance journeys rarely exceed three to four days.

Each transhumant flock generally operated as a single unit, placed under the responsibility of a lead farmer—usually someone with a large flock—who integrated smaller flocks entrusted to him by neighbours, relatives, or friends. Accompanied by his own shepherds, he managed the collective livestock during the transhumance period. The owners of the smaller flocks, having entrusted their animals for the summer months, were then free to focus on other agricultural or non-agricultural work.

Several methods of remuneration coexisted within this shared arrangement, depending on the number of animals contributed and each farm's level of involvement. Contributions might include participation in the ascent or descent of the flock, provision of a shepherd or assistant, or covering the shepherd's food and supplies during the summer.

Until just a few years ago, transhumance to Mont Aigoual in our case study followed this model. From mid-June to mid-September, the farming couple entrusted their 170–180 ewes to a neighbour who combined them with his own flock and with flocks from other nearby farms to form a single transhumant flock under his care. Only the ewes made the journey to the mountain pastures. The couple and their available children took part in shepherding or handled the logistical aspects of the ascent and descent to Mont Aigoual.

V. Past and present changes in transhumance to Mont Aigoual

From our perspective, the changes affecting transhumance in the Cévennes are diverse in nature and span multiple domains. Some changes are specific to transhumance itself—such as those impacting herd management, grazing in high-altitude pastures, or the logistics of the ascent and descent of Mont Aigoual. Others are broader, linked to general shifts in livestock farming, including the changing role of farmers in society, new agricultural and environmental policies, and climate change. Importantly, these changes often have multi-factorial origins, interact with one another, and combine to produce overlapping effects on transhumance to Mont Aigoual and livestock farming in the Cévennes more generally.

One of the most striking changes concerns climates. “Nowadays, cicadas sing at 1,000 metres elevation”—a sign of temperatures exceeding 24–25°C, which was previously unheard of. Winters also seem milder, with spring- or autumn-like days appearing intermittently before winter conditions return suddenly. Rain has become less frequent over the past few decades, with fewer rainy days overall—but this hasn't prevented the occurrence of intense *épisodes cévenols*, which, though less frequent, appear to be more violent. Snowfall has decreased significantly and no longer lasts as long when it does occur. These trends are also reflected in diminished spring flow, with some springs drying up more quickly as summer advances.

Another major change already mentioned is the decline in the number and size of transhumant flocks heading to Mont Aigoual, as well as the reduction in their geographic diversity. Several factors explain this shift: the overall regional decline in sheep numbers; the drastic reduction in the number of farms, particularly those raising sheep; the logistical challenges of transhumance; and changes in production systems, such as a shift to dairy farming. Additionally, some farmers now transport their flocks by truck to summer pastures, sometimes choosing destinations further afield such as the Aubrac plateau, the Pyrenees, or even the Alps.

A significant recent change concerns the management of transhumance. In the past, the flock in our case study was managed by a single lead breeder who took responsibility for several flocks over the summer. This arrangement included organizing both the ascent and descent. Each farmer contributed according to the terms of their individual agreement—through participation in herding, provision of a shepherd, or support with food and logistics. However, following the retirement of the lead breeder, the group had to reorganize. A hired shepherd was brought in, funded in part by public subsidies, and in some years an assistant shepherd was added. The mountain hut was renovated to comply with current labour standards. The ascent and descent of Mont Aigoual became the direct responsibility of each participating farmer, who also had to take turns—often one week each—managing the relationship with the shepherd(s), handling logistics (including food for the shepherd), and addressing any issues that arose during the three-month period. Thus, the social relationship between the group and the shepherd evolved into a dual model: a collective among the farmers, and an employer-employee relationship with the hired herders.

Mobile phones and internet access have also transformed the experience of transhumance, at least in the case of Mont Aigoual. The traditional image of the isolated mountain shepherd is no longer accurate. With a mobile phone, the shepherd remains in contact with family, other shepherds, and the farmers. They can access news, weather forecasts, and predator alerts in real-time. During the ascent and descent, modern communication tools greatly simplify coordination between the front and rear of the flock, and with support teams at resting points.

In the Cévennes, tourism has only a limited impact on transhumance, as visitors have long been present at Mont Aigoual in summer. Interaction is mostly restricted to daytime hours, between 9:00 a.m. and 5:00 p.m., when tourists are out walking. Herding dogs—whose presence is subsidized to protect flocks from predators—can sometimes create tension, as they instinctively perceive tourists as intruders.

On the other hand, the Fête de la Transhumance (Transhumance Festival) has changed the public image of this tradition. At certain locations, the event now attracts hundreds or even thousands of visitors, creating economic and financial benefits for host villages like Espérou. In our case study, the transhumance ascent or descent has become a social event, with family members and friends joining at designated spots to walk with the flock or share a meal (Photo 5).

Conversely, farmers have observed a shift in their relationship with other stakeholders—particularly environmental professionals such as ecologists, biologists, ornithologists, and others—who are seen as intellectualizing nature and increasingly integrated into governance structures (public authorities, park managers, etc.). Farmers sometimes perceive them as “actors telling us what to do,” which occasionally leads to tension or conflict.

Photo 5. Transhumant flocks and their shepherds going to Mont Aigoual with tourists walking along

This tension reflects the growing influence of public policy on livestock farming in the Cévennes. When the couple in our case study began their farming activity in 1983, public subsidies accounted for around 20% of their income. At the time, most of these supports came from national (French) sources. Over time, they became predominantly European. Today, subsidies account for nearly 80% of the farm's income. In return, the farmers must comply with numerous administrative procedures and spend a considerable amount of time on paperwork—either at the computer or in meetings with technical support agencies.

The impact of public policy extends beyond individual farm management to shape the entire context of livestock farming in the region. Initiatives such as the creation of the Cévennes National Park, the designation of Natura 2000 areas, and predator management (including wolves), as well as other agri-environmental measures, all have direct and indirect effects on transhumance. In contrast to these top-down approaches, the Pacte Pastoral des Cévennes (Cévennes Pastoral Pact) is viewed by livestock farmers as a more inclusive and farmer-led initiative. It aims to bring together all land users to build a shared vision for pastoral territories and includes innovative tools such as pastoral easements (e.g. legal access to private rangelands, preservation of transhumance routes) and support for young farmer establishment.

Conclusion

The historical perspective outlined in this chapter highlights the steady and seemingly irreversible depopulation of the Cévennes over recent decades and centuries, accompanied by a parallel decline in agriculture—both in terms of cultivated land and its role in the regional economy. Today, agriculture is largely focused on food production for local markets. Livestock farming, once present in every village, has also sharply declined, with only a small number of farms remaining—and an even smaller proportion raising sheep.

For these remaining sheep farms, transhumance offers a valuable opportunity: it reduces the cost of feeding flocks by utilizing high-altitude pastures and frees up labour for other agricultural tasks during the summer. While managing transhumance requires effort, it is not overly complex when organized efficiently. Under a 'trend scenario', it is likely that some sheep farms will continue the practice. Beyond the practical benefits, the cultural dimension of transhumance could also be reinvigorated, especially in its folkloric form, supported by the development of green tourism—as seen, for example, in the village of Espérou.

However, a more concerning scenario for many farmers involves increasing dependence of livestock farming—and transhumance—on public institutions that oversee the management of natural and agricultural resources in the Cévennes. In such a scenario, farmers risk becoming quasi-employees of public agencies. Already, under the new agricultural policy framework, subsidies are increasingly tied to land use and environmental stewardship rather than actual production. For some environmentalists, the ideal form of agriculture is one that primarily serves ecological functions. A softer version of this vision, more compatible with livestock farming, would downplay concerns about ruminants' greenhouse gas emissions, arguing that they are offset by the numerous socio-cultural, agroecological, and economic functions of livestock systems. Nonetheless, such a model would likely sideline more radical perspectives—such as certain vegetarian or vegan movements—that aim for the complete elimination of animal farming.

In contrast to this institutionalized scenario, the Cévennes Pastoral Pact presents an alternative path—one that re-centres people, particularly herders, in the governance of Cévennes ecosystems. This pact promotes partnerships between farmers and other land users, placing farmers at the core of decision-making processes. Under this approach, transhumance at Mont Aigoual would continue much as it does today, aligning with the trend scenario. Meanwhile, tourism in the Cévennes is expected to grow, driven by economic shifts and the increasing concentration of activity in coastal urban centres.

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Chapter 17

Tradition of goat and sheep transhumance in North Pindos, Greece: heritage and horizons*

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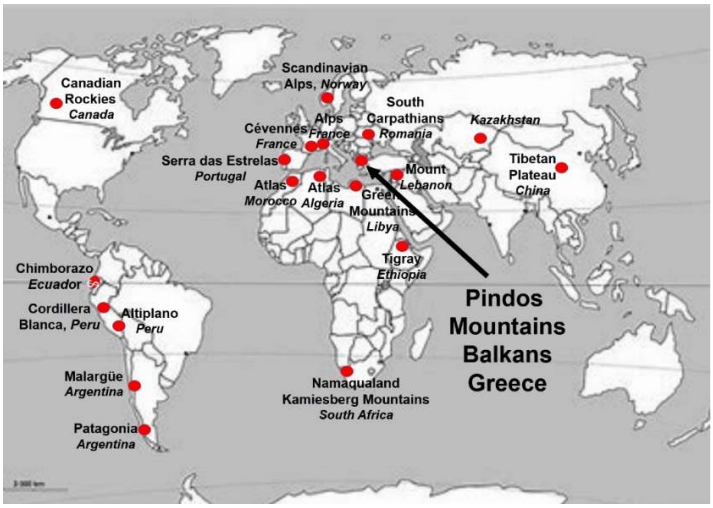
Abstract

Transhumance, a traditional livestock management practice involving the seasonal movement of goats and sheep between pastures, is vital to the ecological balance, cultural heritage, and livelihoods of herders in Greece and beyond. Despite its historical and environmental significance, transhumance is increasingly threatened by challenges such as the lack of legal recognition for migration routes, urban expansion, land privatization, and social resistance. This study focuses on the transhumance practices of goat and sheep herders in the North Pindos mountain region, exploring their historical roots, cultural importance, and the perspectives of herders facing shifting socio-economic and environmental conditions. The findings highlight a decline in transhumance, driven by financial, social, and ecological pressures, compounded by inadequate state support. To ensure its continuity, the study calls for comprehensive policy measures, including subsidies, investment in infrastructure, and legal protection of transhumance routes. Integrated pasture management and targeted incentives to engage younger generations are also essential to sustaining this cultural tradition. By addressing these challenges, Greece can help preserve transhumance, safeguarding both its rich cultural heritage and the ecological integrity of its landscapes.

Keywords: Transhumance; North Pindos; Greece; High-altitude pastures



* Photo credits: the author

Introduction

Transhumance, a traditional system of animal husbandry involving the seasonal movement of goats, sheep, and cattle between fixed summer and winter pastures, is widespread in Greece and around the world. Rooted in ancient Greek traditions, this practice relies on natural fodder resources to sustain livestock. It plays a crucial role in extensive livestock management, contributes to the market economy, and supports subsistence through animal products (Hadjigeorgiou, 2011). Beyond sustaining the livelihoods of many herders, transhumance is vital for maintaining ecological balance and biodiversity. Extensive and semi-extensive livestock systems are essential for preserving traditional agrarian landscapes (Tourrand et al., 2015) and have led to the production of high-quality goods such as Cabrales cheese in Spain (García-Hernández et al., 2022).

The seasonal movement of livestock ensures access to forage and protection from climatic extremes while depending on established migration routes. A previous study noted that transhumance routes from North Pindos to Thessaly in Greece are still capable of supporting a significant number of flocks, thanks to the availability of forage along these paths (Ntassiou et al., 2018). However, in Greece, these routes remain largely undocumented and lack legal protection, putting them at risk of vanishing. Urban expansion, infrastructure development, and land privatization frequently obstruct these paths, while limited public awareness often results in herders encountering hostility when passing near villages or highways. This not only jeopardizes cultural heritage but also presents substantial challenges to herders who rely on these routes for seasonal migration.

Although globally acknowledged, transhumance is increasingly under threat from a range of social and environmental pressures, including market forces, land-use changes, and conflicts between farmers and herders (Sharma et al., 2022). Nevertheless, the continuation of transhumance practices contributes significantly to the sustainability of pastoral ecosystems, fostering a balanced relationship between human activity and the natural environment—regardless of whether herders travel on foot or by vehicle. Despite its recognized value, transhumance is visibly in decline across European mountain regions, where traditional practices are under mounting strain (Liechti & Biber, 2016). In Greece, these pressures are particularly acute.

On December 5, 2023, UNESCO officially recognized transhumance as Intangible Cultural Heritage (ICH) in ten European countries: Albania, Andorra, Austria, Croatia, Spain, France, Greece, Italy, Luxembourg, and Romania. Previous research has emphasized the cultural and ecological importance of traditional transhumance routes, especially those in the North Pindos region (Ntassiou, 2018). Yet, despite international recognition, concerns persist about the economic viability and long-term sustainability of transhumance. In Greece, visits to the Pindos Mountains suggest that the practice threatens to become more of a museum exhibit than a viable livelihood.

This study focuses on the transhumance of goats and sheep in the North Pindos Mountain region—a practice with deep historical roots dating back to antiquity. It explores the historical and cultural aspects of this system and examines the perspectives and choices of herders in shaping the future of transhumance in this part of Greece. Cattle transhumance is excluded from the analysis, as it represents a more recent development and constitutes a distinct topic from the traditional practices associated with goats and sheep.

I. Methodological approach

To understand the decline of transhumance, both historical and contemporary practices in five villages of the North Pindos region were examined. The study employed a participatory methodology that included field observations and

in-depth semi-structured interviews with 28 participants from the area. Interviewees—comprising current and former transhumant herders, as well as their descendants—were selected for their deep knowledge of traditional pastoral practices. Some participants, born between 1920 and 1960, provided valuable insights into past practices, while others, born after 1970, offered perspectives on the current state and future prospects of transhumance. These interviews enabled open discussion while addressing key themes, uncovering a range of economic, social, and environmental factors contributing to the shift from transhumance to more sedentary livestock practices. Additionally, historical data from the French geographer Sivingon and American archaeologists Chang and Tourtellotte—who studied the region in the 1960s and 1980s, respectively—were incorporated. Their findings provided a comparative framework for analysing changes in pastoralism over time.

II. Geographic and bioclimatic context

The study area is situated on the eastern slopes of the Pindos Mountain Range, within the region of Western Macedonia, and includes the villages of Samarina, Smixi, Avdella, Perivoli, and Dotsiko (Table 1, Map 1). These villages are located near several prominent mountain peaks: Mt Avgo (Egg) at 2,177 m in the Perivoli region; Mt Vasilitsa at 2,248 m near Avdella, Smixi and Samarina; Mt Smolikas at 2,637 m near Dotsiko and Samarina; and Mt Annitsa at 1,700 m in Dotsiko area (Photos 1 a, b & c; Map 1). During the summer months, flocks from these villages graze around these mountainous massifs, making use of the available natural forage.

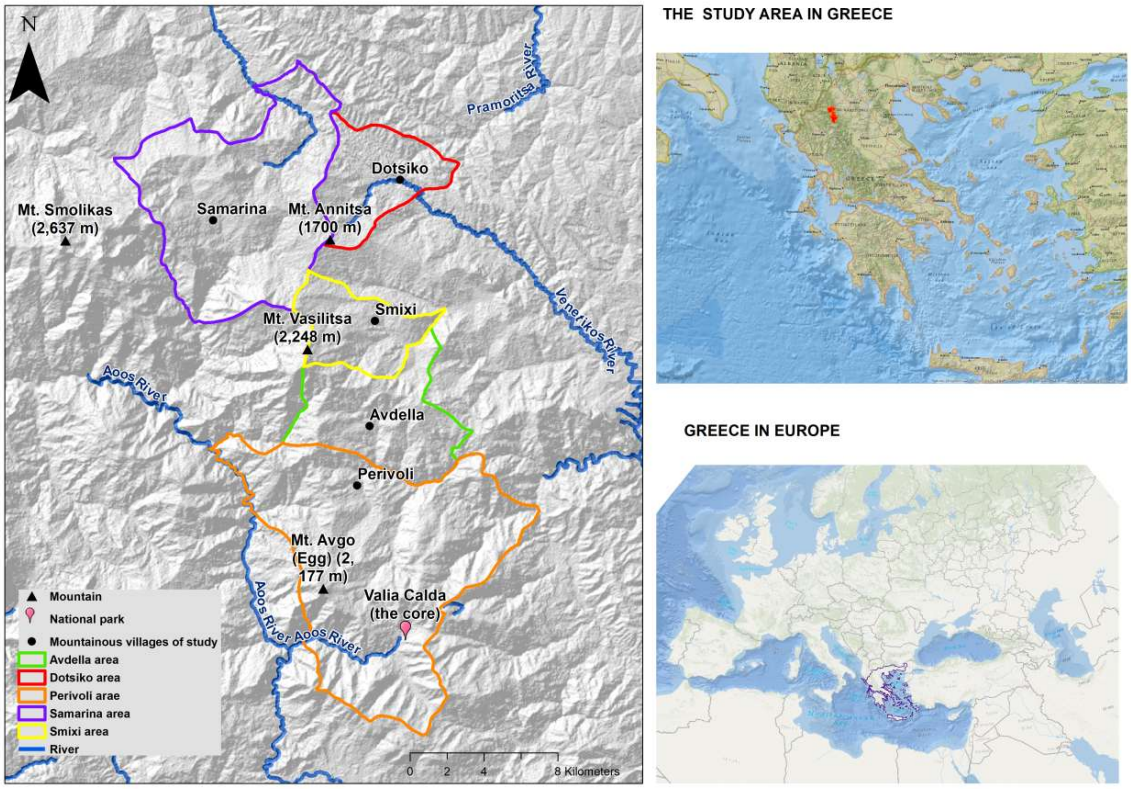
Table 1. Communal areas and average elevations of the villages of the study

	Samarina	Smixi	Avdella	Perivoli	Dotsiko
Total area (ha) (source: Hellenic Statistical Authority)	97.8	25	43.3	137.95	30
Average altitude (m) (source: Wikipedia)	1,450	1,220	1,300	1,280	1,060

Photos 1. Views of mountain peaks of the study area. (a) Avgo Peak; (b) Smolikas Peak; (c) Annitsa Peak

The climate of Northern Pindos is transitional between Mediterranean and continental types. It is characterized by frequent rainfall, cold winters, and relatively warm summers. In the basins and valleys, summers tend to be hot,

whereas in mountainous areas above 800 metres, temperatures remain cooler. Winters are typically harsh, with snowfall occurring more frequently at higher elevations. The relatively even distribution of precipitation throughout the year supports low grassland vegetation in the high-altitude zones (Ntassiou, 2019).



Map 1. Study area (Konstantina Ntassiou)

Vegetation in the region ranges from oak woodlands in the plains and foothills to pine and beech forests in the mountainous areas. This diverse landscape accommodates various land uses, including long-distance transhumant pastoralism and permanent mixed herding and farming communities (Chang, 1993). In the 1960s, geographer Sivignon provided detailed accounts of the geographic and bioclimatic context, especially around Samarina. He noted that the geology of Northern Pindos plays a critical role in shaping vegetation patterns. For instance, the lower slopes with oak groves are associated with the heterogeneous sediments of the Meso-Hellenic furrow. Limestone substrates at elevations up to 1,800–1,900 metres support coniferous forests, while flysch formations host deciduous oak forests up to 1,300–1,400 metres and beech forests beyond that, with beech marking the upper limit of the forest zone. In contrast, ophiolitic areas—such as the summits of the study area—are floristically poor and support sparse vegetation. The interaction between substrate and altitude results in dense pseudo-Alpine meadows on flysch and scattered herbaceous formations on ophiolites (Sivignon, 1968).

Although Northern Pindos receives substantial precipitation overall, there is a notable disparity between the Macedonian and Epirote slopes, with the latter receiving more rainfall (Sivignon, 1968). Precipitation levels vary significantly across the mountain massifs, underscoring the region's diverse bioclimatic conditions and the need for site-specific ecological assessments. For example, Mount Vasilitsa receives approximately 1,045 mm of precipitation annually, whereas Mount Smolikas receives nearly 2,000 mm (Hughes, 2004).

III. Brief historical review

In previous research, the settlements of the North Pindos region have been classified according to the seasonal movements of their populations, resulting in a typology that reflects their corresponding economic practices (Ntassiou, 2020). A key distinguishing feature of some of these settlements is the seasonal abandonment of permanent residences. Among them, pastoral settlements involving seasonal relocation—such as those examined in this study—are particularly noteworthy.

Transhumant livestock breeders in Pindos area have often been associated with the concept of nomadism. However, in practice, these herders typically maintained stable summer settlements in the mountains and, in many cases, permanent or semi-permanent residences in the lowland winter pastures. Historically, some did not have fixed winter homes and instead relied on temporary huts, whose locations varied each year depending on climatic or political circumstances. Therefore, the concept of semi-nomadism, characterized by a lack of permanent winter housing, is more appropriate to describe their traditional way of life.

Settlements such as Perivoli, Avdella, Smixi, and Samarina exemplify this semi-nomadic pattern. Located at elevations above 1,200 metres, these villages were typically abandoned during the winter months. Their inhabitants speak Vlach (or Aromanian), a Romance language. Chang (1993) referred to this group as Koutsovlachs, whereas Schein (1974) used the term Aroumani. Animal husbandry formed the backbone of their economy, complemented by cheese-making, weaving, and livestock trade. This economic activity also extended to trade with wider European markets. Foreign travellers and scholars in the 19th and early 20th centuries described the transhumant lifestyle of these Vlachophone populations and their seasonal migrations to the lowlands (Wace & Tomson, 1910; Weigand, 1897).

Transhumance was also practiced in settlements located at slightly lower elevations (800–1,200 metres), forming another distinct group known as the Koupatsarochoria, situated to the east of the Vlachochoria. These villages lie in the lowest vegetation zones and represent a different ecological and cultural adaptation to transhumance (Chang, 1993). Dotsiko is a representative example of this group.

Seasonal movement in search of suitable pastures was central to this economic model. However, the annexation of Thessaly by Greece in 1881 marked the beginning of a decline in transhumant movements between lowlands and mountain settlements. This was primarily due to the imposition of customs duties and stricter border controls. While the plains of Thessaly became part of Greece, the mountainous regions of Macedonia remained under Ottoman control. Travel documents and passports issued to residents of Southwestern Macedonia during this period provide evidence of these restrictions (Ntassiou, 2014).

Restrictions on livestock movement intensified after 1881 and were exacerbated by the Balkan Wars, which made seasonal migration increasingly dangerous. Following 1917, agrarian reforms in Greece allocated lowland pastures and associated rights to livestock farmers, granting access to vast areas of land. This new availability, coupled with the risks of migration, encouraged many herders to settle year-round in the lowlands. The fragmentation of large estates and redistribution of land to the landless led to more intensive land use, reducing the availability of communal pastures and fallow fields. From 1919 onward, state policies further solidified the relationship between herders and their wintering grounds.

After 1923, refugee resettlement further disrupted land availability, reducing grazing areas. The Greek government attempted to address this issue through decrees in 1938 and 1941, which allowed landless herders to acquire property, including in mountain zones. These measures aimed to support displaced livestock farmers and mitigate the negative impacts of land pressure (Ntassiou, 2017).

The Second World War and the subsequent Greek Civil War brought further dramatic changes. Many mountain settlements were destroyed, and widespread poverty and hunger forced communities to remain in the valleys, combining agriculture with livestock farming (Ntassiou, 2014). Seasonal movement to mountain pastures became severely restricted during this time. It took years for these communities to rebuild and restore their settlements. Nevertheless, the population of the North Pindos region preserved a distinct identity within modern Greece, and transhumant pastoralism remained a powerful symbol of cultural continuity despite the upheavals of war (Chang, 1993).

IV. Brief description of the agrarian context

The agrarian context of Northern Pindos, particularly in the Grevena region, is shaped by its varied topography, climatic conditions, and longstanding land use practices. In high-altitude villages such as Perivoli, Avdella, Smixi, and Samarina (between 1,200 and 2,200 metres) agriculture is constrained by steep terrain and elevation. Land use in these areas is dominated by communal pastures and forests. Flysch formations within this massif provide fertile grazing land and abundant water resources, whereas ophiolitic substrates support poorer quality pastures. High levels of rainfall encourage the growth of dense beech forests; however, summer droughts typical of the Mediterranean climate reduce overall agricultural productivity (Sivignon, 1968). Despite these challenges, flocks continue to graze at elevations ranging from 1,300 to 2,000 metres (Photos 2 a & b).

Milking takes place at these high-altitude pastures, where the traditional *strouga* (milking shed) is located. Historically, herders would sleep at the *stani* (campsite) or return to the village each evening. In goat herding, woodcutting was conducted directly at the grazing site. In the 1980s, transhumant pastoralism was clearly linked to subsidiary activities such as cheese-making, woodcutting, and butchering—key indicators of a transhumant economy (Chang, 1992). Today, milking still occurs at the high-altitude pastures (Photo 2 c), and woodcutting remains common in goat herding (Photo 2 d). However, cheese-making has largely been relocated to village-based facilities. Feta cheese remains the main dairy product, mostly for domestic use, although many herders also sell their milk to merchants.

Photos 2. (a) Grazing at Avgo Peak, Perivoli area at 1,900 m; (b) Grazing at the pastures of Dotsiko at 1,100 m; (c) Strouga *at Avgo Peak; (d) Wool cutting at Dotsiko pasture*

When local pastures proved insufficient for seasonal grazing, herders often moved their flocks to suitable areas in neighbouring regions. In Dotsiko, for instance, there was a traditional shift toward the pastures of adjacent communities during the summer months. Men would travel with their animals to these more distant grazing lands once local resources were depleted. Today, due to a reduction in the number of sheep and goats, such movements occur only occasionally. Additionally, flocks grazing in the highest zones (~2,200 m) now use intermediate pastures upon their arrival in early summer, before descending to lower zones in September.

Historical records help illustrate the former scale of sheep farming in the region. In the 1960s, Sivignon reported that Samarina had around 40,000 sheep, while neighbouring Smixi, with less extensive pastureland, supported 6,467 sheep and 96 large livestock. Avdella maintained approximately 10,000 sheep, and Perivoli had about 20,000. By the 1980s, Chang (1993) recorded 8,425 sheep in Avdella and 17,465 in Perivoli. Meanwhile, historical accounts indicate that Dotsiko supported around 15,000 sheep and goats during the same period (Mpatzis, 1999). These flocks were primarily composed of indigenous Greek breeds—most notably the Karagouniko, Chiotiko, and Katsika goats—well adapted to mountainous terrain and traditional transhumance systems. Today, flock sizes have declined significantly, and many herders now raise a mix of indigenous and imported breeds. Table 2 shows the current livestock figures for each village, highlighting the overall reduction in herd sizes.

*Table 2. Size of the flocks in each village today (*Estimated by observation) (Summer 2024)*

Villages	Samarina	Smixi	Avdella	Perivoli	Dotsiko
Num. of sheep and goats*	18,000	2,000	1,200	5,000	5,000
Num. of flocks	17	3	3	7	8

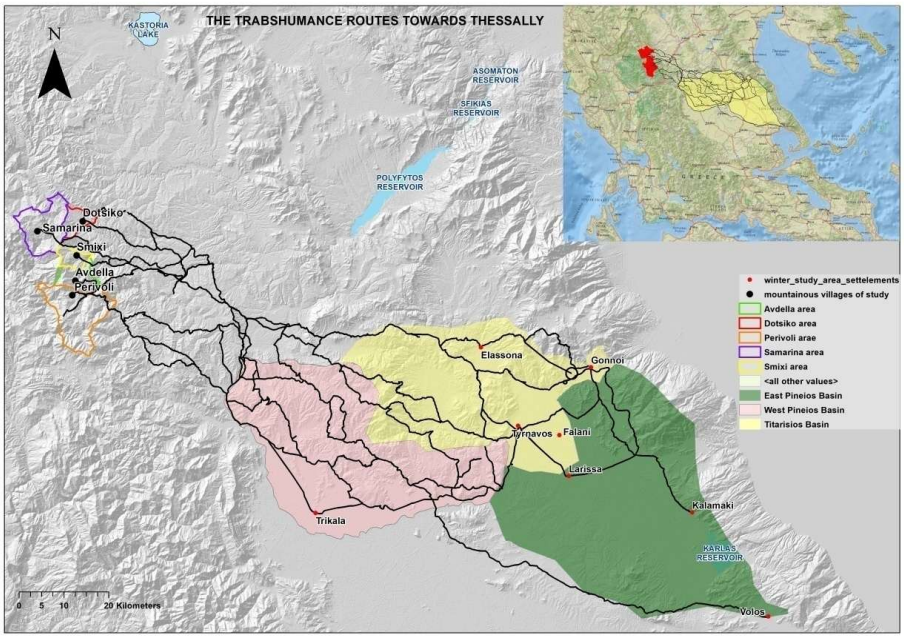
V. From summer highs to winter pastures

By November, the study villages are virtually abandoned. Flocks are expected to be in the mountains by late May and to depart by early November. These seasonal movements traditionally corresponded to religious festivals, particularly those of Saint George in spring and Saint Demetrius in autumn. However, actual departure and return dates were influenced by weather conditions and the quality of available pasture. In classical transhumant systems, the timing of migration also depended on the distance between summer settlements in the mountains and the winter pastures.

Historically, wintering took place in the fertile catchment basins of the Pinios and Titarisios Rivers in Thessaly (Map 2). The Pinios basin is divided into the western plain of Trikala and the eastern plain of Larissa, whereas the Titarisios basin encompasses the provinces of Tyrnavos and Elassona, which remained under Ottoman rule until 1912. Thessaly continues to serve as a preferred wintering destination for many flocks from the mountainous areas of Western Macedonia (Chang & Tourtellotte, 1993; Sivignon, 1968).

In Northern Pindos, the configuration of transhumance corridors (Figure 1) is determined by the availability and quality of forage along the route. Herders select paths based on the type, abundance, and seasonal suitability of vegetation. High-quality forage can prolong the stay of flocks in certain locations (Ntassiou, 2014), whereas inadequate vegetation or the encroachment of cultivated land may hasten their movement. Access to water and grazing areas is also critical, making it necessary to stop at traditional resting points known as *konakia* (singular: *konaki*), which provide vital resources such as spring water and firewood (Wace & Thompson, 1989).

The journey's duration depended heavily on the distance between summer and winter grounds. For instance, an autumn migration covering 135 kilometres could take up to 12 days (Map 2).



Map 2. Transhumance routes from the study area towards the winter pastures of Thessaly

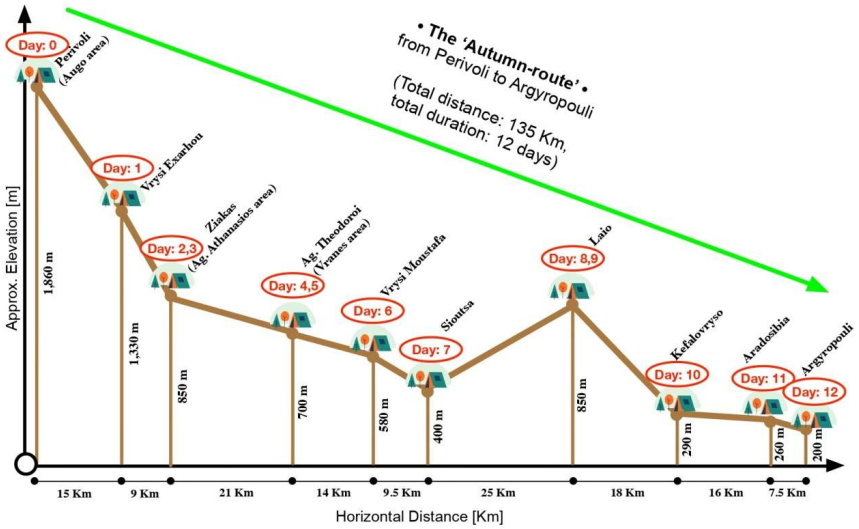


Figure 1. Transhumance route and related konakia*, from Perivoli to Argyropouli (source: Ntassiou et al., 2018)*

Although the traditional practice of seasonal movement on foot has declined—with many flocks now transported by truck—remaining transhumant herders often continue to follow traditional routes and stop at the same *konakia*. Despite changes in flock numbers and the adoption of modern practices, the core elements of transhumance have been preserved. According to testimonies, significant changes to these routes occurred after World War II. From the 1950s onward, the increasing use of automobiles and the expansion of systematically cultivated land made it more difficult for herders to move livestock along central roads or through agricultural zones, although trains continued to serve parts of the routes.

By the 1970s, the widespread use of trucks for seasonal relocation marked a major transformation in transhumance, reducing dependence on foot migration (Ntassiou & Doukas, 2019). Today, most journeys on foot occur in the autumn (Photos 3 a & c), with only a few flocks still making the spring journey in the traditional manner. Autumn migrations often include more *konakia* and take longer, with route variations depending on weather and local conditions. In the spring, transhumant movement was complicated by the labour-intensive tasks associated with milk production and cheese-making (Photo 3 b). These required careful planning and management. Typically, herders made two stops per day—one at midday and one at night—to allow for rest and feeding, while ensuring a timely arrival at the summer pastures and the start of seasonal operations. Today, few flocks undertake the full spring journey on foot (Photo 3 d). A common modern practice involves transporting flocks by vehicle to Grevena, after which the journey continues on foot to the mountain settlements.

Expropriations and the expansion of arable land have significantly disrupted traditional transhumance routes. Many *konakia* have been converted into cultivated or privately owned land, restricting access for herders. As a result, routes have had to be altered to bypass newly developed areas, increasing the risk of crop damage. To avoid conflicts with landowners, some herders now travel at night. Each year, routes are reassessed based on which areas are left fallow, allowing herders to adjust their paths dynamically. This annual re-evaluation provides flexibility and helps sustain traditional practices amid modern land-use pressures.

Photos 3. (a) Autumn departure from the Perivoli pastures; (b) Spring Strouga *on the road to the summer pastures of Samarina; (c) Crossing the river in lower Grevena region (autumn route); (d) Crossing the roads (summer route)*

VI. Prospects of transhumance in North Pindos

In the North Pindos region, many herders who formerly practiced transhumance are now transitioning to stable, sedentary pastoral systems. Younger generations, particularly those who have settled in the plains, are increasingly

abandoning traditional transhumance due to a lack of motivation and limited incentives. Historically, national policies have largely overlooked the needs of transhumant herders, providing minimal support or recognition for the essential ecosystem services they offer—including the production of high-quality agricultural products, wildfire prevention through grazing, and soil fertility enhancement through manure recycling. This institutional neglect has undermined the viability of their livelihoods.

In addition, evolving social dynamics and contemporary pressures—ranging from demographic shifts to economic uncertainty—pose further challenges to the continuation of transhumance. These circumstances raise serious concerns about the future sustainability of this traditional practice in the region. The following sections examine the key factors driving this decline.

1. Governance and policy

Transhumance continues to play a vital role in pastoralism in the North Pindos region. However, it now faces a range of significant contemporary challenges. These include longstanding neglect by the Greek State, unresolved landownership issues, inadequate infrastructure, the growing impacts of climate change, limited financial incentives, and increasing labour shortages. In response to these pressures, many herders who once practiced transhumance are now turning to sedentary farming in the plains, seeking greater safety, predictability, and economic security.

Although some herders retain a strong emotional attachment to the transhumant way of life, the decline in subsidies and institutional support has made it increasingly difficult to maintain. As a result, a substantial number of herders in the study area have abandoned traditional mobility in favour of more stable livelihoods, either in lowland areas or in lower-altitude zones of the mountains.

2. Feeling neglected

A 45-year-old former transhumant herder remarked: “We feel isolated and abandoned, yearning for more than just subsidies. What we truly long for are healthy, thriving animals that produce abundant milk.” And a 28-year-old active transhumant herder attested as well: “We feel completely neglected. We continue with transhumance mainly due to emotional reasons.” These testimonies highlight the deep sense of marginalization felt by transhumant herders in Northern Greece. While transhumance remains culturally and ecologically important, it has become increasingly difficult to sustain it amid policy shifts, economic pressures, and evolving social dynamics.

According to Chang (1993), during the early years of Greece’s membership in the European Economic Community (EEC), the transhumant way of life in the Grevena region benefited from institutional support. EEC development programs and Greek State subsidies encouraged continued seasonal livestock movement to optimize ecological resources (Chang, 1992). Fieldwork conducted in the 1980s revealed that funding and infrastructure investments—such as pickup trucks, paved roads, concrete loading platforms, watering troughs, and animal shelters—fundamentally reshaped pastoral practices in the Eastern Pindos Mountains. Greece’s accession to the EEC in 1982 thus marked a turning point for upland pastoralism, fostering increased mobility and productivity.

During the 1980s and early 1990s, the Common Agricultural Policy (CAP) introduced animal-based subsidies and compensatory premiums for farmers in less favoured areas, contributing to increased incomes, particularly due to the rising demand and prices for milk and meat (Hadjigeorgiou, 2011). However, by the early 2000s, CAP reforms began shifting towards efficiency, environmental stewardship, and market orientation (Welch-Devine & Murray, 2001).

The 2006 CAP reform represented a major shift, replacing production- and livestock-based subsidies with direct payments per hectare of land, regardless of actual output (Nori, 2022). While the new model aimed to simplify

payments and ensure income stability, it severely disadvantaged transhumant herders, whose livelihoods are not primarily based on land ownership. Wealthier farmers and landowners benefited disproportionately, whereas pastoralists—especially those with mobile systems and no formal land tenure—were largely excluded. This transition discouraged transhumance, a practice deeply rooted in local tradition and ecology.

As of 2024, transhumant herders continue to face major challenges due to limited institutional support. Despite residing in less favourable areas and incurring the high costs of seasonal mobility, they receive no substantial premiums or targeted assistance. Many of those who have abandoned transhumance cite economic hardship and a lack of motivation, after suffering financial losses during recent seasonal movements. While products derived from sheep and goats are widely recognized for their quality, they remain undervalued in terms of policy and subsidy allocation.

Some recent initiatives have aimed to address environmental concerns and improve the living conditions of pastoral communities. For example, the European Union funded action Improvement of the Environmental Condition of Grazing Lands in Areas at Risk of Desertification Due to Erosion, part of the Rural Development Program, seeks to promote sustainable land management in vulnerable zones. However, despite studies being conducted to align this program with the needs of transhumant herders, actual implementation has been lacking, and results remain unclear.

3. Landownership and infrastructure challenges

A transhumant herder testified: “We need a stable place to create farm buildings for housing our flocks. The animals suffer a lot of hardship during the strong rainstorms and the cold, and they need a secure place to protect them.” In the 1960s, Sivignon observed that the transfer of community-owned forests to state forest services in certain villages led to a reduction in available grazing lands (Sivignon, 1968). Today, Dotsiko is the only village among the five studied where land remains under community ownership. In contrast, land in the other four villages is predominantly publicly owned, limiting herders’ ability to establish permanent farm structures. This lack of secure tenure hampers infrastructure development, especially the construction of shelters essential for protecting livestock from extreme weather. As a result, animals are frequently exposed to harsh conditions such as heavy rainstorms and cold spells, which significantly affect their welfare. Without adequate shelter, livestock suffer increased stress, higher mortality rates, and reduced productivity.

In addition to landownership issues, herders face significant infrastructure challenges. Poor road conditions often prevent access to grazing areas and livestock enclosures, particularly after storms. Many herders report having to repair these roads themselves due to the absence of public maintenance. Furthermore, the lack of reliable water infrastructure creates ongoing tensions—especially with cattle herders—over limited water resources.

Predation is another major concern. Wolves and bears regularly threaten livestock, causing economic losses and emotional strain. Moreover, logistical difficulties further complicate pastoral life: milk collection trucks often cannot reach remote grazing locations due to the long distances and poor road conditions, making the transportation of milk to market problematic.

4. Social demands and challenges

A 28-year-old transhumant herder reckoned: “When I get married, I’m not sure my wife will want to follow me to the mountains in the summer. Then maybe I’ll have to stop moving—and that doesn’t make me happy.” Social life in the mountain villages of North Pindos is particularly difficult during the early summer and autumn months, when only a small number of herders remain in residence. For much of the transhumant season, these villages are sparsely populated. However, between approximately July 20 and August 20, they experience a temporary revival, becoming crowded with tourists and seasonal visitors.

In the 1960s, Sivignon (1968) noted a significant diversification of the regional economy beyond traditional pastoralism. This shift was largely driven by the development of textile crafts, which provided both economic incentives and social cohesion. A key component of this diversification was the growth of the local textile industry, particularly the production of *scouti*—a thick woollen cloth used for traditional garments—and *flocati*—large wool rugs often used as blankets. These crafts became central to the economy of mountain villages. For many women, weaving on traditional looms offered not only a stable source of income, but also a meaningful way to contribute to household and community life. In doing so, they helped sustain the social fabric of mountainous communities and strengthened the local connection to these places (Sivignon, 1968).

In the 1980s, Professor Chang further explored the social dynamics of transhumant communities in the Pindos-Grevena area. Following the end of Ottoman rule, the Koutsovlach population preserved a strong ethnic identity within modern Greece. The seasonal rhythm of transhumant pastoralism—moving between lowland and highland settlements—symbolized a cultural continuity that endured even through the disruptions of World War II and the Greek Civil War (Chang, 1993). However, Chang also noted a growing social divide: many herders' wives preferred living in the plains or in urban settings, attracted by better living conditions, educational opportunities, and access to healthcare. As a result, herders who remained in the mountains increasingly faced isolation.

This trend has continued into the present. Today's transhumant herders face not only institutional neglect but also growing social fragmentation. A central issue is the reluctance of family members—especially wives and children—to participate in seasonal migration to the mountains. This is driven largely by the appeal of urban life and the availability of social services and infrastructure in the lowlands. Women, in particular, are more likely to remain in the plains, reinforcing the gendered nature of this rural exodus. That said, there are notable exceptions: some women actively support their husbands and even participate in herding activities.

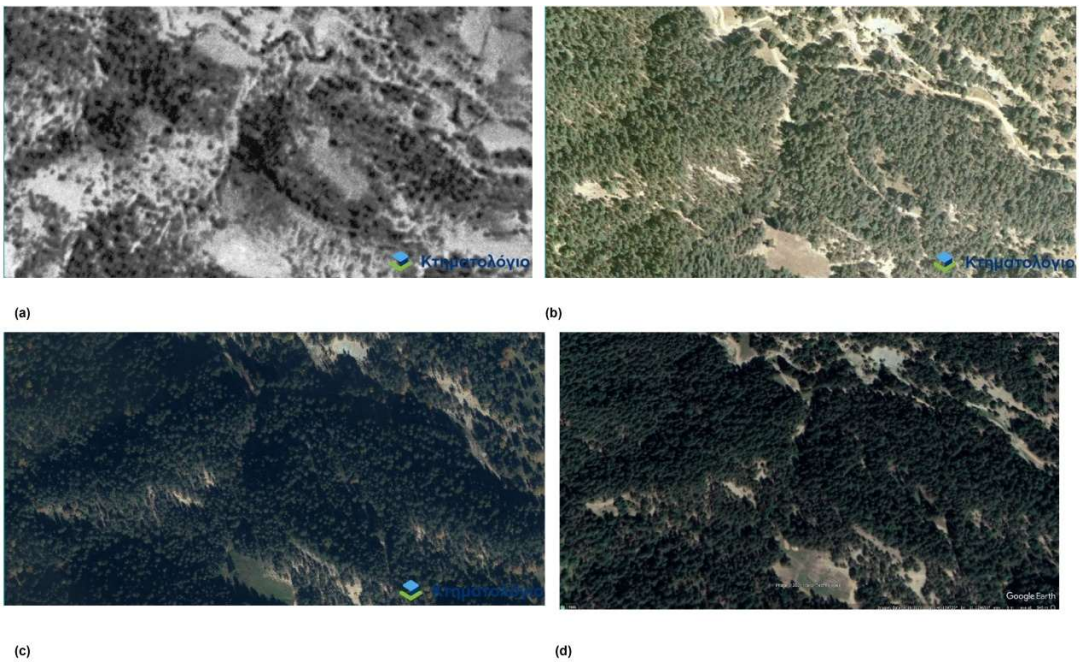
As a result, the transhumant lifestyle is increasingly perceived as socially and emotionally isolating, especially for younger generations. The gradual decline in the number of active herders has eroded the communal character that once defined life in the mountain villages. This sense of isolation exacerbates the practical challenges herders face, making it even more difficult to sustain the traditional practice of transhumance.

5. Landscape changes in high pastures

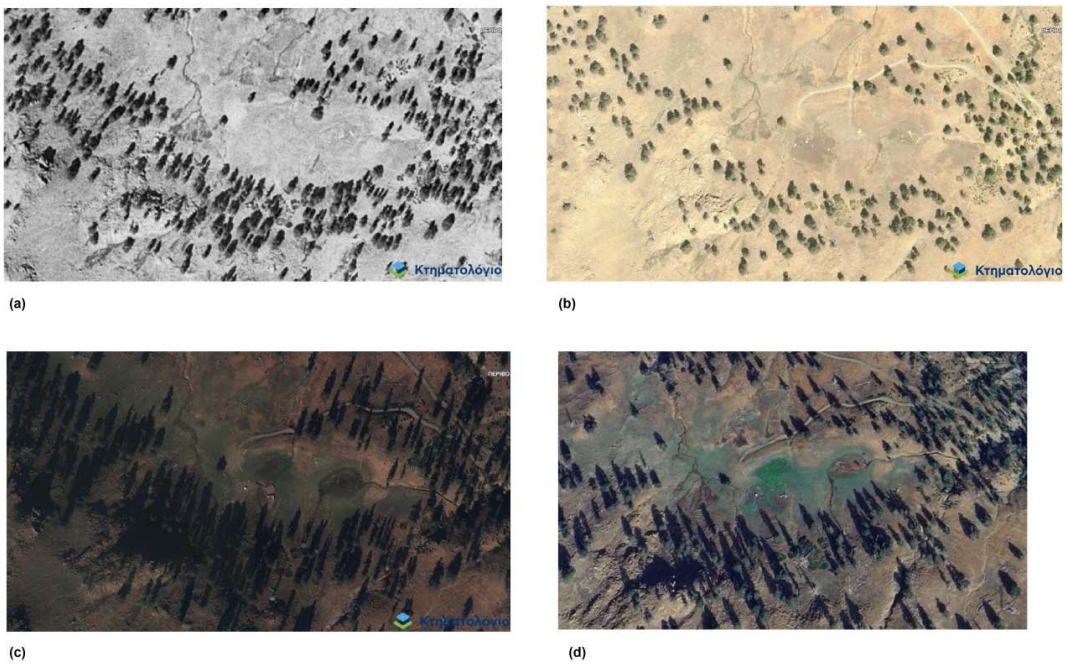
In the 1960s, Sivignon observed that pastoralism in the villages of Perivoli, Avdella, Smixi, and Samarina in North Pindos had undergone significant development and recovery following the devastation of World War II (Sivignon, 1968). Livestock herds, which had previously been decimated, had been fully rebuilt—an observation reflected in the landscape's resistance to natural reforestation. The presence of sharply grazed grass and the absence of encroaching shrubs or forest growth underscored the intensity of grazing activity. However, this revitalization also brought new challenges, particularly overgrazing and soil erosion in specific areas. Compounding these issues was the transfer of community-owned forest lands to state forest services for reforestation, as well as the expansion of agriculture in Thessaly, both of which reduced the availability of grazing land in villages like Avdella and Perivoli. Nevertheless, the postwar period marked a notable era of adaptation and growth for pastoralism in the region (Sivignon, 1968).

Today, however, many pastures in the region are no longer actively grazed, resulting in visible transformations in the landscape. As herd sizes have decreased, the decline in grazing pressure has allowed shrubs and trees to recolonize formerly open pastures. This shift has led to the progressive reforestation of grasslands, contributing to denser vegetation growth and increasing the risk of wildfires due to fuel accumulation. For instance, pastures in Dotsiko area, at an approximate elevation of 1,100 m, have experienced a clear increase in woody vegetation since the postwar period (1945–1960) (Photos 4 a, b, c & d).

By contrast, high-altitude pastures have been less affected by the decline in grazing activity, owing to their pseudo-Alpine vegetation and distinct environmental characteristics. Photos 4 (a, b, c & d) show the landscape near the s*trouga* below Avgo Peak, situated at approximately 1,900 metres elevation, across comparable time periods. These images reveal minimal change in tree cover over time, suggesting that vegetation in these higher-altitude zones has remained relatively stable despite broader regional shifts.



Photos 4. The landscape around a grazing area in Dotsiko, at an approximate elevation of 1,100 m; (a) 1945–1960; (b) 2007–2009; (c) 2015–2016; (d) after 2020. Sources – a, b, c: Hellenic Cadastre; d: Google Earth Pro



Photos 5. The strouga *(delineated as cycles) at Avgo Peak, at an approximate elevation of 1,900 m; (a) 1945–1960; (b) 2007–2009; (c) 2015–2016; (d) after 2020*

Conclusion

The future of transhumance in the North Pindos region appears increasingly uncertain. The evidence presented in this study shows a steady decline in transhumant practices, driven by a complex interplay of financial, social, and environmental factors. A key contributor to this decline is the Greek state's insufficient support and lack of formal recognition for the transhumant way of life. Despite the significant ecosystem services provided by transhumant herders—such as preserving biodiversity, preventing forest fires, and enhancing soil fertility—state assistance remains minimal, undermining their ability to sustain their livelihoods.

This institutional neglect is most evident in the absence of financial incentives, infrastructure investment, and secure land rights. As a result, younger generations are increasingly disinclined to pursue transhumance, further accelerating its decline. The gradual erosion of this culturally and environmentally valuable practice calls for urgent and comprehensive policy intervention.

To ensure the survival and revitalization of transhumance in North Pindos, decisive action is required. The Greek State must formally acknowledge the value of transhumant herders and offer targeted support through improved land tenure policies, modernized infrastructure, and tailored financial incentives. The implementation of integrated pasture management plans is particularly crucial, as these would enable systematic mapping and regulation of pastures and livestock, paving the way for sustainable and efficient resource use.

Equally important is the engagement of younger generations. Policies must be designed to attract and retain young herders, through mechanisms such as start-up grants, access to vocational education, and rural development programs that promote innovation and entrepreneurship in livestock farming. In addition, cooperative models should be encouraged to strengthen market access, share resources, and reduce individual burdens on herders.

Further steps should include the legal recognition and protection of transhumance routes, improvements to herders' living conditions—particularly for their families—and support for seasonal mobility infrastructure. These measures would not only preserve a valuable cultural tradition but also contribute to ecological resilience in mountainous regions.

Moreover, reversing rural depopulation requires a broader, integrated approach. Supporting traditional practices like transhumance must go hand in hand with creating viable, sustainable economic opportunities in rural areas. By reinforcing the cultural and environmental importance of transhumance, such strategies provide compelling reasons for young people to remain in or return to rural regions. Financial support, educational access, and community-strengthening initiatives are essential components of this strategy. Only by making rural life more attractive and economically viable can transhumance be maintained as a living tradition—and leveraged as a foundation for the long-term sustainability of Greece's mountainous landscapes.

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Chapter 18

Spatio-temporal dynamics of transhumant and pendular pastoralism in Romania

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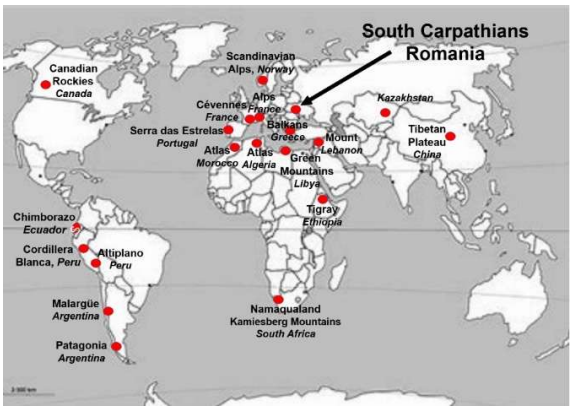
Abstract

Transhumant and pendular pastoralism are ancestral practices in Romania that have evolved over time and continue to be practiced today. This study uses a multi-stage methodology to explore the continuity of these pastoral systems across both time and space in Romania, as well as to identify current trends and drivers of change. The peak of transhumant pastoralism occurred in the early 19th century, when shepherds walked through long distances, often crossing the borders of what is now Romania. However, this practice gradually declined due to various factors, including political, social, and economic influences. Over the centuries, the seasonal movement of livestock under the guidance of herders fostered a distinctive socio-economic and cultural system characterized by unique practices and knowledge. Following the 1950s, the communist regime and, later, the post-communist period introduced significant transformations. During the communist era, flock movements were facilitated by the collectivization of most agricultural land, with some herders employed to manage the sheep of socialist cooperatives nationwide. After 1990, numerous socio-economic changes occurred. The combined impact of factors such as the restoration of private property, land abandonment, insufficient public policies, and socio-demographic shifts made transhumance increasingly challenging. Consequently, the number of herders practicing transhumance has declined, and the distances covered have significantly decreased.

Keywords: Transhumance practices; Pendulation; Communism; Post-communism; Carpathians



Introduction

Pastoralism is a traditional occupation in Romania, which has given rise to a distinctive socio-economic and cultural system characterized by specific practices and knowledge. In certain regions, particularly in hilly and mountainous areas, animal husbandry remains a significant component of the local economy. Over the years, several researchers have developed a typology of pastoralism in Romania by analysing different regions (Vuia, 1924; Morariu, 1937; Herseni, 1941; Dunăre, 1956; Vuia, 1964). They classified pastoralism in the 19th and 20th centuries into four main categories:

(a) Local pastoralism, where herds remain within the boundaries of settlements.

(b) Summer grazing, where herds are moved to mountain pastures, typically at varying distances from the village.

(c) Intermediate grazing, where herds graze on mountain pastures in summer and are sheltered in hay meadows (an intermediary zone between the village and the mountain pastures) during winter.

(d) Transhumance, where herds graze on mountain pastures during summer and are moved to lowlands for wintering.

In other studies (Dunăre, 1956; Dunăre, 1969), type (b) is termed ‘simple pendular pastoralism’, whereas type (d) is known as ‘double pendular pastoralism’. Over time, these two types have been grouped under the broader category of ‘pendular pastoralism’.

Transhumance, type (d), regarded as an advanced form of pastoralism (Constantinescu-Mircești, 1976), is further divided into two subtypes based on the distance covered: reduced and extensive (Dunăre, 1969). Reduced transhumance involves summer grazing on mountain pastures relatively close to the village and wintering in nearby lowland areas.

Currently, any movement of up to 100 kilometres between the village of origin and the winter range is categorized as reduced transhumance (Baskerville, 2020). Extensive transhumance, in contrast, historically involved longer migrations of flocks between mountain pastures for summer grazing and lowlands (plains or marshes) for wintering (Dunăre, 1969). Even today, summer grazing often occurs near villages, while flocks migrate between these two areas in autumn.

Modern transhumance takes various forms, depending on factors such as the mode of flock movement (on foot or by truck). One distinctive characteristic of transhumance is that it traditionally involves only shepherds moving with the animals, while their families remain behind (Baskerville, 2020).

In 2020, "Carpathian Transhumance, part of traditional pastoral life," was included in the National Inventory of Active Intangible Cultural Heritage Elements. Subsequently, in December 2023, transhumance in Romania, along with nine other countries (Spain, Albania, Andorra, Austria, Croatia, France, Greece, Italy, and Luxembourg), was added to the UNESCO Representative List of the Intangible Cultural Heritage of Humanity. This recognition underscores the cultural significance of this ancestral practice and promotes greater global visibility, raising awareness of its importance and the need for its preservation. Locally, it encourages authorities to take measures to maintain and promote transhumance while safeguarding the associated knowledge and traditions.

This paper aims to explore the spatial and temporal dynamics of transhumant and pendular pastoralism in Romania, as well as to identify current trends and drivers of change.

I. Methodology

The present analysis was conducted using a multi-stage methodology. The initial phase involved a documentary analysis of existing research (including reports, articles, books, and other sources) related to pastoralism in various regions of Romania. In the second phase, statistical data were collected to reconstruct the dynamics of the sheep population over time. This data collection relied on both historical statistical yearbooks (up to 1990) and the Tempo Online Database of the National Institute of Statistics.

In the third phase, a content analysis was performed on 15 semi-structured interviews with individuals who practiced or continue to practice transhumant and pendular pastoralism. This was further supplemented by the analysis of five video interviews with transhumant herders available online. Finally, certain features of pastoralism were mapped using Geographical Information Systems (GIS) techniques. By integrating all these sources of information, the study aimed to provide a comprehensive understanding of the continuity and evolution of pastoralism in Romania.

II. Geographic context of Romania - natural environments as favourable conditions for the development of transhumant and pendular pastoralism

Romania is characterized by a diverse and complex landscape, making it an intriguing territory from a geomorphological perspective. Elevations range from below sea level in the recently formed Danube Delta to 2,544 metres above sea level at Moldoveanu Peak in the Southern Carpathians. The country's terrain is evenly distributed among various landforms: 28% consists of mountains, 42% of hills and plateaus, and 30% of plains.

Topographically, Romania's landforms are arranged in an amphitheatre-like structure, which significantly influences the altitudinal zonation of environmental features. At the core of this geomorphological system are the Romanian Carpathians (Map 1), stretching over 910 kilometres and representing 54% of the entire Carpathian range. These mountains are categorized as medium-height, with an average elevation of 840 metres (Badea, 1983; Dumitrescu, 1983). The Southern Carpathians form the most compact mountain sector, consistently exceeding 2,500 metres in elevation. The arch-shaped configuration of the Romanian Carpathians displays a radial-concentric structure, acting as an orographic barrier that generates climatic variations and shapes a radial river network.

Elevation gradually decreases from the Carpathian range toward the hilly depression of Transylvania in the interior and toward the Sub-Carpathians on the exterior, characterized by alternating hills, depressions, and broad valley corridors. To the west of the Carpathians lie the Western Hills, followed by the Western Plain. To the east and south, extensive plateaus have developed on large alluvial fans, beyond which the Romanian Plain extends broadly toward the Danube floodplain and its associated wetlands, featuring fertile soils that support rich vegetation and agricultural activities (Mihăilescu, 1969).

Romania is situated within a temperate continental climate zone, where climatic conditions vary based on latitude, longitude, and altitude. The Carpathian Mountains act as an orographic barrier, influencing the movement of air masses. This results in a drier temperate continental climate in the east, cooler and wetter conditions in the central and western regions, and a wetter, warmer climate in the southwest (Clima României, 2008).

Precipitation is highest in the mountain regions, where multi-annual averages over a 50-year period exceed 1,200 mm at the highest elevations (Mateescu, 2014). In contrast, most of Dobrogea and the Bărăgan region (eastern side

of the Romanian Plain) experience multi-annual average precipitation levels between 400 and 500 mm. Multi-annual average temperatures vary significantly, ranging from 10-12°C in the South, Southeast, and extreme West of the country, to below 0°C at the highest peaks of the Carpathians (Mateescu, 2014).

Map 1. Natural setting and historical regions of Romania

The subalpine and Alpine meadows, situated above the tree line (elevations exceeding 1,600–1,800 metres), are characterized by semi-natural grasslands with high-quality vegetation and remarkable biodiversity. These meadows account for approximately 26% of the total pastureland in Romania (Mocanu et al., 2021).

These natural environmental conditions have historically provided an ideal setting for pastoralism and transhumance practices. Since ancient times, herders have been drawn to the lush Alpine meadows and grasslands, the warmer slopes or depressions of the Carpathians, and the fertile soils of the Romanian Plain—particularly in the Bărăgan region and the Danube floodplain with its wetlands.

The highest peaks of the Carpathian Mountains, particularly in the Southern and Eastern regions, have traditionally served as natural borders between various state entities. Romania's territory has historically encompassed several distinct regions, some of which have existed as independent states or have come under the rule of neighbouring empires.

III. Transhumance until the first part of the 20th century

The historical and ongoing practice of transhumance from Transylvania to Wallachia, located south of the Carpathians, is well-documented by historical records. In June 1418, Mihai I, the ruler of Wallachia, reaffirmed a

privilege granted by his father to the commune of Cisnădie (near Sibiu), allowing them to graze their flocks in the mountains of his domain (Veress, 1927). Although some scholars believe that the origins of transhumance in Romania have not yet been fully clarified (Bucur, 1985), others suggest that it likely began in the current territory of Romania only in the 14th century (Totoianu, 2021; Bucur, 1978).

In 1662, Count Bethlen, the Chancellor of Transylvania, provided a vivid account of the shepherds' seasonal migration: they would leave the valleys "at the end of summer, herding their sheep to the marshy areas along the Danube in Wallachia, where they found grass among the reeds during winter. Then, in spring, they returned..." (Veress, 1927).

Quantifying the extent of the transhumance phenomenon over the centuries is challenging. However, customs registers offer some insights into the number of sheep wintering in Moldavia and Wallachia. In 1792, it was officially estimated that around one and a half million sheep from Transylvania grazed in Wallachia, alongside 80,000 cattle and horses. In Moldavia, records from 1783 mention no more than 50,000 sheep (Veress, 1927). By 1856, nearly two million sheep and cattle were grazing in Wallachia, but this number decreased to one million by 1870 (Meteș, 1925). Some of these flocks extended their journeys into the Dobrogea region.

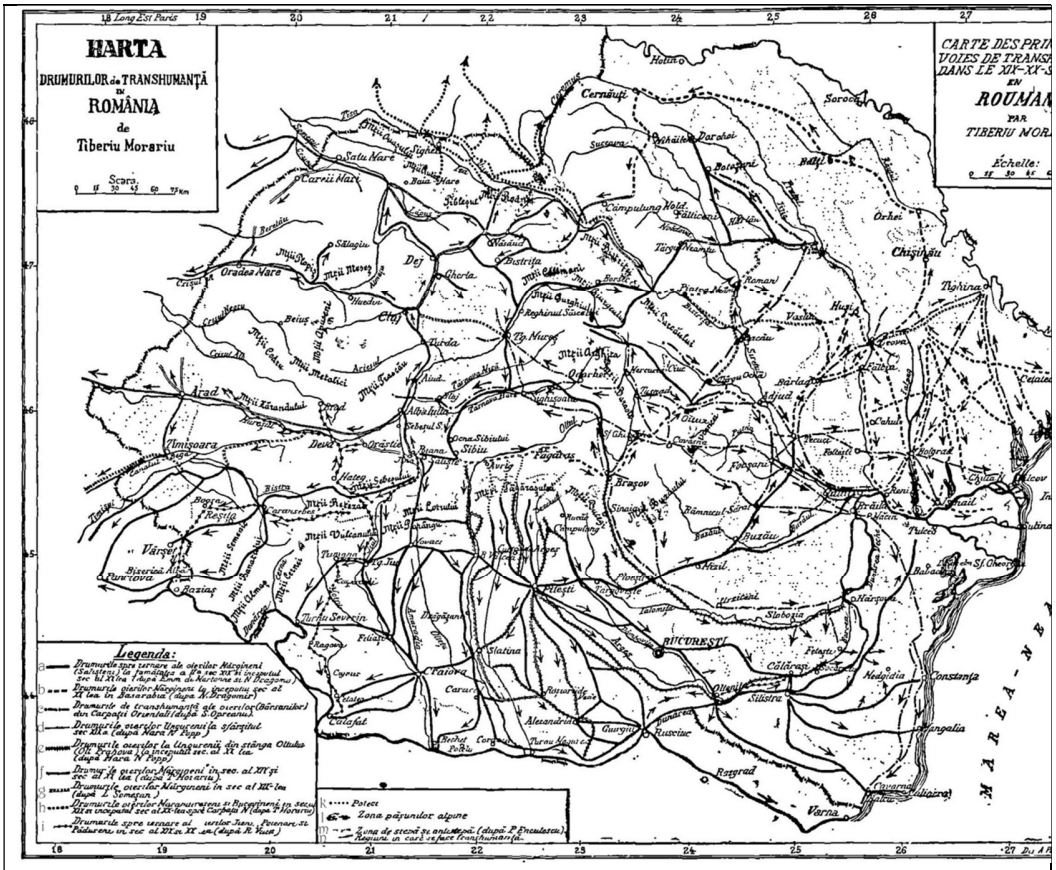
It is important to note that the statistical data from this period may not accurately reflect the true number of animals involved in transhumance. Several factors contributed to this discrepancy. Some flocks remained in the Romanian Plain and Dobrogea throughout the summer without being officially registered. Additionally, evasion was common, with herders avoiding registration, and many cattle brought for sale were temporarily pastured without record (Constantinescu-Mircești, 1976). Moreover, some shepherds from the Southern side of the Carpathians (Wallachia) also wintered their flocks in the Danube floodplain (Vulcănescu, 1964; De Martonne, 1904; Dragomir, 1938).

Transylvanian herders did not restrict their movements to Wallachia. Some flocks traveled northwest and north towards Sălaj, Satu Mare, and Maramureș (Irimie & Popa, 1985), whereas others migrated southwest to Banat or settled along the floodplains of major rivers such as the Mureș and Someș (Dragomir, 1926; Dragomir, 1938b).

Over time, the transhumance routes expanded across the country. Morariu (1942) developed a map consolidating the transhumance routes of the 19th and early 20th centuries in Romania, as defined by the interwar borders. This map, based on his research and the studies of other scholars, provides a comprehensive view of the historical transhumance paths (Map 2).

Between 1831 and 1855, approximately 150 villages in Transylvania sent their herds to graze in Wallachia (Constantinescu-Mircești, 1976). The primary regions from which herders embarked on transhumance were located in Southern and Southeastern Transylvania, including areas around Brașov, Făgăraș, Sibiu, Bran, Covasna, and Brețcu, extending further into the interior of the Carpathians as far as Maramureș (Veress, 1927).

However, the range of Transylvanian shepherds practicing transhumance extended far beyond these areas. Historical records indicate that as early as the 15th century, they travelled with their flocks to Poland, whereas in the 16th and 17th centuries, they ventured to Hungary. By the 19th century, their journeys reached Turkey, Macedonia, and Greece (Meteș, 1925). A detailed study of the sheep herders from the Mărginimea Sibiului region (Transylvania) reveals that their migrations extended even further—to the steppes of Russia, Crimea, the Caucasus in the east and northeast, and as far west as Croatia, or even beyond (Dragomir, 1938). Given the considerable distances, some herders remained in these regions for several years or eventually settled there (Irimie & Popa, 1985). Over time, some transhumant shepherds established permanent settlements on the southern slopes of the Carpathians, in the Romanian Plain, and even in Dobrogea, where many continued to practice their traditional occupation (Constantinescu-Mircești, 1976).



Legend (translated from Romanian)

a) Routes to wintering areas used by shepherds from the Mărginime (Sălișteregion during the second half of the 19th and early 20th centuries (based on Emm de Martonne and N. Dragomir).

b) Routes taken by shepherds from the Mărginime region to Bessarabia at the beginning of the 20th century (based on N. Dragomir).

c) Transhumance routes of shepherds from Eastern Carpathians (Bârsa region) (based on N. Opreanu).

d) Routes of Transylvanian shepherds at the end of the 19th century (based on Mara N. Popp).

e) Routes of shepherds to Transylvanian shepherds previously settled on the left side of the Olt River (between the Olt and Prahova Rivers) at the beginning of the 20th century (based on Mara N. Popp).

f) Routes of shepherds from the Mărginime region during the 19th and 20th centuries (based on T. Morariu).

g) Routes of shepherds from the Mărginime region in the 19th century (based on L. Someșan).

h) Routes of shepherds from the Maramureș and Bucovina regions to the Northern Carpathians in the 19th and early 20th centuries (based on T. Morariu).

i) Routes to wintering areas used by shepherds from the Jieni, Poienari, and Pădureni regions during the 19th and 20th centuries (based on R. Vuia).

k) Pathways.

i) Alpine meadow zone.

m) Steppe and forest-steppe zone (based on P. Enculescu).

n) Regions where transhumance practices are common.

Map 2. Transhumance roads in Romania (interwar borders) in the 19th and 20th centuries (Source: Morariu, 1942)

Transhumance in Romania reached its peak during the first half of the 19th century (Bucur, 1985; Irimie & Popa, 1985; Dragomir, 1926). However, its scope gradually diminished due to several factors, including the conversion of pastures in the plains into arable land, the intensification of crop production in Wallachia and Moldavia, and the agrarian reform of 1864, which redistributed large estates to peasants (Meteș, 1925; Irimie & Popa, 1985). These changes led to increasingly restricted routes for wintering (Dragomir, 1938). The 1921 agrarian reform further exacerbated these limitations on transhumant pastoralism. Before 1920, it is estimated that 25–30% of sheep flocks in Romania participated in transhumance (Drăgănescu, 1998; Maruşca, 2012).

IV. Sheep population dynamics and its driving forces (1920–2023)

In 1920, Romania had a sheep population of approximately 8.7 million (Ilișiu et al., 2013), which increased to over 10 million by 1938 during the interwar period. However, from 1938 to 2023, the sheep population in Romania exhibited oscillatory dynamics (Figure 1), reflecting the country's socio-economic transformations.

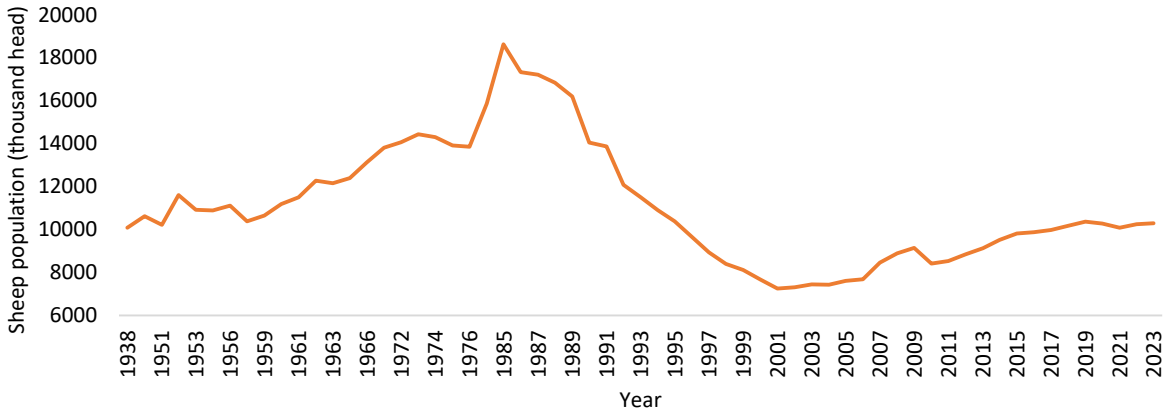


Figure 1. Dynamics of sheep population in Romania (1938–2023). Source: Romanian Statistical Yearbooks 1964, 1975, 1985, 1989; NIS, tempo online (1990–2023)

During the first period (1938–1985), the sheep population increased by approximately 85%, reaching over 18,637,000 heads in 1985 (Central Direction of Statistics, 1986). This upward trend was closely linked to the socio-economic changes brought about by the establishment of the communist regime in the years following World War II. Specifically, between 1949 and 1962, the collectivization process transformed the agricultural landscape, incorporating most of the country's agricultural land into socialist forms of ownership. The only exception was in some mountainous areas, where the formation of collective farms was practically impossible due to the inaccessibility of the terrain.

In 1951, 95.7% of the sheep flocks were privately owned, but this share dropped to 50.3% by 1970 (Central Direction of Statistics). This significant decline in private ownership was a direct result of the state's efforts to consolidate agricultural production under collective management.

Between 1985 and 2001, the sheep population in Romania decreased by 61%, dropping to 7,251,185 head (NIS, Tempo Online). The most significant decline occurred after the fall of the communist regime in 1990, during the transition to a market economy and the shift from public to private ownership. This decline was primarily driven by the dismantling of associative forms of agriculture (agricultural cooperatives) and the closure of large state-owned livestock complexes (Maruşca, 2012).

In 1993, 89% of sheep flocks were privately owned, and this figure has consistently exceeded 99% since 2002 (NIS data). However, some livestock breeders who lacked access to agricultural land were forced to reduce the size of their flocks (Ilișiu et al., 2013). Another major factor contributing to the decline in sheep numbers was the drop in wool prices, which had been heavily subsidized between 1950 and 1989 (Drăgănescu, 1998).

After 2001, the sheep population experienced a resurgence, increasing by 42% to reach 10,299,549 head in 2023 (NIS, Tempo Online). This recovery is largely attributed to subsidies granted to breeders (Ilișiu et al., 2013), particularly following Romania's accession to the European Union in 2007, which provided financial support for land and livestock management.

Since 2018, the sheep population has consistently exceeded 10 million, approaching levels seen in the early period of analysis (up to 1951). In 2023, Romania ranked as the second-largest sheep producer in the European Union, following Spain, accounting for 17.9% of the EU's total sheep population (Eurostat, 2024).

V. Transhumance in the communist and post-communist period (1947–present)

The communist regime brought significant transformations to the practice of transhumance in Romania. Villages inhabited by herders at the foot of the mountains generally avoided collectivization, except for a few located in flatter areas (Ișfănoni, 2010). Following the collectivization of agriculture, transhumant shepherds negotiated agreements with the presidents of communist agricultural units (Agricultural Production Cooperatives [CAP] and State Agricultural Enterprises [IAS]), paying fees to pass through these lands on their way to wintering areas (Ișfănoni, 2010; Huband et al., 2010).

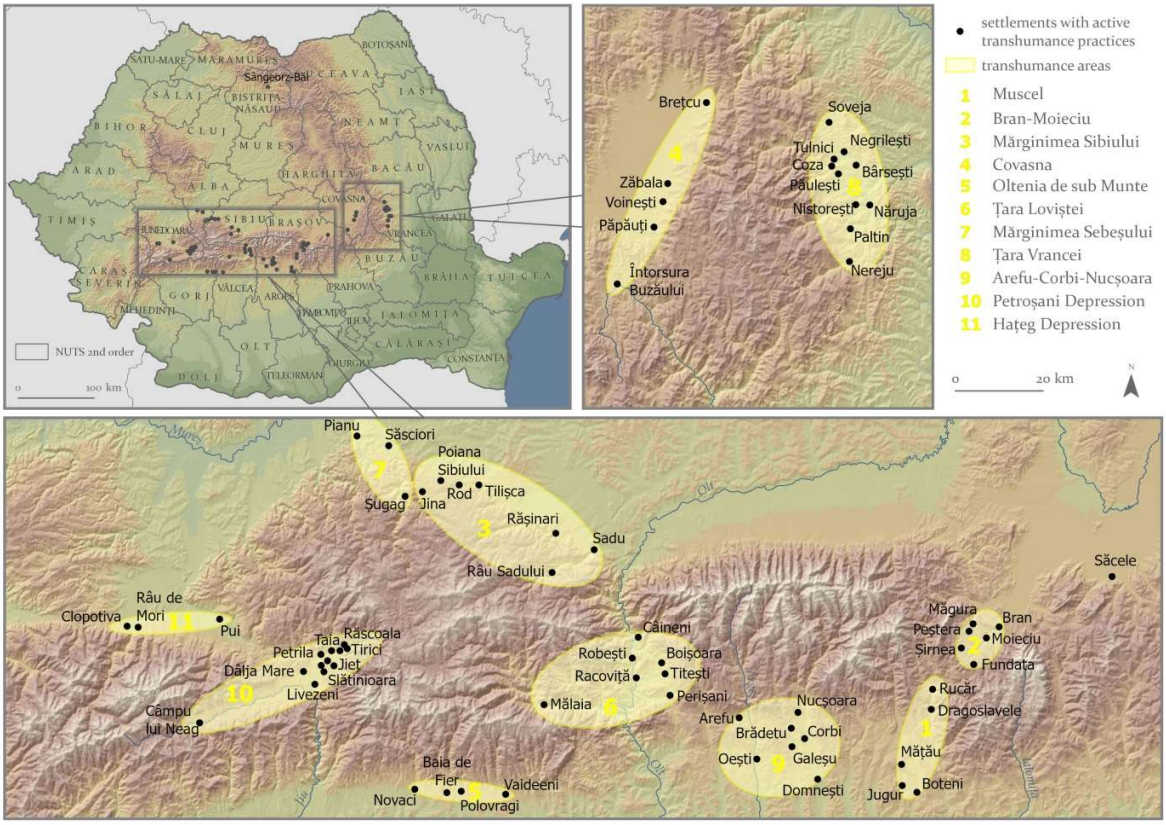
A new trend also emerged, with transhumant shepherds overseeing sheep flocks belonging to CAPs and IASs across the country. In exchange for their supervision, they received payment and were allowed to maintain a certain number of their own sheep, for which grazing and feeding costs were covered (Ișfănoni, 2010). For example, in Poiana Sibiului, one of the villages in Mărginimea Sibiului known for its transhumant pastoralism tradition, 60% of the shepherds were employed in 1974 (Stewart & Stan, 2009).

Many shepherds from the village of Jina found employment at CAPs and IASs in various counties, including Arad, Bacău, Constanța, Caraș-Severin, Hunedoara, and Timiș. Similarly, shepherds from Rășinari village were employed in Timiș, Arad, Bihor, Sălaj, Cluj, and Ilfov (Irimie & Popa, 1985). This arrangement allowed many shepherds to increase the size of their flocks and their earnings, leading some to abandon gradually traditional transhumance due to these favourable conditions. Over time, numerous families from Mărginimea Sibiului and Mărginimea Sebeșului settled in Banat and further north in Crișana, where they had access to extensive pastureland (Ișfănoni, 2010; Totoianu, 2021).

However, during the collectivization period, conflicts over land use arose between shepherds and peasants. Peasants were often frustrated by the damage caused to their agricultural lands when flocks of sheep passed through (Marușca, 2000). In response, an informal system of relationships developed, benefiting both the shepherds and the communist leaders. Shepherds often resolved conflicts by providing products, such as cheese, lambs, or other goods, which served the interests of local leaders (Ișfănoni, 2010; Huband et al., 2010). In return, they were granted grazing rights in specific areas, or instances of crop or pasture damage were overlooked (Marușca, 2007; Stewart & Stan, 2009).

In the post-communist period, after 1990, significant socio-economic changes led to a decline in the practice of transhumance. In 1998, it was estimated that only about 5% of the sheep population participated in extensive transhumance (Drăgănescu, 1998). By 2017, approximately 10% of the total sheep population was reported to be involved in transhumance (Popescu et al., 2022). However, more recent statistics are not available.

Since 2020, transhumance has been recognized as part of the National Inventory of Active Intangible Cultural Heritage Elements, under the designation "Carpathian Transhumance, an Element of Traditional Pastoralism." This recognition acknowledges both the continued practice of transhumance and its cultural reminiscences, which remain characteristic of several regions across the country (Map 3).



Map 3. Villages where shepherds practise the actual transhumance, and its reminiscences. Data source: National Inventory of Active Intangible Cultural Heritage Elements, Baskerville, 2020

Shepherds from the Muscel region traditionally migrate with their flocks to the north-central part of the Romanian Plain, while those from Bran-Moieciu and Mărginimea Sibiului typically winter in various areas of the Transylvanian Depression (Baskerville, 2020). However, field research indicates that they also travel to other regions, such as Satu Mare in the Northwest of the country. Shepherds from Mărginimea Sebeșului generally winter in Banat and Crișana, near the cities of Timișoara, Arad, and Oradea (Totoianu, 2021). Others, especially those from the southern side of the Carpathians, migrate to the eastern part of the Romanian Plain. Due to the absence of a comprehensive nationwide study, it is challenging to identify accurately all the transhumance routes used by shepherds, especially as these routes tend to change over time, as revealed in interviews.

For many shepherds, transhumance remains a way of life. An interviewee from Perișani explained: "In transhumance, we have to go. It's mandatory [...] well, this is our pasture, what we have there in Agnita, and what we have here in

Vâlcea, the mountains. We have to do it all the time, twice a year." This seasonal journey involves traveling approximately 110 kilometres to reach wintering grounds.

Overall, the current trend shows either a decrease in the number of shepherds practicing transhumance or a reduction in the distances they cover. A shepherd from the Nucșoara area mentioned that he used to travel as far as Bărăgan and Dobrogea but has since shortened his journey. In recent years, he has travelled approximately 120 kilometres one way in some years and around 225 kilometres in others. Some shepherds have shifted to transporting their flocks by truck rather than walking them to remote pastures. For instance, a shepherd from Văideeni reported transporting his sheep 330 kilometres by truck to Banat for wintering.

Field research further indicates that some shepherds keep their flocks in the wintering areas until late December or January, depending on weather conditions, while others remain until May, allowing the lambs to be born before returning. A shepherd from the Mărginimea Sibiului area described the traditional practice: "We used to leave in the fall and come back in the spring with the ewes and their lambs, until May 14-15. This is the real transhumance, not just going there and returning [...] or using a car for transportation." Photo 1 illustrates a flock of sheep on its way to wintering grounds.

Photo 1. Flock of sheep journeying to wintering places. (© Lucian David, 2024)

Today, transhumance exists in various forms. Some sheep herders who previously settled in regions such as the Romanian Plain, Dobrogea, Banat, Crișana, and Maramureș continue to practice seasonal migration, taking their flocks to mountain pastures for summer grazing and moving them to lowland areas for wintering.

VI. Pendular pastoralism

Pendular pastoralism remains a common practice in many regions of Romania, particularly in hilly and mountainous areas. Simple pendular pastoralism, in its traditional form, is primarily practiced by herders from villages located in intra-mountain depressions, valleys, or adjacent hilly regions. In this system, animals are grazed on mountain pastures during the summer, using a fixed sheepfold (Photos 2 & 3) (Vlad, 2020). The sheepfold is a durable structure located in the mountain pasture area, which has been used for many years. It serves as a shelter for grazing animals (primarily sheep and cattle) that are brought to these highland pastures at the end of May. However, in years with harsh winters, the animals may only be brought to the pastures in early June (David, 2016).

Photos 2 & 3. Traditional sheepfolds in Făgăraș Mountains, Southern Carpathians. (© Photo 2. Marina Vîrghileanu, 2019; Photo 3 Lucian David, 2023) (cited from David, 2024)

Double pendular (bi-pendular) pastoralism is characterized by the practice of wintering—sometimes extending to the autumn, winter, and spring months—in the hay meadow areas situated between the village and the high-altitude summer grazing pastures (Danube, 1979). This tradition of wintering animals in hay meadows has been documented in the Carpathian Mountains since the 16th century, reflecting a long-established practice (Dunăre, 1969). It is particularly widespread in regions such as Petroșani, Hațeg, Sebeș, Orăștie, Luncani, Mărginimea Sibiului, Bran, Vrancea, and Bucovina (Vlad, 2020).

Mountain pastures are typically rented from local councils and are located relatively close to the villages. In some cases, however, herders move their flocks 30 to 40 kilometres away from their home villages during the summer, as revealed by interviews. Photos 4 & 5 show shepherds with flocks grazing in Alpine pastures in summer. Within the sheepfolds in these mountain pastures, herders produce high-quality cheese using traditional recipes and methods, which is considered more valuable. Outside of the summer season, when the flocks return from the mountain pastures, they produce a different type of cheese adapted to the conditions of the lower-altitude meadows.

Photo 4. Shepherds with flock in Alpine pasture, 2021 (© Lucian David)

Photo 5. Sheep flock grazing on the steep slopes of Făgăraș Mountains, 2018 (© Marina Vîrghileanu)

In some regions where transhumance was practiced until recent decades, only pendular pastoralism remains in use. Although primarily associated with sheep, this form of pastoralism is also practiced, to a lesser extent, with cattle. In certain areas, such as the Bucegi Mountains (particularly the Bucegi Plateau) and the Curvature Carpathians, cattle and sheep graze separately in adjacent sections of the Alpine pastures.

In recent years, pendular pastoralism has diversified, with some herders who previously settled in low-lying areas now bringing their sheep to mountain pastures for summer grazing from even greater distances. This adaptation reflects the evolving nature of pastoral practices in response to changing socio-economic and environmental conditions.

VII. Drivers of change in the post-communist period

The practice of transhumance and pendular pastoralism in Romania has undergone significant transformations since 1990, influenced by a combination of socio-economic, political, and environmental factors. These changes can be broadly categorized into three main drivers: the restoration of private ownership and land abandonment, inadequate public policies, and socio-demographic factors.

1. Restoring private ownership and land abandonment

Following the fall of the communist regime, land restitution returned agricultural land to former owners or their descendants, leading to the re-establishment of private property. This process, however, resulted in the fragmentation of agricultural plots, significantly complicating traditional transhumance practices. Herders were forced to negotiate passage with numerous landowners, some of whom strongly opposed the movement of flocks across their lands due to crop damage (Totoianu, 2021; Drăgănescu, 1998). Interviews with shepherds revealed that some even found the communist period more convenient, as land was consolidated and easier to walk through.

Another critical factor has been land abandonment, driven by depopulation, demographic aging, and migration to urban areas or abroad. This has led to the availability of unused fodder in lowland areas, reducing the need for shepherds to take their sheep to mountainous regions for summer grazing (Maruşca, 2007; 2012). Simultaneously, mountainous pastures have been abandoned, leading to gradual reforestation and the degradation of the traditional ethnographic landscape.

In response to these changes, many former transhumant herders have purchased, rented, or leased farmland and houses in lowland areas where they once spent winters or worked during the communist period. As a result, they have shifted from transhumance to sedentary pastoralism while maintaining connections to their areas of origin.

2. Inadequate public policies

The decline of transhumance is also linked to the lack of effective public policies. One of the primary concerns raised by herders is the inconsistent and delayed distribution of agricultural subsidies. In some cases, landowners receive subsidies for leased land, whereas herders, who actively manage the land, receive none. The absence of designated transhumance routes or corridors further complicates the practice. Herders frequently encounter difficulties crossing highways or are fined for moving flocks along roads. Rising transportation costs have forced many to abandon traditional routes. Another issue is the limited access to markets. After the fall of communism, protected markets for wool and sheep products disappeared, leading to low prices for wool and skins. Although Romania remains a major exporter of live sheep, the lack of processing facilities means that most products are sold at low prices, benefiting intermediaries rather than local producers (Chirchiu et al., 2023).

3. Socio-demographic factors

Demographic changes have further impacted transhumance. The aging population, depopulation of rural areas, and lack of interest among young people in continuing the practice have led to labour shortage. Interviews revealed that

many young people prefer migrating to cities or working in other European countries, leaving only a few older shepherds to maintain the tradition. The complexity of modern regulations has also posed challenges. Many herders have learned the practice of transhumance from their parents, but the intergenerational transmission of this knowledge is becoming increasingly difficult. Additionally, the bureaucratic requirements for permits and compliance with sanitary standards have further discouraged young people from pursuing this way of life.

Conclusion

The analysis of transhumant and pendular pastoralism dynamics reveals a complex typology and a gradual decline over time. Transhumance peaked in the early 19th century but has since declined due to overlapping political, socio-economic, and demographic factors. Nevertheless, it continues to be practiced in various forms and remains a way of life for many herders.

Recent recognition of the cultural importance of transhumance, such as its inclusion in the National Inventory of Active Intangible Cultural Heritage Elements (2020) and the UNESCO Representative List of the Intangible Cultural Heritage of Humanity (2023), highlights its significance. This recognition not only raises awareness but also encourages local and national authorities to promote and safeguard the practice.

Moreover, a growing trend is the integration of animal husbandry with tourism, supported by local authorities and non-governmental organisations. For instance, a cultural-touristic route of transhumance roads was inaugurated on the Transalpina, and traditional hay huts in Râul Sadului (Mărginimea Sibiului) have been rehabilitated for ecotourism.

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Chapter 19

Transhumance in the High-Tarentaise, Alps, France

Going and coming back to the Alpine meadows*

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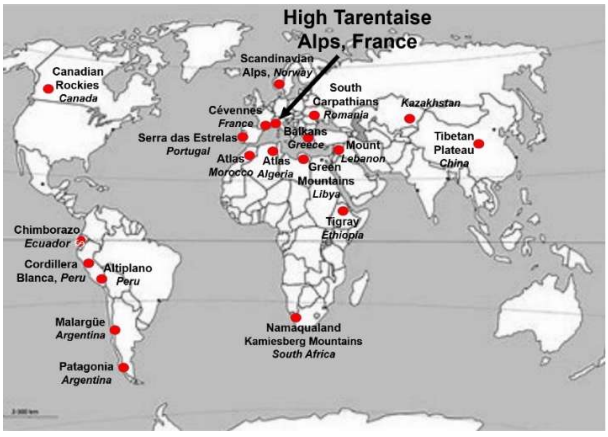
Abstract

Over the past half-century, the Upper Tarentaise region has evolved into one of the largest ski areas in the world. Previously, it was a mountainous region primarily dedicated to livestock farming, specializing in the production of Beaufort and Tomme cheeses, made from the milk of Tarine cows, a breed particularly well-suited to the regional environment. Due to its geomorphological origins, Upper Tarentaise is characterized by a complex network of glacial valleys, bordered by hanging valleys and overlooked by high-altitude watersheds, segmented by rocky outcrops and thresholds. This unique topography has given rise to a system of vertical transhumance, where herds move between high-altitude Alpine meadows (above 1,500–2,000 metres) in summer and the valley floors and slopes (between 800 and 1,500 metres) in spring and autumn. Most villages are also located in these lower areas. During winter, the herds remain in barns, fed with harvested hay. The transformation of Upper Tarentaise is driven by economic development, demographic growth, and urban expansion associated with winter tourism. These changes impact grazing areas, landscapes, and local society which now benefits from new tourism opportunities. This transition affects the local economy, the region's future prospects, and the environment, all within the framework of innovative national and European public policies and evolving social and cultural constraints.

Keywords: Alpine meadows; Herd management changes; High valley pastures; Winter tourism



* Photo credits: the authors

Introduction

The Tarentaise Valley is an intra-Alpine valley located in the Savoie department of France, bordering Italy and Switzerland (Map 1). It stretches from the source of the Isère River near the Val d'Isère ski resort to the town of Albertville. The Upper Tarentaise is situated upstream from the town of Moûtiers. As a glacial valley, it is deeply incised and exceptionally narrow in some areas. The valley is bordered to the north by the Beaufortain and Mont-Blanc massifs and to the south by the Vanoise and Lauzière massifs.

Originally an agricultural and industrial region, the Tarentaise Valley turned to summer and thermal tourism in the latter half of the 19th century, before shifting towards winter sports in the 20th century, ultimately becoming one of the largest ski areas in the world.

Map 1. The Tarentaise located along the Isère River in the French Alps at the border of Italy and Switzerland

A quick gastronomic glance is enough to reveal that the Northern Alps are a traditional stronghold of livestock farming, as evidenced by the diversity and quality of their cheeses. However, upon closer examination, one discovers that this culinary richness is born at high altitudes. It is in the heights of the various mountain ranges that livestock farming and pastures are primarily concentrated. By contrast, the valley floors have followed a classic trajectory since the 19th century, transitioning from mining and industrial activities to urban services and transport. Agriculture does exist in these valleys, but it is more focused on crops such as corn, grapes, apples, and walnuts.

In the remote high valleys of the Northern Alps, Alpine pastures and livestock were long the primary resources for mountain communities. Then, in the 1960s, skiing emerged—the 'white gold' revolution—ushering in a winter sports economy that transformed the Alpine territories. A new Alpine geography has since been shaped by investments, demographic shifts, and the growing impacts of climate change.

Among the various mountain ranges of the Northern Alps, the Upper Tarentaise is emblematic of the coexistence of two models: pastoralism and tourism. Livestock farming has ancient roots here, with records dating back to Roman administrators. It gained further recognition in the late 1960s with the establishment of the Beaufort cheese *appellation d'origine contrôlée* (AOC - controlled designation of origin), celebrated as the 'Prince of Gruyères'. At the same time, the creation of the Vanoise National Park in 1963, France's oldest national park, laid the groundwork for future summer tourism development.

Winter tourism, on the other hand, began in Val d'Isère in the 1930s and experienced a meteoric rise. Today, Upper Tarentaise boasts the highest concentration of ski resorts in the world. Yet, these high-altitude resorts now face a severe threat from the dramatic effects of climate change.

How can a pastoral tradition—no matter how ancient and respected—continue to thrive in a mountainous region so intensely focused on tourism and so profoundly affected by the climate crisis?

I. Complex pastoral resource due to specific mountain landscape

1. A maze of high-altitude valleys and small high mountain basins

In the heart of the Northern Alps in France, the Isère River originates and flows, serving as one of the main tributaries of the Rhône (Photo 1). Over its first fifty kilometres, the main valley is bordered by numerous perched valleys, which are themselves overlooked by multiple high-altitude basins, compartmentalized by rocky bars and natural barriers (Photos 2 & 3). This intricate landscape defines a distinct and well-delineated territory: the Upper Tarentaise.

A geological perspective is essential for understanding how the Upper Tarentaise's forage systems function. Within the inner Alpine massifs, the rocks originate from the deep layers of the Earth's crust. Transformed by intense heat and tectonic pressure, these rocks were uplifted to high altitudes, fractured, displaced, and rearranged through a complex network of geological faults. Over time, these diverse rock formations were further sculpted and shaped by the glaciers of the Quaternary period.

This complex morphogenesis gave rise to the region's tiered valleys and basins, creating a remarkable diversity of soils, slopes, and landforms that significantly influence local vegetation. This stands in sharp contrast to the more orderly landscapes of other Alpine massifs.

Altitude gradients are another crucial factor. They range from a base level of 815 metres above sea level in Bourg-Saint-Maurice to a peak elevation of 3,855 metres at the summit of La Grande Casse. Vegetation types are distributed across an elevation range of over 2,000 metres, exhibiting clear stratification due to variations in atmospheric oxygen, precipitation, temperature, and solar radiation.

Photo 1. The Source of the Isère River in the Upper Tarentaise: At an altitude of 2,700 metres, the Alpine meadow reaches its peak development in early August. Biomass varies significantly depending on sunlight exposure, slope, and soil type. These high-altitude pastures, situated above the rocky cliffs overlooking the village of Val d'Isère, are crossed by skiers in winter, as evidenced by the numerous ski lifts of Espace Killy, one of the largest ski areas in the world.

Photo 2. Vertical gradient between Alpine meadows and valley pastures: This Alpine meadow extends from an altitude of 2,600 metres in the foreground down to 1,900 metres below. During the summer season, herders move from chalet to chalet, following the growth of grass to graze their herds. At lower elevations, around 1,600 metres, it is haymaking season in the valley pastures, visible here in the background.

Photo 3. High valley, perched valleys, and small high watersheds: The bottom of this high valley in the Upper Tarentaise is flat, as is typical of all glacial valleys. This is not the case for the perched valleys and small high basins. Above, layers of rocks of varying types are stacked, as indicated by their diverse colours. This compartmentalized and contrasting relief significantly influences forage management and herd mobility.

The vegetation of the Upper Tarentaise benefits from abundant rainfall. Exposed to westerly atmospheric flows, the region fully receives Atlantic moisture. Unlike the more Southern Alpine massifs, the Upper Tarentaise is not shielded by the Massif Central and is therefore largely unaffected by Mediterranean influences. As a result, its precipitation regime is both plentiful and relatively well-distributed throughout the year, in contrast to the Swiss, Italian, German, and Austrian Alps, where the continental influence is more pronounced.

These climatic conditions are significantly shaped by seasonal variations, driven not only by solar inclination but also by shifting regional air masses. Depending on the season, the Upper Tarentaise may be influenced by Siberian, North Atlantic, Saharan, tropical-Atlantic, or Mediterranean air currents.

This unique geography imposes a complex forage management system on local livestock farmers, who must account for a wide range of factors, both structural and unpredictable. Geological and topographical diversity, seasonality, meteorological variations, sun exposure, vegetation stratification, soil composition, and drainage conditions all combine to create a complex equation for forage production in the Upper Tarentaise.

2. The pastoral resources in High-Tarentaise

In many pastoral farming regions, livestock must move throughout the seasons to access available forage resources, completing their annual feeding cycle by shifting from one area to another. This is also true in the Upper Tarentaise. However, due to the constraints of rugged terrain and dense forests, the grazing circuit cannot extend over a vast perimeter. Instead, livestock mobility is structured by altitude, resulting in a tiered transhumance system where the primary movement axis of the herds is vertical.

Transhumance in the Upper Tarentaise revolves around two main types of grazing areas: high-altitude pastures and valley meadows. Located at different elevations, these two zones were cleared during Antiquity and the Middle Ages. Over time, pastures gradually replaced high-altitude shrub formations, which have only persisted in less accessible areas such as rocky slopes, steep escarpments, and shaded hillsides. Meanwhile, meadows developed at lower elevations through the clearing of deciduous and coniferous forests.

High-altitude pastures or Alpine meadows

These Alpine meadows, or seasonal grass pastures, are key to the renowned quality of dairy products from the Upper Tarentaise, thanks to their rich floral diversity, which imparts distinctive organoleptic qualities to the cows' milk.

Often referred to as 'Alpine lawns' due to their low-growing, dense, and uniform structure, these grasslands cover the slopes and high-altitude valleys between 1,800 and 2,800 metres. Their annual vegetative cycle spans from May to October, beginning with the snowmelt and ending with the return of winter. Beyond this seasonal rhythm, vegetation growth is influenced by sun exposure (with south-facing slopes being earlier and more productive), as well as by altitude, humidity, and soil fertility. Weather conditions also play a critical role, with potential snowfall throughout the season and significant variations in rainfall and temperature.

The shepherd's skill lies in adapting to these ever-changing conditions, ensuring that livestock graze on the best possible grass throughout the season. Meanwhile, the cheesemaker's craft involves fine-tuning the cheese-making process daily, adjusting to the pasture's characteristics to maintain high quality and minimize losses—all despite the absence of modern cold storage.

Valley meadows

Between 800 and 1,800 metres in elevation, south-, east-, and west-facing slopes, along with plateaus and valley floors, host lush valley pastures. Less exposed to the harsh conditions of high altitudes, these grasslands produce significantly more forage biomass than Alpine meadows and sustain a longer growing season, from April to November.

These pastures are grazed in spring and autumn, while two hay-cutting cycles occur during the summer season. The harvested hay is then stored on farms to feed livestock throughout the winter months.

II. Evolution of the pastoral system over time

1. Traditional mobility of the herds

Until the 1970s, each family in the Upper Tarentaise valleys maintained its own small herd, typically consisting of 10 to 20 cows, most of which belonged to the Tarine breed (Photo 4). Sometimes referred to as 'Tarentaise', the Tarine breed is known for its balanced dairy and meat production capabilities, but above all, for its size and agility, which are perfectly suited to the rugged terrain and altitude constraints of the region.

In spring, as the snow begins to melt, the lowest pastures—particularly those with southern exposure—are the first to emerge. This marks the beginning of the grass growth season, prompting the herds to leave the barns for the first pastures. By May, the valley pastures are fully covered in fresh grass, and the cows are grouped into collective herds of 100 to 150 head, led by a herder. The herder, assisted by a team of around ten people, guides the herd through a grazing cycle lasting four to six months. This journey begins with the '*montagnette',* the highest valley pastures, before continuing to the expansive Alpine meadows.

Photo 4. The Tarine (Tarentaise) cow and the Alpine meadow: a symbol of the Tarentaise region, the Tarine cow is small in size, providing it with exceptional agility for grazing on steep slopes, even those that can become slippery after snowfall. Here, at the end of August, at an altitude of 2,000 metres, the Alpine meadow is still in full bloom, which imparts a distinct flavour to the milk of the Tarine cows.

With two milkings per day, the fresh milk is immediately transformed into Beaufort cheese (Photo 5), the primary economic product of farming in the Upper Tarentaise. At the end of the grazing season, after the Beaufort has been produced in the Alpine meadows, the herds descend back to the valley, returning to the *montagnette* they left in spring for autumn grazing. The annual cycle concludes in the lower-altitude meadows, where the cows are reunited with their owners.

Forage management in this region follows a vertical gradient, extending from valley floors to Alpine summits. A key and symbolic moment in this seasonal cycle is the '*enmontagnée*'—the ascent to the mountain pastures—at the end of June. During this ascent, the herder's team, along with the herd, moves to high-altitude chalets that are only accessible during the summer. They will not return to the valley until the end of September, during the '*démontagnée*'—the descent from the mountain pastures.

This system of mobility serves several purposes. First, it maximizes the use of high-altitude forage resources while supporting a summer cheese-making process adapted to the isolation of the Alpine meadows. This process produces cooked, pressed cheeses in 50-kilogram wheels, which are then aged locally. Additionally, it frees the families who own the cattle from the daily tasks of animal husbandry, allowing them to focus on hay production for winter and staple crops (such as potatoes and rye).

Families retrieve their cows in autumn when milk production declines. The winter milk, which is less abundant, less rich, and less flavourful, is traditionally used to produce a smaller, lower-value cheese known as *tomme*. However, starting in the 1950s, an innovation emerged—the 'winter Beaufort'. This development led to the creation of the Fruit Commun, a cooperative system in which families pooled their winter milk, hired a cheesemaker, and produced a higher-value cheese than the traditional *tomme*.

Photo 5. Milking in the Alpine Meadow: The milking system is mobile, allowing it to be positioned as close as possible to the grazing areas. This setup optimizes herd mobility, making the best use of available forage resources based on current conditions. A mobile electric fence is visible in the foreground, used to define the daily grazing area.

In addition to Beaufort, other co-products are produced in the Alpine meadows, including cream, butter, and sérac (a cheese made from buttermilk). The whey is used to fatten young pigs, which are slaughtered in the autumn. The pastures also support sheep flocks, which add value to these resources through the production of wool and meat in areas that are inaccessible to cattle due to distance, altitude, steep slopes, and rocky terrain.

2. Nitrogen in the pasture or disruptions in the forage system

The structure of this vertical mobility system has persisted to this day, but its functioning has undergone profound changes in recent decades. As in the rest of France, mechanization has facilitated transportation and various stages of production, such as stirring, skimming, and churning butter. Electricity and gas have replaced dry wood and manual labour, while industrially produced tools have supplanted handmade instruments.

However, it is primarily the concentration of herds and lands into the hands of a few farming families that has transformed forage systems. Despite the success of the Fruit Common system, the rise of tourism from the 1970s onward led most families to abandon gradually their small herds.

A few families, however, made the opposite choice: they consolidated herds and meadows, initiating a new production model. Herds are now gathered not only in summer but also in winter, within the same farms. New types of barns have been built, where, for the sake of labour productivity, solid and liquid manure are mixed and stored in slurry pits. The large quantities accumulated during the winter are then spread on the meadows in spring.

These substantial inputs of nitrogen, phosphates, and potassium alter soil functioning, disrupt the floral composition of plant communities, and ultimately affect milk quality (Photo 6). With the increasing number of cattle, the volume of slurry also rises, and due to limited available space, spreading gradually extends to Alpine pastures, where the agronomic and ecological impacts are even more pronounced. Beyond disrupting flora, water pollution from eutrophication can occur in catchment areas, affecting rivers and groundwater.

A direct consequence of the growing herds is an increased demand for forage, which local production can only partially meet, even when boosted by organic nitrogen inputs and other chemical fertilizers. Imports of hay from Crau (a region located 300-400 km to the south) have increased, along with imports of alfalfa pellets.

These external inputs further exacerbate imbalances between soils and plants in the meadows and Alpine pastures where slurry is spread. This trend is reinforced by the valorisation of milk produced at altitude, which encourages farmers to enhance the productivity of Alpine meadows, extending the grazing period beyond the traditional 100 days.

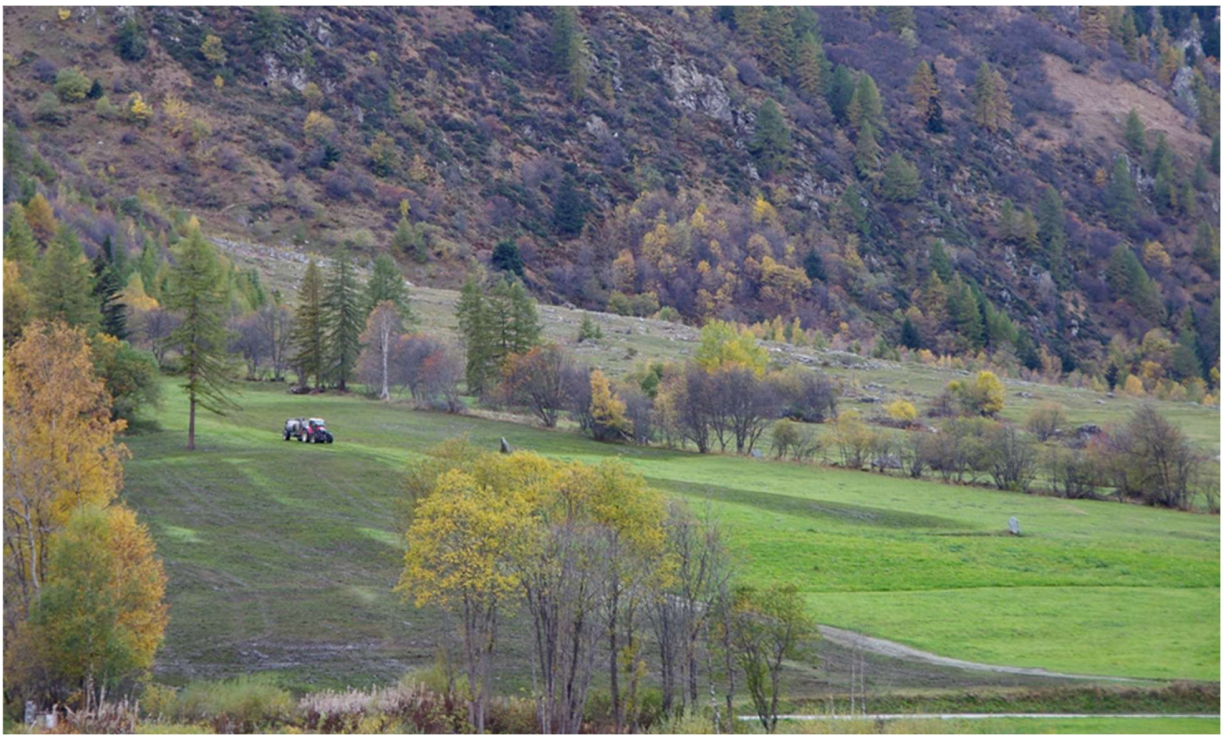


Photo 6. Spreading slurry and manure: before winter begins, slurry and manure pits must be emptied, resulting in their application across valley pastures and Alpine meadows, typically in autumn before the first snow. While this practice boosts forage production, it negatively impacts floral diversity and the sensory qualities of milk. Additionally, it can cause water pollution and generate unpleasant odours.

In response to this trend over recent decades, regulations—such as *appellation d'origine protégée* (AOP - protected designation of origin) Beaufort standards, and European directives—have evolved to mitigate the impact on plant diversity and cheese quality. Additionally, collective efforts have been strengthened through the Fruit Common system and maturation cooperatives. These initiatives provide better control over production processes, from land management to marketing at tourist sites, ensuring the continued profitability of traditional herd and pasture management.

III. Changes and perspectives: coming back to the mountain pasture?

Climate change is reshaping the forage resources of High-Tarentaise, just as it is across the Northern Alps. Winter tourism now faces the challenge of declining snowfall, leading to increased reliance on artificial snow, which introduces new competition for water resources. At the same time, rising risks of drought place additional pressure on forage, especially where livestock numbers have grown.

However, it is tourism—more than any other factor—that has driven change in High-Tarentaise. For decades, tourism has attracted young people, expanded buildable land, and dramatically increased property values due to demand from tourists and developers. This influx of wealth has transformed the local economy, replacing livestock farming with a thriving service sector built around businesses, real estate, and ski-related jobs. The region has urbanized rapidly, despite some regulatory constraints from the Vanoise National Park.

Yet tourism's impact on agriculture is not entirely negative. The millions of tourists who visit annually provide a steady market for local products, especially the renowned Beaufort cheese, supporting high prices regardless of product quality. Livestock farming, once in decline, has been revalued as cultural heritage—sometimes even achieving a folklore status. It contributes to the region's iconic landscapes, a critical asset for tourism. As a result, the activity has regained appeal among young people, who are returning to shepherding and cheesemaking. This resurgence is supported by strong product value, family real estate income, a dynamic job market (including opportunities for dual occupations), and regulatory measures that encourage a return to mountain life.

However, tensions persist over land use. Agricultural lands, particularly valley meadows with prime southern exposure, are being converted to buildable plots (Photos 7 & 8). The expansion of ski slopes, often involving extensive earthmoving, alters soil composition and degrades pasture diversity, impacting forage quality.

Photo 7. Grazed landscapes and tourist areas: In High-Tarentaise, pastures serve as expansion zones for tourism, accommodating ski slopes, golf courses, and residential developments, as shown here in Arc 1800. In the background lies the Tarentaise Valley near Bourg-Saint-Maurice, flanked by numerous perched valleys, with high-altitude pasturelands rising above.

Photo 8. Haymaking in valley pastures during summer: while herds graze in the Alpine meadows, two hay-cutting cycles take place in the valley pastures each summer, following spring grazing. These pastures are essential for ensuring farms' forage self-sufficiency during the harsh winter months. However, they are increasingly threatened by the expansion of buildableland, as shown by the campsite on the left and the tourist residence on the right. This pressure drives the push for higher pasture productivity, altering plant diversity and ultimately diminishing both product quality and landscape beauty.

Livestock farming also presents challenges for tourism. Manure spreading produces unpleasant odours and can contaminate watercourses, conflicting with tourist expectations. Large Patou dogs, while essential for protecting herds from wolves, can pose risks to summer hikers. Off-road vehicles—bicycles, motorcycles, and quads—preferred by some tourists, damage pastures and trails. Hikers' dogs, uncontrolled, threaten herds and local wildlife. Beyond forage management and livestock farming, tourism's rapid growth has disrupted many foundational aspects of High-Tarentaise.

Altitude, once a barrier and defining feature, has been conquered. It is now accessible to tourists year-round, crossed by skiers and hikers, connected by roads, dotted with comfortable housing, and governed by strict regulations on flora and fauna. Larger, more productive herds graze these mountain spaces, which have become normalized, no longer demanding the same resilience and skills.

The region's population has also transformed. After two generations of intense migration, a diverse, multicultural community has emerged. Once isolated and even marginalized, mountain residents now embody values of progress, sustainability, and quality of life that were once seen as urban. These human resources have redefined the region’s identity, transforming traditions to align with new values. Tourism—once the primary threat to traditional life—now helps preserve and celebrate it, highlighting the complex balance between tourism and livestock farming in High-Tarentaise.

Despite being impacted by significant territorial changes, the forage system of High-Tarentaise has become a driver of change itself, thanks to its economic significance, its deep connection to the landscape, and the iconic value of its products. Yet, in High-Tarentaise, the allure of ‘white gold’ (snow) continues to dominate. Investments keep pouring in to enhance and internationalize tourism offers, leveraging the region's environmental and logistical advantages to position it as a leader in addressing the risks of climate change.

Balancing these two key activities—agriculture and tourism—within the region is a complex task, overseen by multiple public institutions. These organizations face challenges such as navigating complex administrative structures, managing the difficult consolidation of small municipalities as encouraged by the state, and addressing uncertainties in overseeing the peripheral areas of the Vanoise National Park.

Conclusion

Situated at the foot of Mont Blanc, where France, Italy, and Switzerland meet, High-Tarentaise has long been a region of strategic importance. Over the past half-century, it has experienced profound economic, social, cultural, and political changes driven by the growth of winter tourism. Despite the evolution of some pastoral practices, High-Tarentaise remains a region rooted in livestock farming, with transhumance at its core, making use of diverse high-altitude grazing areas.

However, the region now grapples with two major challenges. On one hand, urban and peri-urban expansion encroaches on grazing lands, altering traditional land use. On the other, evolving livestock farming practices are causing irreversible environmental impacts. A range of public policies at local, national, and European levels aims to address these challenges, seeking a balance between conservation, development, and sustainability.

Although the outcomes do not always align with local stakeholders' expectations, these policies offer coherent alternatives for managing mountain territories—both in the Alps and beyond.

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Chapter 20

Practices of transhumance and mountain summer farming in Norway, Scandinavian Alps

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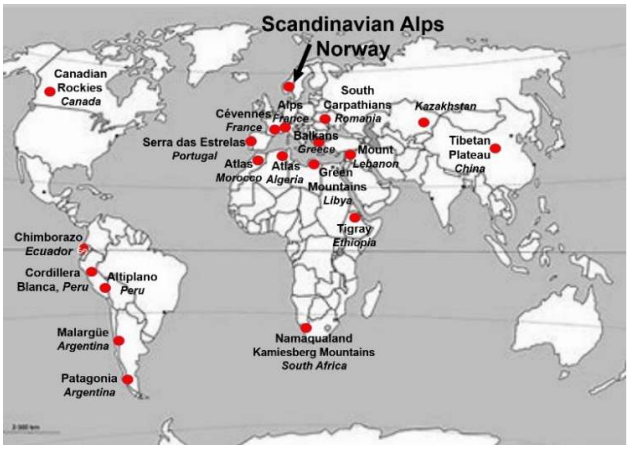
Abstract

In Scandinavia, transhumance—the seasonal movement of livestock and their caretakers between geographic or climatic zones—has been traditionally associated with a system of mountain summer farming involving dairy cows and goats. Typically, cows calved in the spring and produced most of their milk during the summer months, while winter feeding strategies focused on conserving feed. This system may be as old as agriculture itself in the region and can be viewed as a seasonal survival strategy. Numerous traces of early forms of such activities have been found in the high mountain regions, dating back to the Iron Age and earlier, suggesting that some type of summer farming was practiced. The system likely reached full development before the Great Plague (the Black Death) of 1348/49 and the subsequent late medieval agricultural crisis. By around 1850, the number of summer farms had rebounded to what was likely the highest level ever recorded in both Norway and Sweden, with 45% of Norwegian farm holders owning one or more summer farms. There were three main types: complete summer farms, milking summer farms, and outfield harvesting summer farms. Today, fewer than 800 active summer farms remain. This decline is attributed to various factors, including ecological values, land ownership issues, as well as both threats and opportunities for the preservation and development of this traditional system.

Keywords: Summer farms; Dairy production; Cows; Goats; Mountain; Ecological values



Introduction

Transhumance, defined as the seasonal movement of livestock and their caretakers between geographic or climatic zones, is associated with two distinct livestock systems in Scandinavia: Sami reindeer herding, and mountain summer

farming, which sometimes also occurs on coastal islands. The latter is primarily focused on milk production from dairy cows and goats (Store norske leksikon, 2024).

Sami reindeer herding has historically been, and remains, a semi-nomadic system characterized by the seasonal movement of reindeer herds. For example, reindeer graze on winter pastures on the Finnmark plateau in Southern Finnmark and are moved to the coast and coastal islands for summer pasture. Herders and their families traditionally followed the herds throughout this migration.

The other system, which is the primary focus of this chapter, is the mountain summer farming system (Photos 1, 2 & 3). In Scandinavia, these mountain summer farming practices continue in Norway and parts of Sweden bordering Norway. Historically, several variants of the system existed, some of which more closely aligned with the classic concept of transhumance.

Photos 1, 2 & 3. Traditional Norwegian summer farms in a mountain area. Top: retrieved from the National Library, year unknown (by A.B. Wilse). Bottom Left & Right: Aure, Møre and Romsdal County (by J.A. Thorvaldsen, 1943)

In many areas, both livestock and their caretakers moved to the summer farms, where they stayed throughout the summer, processing milk on-site. In another variation, the milk was brought down daily to the main farm for processing. Typically, a milkmaid (often a woman) would walk to the summer farm in the afternoon, milk the cows or goats, store the milk for cooling, spend the night in a small hut, milk the animals again in the morning, and then bring the fresh milk back home.

A third variant focused on harvesting winter feed in areas far from the main farm. Families would relocate for the harvesting season, bringing their livestock along. These variations are discussed in more detail in the chapter.

Additionally, livestock (mainly cattle and horses) were moved from the valleys of Eastern Norway and from Western Norway to towns and lowland areas in the Eastern part of the country. In spring, animals were gathered in Western Norway and driven to the mountainous regions between the east and west, where they spent several months gaining weight. In autumn, the livestock were driven to central Eastern Norway and sold either for slaughter or as live animals. This was a form of one-way seasonal livestock movement, accompanied by a two-way movement of people.

This type of transhumance, which supplemented the traditional summer farming system, was especially common from the 18th to the early 20th century (Tobiassen, 2008). However, it is typically excluded from discussions of transhumance and is not covered further here.

Mountain summer farming can be explored and analysed from several perspectives. One approach is to examine the system's impacts on landscapes and biodiversity (Bele et al., 2019; Bunce et al., 2004). Another is to investigate its historical background, growth, decline, and the factors that have influenced its development. Human and socio-economic factors play a crucial role in this context. Reinton (1955, 1957, 1961, 1969) conducted comprehensive studies on nearly all aspects of the mountain summer farming system, which remain foundational sources for understanding this practice.

The purpose of this chapter is to present information about the geographic and climatic conditions that support mountain farming in Scandinavia, with a focus on Norway. We explore its historical background and development, provide an analysis of the current situation, and discuss future perspectives.

I. Geographical and climatic context of Norway and Scandinavia

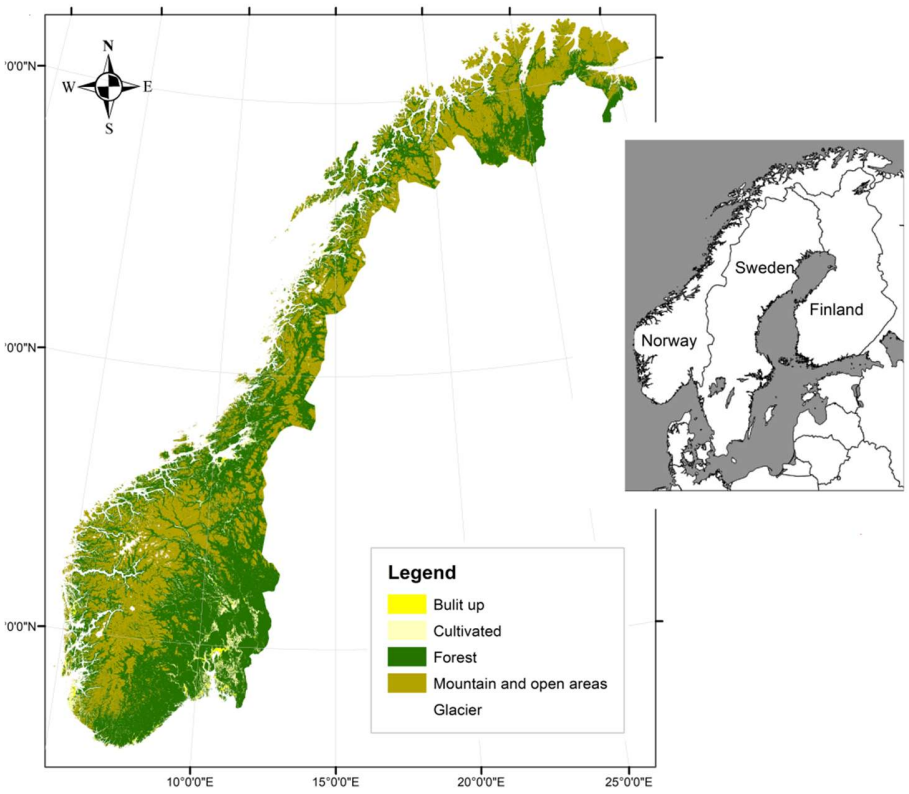
Norway's mainland forms the Western and Northern parts of the Scandinavian Peninsula. To the east, Norway shares borders with Sweden, Finland, and Russia, whereas it is surrounded by the sea to the south, west, and north. The country is characterized by its long and narrow shape, extending from 57°57'31"N to 71°11'09"N and from 4°29'57"E to 31°10'07"E. Its total area is 323,808 km², including islands (Map 1).

Norway is part of the western edge of the boreal forest belt, or taiga, which stretches into Sweden, Finland, and Russia. The most common tree species in this forest zone are spruce (*Picea abies*) and pine (*Pinus sylvestris*).

Nearly 60% of Norway's land area is situated below 600 metres above sea level, whereas approximately 20% of the land is above 900 metres. The forest line reaches an elevation of around 1,200 metres above sea level in the central regions of Southern Norway (Jotunheimen) but gradually declines in both east-west and north-south directions. Along the coast, the forest line stands at 500–600 metres and drops to 200–300 metres in Troms (Moen and Lillethun, 1999). Further north, along the coast of Finnmark, the tree line descends to sea level.

Local variations in the tree line exist due to factors such as slope orientation (north or south). Birch (*Betula pubescens*) is the most common tree species at the tree line, and pastures in birch-dominated forests generally offer better grazing quality than those in spruce or pine forests.

Only about 3.5% of Norway's total land area is classified as agricultural land, whereas 21.6% is considered productive forest land. In total, forests cover 37.4% of the country. Built-up areas, freshwater bodies, glaciers, and land under



Map 1. Scandinavia including Norway, Sweden, Denmark and Finland, and especially the Scandinavian Alps

permanent snow cover account for 8.7% of the land, whereas wetlands (bogs) constitute 5.3%. The remaining 45% is primarily land situated above the forest line (Thorsnæs, 2024).

Because of the North Atlantic Current (Gulf stream), and prevailing western winds, the temperature is higher in Norway than at the same latitude in North America and East Asia. The temperature is also relatively similar along the coast from south to north. Therefore, certain forms of agriculture, mainly animal production, are possible even north of the Polar circle. About 30% of the total area of Norway is north of the Polar circle but most parts of the country have a growing season limited to five months or less.

II. Historical context of the mountain summer farm system in the Scandinavian Alps of Norway and Sweden

Due to the climate, topography, the use of farmland for cereal cultivation, and the scarcity of land suitable for cultivation, it was far more challenging for farmers to collect sufficient winter feed than to secure grazing areas for livestock. In mountainous and other outfield areas, abundant grazing resources were available. Typically, cows calved in the spring and produced most of their milk during the summer months. During winter, the feeding strategy focused on strict feed conservation, ensuring that the animals survived until the pastures were ready. This approach, often referred to as 'starvation feeding', was common well into the 19th century in many districts (Gjerdåker, 2002).

Despite using various types of feed and harvesting both infields and outfield areas, winter feed remained scarce. As a result, cows generally lost weight during the winter. Farmers released their livestock to graze as early as possible in the spring. Forests, wetlands, and areas above the forest line were used for summer grazing, and some of these areas also served as sources of winter feed.

The exact origins of the mountain summer farm system remain unclear. However, it is essential to recognize that people lived on the edge of survival. In an average year, they had enough food, but a cold, wet summer or a late spring could bring hunger dangerously close. Using mountain pastures can therefore be viewed as a seasonal survival strategy. Some historians, such as Reinton (1961), argue that the system may be as old as agriculture itself in the region. Numerous traces of early activities in the high mountain regions, dating back to the Iron Age and earlier, suggest that some form of summer farming existed.

Other historians, however, believe that the summer farm system, as we know it today, developed in the first centuries AD (Myhre, 2002). It is also clear that Norwegian settlers introduced the summer farm system to Iceland and other settlements on the Western islands during the Viking Age (approximately 800 to 1066 AD) (Reinton, 1961). The system is even mentioned in Norwegian laws written in the 12th century but dates probably from much earlier. Thus, it can be concluded that the summer farm system has existed for over a thousand years. However, it did not necessarily develop at the same time or in the same way across all regions of the country, and local variations were common.

The mountain farming system was likely fully developed before the outbreak of the Great Plague (the Black Death) in Norway in 1348-49. This plague, along with subsequent epidemics, led to a drastic population decline of around 65% between the 1340s and 1520, with the number of farms declining by a similar proportion (Lunden, 2002). The decline was probably less severe in Sweden, where the population began to recover earlier and at a faster rate than in Norway (Lunden, 2002). This period, known as the late medieval agricultural crisis, led to extensive farm abandonment.

The increased availability of grazing areas in forests and other outfield areas closer to surviving farms may have contributed to the abandonment of more remote summer farms. In some cases, abandoned farms were temporarily used as summer farms and could be relatively easily converted back to regular farms later (Reinton, 1961).

From around 1500, Norway's population began to grow again, with some areas experiencing rapid growth (Lunden, 2002). The number of farms and holdings increased and, in some communities, the number of holdings soon reached levels that remained stable until the 20th century. The number of summer farms also rose during this period, with a similar increase in Sweden's summer farm system (*fäbodväsendet*).

It is worth noting that Larsson (2009) found no evidence of summer farms in medieval Northern Sweden, suggesting that the summer farm system there originated in the 16th and 17th centuries, whereas it developed earlier in Southern regions.

Around 1850, the number of summer farms reached its historical peak in both Norway and Sweden (Bele et al., 2017). At that time, approximately 50,000 holdings in Norway had at least one summer farm (Reinton, 1961). This was out of approximately 112,000 farm holders (owners) and leaseholders (*leiglendingar*), along with 60,000 crofters (*husmenn*) with rented land (Reinton, 1961). Notably, it was mainly the farm holders who owned summer farms, indicating that around 45% of all holders had one or more summer farms at that time.

Traditionally, dairy cows generally calved in the spring, and a significant portion of milk production occurred during the grazing season. During the summer, cows also built-up body reserves to help them survive the winter months. However, in the second half of the 19th century, changing demand for milk and dairy products led to a greater emphasis on producing milk during the winter season. This shift resulted in a gradual transition to autumn calving

and improved winter-feeding practices. Consequently, milk yields per cow increased, albeit slowly. A 1935 report on grazing practices highlighted that many grazing areas were inadequate for high-yielding dairy cows. While these pastures were sufficient for dry cows, young cattle, and sheep, they did not provide enough nutrition for cows with high milk production. The report also noted that several farmers in regions with numerous summer farms had transitioned to autumn calving (Skappel, 1939). This shift was likely one of many factors that led farmers to stop sending high-yielding dairy cows to summer farms. Instead, many chose to send dry cows and young livestock to graze there. As the number of dairy cows at summer farms declined, the number of grazing sheep increased. Since around 1990, the number of suckler cows in Norway has risen from nearly zero to approximately 100,000 (Statistics Norway, 2024). Some of these suckler cows, along with their calves and heifers, likely graze near former summer farm locations, although the exact number is unknown.

III. Types of summer farms

As mentioned above, several types of summer farms were typically distinguished. According to Reinton (1955), there were three main types:

- Complete summer farms (often called *seter* or *sæter*), where people lived throughout the grazing period. One or more individuals tended the animals, milked the cows, and processed the milk into butter and various cheeses, which were then brought back to the main farm and sold in local or regional markets;
- Milking summer farms (*mjølkeseter*, often called *støl* or *støyl*), where cows were milked, but the milk was transported to the main farm daily or almost daily. The person responsible for milking, usually stayed overnight in a small hut (*sel*), and returned to work on the main farm during the day;
- Outfield harvesting summer farms (*slåtteseter*), where the entire family or a significant portion of it, along with their livestock, moved to the summer farm to make hay and collect other types of feed. These farms likely originated in areas where the primary purpose was to harvest winter feed for the livestock.

Of these types, complete and outfield harvesting summer farms best align with the definition of transhumance.

Regional differences existed in the distribution of these summer farm types. Milking summer farms were most common in coastal regions of Western and Northern Norway. Outfield harvesting summer farms were most prevalent in one region of Southern Norway, whereas complete summer farms dominated the rest of the country (Reinton, 1969).

Establishing a summer farm required finding suitable areas where the farm had, or could secure, grazing rights. Historically, summer farms were sometimes located on common land (*allmenning*) or no man's land (Reinton, 1961). In such cases, farmers needed to agree on grazing rights. Proximity to the main farm was also an important consideration, along with access to flowing water for animals, cooking, and cleaning. Additionally, there was a need for access to firewood, building materials, and fencing supplies.

Many summer farms were established near the forest border, where grazing conditions were often better than in coniferous forests at lower altitudes (Reinton, 1955). In some cases, intense use of these areas led to a lowering of the forest line (Bryn and Potthoff, 2018). Currently, the opposite trend is observed: the forest line is moving upward due to natural forest re-establishment in areas previously cleared by logging and grazing. Climate change may also be contributing to this effect.

While cattle and goats were the primary livestock at summer farms, other animals were sometimes brought along. According to Reinton (1955), sheep—and in some cases pigs—were also kept at summer farms. Notably, in earlier periods (before around 1830), sheep were milked, which was a key reason for having sheep alongside cattle. Another

reason was predator protection. Shepherds guarded the livestock against predators, and farmers engaged in hunting to reduce losses.

In 1845, the Norwegian parliament passed a law for the eradication of predators and the protection of other wild animals (Lov om Udryddelse af Rovdyr og Fredning af andet Vildt). This legislation introduced financial rewards for killing predators. Its impact, along with other measures, led to a significant decline in predator numbers around 1900, which remained low until about 1970. This reduction allowed sheep to graze more freely.

A typical summer farm consisted of a cottage (*sel*) for people and a cowshed for the animals, where they stayed at night (Photos 4 & 5). However, in some cases, cows were milked outdoors and even kept outside during the night. The distance between the main farm and the summer farm varied significantly. Generally, milking summer farms were located relatively close to the main farm, with a walking distance of about half an hour to one hour. In contrast, other types of summer farms could be much farther away, sometimes requiring more than a day's journey to reach them. Reinton (1955) provides detailed information on distances and routes to these summer farms.

Photos 4 & 5. Ruins of a summer-farm in the mountains of Geiranger, Møre and Romsdal County. Left: remains of the cottage. Right: the cowshed with pens for 10 cows. A big rock was used as one wall for both buildings (© P. Thorvaldsen, 2007)

Several farm holders established their summer farms close to one another, forming small communities known as Setergrend, particularly in areas where a single original farm had been divided into multiple holdings. However, each holder typically maintained its own cowshed and cottage for personal use. Some farmers even had two or, more rarely, three summer farms. In such cases, one farm would be used in the spring and early summer, whereas the others, located at higher elevations in the mountains, were used during the peak summer season in July and August. Afterward, the livestock were returned to the spring farm for a period before being brought back to the main farm. This extensive movement of livestock enabled the efficient use of scarce grazing resources, following the patterns of snowmelt and grass growth at various altitudes and locations.

Additionally, some farmers practiced winter grazing on mountain farms (*winterseter*). This approach was particularly relevant in areas with abundant mountain land compared to land available at the main farm site. Livestock could be kept indoors at the mountain farm during the autumn until the stored hay was fully consumed in October or November. Alternatively, they could be brought to the mountain farm in late winter or early spring (March or April) and fed with hay harvested the previous year. On calm days, temperatures in the mountains were sometimes higher than in the valleys below. However, the number of farms practicing such winter mountain grazing was relatively small.

For centuries, until around 1800, an average Norwegian cow had a body weight of approximately 200 kg, with a carcass weight of less than 100 kg, and an annual milk yield of around 500 kg per cow (Lunden, 2002). During the 19th century, the average milk yield per cow doubled (Gjerdåker, 2002). Currently, a typical Norwegian dairy cow

weighs around 600 kg (with a carcass weight of approximately 285 kg) and produces around 7,500 kg of milk per year (Budsjettnemnda for jordbruket, 2023).

According to Skappel (1939), the average daily milk yield per cow on most summer farms rarely exceeded 5 litres, even during the grazing period. A single person, usually the milkmaid, could carry between 25 and 30 litres of milk home each day. Given that each cow typically produced 4 to 5 liters of milk—a common yield before World War II—one person could realistically only carry milk from about 6 to 8 cows. At the beginning of the 20th century, the average herd size was around four cows, making it feasible for one person to transport the milk home daily.

For farms producing more milk than one person could carry, alternative solutions were necessary. Transporting dairy products on horseback was a common method. In some regions, particularly Western Norway, farmers installed steel wire systems in the late 19th century to send milk from the summer farm to the main farm or a nearby road (Reinton, 1961). For example, Råd (2004) noted that many summer farms in the parishes of Olden and Loen in Stryn used such steel wire systems. However, this method was a viable solution for only a limited number of farmers.

Building roads significantly improved transport between summer farms and main farms, which became even more important with the establishment of common dairies. Initially, these roads were designed for horse-drawn transport, but trucks eventually replaced horses. Today, most remaining active summer farms have road access for trucks.

In the 20th century, a new type of grazing organization emerged. Two or more farmers—usually between three and six—formed cooperatives, pooling resources to buy or lease land that was then cultivated and used for grazing. These pasture areas could be located in traditional mountain summer farm regions or in other areas. The farmers built a central milking facility with modern equipment, and the milk was delivered directly to a common dairy.

This cooperative approach enabled farmers to increase forage production while reducing capital costs and labour per farm, compared to managing individual summer farms. Additionally, it provided dairy farmers with the opportunity for leisure time, particularly if they hired workers to handle milking. This model was recognized as a new variant of the milking summer farm system (*mjølkeseter*) (Reinton, 1961).

IV. Reasons for the decline in summer farming activity

The number of summer farms in Norway peaked around 1850. Reinton (1961) estimated that approximately one-seventh of the country's total dairy production was generated at mountain summer farms at that time. Simultaneously, the number of crofters (*husmenn*) also reached its highest point (Skappel, 1922). These trends can be attributed to two main factors: improved work opportunities outside agriculture in Norway and increasing emigration, particularly to North America. The mountain farming system was labour-intensive, and as labour costs rose, the system's sustainability declined. Between 1860 and 1920, the population in Norwegian cities and towns grew, whereas the rural population remained relatively stable. Even in rural areas, however, non-agricultural employment opportunities became more common. Norwegian emigration to North America, which began in 1825, accelerated around 1850 and experienced three major peaks: 1866–1873, the late 1870s to 1893, and approximately 1900 to 1910 (Mørkhagen, 2009).

1. Decline of summer farms

The decline of summer farms began in the lowland areas of Eastern Norway, where many summer farms were located in forested regions. Initially, this reduction was gradual, but starting around 1910, the decline became more pronounced, continuing until 1980. This trend was briefly interrupted during World War II when the decline slowed

down (Figure 1). Since 1980, the decline in the number of summer farms has been somewhat slower than that of dairy farms overall (Bundner & Haarsaker, 2020). By 2022, approximately 11% of Norway's dairy cow farms and 40% of dairy goat farms continued to use summer farms (Landbruksdirektoratet, 2023). This data has also included more modern summer farms that differ from traditional models.

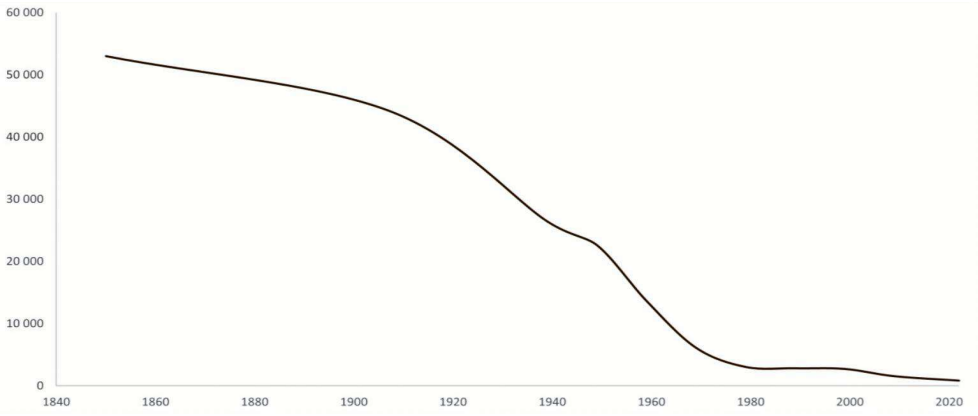


Figure 1. Historical trend in the number of farms with mountain summer farms since 1850. The data are based on numbers compiled by Kari Stensgård, derived from sources including Lars Reinton, Statistics Norway, and the Directorate for Agriculture. The earliest figures are estimates.

2. Land consolidation and agricultural modernization

During the 19th century, a process of land consolidation began in Norway. The primary goal was to increase agricultural productivity by reducing the number of fragmented plots each farmer managed. This was achieved by creating fewer, larger fields, making it easier for farmers to invest in land improvements, such as drainage and soil enhancement.

Another significant change was the gradual shift from joint land ownership in outfield areas to individual land ownership (Gjerdåker, 2004). This transformation made it easier for farmers to clear new land and improve pastures closer to the main farm.

Additionally, the second half of the 19th century saw a notable increase in average milk yields. This improvement was driven by several factors:

- Access to imported cheap grain, which allowed for better livestock feeding;
- Enhanced feeding practices, as farmers adopted improved strategies for winter feeding;
- Genetic improvements, as modern breeding methods were introduced, further increasing milk yields.

These developments have continued throughout the 20th and 21st centuries, driven by ongoing advances in agricultural technology, animal genetics, and improved farming techniques.

The use of mineral fertilizers began to increase after the establishment of Norsk Hydro in 1905 (Yara International ASA since 2004), which initiated the production of nitrogen fertilizers. This development led to significant improvements in crop and pasture biomass yields on the main farm site, reducing the reliance on outfield pastures for livestock grazing. Additionally, the increased availability of mineral fertilizers provided more feed and generated more manure, which further enhanced forage production on the farm.

In the traditional farming system, manure was a valuable and often scarce resource. Keeping livestock on outfield summer pastures limited the amount of manure available for use at the main farm. Although some summer farms featured fenced fields or enclosures where manure was collected and applied to hay production, there are no records indicating that manure was transported back to the main farm.

The decline in the number of summer farms has continued into the 21st century. The most recent trends in this decline are illustrated in Figure 2, whereas Map 2 shows the current (2021) distribution of active summer farms.

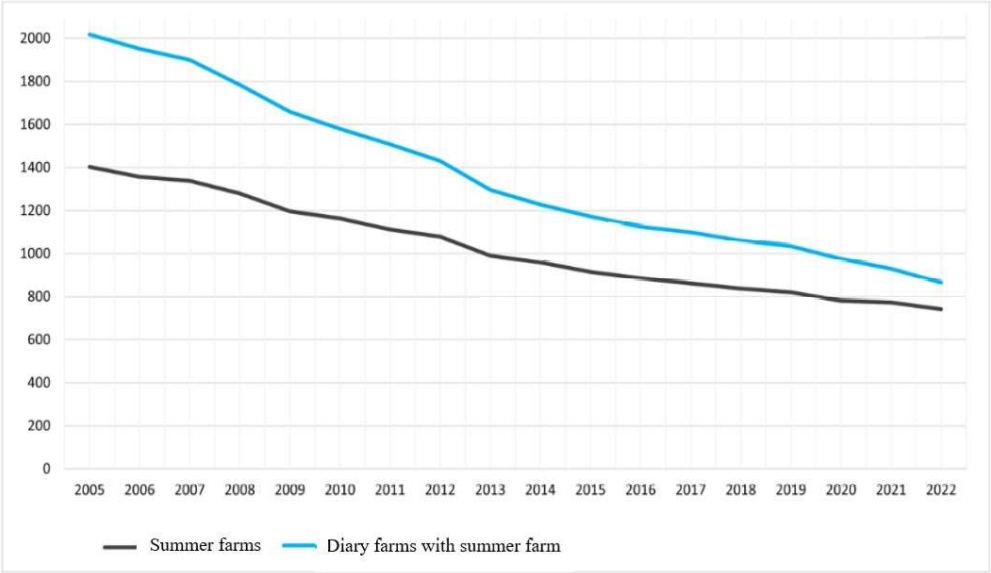


Figure 2. Development of number of summer farms and number of dairy farms with a summer farm (or part of one) in Norway from 2005 (Landbruksdirektoratet, 2023).

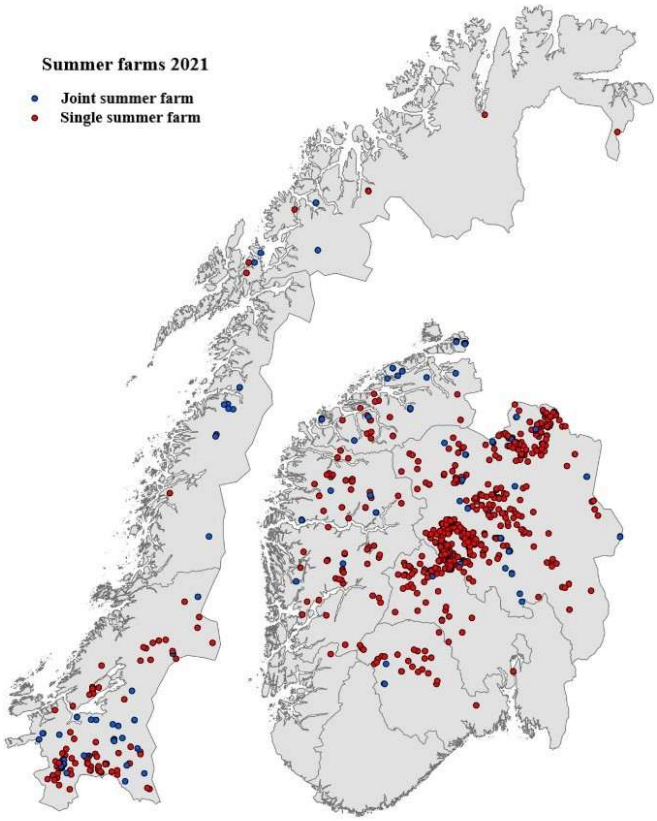
3. Ecological values of mountain summer-farming

Traditional agricultural practices, such as grazing and mowing without the use of fertilizers or pesticides, in sub-Alpine areas where mountain summer farming has been practiced, have proven beneficial for biodiversity (Olsson et al., 2004; Kampmann et al., 2008; Pornaro et al., 2021). Centuries of continuous and sustainable land use have shaped grass- and herb-dominated semi-natural habitats of high ecological value, often at the expense of forested areas. These semi-natural ecosystems are of considerable conservation value, and all Norwegian semi-natural habitats are listed on the Norwegian Red List of Habitats (Hovstad et al., 2018).

Biodiversity and species richness in semi-natural habitats

Semi-natural habitats are critical for plant biodiversity (Austrheim et al., 1999; Bullock et al., 2011; Johansen et al., 2022). Continuous land use has led to the development of specific plant communities characterized by high species richness, including both Alpine and lowland species. Among these species is *Primula scandinavica*, one of the few plant species endemics to Scandinavia and a mountain grassland specialist that also thrives in sub-Alpine semi-natural grasslands.

Several European vulnerable plant species can also be found in Norway's semi-natural grasslands, including *Botrychium lunaria*, *Gentiana amarella*, and *Gentiana campestris* (Austrheim et al., 1999). In addition, these habitats host vulnerable grassland fungi from the genera *Clavaria, Entoloma, Hygrocybe*, and *Geoglossum* (Bratli et al., 2011).



Map 2. Location of individual and common summer farms in Norway in 2021. Based on farms obtaining regional environmental support (Landbruksdirektoratet, 2023).

The region is also home to several farmland bird species, such as the skylark (*Alauda arvensis*), house martin (*Delichon urbicum*), and whinchat (*Saxicola rubetra*) (Pedersen and Krøgli, 2017), showing their preference for these open grassland areas.

Decline of semi-natural grasslands in Europe

Many of these species were once relatively widespread in semi-natural grasslands across Europe but have now become rare or significantly reduced in population size (van Dijk, 1991; Bratli et al., 2011; Hovstad et al., 2018). The main factors contributing to this decline are the destruction and fragmentation of semi-natural habitats. Key changes in land use that have negatively impacted these habitats include:

- Altered grazing pressure - Reduced or intensified grazing affects the structure and composition of grassland vegetation;
- Abandonment of mowing for hay - Traditional hay meadows are increasingly replaced by other land uses;
- Ploughing and fertilization - Some areas have been converted to arable land, leading to habitat loss;
- Reduced wood cutting in sub-Alpine woodlands - This has altered the natural disturbance regime, allowing forest encroachment.

These changes have triggered ecological succession, resulting in the gradual transformation of semi-natural grasslands into other habitat types, ultimately leading to habitat loss.

Conservation and management of semi-natural habitats

To ensure the long-term preservation of these semi-natural ecosystems, it is essential to maintain the ecological processes that created them while addressing both ecological and cultural factors (Bengtsson-Lindsjö et al., 1991; Pickett et al., 1992; Heywood and Watson, 1995; Bele et al., 2024). The current shift in land use represents a break in a long-standing cultural tradition and a disruption of the disturbance regime that originally shaped these habitats. Effective conservation strategies include:

- Continued grazing by ungulates - Maintaining appropriate grazing intensity is crucial to prevent forest colonization and maintain open grassland conditions;
- Protection through designation - Large areas of the central mountain summer-farming region in Norway are now protected as National Parks and Landscape Protection Areas;
- Subsidies for grazing and summer farming - Targeted subsidies within these protected areas encourage the continuation of traditional land-use practices, ensuring that semi-natural habitats are maintained.

4. Financial analysis

Studies by Norum (1966) and Asheim (1985) demonstrated that mountain summer farming was more profitable than keeping cows exclusively at the main farm, but only when the available farmland in the valley was limited. In cases where sufficient farmland was available in the valley, farmers were advised to prioritize expanding their valley pastures rather than invest in mountain summer farming. Further research by Asheim et al. (2010) showed that mountain summer farming remained profitable under specific conditions:

- The cows calved in autumn;
- The cows were kept in the mountains for at least eight weeks;
- The milk was not processed on-site, it was delivered to a dairy for at least four weeks.

The governmental support provided for mountain summer farming was generally sufficient to cover the additional labour and maintenance costs associated with maintaining the mountain milking barn and chalet, particularly for farms practicing autumn calving. However, this support did not generate significant additional profit.

Asheim et al. (2014) further analysed the economics of seasonal cheese production in mountain areas, comparing it to alternative farming systems, including keeping cows at the main farm, investing in common pasture areas, or engaging in cooperative dairy farming. Their findings revealed several advantages of mountain cheese production:

- Enhanced milk quality - Cows grazing on Alpine pastures produced milk with higher levels of polyunsaturated fatty acids, conjugated linoleic acid (CLA), and various antioxidants, which improved the milk's processing properties and enhanced the flavour and nutritional profile of the resulting dairy products;
- Higher profitability - Seasonal mountain cheese production (over 70 days) was generally more profitable for both risk-neutral and risk-averse farmers. This was due to higher market prices for mountain dairy products, government subsidy payments for mountain farming, and an exemption for farm-processed milk from the national milk quota system;
- Risk factors - The primary risks associated with mountain cheese production included fluctuations in market prices, variations in milk yield and output, and political risks, particularly because profitability was strongly dependent on subsidies and premium payments.

Investments in farming cooperatives were found to be unprofitable due to lower subsidy payments than to individual farms. To further enhance the profitability of mountain summer farming, Asheim et al. (2014) suggested several strategies:

- Adjust calving times to align with the mountain grazing season;
- Introduce fertilized pastures or night pens to extend the grazing period;
- Provide supplementary feeding to maintain milk yields during the mountain grazing period.

5. Landownership in the mountain summer farming region of Norway

Land tenure in the mountainous regions of Norway has evolved over centuries, resulting in a complex history of land ownership (Sevatdal, 1998; Sevatdal, 2006). Today, three main categories of common land ownership are particularly significant in the mountain regions of Southern and central Norway:

State Common Land (Statsallmenning)

State Common Land accounts for nearly 8.2% of Norway's total area (Sevatdal, 1998), with the majority of this land located in mountainous regions. In these areas, activities such as hunting, fishing, and summer farming above the forest line are regulated and managed by a regional board of local residents, known as the Fjellstyret, which is appointed by the municipal council. The Fjellstyret plays a crucial role in the management of several important summer farming areas, including Einunndalen and Grimsdalen. For areas below the forest line, where some farms may hold rights to timber or firewood, management decisions are made by a separate group elected by the rights holders.

The legal framework governing State Common Land dates back to medieval times. The fundamental principle is that the right to traditional resource use in a specific area belongs to the local community, typically a local settlement (Bygd), which is an area smaller than a municipality. However, these usage rights are limited by the concept of "household needs." This means that resources cannot be extracted for commercial sale outside the local community. For example:

- Milk and meat produced in the area can be sold;
- Rights to summer farming, fishing, hunting, and grazing are tied to specific farms and cannot be sold separately;
- Ownership of any buildings on the land is also tied to the farms and cannot be transferred independently.

Local Settlement Common Land (Bygdeallmenning)

Local Settlement Common Land is collectively owned by the local farmers within a community, although others may have specific usage rights, such as grazing rights. All decisions regarding the management of Local Settlement Common Land are made by an elected board of farmers who hold rights to the land. Unlike State Common Land, fishing and hunting rights in these areas can be sold or leased to individuals outside the local community.

Jointly Owned Common Land (Sameige)

Also known as 'land jointly owned by farm units', Jointly Owned Common Land is entirely private. No public institution, whether at the state or municipal level, has any authority over the management of these lands. Such lands are typically found in outfield areas and are relatively rare in forested regions with timber resources. However, in the mountainous regions of Southern and Western Norway, Jointly Owned Common Land is the dominant form of land ownership.

6. Future opportunities and threats

In 2022, there were 742 active summer farms in Norway, with 865 holdings having either full or partial ownership of a summer farm (Photos 6, 7 & 8). At the same time, there were 6,732 farms with dairy cows and 268 farms producing goat milk. This means that around 11% of dairy cow farms and 40% of dairy goat farms maintained a summer farm or had a share in one (Landbruksdirektoratet, 2023). Dairy cows typically spend less than 15−20% of the year on summer farms. Assuming the daily milk yield at summer farms matches the annual average, this means that less than 2% of the country's total annual cow milk production currently comes from summer farms.

Photos 6, 7 & 8. Modern Norwegian mountain summer farms. Top Left: Herdalsetra, goat summer farm located in Møre og Romsdal (2012). Top Right: Kvanndalsetra, summer farm in Geiranger, Møre og Romsdal (2012). Bottom: Cow summer farm in the Eastern part of Dovre plateau in Innlandet County (2024) (All photos © P. Thorvaldsen)

Several factors have contributed to the decline of summer farming, yet some farmers remain resilient, and some summer farms continue to operate. The key questions are: What characterizes these remaining summer farms, and what does the future hold for the mountain summer farming system in Norway?

One critical factor is access to high-quality pastures, ideally located near a road and with access to electricity. Most active summer farms remain family-operated businesses, with milk collected by truck and delivered to a central dairy plant. However, there may be opportunities to develop specialty dairy products and services for sale in local markets or to mountain hikers.

In the 19th century, both Norwegian and foreign tourists began to explore Norway's mountains. The Norwegian Trekking Association was founded in 1868 to promote mountain hiking and outdoor activities. Summer farms provided shelter and food for these mountain hikers, as well as for hunters and other visitors, even outside the grazing season. Over time, some summer farms began to rent out cabins to tourists, whereas others sold or leased plots for cabin construction. In some areas, summer farm regions have evolved into cottage towns, leading to conflicts between those who wish to preserve grazing land and cabin owners (Strand et al., 2021). This is part of a broader conflict over the use of outfield areas in Norway.

For the mountain farming system to survive, dairy farmers must be genuinely interested in this form of farming. Cost is another crucial factor. When multiple farms collaborate on a single summer farm, they can reduce capital and labour costs per cow and per litre of milk due to economies of scale. Each summer farm receives an average of approximately NOK 90,000 (€8,000) in annual government support. In 2022, total support for summer farms amounted to NOK 67 million (€6 million). This support is part of the regional environmental programs funded by the central government and administered by the county governors. Payment criteria vary between counties. In Innlandet County, for example, support is provided if milk is produced at the summer farm for more than four weeks, is delivered to a dairy or processed on-site, and meets a minimum production threshold (Statsforvalteren i Innlandet, 2024).

Farms with summer farms tend to be smaller than other milk-producing farms. A relatively high proportion of these farms are organic, and many maintain breeds considered worthy of preservation. These include older regional breeds adapted to local pastures, such as Telemarksfe, Vestlandsfe, and Nordlandsfe. These breeds are generally smaller and have lower yields than the dominant Norwegian Red breed. Special support payments are available for farmers who maintain such heritage breeds.

Few summer farms have transitioned to free-stall systems for cattle (Bunger and Haarsaker, 2020). Norwegian regulations will require cattle to be kept in free-stall systems starting in 2034, with mandatory pasture access for a minimum number of weeks. However, exceptions may allow farmers to maintain heritage breeds in tie-stall barns even after 2034 (Forskrift om hold av storfe, § 28). This could influence the future of summer farming.

While the total number of milk producers in Norway has been declining for many years, the percentage of those with summer farms has remained relatively stable over the past two decades. This suggests that the number of milk producers will be an important factor in the future of summer farming. Profitability in milk production and the investments required to comply with future animal welfare regulations—particularly the free-stall system—will also be significant.

A recent working group, including representatives from the Agricultural Authority (Landbruksdirektoratet), the Directorate for Cultural Heritage (Riksantikvaren), and the Norwegian Environment Agency (Miljødirektoratet), has analysed the situation of summer farms and identified reasons for preserving the system. The group emphasized the value of milk from cows grazing on natural pastures and highlighted the multifunctional benefits of summer farms. Currently, milk produced at summer farms is mixed with milk from other farms at the dairy, which means its unique qualities are lost. To preserve these qualities, separate processing of summer farm milk may be necessary, with small-scale cheese production as one potential solution.

The working group recommended maintaining the current number of active summer farms and emphasized that direct financial support should remain the primary tool for promoting their survival (Landbruksdirektoratet, 2023).

Research by Vennesland and Veidal (2021) found that many tourism businesses believe active summer farms attract tourists and boost off-farm economic activities. In this sense, active summer farms generate positive external effects.

Norway has long been home to several large predators, including brown bears, wolves, wolverines, lynx, and golden eagles. Among these species, Norway serves as the primary habitat for wolverines, whereas Sweden and Finland are more significant habitats for bears and wolves. These predators have historically posed a threat to farm animals, with red foxes—though only partially protected—also being capable of killing lambs.

Over time, these predators have received varying degrees of legal protection in Norway. Golden eagles were first protected in 1968, followed by wolves, brown bears, and wolverines in 1973, and lynx in 1992. As part of this protection strategy, payments for killing these predators were largely abolished (with a few exceptions). Today, Norway's predator management policy aims to maintain sustainable populations of these protected species.

Regulation of predator populations is achieved through licensed hunting (for wolves, wolverines, and brown bears) and quota hunting (for lynx). In addition, predator management areas have been established. Within these designated areas, predators receive stricter protection compared to areas outside.

Farmers are eligible for compensation payments for livestock lost to protected predators. However, the documentation requirements are strict, often leading to disputes, particularly involving sheep farmers and reindeer herders. Among the main predators, golden eagles, wolverines, and lynx are generally not considered a significant threat to cattle. The risk to dairy cows and goats on mountain summer farms is also relatively low because these animals are milked daily and can be kept indoors or within fenced enclosures at night if necessary.

Whereas brown bears and wolves are capable of attacking cows, their populations are not considered large enough to pose a serious threat to the continued development of the mountain summer farming system. However, their presence may force some sheep farmers to switch to dairy sheep farming, though this trend has not yet been widely observed. In some cases, sheep farmers have transitioned to cattle farming, either with dairy cows or suckler cows, as an alternative to traditional sheep farming (Finset et al., 2011).

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Afterword

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I hope in the reading of this book, like me, you have been captivated by the richness, rhythm, flow and patterns that transhumance demonstrates and shapes.

Transhumance is a social-ecological system that encompasses ancient practices that have shaped landscapes, and societies over millennia, leaving a deep legacy. Ancient routes traversed by generations of people and livestock are imprinted into the landscape, natural vegetation has evolved, and cultural traditions embedded.

The practice of transhumance is context specific so there are many ways of 'flowing'. Common functions desired are feed for animals, human food security, and family livelihoods. However, as the cases testify, there are so many more intangible benefits beyond these principal functions. The natural grassland habitats offer unique biodiversity and landscapes. These are living landscapes that confer cultural identity including culinary traditions and a sense of place. Social networks are strengthened enhancing that sense of identity and wellbeing of local communities.

Sheep, goats and cows all have the marvellous ability to thrive on grasslands. If you can feed an animal on forage derived from grassland, then feed costs are minimal. However, the ability to do this is dependent on access to grass and its products all year around. Enter the ability to move animals to where the grass grows. Transhumance works because of the inherent natural variability present in the landscape. The geomorphology and climate offer a vast heterogeneity that can be utilised to deliver the principal functions sought.

There are basic requirements for a transhumance event to be successful including: unimpeded access to land and water, safe passage to your destination, local knowledge of the state of the resource and routes. This needs collective alliances, sharing of knowledge, an understanding of protocols and rules and superb organisational skills. This in turn is underpinned by trust.

A key insight for me, in reading the rich history that has shaped transhumance practice, is the resilience of the systems and the ability of different generations to adapt and evolve with nature and societal challenges, for there have been and continue to be many. Wars and revolutions, changes in land ownership and tenure, with the resulting loss of common lands, increased competition for land use disrupting migratory routes and increasing tension between those practicing transhumance and others utilising the same environment. Currently, there are other challenges that offer both opportunities and risks, principal among these is climate change that is impacting on the availability and quality of grasslands and water. The variability in weather requires close attention to the state of the resources for planning purposes. Technology can be an asset assisting in real time weather updates and remote knowledge of grassland state. Technology in the form of transport can shorten the time taken to reach a destination and may reduce the tension with other land uses as animals no longer walk and graze through the landscape en route. This comes with an increased cost for running vehicles and means that the manure transfer at stopping points along the route no longer happens, neither does the grazing of roadside verges and understoreys of forest occur. This reduces the benefits of 'free' fertiliser and reduction of biomass that if left unchecked can become a fire hazard.

Most of the farms that practice transhumance are family farms where farming is now only one economic activity, as many farmers and their relatives have secondary jobs. A rural exodus is occurring, and succession is an issue since young people migrate to the urban centres that allow access to services compared to the relative isolation of the farming community. In all the cases, the decline of this rich cultural heritage appears to be inevitable but the scenarios for the future continue to demonstrate the resilience of these systems.

Transhumance contributes to inclusive sustainable development. Livestock graze on natural grasslands and maintain eco-system services particularly the maintenance of landscape vista, and biodiversity. In turn, the meat and milk products have qualities related to the diet of the animals and these qualities can be marketed to local consumers and tourists to gain added value. This in turn along with reduced costs, compared to purchased feed, will increase the profitability of the family farm, making it more attractive to the young. The continuation of transhumance cultural practice offers the opportunity to attract tourists to contribute economically to the local community through providing events including, festivals, local culinary traditions, and guided walks along transhumance routes. Care will be needed to manage the unintended negative consequences of increased tourist numbers that may increase tension around land use and degradation of the local environment. Collective alliances have worked in the past and the rise of tourism in these mountain landscapes offers an opportunity for new collaborations across the different actors associated with the mountains that can deliver environmental, economic and cultural outcomes to local communities.

The creation of national parks that recognise and respect the role of transhumance in maintaining the landscape while mitigating the potential for wildfires and paying farmers for that service can help secure the practice. The recognition by UNESCO of transhumance as an Intangible Cultural Heritage of Humanity certainly serves as a global acknowledgment of the importance of preserving and celebrating transhumance for generations to come. These two examples of recognising the contribution beyond food production is required by policy makers so that financial and other policy recommendations can influence the whole socio-ecological system that is transhumance along with empowering the local communities to add value. I remain optimistic that the system that is transhumance will continue to evolve and play a part in maintaining the well-being of the planet and people.

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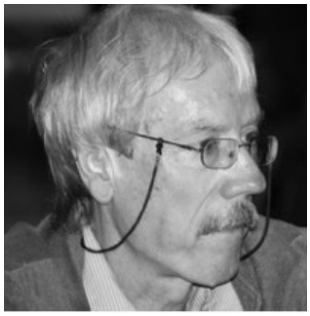
	CABANNES, Noémie: Territorial engineer, project officer for the Intercommunal Pastoral Pact for the Causses Aigoual Cévennes Terres Solidaires Community of Communes, France, pactepastoral@cac-ts.com After completing both technical and academic studies (Master's degree from InstitutAgro Rennes-Angers), and holding various positions as an advisor to livestock farmers, trainer, and coordinator of a certificate program on sheep farming, I have been leading the Intercommunal Pastoral Pact since 2017. I work with elected officials and a network of stakeholders to implement actions aimed at preserving and revitalizing pastoralism. In particular, I focus on: mobilizing land and engaging with landowners, integrating pastoralism into urban planning documents, raising awareness and recognition of pastoralism among residents and elected officials, and restoring and maintaining transhumance routes.
	CARREIRA DOS SANTOS, Luís Felipe Neves: Professor, at the Polytechnic Institute of Tomar and Researcher at the Geosciences Centre, Coimbra, PORTUGAL, lsantos@ipt.pt Biologist, graduated from Napier University, Scotland, Master's Degree from Leiden University, Netherlands and PhD from Ferrara University, Italy. Participated and coordinated several EU projects. Professionally, held positions as Course Leader and Director of the Institutional Research and Innovation Office. Scientifically, an editor, reviewer, and author of several papers in various recognized journals. Member of the Co-management of Paul do Boquilobo Nature Reserve and the Natural Park of Serras D'Aire and Candeeiros. Currently developing research in mountain Protected Areas, focusing on sustainability-related problems, management and adaptation strategies.
	CASTRO SUÁREZ, Eduardo: President of the Asociación Urpichallay AMDES, Lima, Peru, castroeduardo95@gmail.95 I am a professional graduated in Zootechnical Engineer with a Master's in Andean-Amazonian Agriculture and 30 years of experience managing conservation and rural development projects. Specialized in high Andean regions and indigenous communities, focused on biodiversity and water source conservation. Currently researching high Andean grassland preservation and indigenous traditional knowledge recovery for biodiversity protection. Co-author of conservation and research publications, educated at Universidad Nacional Agraria La Molina and Universidad Nacional Agraria de La Selva.
	CHEDID, Mabelle: Independent Researcher, Animal Scientist and Farming Systems Specialist, TLS, Poland; Envir. & Sust. Develop. Unit, Fac. Agric. & Food Sci., AUB (American Univ. of Beirut), Lebanon, mabelle.chedid@gmail.com I am a researcher and consultant with more than ten years of experience in community development, women and youth empowerment and refugees support. I hold a master degree in Animal Science from the American University of Beirut, and a PhD degree from AgroParisTech, France. My research interest includes livestock production systems, small ruminant value chain and agro-pastoral communities' development, relation between local food systems, traditional foods and food security. My work combines research and development with focus on adaptation strategies and mitigation.

	CORONATO, Fernando: Geographer, retired from CENPAT (National Centre of Patagonia), Puerto Madryn, Argentina, fernandocoronato1@gmail.com My first professional interest was climatology and its interactions with the physical environment and vegetation in Patagonia, topics on which I worked for four decades in research groups at CONICET. As a geographer, I was also interested in the adaptation of human settlement to a harsh environment like Patagonia. This led me to study the territorial occupation, (i.e. geo-history) of this region, which took place mainly through sheep farming from 1880 onward. I also taught climatology at the University of Patagonia until my retirement. I have published many articles in international scientific journals as well as some books on Patagonia geography.
	CUELLAR CONDORI, Nestor Edwin: Researcher in water and soil management at the National Institute of Agrarian Innovation (INIA) and ILLPA Agricultural Experimental Station, Lima, Peru, ncuellar07@gmail.com I am a soil, water, and crop researcher specializing in investment projects, agricultural innovation, and agroecology. I am an agricultural engineer with a master's degree in agricultural innovation for rural development from the National Agrarian University of La Molina (Peru). As a researcher, I have conducted research on quinoa crops. I have led development projects in collaboration with NGOs and the public sector at the local level and in the Southern region of Peru. I currently work as a research and technology transfer specialist at INIA at the ILLPA Agricultural Experimental Station.
	CUPIDO, Clement: Ecology, Researcher at the Agricultural Research Council of the University of Western Cape, South Africa, ccupido@uwc.ac.za I am a rangeland ecologist. My work focuses on Southern Africa's arid environments, collaborating with rural livestock-dependent communities. With an MSc from Stellenbosch University, I take an interdisciplinary approach, partnering with social scientists and economists. Beyond ecology, I'm passionate about anthropology and community development, especially in Namaqualand, where I mentor agricultural groups. My research highlights how pastoralists blend traditional and modern knowledge for sustainable resource management. I have presented nationally and internationally, co-authored publications, and serve on the Gouritz Cluster Biosphere Reserve board, advocating for resilient rural futures.
	DAOUD, Ibrahim: Scientist in water and soil management, Desert Research Centre (DRC), Cairo, Egypt, ibrahim_daoud@yahoo.com I am a researcher at DRC (Desert Research Center) in Egypt. I Graduated from AgroParisTech-France with a PhD in Agroecology, and a BSc and MSc in soil and water science, I have more than 26 years of work experience in research and development projects in dry and wet regions, I worked with many research and development organizations, such as CIRAD, WB, WFP, ACF, FAO, GIZ, ACSAD, AICS and EU, in Egypt and many Arab countries. I was involved in practical development projects and research in conserving natural resources (soil, water, vegetation) and livestock sector development. I used GIS and remote sensing in vegetation coverage, land degradation, hydrology, land use land cover change, etc. I have published 26 articles in peer-reviewed international scientific journals.

	DING, Luming: Professor, College of Grassland Resources, Southwest Minzu University, China, dinglm@swun.edu.cn I am specialised in rangeland management. My PhD studies were on yak grazing behaviour in the Alpine grassland of Qinghai-Tibetan Plateau. Then my research focused on how to improve the grazing efficiency in yak management in Alpine grassland ecosystems, such as by the early introduction of weaning yak calves, rotational grazing and intelligence techniques. The impact of grazing on ecological functions, such as biodiversity, carbon sequestration, is also a major focus of my research. Many results have established the positive effects of appropriate grazing on Alpine grassland. I have published more than 60 peer-reviewed articles.
	EL AAYADI, Soufiane: Lecturer-Researcher, Hassan II Agronomy and Veterinary Medicine Institute, Rabat, Morocco, s.elaayadi@iav.ac.ma My research focuses on the global and dynamic analysis of livestock system performance in response to changing contexts, as well as the development of technical innovations to enhance productivity. I have a particular interest in small ruminant pastoral systems in mountainous areas. I have published over 10 articles in peer-reviewed journals. Since 2017, I have led and contributed to multiple research projects on the resilience and sustainability of small ruminant and camel production systems. Additionally, I have provided expert consultancy for various national initiatives.
	FASOILI, Enzo: Independent Researcher, Santa Cruz, Argentina, enzofasioli@gmail.com I am a renewable natural resources engineer with a PhD in Geography, specializing in the use of natural and social resources in arid-zone agricultural systems. Early in my career, I focused on topics related to territorial planning, making specific contributions to sheep farming in Argentine Patagonia and its associated supply chains. Subsequently, I worked as an extension agent for sheep farming systems at the National Institute of Agricultural Technology (INTA) in Puerto Deseado, Argentina. This experience led me to study the challenges faced by livestock systems from a social sciences perspective in Southern Patagonia, Argentina, aiming to address the issues affecting agricultural production and productivity. Currently, I work as an independent researcher and livestock producer.
	FAYE, Bernard: Veterinarian specialized in tropical veterinary medicine, and independent international camel expert, bjfaye50@gmail.com I stayed eight years in Africa (Ethiopia, Niger) for research and development activities (1975–83) before joining the National Institute of Agricultural Research (INRA) as Eco-Pathology Laboratory Director. I then joined the Centre for International Cooperation in Agricultural Research for Development (CIRAD) as Head of the Animal Productions Program (1996), then as scientific project manager (2007). My interest in camels started with a focus on mineral metabolism in Ethiopia in 1975. I founded the International Society for Research and Development on Camelids (ISOCARD). I worked in Saudi Arabia as FAO consultant in a camel research centre (Al-Jouf, then Al-Kharj) in 2010–15. Author of more than 450 scientific publications, 340 communications in national and international conferences, 45 books and book chapters (notably on camel production, camel farming, camel physiology and camel

	welfare), 210 technical reports and 12 scientific editions. My last book (Large camelids farming) was translated into French, Turkish, Arabic, Spanish, Kazakh and Russian.
	GEBREMICHEL, Hagos Fikre: Academic Chief Technical Assistant in Mekelle University, Mekelle, Ethiopia, fikregis@gmail.com I have graduated from Mekelle University in (Ms'c) in Geoinformatics, BS'C in Computer Science, BSc in Management Information System (MIS) and BA in General Managements (2017-18, 2015, 2010 and 2008). I have more than 17 years' work experience in different organization in Tigray Ethiopia. I have been involved in practical teaching and research in different fields using GIS and remote sensing applications (Geospatial Data Analysis) and ICT equipment on urban expansion, vegetation coverage, land-use, land cover change, etc. I have published four articles in peer-reviewed international journals.
	GEBREMIKAEL, Mulubrhan Balehegn: Researcher and educator in animal and environmental sciences with over 18 years of experience across Africa, Asia, and North America, mulubrhanbghz@gmail.com My work focuses on sustainable livestock systems, animal nutrition, climate change, and environmental resilience. Currently, I serve as a Research Associate II at the World Resources Institute and as Adjunct Faculty in Agriculture and Environmental Sciences at Unity Environmental University. My research and teaching emphasize silvopasture, agroecology, and climate-smart agriculture—aiming to enhance food security while reducing greenhouse gas emissions. I have led and coordinated, multi-country research and development projects—funded by organizations such as USAID, Gates Foundation, FAO—that have improved productivity and climate resilience for thousands of smallholder farmers and pastoralists in East Africa and the Sahel.
	GRIJALVA OLMEDO, Jorge Eduardo: Professor & Researcher, Faculty of Veterinary Medicine and Zootechnics, Central University of Ecuador, Ecuador I am a researcher in pasture and livestock, ruminant nutrition and advanced pasture management in temperate and tropical regions. I have contributed to the assessment and sustainable use of forest genetic resources, to the analysis of relationships between climate change, natural resources and agriculture in the Andes and Amazonia, and to the analysis of integrated systems of land use and sustainable use of tropical forests in the Ecuadorian Amazon.
	HAMADEH, Shady: Professor of animal sciences at the American University of Beirut, Lebanon, since 1988, shamadeh@aub.edu.lb I have held various administrative positions within the Faculty of Agricultural and Food Sciences. My research interests range from animal–environment interactions to sustainable food systems leading to over 100 international publications as books, book chapters and peer-reviewed articles. I have co-founded and have been leading the award-winning Environment and Sustainable Development Unit (ESDU) since 2001, an initiative transforming food and agriculture, implementing multimillion-dollar rural research and development projects in Lebanon and the region.

	HEGRENES, Agnar: Senior Research Officer, Norwegian Institute of Bioeconomy Research (NIBIO), Ås, Norway, agnar.hegrenes@nibio.no I am an agricultural economist with a PhD in agricultural economics. My special interests have been production economics and the relationship between agricultural policy and farm profitability. I am also interested in technological development and changes in agriculture and society. Most of my career was at NIBIO and its predecessors, where I was responsible for several research projects. In some projects I worked closely with scientists in animal science and crop production. Since I retired in 2015, I have worked on a part time basis for NIBIO.
	HINTSA SBHATU, Kidane: Lecturer and researcher, Department of Animal, Rangeland and Wildlife Sciences, Mekelle University, Tigray, Ethiopia, kidanehintsa@gmail.com I am an animal scientist, with research interest in animal production and nutrition, rangeland ecology and management. I have conducted researches focused on conservation status of livestock feed resources, utilization of non-conventional feed resources, livestock production and management systems and rangeland condition assessment in highland and pastoral areas. Recently, I have investigated the effect of an invasive species, *Prosopis juliflora*, on animals and productivity of rangelands. In this research, I have been able to investigate the nutritional and feeding values of *P. juliflora*, and controlling it through utilization as animal feed.
	**HUBERT, Bernard**: member of the French Académie d'Agriculture, Emeritus Senior Scientist at INRAE, Prof. at EHESS, France, Bernard.hubert@inrae.fr Trained as an ecologist, my work has broadened as I have questioned the role of human activities in this setting, seeking to understand the contribution of the social sciences to issues in the life sciences. I wrote about 110 papers in scientific journals, 100 book chapters, edited or co-edited 28 books, and supervised 26 PhD theses. I worked as lead author for the “Natural resources use regimes” of the “Global” report of IAASTD. I have been chairing since 2010 the French Commission for International Agricultural Research (CRAI), which groups four French research organizations and three ministries. I was a founding member of the journal *Natures Sciences Sociétés* (EDP Sciences) which was launched in 1993, and remain one of its chief editors. I am chairing the Scientific Committee of the journal *Cahiers Agricultures* and I am also an Associate Editor of *The Rangeland Journal*.
	JABER, Lina S.: Lecturer in Animal Science at the Faculty of Agricultural and Food Sciences at the American University of Beirut (AUB), Lebanon I hold a BS in Agriculture and an MS in Animal Science from AUB and a PhD in Animal Science from AgroParisTech, France. I wrote more than 30 articles published in peer-reviewed scientific journals. One of my focuses is to teach across disciplines. My scientific interests include circular agriculture, the small ruminant sector from physiology to production and value chain considerations, in addition to the wider scope of food security and sustainable development under climate change especially in arid and semi-arid regions.

	JOFRÉ, Gabriel: Werken or Traditional Authority of the Malaweche Territorial Identity Organisation / spokesperson for Mapuche-Pehuenche communities, Argentina, jofregabriel1@gmail.com I am the representative of the Mapuche community of Malargüe, in the province of Mendoza, Argentina. I am a defender of the traditions and beliefs of my people. I am an activist, historian, and educator dedicated to preserving and recovering the history and cultural heritage of the transhumant peoples of Puelmapu.
	KONUPATEVA, Gaukhar: Professor of Food Biotechnology at Al-Farabi University, Almaty, Kazakhstan, FAO consultant, konuspayevags@hotmail.fr I graduated from the University Al-Farabi at Almaty (Master) and the University of Montpellier (PhD in Food Sciences; HDR). I worked for FAO in Saudi Arabia at the Camel Research Centre in Al-jouf (2010−12), then at the Kharj Centre (2012−15) where I developed extensive work on the composition and processing of camel milk. Then I carried out extensive expertise on this subject in Kazakhstan, Morocco and Mauritania with FAO, Tunisia for the private sector, and participated in numerous international conferences, organizing the 4th International Society of Camelid Research and Development (ISOCARD) conference at Almaty in 2015. I am also partner of EU project CAMELMILK (PRIMA program). In 2021, I was a visiting researcher at CIRAD on the topic of the development of the camel milk sector within the MAKit program. In 2022−24, I worked again for FAO in the Sultanate of Oman on camel cheese processing with Rakhyut Women Association. I am at present leader of the program Camel Sector Development in Kazakhstan. I am also an expert for camel milk international standard implementation at ADAFSA (UAE). I was elected among the top 50 scientists in Kazakhstan.
	LEENHARDT, Christine: Nurse and sheep farmer, Valleraugue, Cévennes, France, moulindelabecede30@free.fr Born at the end of the 1950s in Alès in the South of France. I grew up there then moved to La Grande Motte, also in the South of France. I was a nurse. Then my meeting and mariage with Rémi Leenhardt led me to become also a farmer and shepherdess, active in both market gardening and sheep herd management. I raised our two kids. I am a key player in transhumance to Mt Aigoual, Cévennes, providing a large part of the logistics when my husband leads the herds to the Alpine meadows.
	LEENHARDT, Rémi: Sheep farmer, Valleraugue, Cévennes, France, moulindelabecede30@free.fr I grew up in Marseille in the South of France. In 1981, like many young French people at that time, I decided to take over, with my wife, who is a nurse, the family farm located in Valleraugue, at the foot of Mont Aigoual in the Cévennes Massif, in the southeast of the Massif Central, France. After engaging in various agricultural and livestock activities, I specialized in sheep production with a flock of Rayole breed sheep. I have been heavily involved in progressive trade union movements, often going against the established order. I was a key figure in the Cévennes Pastoral Pact, a structure bringing together all stakeholders involved in the region. I am considered a stakeholder in transhumance at Mont Aigoual and in the Cévennes.

	LONG, Ruijun: Professor, Lanzhu University, Gansu Province, China, Longrj@lzu.edu.cn I finished my PhD studies at Gansu Agricultural University, China, in 1995, and postdoc research at Rowett Research Institute, UK, in 1997–99. My research focuses on understanding how natural and social factors interact in response to ecosystem services including livelihood and food security in the Asian Highlands, and identifying actions and pathways to increase the resilience of pastoral systems to cope with climate change. I have published over 500 peer-reviewed articles, and supervised the graduation of over 120 MSc and PhD students.
	LOPES, Vasco Augusto Amaro: Guest Lecturer at the Polytechnic Institute of Tomar (IPT), Portugal, Santiago de Compostela, Spain, vasco.augusto@rai.usc.gal I hold a PhD in History, Geography and Art History from the University of Santiago de Compostela on integrated landscape research, and a Master in Geographic Information Systems specialized in Planning and Territorial Management from the Polytechnic Institute of Tomar. I am a member of the National Republican Guard in the Nature and Environment Protection Service. Currently, I am a lecturer of different courses in areas such as GIS modeling, forest management and environmental hazards. My research interests focus on landscape analysis and natural resource modeling. I have published several scientific peer-reviewed articles and actively participated in EU funded projects.
	LUCIAN, David: Researcher, Institute of Ethnography and Folklore Constantin Brăiloiu of the Romanian Academy, Bucharest, Romania, david_lucian@yahoo.com I completed my bachelor's and master's degrees in Geography followed by a PhD in Ethnography. Additionally, I conducted postdoctoral research on cultural studies, completing a thesis titled "Cultural Landscape: Sustainable Development of the Pastoral Landscape in the Rucăr-Bran Corridor". Currently, I work as an ethnographer and serve as an expert on the National Commission for the Safeguarding of Intangible Cultural Heritage of the Ministry of Culture. With over 25 years of experience in researching folk culture, I have focused on traditional occupations (shepherding), cultural and ethnographic landscapes, vernacular architecture, etc. I was also part of the team that contributed for Romania to the multinational dossier "Transhumance, the seasonal driving of livestock", submitted to UNESCO with nine other countries and subsequently inscribed in the Representative List of the Intangible Cultural Heritage of Humanity.
	MADANI, Toufik: Senior lecturer, Department of Agriculture, University of Ferhat Abbas – Sétif 1, Algeria, t.madani@univ-setif.dz, madam2000dz@yahoo.fr I am a researcher studying the livestock systems in the Mediterranean. My primary interests focused on the assessment of local breeds' performances. I also investigated the diversity of production strategies of small-scale family farms using multiple species in agro sylvo pastoral systems. Subsequently, I analysed challenges and coping strategies of mixed crop-livestock systems in semi-arid areas subjected to frequent droughts. More recently, I have been exploring livestock value chain diversity and organisation in pastoral and agro pastoral areas and the roles of innovation.

	MARAVAL, Marie-Cécile: Editor, retired from CIRAD, Montpellier, France, mariececile.maraval@free.fr I lived for 14 years in the USA where my last job was Fiscal Coordinator at the University of Pennsylvania in the Department of Biochemistry and Biophysics. Upon returning to France I was Publishing Coordinator and Editor of the *Revue d'élevage et de médecine vétérinaire des pays tropicaux* at CIRAD from 1996 to 2023; since then I retired.
	MOUSSA, Abdelhafid A.: Former Dean, Faculty of Natural Resources and Environmental Sciences, Libya, Omar Al-Mukhtar University, Boeda_5@yahoo.com I am at Omar Al-Mukhtar University, Libya, former Dean of the Faculty of Natural Resources and Environmental Sciences. I hold a PhD from Alexandria University, Department of Soil and Water. I have 40 years of experience in the Ministry of Agriculture and at the university. I also was the Libya focal point for the Regional Activity Center for Specially Protected Areas (SPA/RAC). My numerous research activities are in the fields of soil, water and environment. I have participated in many conferences, seminars and workshops, as well as in scientific and research committees. I have supervised several master's theses, and I have been an editorial member of several scientific journals and a reviewer of research publications.
	NTASSIOU, Konstantina: Dr Rural and Surveyor Engineer, Hellenic Ministry of Culture, Athens, Greece, kntassiou@gmail.com I hold a diploma in Rural and Surveying Engineering from the Aristotle University of Thessaloniki (AUTH), an MSc in Environmental Protection and Sustainable Development from the same institution, and a PhD focused on the Historical GIS (AUTH). A key aspect of my work involves the evolution of transhumance practices and mapping/analyzing traditional transhumance routes. I have been a contract lecturer at Greek universities and an Associate Researcher in research groups at universities abroad, e.g. University of Bristol, UK, and Université Catholique de Louvain, Belgium.
	OLIVERA VILCA, Socrates: Director of the Soil and Water Project at the Institute National for Agrarian Innovation (INIA), Lima, Peru, solivera.ambiental@gmail.com I hold a Master's degree in Environmental Sciences and Accounting / Administration, specializing in Public Management, and a Doctorate in Science, Technology, and the Environment. As an agricultural professor, I have taught courses on natural resources at both undergraduate and graduate levels. Over the course of 20 years of professional experience, I have led development projects and public policies in sustainable soil, water, and forestry management in High Andean regions. I have collaborated with FAO and worked with conservation committees in rural communities in Puno and Ayacucho, in addition to participating in social management in areas with mining activity and in disaster risk management.

	OPPLERT, Marie Jeanne: Researcher, The Livestock Sustainability (TLS), Johannesburg, South Africa, marie.opplert@gmail.com Agricultural engineer, graduated from AgroSup Dijon, France, I completed a PhD in Environmental Policy and Development at the University of Brasília, Brazil, in collaboration with the French Agricultural Research Centre for Development (CIRAD). Researcher in sustainable development and agriculture with interests in public policy, international cooperation, and rural dynamics, and extensive experience in France, South Africa, and Brazil, I am currently an Associate Researcher at TLS, France.
	OSCANOA GAMARRA, Luis Lizardo: PhD in Animal Science, High Andean Ecohydrology Research & Professor at University of La Molina, Lima, Peru, oscanoa.luis@gmail.com I am a researcher in the conservation of high-altitude natural pastures, participatory research, and mountain cultures. Zootechnical engineer with a Master's degree in Nutrition and PhD in Animal Science from the National Agrarian University of La Molina, Peru. As a professor, I have taught scientific research methodology, grassland management and agroecosystems, among other subjects. I have led development projects in collaboration with NGOs and the mining industry. As an author and reviewer for indexed journals, I have contributed to scientific books, e.g. *Livestock Policy*. Currently, I work as a supervising specialist at the National Institute of Agrarian Innovation (INIA).
	PIRES, Paula Cristina: Professor at the Polytechnic Institute of Guarda (IPG), Portugal, paulapires@ipg.pt I completed a Postgraduate degree in Nutrition and Food Security at the Escola Superior Agrária de Viseu (2012), and a Master's degree in Tourism Management and Sustainability at the Guarda Polytechnic (2021). Currently, I am a PhD student in Tourism at the University of Aveiro. Since 2006, I have taught in the areas of hotel management, catering, and tourism. Between 2021 and 2023, I worked as a research technician at the Polytechnic Institute of Guarda. My areas of interest include tourism and hotel management, rural tourism, agrotourism, heritage, mountain territories (with a particular focus on pastoralism and transhumance), and agri-food products.
	POCCARD-CHAPUIS, René: Geographer, CIRAD, Mediterranean and Tropical Livestock Systems Research Unit, Paragominas-PA, Brazil, rene.poccard-chapuis@cirad.fr I was born and grew up in the village of Peisey, Savoie, Alps, France, in a breeders' family. My studies focused on cattle production chains (my PhD thesis), territorial development, and land use change, using geographical tools in research and development approaches. I am currently developing original research in three areas: (i) agroecological transition in livestock farming, (ii) reorganization of Amazonian rural landscapes to increase large scale efficiency, and (iii) territorial certification. My activities and methods are carried out in close collaboration with local farmers and local stakeholders. Based in Paragominas (Pará, Brazil) since 2014, at the Embrapa Center, I am also responsible for the Amazonian partnership research network Territórios Amazônicos. I am author of more than 350 referenced scientific publications, most of them concerning the Amazon Basin.

	RUIZ-PEYRÉ, Fernando: Geographer, Junior Group Leader at the Institute for Interdisciplinary Mountain Research of the Austrian Academy of Sciences, Innsbruck, Austria, Fernando.ruiz-peyre@oeaw.at I am a Human Geographer specializing in mountain and rural regions. My doctoral research focused on transhumant communities in Western Argentina. In subsequent projects, I explored conflicts related to natural resources. Currently, my research centres on social-ecological transformations, with a particular emphasis on mining conflicts in mountain areas.
	SAMUELS Igshaan: Animal Production Scientist, Agricultural Research Council - Range and Forage Sciences, University of the Western Cape, Bellville, South Africa, isamuels@uwc.ac.za I am a specialist researcher in rangeland ecology and pastoralism for the Agricultural Research Council in South Africa. I have worked in dry-land pastoral landscapes and biodiverse ecosystems for almost 20 years. My research focuses on livestock mobility dynamics of pastoralism, climate change adaptation and plant-animal interactions particularly in the arid zone and has led several international and national projects under these themes. I am currently the Global Co-Chair of the Global Alliance for the United Nations declared International Year of Rangelands and Pastoralists in 2026. I am also a member of the International Rangeland Congress continuing committee.
	SCHWEITZER, Alejandro Fabián: Professor and Researcher, Universidade Nacional de la Patagonia Austral and CONICET, Rio Gallegos, Province de Santa Cruz, Argentina, aschweitzer@uarg.unpa.edu.ar I am a principal researcher of the National Council of Scientific and Technological Research, based in the Santa Cruz Research and Transfer Center (CONICET-CIT SC) and a professor at the National University of Patagonia Austral (UNPA). I coordinate the group of studies on territories, power and ecologies from the South (CIT-SC) and I am co-coordinator of the CLACSO Working Group, Borders, Regionalization and Globalization. My doctorate (2000) is in geography and territorial planning with border integration mention. My main research line is space production and territory projects in Patagonia Sur (Chile-Argentina border in the South Andes) in the context of ecological transition
	SOTO, Oscar: Professor, Faculty of Political and Social Sciences - Universidad Nacional de Cuyo (Argentina), CONICET fellow, sotooscarhumberto@gmail.com I am a political scientist with a Master's in Latin American Studies and a PhD in Social Sciences. My expertise lies in public policies targeting rural areas, with a particular focus on the strategies of permanence and resistance among peasant and indigenous communities in Mendoza, Argentina, and across Latin America. My current research centres on territorial synergies within rural socio-ecological systems, land-use planning debates, and the defence of peasant rights. I have authored five books and published over 40 articles in international peer-reviewed scientific journals.

	SRAÏRI, Mohamed Taher: Professor, Hassan II Agronomy and Veterinary Institute, Rabat, Morocco, mt.srairi@iav.ac.ma I am an animal scientist, with interest in resources uses in crop/livestock systems. At the beginning of my research career, I have investigated smallholder dairy herds' performances. Then, I worked on the different facets of crop/livestock coupling in irrigation schemes, rain-fed plains, and high mountains. This has brought me to study water productivity (volumes, economic return) in agriculture. I have also developed research activities to characterize work uses in the Moroccan agricultural sector and its remuneration. I have led several international research projects on topics related to water, work and dairy production with colleagues from Algeria, Egypt, France, Italy, Tunisia, etc. I have been a consultant to many international organisations (AU-IBAR, FAO, GIZ, etc.) on topics such as livestock production in North Africa and its numerous roles. I have published more than 80 articles in peer-reviewed recognised scientific journals and serve on the scientific committees of international journals such as *Cahiers Agricultures* and *Revue d'élevage et de médecine vétérinaire des pays tropicaux*.
	STOICA, Valentina Ilinca: Lecturer, Faculty of Geography, Human and Economic Geography Department, University of Bucharest, Romania. Researcher, Interdisciplinary Centre for Advanced Research on Territorial Dynamics (CICADIT), University of Bucharest, Romania, valentina.stoica@unibuc.ro I have an interest in spatial planning and local development. During my doctoral and postdoctoral studies, I investigated the dynamics of some rural areas and local development policies. Over the years, I have been involved in various projects focused on spatial planning, rural development, and the urban-rural interface, among others, at different scales of analysis (local, national or international). My current research interests include small towns, urban expansion processes, socio-economic disparities, and local development in mountain areas. I have published over 50 scientific articles and more than 10 books or book chapters;
	STRANKMAN, Peggy: Ecology, Special Areas Enterprise, Calgary-AB, Canada, strankmanp@gmail.com Born and raised on a farm, producing crops and beef cattle. This was my first and excellent experience with agriculture. Earning a Master in Environmental Design at the University of Calgary, I worked for 20 years developing environmental policy for agricultural organizations in Canada. Now retired, I live in Southern Alberta and volunteer with conservation organizations. I'm also participating in diverse international research projects, mainly focused on cattle ranching in grasslands and rangelands, and involving several countries in the five continents. Beside my competence in nature conservation, I'm a stakeholder and expert in diverse cattle ranching systems.
	TELENCHANO, Andrès: Peasant Leader. andrestelenchano81@gmail.com Peasant Leader of the Organization of High Andean Communities of Chimborazo, whose mission is based on promoting community organisation through agricultural activities, micro-watershed management, health and nutrition. I am a specialist in the development of agroforestry systems and the management of Andean watersheds.

THORVALDSEN, Pål: Research Scientist, Department of Landscape and Biodiversity, Norwegian Institute of Bioeconomic Research (NIBIO), Trondheim, NORWAY, pal.thorvaldsen@nibio.no

I am a vegetation ecologist specializing in semi-natural habitats and the effect of management and climate change on biodiversity. In my research I have mainly been working with coastal landscapes and habitats along the coast of Norway. I have also been working with Human-Wildlife conflicts, monitoring and restoration of habitats for biodiversity, and management plans for the central and local government administration. Currently, my research focuses on protected agricultural heritage landscapes and developing methods to measure their value for biodiversity.

TOURRAND, Jean-François: Veterinary, TLS, retired from CIRAD and MAAF, Montpellier, France, tourrand@aol.com

During my 45-year career, I started as rural veterinary in diverse regions of France. After this first and very interesting experience, I have been a lecturer and researcher at various universities and research centers in Africa (Senegal, Egypt), Asia (China and Indonesia), North America (United States and Canada), South America (Brazil, Argentina, Uruguay, Ecuador, Peru and Colombia), and supervised or co-supervised in total around 50 PhD candidates. I have participated in the setting up and coordination of several European and international research and teaching networks. I have written, edited and co-edited fifteen books and nearly 200 articles related to research themes on techniques, performance and adaptation of livestock societies to global change.

VIRGHILEANU, Marina-Ramona: Lecturer and Researcher, University of Bucharest, Faculty of Geography, Bucharest, Romania, marinavirghileanu@unibuc.ro

I am a geographer with expertise in Earth observation, geospatial data processing and environmental hazard assessment. My work focuses on applying machine learning techniques for geospatial analysis, particularly in landscape dynamics, vegetation monitoring, and geomorphic processes studies. I have been actively involved in Horizon Europe and Erasmus+ projects, contributing to studies on natural hazards, climate change impacts, and predictive modeling of geohazards.

WEDDERBURN, Liz: lizwedderburn1@gmail.com

I have 40 years research and leadership experience in sustainable agriculture within livestock grazing systems. With expertise in pastoral ecology, sustainable farming, collaborative processes and systems-thinking. Using my integration strengths, I have developed and led trans-disciplinary research teams involving multi-stakeholder partnerships and formed collaborative models focused on outcomes. This has resulted in significant contributions to sustainable farming and rural communities, not only in New Zealand, but globally, especially in developing nations. Throughout my career, I have worked with Māori, the indigenous people of New Zealand, on land use and their ability to attain their aspirations through healthy land and water. Through this leadership, I have managed to influence the strategic direction of national and international science policy and agribusiness.

ZAMFIR, Daniela: Associate Professor, Faculty of Geography, University of Bucharest, Romania. Researcher, Interdisciplinary Centre for Advanced Research on Territorial Dynamics (CICADIT), University of Bucharest, Romania, daniela.zamfir@unibuc.ro

I am a geographer with a general interest in human geography, particularly in demography, spatial planning, and regional development. Since 1998, I have participated in numerous national and international projects in these fields. I have published over 55 articles in scientific journals, as well as 14 books or book chapters covering a range of topics, including small town analysis, suburbanization, and regional and local development.