Politecnico di Torino

Master's Thesis

Master of Science in Territorial, Urban, Landscape and Environmental Planning

Climate change in Langhe area

Case study: Alba

Supervisor:

Stefano Ferrari

Candidate:

Golbarg Morvarid

Academic Year:

2024/2025

Abstract

Tourism is a key economic and cultural driver for many rural and heritage-rich regions in Europe, and the Langhe area in northern Italy stands out as a prime example. Recognized by UNESCO for its vineyard landscapes and globally renowned for its truffles, wines, and culinary traditions, this region's tourism industry is deeply dependent on environmental conditions and seasonal rhythms. However, the increasing intensity and unpredictability of climate change pose significant challenges to the sustainability and resilience of this landscape-based tourism.

This thesis explores the relationship between climate change and tourism in the Langhe region, with a focused case study on the city of ALBA. The research aims to understand how climate change is already affecting tourism patterns, agricultural production, and stakeholder behavior, and what strategies can be developed to support long-term adaptation. The study begins with a comprehensive review of scientific literature on global tourism vulnerabilities to climate change, followed by a detailed analysis of climate data and environmental trends specific to the Langhe area.

The research methodology includes both qualitative and quantitative components: interviews with local experts, tourism operators, and municipal representatives in ALBA, as well as data analysis on temperature variations, extreme weather events, and seasonal visitor flows. These interviews revealed both positive and negative effects of climate change.

One of the key findings of this study is that, although awareness of climate risks is growing among local stakeholders, there is still a lack of systematic planning and coordinated adaptation strategies at the local and regional levels.

This thesis concludes with a series of planning and policy recommendations aimed at strengthening climate resilience in the Langhe's tourism sector. These include the integration of climate adaptation into local development plans, greater support for sustainable tourism practices, and enhanced collaboration between scientific institutions, municipalities, and private operators. Ultimately, this research contributes to a broader understanding of how small but iconic tourism regions can navigate the complex challenges posed by climate change.

Index

INTRODUCTION

1.1 Background and Importance of the Study

Climate change is one of the most pressing global challenges of the 21st century, affecting ecosystems, economies, and societies at all levels. (IPCC, 2022) Its impacts are wide ranging, influencing not only natural systems but also human activities such as agriculture, energy production, urban development, and tourism. In particular, the tourism sector is highly sensitive to both climate variability and long-term climatic changes (Scott et al., 2012).

Tourism depends heavily on the quality and stability of environmental resources, predictable weather patterns, and the accessibility of landscapes and cultural sites all of which are increasingly at risk due to climate change.

The effects of climate change on tourism can be both direct and indirect. Direct impacts include an increased frequency and severity of extreme weather events such as heatwaves, droughts, heavy rainfall, and storms that can disrupt tourism operations, damage infrastructure, and alter the natural environment that tourists seek to experience (IPCC, 2022).

Indirect impacts involve gradual changes, such as shifts in seasonal timing, rising average temperatures, ecosystem transformations, and biodiversity loss. These changes affect the desirability of destinations, the availability of services, and the behavior of tourists, thereby challenging the stability of local tourism economies (Scott et al., 2012).

Tourist areas located in rural and natural environments, such as the **Langhe region in northern Italy**, are particularly vulnerable. The Langhe, designated as a UNESCO World Heritage Site, is internationally renowned for its vineyard-covered hills, historical villages, and culinary excellence, especially its prestigious wine and truffle production (UNESCO, 2014).

The town of ALBA, in particular, serves as a cultural and economic hub of the region and is central to its tourism identity. With its annual White Truffle Fair, high-quality wineries, and historical architecture, ALBA has become a key destination for visitors from around the world.

However, the local tourism economy is tightly linked to agricultural production, climate-dependent natural cycles, and the preservation of the landscape. Climate change threatens this delicate balance by altering grape-growing conditions, increasing the frequency of extreme weather events, contributing to soil degradation, and impacting the overall environmental quality that defines ALBA and the Langhe's tourist appeal. (Bonfante et al., 2018).

In recent years, earlier grape harvests, reduced truffle yields, and increasingly unpredictable weather patterns have raised concerns among tourism operators and local institutions. (Bonfante et al., 2018).

Understanding the relationship between climate change and tourism in ALBA and the broader Langhe area is therefore of critical importance. Tourism is not only a vital source of income and employment for the region but also a key factor in maintaining its cultural identity and traditional landscape.

Without appropriate planning strategies, the effects of climate change could undermine the long-term sustainability of tourism development, leading to negative economic, environmental, and social consequences.

From a planning perspective, addressing climate change in tourism areas requires a multidisciplinary approach that integrates **territorial, urban, environmental, and landscape planning** (UNWTO, 2021). Planners and policymakers must develop adaptive strategies to protect natural and cultural resources, promote sustainable tourism practices, enhance infrastructure resilience, and ensure the economic viability of tourism-based communities.

By focusing on ALBA as a case study, this research aims to contribute to the broader field of climate adaptation in tourism destinations and provide practical planning insights that are locally grounded yet globally relevant.

Ultimately, this study highlights the urgent need for forward-thinking, place-based strategies that safeguard environmental and cultural assets while supporting the economic vitality of rural tourism destinations under climate stress (UNWTO, 2021).

The case of ALBA in the Langhe region serves as an emblematic example of how heritage, agriculture, tourism, and climate change are deeply interconnected and must be addressed holistically to ensure a resilient and sustainable future.

1.2 Research Objectives

The principal aim of this thesis is to investigate the intersection between climate change and tourism in the Langhe area focusing specifically on the city of ALBA as a means of understanding how local tourism systems are being affected and what adaptive planning strategies can be employed to ensure their sustainability.

Climate change is no longer a distant threat but a current reality that is beginning to reshape rural landscapes, agricultural systems, and tourism flows (Scott et al., 2012). For a territory such as the Langhe, where tourism is deeply intertwined with the environment, seasonal cycles, and traditional food and wine production, the stakes are particularly high (Bonfante et al., 2018).

This research seeks to understand how climate change is altering the environmental conditions and cultural dynamics that have long defined ALBA as a rural tourism destination. The study will also explore how local communities, tourism operators, and public institutions are reacting or failing to react to these changes.

By integrating territorial and urban planning approaches with environmental and socio-economic analysis, the thesis aspires to offer concrete proposals for a more resilient and sustainable tourism model for the region (UNWTO, 2021).

General Aim of the Research

To explore and analyze the current and projected impacts of climate change on tourism in the ALBA area and to identify sustainable planning strategies that can help mitigate vulnerabilities while preserving the cultural, environmental, and economic integrity of the region.

Specific Objectives

- To **review** scientific literature on climate change and its effects on tourism, with a focus on rural and wine-producing areas similar to Langhe.
- To **analyze** the territorial and environmental characteristics of ALBA and the surrounding Langhe area, including land use patterns, ecological sensitivity, and the socio-economic role of tourism.
- To **examine** observed and projected climate trends (temperature, precipitation, extreme events) that may affect tourism directly or indirectly in the coming decades.
- To **document** the specific vulnerabilities of the local tourism economy especially wine, truffle, and agrotourism sectors based on both environmental and socio-economic data.
- To **collect** and **integrate** insights from local stakeholders through interviews with tourism professionals, local producers, and public officials in ALBA.
- To **evaluate** current planning and adaptation efforts being undertaken by local and regional institutions, including any alignment with national or EU climate adaptation goals.
- To **formulate** context-sensitive recommendations for sustainable tourism development and territorial planning that are tailored to ALBA's climate, culture, and tourism dynamics.

Key Research Questions

In support of the above objectives, the research is guided by the following key questions:

- How is climate change currently manifesting in the ALBA region, and what are the projected future scenarios?
- What are the most significant impacts of these changes on the tourism sector, especially agri-food tourism?
- What planning strategies are currently in place or under development, and where are the major gaps?
- How can territorial and landscape planning tools be leveraged to enhance climate resilience while protecting cultural heritage?

Relevance to Territorial and Urban Planning

This study is situated within the field of territorial, urban, and landscape environmental planning. It responds to a growing demand for local-level, actionable strategies that integrate climate adaptation with spatial and land-use planning. The Langhe's status as a UNESCO cultural landscape further reinforces the need for holistic planning approaches that respect both ecological processes and cultural identity. The findings will be relevant not only for planners and policymakers in ALBA but also for other rural heritage destinations in Europe facing similar climatic and tourism challenges.

1.3 Methodology and Structure of the Thesis

This thesis employs a qualitative, interdisciplinary case study methodology to analyze the impact of climate change on tourism in the city of ALBA, located in the Langhe region of northern Italy. The research integrates elements of territorial, environmental, and landscape planning with climate science and tourism studies. The methodology is built around both secondary data analysis (literature review, climate projections, and policy documents) and primary data collection (semi-structured interviews with local stakeholders).

Methodological Approach: The research follows a multi-phase process:

- Phase 1: Literature and Contextual Review

A comprehensive review of academic literature and policy documents was conducted to frame the theoretical basis of the study. This includes global and European research on tourism and climate change, sustainable planning approaches, and rural landscape vulnerabilities.

- Phase 2: Territorial and Environmental Analysis of ALBA and the Langhe

Geographic and environmental data were collected to map the natural landscape, land uses, elevation patterns, and environmental assets of ALBA. Maps and GIS visualizations support the analysis of the region's exposure to climate change.

- Phase 3: Climate Trend and Impact Assessment

Observed and projected climate data (temperature, precipitation, extreme events) from reliable scientific and institutional sources (ISPRA, ARPA Piemonte, Copernicus, etc.) were examined to understand current and future climate risks to tourism (IPCC, 2022).

- Phase 4: Field Interviews with Local Stakeholders

Semi-structured interviews were carried out with local tourism officials, producers, and residents in ALBA. These interviews offer grounded insights into how local actors perceive climate risks, how their activities are affected, and what adaptation strategies are being used (Bonfante et al., 2018).

- Phase 5: Planning and Policy Analysis

Existing local and regional planning instruments (e.g., PAESC ALBA, regional climate strategies) were reviewed to assess the level of integration of climate change in tourism development plans (UNWTO, 2021).

- Phase 6: Strategic Recommendations

The final phase involves proposing spatial and policy strategies to enhance climate resilience in ALBA's tourism sector, based on the data collected and analyzed.

Structure of the Thesis

The thesis is organized into six main chapters, each building upon the previous one to provide a comprehensive understanding of the problem and possible solutions:

	Phase	Purpose	Main Tasks / Methods
1	Literature & Contextual Review	Build theoretical and empirical background	Systematic review on climate change & tourism; screening databases (Scopus, Web of Science)
2	Territorial & Environmental Analysis	Understand Alba/Langhe physical & land-use context	GIS mapping (land use, elevation, hazards); UNESCO/ISTAT datasets
3	Climate Trend & Impact Assessment	Quantify observed & projected changes	Trend analysis, RCP scenarios (RCP4.5/RCP8.5)
4	Field Interviews with Stakeholders	Capture local perceptions & practices	Semi-structured interviews (tourism, wine, truffle, institutions)
5	Planning & Policy Analysis	Evaluate planning coherence	Review PAESC, regional plans (PPR, PRGRA, PNIEC)
6	Strategic Recommendations	Propose actionable responses	Synthesis of evidence; multi-level policy toolkit

Figure1. Research design and methodological phases
Source: Author's elaboration based on Yin (2014), Creswell (2014), UNWTO (2021), ARPA Piemonte (2023), Copernicus CDS (2022).

LITERATURE REVIEW

2.1 Climate Change and Tourism: Global Perspectives

Tourism is one of the most dynamic sectors of the global economy, contributing significantly to employment, regional development, and cultural exchange. Yet, it is also highly vulnerable to environmental conditions and, increasingly, to the impacts of climate change. This dual relationship being both a contributor to and a victim of climate change.

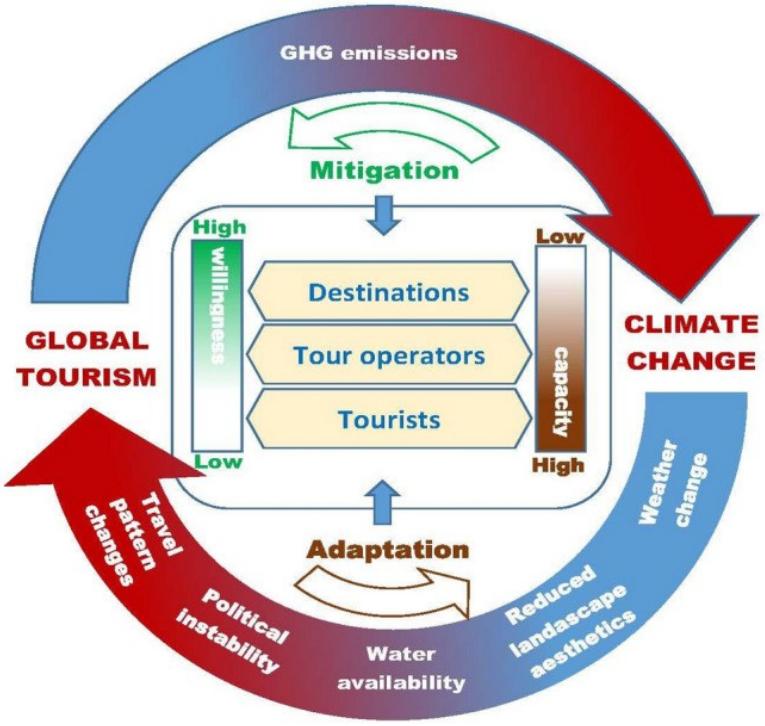

Figure 2. Global tourism and climate change: interrelations between GHG emissions, vulnerability, adaptation, and mitigation across key actors (destinations, tour operators, tourists).
Source. Becken & Hay, 2022. Reproduced with permission from Springer Nature

we can see the current complex, overall interconnections of global tourism and climate change. Tourism contributes to climate change via greenhouse gas emissions, while climate change impacts tourism in multiple ways:

1.directly, by the weather changes resulting in, e.g., severe weather conditions or less snow in winter sports destinations;

2.indirectly, through reduced landscape aesthetics, loss of biodiversity, lower water availability, or increased incidence of diseases;

3.through mitigation policies that may result in changing tourists' travel patterns;

4.through societal impacts, possibly resulting in social unrest and political instability.

Tourism as Both a Contributor and a Victim

Tourism accounts for an estimated 8% of global greenhouse gas emissions, primarily through transport, accommodation energy use, and related activities (Lenzen et al., 2018). At the same time, tourism is highly sensitive to climatic variables such as temperature, precipitation, snow reliability, and natural hazards (Scott et al., 2012). These factors determine not only where tourists travel but also when, how often, and for how long.

Climate change is already altering these conditions across various tourism segments (IPCC, 2022). Coastal destinations face increased risks from sea-level rise, storms, and erosion; winter destinations are experiencing reduced snow cover and shortened ski seasons (Steiger et al., 2019); and rural landscapes are threatened by droughts, biodiversity loss, and shifting agricultural cycles (IPCC, 2022). These changes directly impact visitor behavior, the operational calendar of tourism enterprises, and the long-term viability of certain destinations.

Global Trends and Regional Vulnerabilities

As the climate changes, some tourist areas may actually benefit. For example, northern European countries might become more popular in the summer because of milder weather (Gössling & Hall, 2006). However, many other destinations especially those that depend on stable weather or delicate ecosystems are at greater risk. These include mountain regions, small islands, and rural areas known for wine and food tourism.
Not all places are equally prepared to deal with these changes. Wealthier regions often have more resources to adapt, while poorer areas such as parts of the Global South or rural regions in Europe may find it harder to cope (IPCC, 2022). This is particularly important in places like the Langhe area in northern Italy, where tourism depends heavily on the landscape, agriculture, and seasonal activities (Scott et al., 2012).

Towards Climate-Resilient Tourism

International organizations such as the UNWTO, UNEP, and IPCC have emphasized the need for integrated planning frameworks that address both mitigation and adaptation in tourism (UNWTO, 2020; UNEP, 2023; IPCC, 2022).

Key strategic responses being promoted globally include:

- Shifting towards low-emission transportation and accommodation systems;
- Encouraging diversification of tourism seasons and activities;
- Enhancing ecosystem resilience and landscape conservation;
- Promoting sustainable resource use and circular economy models in tourism destinations. (UNWTO, 2020; UNEP, 2023)

2.2 Key Risks and Vulnerabilities in Tourism Destinations

Tourism destinations worldwide are increasingly exposed to a complex matrix of climate related risks that go far beyond episodic weather disturbances (IPCC, 2022; EEA, 2023). These encompass systemic vulnerabilities tied to environmental degradation, economic fragility, infrastructure resilience, and institutional capacity. While tourism is often perceived as adaptable and dynamic, its dependence on stable environmental and socio-cultural conditions renders it highly sensitive to climate induced disruptions (Scott et al., 2016).

This is particularly true for destinations whose appeal relies on natural landscapes, agricultural heritage, and seasonality as is the case with Alba and the broader Langhe region (UNESCO, 2022).

1. Physical and Environmental Risks

One of the most immediate and tangible threats posed by climate change to tourism destinations is environmental degradation. Rising average temperatures, altered precipitation regimes, and the increasing frequency of extreme weather events such as droughts, floods, storms, and wildfires pose direct risks to the integrity of natural and cultural landscapes (IPCC, 2022). These phenomena can damage trails, reduce snow cover, erode coastlines, and degrade ecosystems and biodiversity (Ciscar et al., 2018).

In the Langhe region, where tourism is intimately connected to viticultural landscapes and forested areas, environmental risks translate into profound challenges. Prolonged drought, changing rainfall patterns, and unseasonal frosts threaten grape yields, truffle habitats, and hazelnut groves (Biasi et al., 2019)(Droulia et al., 2021).

These changes jeopardize not only the ecological equilibrium but also the scenic and experiential value that attract tourists to the region.

2. Economic Vulnerabilities

The economic sustainability of tourism destinations often hinges on seasonal patterns and reliable climatic conditions (EEA, 2023). Disruptions in these patterns due to climate change generate uncertainty in visitor flows and revenue stability. In areas such as Alba where wine, truffles, and agrotourism form a vital economic ecosystem climatic disturbance in agriculture can have cascading effects on the entire tourism value chain.

Increased operational costs (e.g., cooling infrastructure in accommodations), damage to property and public amenities, and reduced tourist demand during adverse weather periods all contribute to economic vulnerability. Small family-run businesses, typical of rural Italy, may lack the capital and resilience to adapt swiftly, placing long-term viability at risk.

3. Socio-Cultural Impacts

Tourism in the Langhe is not merely economic it is deeply embedded in cultural rhythms and traditions, such as the timing of grape harvests, truffle fairs, and seasonal culinary festivals. Climate variability increasingly disrupts these cycles, altering the cultural calendar and diminishing the authenticity of visitor experiences (IPCC, 2022).

Shifts in the agricultural calendar and the unpredictability of natural cycles also make it difficult to plan tourism offerings in advance. Moreover, as climate stress intensifies, local communities may experience pressure to alter or abandon traditional practices, potentially weakening cultural identity (UNESCO, 2022). This transition risks creating tension between adaptation needs and heritage preservation.

4. Infrastructure and Accessibility Constraints

Tourism infrastructure including transportation networks, hospitality facilities, and public services is vulnerable to the physical impacts of climate change. Flooding, landslides, and erosion, especially in hillside regions like Langhe, can damage roads, isolate attractions, and reduce accessibility (Ciscar et al., 2018). Inadequate drainage systems or lack of emergency preparedness can further exacerbate the impact of extreme weather, reduce tourist safety and deterring future visits.

Additionally, limited investment in climate-resilient infrastructure poses a structural challenge in many rural tourism areas, where funding is often prioritized for agricultural or heritage conservation needs rather than forward-looking climate adaptation.

5. Institutional and Governance Vulnerabilities

The capacity of tourism destinations to adapt effectively to climate risks depends on proactive governance, coherent planning, and cross-sectoral coordination. In many rural areas, including Piedmont, tourism policy remains fragmented and often secondary to agricultural or cultural policy frameworks (IPCC, 2022). This hinders the integration of climate change considerations into long-term tourism strategies.

Limited availability of climate-specific data at the local level, coupled with bureaucratic inertia or limited political will, slows down the development and implementation of adaptation measures. Strengthening institutional capacity and governance coherence is therefore a critical component of building resilience in tourism-dependent territories.

Conclusion

Tourism destinations such as Alba and the Langhe region face multi-layered vulnerabilities that intertwine physical, economic, cultural, infrastructural, and institutional dimensions (EEA, 2023). Understanding these interconnected risks is essential for designing adaptive and sustainable tourism models.

The Langhe's identity and economic structure, rooted in a climate sensitive landscape, demand place-based, integrative responses that recognize the complex impacts of climate change. Proactive planning grounded in scientific evidence and informed by local realities is crucial to safeguarding tourism in this and other culturally significant rural regions.

2.3 Adaptation Strategies in Tourism Planning

In light of the growing evidence of climate risks, it is essential for tourism destinations to adopt planning strategies that increase their resilience and ensure sustainable development (IPCC, 2022). Research shows that proactive, integrated, and adaptive planning approaches are key to mitigating the negative impacts of climate change while seizing potential new opportunities (Scott et al., 2016).

One of the primary strategies is the diversification of tourism products and seasons (Gössling & Hall, 2021). Destinations highly dependent on a specific season or activity such as summer beach tourism or winter skiing are particularly vulnerable to climatic changes (UNWTO, 2021). Diversifying the types of activities offered, promoting year-round tourism, and targeting different market segments can reduce vulnerability and spread visitor flows more evenly across the year.

In rural areas like the Langhe, for example, combining wine tourism with cultural events, nature-based tourism, and gastronomy experiences throughout different seasons can strengthen resilience (Simpson et al., 2008).

Another key strategy is the development of climate-resilient infrastructure (European Commission, 2021). This means that all structures connected to tourism such as hotels, restaurants, transportation networks, and public areas should be designed or updated to withstand extreme weather events, high temperatures, and other changing environmental conditions (IPCC, 2022).

To achieve this, planners can employ sustainable and durable building materials suited to evolving climates. Infrastructure improvements may include efficient drainage systems to manage heavy rainfall and reduce flood risks, as well as energy-efficient technologies such as solar panels and advanced insulation systems.

Additionally, preserving and expanding green infrastructure such as tree lined roads, shaded public spaces, and urban gardens can help cool local environments, especially in densely visited areas, reducing the heat island effect (Gössling & Hall, 2021).

Environmental conservation and ecosystem restoration are also essential components of climate-adaptive tourism planning (Simpson et al., 2008). Protecting natural assets forests, rivers, soil, wetlands, and vineyards not only supports biodiversity but also sustains the ecosystem services on which tourism depends, including clean water, healthy landscapes, and visual appeal.

Nature-based solutions such as reforestation, wetland rehabilitation, and integrated vineyard management are increasingly recognized for their dual role in climate mitigation and tourism enhancement (European Commission, 2021).

Another important measure is the integration of **climate risk assessments and early warning systems** into local and regional tourism planning (IPCC, 2022). Identifying vulnerable areas, producing hazard maps, and implementing monitoring systems for extreme events can allow local authorities and destination managers to act quickly and minimize disruptions.

Communicating these risks to stakeholders including tourists, businesses, and public services is key to ensuring both safety and confidence.

A long-term transition toward **low-carbon and sustainable tourism** is also critical (UNWTO, 2021). Reducing tourism's environmental footprint through public transport promotion, pedestrian pathways, energy-efficient accommodations, and sustainable food chains contributes to broader mitigation goals. Eco-certifications and environmental labels for tourism operators can help raise awareness and build market value for destinations aligned with climate goals (Gössling & Hall, 2021).

Furthermore, **community involvement and stakeholder collaboration** are vital (Simpson et al., 2008). Local residents, tourism professionals, agricultural producers, and policymakers must be actively engaged in planning processes to ensure adaptation measures are contextually appropriate, socially inclusive, and widely accepted. Participatory approaches help build trust, encourage innovation, and foster a shared sense of responsibility.

Lastly, successful adaptation requires **institutional coordination and governance integration** (Scott et al., 2016). Climate-related planning for tourism must be embedded into broader frameworks such as land use plans, cultural heritage conservation strategies, and environmental regulations at municipal, regional, and national levels (European Commission, 2021).

Effective collaboration between sectors (tourism, agriculture, infrastructure, and environmental protection) is essential to address the cross-cutting nature of climate risks.

In the case of Alba and the wider Langhe area, these strategies are particularly relevant due to the region's dependence on agriculture-based tourism, such as viticulture and truffle foraging (IPCC, 2022). Climate-resilient infrastructure, diversification of visitor experiences, and preservation of rural landscapes are all necessary to safeguard the long-term viability of local tourism. This thesis will explore how these adaptation measures are being implemented or overlooked through a review of local planning policies and interviews with stakeholders.

2.4 Planning and Policy Gaps in Rural Tourist Areas

Tourism in rural areas like the Langhe depends strongly on the natural environment, local culture, and agricultural traditions (Cavicchi & Ciampi Stancova, 2016). However, these areas often face challenges in planning and policies when it comes to climate change.

While tourism is promoted as a way to support local development, many rural regions lack the right tools, coordination, and attention to make tourism more climate-resilient (Becken, 2013). This section looks at the main problems in tourism planning, using Alba and the Langhe as examples.

Lack of Coordination Between Tourism and Environmental Planning

A major issue is that tourism and environmental planning often work separately (Bramwell & Lane, 2011). Tourism policies usually focus on attracting more visitors, organizing events, and promoting the area, while environmental plans focus on protecting nature and managing risks. The two are rarely combined into one strategy (Bramwell & Lane, 2011).

In Alba, for example, the city's climate action plan (PAESC) includes actions for energy use and reducing emissions, but it does not clearly mention tourism or how climate change might affect it (Becken, 2013). At the same time, tourism organizations focus on promoting food, wine, and culture, but not on adapting to climate risks like drought or heatwaves.

No Clear Climate Guidelines for Tourism

Most rural areas don't have rules or plans that specifically help tourism adapt to climate change (Calgaro et al., 2014). Zoning plans don't always consider the risk of floods, landslides, or high temperatures. There are also no clear standards for how to build or renovate tourism structures like hotels, restaurants, or wineries in a climate-friendly way. In the Langhe, where tourism depends on vineyards and forests, there are few policies that help farmers and tourism operators deal with extreme weather or changes in the seasons. Many have to make decisions on their own without guidance from public institutions (Becken, 2013).

Poor Use of Climate Data in Planning

Although organizations like ARPA Piemonte provide good data on climate trends, this information is not often used in local tourism planning (Calgaro et al., 2014). Towns like Alba don't always have updated maps or tools showing which areas are most at risk from floods, droughts, or heatwaves. As a result, local authorities and tourism businesses are not fully prepared for future climate risks. For example, changing rainfall and temperature are affecting truffle hunting and wine production but events and services are still planned using old seasonal calendars, which may not match the new climate reality (Becken, 2013).

Limited Participation and Communication

In small towns, it's often difficult to involve different people like researchers, business owners, and residents in climate planning (Bramwell & Lane, 2011). There are few opportunities to share ideas or get information. Even when universities or environmental agencies have useful knowledge, it often stays in reports and is not shared in a way that local planners or tourism operators can use (Calgaro et al., 2014).

Focus on Heritage, Not Adaptation

Places like ALBA are proud of their cultural and landscape heritage, especially because the Langhe is a UNESCO site. While protecting historic buildings and traditional views is important, it can make it harder to introduce new solutions like solar panels, green roofs, or rainwater systems because of strict building rules (Cavicchi & Ciampi Stancova, 2016).
For example, a winery in a traditional village may want to improve its energy use or add cooling systems, but local regulations may not allow modern changes that affect the building's appearance (Bramwell & Lane, 2011).

Conclusion

To protect rural tourism in places like Alba and the Langhe, it is important to update planning tools and policies (Becken, 2013; Calgaro et al., 2014). Tourism must be included in climate strategies. Local authorities need to use climate data, involve more people in decision-making, and support sustainable improvements. Only with better coordination and forward-looking plans can these areas stay attractive and resilient in the face of climate change.

3.1 Geographical Characteristics and Landscape Features of the Langhe Region: Focus on ALBA

The Langhe region, located in the southern part of the Piedmont region in northwestern Italy, is characterized by a diverse and evocative landscape composed of rolling hills, vineyard covered slopes, and historical villages. It is part of the UNESCO World Heritage designation "Vineyard Landscape of Piedmont: Langhe-Roero and Monferrato," recognized for its outstanding cultural and agricultural value (UNESCO, 2014). Within this setting, the city of Alba stands as a central node, both geographically and economically, playing a key role in shaping the identity of the Langhe.

Geographical Location and Topography

Alba is situated in the province of Cuneo, nestled between the Tanaro River to the north and the Barolo hills to the south. The city lies at an elevation of approximately 172 meters above sea level and is surrounded by hilly terrains that range from 200 to 600 meters in elevation. These hills are primarily composed of sedimentary formations sandstones, marls, and clays which contribute to the region's unique soil profiles essential for viticulture (Comune di Alba, 2022).

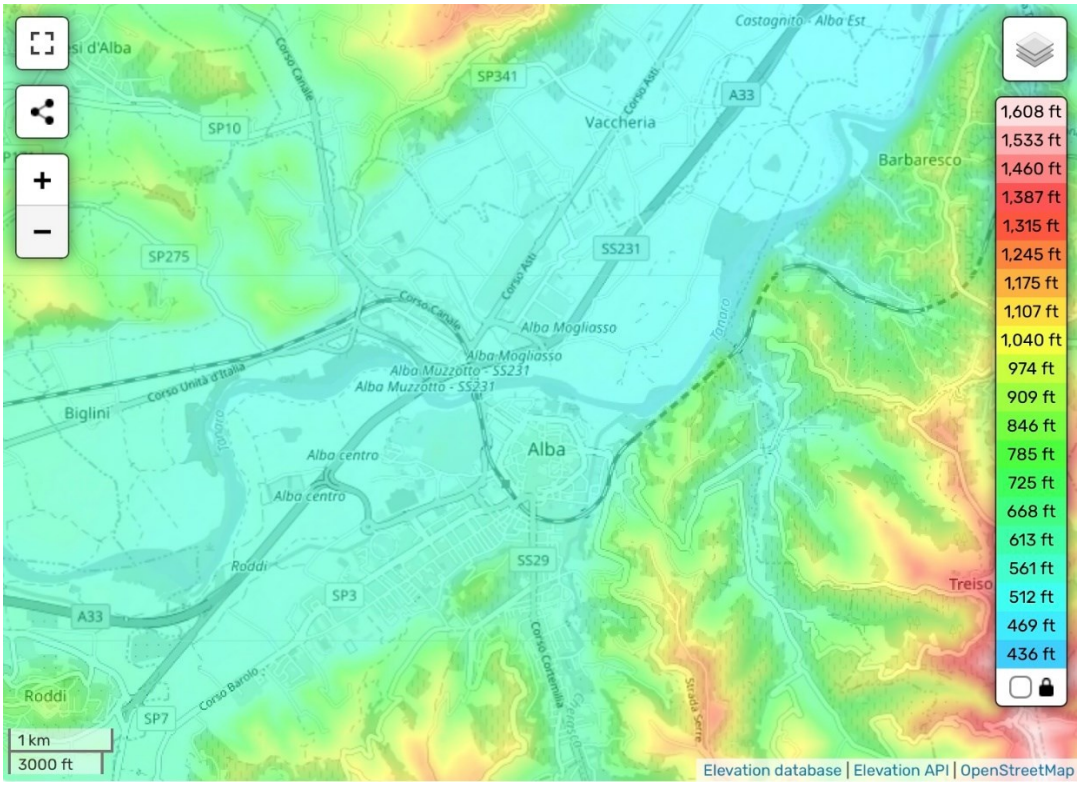

Figure. 3. Topographic map showing the geographical location and elevation gradients of Alba and its surroundings, used to analyze terrain vulnerability and landscape exposure. Average elevation: 837 ft / Minimum elevation: 459 ft / Maximum elevation: 1,916 ft
Source: Topographic-Map.com (n.d.).

The topographical diversity supports a variety of microclimates, which, combined with sun exposure and slope orientation, result in ideal conditions for wine production.

The amphitheater-like arrangement of hills around Alba also enhances its scenic and experiential quality, contributing to the area's tourism appeal (Regione Piemonte, 2023).

Climate and Environmental Conditions

The climate of the Langhe is temperate continental, characterized by hot summers, cold winters, and notable seasonal variability. Average annual temperatures in Alba range between 11°C and 13°C, (Regione Piemonte, 2023) with summer peaks reaching 30°C and winter lows dropping below freezing.

Rainfall is distributed fairly evenly throughout the year but with peak precipitation during spring and autumn seasons critical for agricultural productivity and tourism activity. However, data from ARPA Piemonte and ISPRA indicate that the region has undergone significant climatic shifts in recent decades.

These include a steady rise in average temperatures, greater frequency of extreme events such as droughts, hailstorms, and heatwaves, and more irregular rainfall patterns. These changes affect the timing of grape harvests, water availability, and the health of vineyard ecosystems all of which are foundational to Alba's tourism economy.

Landscape Patterns and Land Use

The landscape of Alba and the surrounding Langhe is a mosaic of vineyard terraces, wooded valleys, cultivated fields, and small rural settlements (Regione Piemonte, 2023). Land use is dominated by viticulture especially the cultivation of Nebbiolo, Barbera, and Dolcetto grape varieties as well as hazelnut groves and truffle-rich woodlands.

These agricultural patterns not only sustain the local economy but also shape the visual and cultural identity of the region. Urban expansion in Alba has been moderate, preserving much of the rural character (Comune di Alba, 2022).

The city center retains a rich architectural heritage, with Romanesque and medieval buildings that complement the surrounding agricultural areas (UNESCO, 2014). Rural tourism has grown around these land-use features, with agriturismi (farm-stay accommodations) and wine estates offering immersive visitor experiences.

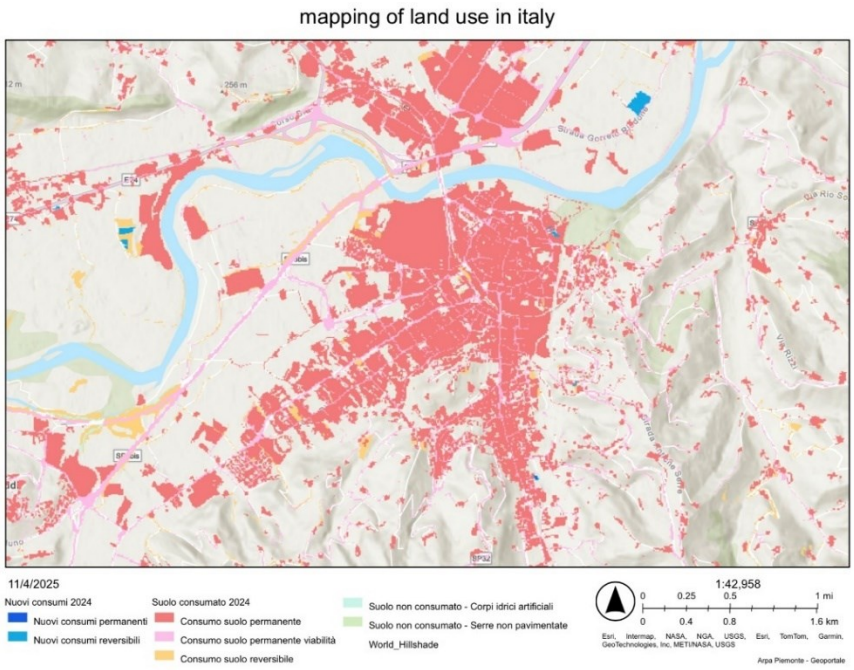

Figure 4. Land use and soil consumption patterns in the municipality of Alba (2024). **Source:** ARPA Piemonte – Geoportale (2025).

Cultural Landscape and Visual Identity

The Langhe's cultural landscape, particularly around Alba, is defined by human interaction with the environment over centuries (UNESCO, 2014). Dry-stone vineyard walls, chapel-topped hill crests, and ancient farmhouses reflect a harmonious relationship between tradition, territory, and agriculture.

This distinctive identity is reinforced by festivals (e.g., the Alba White Truffle Fair), seasonal harvests, and gastronomic tourism routes that connect landscape features to cultural narratives.

Preserving this landscape is a central challenge in climate-resilient planning (Regione Piemonte, 2023). As changing climatic conditions threaten the balance between nature and human activities, the need for integrated landscape management becomes more urgent.

Policies must therefore address not only environmental risks but also visual and experiential quality, which are essential to Alba's tourism offer.

3.1.1 Topography and Land Use Patterns

The Langhe region, and particularly the area surrounding Alba, is defined by a complex topography of rolling hills, river valleys, and stratified geological formations that have shaped both the cultural landscape and land use practices over centuries. The terrain is primarily hilly, with altitudes ranging between 150 and 600 meters above sea level, offering a varied and scenic morphology (Comune di Alba, 2022). Alba itself lies in a relatively flatter zone near the Tanaro River, at an elevation of approximately 172 meters, but is encircled by increasingly undulating terrain as one moves outward toward the vineyards and ridgelines.

The hills are generally composed of sedimentary rocks from the Miocene epoch principally marls, clays, and sandstones which have contributed to diverse soil profiles particularly suited to viticulture. Slope orientation plays a significant role in microclimatic variations, influencing decisions on crop placement and vineyard exposure. South-facing slopes, for instance, are prized for grape cultivation due to optimal sun exposure, while steeper or less accessible slopes are often wooded or used for hazelnut groves and truffle-rich forests.

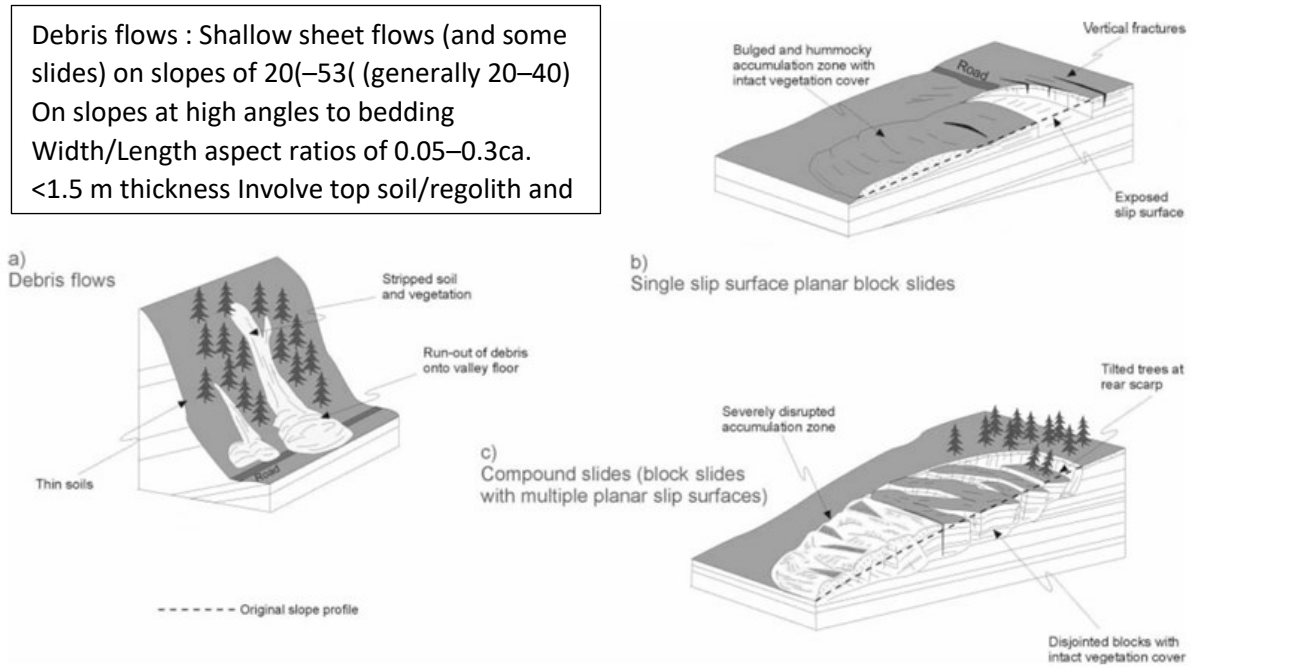

Figure 5. Types of slope movement in the Langhe region, including debris flows, planar block slides, and compound slides.
Source: Guzzetti et al., 1999

The land use in the Alba-Langhe area reflects a delicate balance between human cultivation and the preservation of natural habitats. Agricultural land, particularly vineyards, dominates the landscape and is often arranged in terraced systems to accommodate the sloping terrain. Key grape varieties such as Nebbiolo, Barbera, and Dolcetto are grown in these vineyards, with distinct zoning that reflects differences in elevation, aspect, and soil composition. These zones correspond to prestigious wine denominations such as Barolo and Barbaresco, whose production areas are stringently regulated to maintain quality and traceability (Regione Piemonte, 2023).

Beyond viticulture, the hills host a mosaic of hazelnut plantations (notably the Tonda Gentile delle Langhe variety), small cereal plots, and forests. The latter are essential for biodiversity conservation and serve as habitats for truffle-bearing mycorrhizal trees like oak, poplar, and hazelnut. The Alta Langa area, at higher elevations, remains more forested and less cultivated, offering greater ecological continuity and serving as a buffer against land degradation.

Urban land use in Alba has remained relatively compact, centered around the historic core with its medieval towers and Renaissance buildings (Comune di Alba, 2022). Urban expansion in recent decades has generally followed the valley floors, avoiding excessive sprawl on the surrounding hills. The municipality has preserved many rural hamlets (frazioni) and traditional farmsteads, which are now often adapted into agriturismi, boutique accommodations, or wine estates. Infrastructure such as roads, service areas, and irrigation systems are carefully integrated into the terrain to minimize landscape fragmentation (Regione Piemonte, 2023).

The topography and land use configuration of the Alba-Langhe area not only define its visual identity but also influences climate resilience. Steep slopes are vulnerable to erosion during extreme rainfall, while the concentration of monocultures (especially vineyards) presents challenges for ecological balance. The traditional patchwork pattern of mixed use combining cultivated fields, forests, and settlements offers a model of landscape diversity that is both culturally significant and environmentally adaptive (UNESCO, 2014).

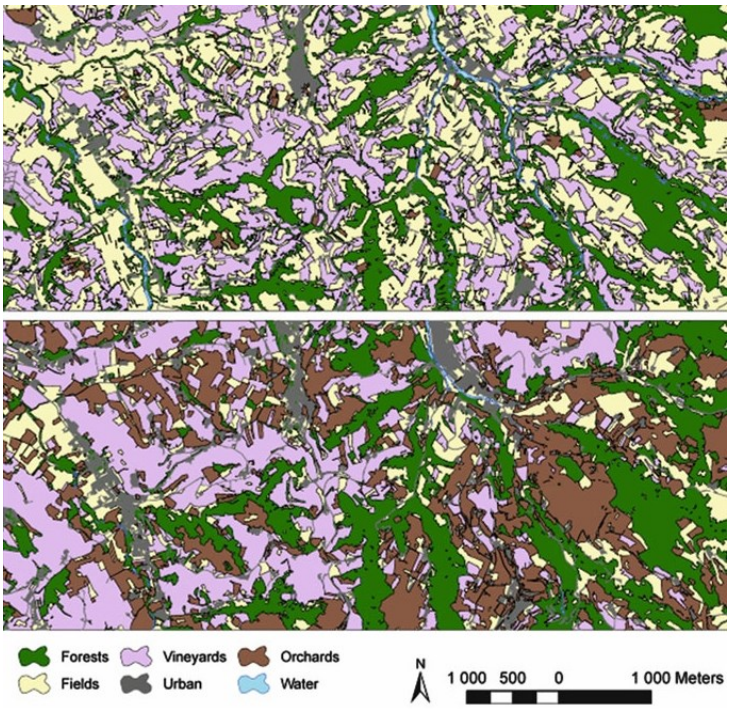

Figure 6. Land use changes in the Langhe hills: comparison between past and recent distribution of vineyards, forests, orchards, and urban areas.(Land use classifications of 1954 (upper map) and 2000 (lower map) ortho images)

Source. Tempesta & Vecchiato, 2014

3.1.2 Environmental Pressures Impacting Tourism in the Langhe

The Langhe region's tourism economy deeply connected to its landscapes, vineyards, and rural ecosystems is increasingly exposed to environmental stressors driven by climate change. Rising temperatures, altered precipitation patterns, and extreme weather events (such as hailstorms and droughts) are affecting agricultural cycles and degrading the aesthetic and ecological quality of the territory (ARPA Piemonte, 2023). These changes pose direct risks to tourism activities based on wine production, truffle hunting, and outdoor experiences (Marinelli, 2016).

Soil erosion, pressure on water resources, and biodiversity loss are also becoming more visible due to more intensive land use and shifting climate conditions (ARPA Piemonte, 2024). For instance, prolonged drought periods reduce vineyard yield and quality, which in turn impacts wine tourism and local events tied to harvest cycles (Ferrara & Anfossi, 2021). Likewise, forest stress and habitat fragmentation may reduce opportunities for nature-based tourism and limit the experiential value of the landscape (Battiston et al., 2019).

These environmental vulnerabilities highlight the urgent need for integrated planning approaches that prioritize the protection of ecosystem services as a foundation for sustainable tourism development in Alba and the broader Langhe region (Marinelli, 2016).

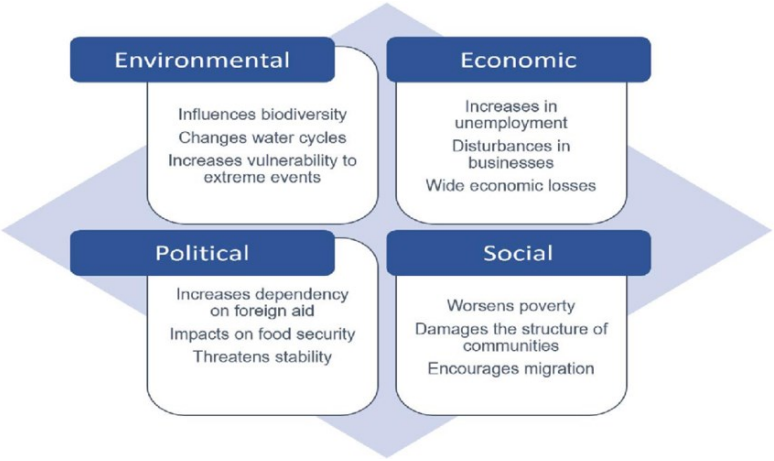

Figure 7. Environmental, economic, political, and social pressures exacerbated by climate change and their impact on tourism systems.

Source. García-Herrera et al., 2022

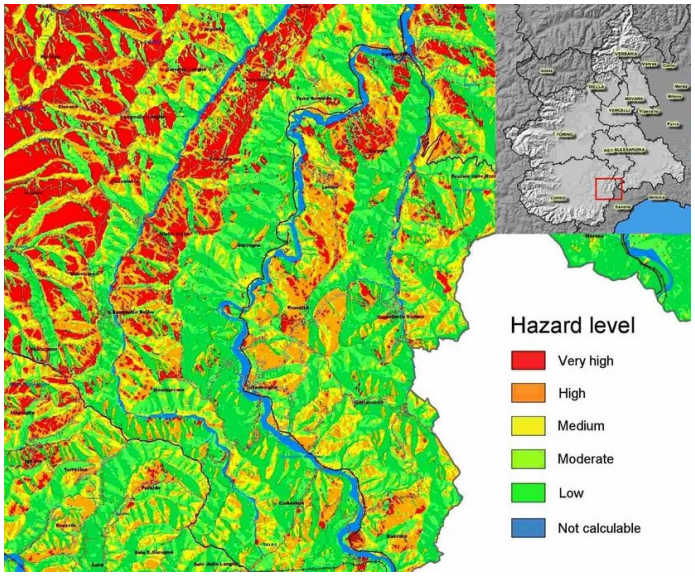

Figure 7. Landslide hazard zones in the Langhe hills, illustrating areas of moderate to high geological instability.

Source. (ARPA Piemonte, n.d.)

3.2 Socio-Economic Importance of Tourism in Alba and Langhe

Tourism is very important for the economy and society of the Langhe region. In recent years, it has become one of the main sources of income for local communities, working alongside traditional activities like farming and winemaking. Thanks to its beautiful hills, historic villages, excellent wines, and famous food traditions, Langhe has become known benchmark for wine and gastronomy tourism in Europe (UNWTO, 2012).

Tourism as a Pillar of the Local Economy

Tourism plays a pivotal role in the economy of Alba and the broader Langhe region (MacCannell, 1999). According to data from Regione Piemonte the province of Cuneo where Alba is located ranks among the top rural destinations in Italy in terms of visitor numbers, particularly for wine and food-related travel (UNWTO, 2012) (Regione Piemonte, 2022). Tourists come from all over the world to visit the vineyards, taste the wines like Barolo and Barbaresco, see old wine cellars, and take part in events such as the Alba White Truffle Fair which annually attracts tens of thousands of visitors and generates significant local revenue (Pine & Gilmore, 1999). The Langhe area attracts both domestic and international tourists drawn by its UNESCO-designated vineyard landscapes, prestigious wine routes, truffle fairs, and scenic hill towns (UNESCO, n.d.). These activities not only bring money directly into the region but also help promote the Langhe's name and its products internationally, helping farmers and winemakers sell more wine abroad (MacCannell, 1999).

Tourism also has important social benefits

It encourages the preservation of local traditions, crafts, and cultural heritage (Richards, 2001). Many historic buildings have been restored, old culinary recipes are promoted, and cultural festivals have grown because of tourism. It gives people in the Langhe, especially younger generations, new opportunities to live and work in the countryside rather than moving to big cities. The growth of tourism has led to the development of numerous small and medium-sized enterprises in agritourism, event organization, and food services.
This diversification has strengthened the economic resilience of rural communities, including those in smaller frazioni, which benefit from visitor flows. It also provides opportunities for women and young entrepreneurs, often through EU-funded rural development programs contributing to demographic stability in otherwise aging areas (European Network for Rural Development, 2021).

However, tourism also creates new challenges. Visitor numbers can be extremely high in some seasons, putting pressure on local infrastructure, landscapes, and resources like water and energy. There is a risk that if tourism grows too fast without good planning, it could damage the very landscapes and traditions that attract visitors in the first place. Rising costs of living in popular areas can also make life harder for local residents. Climate change adds a further risk. If extreme weather events become more common, or if farming conditions for vineyards change, the tourism that depends on wine production and beautiful landscapes could suffer (Scott, Hall, & Gössling, 2008).

In summary, tourism is a key part of the Langhe region's economy and cultural life. But to protect its benefits, it is important to plan carefully for the future, balancing economic development with the protection of the environment, culture, and community well-being.

3.2.1 Seasonal Trends and Tourist Demographics

Tourism activity in Alba and the Langhe region displays a pronounced seasonality and a well-defined demographic structure, reflecting the region's strong specialization in Eno gastronomic, landscape-based, and cultural tourism. Understanding these temporal and visitor-related patterns is essential for designing effective tourism planning, managing environmental and infrastructural pressures, and identifying vulnerabilities related to climate variability (ENIT, 2021).

Seasonal Trends

The tourism calendar in the Langhe is marked by two distinct peak periods spring and autumn each closely tied to the region's agricultural rhythms and cultural events. Autumn (September to November) represents the high season, largely driven by the internationally renowned Fiera Internazionale del Tartufo Bianco d'Alba (Alba White Truffle Fair), as well as the grape harvest (vendemmia) and associated wine festivals. During this time, the landscape's transformation vivid vineyard colors and crisp air enhances the appeal of the region for both domestic and international visitors (UNESCO, n.d.) (Regione Piemonte, 2022).

Spring tourism (April to early June) benefits from milder weather, the blooming countryside, and cultural events such as Vinum, Alba's premier wine fair (Richards, 2001). Outdoor activities like hiking, cycling, and countryside tours gain popularity during this period (Langhe.net, 2021).

By contrast, the summer months (July and August), despite offering longer daylight and holidays, are less attractive due to high temperatures that discourage outdoor excursions. Still, summer tourism is growing slowly thanks to agritourism accommodations, swimming pools, and shaded historical centers.

Winter (December to March) remains the least active season. Although some visitors are drawn by winter gastronomy, holiday markets, and the region's tranquil ambiance, overall tourist flows decline sharply due to colder temperatures and the absence of major events.

The seasonal concentration of tourism generates several challenges:

infrastructure strain during peak months, underutilized capacity during the low season, and income volatility for tourism operators. Moreover, climate change has begun to shift seasonal patterns, with extreme heat reducing summer attractiveness and irregular rainfall affecting spring and autumn events (Scott, Hall, & Gössling, 2008).

These shifts demand a strategic rebalancing of tourism flows through diversification and off-season development.

Tourist Demographics

Visitor profiles in Alba and the Langhe are diverse but predominantly composed of two key demographic groups. The first consists of middle-aged and older adults (ages 40–65), typically affluent, seeking high-quality gastronomic and cultural experiences.

This cohort includes a high number of repeat visitors, especially from Italy and neighboring European countries. They often prefer well-organized experiences, including vineyard tours, tasting menus, and art or heritage excursions. The second emerging group includes younger adults (ages 25–39), who are increasingly motivated by sustainability, experiential tourism, and digital convenience (UNESCO, n.d.) (UNWTO, 2019).

These travelers favor informal agritourism stays, eco-conscious dining, wellness retreats, and authentic rural experiences. They tend to plan trips independently via online platforms, and often seek meaningful engagement with local communities (Richards, 2001).

According to Regione Piemonte (2022), domestic tourists still represent the largest segment, especially from Lombardy, Liguria, and Emilia-Romagna. However, international arrivals particularly from Germany, France, Switzerland, the Netherlands, and the United States have increased steadily.

North American and East Asian tourists often arrive through organized tours, though individual international travel remains dominant, especially for rural accommodations and boutique experiences.

The seasonal and demographic dynamics of tourism in Alba and the Langhe reveal both strategic advantages and planning challenges. While seasonal peaks generate economic vitality, they also risk concentrating impacts and reducing resilience to climate variability.

Similarly, evolving tourist preferences toward sustainability and immersive travel offer new opportunities but require destination managers to innovate services, infrastructure, and communication strategies (UNWTO, 2019)**.**

Addressing these shifts through data-driven, inclusive, and climate conscious planning is essential to preserving the socio economic and cultural value of tourism in the region.

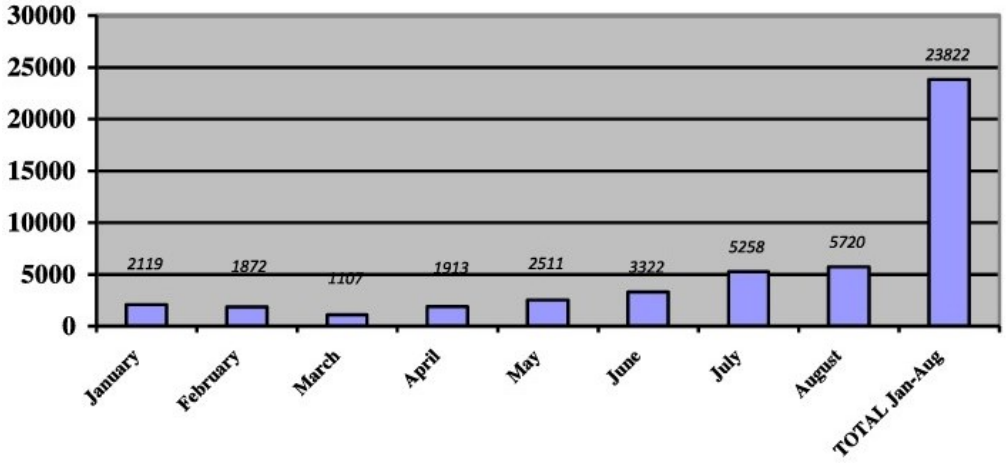

Figure 8. Monthly tourist arrivals in Alba (January–August).

Source. Iancu & Ţîrcă (2016).

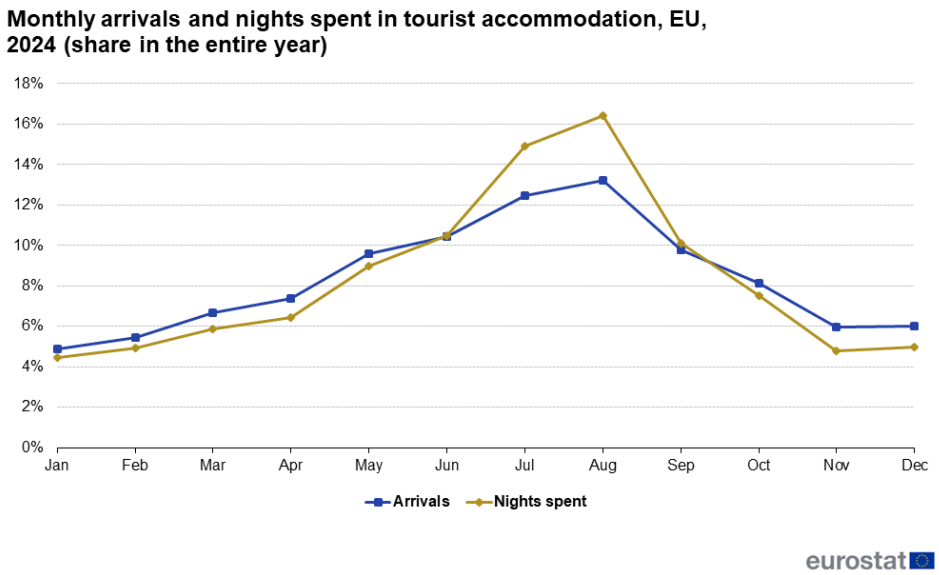

Figure 9. Seasonal variation in tourist arrivals and nights spent in the EU, 2024.

Source. Eurostat. (2024). Seasonality in tourism demand.

Figure 9. illustrates generic tourist seasonality in EU accommodation facilities, with arrivals and overnight stays peaking during summer months. While specific data for Langhe is recommended, this pattern provides a comparative framework to better understand the region's seasonality.

About this chart many tourist activities have always been highly seasonal. Leading reasons are environmental factors, such as climate conditions or geographical location, together with social and cultural factors, such as school holidays. During peak vacation times, tourist areas may face overcrowding and resource strain. Conversely, quieter periods can lead to under-utilized facilities and job instability due to fluctuating demand.

The most popular months were August (16% of all nights spent at EU tourist accommodation in 2024, corresponding to 493 million nights spent) and July (15%, 449 million nights). The number of nights spent during the peak summer month was nearly 4 times higher than in the off-peak month January (134 million).

Figure 9 shows that the seasonal pattern for nights spent was a bit more pronounced than for arrivals, with 26% of annual arrivals recorded in July or August. This suggests that the length of stay is longer during these busier months, likely corresponding with many tourists' main holiday period.

3.2.2 Key Attractions and Cultural Assets

The Langhe region, with Alba at its heart, offers a unique and multi-seasonal tourism experience shaped by its agricultural heritage, natural biodiversity, and deeply rooted cultural traditions. Unlike destinations dependent on a single peak season, Langhe's attractions are distributed across the year, providing continuous engagement for diverse types of visitors (Langhe.net, 2021).

Spring in Langhe is marked by the blooming of vineyards and the extraordinary presence of wild orchids this region hosts the highest concentration of wild orchid species in Italy, visible from April through June (Regione Piemonte, 2022). These floral displays attract nature lovers, photographers, and botanists alike, adding ecological richness to the visitor experience.

Autumn is the region's most celebrated tourism period. The transformation of the vineyard landscape into vibrant shades of red and gold creates a compelling visual setting (UNESCO, n.d.). This coincides with the grape harvest season and the internationally renowned Alba White Truffle Fair, drawing culinary tourists and wine enthusiasts from across the globe (ENIT, 2021). Even in late autumn and winter, Langhe maintains tourist interest through indoor cellar tours, wine tastings, and organized truffle hunting experiences in the forests surrounding Alba (Langhe.net, 2021).

Beyond its seasonal agricultural attractions, the Langhe region offers a wealth of cultural and historical assets. More than 30 medieval castles dot the landscape, many accessible through designated cultural tourism routes (Regione Piemonte, 2022). These castles, often perched on scenic hilltops, serve as venues for events, exhibitions, and guided historical tours, reinforcing the region's identity as a landscape of heritage (UNESCO, n.d.).

Local traditions further enrich Langhe's cultural profile. Traditional sports like pallone elastico and pantalera are still played in village squares, offering an authentic glimpse into rural community life (Langhe.net, 2021). These cultural practices are not re-enactments for tourists but ongoing elements of local identity.

Museums across the region also contribute to its year-round cultural offering.
Highlights include:

- MUDET: The Truffle Museum in Alba, dedicated to the science and culture of truffle hunting (ENIT, 2021).
- The Wine Museum in Barolo, showcasing the history of viticulture (Regione Piemonte, 2022).
- The Museum of Magic in Cherasco, offering a whimsical yet scholarly attraction (Langhe.net, 2021).
- The Craveri Museum in Bra, known for its natural history collections (ENIT, 2021).
- The Eusebio Civic Museum in Alba, housing archaeological and ethnographic exhibits (Regione Piemonte, 2022).
- The Museum of Chalks in Magliano, a rare tribute to regional artisan traditions (Langhe.net, 2021).

These institutions are strategically distributed throughout the Langhe, encouraging exploration beyond major tourist hubs and supporting a more even territorial distribution of visitors (ENIT, 2021). Altogether, the Langhe's mix of sensory experiences tied to food, nature, history, and tradition reinforces its role as one of Italy's most distinctive rural cultural landscapes (UNESCO, n.d.).

3.3 Tourism-Related Climate Sensitivities and Observed Impacts

The tourism sector in the Langhe region, while economically vital, is increasingly sensitive to climate variability and long-term environmental changes (IPCC, 2022). The area's dependence on seasonal agricultural cycles, landscape aesthetics, and outdoor experiences makes it particularly vulnerable to shifts in temperature, precipitation patterns, and extreme weather events (Regione Piemonte, 2023). This section outlines the climate sensitivities specific to Alba and the surrounding Langhe territory and examines observable impacts on the tourism system.

Climatic Sensitivities of the Local Tourism Economy

Tourism in the Langhe is closely intertwined with viticulture, truffle production, and landscape-based experiences. These elements are extremely sensitive to even subtle climatic shifts (van Leeuwen et al., 2019):

Viticulture is vulnerable to rising temperatures, erratic rainfall, and increased risk of drought and hailstorms (Cavicchioli & Ciavarella, 2022). Grapes such as Nebbiolo and Barbera are highly dependent on specific temperature ranges and growing season lengths, which are being altered by climate change (van Leeuwen et al., 2019). This affects not only the volume and quality of wine production but also the timing of harvest-related tourism activities (Cavicchioli & Ciavarella, 2022).

Truffle growth depends on soil moisture levels and stable underground ecological conditions. Prolonged dry periods or intense rainfall can reduce truffle availability and quality, with immediate consequences for autumn tourism flows associated with the Alba White Truffle Fair (Bonet et al., 2020).

Observed Climate Trends and Impacts

According to data from ARPA Piemonte (2024), the Langhe region has witnessed a gradual increase in average annual temperatures over the past three decades, with a notable rise in extreme heat days (above 30°C) during the summer months. These shifts have led to the following observable impacts on tourism:

Earlier Harvests and Compressed Seasons: Winemakers report that grape harvesting is occurring up to two weeks earlier than in past decades, compressing the tourism season and disrupting the traditional rhythm of wine festivals and guided vineyard tours (Cavicchioli & Ciavarella, 2022).

Shifting Tourist Behavior: Interviews with local tourism stakeholders suggest that visitors are increasingly avoiding travel during hot summer weeks, preferring spring and autumn instead. This intensifies the existing seasonality problem and creates a higher concentration of tourism in fewer months (IPCC, 2022).

Biodiversity and Landscape Aesthetics: Changes in flowering patterns, such as the early blooming of wild orchids, and decreased vineyard foliage quality during droughts affect the visual appeal of the landscape a core element of the Langhe's tourism offering (Regione Piemonte, 2023).

In summary, the observed impacts of climate change in Alba and the Langhe underscore the sensitivity of tourism to environmental fluctuations (IPCC, 2022). Seasonal shifts in agricultural productivity, landscape appearance, and outdoor activity suitability are already affecting visitor experiences and business operations (van Leeuwen et al., 2019). As climate trends continue, the need for adaptive tourism strategies such as infrastructure resilience, flexible scheduling, and diversification of tourism offerings becomes increasingly urgent (Regione Piemonte, 2023).

4. Analysis of Climate Data and Projections

4.1 Historical Climate Trends in the Langhe Region

Data from ARPA Piemonte and regional meteorological networks indicate that the Langhe area has experienced a gradual but significant warming over recent decades (ARPA Piemonte, 2023). Between 1961 and 2022, average annual temperatures in the province of Cuneo, where Alba is located, increased by approximately 1.5°C (IPCC, 2021).

The frequency of heatwaves has also risen, with more days exceeding 30°C during the summer months (European Environment Agency, 2021). This trend is particularly relevant for outdoor tourism, as elevated temperatures can diminish visitors' comfort and affect the scheduling of open-air events and agricultural activities.

Precipitation patterns have also changed, showing greater seasonal variability and an increase in extreme weather events (ARPA Piemonte, 2023). Autumn and spring, traditionally vital periods for tourism and agriculture, have experienced more intense rainfall episodes, sometimes leading to localized flooding, soil erosion, and landslides (ARPA Piemonte, n.d.). Conversely, summer months are increasingly marked by prolonged dry spells, creating stress on water resources critical for both local communities and the agritourism sector (European Environment Agency, 2021).

According to ARPA Piemonte, the frequency of drought conditions in the Langhe region has doubled in the past 30 years, directly affecting vineyard health and truffle yield two key attractions for visitors (Zambon et al., 2022).

In addition, early blooming and grape maturation dates have been documented in vineyard phenological studies (Van Leeuwen et al., 2019). These shifts not only affect the quality and timing of wine production but also the organization of harvest-related tourism activities, including guided tastings and seasonal festivals.

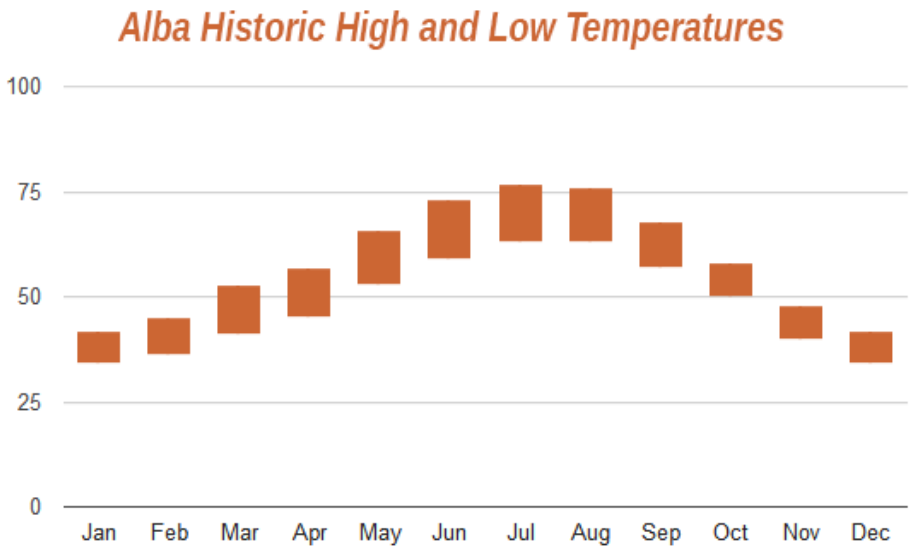

Figure 10. Alba's historic temperature precipitation patterns.

Source. Wandering Italy. (n.d.). Alba Italy weather.

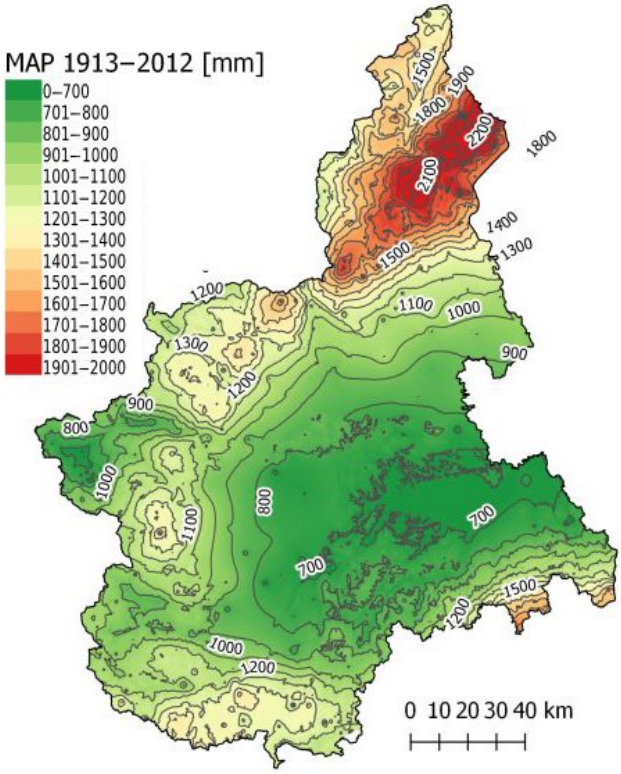

Figure 12. Mean Annual Precipitation (MAP) in Piedmont Region (1913–2012).

Source. Luino et al., 2018

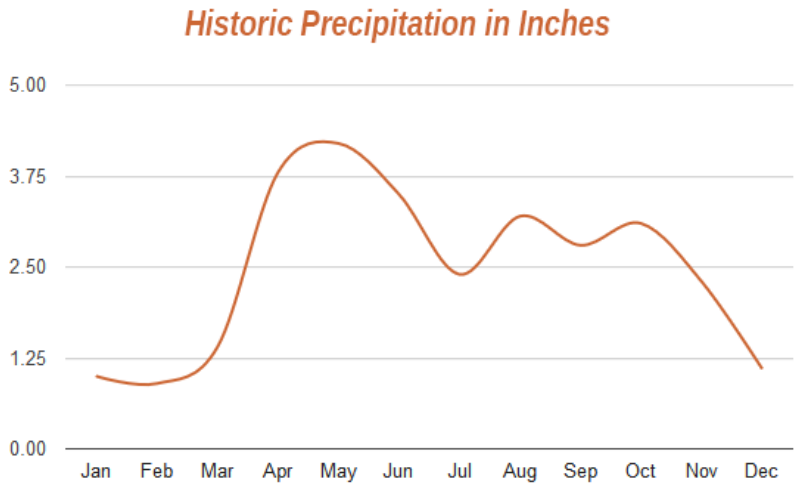

Figure 13. Alba's precipitation patterns.

Source. Wandering Italy. (n.d.). Alba Italy weather.

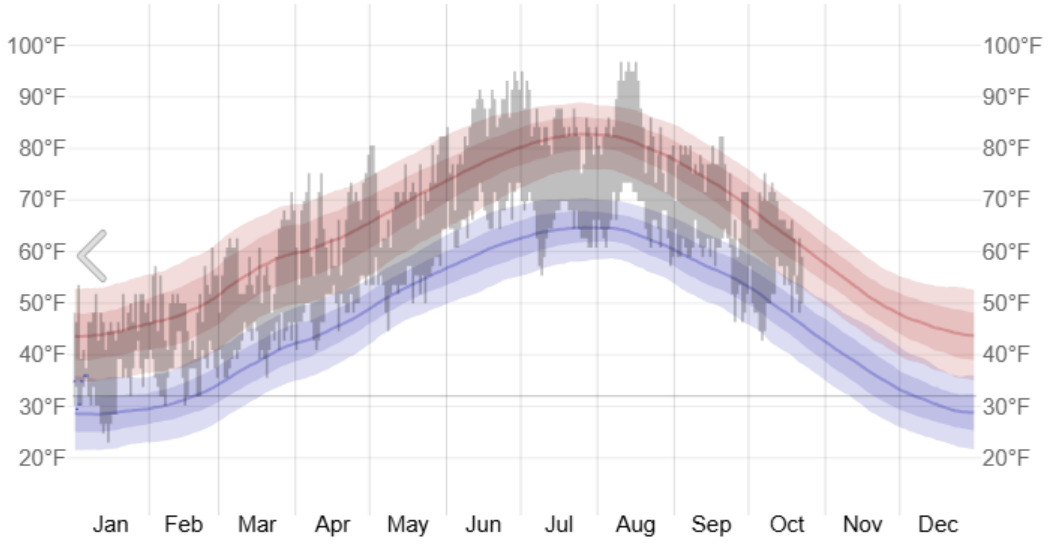

Figure 14. Alba Temperature History 2025

Source. WeatherSpark, 2025

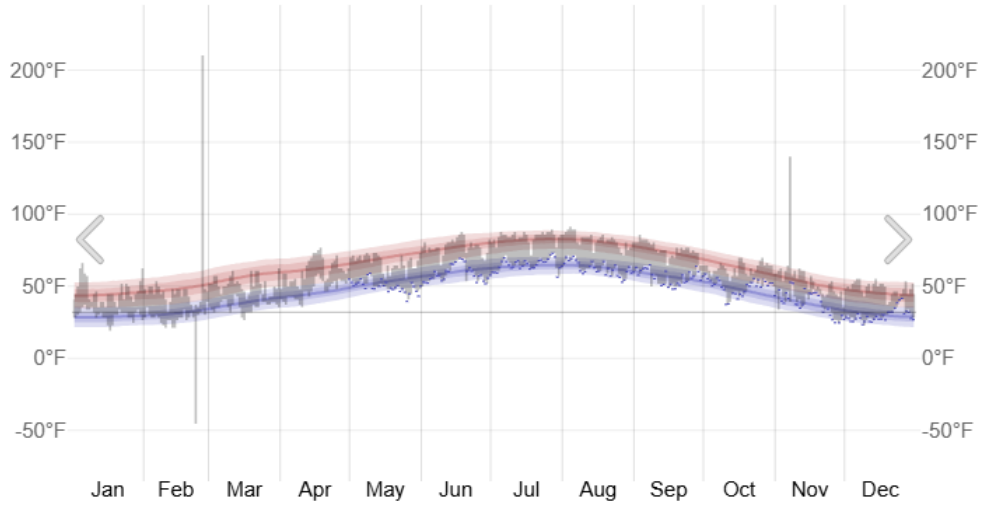

Figure 15. Alba Temperature History 2013

Source. WeatherSpark. (2025). Historical weather during 2025 in Alba, Italy.

4.2 Climate Change Projections for Piedmont and Alba

Climate modeling based on IPCC scenarios, particularly RCP4.5 (moderate emissions) and RCP8.5 (high emissions), suggests that the Langhe region will continue to experience rising temperatures and increased climate variability through the mid- and late 21st century (IPCC, 2021). Projections indicate that average annual temperatures could rise by an additional 1.5–2.5°C by 2050 under RCP4.5, and by over 3°C under RCP8.5.

Summers are expected to become hotter and longer, with more frequent days exceeding 35°C, especially in lowland areas such as Alba (European Environment Agency, 2021).

Precipitation projections are more complex but suggest an overall increase in extreme rainfall events during the transitional seasons, while summer rainfall is likely to decline (CMCC, as cited in Comune di Alba, 2022). This may lead to a heightened risk of both flooding and drought, depending on seasonal dynamics. According to the Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), the combination of hotter, drier summers and wetter springs may disrupt both agricultural production cycles and peak tourism flows, particularly in wine and food tourism (Comune di Alba, 2022).

Projected climatic changes are also expected to increase wildfire risk, particularly in forested and semi-natural areas surrounding rural tourist trails (European Environment Agency, 2021). This poses challenges not only for environmental safety but also for landscape preservation and visitor confidence.

4.3 Implications for Tourism and Local Planning

The observed and projected climate trends pose several strategic challenges for tourism in ALBA and the Langhe. Rising summer temperatures may reduce the attractiveness of outdoor activities, especially for older tourists, while shifting weather patterns could affect the reliability of traditional cultural and gastronomic events (European Environment Agency, 2021).

For example, the changing timing of the grape harvest and truffle season may require event organizers and hospitality providers to adapt their calendars and promotional strategies (Van Leeuwen et al., 2019; Zambon et al., 2022).

Additionally, the intensification of climate extremes necessitates the integration of climate risk assessments into tourism planning, infrastructure development, and landscape management (Comune di Alba, 2022). Policies that promote seasonal diversification, sustainable mobility, water conservation, and green infrastructure will be critical to enhancing the resilience of the tourism economy (European Environment Agency, 2021).

Municipal and regional authorities, in collaboration with scientific institutions such as ARPA Piemonte, must ensure that climate projections inform spatial planning and tourism policy frameworks, particularly in areas of UNESCO heritage significance (ARPA Piemonte, 2023).

Visual aids such as climate trend graphs and vulnerability heatmaps can be included to support decision-making and raise awareness among stakeholders. Furthermore, monitoring and early warning systems should be scaled up to protect both visitors and residents from climate-related disruptions (Comune di Alba, 2022).

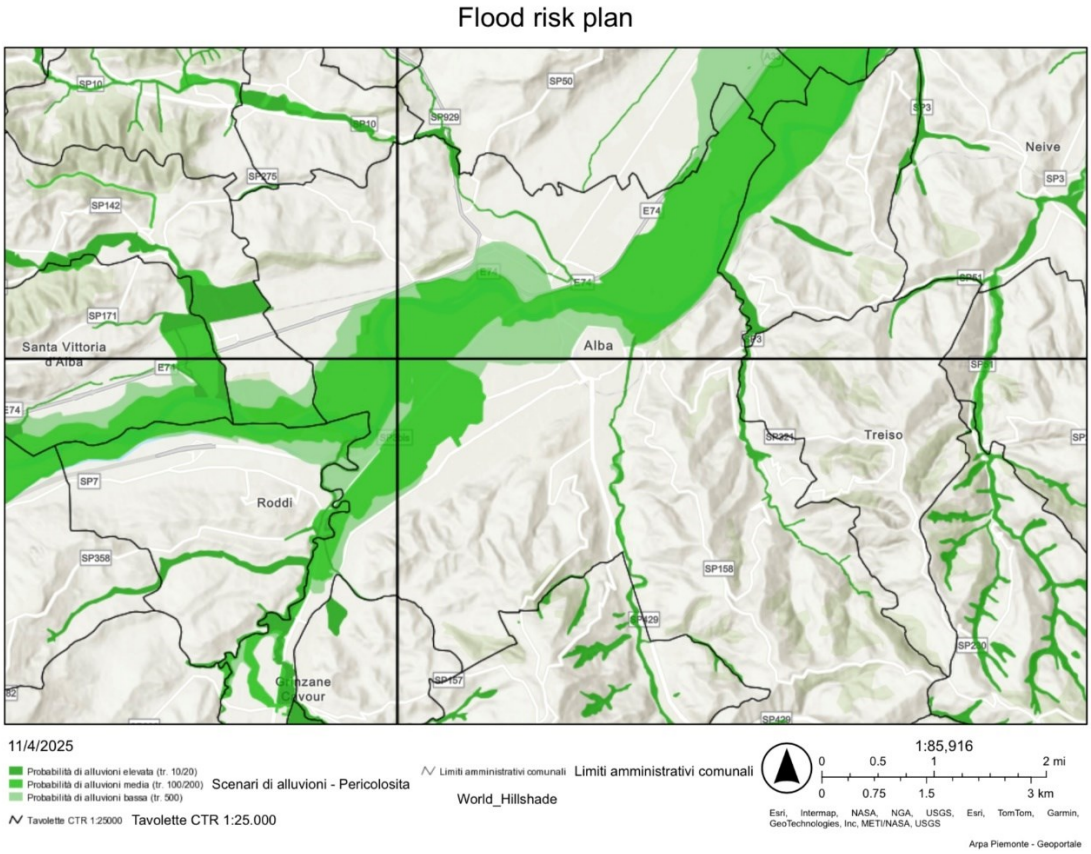

Figure 16. Flood risk zones in Alba and surrounding municipalities, based on ARPA Piemonte hydrological hazard classifications.
Source: ARPA Piemonte (2025).

5. Interviews with Local Experts and Residents

5.1 Current State and Unique Value of Tourism in Alba

Over the past two decades, the tourism sector in Alba and the wider Langhe region has experienced continuous and significant growth. This expansion is primarily driven by the area's internationally recognized **wine and gastronomic culture**, which has become a powerful symbol of local identity. The vineyards and winemaking traditions have not only shaped the **hilly landscape** but also earned the Langhe and Roero areas designation as **UNESCO World Heritage Sites**, acknowledging their value as a living cultural landscape.

A key contributor to this reputation is the **White Truffle of Alba**, a highly prized seasonal delicacy that draws thousands of visitors during the truffle season and especially during the annual **International White Truffle Fair**. This has solidified Alba's role as a central node in the region's food-tourism economy and reinforced the synergy between **rural agriculture** and **cultural tourism**.

Things that make this area unique and attractive to tourists throughout the year:

The Langhe region offers a year-round tourism experience, deeply tied to its agricultural calendar and cultural heritage. In **spring**, visitors are attracted by the scenic beauty of **vineyard blossoms**, while in **autumn**, the landscape transforms with vibrant **foliage**, making it a peak season for nature lovers and photographers. During **late autumn and winter**, tourists are drawn to **wine cellars** to witness the process of wine production and to participate in **truffle hunting excursions**, activities that maintain high visitor interest even in colder months.

Beyond seasonal attractions, Langhe's uniqueness lies in its blend of **traditional rural life** and **historical heritage**:

- Traditional sports like **pallone elastico** and **pantalera**, played in village squares
- Over **30 accessible medieval castles** across the hills, offering cultural tourism routes
- The presence of **wild orchids**, with the highest concentration in Italy blooming between April and June
- A network of **museums**, including:
    - MUDET – Museum of Truffles (Alba)
    - Wine Museum (Barolo)
    - Museum of Magic (Cherasco)
    - Craveri Museum (Bra)
    - Eusebio Museum (Alba)
    - Museum of Chalks (Magliano)

This rich **mosaic of biodiversity, heritage, and tradition** positions Langhe as a distinctive and multi-seasonal destination.

5.2 Observed Impacts of Climate Change on Tourism Offerings

In recent years, stakeholders in the Langhe region have observed both positive and negative effects of climate change on the local tourism sector. According to the expert interview, one of the more noticeable positive trends has been the extension of the tourism season.

Milder springs and autumns have allowed for a longer period of outdoor activities, leading to increased visitation beyond the traditional high seasons. This extension has benefitted local businesses by smoothing demand curves and offering more flexibility in tourism planning.

However, several negative impacts have simultaneously emerged. Among the most significant is the alteration of the region's distinctive landscape rhythms. The phenomenon of "foliage," which attracts many tourists in autumn, has diminished in intensity due to delayed leaf-fall and prolonged greenery. This reduces the aesthetic appeal of the landscape and alters visitors' expectations tied to seasonal color changes.

More critically, climate change has begun to disrupt the ecological processes that underpin Alba's tourism experience. Extended droughts and unpredictable weather patterns have led to a significant decline in truffle yields, one of the region's key attractions. Furthermore, increasingly frequent extreme weather events such as cloudbursts, hailstorms, and strong winds have caused damage to properties, cancellations of tourist reservations, and logistical complications for tourism operators.

These observations highlight the dual nature of climate impacts on tourism: while certain shifts may temporarily expand opportunity windows, they also introduce new risks that threaten the reliability, safety, and identity of the tourism offer in the Langhe. Adaptive strategies must therefore be responsive to this evolving landscape and capable of addressing both opportunity and vulnerability.

Figure 16. showing yearly growth, with a visible dip around 2020 likely due to COVID-19.

Source. Adapted by the author using data from Regione Piemonte Tourism Statistics (2024)

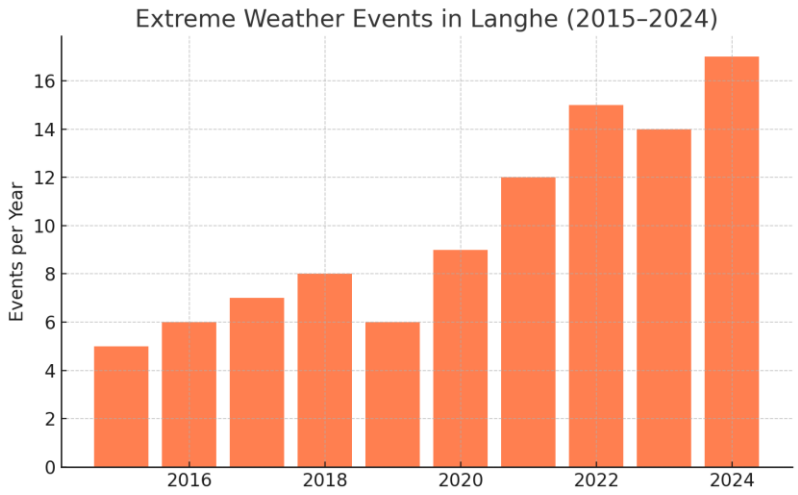

Figure 18: Extreme Weather Events in the Langhe (2015–2024). An increasing trend in extreme weather events in the Langhe region may correlate with tourism vulnerabilities, especially during peak seasons.

Source: Elaborated by the author based on local climate impact reports (e.g., ARPA Piemonte, 2024)

5.3 Concerns Among Operators and Adaptation Gaps

The evolving climate context has prompted increasing concern among tourism operators in Alba and the wider Langhe region. The interviewee outlined two primary areas of apprehension that are shaping the local discourse on climate and tourism.

The first concern relates to the growing unpredictability of weather patterns and their direct impact on tourist flows. For example, extended periods of unseasonal rainfall in early 2025 led to a considerable number of booking cancellations. Such events not only affect the immediate economic performance of hospitality and service providers but also erode long-term visitor confidence and planning.

Tourism in the Langhe, being deeply seasonal and linked to landscape-based experiences, is particularly vulnerable to such climatic irregularities.

The second area of concern centers around rising operational costs for tourism-related businesses. Higher temperatures in summer have increased the demand for air-conditioned accommodation and swimming pool facilities.

Establishments lacking such amenities face reduced competitiveness during hotter months, while those that do offer them experience steadily rising energy costs. This economic burden disproportionately affects smaller, family-run businesses that constitute the backbone of the region's rural hospitality sector.

5.4 Impacts on Wine, Truffles, Hazelnuts, and Local Economy

Effects of Recent Weather Patterns and Temperature Changes on Wine and Food-Related Activities

The Langhe region's identity and economy are intimately tied to its agricultural products particularly wine, truffles, and hazelnuts. These commodities are not only key economic drivers but also essential elements of the area's tourism appeal.

However, as the interview with a local expert revealed, recent climate-related changes are profoundly affecting both production and product quality, with cascading implications for tourism and the broader regional economy.

The wine sector, central to Langhe's global reputation, is experiencing significant changes in production dynamics. Over the past three decades, the grape harvest has shifted forward by nearly a month due to warming temperatures. This early harvest affects the chemical composition of the grapes, often resulting in musts with higher sugar content, which in turn produces wines with elevated alcohol levels.

While this may be manageable for structured wines such as Barolo, Barbaresco, and Barbera, it poses a serious quality challenge for lighter, ready-to-drink varieties like Dolcetto, Grignolino, Brachetto, Freisa, and whites such as Arneis and Favorita. The inability of these wines to age well or retain balance may compromise their market competitiveness and, by extension, reduce their touristic appeal.

Additionally, to maintain suitable growing conditions, many wine producers have begun relocating their vineyards to higher elevations above 400 to 500 meters. While this adaptation strategy helps mitigate the effects of rising temperatures, it introduces ecological concerns. Higher-altitude vineyard expansion often requires deforestation and encroachment into areas with different soil chemistry and microclimates, potentially altering the landscape character and affecting the integrity of the UNESCO-designated cultural landscape.

These transformations could undermine the visual and ecological assets that attract wine tourists in the first place.

The impact on hazelnut production another hallmark of the Langhe economy is equally troubling. Due to warmer winters and increased climate volatility, the hazelnut yield has plummeted by an estimated 60–70% over the last three years.

In some cases, farmers have foregone harvesting altogether, as labor and processing costs outweigh the value of the diminished harvest. This economic strain weakens a critical part of the rural economy and reduces the supply of a product central to local gastronomy and identity.

Truffle production has also been disrupted. Prolonged dry periods reduce the availability of white truffles, one of Alba's most valuable and emblematic products. Given the central role of truffle-related tourism particularly during the Alba White Truffle Fair such reductions threaten not only agricultural revenues but also seasonal tourism flows.

5.5 Awareness, Engagement, and Role of Local Institutions

The effectiveness of climate adaptation in tourism is closely linked to the awareness levels and engagement of both institutions and local stakeholders. In the Langhe region, although environmental and climate concerns are increasingly acknowledged by producers and tourism operators, institutional responses remain fragmented and often lack strategic coordination.

The interviewee highlighted that, at present, there are no fully structured adaptation plans for the tourism sector specifically. While some awareness-raising activities have been organized for tourism professionals mainly aimed at providing information about climate risks and sustainable practices these remain sporadic and lack a comprehensive implementation framework. Notably, more structured adaptation initiatives have emerged in the agricultural sector. For instance, winemakers have adopted anti-hail nets, reinstated traditional practices like vineyard grassing to enhance soil stability, and collaborated on reforestation projects to restore truffle woodlands. However, these efforts focus more on production resilience than on broader tourism infrastructure or visitor experience planning.

Institutional engagement varies across administrative levels. The Municipality of Alba, for example, has made significant strides by joining the EU Covenant of Mayors and developing a Sustainable Energy and Climate Action Plan (PAESC), with the goal of reducing emissions by 55% by 2030. This demonstrates a willingness to align with broader European goals, yet concrete linkages between this plan and tourism-specific strategies are not clearly established.

The interview also suggests a notable gap in coordination between institutions and local tourism actors. While public entities show increasing concern, tourism development initiatives still largely originate from private or associative sectors. Entities like the Langhe Roero and Monferrato Tourism Board and the White Truffle Fair Committee are actively promoting sustainability and have hosted training and networking sessions on climate change. These efforts, though commendable, would benefit from being integrated into formal regional policies.

Moreover, the lack of a unified local climate adaptation strategy means that opportunities for harmonizing sustainable tourism with landscape conservation, energy transition, and mobility planning are being missed. The interviewee underlined the need for stronger political leadership and planning capacity to guide a coordinated response.

In summary, while there are promising signs of awareness and localized efforts, the role of local institutions in enabling a climate-resilient tourism model in the Langhe remains limited. Enhanced governance structures, dedicated funding mechanisms, and closer collaboration between municipalities, regional bodies, and tourism stakeholders will be essential to unlock the full potential of sustainable development in this climate-sensitive region.

5.6 Stakeholder Collaboration with Scientific Institutions

Scientific collaboration plays a critical role in developing informed strategies for climate adaptation and sustainability in tourism. However, in the case of Alba and the Langhe region, such cooperation remains limited and loosely structured. As the interviewee pointed out, there is currently "nothing particularly structured" in terms of systematic collaboration between tourism stakeholders and environmental or scientific organizations. While there are some notable partnerships, these efforts appear fragmented and lack integration into broader territorial planning processes.

One of the most significant initiatives involves the Fondazione Cassa di Risparmio di Cuneo, which has supported projects in collaboration with key academic and research institutions, including the University of Turin, the Polytechnic University of Turin, and EnviPark (Environmental Park). These partnerships have primarily focused on knowledge production and pilot projects related to climate resilience, renewable energy, and environmental monitoring. While not exclusively aimed at tourism, they provide a valuable knowledge base that tourism planners could draw upon.

In addition, dissemination efforts led by winegrower associations and meteorological societies such as the Italian Meteorological Society have attempted to bridge the gap between scientific data and local practice. These activities include workshops and educational materials aimed at helping agricultural producers, truffle hunters, and rural entrepreneurs better understand climatic shifts and adapt their operations accordingly.

Nevertheless, there is no formal platform or permanent forum where tourism operators, policymakers, and researchers can routinely interact and align strategies. This absence weakens the capacity of the tourism sector to proactively address climate risks through evidence-based action.

Strengthening these collaborative ties particularly through interdisciplinary research, shared data systems, and community-based adaptation planning could significantly enhance the region's readiness for future challenges.

5.7 Alignment of Local Policies with Broader Climate Goals

According to the interviewee, local tourism policies in the Langhe region currently show limited alignment with broader regional and national climate adaptation goals. While Italy has made formal progress on climate strategy such as the updated National Energy and Climate Plan (PNIEC) revised in July 2024 the practical implications at the local level remain unclear and weakly implemented. As the respondent noted, "no local practical implications have yet been seen." This disconnect underscores a critical policy gap: while high-level frameworks exist, they are not effectively operationalized in rural tourism contexts such as Langhe.

The lack of tangible measures and integration between national objectives and local tourism planning makes it difficult for operators and municipalities to act decisively on climate adaptation.

5.8 Role of Local Businesses and Tourism Operators

The interview highlighted the active engagement of local businesses, wine producers, and tourism operators in shaping the region's tourism future often taking initiative ahead of institutional responses. Associations such as the Langhe Roero and Monferrato Tourism Board, the UNESCO Wine Landscapes Association, and the Alba Truffle Fair Organization have initiated educational programs, climate awareness campaigns, and practical sustainability interventions. These include promoting shared mobility, improving waste management systems, and encouraging the installation of photovoltaic panels in agritourism and hospitality facilities.

While these efforts represent a grassroots commitment to sustainable tourism, the interviewee stressed that a comprehensive regional strategy is still lacking. Local operators show innovation and leadership, but require institutional support, policy alignment, and financial tools to scale these initiatives.

5.9 Long-Term Vision for Tourism under Climate Change

The interviewee presented a reflective and cautious vision of the future of tourism in Alba and Langhe. Emphasizing the deep interdependence between tourism and the natural landscape, the respondent warned that climate change poses existential risks to the area's value proposition. Unlike cities of art, where cultural heritage is more resistant to climate stress, Langhe's appeal depends on climate-sensitive assets such as wine production, truffles, and scenic rural vistas.

The interviewee described three major risks:

(1) deterioration of agricultural quality and biodiversity,
(2) increased frequency of extreme weather events affecting access, infrastructure, and visual landscapes,
(3) rising operational costs for hospitality providers. These dynamics could lead to declining competitiveness and economic instability if not addressed through robust planning.

5.10 Message to Young Researchers and Professionals

The interviewee offered a compelling call to action for young researchers and professionals focused on climate and tourism. First, they emphasized the urgent need for macro-level planning: a large-area adaptation and mitigation strategy capable of achieving climate neutrality by 2050. Second, they advocated for widespread education and communication efforts aimed at both tourism operators and local residents.

The goal is to build awareness of local vulnerabilities and foster pride in the region's biodiversity, culture, and agricultural strengths. Finally, the interviewee called for greater political courage and decisiveness among local institutions, emphasizing the importance of both opportunity creation and regulation.

These messages highlight the need for multi-level, participatory approaches in addressing climate risks and building a resilient tourism economy.

6.1 Current Adaptation Practices in Agriculture and Tourism

Over the past decade, both agricultural and tourism sectors in the Langhe region have begun to confront the impacts of climate change with adaptive responses (Regione Piemonte, 2021). Although these responses remain largely fragmented and driven by individual actors or associations, they reveal a growing awareness of climate risks and the need for resilient systems.

Agricultural Adaptation

In the agricultural sector, adaptation efforts have primarily targeted viticulture, hazelnut farming, and truffle cultivation the economic pillars of the region. Key strategies include:

- **Shifting vineyard locations:** As noted during stakeholder interviews, winegrowers are increasingly moving vineyards to higher altitudes (above 400–500 meters) to mitigate rising temperatures. While this helps maintain grape quality, it can lead to unintended consequences such as deforestation, soil erosion, and altered biodiversity in formerly wooded areas (Fraga et al., 2016; Moriondo et al., 2011).

- **Soil and water management**: To cope with prolonged droughts, some producers have adopted mulching, cover cropping (grassing), and low-impact tillage techniques that preserve soil moisture and improve fertility. Anti-hail nets and water retention systems have also been introduced in vineyards and orchards (Moriondo et al., 2011).

- **Truffle habitat conservation:** In response to declining truffle yields, local truffle hunters and associations have planted thousands of host trees to restore suitable forest ecosystems, creating a more stable environment for truffle growth despite erratic weather patterns (Hall et al., 2007).

Tourism Adaptation

While agricultural adaptation is relatively advanced, the tourism sector has not adopted systematic responses. Some encouraging efforts include:

- **Shifting tourism timing:** Many operators are now promoting off-season visits to avoid climate-related crowding and discomfort during extreme summer heat. Spring and early winter are marketed as alternatives, aligning better with milder conditions and cultural experiences such as wine cellar visits or truffle hunting (Bourdeau & Mao, 2011).

- **Facility upgrades:** Some hotels and agriturismi have invested in passive cooling techniques, solar panels, water-saving systems, and shaded outdoor spaces. However, such upgrades are more common among larger or better-funded enterprises (Bourdeau & Mao, 2011).

- **Awareness initiatives:** Local tourism boards (e.g., Ente Fiera Internazionale del Tartufo Bianco, Ente Turismo Langhe Monferrato Roero) have begun disseminating climate-related information through workshops and publications, but coordination across municipalities remains limited (Regione Piemonte, 2021).Despite these initiatives, tourism-related adaptation is hindered by limited funding, a lack of clear institutional

mandates, and fragmented governance. Most responses remain reactive rather than proactive, highlighting the need for stronger strategic planning frameworks (Bourdeau & Mao, 2011; Regione Piemonte, 2021).

6.2 Sustainable Tourism Development Practices and Challenges

The Langhe region has emerged as a leading model of integrated food, wine, and cultural tourism. Yet sustaining this success under climate stress requires a reassessment of development patterns, infrastructural capacity, and governance structures (Fuller, Kellert, & Serrell, 2021).

Current Sustainable Practices

Several ongoing practices support the region's sustainable development goals:

- Regional branding for authenticity: The "Langhe Monferrato Roero" identity promotes slow tourism, local sourcing, and traditional experiences. Labels such as DOCG wine certifications, local product trails, and agritourism designations reinforce environmentally respectful tourism (Fuller et al., 2021).
- Landscape conservation: The UNESCO designation requires local stakeholders to preserve the visual integrity of vineyard landscapes. This has incentivized landscape restoration projects and controlled urban development (UNESCO, 2014).
- Cultural heritage integration: Events like Vinum and the Truffle Fair not only promote local economy but foster intergenerational knowledge sharing and community pride. They offer opportunities to tie tourism to heritage conservation (Comune di Alba, 2023).

Challenges

However, several critical challenges undermine the sustainability of tourism in Alba and the Langhe:

- Seasonality and congestion: Overreliance on autumn tourism (for wine and truffle seasons) leads to overcrowding, strains infrastructure, and creates uneven income distribution for tourism actors. It also amplifies vulnerability to climate disruptions (e.g., hail, late harvests) (Dodds & Butler, 2010).

- Gentrification and affordability: Rising real estate prices in Alba and tourist hotspots make it difficult for local residents and young workers to remain, leading to demographic shifts and loss of cultural vibrancy (Dodds & Butler, 2010).

- Weak governance integration: Tourism, agriculture, and environmental management are often handled by separate authorities. This fragmentation prevents coordinated climate strategies and policy implementation across sectors (Dodds & Butler, 2010).

- Low climate preparedness: Many operators, especially small enterprises, lack the resources or knowledge to assess their climate vulnerabilities or adopt resilient practices. There is also a shortage of training programs and financial support for innovation in climate-sensitive tourism (Comune di Alba, 2023).

6.3 Proposals for Langhe: Planning and Policy Recommendations

Building a resilient and inclusive tourism model in the Langhe region requires multi-level governance, place-based strategies, and climate foresight (IPCC, 2022). The following policy recommendations are organized across four key domains: spatial planning, governance, capacity building, and economic incentives.

1. Integrated Spatial and Landscape Planning

- Introduce zoning tools that prioritize low-impact development, protect rural settlement patterns, and preserve view corridors crucial to the Langhe's tourism appeal (EEA, 2020).
- Design green corridors and agroforestry buffers to mitigate soil erosion and biodiversity loss caused by vineyard expansion into forested hills (EEA, 2020).
- Encourage the use of climate-resilient materials and energy-efficient designs in tourism infrastructure, guided by updated building codes (IPCC, 2022).

2. Governance and Institutional Coordination

- Establish a regional climate-tourism coordination body involving stakeholders from agriculture, tourism, heritage, and environmental sectors (IPCC, 2022). This body could monitor risks, plan adaptation, and secure funding.
- Strengthen the role of municipal planning tools (e.g., PAESCs: "Piano d'Azione per l'Energia Sostenibile e il Clima", "Sustainable Energy and Climate Action Plan") in tourism strategy, ensuring climate targets are reflected in tourism and land use policies (EEA, 2020).
- Collaborate with ARPA Piemonte, local universities, and Envipark to support climate data sharing and scenario modeling for tourism operators (IPCC, 2022).

3. Capacity Building and Awareness

- Launch targeted training programs for small and medium tourism enterprises on sustainable practices (e.g., water conservation, digital marketing, risk preparedness) (EEA, 2020).
- Support community-based adaptation initiatives such as "climate stewards" in villages, responsible for disseminating information and mobilizing local action (IPCC, 2022).
- Integrate climate education into tourism experiences (e.g., guided walks that explain environmental risks and traditional adaptation techniques) (EEA, 2020).

4. Economic and Fiscal Tools

- Offer grants or tax incentives for agriturismi and B&Bs adopting green technologies (e.g., solar power, rainwater harvesting, thermal insulation) (EEA, 2020).
- Promote a "tourism for regeneration" fund supported by seasonal tourist taxes, directed toward conservation projects, biodiversity corridors, and youth entrepreneurship (IPCC, 2022).
- Develop certification systems (e.g., "Langhe Climate-Conscious Tourism") that reward enterprises demonstrating commitment to low-impact, year-round, inclusive tourism models (EEA, 2020).

Final Reflection

If carefully planned and collaboratively governed, tourism in Alba and the Langhe can become not just resilient to climate change but a powerful engine for rural regeneration, environmental stewardship, and cultural continuity (IPCC, 2022). The time to act is now: through targeted policy, institutional commitment, and grassroots innovation, the region can secure its future as a model for sustainable rural tourism in Europe.

INTERGRATION WITH REGIONAL AND LOCAL PLANNING FRAMEOWRK

7.1 Overview of National and Regional Climate Planning in Italy

Italy has made significant strides in structuring its national and regional responses to climate change, guided by both European Union directives and domestic legislation. The overarching framework for climate policy at the national level is defined by the National Energy and Climate Plan (Piano Nazionale Integrato per l'Energia e il Clima – PNIEC), which outlines objectives for reducing greenhouse gas emissions, improving energy efficiency, and increasing the share of renewable energy sources by 2030 (Regione Piemonte, 2020).

Updated in July 2024, the PNIEC aligns with the European Green Deal and the Fit for 55 packages and introduces mitigation targets and sectoral actions relevant to tourism, agriculture, and regional development.

Complementing the PNIEC is the National Adaptation Strategy to Climate Change (Strategia Nazionale di Adattamento ai Cambiamenti Climatici – SNACC), which identifies climate-related vulnerabilities across Italy and recommends strategic adaptation measures across sectors and regions. While the SNACC emphasizes the importance of safeguarding Italy's natural and cultural landscapes such as those in Piedmont it lacks binding implementation mechanisms, thus leaving a crucial role to regional and municipal authorities in operationalizing its goals.

At the regional level, the Piemonte Region has developed its own climate adaptation and mitigation instruments in alignment with national guidelines. Piemonte's regional strategy includes the Programma Regionale di Sviluppo Sostenibile (PRSS) and the Climate Change Adaptation Plan (Piano di Adattamento ai Cambiamenti Climatici – PACC), which address sector-specific vulnerabilities, including those in agriculture, biodiversity, and rural tourism (Regione Piemonte, 2020).

These plans are often informed by data and scientific input from institutions like ARPA Piemonte (Agenzia Regionale per la Protezione Ambientale), which provides climate monitoring, environmental risk maps, and territorial planning tools. For instance, ARPA's flood risk mapping, accessible via its Geoportale, is a key planning resource for municipalities such as Alba, which are required by law to incorporate hydrogeological risk into their urban planning frameworks (ARPA Piemonte, 2024; Regione Piemonte, 2020).

In terms of governance instruments, many municipalities in Piemonte, including the city of Alba, have joined the Covenant of Mayors for Climate and Energy a European initiative aimed at promoting local-level mitigation and adaptation (Comune di Alba, 2023).

Through this initiative, Alba developed its Sustainable Energy Action Plan (PAES) in 2016, which was later updated to the Sustainable Energy and Climate Action Plan (PAESC) to incorporate climate adaptation. The PAESC sets targets for reducing CO_2 emissions by 55% by 2030 and includes initiatives related to sustainable mobility, energy retrofitting of public buildings, and awareness campaigns for climate-resilient lifestyles (Comune di Alba, 2023).

Despite these advances, challenges remain in terms of coordination, funding, and public engagement. Climate planning in Italy often suffers from fragmentation, limited stakeholder involvement, and a lack of mechanisms to translate strategic intentions into local action (Regione Piemonte, 2020). Particularly in rural regions like Langhe, where tourism, agriculture, and landscape heritage are tightly interlinked, climate strategies must better integrate local needs with higher-level objectives.

This overview of national and regional frameworks establishes the foundation for analyzing how specific planning instruments especially those of the Piemonte Region, the Province of Cuneo, and the Comune di Alba address the challenges and opportunities of climate change adaptation in tourism-dependent rural landscapes like Langhe.

7.2 Piemonte Regional Plans

The Regione Piemonte plays a crucial role in coordinating climate and spatial planning initiatives that affect tourism, agriculture, land use, and environmental sustainability throughout the region, including the Langhe and the city of Alba.

Over the past decade, several regional planning tools have been developed to address the challenges posed by climate change and to support a sustainable transition across sectors (Regione Piemonte, 2021).

- **Piano Territoriale Regionale (PTR)**

The Piano Territoriale Regionale (PTR) is Piemonte's overarching spatial planning document. It outlines guidelines for land use, environmental protection, and infrastructure development across the entire region. One of the key principles of the PTR is the protection of landscapes, particularly those recognized as cultural heritage sites such as the Langhe-Roero and Monferrato vineyard landscapes (UNESCO).
The PTR emphasizes the need for integrated management of rural and natural areas, calling for synergy between tourism, agriculture, and ecosystem conservation. It includes references to preserving scenic quality, rural identity, and biodiversity elements that directly relate to Alba's tourism development.

- **Piano Regionale di Adattamento ai Cambiamenti Climatici (PRACC)**

The PRACC, Piemonte's official Climate Adaptation Plan, defines strategies for increasing the region's resilience to climate change. It identifies vulnerable sectors (e.g., agriculture, water, forests, tourism) and proposes adaptation actions such as soil conservation, water resource management, biodiversity protection, and sustainable tourism promotion (Regione Piemonte, 2021). For tourism, the PRACC encourages diversification of offers throughout the year, strengthening infrastructure to cope with extreme weather, and educating stakeholders on climate risks.

ALBA and the Langhe, with their strong dependence on seasonal agricultural products (e.g., wine, hazelnuts, truffles), are clearly framed within this vulnerability. However, while the plan is comprehensive, its application at the municipal level remains variable.

- **Piano Paesaggistico Regionale (PPR)**

The Piano Paesaggistico Regionale (Regional Landscape Plan), drafted in coordination with the Italian Ministry of Culture, provides tools for landscape conservation and enhancement. It links planning policy with the European Landscape Convention's goals, emphasizing the visual, cultural, and ecological values of regional landscapes.
In the Langhe, this is especially important given the tourism sector's dependence on high-quality scenery. The PPR identifies historic rural systems, terraced vineyards, and hilltop villages as priority areas for protection, while encouraging local authorities to integrate landscape quality into development planning.

- **Piano Energetico Ambientale Regionale (PEAR) and Air Quality Plans**

Piemonte has also developed plans for energy transition (PEAR) and air quality improvement. These frameworks promote renewable energy, emissions reduction, and cleaner mobility solutions factors relevant to both tourism infrastructure and environmental health. Initiatives such as photovoltaic incentives for agritourism businesses, eco-certification for accommodations, and promotion of public transport in rural destinations are partially supported by these regional plans.

Limitations and Opportunities

Despite the progressive nature of these plans, several limitations have been observed. Implementation varies significantly across municipalities. Smaller towns, such as those in the Langhe hills, often lack the technical and financial resources to translate regional goals into local action. Furthermore, while most plans acknowledge climate risk to agriculture, they give limited attention to tourism-specific vulnerabilities or the need for climate-resilient visitor infrastructure.

Nonetheless, these instruments offer a solid foundation for coordination between regional and local planning authorities. There is growing momentum, particularly through EU funding and partnerships with scientific institutions, to operationalize these plans at the provincial and municipal levels (European Commission, 2021).

7.3 Provincial Strategy – Provincia di Cuneo

The Provincia di Cuneo, encompassing ALBA and the Langhe region, plays a strategic intermediate role between regional directives and local municipal planning. As one of the largest provinces in Italy by area, and one with a significant share of rural, agricultural, and UNESCO-designated landscapes, it holds responsibilities related to territorial coordination, environmental monitoring, infrastructure, and support for local governance (Provincia di Cuneo, 2022).

Provincial Territorial Coordination Plan (PTCP)

The principal planning instrument at the provincial level is the Piano Territoriale di Coordinamento Provinciale (PTCP). This plan outlines spatial development priorities and environmental conservation goals for the province as a whole. While less frequently updated than regional or municipal plans, the PTCP establishes guidelines that municipalities are required to take into account when developing their own local plans.

Within the PTCP, the Langhe area is designated as a "landscape of high cultural and ecological value," reflecting its unique blend of productive vineyards, natural habitats, and historic towns (Provincia di Cuneo, 2022). Specific attention is given to limiting urban sprawl, regulating hillside construction, and preserving panoramic views all aspects directly relevant to sustaining the tourism offer of the region.

The PTCP also identifies areas prone to hydrogeological risk, including the flood-prone Tanaro River corridor near ALBA. This geophysical risk mapping often developed in collaboration with ARPA Piemonte serves as a tool for regulating land use and for defining priority zones for civil protection, infrastructure resilience, and water management.

Climate Monitoring and Environmental Data

While the Provincia di Cuneo does not have a dedicated climate adaptation plan, it plays an important role in climate and environmental monitoring through collaboration with regional agencies such as ARPA Piemonte and scientific bodies such as the University of Turin. These partnerships contribute to data collection on temperature trends, precipitation variability, biodiversity changes, and land degradation all of which are crucial for both agricultural and tourism planning.

One particularly useful initiative involves the maintenance and dissemination of local flood hazard and landslide risk maps (LIFE Project Reports, 2020). These are essential for urban planning in flood-prone areas like ALBA and for ensuring the safety of tourist infrastructure and events held near rivers or slopes.

Tourism Support and Strategic Projects

The province also plays an indirect but relevant role in supporting tourism development. It has supported the candidacy of the Langhe-Roero area as a UNESCO World Heritage site and collaborates with consortia such as the Ente Turismo Langhe Monferrato Roero and various local GALs (Gruppi di Azione Locale) to implement rural development initiatives. These programs support small hospitality businesses, improve local roads and signage, and promote the digitalization and environmental certification of tourist services.

Although no formal climate-tourism strategy is currently operational at the provincial level, several projects co-funded by EU rural development programs (PSR Piemonte) include components related to climate resilience, biodiversity protection, and sustainable mobility all indirectly relevant to a more climate-conscious form of tourism (LIFE Project Reports, 2020).

Limitations and Opportunities

The main limitation at the provincial level is the lack of an integrated adaptation plan that directly links climate science to tourism development. Nevertheless, the Provincia di Cuneo remains a key factor in facilitating inter-municipal cooperation, technical assistance, and data-sharing especially relevant for smaller municipalities with limited planning capacity.
Moving forward, the province could play a stronger coordinating role by encouraging joint initiatives across municipalities (e.g., shared electric mobility services, landscape restoration programs, climate-safe trail infrastructure) and by lobbying for provincial adaptation guidelines that include tourism as a strategic focus (Provincia di Cuneo, 2022).

7.4 Local Planning – Comune di ALBA

The Comune di ALBA, as the administrative and economic heart of the Langhe region, has demonstrated an evolving awareness of the environmental and climate challenges affecting its territory. While not historically a leader in climate action, the municipality has recently begun integrating climate-related concerns into its local planning instruments, aligning its efforts with broader regional and European sustainability goals (Comune di Alba, 2023).

Urban Planning Instruments and Regulatory Framework

The principal planning document guiding land use in ALBA is the Piano Regolatore Generale Comunale (PRGC). This general urban plan regulates building densities, land zoning, transportation infrastructure, and environmental protection at the municipal scale. The current PRGC integrates key conservation provisions, particularly in hillside areas around the Tanaro River and zones designated as part of the UNESCO World Heritage site.

These include restrictions on new hillside developments, preservation of rural architectural typologies, and the protection of visual corridors important for tourism. In terms of climate adaptation and risk prevention, the municipality relies on the indications provided by ARPA Piemonte and the Piano di Assetto Idrogeologico (PAI), which identifies flood-prone areas. This is particularly relevant given that the city of ALBA lies in the Tanaro River floodplain.

PAESC: Local Climate and Energy Action Plan

A significant step in ALBA's climate planning was the development of its Piano d'Azione per l'Energia Sostenibile e il Clima (PAESC), which builds upon the earlier PAES (Sustainable Energy Action Plan) framework. Alba joined the EU's Covenant of Mayors and committed to reduce greenhouse gas emissions by at least 40% by 2030 and to improve resilience to climate-related risks (Comune di Alba, 2023).

The updated PAESC includes several actions relevant to both tourism and broader environmental goals:

- Promotion of energy-efficient public buildings and low-emission transport
- Encouragement of green roofs and permeable surfaces to reduce urban heat and manage rainwater
- Awareness campaigns targeting citizens and businesses on climate adaptation and energy-saving practices
- Monitoring tools to assess climate vulnerability and emissions across municipal sectors

While tourism is not a primary focus of the PAESC, its measures indirectly benefit the tourism sector by enhancing the environmental quality of the urban core, improving air quality, and protecting heritage assets from weather-related risks.

Tourism and Landscape Management

ALBA's municipal strategies for tourism development emphasize quality over quantity, with a focus on preserving cultural landscapes and promoting sustainable experiences. The city's cultural calendar (e.g., the Truffle Fair, Vinum) is coordinated in tandem with infrastructure improvements, pedestrianization, and visitor service expansion, often supported by EU co-funding through the GAL Langhe Roero Leader program (UNESCO, 2023).
The municipality also supports efforts to regulate tourist flows during peak seasons and has initiated plans to develop digital monitoring tools for accommodation capacities and visitor movement potentially useful for future climate-sensitive planning.

Challenges and Future Opportunities

Despite progress, several limitations remain. The PRGC is not fully aligned with long-term climate projections, and adaptation measures specific to tourism infrastructure (e.g., shaded areas, water-saving facilities, fire safety in rural areas) are not yet institutionalized.
Additionally, enforcement of flood risk regulations and building standards may vary in peripheral areas.

Future updates of the PRGC and PAESC could explicitly address tourism-related climate risks, such as rising temperatures affecting visitor comfort, biodiversity loss in ecotourism zones, or infrastructure vulnerabilities during extreme events. Moreover, the municipality could benefit from structured partnerships with local universities, ARPA Piemonte, and tourism operators to co-develop place-based adaptation strategies grounded in scientific data and stakeholder input.

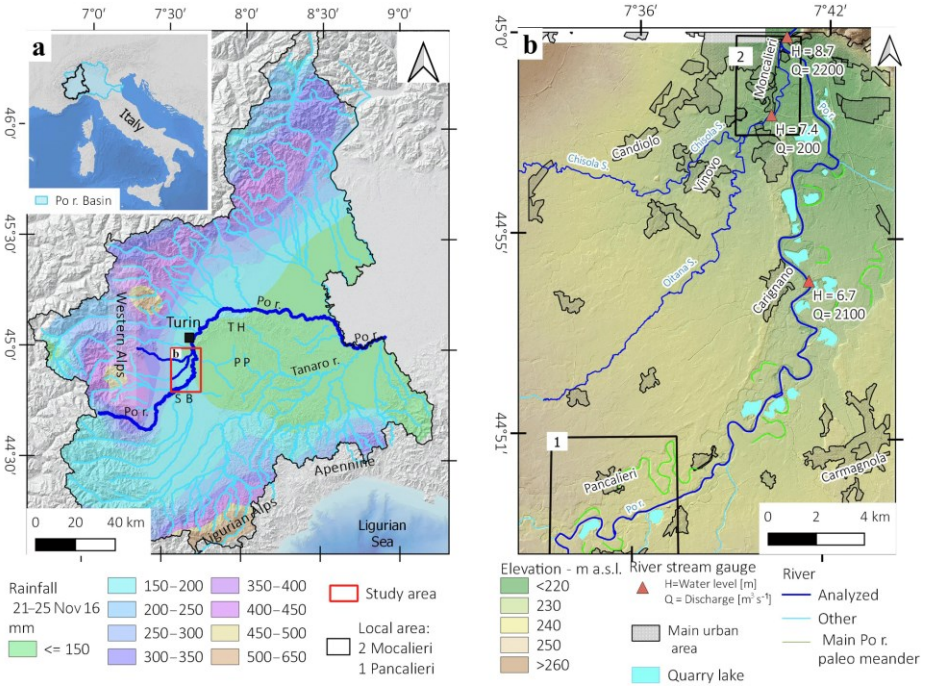

Figure 20. Flood risk areas in the Tanaro River Basin encompassing Alba and nearby valleys (ARPA Piemonte & CNR-IRPI, 2018).

Source: Reproduced from Cavallo et al. (2018).

7.5 Assessment of Integration with Tourism and Climate Goals

This section evaluates the extent to which national, regional, provincial, and local planning frameworks integrate tourism development with climate change mitigation and adaptation strategies. It aims to identify policy alignments, gaps, and opportunities for enhancing resilience and sustainability in the Langhe region, with a specific focus on the city of ALBA.

Coherence Across Planning Levels

A review of strategic documents from Italy's National Energy and Climate Plan (PNIEC) and the national tourism strategy, to regional (Piano di Adattamento ai Cambiamenti Climatici Piemonte), provincial (Provincia di Cuneo's Strategic Environmental Plans), and municipal (Comune di Alba's PAESC and PRGC) reveals partial alignment between climate policies and tourism-related objectives. While climate action and sustainable tourism are both recognized as priorities, their articulation across scales is uneven and often fragmented (Bourdeau & Mao, 2011).

For example, the Regione Piemonte adaptation strategy includes broad environmental goals and mentions sustainable tourism indirectly, but lacks dedicated actions targeting tourism infrastructure or seasonality management.

Similarly, ALBA's PAESC outlines general climate resilience targets such as reducing emissions, promoting green infrastructure, and managing hydrological risks but stops short of addressing tourism's direct contributions or vulnerabilities.

Sector-Specific Integration

There is some evidence of cross-sectoral initiatives, especially within agriculture and landscape management, which indirectly benefit tourism. Actions such as vineyard reforestation, anti-erosion measures, and biodiversity corridors improve the aesthetic and ecological value of rural areas, supporting year-round visitation. However, explicit planning tools designed to make tourism more climate-resilient such as visitor heat risk reduction, climate-informed scheduling of major events, or drought planning for tourism-dependent agritourism facilities are notably absent.

Moreover, tourism's role in financing landscape maintenance (through visitor fees or green tourism certification schemes) is not leveraged within public planning instruments, despite being relevant to preserving UNESCO landscapes and maintaining rural viability.

Institutional Collaboration and Governance

The interview conducted in ALBA highlights a gap between institutional climate planning and tourism stakeholder engagement. While some proactive organizations (e.g., the Langhe-Roero Tourism Board, Truffle Fair Committee) are implementing sustainability practices, there is no formalized platform for integrating their efforts into municipal or regional climate frameworks (Pirani & Tamea, 2021). This fragmentation limits coordinated adaptation, particularly in response to growing risks such as water scarcity, extreme weather, or seasonal imbalance in visitor flows.

Opportunities for Stronger Integration

Several opportunities exist to improve the coherence and effectiveness of tourism and climate planning:

- Incorporate tourism-specific vulnerability assessments into future PAESC and PRGC updates in ALBA.
- Develop a regional Sustainable Tourism and Climate Action Strategy led by Regione Piemonte with contributions from Provincia di Cuneo and local municipalities.
- Establish multi-stakeholder working groups linking tourism operators, environmental experts, and public authorities to co-design place-based adaptation strategies.
- Use data from ARPA Piemonte, regional tourism observatories, and scientific partners (e.g., University of Turin) to inform tourism adaptation indicators and early warning systems.
- Promote climate-responsive investments in rural mobility, shaded visitor infrastructure, green certifications for hotels, and digital tools for managing visitor flows.

Conclusion

Overall, while significant efforts exist at each governance level, the integration between tourism development and climate planning remains nascent and needs institutional reinforcement. Achieving effective, climate-resilient tourism in ALBA and the Langhe region will require a more structured approach, embedded within statutory planning documents and supported by cross-sectoral partnerships.

8.1 Summary of Research Findings

This thesis has investigated the multifaceted relationship between climate change and tourism in ALBA and the Langhe region of northern Italy. Through a combination of literature review, climate data analysis, interviews with local stakeholders, and an assessment of institutional responses, the research has identified both the strengths and vulnerabilities of this renowned rural tourism destination.

The Langhe region stands out for its unique cultural landscape, recognized by UNESCO, and its integration of tourism with agriculture especially wine production, truffle hunting, and artisanal food traditions. Tourism has become a key pillar of the local economy, with significant socio-economic impacts on employment, entrepreneurship, and territorial identity (ENIT, 2023).

However, climate change is reshaping these dynamics. Seasonal weather instability, extreme events (e.g., hailstorms, droughts), and shifting agricultural calendars are already affecting the quality of the visitor experience, the viability of wine and hazelnut production, and the availability of truffles (Bourdeau & Mao, 2011).

These pressures are not just theoretical risks they are being observed and felt by tourism operators and producers alike, as highlighted in the stakeholder interviews.

The research also found that although awareness of climate challenges is growing among operators, concrete adaptation strategies in the tourism sector are still limited. Most climate-related actions are concentrated in agriculture, while tourism responses remain fragmented, mostly focused on individual initiatives such as energy efficiency, separate waste collection, or event rescheduling.

Importantly, the analysis of local and regional planning documents revealed a limited integration of tourism and climate adaptation goals.

While planning tools like the PAESC (Sustainable Energy and Climate Action Plan) in ALBA acknowledge climate mitigation targets, they do not yet fully align with tourism development strategies. This lack of coordination across sectors and governance levels weakens the potential for a comprehensive and climate-resilient approach to tourism.

8.2 Expert Vision: Long-Term Risks and Reflections

The voices of local stakeholders especially those actively engaged in tourism, agriculture, and cultural promotion provide critical insights into the long-term trajectory of the Langhe region. Their reflections reinforce the notion that tourism in this area cannot be detached from its environmental context. The quality of wine, the quantity of truffles, the beauty of the vineyard landscapes all of these are climate-dependent (IPCC, 2022).

Stakeholders expressed a growing concern about the region's vulnerability to extreme weather events, reduced biodiversity, rising operational costs, and demographic pressures. They emphasized that while tourism in cities might adapt through infrastructure upgrades or indoor attractions, rural destinations like Langhe face deeper structural risks, because their attractiveness is grounded in fragile ecosystems and cultural landscapes (Pirani & Tamea, 2021).

Another risk is the slow institutional response. While awareness exists, there is not yet a shared, actionable strategy at the territorial level. Without stronger coordination between public bodies, scientific institutions, and private actors, adaptation measures risk being piecemeal and reactive rather than proactive (Pirani & Tamea, 2021).

The expert vision also included a call for better communication, citizen involvement, and education. The younger generation, in particular, must be engaged not only as workers or entrepreneurs but as informed stewards of their land and heritage. Otherwise, the long-term viability of tourism in Langhe may be undermined by environmental degradation, cultural loss, and economic instability.

8.3 Final Recommendations for Future Researchers and Policymakers

Based on the findings of this thesis, several recommendations are proposed to guide both academic research and policy design at local, regional, and national levels.

For Policymakers:

- Strengthen institutional integration: Regional and municipal planning tools (e.g., PRGC, PTI, PAESC) must explicitly incorporate tourism and climate resilience objectives. A coordinated vision is necessary to avoid fragmented or conflicting interventions (OECD, 2023).
- Develop climate-specific tourism policies: Local tourism boards should partner with environmental agencies (e.g., ARPA Piemonte) to assess vulnerabilities, develop risk maps, and design targeted interventions such as heatwave response protocols or drought-adapted visitor services (European Commission, 2021).
- Promote sustainable mobility and infrastructure: Investments in year-round public transport, green infrastructure, and eco-friendly accommodations will support both mitigation and adaptation c.
- Foster collaboration between tourism and agriculture: Given their shared dependence on climate-sensitive resources, policies should encourage knowledge exchange, shared

data systems, and joint initiatives (e.g., wine route certifications that include environmental criteria) (OECD, 2023).

For Researchers and Institutions:

- Expand local-scale climate monitoring: Data disaggregation for rural microclimates is essential. Regional projections should be supplemented with site-specific analysis to inform localized decision-making (OECD, 2023).
- Conduct longitudinal impact studies: Research should track climate impacts over time on specific tourism segments (e.g., enotourism, truffle hunting, hiking) and correlate them with visitor satisfaction, local income, and ecological indicators (OECD, 2023).
- Explore governance models: Comparative studies of rural tourism regions across Europe can identify best practices in integrated climate-tourism planning.
- Support participatory planning: Researchers can help design co-creation tools and workshops where residents, youth, and entrepreneurs contribute to local climate strategies (European Commission, 2021).

In sum, ALBA and the Langhe face a critical juncture. Tourism remains a powerful engine of socio-economic vitality, but its sustainability is increasingly at risk. Through improved governance, informed planning, and a commitment to local identity and ecosystems, the region can not only adapt to climate change but lead by example in shaping a more resilient, inclusive, and regenerative tourism model.

REFERENCES

- ALBA Weather and Climate Charts. (n.d.). Wandering Italy. https://www.wanderingitaly.com/weather/piedmont/alba
- Bourdeau, P., & Mao, P. (2011). Tourism and climate change: Risks, adaptation, and new opportunities. Journal of Alpine Research, 99(3). https://doi.org/10.4000/rga.1561
- Colangelo, A., Spandre, P., Terzago, S., & Mercalli, L. (2021). Climate change impacts on Piedmont's vineyards: Observations and trends. Italian Journal of Agrometeorology, 26(2), 53–63. https://doi.org/10.19199/2021.2.1120-4604.053
- Comune di ALBA. (2021). Piano d'Azione per l'Energia Sostenibile e il Clima (PAESC). https://www.comune.alba.cn.it/ambiente/paesc
- Ente Turismo Langhe Monferrato Roero. (2023). Strategic plans and sustainability initiatives. https://www.visitlmr.it/
- ENIT – Agenzia Nazionale del Turismo. (2023). Rapporto annuale sul turismo. https://www.enit.it
- European Commission. (2021). Forging a climate-resilient Europe – The new EU Strategy on Adaptation to Climate Change. https://climate.ec.europa.eu/eu-action/adaptation-climate-change_en
- European Commission. (2023). Smart specialisation platform: Piemonte region. https://s3platform.jrc.ec.europa.eu
- FAO. (2022). Climate change and rural tourism: Strategies for resilience. Food and Agriculture Organization of the United Nations. https://www.fao.org
- Geoportale ARPA Piemonte. (2024). Mappa del rischio idrogeologico in Piemonte. https://geoportale.arpa.piemonte.it/app/public?pg=mappa&ids=a62c4c72e766457a845552e51d3bf43d
- IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Sixth Assessment Report. Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/wg2/
- ISTAT. (2023). Indicatori del turismo in Italia: flussi turistici regionali e internazionali. https://www.istat.it
- Langhe Wine Region of Piemonte. (n.d.). Martha's Italy. https://www.marthasitaly.com/articles/langhe-wine-region-of-piemonte

- Map of cumulative visibility in the Langhe area. (n.d.). In ResearchGate. https://www.researchgate.net/figure/Map-of-cumulative-visibility-in-the-Langhe-area-The-squares-indicate-the_fig4_309933662
- OECD. (2023). Enhancing climate resilience in rural regions. https://www.oecd.org/environment/climate
- Pirani, F., & Tamea, S. (2021). Climate adaptation and stakeholder engagement in Piemonte: Policy integration and governance approaches. Environmental Policy and Governance, 31(3), 247–263. https://doi.org/10.1002/eet.1932
- Provincia di Cuneo. (2022). Piano Territoriale di Coordinamento Provinciale (PTCP). https://www.provincia.cuneo.it
- Regione Piemonte. (2020). Strategia regionale di adattamento ai cambiamenti climatici. https://www.regione.piemonte.it/web/temi/ambiente-territorio
- Regione Piemonte. (2023). Osservatorio regionale per il turismo. https://www.visitpiemonte-dmo.org/osservatorio-turismo/
- UNESCO. (2024). Vineyard Landscape of Piedmont: Langhe-Roero and Monferrato – Maps. World Heritage Centre. https://whc.unesco.org/en/list/1390/
- Visit Piemonte DMO. (2023). Annual tourism report and statistics. https://www.visitpiemonte-dmo.org