




## REFLECTIONS OF CLIMATE CHANGE ON CULTURAL LANDSCAPES

Prof. Dr. Ertan Düzgüneş<sup>1, a, \*</sup> - MSc Student Feride Erkan<sup>1, b</sup> - MSc Student Sedef Bozkuş<sup>1, c</sup>

*1Karadeniz Technical University, Faculty of Forestry, Department of Landscape Architecture, 61080, Trabzon-Türkiye*

*\*Corresponding Author:  
E-mail: ertan.duzgunes@ktu.edu.tr*

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a:  ORCID: 0000-0002-1523-9722, b:  ORCID: 0009-0006-9129-2177, c:  ORCID: 0009-0000-5412-3055

**ABSTRACT.** Climate change profoundly affects not only ecological processes but also cultural landscapes, which encompass historical, aesthetic, and socio-cultural values. Rising temperatures, sea-level rise, extreme weather events, and shifting precipitation patterns disrupt the ecological balance of these complex systems, which comprise both natural and human-made elements, undermine their spatial integrity, and threaten the traditional livelihoods of local communities. This study aims to examine the multidimensional impacts of climate change on cultural landscapes and to develop strategic recommendations for conservation policies.

The study addresses the climate-induced vulnerabilities of cultural landscapes of various scales and typologies, including historic urban fabrics listed as UNESCO World Heritage sites, coastal settlements, agricultural terrace systems, and sacred sites. In addition to erosion, salinisation, loss of biodiversity, and disruptions in hydrological cycles, the study discusses socio-economic impacts that threaten local communities' cultural practices and traditional knowledge systems. Furthermore, the study emphasises the importance of landscape-scale climate adaptation strategies, risk-based conservation approaches, green infrastructure implementation, and community engagement.

The findings indicate that cultural landscapes exhibit both physical and cultural vulnerabilities to climate change, and that conservation policies should not be limited to structural measures but instead be grounded in a holistic adaptation perspective incorporating local knowledge and community participation. Moreover, it provides a roadmap for decision-makers and planners to develop sustainable conservation strategies by adopting an interdisciplinary perspective at the intersection of climate change and cultural heritage.

**Keywords:** cultural landscape, climate change, conservation policies

### INTRODUCTION

Global-scale research shows that the impacts of climate change on cultural landscapes are rapidly intensifying. As noted in the IPCC's 2021 and 2023 reports, the 1.1°C temperature increase compared to pre-industrial levels has led to significant changes in the water cycle, soil moisture, vegetation cover, and ecosystem processes. These climatic shifts affect not only natural landscapes but also simultaneously influence the physical integrity, ecological functioning, and social continuity of cultural landscapes, thereby necessitating a reassessment of existing conservation approaches (1).

Climate change not only transforms the functioning of natural systems but also profoundly affects the spatial configurations, production practices, and cultural accumulations that societies have historically developed. Rising greenhouse gas concentrations generate impacts such as increased temperatures, sea-level rise, and intensified extreme weather events, creating multidimensional risks across a wide spectrum—from cultural heritage and sacred landscapes

to rural production areas and traditional settlement patterns (2). In this context, cultural landscapes are integrated systems that embody both tangible (structures, materials, morphology) and intangible (rituals, knowledge systems, practices of use) components, emerging as long-term outcomes of human–nature interaction.

Although cultural landscape typologies such as agricultural terraces, coastal landscapes, water management structures, and rural settlements have historically developed various adaptation strategies, the speed and scale of contemporary climate change often exceed their adaptive capacity, rendering it insufficient in many cases (3).

UNESCO’s conceptualization of cultural landscapes defines these areas as dynamic structures shaped by the continuous interaction between natural processes and human activities. Within this framework, vulnerabilities in cultural landscapes must be assessed not through isolated elements but through a relational and systems-oriented approach (4).

Vulnerability is generally examined across three main dimensions:

- **Physical Vulnerability:** Components such as building materials, architectural fabric, and morphological units are directly exposed to climatic stresses.
- **Ecological Vulnerability:** Habitat structure, species composition, the water cycle, and soil processes exhibit high sensitivity to climate change.
- **Socio-Cultural Vulnerability:** The continuity of cultural practices—including social organization, economic sustainability, traditional knowledge systems, and rituals—may weaken under climatic impacts (5).

These dimensions are not independent from one another. In most cases, they form mutually dependent cycles that trigger one another. For instance, disruptions in ecological processes may weaken social memory and cultural practices, while socio-economic vulnerability can constrain conservation capacities (6).

## IMPACTS OF CLIMATE CHANGE ON CULTURAL LANDSCAPES

### *Historic Urban Fabrics*

Historic urban fabrics are multilayered cultural landscapes that integrate construction techniques, street networks, and cultural practices from different periods. These fabrics constitute dynamic systems that encompass not only the physical environment but also social memory and the processes through which cultural identity is produced (7).

### *Physical Vulnerabilities*

Rising temperatures and changing precipitation regimes accelerate thermal expansion, crack formation, salt crystallization, and surface loss in traditional materials such as stone and brick. In sloped urban areas, increased surface runoff leads to erosion of stone pavements and weakening of ground stability, while infrastructure failures may occur along terraced streets (8). In coastal cities, increased salinity associated with sea-level rise accelerates crystallization and weathering processes in stone structures, thereby threatening their structural integrity (9) (Fig. 1).



**Fig. 1.** Stone wall composed of blocks exhibiting signs of salt-induced erosion

### *Ecological and Hydrological Impacts*

Loss of biodiversity and microclimatic changes increase temperature and moisture stress in historic fabrics, accelerating material deterioration. Irregularities in precipitation patterns can overwhelm drainage systems, creating significant risks of damage to both monumental and vernacular architecture during flash flood events (10) (Fig. 2).



**Fig. 2.** Damage to a historic building caused by biodiversity loss and microclimatic changes.

### *Socio-Economic Impacts*

Climate change generates income fluctuations and economic vulnerability in historic cities dependent on tourism, negatively affecting regular maintenance and repair processes. Rising maintenance costs, declining local populations, and changing usage patterns hinder the continuation of cultural practices and reduce levels of social ownership (11).

Globally, historic cities such as Venice, Dubrovnik, Fez, and Kyoto face climate-induced risks including sea-level rise, extreme precipitation, inadequate infrastructure, and salinization. Similarly, in T, the Historic Peninsula of Istanbul, Safranbolu, Mardin, and Beypazarı require adaptive conservation plans due to increasing climatic and socio-economic pressures (12) (Fig. 3).



*Fig. 3. Socio-Economic Impact*

### *Coastal Settlements*

Coastal settlements are dynamic cultural landscapes shaped by the interaction of natural processes and human activities, exhibiting high sensitivity to environmental changes. The integrated character of topography, geological structure, and coastal morphology situates these areas within a multilayered vulnerability to climate change. Sea-level rise, coastal erosion, salinization, and intensified storm regimes weaken the spatial integrity of coastal settlements and accelerate the process of “coastal squeeze,” which reduces the extent of natural buffer zones (13) (Fig. 4).



*Fig. 4. Coastal erosion and sea-level rise.*

### *Physical Vulnerabilities*

Coastal erosion, increased wave energy, and storm surges result in surface loss, stratification disruptions, and structural weakening in traditional materials such as stone, brick, and rubble masonry. Salinization processes accelerate crystallization as saline water infiltrates capillary spaces and evaporates triggering mechanisms such as blistering, disintegration, and internal collapse. Intensified storm and wave impacts test the durability of harbor structures, coastal walls, and religious/architectural buildings along the shoreline, while changes in sediment dynamics accelerate surface degradation in archaeological sites (14) (Fig. 5).



**Fig. 5.** Coastal erosion at Skipsea on the East Yorkshire coast.

### *Ecological and Hydrological Impacts*

Biodiversity loss in coastal ecosystems leads to the weakening of natural barriers and a reduction in the physical defense capacity of coastal settlements. Coral bleaching, the decline of seagrass beds, and the reduction of coastal vegetation facilitate the direct reach of wave energy to the shore, thereby accelerating erosion (15). Disruptions in the hydrological cycle increase saline intrusion into coastal aquifers, threatening freshwater resources. This process, referred to as “saltwater intrusion,” directly affects agriculture, tourism, and daily life activities, particularly in narrow coastal plains (16) (Fig. 6).



**Fig. 6.** Coral reef bleaching.

### *Socio-Economic Impacts*

Key economic activities such as fishing, small-scale agriculture, maritime trade, and tourism are becoming increasingly vulnerable due to climate-related risks. Storm damage, weakened port infrastructure, and changes in marine resources threaten the sustainability of local economies. In coastal cities dependent on tourism, economic fluctuations destabilize investments in the maintenance and conservation of cultural heritage, adversely affecting both the holistic preservation of spatial heritage and the traditional lifestyles of communities. Economic pressures and increasing risks also trigger migration in some settlements, undermining cultural continuity (17).

Regions such as the Venetian Lagoon, the Dutch coastal plains, and the Seychelles are identified globally as high-risk areas due to sea-level rise, salinization, and coastal erosion. Similarly, historic coastal settlements such as Foça, Amasra, Datça, and Side face rising sea levels, coastal retreat and intense tourism pressures (18) (Fig. 7).



*Fig. 7. Sea-level rise.*

### *Agricultural Terrace Systems*

Agricultural terrace systems are among the oldest and most advanced land management practices regulating human–topography interaction, encompassing both the material and knowledge-based components of cultural landscapes in an integrated manner. Developed to retain soil, manage water, and sustain production on steep slopes, terraces perform critical ecological functions such as sediment control, micro-basin regulation, and soil fertility preservation. They also embody cultural heritage rooted in collective labor organization and traditional irrigation techniques. However, climate change increasingly threatens the physical structure and functional integrity of these systems (19) (Fig. 8).



*Fig. 8. Rice terraces.*

### *Physical and Hydrological Vulnerabilities*

Climate-induced extreme rainfall events weaken the integrity of dry-stone walls used in terrace construction, causing displacement of stones and collapse of terraces. Intense precipitation exceeds the soil's infiltration capacity, increasing surface runoff; this process accelerates topsoil loss and leads to sediment accumulation on lower terraces. During drought periods, reduced soil moisture weakens the binding microstructures between terrace blocks, triggering crack formation and compromising wall stability. Irregularities in the hydrological cycle—including unseasonal rainfall, prolonged droughts, and sudden downpours—reduce the water retention capacity of terraces, disrupt the functioning of traditional irrigation systems, and make the seasonal continuity of agricultural production more vulnerable (20) (Fig 9).



**Fig. 9.** *Deterioration of dry-stone terrace walls in the Tramonti, Salerno region of Italy.*

### *Ecological and Biological Impacts*

The sustainability of terrace systems relies not only on the physical integrity of wall structures but also on an integrated framework of ecological components, including surrounding vegetation, soil microorganisms, and local seed diversity. Loss of biodiversity reduces the adaptive capacity of terraces, undermining the natural cycle of soil fertility and decreasing water retention. The decline of local seed varieties and the spread of monoculture practices limit production diversity and reduce the resilience of terrace systems to climate change. Disruption of ecological balance also weakens traditional agricultural knowledge, water management practices, and collective production processes, directly threatening cultural continuity (21) (Fig. 10).



**Fig. 10.** *Example of local seed diversity and agricultural biodiversity.*

### *Socio-Economic Dimension*

Agricultural terrace systems constitute the foundational production infrastructure of rural economies, playing a critical role in food security, livelihoods, and cultural identity. However, climate change–related income fluctuations, production losses, and rising maintenance costs undermine the economic resilience of rural households. The migration of young populations away from agriculture and the acceleration of rural depopulation disrupt collective terrace maintenance processes, while the abandonment and collapse of terraces exacerbate both ecological and cultural losses (21). Globally, the Andean terraces in Peru face serious threats due to rapidly melting glaciers and irregular water regimes; China’s Longji Rice Terraces are at risk from monsoon variability and landslides; Yemen’s Haraz threatened by water scarcity and the loss of traditional irrigation systems. In Türkiye, tea terraces in Artvin and Rize contend with intense rainfall and landslide hazards, olive terraces in Hatay face drought and salinization,

and terraces around Cappadocia struggle with tourism pressures and hydrological irregularities (22) (Fig. 11).



*Fig. 11. Reduced water levels and vegetation cover on terraces during drought periods.*

### ***Sacred Sites***

Sacred sites are multilayered spaces within cultural landscapes that integrate both material elements and the spiritual and ritual relationships communities maintain with nature. Comprising natural features such as cosmologically significant elements, ritual practices, pilgrimage routes, water sources, sacred mountains, and forests alongside temples and monumental tombs, these sites function not only as physical spaces but also as living cultural–ecological systems that embody belief systems, the production of cultural identity, and ecological knowledge. Due to their integrated position within natural landscapes, sacred sites exhibit high vulnerability to the ecological, hydrological, and geomorphological impacts of climate change (23) (Fig. 12).



*Fig. 12. Crack formation and deterioration of stone blocks in a historic temple structure*

### ***Physical and Hydrological Vulnerabilities***

Climate change–related increases in temperature, intense precipitation, and extreme weather events rapidly undermine the physical integrity of stone monuments, temple walls, and ritual spaces within sacred sites. In sites located on slopes or open terrain, erosion disrupts soil stability, placing both structures and their environmental context at risk. Salinization and increased humidity cause flaking, biochemical decomposition, and surface loss on stone surfaces, leading to severe deterioration in rock-cut spaces, stelae, and tomb chambers. Changes in the hydrological cycle reduce the flow of sacred water sources, cause lakes and rivers to

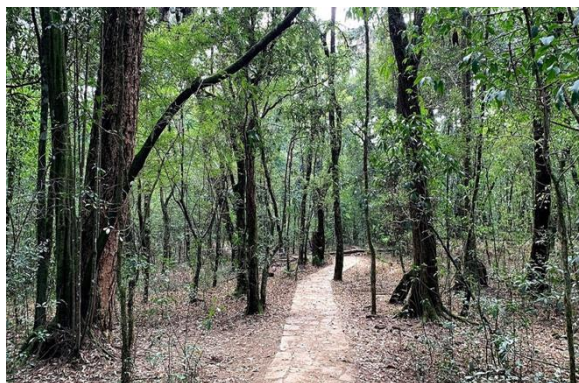
recede during dry periods, and increase flood risk, thereby threatening both the ecological and ritual functions of these areas (24) (Fig. 13).



**Fig. 13.** *Carving and erosion on a rock surface.*

### *Ecological and Biological Impacts*

Sacred forests, mountains, and water sources function in many societies as traditional mechanisms for preserving biodiversity. Although the perception of these areas as “untouchable” has historically protected the habitats of numerous flora and fauna species, climate change–related habitat contraction, temperature increases, and species migrations have significantly weakened the integrity of these ecosystems. The loss of symbolically significant plant and animal species is not merely an ecological issue; it has profound cultural impacts on ritual practices, religious symbols, and cosmological narratives. Consequently, the conservation of sacred natural sites carries a dual responsibility, ensuring both the continuity of ecological processes and the persistence of cultural memory (25) (Fig. 14).



**Fig. 14.** *Mawphlang Sacred Forest, India.*

### *Socio-Cultural and Economic Impacts*

Climate-induced changes directly affect the life practices, community rituals, pilgrimage cycles, and local livelihood patterns associated with sacred sites. Drought, flooding, heatwaves, and ecosystem degradation lead to shifts in ceremonial calendars, relocation of rituals to different periods, and the complete disappearance of certain traditions. Economic vulnerability among communities responsible for the maintenance of sacred sites weakens collective labor and cultural transmission processes, interrupting cultural continuity. This generates multidimensional vulnerability, undermining both social memory and cultural identity (26).

Globally, Nepal's Annapurna region faces retreating glaciers and increased landslide risk; India's Ganges Valley contends with monsoon irregularities and water pollution; Japan's Kii Mountains are threatened by intensified typhoons; and the rock-hewn churches of Lalibela in Ethiopia are experiencing deterioration due to increased precipitation and humidity. In Türkiye, temperature fluctuations at Mount Nemrut exacerbate micro-cracking; in Cappadocia's rock churches, moisture, salinization, and erosion are accelerating; and at Göbeklitepe, changes in temperature and precipitation patterns affect the stability of stone blocks (27) (Fig. 15).



*Fig. 15. The standing stones of Göbekli Tepe*

## DISCUSSION AND CONCLUSION

Cultural landscapes are multilayered systems that reflect the historical accumulation of human–space interactions and ecological continuity, making them among the areas most acutely affected by climate change. Analyses indicate that physical, ecological, and socio-cultural vulnerabilities interact in mutually reinforcing ways. Rising temperatures, irregular precipitation patterns, and extreme weather events lead to irreversible physical degradation, such as material erosion and micro-cracks in historic urban fabrics, infrastructure damage, and salinization in coastal settlements. These physical losses undermine not only structural integrity but also the spatial identity of the landscape and collective memory (28).

At the ecological level, biodiversity loss, microclimatic alterations, and hydrological irregularities threaten the ecosystem services of agricultural terrace systems, sacred sites, and historic gardens. The Andean terraces in Peru, the Longji Rice Terraces in China, and terraces in Cappadocia and Artvin–Rize in Türkiye are particularly vulnerable physically and ecologically due to disrupted water regimes, extreme precipitation, and tourism pressures (29).

At the socio-cultural level, climate pressures destabilize rural production systems, accelerate migration, and commercialize cultural practices due to tourism intensity. This undermines the transmission of traditional knowledge, collective labor organization, and ritual practices, threatening the living memory of cultural landscapes.

Therefore, the conservation of agricultural terrace systems must adopt a holistic approach, integrating structural reinforcement, ecological practices that support environmental balance, the preservation of traditional knowledge systems, and enhancement of local economic resilience. Similarly, nature-based solutions in historic urban fabrics, ecosystem restoration in coastal settlements, and the maintenance of both ecological and ritual functionality in sacred sites should be central components of cultural landscape management (30).

In conclusion, the preservation of cultural landscapes should not be limited to architectural restoration. Resilient strategies that account for the interactions among physical, ecological, and socio-cultural vulnerabilities—centered on community participation, local knowledge systems,

and adaptive management principles—offer the most effective response to the multidimensional impacts of climate change. In this way, cultural landscape conservation can shift from a static preservation paradigm toward a dynamic resilience framework that adapts to changing environmental conditions.

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