

Research Paper

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**Environmental Pressures and Policy Responses on the Lycian Way:
Towards Sustainable Cultural Route Management****Tutku Gizem Yazıcı^{1*}, Fahriye Yavaşoğlu², Mine Özdemir³**¹Research Assistant, Department of City and Regional Planning, Gazi University, Türkiye²PhD, Disaster Management and Earthquake Engineering Application and Research Center, Gazi University, Türkiye; Department of City and Regional Planning, Fırat University, Türkiye³Research Assistant, Department of City and Regional Planning, Gazi University, Ankara, Türkiyetutkugizemyazici@gazi.edu.tr, fahriyeyavasoglu@gazi.edu.tr, mineozdemir@gazi.edu.tr**Abstract**

The Mediterranean and Anatolian regions serve as a crossroads for civilizations, representing a dynamic intersection of cultural, ecological, and political systems. The Lycian Way, a 540-kilometer cultural route along Türkiye's southern coast, embodies this heritage by connecting ancient cities, rural landscapes, and coastal ecosystems. However, rapid urbanization, greenhouse expansion, and a lack of adequate protection measures increasingly threaten the route's integrity. This study aims to examine the spatial and temporal distribution of environmental pressures along the route to guide sustainable management strategies. Remote sensing and GIS were applied for supervised land-use/land-cover (LULC) classification and categorical change detection based on Landsat imagery from 1999, 2009, 2019, and 2025, focusing on a 1-km impact corridor. Furthermore, hot spot analysis identified regional clusters of greenhouse and urban transitions; major change nodes were cross-referenced with relevant protection statuses and planning decisions. The results reveal significant transformations driven by tourism-oriented urban growth and intensive greenhouse agriculture, particularly concentrated at critical gateway nodes and coastal plains. The study underlines that effective conservation requires governance-oriented and data-informed strategies. Integrating cultural heritage with spatial planning and sustainability frameworks is essential to ensure the long-term integrity of this unique Mediterranean cultural landscape.

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Keywords*Cultural routes; The Lycian Way; Heritage management; Sustainable cultural tourism; Anatolian Cultural Routes***1. Introduction**

Cultural routes represent the spatial manifestation of multifaceted interactions that have occurred among societies throughout history. These routes are not merely physical pathways; they are also dynamic structures in which cultural transmission, social transformation, mobility, and mutual interaction converge with both tangible and intangible heritage elements (ICOMOS, 2008).

Since the late 20th century, cultural routes have emerged as pivotal components of international conservation policies. The institutional framework was pioneered by the Council of Europe's 1987 program (Council of Europe, n.d.),

followed by UNESCO's 1993 designation of the Routes of Santiago de Compostela as the first European Cultural Route inscribed on the World Heritage List. Subsequent frameworks transformed the definition from simple physical paths into dynamic, multidimensional cultural landscapes. The 1994 UNESCO Experts Meeting Report (Madrid) highlighted that cultural routes should be evaluated from a broad perspective encompassing economic, social, symbolic, and philosophical dimensions (UNESCO, 1994; UNESCO, 2014). Similarly, the Charter on Cultural Routes, adopted by ICOMOS in 2008, established methodological principles for the definition, conservation, and management of cultural routes, emphasizing the need to approach these routes based on the principles of authenticity and integrity. For the first time, the Charter explicitly stated that cultural routes should be considered as multidimensional structures integrating both tangible and intangible heritage elements (ICOMOS, 2008).

Türkiye, with its multi-layered historical background and strategic geographical position, possesses significant potential in terms of cultural routes. While the country hosts more than ten Council of Europe-certified routes, it currently lacks a UNESCO-designated cultural route despite having numerous sites on the World Heritage List (ICOMOS Türkiye, n.d.). One of the most prominent examples of this potential is the Lycian Way, which stretches along the southwestern coast of Anatolia. Beyond being a hiking trail, it is a multi-layered cultural landscape encompassing major archaeological centers such as Xanthos–Letoon. However, the route's integrity is increasingly threatened by development pressures and the absence of a formal conservation status. Therefore, identifying and spatially analyzing these threats is crucial for the preservation of the Lycian Way and the broader management of cultural routes.

While existing academic literature on the Lycian Way has predominantly focused on user experience and tourism motivation (Bastemur, 2011; Akgündüz & Kızılcıoğlu, 2016; Şenel, 2019; Tütüncü et al., 2020; Kurar & Kavacık, 2022; Aydın, 2024), current studies on conservation and environmental change are often limited to specific segments, providing only a partial perspective on broader regional dynamics (Erdoğan & Kuter, 2010; Bozhüyük Ardahanlıoğlu & Çınar, 2013; Selçuk et al., 2020; Sünbül & Tonyaloğlu Ersoy, 2021; Tunçer & Atik, 2023). In this regard, identifying and spatially analyzing these threats is therefore crucial for the preservation of the Lycian Way and for the broader protection of cultural routes.

Existing literature on the conservation of cultural landscapes and cultural routes utilizes remote sensing and Geographic Information Systems (GIS) to examine vegetation dynamics, land-use change, urban sprawl, and related environmental threats (Wang et al., 2009; Butt et al., 2025; Cao & Li, 2023; Elfadaly et al., 2018; Rojas Celis et al., 2025; Yu et al., 2016). These studies underscore the necessity of proactive conservation measures. Furthermore, research has employed site-specific spatial analyses to reveal the dramatic consequences and magnitude of threats posed by urban encroachment toward archaeological and protected sites, alongside the economically driven pressures of coastalization in maritime regions (Butt et al., 2025; Cao & Li, 2023; Imene, 2021). Additionally, corridor-based analyses show how urbanization and climate-induced deforestation transform the cultural and landscape integrity of these heritage corridors (Ignatius et al., 2025; Oikonomopoulou et al., 2017).

This study provides a novel scientific contribution by moving from localized, segment-based inquiries toward a comprehensive, regional-scale analysis of a cultural route. While the majority of existing literature focuses on area-based protected sites or static heritage zones (polygons), this research prioritizes the spatial and cultural continuity of a linear cultural trail. It enriches the existing literature on cultural landscapes by investigating the ecological and developmental corridor surrounding the route, accounting for its diverse segments characterized by varying national protection statuses and heterogeneous environmental pressures, extending through a region where the impacts of coastal tourism and intensive agriculture are most acutely felt. Crucially, this research contextualizes these dynamics within a middle-income country, where economic prioritization often overshadows conservation mandates and intense coastalization reveals profound misalignments between official legislative frameworks and their practical implementation. Methodologically, the study advances GIS-based monitoring by integrating multi-temporal spatial data to quantify the synergistic impact of diverse anthropogenic pressures along a continuous linear corridor.

In this context, the study aims to analyze the types, spatial distribution, and temporal changes of environmental pressures along the Lycian Way route. Using remote sensing and Geographic Information Systems (GIS) techniques, a supervised land use/land cover (LULC) classification is conducted at a regional scale, based on Landsat imagery

from 1999, 2009, 2019, and 2025, with a focus on a 1-km impact corridor defined around the route. The study addresses the following research questions: i. How have land-use patterns along the Lycian Way evolved temporally and spatially over the last 26 years? ii. In which specific nodes or segments of the route are environmental pressures, particularly urban sprawl and greenhouse agriculture, most concentrated? iii. To what extent do the current national protection designations and associated planning instruments align with the observed intensity and character of landscape transformations along the Lycian Way's critical nodes?

This analysis seeks to contribute to the development of a data-driven and spatially grounded conservation strategy to ensure the sustainability of cultural routes. In this regard, the research highlights the necessity of large-scale, integrated conservation approaches by revealing the effects of regional development trends on cultural routes. Ultimately, the study offers a unique contribution to the conservation of Mediterranean cultural landscapes, as exemplified by the case of the Lycian Way.

The following section briefly outlines the historical background and cultural heritage of the Lycian civilization, examining the cultural and spatial characteristics of the Lycian Way and highlighting the values it embodies within its multi-layered landscape. The third section presents the research methodology, including the database, the remote sensing techniques employed, the use of Geographic Information Systems (GIS), and the overall analytical approach. The fourth section presents the spatial transformations and environmental pressures observed along the route, based on land use/land cover (LULC) classifications and categorical change analyses conducted across selected years. Lastly, the fifth section evaluates the findings, relates conservation policies for the sustainability of cultural routes to international frameworks, and proposes a spatial data-driven conservation strategy specific to the Lycian Way.

2. Lycia: History and Conservation

2.1 The Lycian Civilization: history, political structure, and cultural legacy

The Lycian civilization was a long-standing historical civilization that developed in the region known today as the “Teke Peninsula,” located in southwestern Anatolia along the Mediterranean coast (Figure 1). Situated within the mountainous and coastal areas between the present-day provinces of Antalya and Muğla, Lycia is recognized as one of the unique civilizations of the ancient world due to its distinctive political organization, language, architecture, and funerary culture (Bryce, 1986; Keen, 1998).



Figure 1. Settlements and ancient cities on the Teke Peninsula.

Source. Prepared by the authors based on Google Earth satellite imagery and data from Ancient Cities of Turkey on Council of Europe, 2021.

From as early as the 2nd millennium BCE, the Lycians inhabited the region, and by the 1st century BCE, they had established a federative political structure known as the Lycian League, which is considered one of the earliest

examples of democratic representation in the ancient world (Republic of Türkiye Ministry of Culture and Tourism, n.d.). Prominent cities of the League included Patara, Xanthos, Letoon, Myra, Tlos, Olympos, Phaselis, and Pinara, while smaller cities such as Aperlae, Kyaenai, Simena, Soura, Theimussa, and Limyra were also represented within the federal structure. The majority of these ancient cities are interconnected by the modern Lycian Way, transforming this historical network into a continuous corridor. See **Figure 1** for the spatial distribution of these cities.

Xanthos, known as the capital of Lycia, and Letoon, its religious center, were inscribed on the UNESCO World Heritage List in 1988, marking the international recognition of the civilization's cultural heritage (ICOMOS Türkiye, n.d.). While Xanthos held historical significance as the political capital of Lycia, Letoon served as the religious center of the Lycian League. Today, Xanthos is located near the village of Kınık in the Kaş district of Antalya Province, approximately 70 kilometers from the Kaş highway. The city's structures, shaped by various civilizations over time, reflect a fusion of Lycian traditions with Hellenistic and Roman architectural features.

Located approximately 4 km from Xanthos, the ancient city of Letoon held a special position as Lycia's religious center, which represents a unique heritage value, both religiously and architecturally (UNESCO World Heritage Centre, n.d.-a). Additionally, the artistic production of Xanthos-Letoon had a direct influence on other Lycian cities and surrounding regions, including Patara, Pinara, and Myra (UNESCO World Heritage Centre, n.d.-b). The Parliament building in Patara, Lycian rock tombs, fortress remains, temple ruins reflecting the belief systems of the society, and urban remnants that offer insights into Lycian social life all contribute to this rich cultural landscape (Republic of Türkiye Ministry of Culture and Tourism, n.d.). Together, these remains reflect the cultural importance of the Lycian civilization and its legacy along the Lycian Way.

2.2 Historical and physical characteristics of the Lycian Way

The Lycian Way is a cultural route approximately 540 kilometers long, extending across southwestern Türkiye from the Fethiye district of Muğla to the Geyikbayırı area of Antalya. Introduced in 1999 by Kate Clow and her team, the trail gained recognition within the international hiking community and has since become a popular tourism destination among both domestic and international nature enthusiasts (Clow, 2019).

The Lycian Way is situated within a complex cultural landscape that connects numerous ancient cities, mountain villages, forested areas, highlands, and coastal towns. While parts of the trail follow ancient roads and aqueducts, other sections intersect with modern asphalt roads. To aid navigation, the Cultural Routes Society carries out marking and maintenance work along the route.

In addition to trekking, various activities such as swimming, diving, nature and bird watching, climbing, paragliding, and cultural tourism through visits to ancient sites are also available along the route (Bastemur, 2011). Hikers are motivated not only by the desire to socialize but also by personal goals such as self-realization, the pursuit of meaningful experiences, and a desire to explore the world (Akgündüz & Kızılcıoğlu, 2016). Although some hikers find the route physically demanding—due to steep slopes and sections that require endurance—it is widely regarded as rewarding on physical, emotional, and intellectual levels (Aydın, 2024).

Despite a generally high level of satisfaction, several infrastructure issues have been reported to affect the overall experience negatively. These include a lack of informational panels on flora and fauna, limited access to healthcare and internet, insufficient accommodation and food options, high prices, hygiene problems, environmental pollution, water shortages, and inadequate signage for orientation and guidance (Tütüncü et al., 2020). Within this context, most academic studies on the Lycian Way have focused on user experience.

2.3 Conservation challenges and development pressures on the Lycian Way

The Lycian Way is considered an important destination within the scope of alternative tourism, sustainable tourism, and ecotourism (Şenel, 2019; Kurar & Kavacık, 2022; Bozhüyük Ardahanlıoğlu & Çınar, 2013). Kurar and Kavacık (2022) highlight the route's strengths, including its historical and cultural sites, natural heritage, rich vegetation, authentic accommodation options such as village guesthouses and stone houses, and favorable climate conditions. However, they also highlight structural problems that threaten sustainability, such as insufficient promotion and

marketing, inadequate trail signage, limited access to food and water, underdeveloped accommodation infrastructure, lack of data, and shortage of skilled labor.

The authenticity of the region is threatened by unplanned development and marble quarrying, whereas environmental degradation is further exacerbated by illegal excavations, treasure hunting, pollution, and insufficient environmental awareness. These pressures are further intensified by weak legal enforcement, which undermines the protection of both cultural and natural heritage along the route. In this context, it has been suggested that the Lycian Way should be aligned with the standards defined by the European Institute of Cultural Routes, and steps should be taken toward its inclusion in international conservation programs such as the Cultural Routes of the Council of Europe (Bastemur, 2011; Kurar & Kavacık, 2022).

Bozhüyük and Çınar (2013), in their ecotourism-focused study on the Fethiye section of the Lycian Way, found that increasing construction in Ölüdeniz since the 2000s has placed pressure on natural areas. They also observed that tourism intensity in areas such as Kabak and the Butterfly Valley has led to dispersed settlement patterns, and in places like Kabak and Patara, tourism density poses threats to both ecosystems and coastal landscapes.

More recent spatial analyses, particularly in the Kaş district, show that between 2000 and 2020, built-up areas increased by 2.5 times, greenhouse areas tripled, and agricultural land was reduced by half (Sünbül & Tonyaloğlu Ersoy, 2021). These findings show a transformation of the natural landscape resulting from non-agricultural land use.

Tourism pressure on coastal areas is especially evident in cultural and natural heritage sites such as Korsan Bay, Ceneviz Bay, and Phaselis. Studies report serious threats in these areas, including pollution, exceeding carrying capacities, and coastal erosion (Erdoğan & Kuter, 2010; Selçuk et al., 2020). Plans for the construction of concrete day-use facilities in Alacasu (Cennet) and Bostanlı Bays have been criticized by civil society organizations and professional chambers, pointing to shortcomings in the enforcement of conservation decisions (Türkiye Ormancılar Derneği, 2023; Bianet, 2023).

Even specially protected areas like Patara face increasing threats such as illegal construction, environmental pollution, and tourism pressure. Similarly, despite their conservation status, development pressures continue in natural protected areas such as Kaputaş and Fırnaz Bays (Tunçer & Atik, 2023).

3. Materials and Methods

This research adopts a multi-scalar geospatial approach to systematically evaluate long-term landscape transformations and environmental pressures along the Lycian Way corridor over a 26-year period. The overall methodological framework, integrating remote sensing analysis, spatial statistics, and policy review, is illustrated in **Figure 2**.

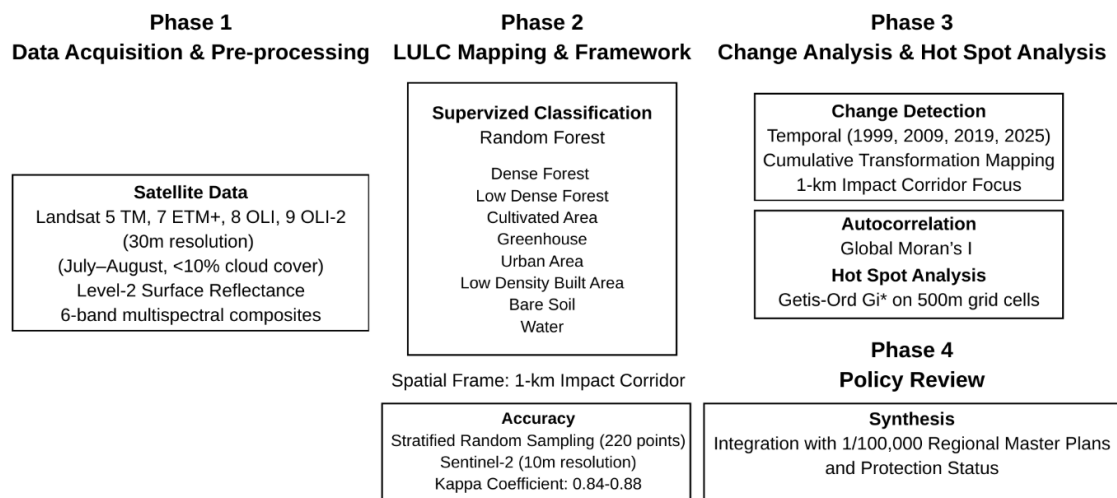


Figure 2. Methodological workflow of the study, illustrating the phases from data acquisition to spatial-policy synthesis.

To monitor land-use and land-cover (LULC) dynamics over 26 years, Landsat Level-2 Surface Reflectance products with a 30×30 m spatial resolution were utilized for four reference years: 1999 (Landsat 7 ETM+), 2009 (Landsat 5 TM), 2019 (Landsat 8 OLI), and 2025 (Landsat 9 OLI-2). To ensure seasonal comparability and minimize phenological variations, all scenes were selected from the summer months (July–August) with cloud-free or low cloud cover. Multispectral composites were generated using six primary bands (Blue, Green, Red, Near-Infrared (NIR), SWIR1, and SWIR2) to maximize spectral separability for identifying major land-use categories.

LULC maps were produced using Supervised Classification in ArcGIS Pro, applying the Random Trees algorithm. As an implementation related to Random Forest, Random Trees allows multiple decision trees to be trained on randomly selected subsets, improving classification accuracy (Gislason et al., 2006). In this study, the classifier was configured with specific hyperparameters to ensure an optimal balance between model complexity and generalization: the maximum number of trees was set to 50, the maximum tree depth was limited to 30, and a maximum of 500 samples per class was utilized for training. Training samples were collected across the study area to represent the classes defined in the legend: Dense Forest, Low-Density Forest, Cultivated Area, Greenhouse, Urban Area, Low-Density Built Area, Bare Soil, and Water. Classification was performed for the full study area; additionally, a 1-km impact corridor around the Lycian Way was used for corridor-based analysis and interpretation of surrounding land-use patterns.

A 1-km impact corridor was defined around the Lycian Way to facilitate the visual interpretation of the spatial relationship between the trail and its surroundings. Empirically, existing practice demonstrates that buffer delineations are highly context-dependent rather than standardized. For example, the ICOMOS advisory body evaluation for the Routes of Santiago de Compostela notes that protection can rely on a “generic 30-m band” and that buffer zones are regulated independently by each Autonomous Community and may be contextual (ranging from 15 m to 100 m, depending on location and context) (International Council on Monuments and Sites, 2015). The Via Appia nomination file similarly reflects multi-scalar integrity-oriented approaches, with buffer-zone mapping presented at different scales, ranging from 100 m up to 4 km across sections (Ministero della Cultura, 2023). In Chios (Greece), Oikonomopoulou et al. (2017) report a 500-m corridor (each side) for fire protection and segment-specific protection bands for other purposes, including heritage conservation, varying from 70 to 450 m.

Bambi et al. (2019) explicitly apply a one-kilometer buffer to support landscape and socio-economic characterization along the St. Francis’s Ways, noting its usefulness for assessing marginality and territorial conditions surrounding the route. Rather than implying a fixed, universally ‘correct’ buffer width for cultural routes, this study also treats the 1-km corridor as an analytical landscape setting within which route–territory interactions can be observed consistently. This framing aligns with the ICOMOS Charter on Cultural Routes (ICOMOS, 2008), which stresses that the route’s territorial setting provides the framework and atmosphere necessary for understanding the Cultural Route and calls for the setting to be delineated through a regulated buffer zone where appropriate.

Within this broader evidence base, adopting a 1-km impact corridor offers a transparent and replicable compromise for landscape-scale GIS/remote-sensing analysis—wide enough to capture the surrounding territorial patterns that condition route experience and vulnerability, while remaining closely tied to the route corridor. Drawing on these precedents, the 1-km distance in this study is specifically determined to ensure that the 30-meter spatial resolution of satellite imagery yields representative descriptive results. This buffer functions as an analytical frame for understanding spatial dynamics and visual integrity rather than as a regulatory protection strip. Nevertheless, it is acknowledged that for a formal conservation management plan, buffer zones should be delineated differently, reflecting the specific historical and natural unique features of the route segment.

Accuracy assessment was performed only for the 2019 and 2025 classifications, as Sentinel-2 Views imagery (10 m resolution, ESRI Living Atlas service) was available for these years, providing an independent and higher-resolution reference compared to Landsat data. For 1999 and 2009, Sentinel-2 was not yet operational, and validating Landsat with Landsat would not constitute an independent assessment. Therefore, 220 stratified random points were generated for both 2019 and 2025, visually interpreted using Sentinel-2 Views imagery, and compared with the classified maps to produce confusion matrices. The 2019 classification achieved an overall accuracy of 87.2% with a KAPPA (Cohen, 1960) coefficient of 0.84, while the 2025 classification achieved 90% and 0.88. According to the widely accepted

benchmarks by Landis and Koch (1977), Kappa values between 0.61–0.80 represent 'substantial' agreement, while values between 0.81–1.00 indicate 'almost perfect' agreement. In this study, the Kappa coefficients of 0.84 for 2019 and 0.88 for 2025 fall into the 'almost perfect' category, confirming the high statistical reliability and robustness of the classification results.

Change analysis was performed through categorical change detection to identify transitions between land-use classes over the study period, focusing particularly on transitions from Natural Areas to Urban Areas and Greenhouses, highlighting the expansion of built-up land uses and their encroachment into natural and agricultural landscapes. To minimize spectral noise and enhance the spatial coherence of the classified outputs, a 3×3 median filter was applied. The analysis was conducted in two sequential stages:

- Temporal Transition Assessment: Land-use changes were first examined for three distinct sub-periods: 1999–2009, 2009–2019, and 2019–2025.
- Cumulative Transformation Mapping: An aggregated change map for the entire 26-year period (1999–2025) was generated.

In the next step, hot spot analysis was conducted on the overall land-use change map (1999–2025) to identify the spatial clustering patterns of land-use conversions across the study area. In the hot spot analysis, greenhouse-related conversions and urban-area conversions were treated as aggregated change classes and analyzed to identify statistically significant clustering patterns. Global spatial autocorrelation was assessed using Global Moran's I to test whether conversion intensity is randomly distributed; after confirming statistically significant positive clustering, Getis–Ord G_i^* hot spot statistics were computed to locate and map local clusters (Mitchell, 2005; Getis & Ord, 1992). To improve interpretability and to better capture regional effects and fringe patterns, the study area was partitioned into $500 \text{ m} \times 500 \text{ m}$ (25 ha) grid cells. This resolution was selected to reduce the influence of sparse, zero-dominated cells (thereby strengthening statistical robustness) while providing a meaningful spatial unit for interpreting landscape-ecological functions. Spatial relationships were defined using a k-nearest neighbors (KNN) scheme ($k = 8$) with row standardization. For greenhouse-conversion intensity, Global Moran's I indicated strong, statistically significant positive spatial autocorrelation (Moran's I = 0.423031; $z = 184.812$; $p \ll 0.001$; expected I = -0.000021); similarly, urban conversion intensity exhibited significant clustering (Moran's I = 0.455162; $z = 198.648702$; $p \ll 0.001$; expected I = -0.000021). The high z-scores and extremely low p-values indicate that the spatial distribution of land-use transitions is not a result of random chance, but instead confirms a strong, non-random clustering pattern with geographically concentrated high-intensity conversions (Mitchell, 2005; Getis & Ord, 1992).

Local clustering was then evaluated using Getis–Ord G_i^* under the same neighborhood definition (KNN, $k = 8$) on 500-m grid–aggregated conversion intensities. G_i^* computes a z-score (and its associated p-value) for each cell, and ArcGIS summarizes statistical significance using confidence-level (significance) bins; these 90%–95%–99% confidence classes correspond to p-value thresholds derived from the G_i^* z-scores under the standard normal distribution (Mitchell, 2005). Separate G_i^* outputs were produced for urban area and greenhouse conversions and were overlaid in a single map to compare hot-spot patterns, while simultaneously displaying the Lycian Way polyline (and analytical buffer) to visually emphasize locations where statistically significant conversion clusters intersect the cultural-route environment.

Finally, in addition to the GIS-based change detection, an interpretive policy review was conducted for the major change nodes/hotspots. This review drew on the 1/100,000 scale regional master plans for the Aydın–Muğla–Denizli and Antalya–Burdur–Isparta planning regions, which were used as analytical base maps to delineate settlements, protected areas, and cultural/natural heritage designations along the Lycian Way corridor. For the nodes, the observed LULC transitions were cross-referenced with the relevant national protection designations and associated planning instruments in order to contextualize spatial pressures within the prevailing legislative and administrative framework. This step provides a structured basis for assessing whether the current protection regime is commensurate with the intensity and character of landscape transformation observed along the route corridor.

3.1. Limitations

The analytical approach employed in this study involves several inherent limitations and boundary conditions that should be acknowledged. In the northern mountainous regions of the study area, classification accuracy was limited due to reflectance heterogeneity associated with bare soils, rock outcrops, and seasonal snow cover. However, as these areas lie outside the Lycian Way corridor, they were not considered in the interpretation of results. The 30-m spatial resolution of Landsat data limits the ability to capture small-scale land-use features but remains suitable for assessing broader regional-scale transformations over time. Using multiple Landsat sensors across the study period may introduce inter-sensor differences that affect class separability and temporal comparability. All scenes were selected from summer months to improve seasonal comparability; consequently, the analysis does not capture intra-annual variability, although detailed vegetation dynamics were not considered necessary given the study's primary focus on built-up change.

Supervised classification outcomes also depend on the representativeness of training samples and class definitions, which may introduce uncertainty—particularly where land-use classes exhibit spectral similarity; to mitigate this, potentially controversial areas were cross-checked using contemporaneous high-resolution Google Earth imagery. Finally, the 3×3 median filter improves spatial coherence but may smooth small patches and narrow features, potentially under-representing fine-grained change. Because this choice was intended to tolerate resolution-related noise, the resulting spatial data provide a conservative estimate of landscape transformation, as small-scale and isolated anthropogenic footprints may have been removed alongside spectral noise. Accordingly, the results are discussed with a focus on key nodes. Findings are also conditioned by the chosen analytical corridor (1-km impact corridor), and alternative buffer widths could yield different estimates of surrounding land-use patterns.

4. Findings and Discussion

4.1 Land use change at the regional scale

The supervised classification results obtained through the Random Trees algorithm illustrate the spatial distribution of land-use categories along the Lycian Way for the years 1999, 2009, 2019, and 2025. The Mediterranean vegetation cover, dominated by maquis shrublands, required a distinction between *dense forest* (closed-canopy, non-maquis woodlands) and *low-density forest* (more open, maquis-dominated areas) to improve the training sample accuracy.

Although the 30 × 30 m resolution of Landsat imagery limits the detection of small-scale rural settlements, the classification adequately captures the major categories relevant to regional change dynamics, including forest, cultivated areas, greenhouses, and urban expansion. The 1-km impact corridor around the Lycian Way emphasizes the interaction between the trail corridor and surrounding land uses. As observed, different sections of the Lycian Way intersect with diverse land-use mosaics, ranging from dense forests to intensified greenhouse and urban development along the coastal plains.

The change detection analysis was conducted for three consecutive periods: 1999–2009, 2009–2019, and 2019–2025 (**Figure 3**). The results highlight the timing and intensity of land-use transitions from natural environments to built environments, specifically *urban areas* and *greenhouses*.

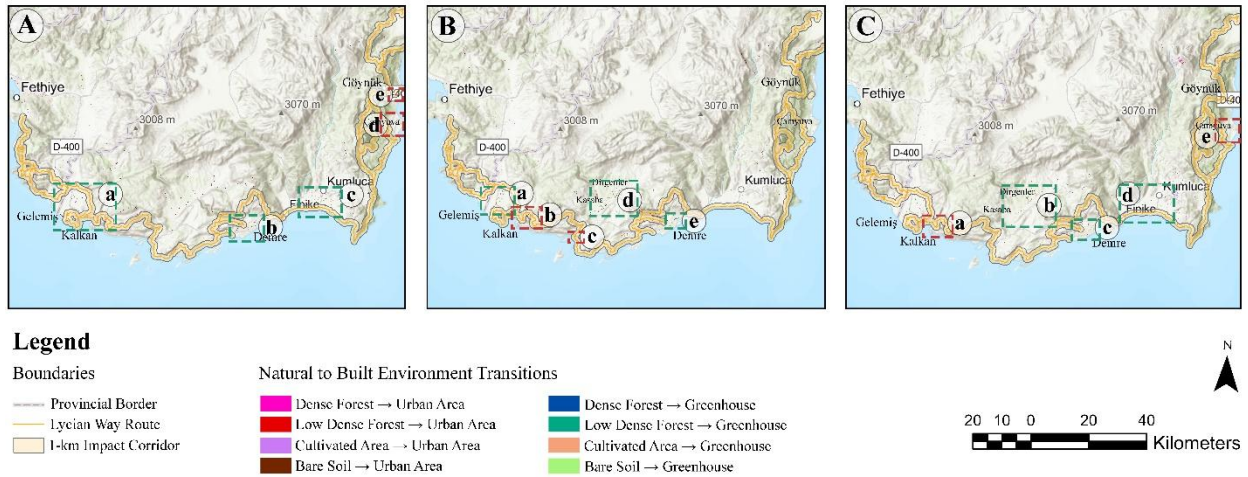


Figure 3. Overview maps of land-use/land-cover (LULC) transitions from natural to built environments along the Lycian Way for three analyzed periods: (A) 1999–2009; (B) 2009–2019; (C) 2019–2025.

The period-specific change detection maps (**Figure 3**) reveal spatially concentrated transitions from natural to built environments and delineate several key transformation nodes along the Lycian Way corridor. Primary nodes are highlighted on the overview maps, and these nodes are shown as enlarged inset panels for closer inspection in the following figures (**Figure 4**, **Figure 5**, **Figure 6**).

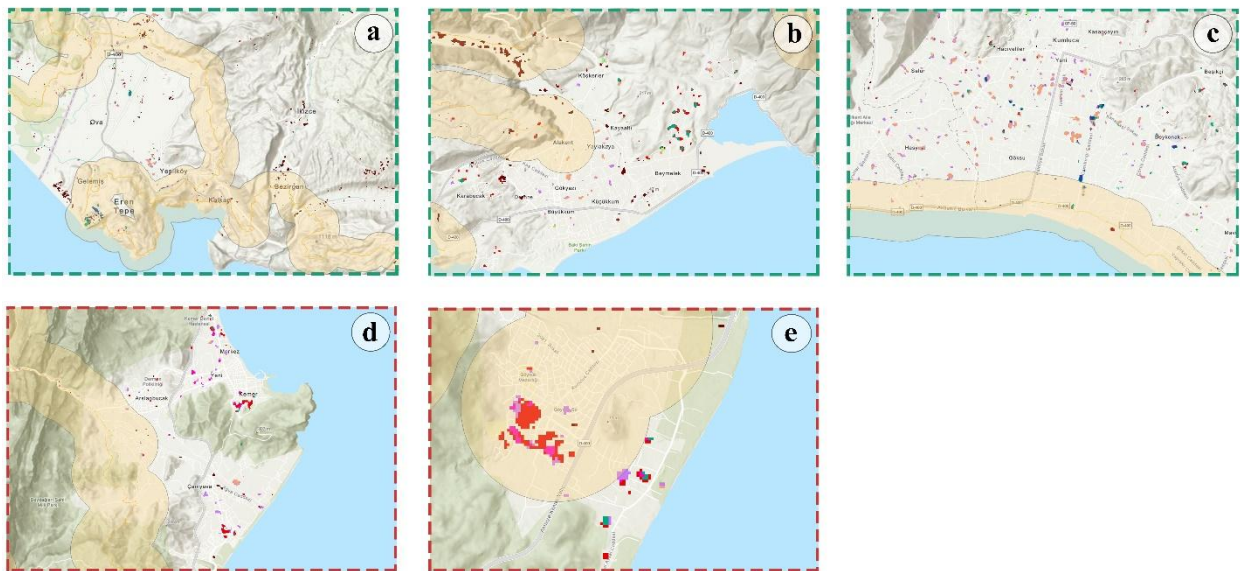


Figure 4. Detailed maps of land-use transitions from natural to built environments for the 1999–2009 period: (a) Gelemiş and Kalkan; (b) Demre; (c) Kumluca; (d) Çamyuva and Kemer; (e) Göynük. Legend as in **Figure 3**.

Period of 1999–2009

Regarding the primary nodes of change during the 1999–2009 period, the area encompassing Gelemiş and Kalkan (**Figure 4a**) exhibits distinct transition patterns. For descriptive purposes, the cluster comprising the neighborhoods of Gelemiş, Kımık, Ova, and Yeşilköy is hereafter referred to as the Gelemiş area. Within this area, and particularly across the existing agricultural and greenhouse zones, transitions from Low-Density Forest and Cultivated Area to Greenhouse are dominant. Furthermore, the conversion of Low-Density Forest and Bare Soil into Urban Area is observed, particularly toward the coastal sections. Simultaneously, in Kalkan—a coastal tourist settlement—the transformation from Low-Density Forest and Bare Soil into an Urban Area is prominently observed.

In the Demre area (**Figure 4b**), transitions are characterized by the intensive conversion of Cultivated Area into Greenhouse. Additionally, Urban Area transformations from Low Dense Forest, Cultivated Area, and Bare Soil are evident. Within Kumluca (**Figure 4c**), the Cultivated Area to Greenhouse transformation is the primary trend, while the Cultivated Area to Urban Area transformation is also significantly observed. It is noteworthy that the spatial extent of change in this area is distributed across a wide territory.

In the area covering Çamyuva and Kemer (**Figure 4d**), the conversion of Dense Forest, Low Dense Forest, and Cultivated Area into Urban Area constitutes the most frequent transition type. In the Göynük area (**Figure 4e**), Urban Area transformation remains the most prominent feature, with the conversion of Low Dense Forest into Urban Area acting as the primary driver.

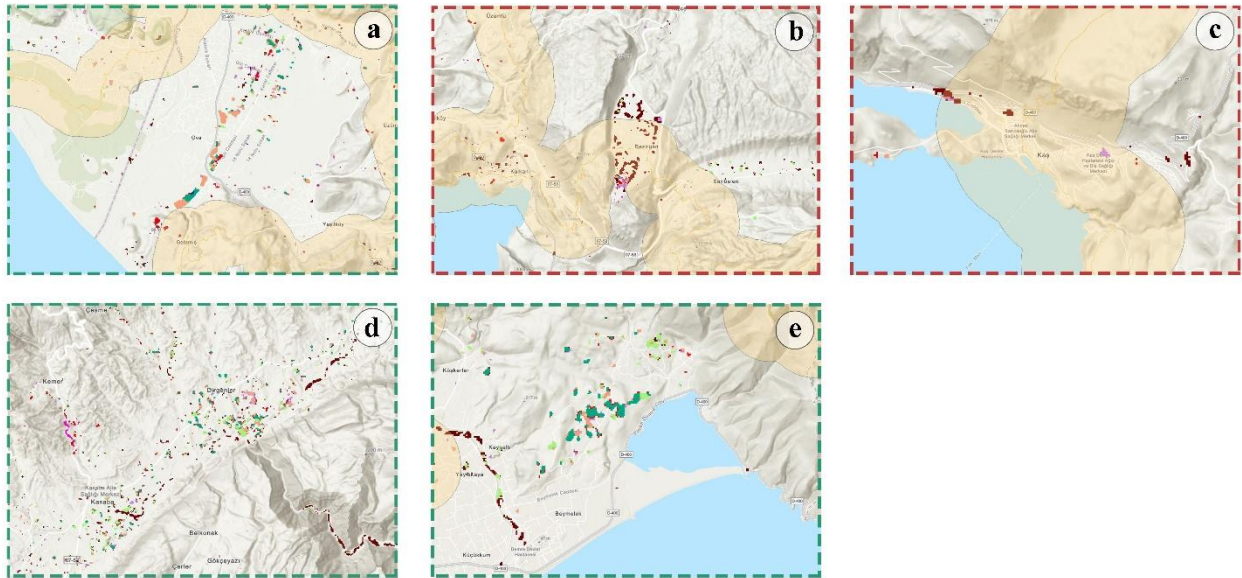


Figure 5. Detailed maps of land-use transitions from natural to built environments for the 2009–2019 period: (a) Gelemiş area (including Kınık, Ova, and Yeşilköy); (b) Kalkan, Bezirgan, and Saribelen; (c) Kaş; (d) Kasaba and Dirgenler; (e) Demre and Beymelek. Legend as in **Figure 3**.

Period of 2009–2019

Between 2009 and 2019, while the established trends in Kumluca, Çamyuva, and Göynük persisted, the spatial patterns of change diversified and intensified in specific focal points.

In the Gelemiş area, which encompasses the Kınık, Ova, Yeşilköy, and Gelemiş neighborhoods (**Figure 5a**), Greenhouse conversion accelerated during this decade. Specifically, along the Göl Street corridor in Ova Neighborhood, the transition of Cultivated Area and certain Low-Density Forest patches into Greenhouse is clearly visible. In the region encompassing Kalkan and the rural settlements of Bezirgan and Saribelen (**Figure 5b**), a marked transformation into an urban area is observed. This transition is particularly significant in Bezirgan, while Saribelen also exhibits transitions into the greenhouse.

In the area containing the Kaş city center (**Figure 5c**)—a coastal touristic town—spatial transformation follows a fragmented pattern, with Bare Soil to Urban Area transitions occurring across various parts of the district. An extensive conversion to Greenhouse is observed in the area covering the villages of Kasaba and Dirgenler (**Figure 5d**). Significant transitions from Low-Density Forest, Bare Soil, and Cultivated Area to Greenhouse are evident. Although this area is not directly intersected by the Lycian Way route, it is crucial for demonstrating the general characteristic of greenhouse expansion in the region. In Demre (**Figure 5e**), the conversion from Low-Density Forest, Cultivated Area, and Bare Soil into Greenhouse is concentrated northwest of the Beymelek Lagoon, effectively encircling the water resource with greenhouse areas.

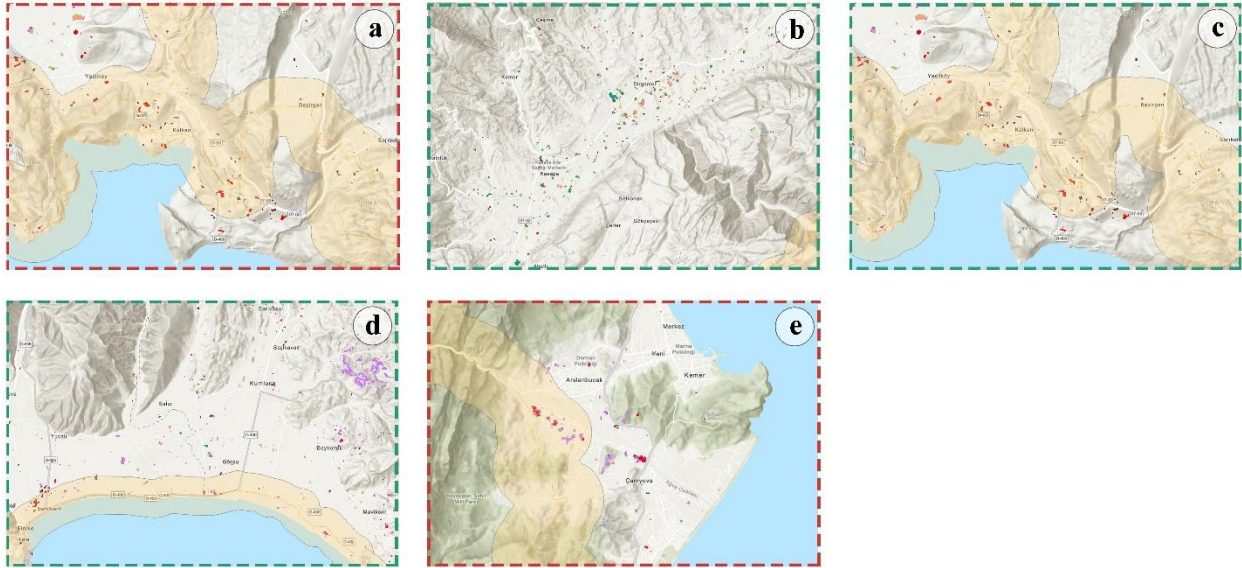


Figure 6. Detailed maps of land-use transitions from natural to built environments for the 2019–2025 period: (a) Kalkan and surroundings; (b) Kasaba and Dirgenler; (c) Demre and Beymelek; (d) Finike and Kumluca; (e) Çamyuva and Kemer. Legend as in **Figure 3**.

Period of 2019–2025

The analysis for the 2019–2025 period indicates that Greenhouse expansion in the Gelemiş area has continued throughout the district. In Kalkan and its surroundings (**Figure 6a**), the expansion of the Urban Area persists at the city fringes, characterized primarily by Low-Density Forest to Urban Area transformations.

In the villages of Kasaba and Dirgenler (**Figure 6b**), the Greenhouse transition trend has spread across the entire area, representing the persistence of intensive greenhouse cultivation. In the Demre area (**Figure 6c**), the trend of conversion to Greenhouse remains focused around the Beymelek Lagoon, primarily involving Cultivated Area and Bare Soil, while fragmented transitions continue across the wider Demre district.

In the Finike and Kumluca areas (**Figure 6d**), fragmented Cultivated Area to Greenhouse transitions are observed throughout the region. Notably, in Finike, Urban Area expansion from Low Dense Forest is concentrated and intensified within coastal zones. Finally, in the Çamyuva and Kemer areas (**Figure 6e**), Cultivated Area to Urban Area and Low-Density Forest to Urban Area transitions are observed in a scattered manner, with an increasing trend towards the urban peripheries.

Particularly in Demre, Gelemiş, and Kumluca, the expansion of greenhouses has significantly contributed to the total increase in the built areas. Across the plains, the spread of greenhouse-based agriculture within croplands is evident in the satellite classifications. This finding is consistent with national statistics: Türkiye's total greenhouse area expanded from 536,000 decares in 2002 to 811,000 decares in 2022, representing a 51% increase. Antalya alone accounts for the largest share nationwide, with 308,427 decares of greenhouse cultivation (Republic of Türkiye, Ministry of Agriculture and Forestry, 2023).

These findings are also consistent with previous research in Kaş district, which documented a 2.5-fold increase in built-up areas, a tripling of greenhouse cultivation, and a significant reduction of agricultural lands between 2000 and 2020 (Sünbül & Tonyaloğlu Ersoy, 2021). The conducted land use/land cover change analysis likewise demonstrates marked increases in greenhouse areas and substantial decreases in cultivated lands between 1999 and 2025. The concentration of greenhouse and urban transformations along particular segments of the Lycian Way corridor indicates that regional-scale dynamics are strongly manifested at the local scale.

The cumulative land-use change map for the period 1999–2025 provides an integrated perspective on the long-term transitions from natural environments to built environments along the Lycian Way corridor. In particular, the cumulative land-use change analysis within the 1-km impact corridor of the route (**Table 1**) reveals a spatially

concentrated pattern of landscape transformation. While transitions to Urban Areas account for 58.9% (417 ha) of the total transitions, transitions to Greenhouses comprise 41.1% (290 ha) in total. These transitions show that urban development emerges as the primary driver of landscape transformation, largely fueled by the encroachment of built-up areas into natural maquis cover and existing croplands. This trend suggests a progressive fragmentation of the Mediterranean landscape, particularly where residential and tourism-related infrastructure displaces low-density forested areas. Simultaneously, the transition from traditional cultivation to greenhouse-based production reflects a shift toward industrial-scale agriculture in the surrounding area of the route. Although the aggregate footprint of change constitutes a small fraction of the total corridor area, its high spatial density at specific nodes represents a significant threat to the route's visual integrity and traditional rural character. While the total converted area of 707.4 ha accounts for only 0.7% of the 96,300 ha 1-km impact corridor, its high spatial concentration at critical nodes signifies irreversible anthropogenic impact within the trail's immediate environment. Since these figures represent a conservative estimate due to noise-reduction filtering, they effectively underscore the most established and intense zones of localized pressure.

Table 1. Summary of transitions from natural to built areas within the 1-km impact corridor (1999-2025).

Transition	Pixels	Area (ha)	% of Total
Dense Forest → Greenhouses	90	8.1	1.15
Dense Forest → Urban Areas	244	21.96	3.1
Low-Density Forest → Greenhouses	923	83.07	11.74
Low-Density Forest → Urban Areas	1821	163.89	23.17
Cultivated Area → Greenhouses	1248	112.32	15.88
Cultivated Area → Urban Area	1512	136.08	19.24
Bare Soil → Greenhouses	965	86.85	12.28
Bare Soil → Urban Area	1057	95.13	13.45
Total → Greenhouse	3226	290.34	41.05
Total → Urban Area	4634	417.06	58.96

To examine the pressure of regional change trends on the Lycian Way in greater detail, a hot spot analysis was conducted to identify spatial clustering patterns of Greenhouse and Urban Area transformations. These clusters were evaluated in relation to the Lycian Way route and its 1-km impact corridor. As illustrated in **Figure 7**, Greenhouse transitions are concentrated in Gelemiş, Demre, Finike, and Kumluca (indicated by green hatched areas), whereas Urban Area transitions cluster in Gelemiş, Kalkan, Finike, the northern part of Kumluca, Çamyuva, Kemer, and Göynük (shown in pink). Current land use in these areas was cross-checked using high-resolution Google Earth imagery to evaluate classification accuracy. The results confirm that the analysis is generally consistent; however, the cluster identified in northern Kumluca was determined to be invalid. In this specific area, remote sensing tools were unable to accurately distinguish the highly fragmented distribution of agriculture, greenhouses, and residential areas, leading to misleading clustering results.

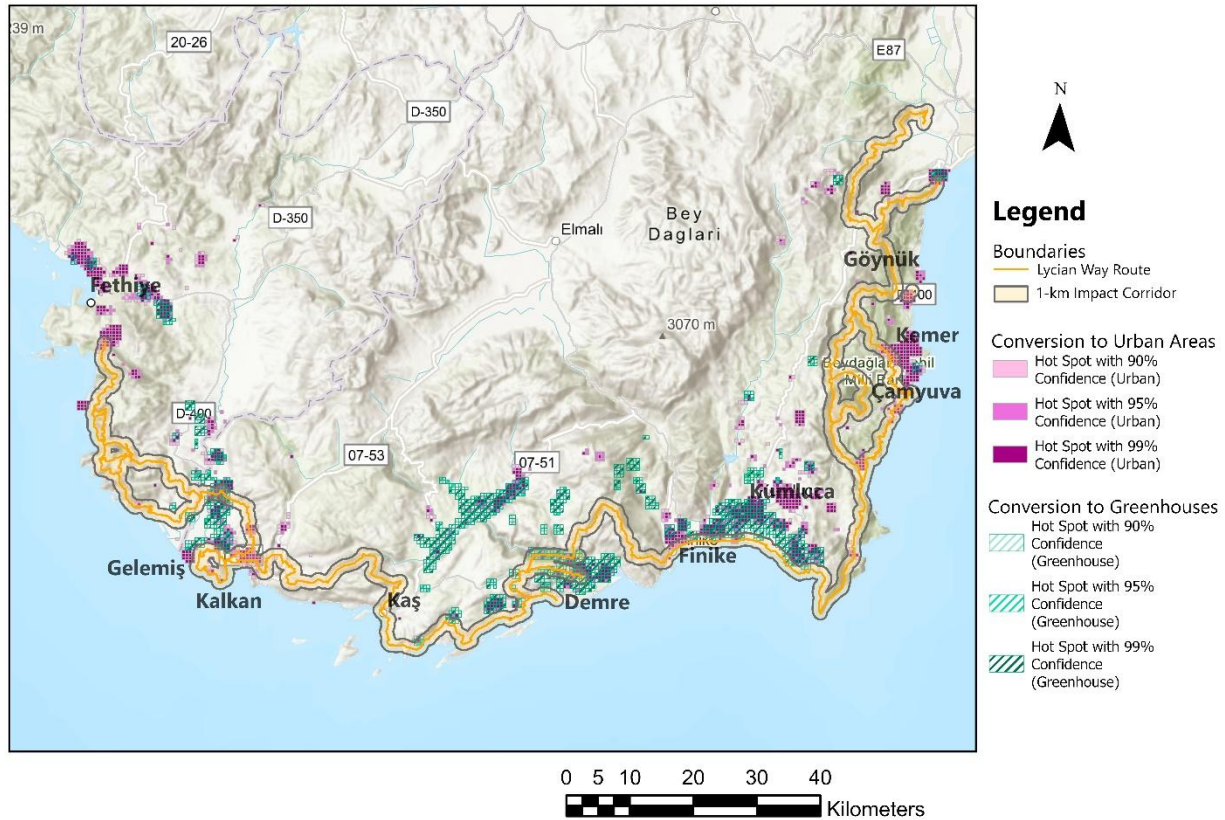


Figure 7. Hot spot map of land-use conversion from natural areas to greenhouses and urban areas (1999–2025).

The statistical magnitude of these hot spots underscores a profound and systemic transformation of the regional landscape. With transition to urban area hot spots covering approximately 872.0 km² (87,200 ha)—representing approximately 7.36% of the total study area—and transition to greenhouse clusters totaling 645.5 km² (64,550 ha), it is evident that built-up expansion and industrial agriculture exert parallel and massive pressures on the territory. The high concentration of these transformations within 99% confidence cores—nearly 50,000 hectares each (492.5 km² for greenhouses and ~547.0 km² for urban areas)—indicates that these changes are not isolated or random events but are instead highly localized, intense, and persistent spatial shifts.

For a cultural heritage route like the Lycian Way, these figures represent more than just land-use data; they signify a narrowing window of preservation. The fact that nearly 1,500 km² (150,000 ha) of the region is now identified as a statistically significant zone of rapid anthropogenic change highlights the urgent need for integrated landscape management. These expansive ‘hot cores’ effectively function as encroachment zones that threaten to diminish the trail’s environmental buffer and permanently alter its traditional rural and natural character.

These patterns reflect the dual intensification of agricultural modernization and urban development along the cultural route. In contrast to the period-specific analyses, this cumulative representation captures the aggregated spatial consequences of anthropogenic pressures accumulated over more than two decades. The findings underscore two dominant trajectories: the continuous expansion of greenhouse agriculture across fertile coastal plains and the progressive urban sprawl concentrated around touristic and residential centers.

These site-specific transformations directly affect the quality and character of the natural and cultural landscapes through which the route passes. Many of the corridor’s touristic settlements are characterized by a locally distinctive spatial pattern that is historically integrated with surrounding nature, producing a landscape identity grounded in the close interweaving of built form and Mediterranean ecological features. At the same time, the areas surrounding these tourism nodes are frequently designated for protection due to their environmental significance and sensitive natural attributes. The Lycian Way’s embeddedness within Mediterranean landscapes constitutes one of its key defining

characteristics; accordingly, degradation in adjacent natural areas—and the environmental changes associated with the expansion of greenhouses—poses a direct challenge to the route’s landscape integrity and experiential legibility.

Comparable dynamics have been documented in site-specific remote sensing studies of heritage landscapes, where development pressures translate into measurable land-cover conversions around protected cultural assets. While prior work often foregrounds tourism- or settlement-led built-up expansion, our corridor-scale results point to a coupled trajectory in which urban growth co-evolves with greenhouse-based agricultural intensification. For instance, Butt et al. (2025) report a marked increase in built-up area around the UNESCO World Heritage Site of Taxila between 1990 and 2024, alongside substantial conversions of cropland and vegetation to built-up and bare land—changes discussed in relation to risks for site integrity and documented concerns about urban development and encroachment in UNESCO reporting.

In a similar vein, analyses in cultural-heritage contexts in China emphasize that built-up expansion is commonly associated with declining ecological land and increased landscape fragmentation, and they argue for integrating ecological considerations into urban planning while also examining how policy-driven mechanisms shape land-use trajectories (Cao and Li, 2023). Conceptually, this aligns with planning-oriented discussions that frame cultural landscape preservation as increasingly intertwined with urban planning and sprawl, underscoring that ‘coastalization’-type growth dynamics can generate structural pressures that are not unique to the Lycian context but are clearly visible in its corridor-scale pattern of change (Imene, 2021).

Antalya’s favorable climatic conditions provide a comparative advantage for greenhouse-based agricultural production, accelerating the transformation of fertile coastal lowlands into highly commercialized landscapes. Collectively, these dynamics highlight the dual role of commercial agriculture and urbanization as the primary drivers of landscape transformation along the Lycian Way corridor. In this context, the management of cultural routes requires cross-sectoral coordination to integrate policies on conservation, preservation, regional organization, sustainable development, land use, and tourism. Therefore, joint projects should be developed at national (provincial, regional, and local) and international levels to promote sustainable development and to establish management tools designed to safeguard the route against natural hazards and any risks that may threaten its integrity, authenticity, and overall significance (ICOMOS, 2008).

4.2 Conservation and environmental threats across the region based on master plans

In Türkiye, legally protected areas are defined as zones restricted in terms of usage to conserve natural, ecological, and cultural values. Within this scope, it is observed that the natural, historical, and built environment is protected under various statuses through different classifications, primarily including Special Environmental Protection Areas (SEPA). These areas are defined as zones with high environmental sensitivity, approached through an ecosystem-based perspective. The SEPA status restricts any activity that could disrupt the natural environment, biodiversity, and landscape character by enforcing planning decisions that prioritize conservation. Beyond this, protected areas are defined through various classifications such as national parks, conservation areas, archaeological conservation areas, wetlands, and wildlife conservation areas. These classifications are defined under various legislative frameworks (Republic of Türkiye, 1983a; 1983b; 1983c; 1985).

In statutory regulations and urban plans prepared at different scales, approaches similar to the protected area classification defined by the International Union for Conservation of Nature (2008) are gradually applied. In this context, strictly protected sensitive areas, qualified natural conservation areas, and sustainable conservation and controlled-use areas, as well as the reclassification of natural sites, reflect a hierarchy ranging from absolute protection to limited use. Special Environmental Protection Areas are particularly defined as regions of national and international ecological significance, where construction and land use must be strictly regulated. While this classification, which encompasses a broader scope, aims to graduate the protection–use balance, the management of these areas is distributed across the authorities of different institutions.

Accordingly, the implementation and spatial reflection of these multi-layered conservation statuses can be traced through statutory master plans prepared at different scales. These plans provide a structured framework for organizing the spatial components of the Lycian Way, linking legal conservation categories with observable land uses and

settlements along the route. The Lycian Way and its surroundings have been analyzed under four main categories: settlements, natural and historical sites, and protected areas. Accordingly, the analysis relies on the master plans: (1) the Master Plan of the Aydın–Muğla–Denizli Planning Region (1/100,000 scale), and (2) the Master Plans of the Antalya–Burdur–Isparta Planning Region (1/100,000 scale) (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, Spatial General Directorate, 2023; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, Directorate General of Spatial Planning , 2025a; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, Directorate General of Spatial Planning , 2025b). In both plans, the region located between the Muğla and Antalya provinces of Türkiye is comprehensively represented in terms of diverse land uses, including settlements, forests, pasture, agricultural, and protected areas. These plans serve as the analytical base map, upon which various spatial features have been delineated along the Lycian Way and its surroundings. These include urban and rural settlements, archaeological sites, ancient cities, natural conservation areas, historical conservation areas, national parks and their conservation areas, special environmental conservation areas, qualified natural conservation areas, strictly protected sensitive areas, wildlife conservation areas, sea turtle breeding and conservation areas, as well as sustainable and controlled use areas (**Figure 8**).

Aydın–Muğla–Denizli master plan encompasses the western part of the study area, whereas Antalya–Burdur–Isparta master plan encompasses the eastern part, which constitutes the majority of the study area. The urban and rural settlements within the study area include Ölüdeniz, Kaş, Kalkan, Demre, Finike, Tekirova, Kemer, and Göynük. Forest, agricultural, and pasture areas represent the predominant land uses in the study area. In addition, several significant natural conservation areas are located within the study area, including Saklıkent National Park, Çıglıkara Natural Protection Area, Avlan Lake Wetland, Sarıkaya National Park, and Beydağları National Park and its associated conservation zones (Republic of Türkiye Ministry of Forestry and Water Affairs, 2025).

The western part of the Lycian Way begins in Ölüdeniz, Muğla, and the eastern part extends to the northern part of the Göynük district in Antalya. This route encompasses a series of ancient cities, including Telmessos, Kayaköy (Levissi), Patara (the capital of Lycia), Xanthos and Letoon (listed on the UNESCO World Heritage List), Antiphellos, Apollonya, Kyaneai, Simena, Myra, Arykanda, Limyra, Olympos, Phaselis, İdebessos, and Kitanaura (Ancient Cities of Turkey, n.d.). Beyond these major sites, the route and its surroundings also encompass smaller-scale yet historically significant archaeological sites. Numerous additional archaeological remains are dispersed across the Teke Peninsula. Furthermore, natural conservation areas are located between Ölüdeniz and Kalkan, as well as between Tekirova and Göynük, while wildlife protection zones are present to the north of Finike and Kaş.

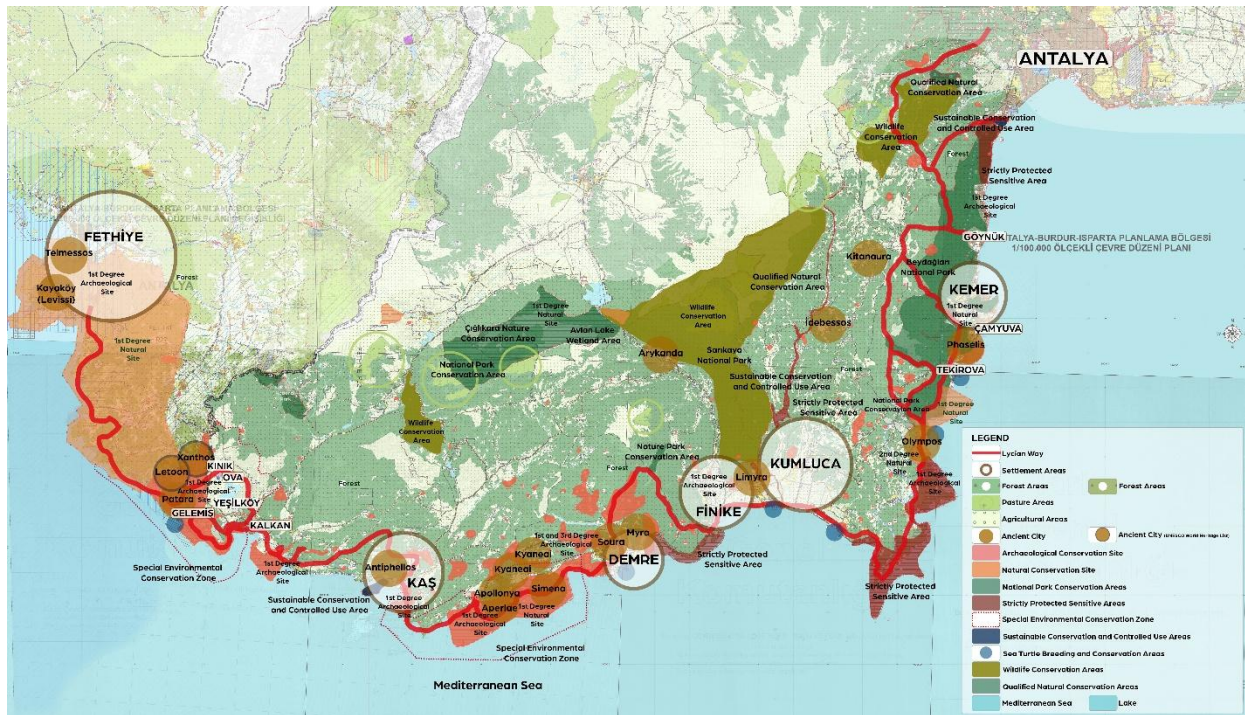


Figure 8. Settlements, Conservation and Natural Areas (2025)
 Source. Prepared by the authors based on the Master Plans

Based on spatial analyses and existing plans, a review of existing literature, investigation of different land uses and protection statuses along the Lycian Way reveals several critical challenges. One of the main issues is the presence of privately owned lands along the trail, along with ongoing road construction projects (Bolat, 2023) and villa-type second homes near residential areas. While these developments threaten the continuity of the route, the changing landscape also undermines its harmony with the natural environment. The intensive utilization and high density of key tourism zones along the trail and the urbanization pressure they generate have a notable impact on the natural character of the region.

In particular, settlements such as Kaş, Kalkan, Tekirova, and Kuzdere have experienced rapid urban expansion due to growing tourism pressure, threatening the natural landscape in these dispersed tourist areas. Villages like Saribelen and Bezirgan, located near Kalkan, are under intense urbanization pressure as a result of their proximity to tourism hubs. The rising demand in these areas has led to the development of second homes and villa-style accommodations aimed at meeting tourism demand, rather than maintaining the rural identity of the villages. This trend puts additional pressure on agricultural lands in the region.

In contrast, agricultural zones in settlements like Gelemiş (also Kınık, Ova, and Yeşilköy neighborhoods), Demre, and Kumluca are largely dominated by greenhouse farming, which has intensified over time. As a result, the sections of the Lycian Way passing through these areas often run along paved roads, creating environments that are isolated, insecure, and lacking interaction with nature due to the industrial nature of the landscape.

Both existing settlements and new developments place increasing pressure on the region’s archaeological and natural character. For example, in the Xanthos-Letoon archaeological zone, a long-standing asphalt road running through the ancient city poses a direct threat to the integrity of the site. Although the Regional Council for the Conservation of Cultural Heritage decided to close this road and install fencing in 2010 under the revised Conservation Legislation enacted in 2004, these measures have not been effectively enforced. Consequently, additional steps are needed to ensure the protection and continuity of the site. Meanwhile, in Letoon, monuments and archaeological remains within the sacred area face seasonal threats from rising groundwater levels. Furthermore, the dominance of greenhouses surrounding the site has resulted in a visually incompatible landscape.

In terms of both local community capacities and the region’s characteristic cultural and ecological features, the Lycian Way offers significant opportunities for sustainable management and protection. In response to increasing pressure

from tourism-driven development, several local communities and initiatives have been established throughout the region. These include environmental movements such as Phaselis İnisiyatifi (*Phaselis Initiative*), which opposes hotel construction and coastal development in Phaselis; Beycik Yöre Sakinleri (*Beycik Community Group*), formed in response to deforestation; and the Çıralı Ulupınar Çevre Koruma Kooperatifi (*Çıralı Ulupınar Environmental Protection Cooperative*), which was founded to resist environmental degradation in the Çıralı area. Culturally focused organizations also play a key role, including the Kemer Yörükler Derneği (*Kemer Yörüks Association*), which seeks to preserve and promote Yörük heritage, and the Kültür Rotaları Derneği (*Cultural Routes Society*), which works to protect and promote cultural routes (Bolat, 2023). The presence of these local initiatives offers significant potential for the success of site management. According to UNESCO (2013), cultural heritage management is not limited to physical conservation but is also a human- and community-oriented process. Therefore, the participation of local stakeholders constitutes a fundamental component of effective heritage management.

The Lycian Way passes through numerous ancient settlements, including Xanthos–Letoon— inscribed on the World Heritage List in 1988 (UNESCO World Heritage Centre, n.d.-c) —as well as first-degree archaeological and natural conservation zones. This makes the trail a rare example where cultural and natural assets coexist within a single route. Additionally, the region reflects key characteristics of the Mediterranean ecosystem. The presence of olive groves and citrus orchards indicates fertile agricultural land, while large areas are covered by forests and pastures. Inland, protected wildlife zones and national parks exist alongside nesting areas for *Caretta caretta* (sea turtles) along the coast, underlining the importance of preserving biodiversity. Altogether, the integration of natural and cultural diversity shapes the distinctive identity of the Lycian Way (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, Directorate General of Spatial Planning 2025a; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, Directorate General of Spatial Planning 2025b).

The protection statuses defined within the legal framework are accompanied by restrictions and sanctions concerning construction and land use. Activities in protected areas, such as unauthorized construction, road development, alteration of land use, and interference with the natural environment, are subject to administrative fines, demolition orders, and cessation of operations under the relevant legislation. In particular, within Special Environmental Protection Areas and natural conservation sites, construction is permitted only in accordance with conservation-oriented master plans and under strictly limited conditions (Republic of Türkiye, 1983a; Republic of Türkiye, 1983b; Republic of Türkiye, 1983c; Republic of Türkiye, 1985). Nevertheless, in practice, the spatial implementation of this multi-layered protection system appears weak. Despite clearly defined protection statuses and legal sanctions, illegal constructions, second-home and villa-type developments, intense tourism pressure, and uncontrolled spatial interventions are observed, particularly in Special Environmental Protection Areas encompassing settlements such as Kaş, which contains sections of first-degree archaeological sites and areas designated for sustainable conservation and controlled use; Kalkan, which contains areas designated as Special Environmental Protection Areas; Tekirova and Kuzdere, which contain sections of first-degree natural sites and parts of a national park; Gelemiş, which contains sections of first-degree archaeological sites; and Demre, which contains sections of both first- and third-degree archaeological sites. These issues are further intensified by weak monitoring, fragmented planning authority, and delays in implementation, which help explain why rapid spatial transformations along the Lycian Way persist despite the protection framework. In light of these considerations, it becomes evident that national conservation policies should be re-evaluated within the frameworks established by international organizations and institutions. As ICOMOS (2008) emphasizes, the partial, fragmented, or ad hoc protection of heritage attributes is inadequate. Instead, effective stewardship requires the development of strategies to manage and mitigate the impacts of deterioration processes affecting the cultural route and to prevent the negative consequences of neglect. All these efforts require the establishment of a coordinated system of legal measures and appropriate management tools that ensure the preservation of the route and the holistic emphasis of its value and significance. In this context, UNESCO (2013) provides a significant guiding framework for the management of Cultural World Heritage sites through the preparation, implementation, and monitoring of management plans.

As Lin et al. (2024) state, one of the most commonly used strategies for the management of cultural routes in terms of regional conservation is establishing a route's committee or association. This is followed by integral tourism management and route planning, constructing infrastructure facilities, and community participation. From this

perspective, the conservation of this route is maintained by a non-governmental organization, the Cultural Routes Association, with partial support from the Ministry of Culture. Due to the limited scope of this association, no regulation or supervision can be imposed on the interaction between the route and the surrounding natural and cultural landscape areas. In addition, infrastructure facilities are provided through individual initiatives in rural establishments along the route, and there is no dedicated unit responsible for improving, regulating, or controlling the conditions of these facilities. Furthermore, in the absence of a route-specific conservation strategy, community participation in the protected areas surrounding the route is realized at a limited level. Higher-level conservation decisions are determined not by local units but by the central administration. In this context, planning, implementation, and supervision authorities are assigned to the central administration. While Special Environmental Protection Areas are designated by the Ministry of Environment, Urbanization, and Climate Change, national parks, and wildlife protection zones fall under the authority of the Ministry of Agriculture and Forestry, and natural conservation sites are evaluated by conservation boards affiliated with the Ministry of Culture and Tourism. Taken together, these institutional arrangements and management limitations reveal the segments of the route where its integrated cultural and natural values are most vulnerable, setting the stage for the subsequent discussion.

5. Conclusions

This study identifies the physical, environmental, and economic conditions of the Lycian Way, together with its spatial challenges, threats, opportunities, and associated risks. As such, it provides important insights within the framework of the baseline assessment, which represents one of the core components of the UNESCO (2013) Management Plan approach. The Lycian Way, which holds substantial potential as a cultural route, is found to have sections where its distinctive and integrated values are currently under threat.

Multi-temporal classification, categorical change analysis, and hot spot analysis reveal a spatially concentrated pattern of transformation along the Lycian Way corridor. Greenhouse agriculture has expanded across coastal lowlands in and around Gelemiş (also Kımık, Ova, and Yeşilköy neighborhoods), Demre, Finike, and Kumluca, while tourism-driven urbanization has spread around key settlements—most notably the coastal nodes of Kalkan, Finike, Kemer, and Göynük—and into nearby rural localities in geographic proximity (such as Saribelen and Bezirgan villages near Kalkan). These dynamics have generated persistent transitions from natural and agricultural classes to built categories. For the 1999–2025 period (the reference interval beginning with the year in which the route was promoted), change detection indicates that transitions from natural to built areas amount to 707.4 ha. Although the cumulative converted area represents a relatively small share of the corridor, its clustering at gateway nodes, along wetland/lagoon edges (such as Beymelek Lagoon), and in the vicinity of archaeological ensembles is likely to produce disproportionate impacts on landscape integrity, legibility, ecological integrity, and visitor safety. The most prevalent change trajectories along the 1-km impact corridor along the Lycian Way include Low-Density Forest to Urban Areas (23.2%), Cultivated Areas to Urban Areas (19.2%), and Cultivated Areas to Greenhouses (15.9%). Furthermore, the regional-scale hotspot analysis reveals a systemic landscape transformation, identifying approximately 1,500 km² (150,000 ha) as statistically significant zones of rapid anthropogenic change. These key nodes of urban and greenhouse expansion act as encroachment zones that directly threaten the environmental buffer and traditional character of the Lycian Way, signaling a narrowing window for effective preservation.

Overall, the findings of the spatio-temporal analysis point to i. tourism-led urbanization pressures encroaching upon cultivated lands, ii. a concurrent increase in greenhouses within agricultural areas, and iii. urban sprawl effects extending into peri-urban landscapes, including forested zones adjacent to expanding settlements. In dialogue with the wider cultural landscape literature that highlights coastalization and urban sprawl as structural pressures, the study therefore examines the adequacy of national conservation legislation and planning approaches in addressing these threats along the Lycian Way.

The region's high concentration of historical, cultural, and natural assets simultaneously underpins its value as a cultural route and intensifies investment interest, placing a premium on the quality of tourism and its management rather than sheer growth. Findings related to the assessment of regional plans and existing protection regimes reveal limited effectiveness; fragmented designations fail to function as a coherent corridor framework. Overlays with

planning layers confirm frequent co-occurrence of pressures within formally protected landscapes, underscoring a persistent policy gap: designation without sufficient implementation capacity.

ICOMOS (2008) emphasizes the importance of the indicators of authenticity and integrity in the process of identifying cultural routes. In this context, the present study has contributed to identifying priority intervention areas along the Lycian Way—an area with strong potential to be designated as a cultural route—and has helped to determine the specific challenges within those areas that threaten its authenticity and integrity.

The study also highlights that Türkiye's rich and diverse cultural heritage offers significant potential for the development of cultural routes from both the Council of Europe and UNESCO perspectives. As clearly seen in the example of the Lycian Way, Türkiye's archaeological, religious, and cultural heritage provides a strong foundation for the development of cultural routes at both national and international levels.

Adopting a macro-scale regional perspective, the analysis reveals that change and development pressures are concentrated in specific locations, suggesting the value of complementary, micro-scale inquiries that integrate spatial and social dimensions (e.g., settlement/village studies, site-specific diagnostics). Although not examined in this study, one of the most immediate threats along the route is the proposed Kaş–Demre road project, which approaches the region's natural and cultural significance predominantly through an economic-growth lens and underestimates the threats posed to natural habitats and the Lycian Way.

In this context, securing an international conservation status (e.g., alignment with Council of Europe/ICOMOS/UNESCO frameworks) could provide a significant opportunity to enhance recognition of the route's outstanding cultural and natural values. Such a designation would also strengthen the policy frameworks and implementation mechanisms necessary for their effective protection.

In conclusion, there is a clear need for comprehensive, multidimensional follow-up research to assess the extent to which the characteristics of the Lycian Way meet the criteria set by ICOMOS and UNESCO for designation as a Cultural Route and a World Heritage Site. Research in this direction would provide a scientific basis for both positioning the route within an international heritage context and for developing a long-term, integrated conservation strategy.

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Conflict of interest

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References

- Akgündüz, Y., & Kızılcıoğlu, G. (2016). Travel motivations and satisfaction levels of tourists walking the Lycian Way. *Management and Economics*, 23(3), 817–836. <https://doi.org/10.18657/yonveek.281972>
- Ancient Cities of Turkey. (n.d.). *Ancient Cities of Turkey*. Retrieved August 14, 2025, from <https://ancientcitysturkey.com/>
- Aydın, Ç. (2024). From ancient paths to modern discoveries: The backpacker tourism experience on the Lycian Way. *Research on Multidisciplinary Approaches*, 4(2), 35–46. <https://doi.org/10.5281/zenodo.13953262>
- Bambi, G., Iacobelli, S., Rossi, G., Pellegrini, P., & Barbari, M. (2019). Rural tourism to promote territories along the ancient roads of communication: Case study of the rediscovery of St. Francis's ways between Florence and La Verna. *European Countryside*, 11(3), 462–474. <https://doi.org/10.2478/euco-2019-0025>

- Bastemur, C. (2011). A new destination for alternative tourism; Lycian Way. In K. Andriotis, A. Theocharous, & F. Kotsi (Eds.), *Proceedings of the International Conference on Tourism (ICOT 2011): Tourism in an era of uncertainty* (pp. 78–85). International Association for Tourism Policy.
- Bianet. (2023, June 6). *Second suspension decision for the project in Phaselis Ancient City*. Bianet. Retrieved September 28, 2025, from <https://bianet.org/haber/phaselis-antik-kenti-ndeki-proje-ikinci-durdurma-karari-279921>
- Bolat, A. (2023). *Environmental consciousness step by step: The Lycian Way* (Publication No. 826352) [Master Thesis, İstanbul Bilgi University]. National Thesis Center of the Turkish Council of Higher Education. <https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp>
- Bozhüyük Ardahanlıoğlu, Z. R., & Çınar, İ. (2013). Recreational opportunities and ecotourism assessment of the Lycian Way route: Fethiye stage. In R. Efe, İ. Atalay, & İ. Cürebal (Eds.), *Proceedings of the 3rd International Geography Symposium - GEOMED 2013* (pp. 334–344). Kemer, Antalya: ISBN 978-605-62253-8-3.
- Bryce, T. (1986). *The Lycians in Literary and Epigraphic Sources*. Copenhagen: Museum Tusulanum Press.
- Butt, N., Wang, X., Luo, L., & Hussan, H. (2025). Evaluating the Impact of Urban Encroachment and Land Cover Changes on World Cultural Heritage Site Taxila: A Spatio-Temporal Analysis from 1990 to 2024. *Sustainability*. <https://doi.org/10.3390/su17031059>
- Cao, J., & Li, T. (2023). Analysis of spatiotemporal changes in cultural heritage protected cities and their influencing factors: Evidence from China. *Ecological Indicators*, *151*, 110327. <https://doi.org/10.1016/j.ecolind.2023.110327>
- Clow, K. (2019). *Turkey's first long-distance hiking route: The Lycian Way* (H. Eryurt, Trans.; 3rd ed.). Hil Publishing.
- Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, *20*(1), 37–46. <https://doi.org/10.1177/001316446002000104>
- Council of Europe. (2021). Cultural Routes of the Council of Europe: National Country Mapping Turkey. <https://rm.coe.int/cmd-turkey-eng-web-2021-01/1680a3c4f4>
- Council of Europe. (n.d.). *Cultural routes*. Council of Europe. Retrieved September 27, 2025, from <https://www.coe.int/en/web/culture-and-heritage/cultural-routes>
- Elfādaly, A., Attia, W., Qelichi, M., Murgante, B., & Lasaponara, R. (2018). Management of Cultural Heritage Sites Using Remote Sensing Indices and Spatial Analysis Techniques. *Surveys in Geophysics*, *39*, 1347-1377. <https://doi.org/10.1007/s10712-018-9489-8>
- Erdoğan, E., & Kuter, N. (2010). Coastal landscapes and conservation issues: Antalya-Phaselis. *African Journal of Agricultural Research*, *5*(7), 468–475. <https://doi.org/10.5897/AJAR09.017>
- Getis, A., & Ord, J. K. (1992). The analysis of spatial association by use of distance statistics. *Geographical Analysis*, *24*(3), 189–206. <https://doi.org/10.5897/AJAR09.017>
- Gislason, P. Ó., Benediktsson, J. A., & Sveinsson, J. R. (2006). Random forests for land cover classification. *Pattern Recognition Letters*, *27*(4), 294–300. <https://doi.org/10.1016/j.patrec.2005.08.011>
- ICOMOS (2008). The Icomos Charter On Cultural Routes. https://www.icomos.org.tr/Dosyalar/ICOMOSTR_en0623812001536913379.pdf
- ICOMOS Türkiye. (n.d.). Dünya mirası listesinde Türkiye. ICOMOS Türkiye. Retrieved September 27, 2025, from <https://www.icomos.org.tr/?Sayfa=Dunyamirasilistesindeturkiye&dil=tr>
- Ignatius, A. R., Annis, A. N., Helton, C. A., Reeb, A. W., & Rieke, D. F. (2025). Spatiotemporal Vegetation Dynamics, Forest Loss, and Recovery: Multidecadal Analysis of the U.S. Triple Crown National Scenic Trail Network. *Remote Sensing*, *17*(7), 1142. <https://doi.org/10.3390/rs17071142>
- İmene, L. (2021). Cultural Landscapes Preservation at the interface of urban planning and Sprawl. *International Journal of Environmental Science and Sustainable Development*, *6*(2), 37–47. <https://doi.org/10.21625/essd.v6i2.836>
- International Council on Monuments and Sites. (2015). *Routes of Santiago de Compostela: Camino Francés and Routes of Northern Spain (Spain)* (No. 669bis) [Advisory body evaluation]. UNESCO World Heritage Centre. <https://whc.unesco.org/en/list/669/>
- International Union for Conservation of Nature. (2008). Guidelines for Applying Protected Area Management Categories. Gland: IUCN. Retrieved January 22, 2026, from <https://portals.iucn.org/library/sites/library/files/documents/pag-021.pdf>
- Keen, A. G. (1998). *Dynastic Lycia: A Political History of the Lycians and Their Relations with Foreign Powers*, C. 545–362 B.C. Leiden: Brill.
- Kurar, İ., & Kavacık, M. (2022). The Lycian Way and recreational activities within the scope of alternative tourism. *Journal of History, Culture, and Art Research*, *11*(4), 1–23. <http://dx.doi.org/10.7596/taksad.v11i4.3220>
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*(1), 159–174. <https://doi.org/10.2307/2529310>
- Lin, X., Shen, Z., Teng, X., & Mao, Q. (2024). Cultural Routes as Cultural Tourism Products for Heritage Conservation and Regional Development: A Systematic Review. *Heritage*, *7*(5), 2399-2425. <https://doi.org/10.3390/heritage7050114>
- Ministero della Cultura. (2023). *Via Appia. Regina Viarum* [World Heritage List nomination dossier]. UNESCO World Heritage Centre. Retrieved January 22, 2026, from <https://whc.unesco.org/en/list/1708/documents/>
- Mitchell, A. (2005). *The ESRI guide to GIS analysis: Vol. 2. Spatial measurements and statistics*. ESRI Press.
- Oikonomopoulou, E., Delegou, E. T., Sayas, J., & Moropoulou, A. (2017). An innovative approach to the protection of cultural heritage: The case of cultural routes in Chios Island, Greece. *Journal of Archaeological Science: Reports*, *14*, 742–757. <https://doi.org/10.1016/j.jasrep.2016.09.006>
- Republic of Türkiye Ministry of Culture and Tourism, Directorate General of Cultural Heritage and Museums. (n.d.). *Likya Uygarlığı Antik Kentleri* [Ancient Cities of the Lycian Civilization]. Retrieved September 27, 2025, from <https://www.kulturvarliklari.gov.tr/yazdir?4C2819D898BCF150CB9CD2C67BD09B0F>

- Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, Directorate General of Spatial Planning. (2025a) *Aydın-Muğla-Denizli Planning Region*. Retrieved September 28, 2025, from <https://mpgm.csb.gov.tr/aydin---mugla---denizli-planlama-bolgesi-i-82184>
- Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, Directorate General of Spatial Planning. (2025b) *Antalya-Burdur-Isparta Planning Region*. Retrieved September 28, 2025, from <https://mpgm.csb.gov.tr/antalya-burdur-isparta-planlama-bolgesi-i-82219>
- Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, Spatial Planning General Directorate. (2023). *Antalya-Burdur-Isparta Planning Region 1/100,000 Scale Master Plan Report*. Retrieved January 22, 2026, from <https://webdosya.csb.gov.tr/db/mpgm/iicerikler/planaciklamaraporu-20230315122349.pdf>
- Republic of Türkiye Ministry of Forestry and Water Affairs. (2025). *Wetlands Map Application* [Interactive map]. Retrieved August 14, 2025, from <https://www.arcgis.com/apps/View/index.html?appid=5f3978146c4643438ab446620e275269>
- Republic of Türkiye, Ministry of Agriculture and Forestry. (2023). *Inventory report on domestic greenhouse investments*. General Directorate of Agricultural Reform. Retrieved January 22, 2026, from <https://share.google/60hDh6UToRokKHCPQ>
- Republic of Türkiye. (1983a). *Environment Law (Law No. 2872)*. Official Gazette of Türkiye. Retrieved January 22, 2026, from <https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=2872&MevzuatTur=1&MevzuatTertip=5>
- Republic of Türkiye. (1983b). *Law on the Protection of Cultural and Natural Assets (Law No. 2863)*. Official Gazette of the Republic of Türkiye. Retrieved January 22, 2026, from <https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=2863&MevzuatTur=1&MevzuatTertip=5>
- Republic of Türkiye. (1983c). *National Parks Law (Law No. 2873)*. Official Gazette of the Republic of Türkiye. Retrieved January 22, 2026, from <https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=2873&MevzuatTur=1&MevzuatTertip=5>
- Republic of Türkiye. (1985). *Zoning Law (Law No. 3194)*. Official Gazette of the Republic of Türkiye. Retrieved January 22, 2026, from <https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=3194&MevzuatTur=1&MevzuatTertip=5>
- Rojas Celis, A. P., Shen, J., & Martinez Otalora, J. D. (2025). Spatiotemporal Land Use and land cover changes and their impact on landscape patterns in the Colombian Coffee Cultural Landscape (2014–2034). *Land, 14*(5), 1045. <https://doi.org/10.3390/land14051045>
- Selçuk, O., Karakas, H., & Ipekci Cetin, E. (2020). Determination of hazard levels of natural areas open to tourism in Antalya province using the integrated SWARA-MOORA method. *Journal of Geography*, 41, 77–91. <https://doi.org/10.26650/JGEOG2020-0059>
- Şenel, A. (2019). *Sustainable tourism, cultural routes, and the Lycian Way example* [Unpublished undergraduate project, İstanbul Ayyansaray University, Plato Vocational School, Tourism Guidance Program].
- Sünbül, V., & Tonyaloğlu Ersoy, E. (2021). Detection of land use/land cover changes: The case of Kaş district, Antalya province. *International Journal of Eastern Anatolia Science, Engineering and Design (IJEASED)*, 3(2), 376–387. <https://doi.org/10.47898/ijeased.981248>
- Tunçer, M., & Atik, A. S. (2023). *Protecting Patara* (2nd ed.). Akademisyen Publishing. <https://doi.org/10.37609/akya.2490>
- Türkiye Ormancılar Derneği. (2023). *Don't touch Phaselis!* Ankara: TOD Publications. <https://www.ormancilardernegi.org/JournalFiles/943c7ec9-b0d7-4996-8027-fed38fd20015.pdf>
- Tütüncü, B., Pamukçu, H., & Tandırsever, C. (2020). Profiles and satisfaction levels of Lycian Way hikers. *Anatolia: Journal of Tourism Research*, 31(2), 113–124. <https://doi.org/10.17123/atad.641641>
- UNESCO World Heritage Centre. (n.d.-a). *Türkiye* [State Party profile]. Retrieved September 24, 2025, from <https://whc.unesco.org/en/statesparties/tr>
- UNESCO World Heritage Centre. (n.d.-b). *Xanthos-Letoon*. Retrieved August 14, 2025, from <https://whc.unesco.org/en/list/484>
- UNESCO World Heritage Centre. (n.d.-c). *World Heritage List*. Retrieved September 24, 2025, from <https://whc.unesco.org/en/list/>
- UNESCO. (1994). *Report on the Expert Meeting on Routes as a Part of our Cultural Heritage (Madrid, Spain, November 1994)* <https://whc.unesco.org/en/documents/1244>
- UNESCO. (2013). *Managing Cultural World Heritage*. Retrieved August 14, 2025, from <https://whc.unesco.org/en/managing-cultural-world-heritage/>
- UNESCO. (2014). *Operational Guidelines for the Implementation of the World Heritage Convention*. Paris: UNESCO. Retrieved August 14, 2025, from <https://whc.unesco.org/en/guidelines/>
- Wang, Y., Mitchell, B. R., Nugranad-Marzilli, J., Bonyng, G., Zhou, Y., & Shriver, G. (2009). Remote Sensing of land-cover change and landscape context of the national parks: A case study of the northeast temperate network. *Remote Sensing of Environment*, 113(7), 1453–1461. <https://doi.org/10.1016/j.rse.2008.09.017>
- Yu, H., Verburg, P., Liu, L., & Eitelberg, D. (2016). Spatial Analysis of Cultural Heritage Landscapes in Rural China: Land Use Change and Its Risks for Conservation. *Environmental Management*, 57, 1304–1318. <https://doi.org/10.1007/s00267-016-0683-5>