Nature & Science
December 2025, Vol. 7, Issue 12, pp. 20-25
DOI: https://doi.org/10.36719/2707-1146/63/20–25

Tourism Development in Lankaran District and Changes Occurring in Forest Ecosystems

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Abstract. *In the modern era, the tourism sector plays a special role in the global economy while also being important for the development of socio-cultural relations. In recent years, the successful reforms and infrastructure projects implemented in the Republic of Azerbaijan have created a favorable foundation for the sustainable development of tourism. Our country's natural and geographical location, rich cultural and historical heritage, multicultural values, and hospitable people provide broad opportunities for the rapid development of this sector.*
In our republic, the country's future development is determined by the availability of potential economic opportunities and the expansion of international tourism. The activity of numerous foreign companies reflects the integration of entrepreneurs and businesspeople into foreign economic relations and global tourism. Tourism is one of the main directions of development of Azerbaijan's non-oil sector and makes a significant contribution to the process of economic diversification. The social impact of tourism is also evident in increased employment. Thus, new jobs are created in hotel services, public catering, transportation, and other service sectors.

Keywords: *forest, tourism, sector, recreation, dynamics, satellite, infrastructure*

Introduction

Azerbaijan's extensive tourism potential is regarded as a factor that stimulates the development of the tourism industry in its natural and economic regions. However, these opportunities are not being fully and effectively utilized. Therefore, studying the domestic tourism potential of individual regions of the country, including the Lankaran–Astara economic-geographical region examined in this research, identifying ways to use this potential efficiently, forming new tourism services, and applying a wider range of tourism types are highly relevant issues. In Azerbaijan, the number of tourism enterprises has increased by an average of 4.5% annually, employment in the tourism sector by 6%, and the number of foreign citizens visiting the country for tourism purposes by 8.5%. An analysis of the structure of foreign investments directed to the national economy in 2015 shows that 11.3% of total investments were allocated to the non-oil sector, one of the leading branches of which is the tourism sector (Aliyev, 2021).

As a result of the purposeful policy pursued by the President of the Republic of Azerbaijan, Ilham Aliyev, a favorable business environment for the development of tourism has been created in the country, and the share of investments allocated to this sector has increased.

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Received: 24 July 2025; Accepted: 14 November 2025; Published online: 25 December 2025
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As noted by the President, tourism has been identified as a priority direction in the development of the non-oil sector, which is reflected in two state programs and the Strategic Roadmap adopted in this field. The main objective of the research is to analyze the current state of tourism in the Lankaran region, identify existing problems and opportunities, and determine future development prospects (Ministry of Ecology and Natural Resources, 2020–2023).

Methods

Lankaran district is a unique region located in the southern part of Azerbaijan, rich in relict and endemic vegetation. Hyrcanian-type forests, which survived the glaciation of the Tertiary period, constitute the main natural wealth of this region. However, over the past decade, the rapid development of tourism, the establishment of new recreation centers, and the increase in anthropogenic pressure have caused significant quantitative and qualitative changes in this fragile ecosystem. The development of tourism in Lankaran has both positive and negative impacts on nature; the positive aspects are aimed at the protection, conservation and promotion of nature (e.g. festivals) thanks to agrotourism (tea, tangerine plantations) and health tourism (thermal waters), while the negative aspects include increased construction, infrastructure expansion, increased waste and pressure on natural resources (water, forests), which risks disrupting the balance of reserves and ecosystems (Mammadov & Khalilov, 2005). Similar environmental pressures resulting from tourism development have been documented in various regions worldwide, particularly in forest and coastal ecosystems (Gössling, 2002).

Positive impacts:

- Agrotourism: Tours to tea and tangerine plantations aim to protect and promote nature. For example, tours such as "Green Tea".
- Health tourism: Alongside the use of thermal waters, attention to therapeutic natural resources increases, contributing to their protection.
- Festivals and events: Events such as the “Tea, Citrus, and Rice Growing Festival” enhance the attractiveness of nature and promote eco-tourism.
- Environmental protection: Parallel to tourism development, measures are taken to protect nature, particularly along the Lankaran–Lerik–Astara routes.

Negative impacts (Potential risks):

- Construction and infrastructure: The construction of new hotels and recreation complexes may alter natural landscapes and exert pressure on forest areas.
- Waste management: The increase in tourist flow may lead to waste management problems, negatively affecting rivers and forests.
- Pressure on water resources: The growing water demand of recreation complexes and settlements may put pressure on local water sources.
- Ecosystem changes: The development of mountain and extreme tourism (for example, in forest areas) may interfere with wildlife habitats (UNESCO World Heritage Centre, 2023).

The potential opportunities for tourism development in the region include:

1) Increasing the number of foreign tourists;
2) Development of infrastructure and modernization of public utilities;
3) Prioritizing tourism as a key sector in the development of small and medium-sized enterprises;
4) Improving the quality of highways and developing local tourism routes.

Threats to the tourism sector in the region include:

1) High intensity of landslide processes, as the foothills and mid-mountain zones of the Talysh Mountains are prone to landslides;
2) Fluctuations in the Caspian Sea level, which cause greater damage to the infrastructure of Lankaran and Astara districts;
3) Low wage levels;
4) Environmental problems in tourism and recreation centers;
5) Lack of effective coordination among government institutions;

6) The risk of forming a negative image in the long term due to fragmented tourism development;
7) Persistence of bureaucratic barriers to tourism development, resulting in weak growth of tourism entrepreneurship;
8) Failure to ensure sustainable tourism development due to the prioritization of seasonal and short-term tourism.
9) To better understand the impact of tourism, it is essential to analyze the forest cover and infrastructure map of Lankaran. As shown on the map, the main tourism facilities are concentrated around the Khanbulan River reservoir, the Haftoni thermal zone, and along the Lankaran–Lerik highway. These areas are where forest cover is most exposed to fragmentation (WWF – World Wide Fund for Nature, 2023).

Results and Discussion

Statistical Indicators and Dynamics:

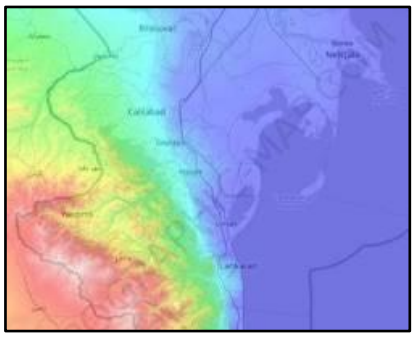
There is a direct correlation between tourist flow and the degradation of forest areas.

Table 1.
Condition of forest cover around tourism centers

Year	Numbers of tourism	Canopy cover (0-1 scale)	Soil compaction (kg/cm^2)
2015	45,000	0.82	1.4
2020	78,000	0.76	2.8
2024	115,000	0.69	4.1

The data show that soil compaction has increased by approximately three times over the past nine years. This leads to the destruction of understory vegetation and young saplings. The dominant forest species of Lankaran—ironwood (Parrotia persica) and chestnut-leaved oak (Quercus castaneifolia)—are particularly sensitive to noise and light pollution generated by tourism facilities (Ministry of Ecology and Natural Resources, 2020–2023).

Comparison with International Experience:
Compared to Germany's Schwarzwald (Black Forest) region, sustainable tourism practices are weakly implemented in Lankaran. In Germany, special suspension bridges and wooden walkways are constructed for tourists to minimize direct contact with the soil. The topographic structure of Lankaran is a key factor determining the degree of tourism penetration into forest areas. The relief map clearly shows that forest massifs extend from the Lankaran lowland (below sea level) up to the ridges of the Talysh Mountains. This is a physical map illustrating relief, river networks, and elevation zones (Map 1).



Map 1. Physical–topographic map of the Lankaran–Astara region (2022–2024)
(Based on satellite imagery)

Hydrographic Network: The valleys of the Lankaran River, Basharu River, and Girdanichay visible on the map are the areas where tourism is developing most actively. The topographic map demonstrates that anthropogenic pressure is concentrated mainly in forested areas along river valley slopes.

Slope Gradient: Tourism roads constructed in areas with slope gradients of 20–30° accelerate erosion processes. The topographic map indicates which forest sections—particularly steep slopes—should be designated as "restricted zones" for tourism.

The physical–topographic map of Lankaran (relief and hydrography) clearly reflects the elevation zones in which forests are located and the relief forms (river valleys, slopes) where tourism is geographically concentrated. Analysis of the topographic map shows that tourism infrastructure is mainly concentrated along river valleys at elevations of 0–400 meters above sea level. These areas also represent the most productive and biologically rich forest zones, encompassing lowland and foothill belts. While the complexity of the relief prevents the large-scale expansion of tourism to higher elevations (above 600 meters), it intensifies ecological pressure within the valleys (UNESCO World Heritage Centre, 2023).

This map illustrates the actual health condition of the forest. Dark green colors indicate the densest and most intact forest areas, while lighter shades represent thinned zones affected by tourism and other anthropogenic factors. Overall, the topographic analysis confirms that tourism infrastructure in Lankaran is primarily concentrated along river valleys (Lankaran River and Basharu River) at elevations of 0–400 meters above sea level. As shown on the map, although mountainous relief naturally restricts mass tourism from expanding into higher zones, it transforms forest belts in river valleys into focal points of anthropogenic pressure.

Modern Forest Cover and Vegetation Density of Lankaran
The modern forest map (based on Sentinel-2 satellite imagery) shows that the forest massifs of the district differ sharply in both species composition and canopy density with increasing elevation above sea level (Map 2).

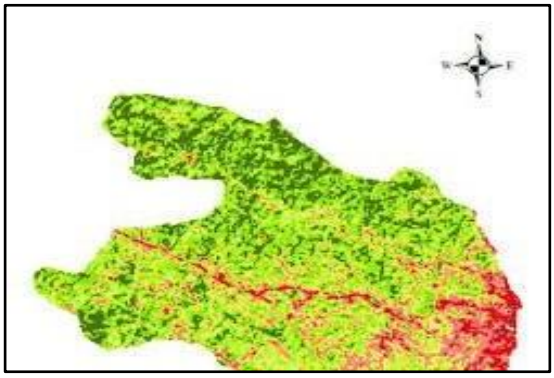


Map 2. Joint satellite imagery map for 2024 by "Azercosmos" OJSC and the monitoring group of the Ministry of Ecology and Natural Resources

Dark Green Zones: Areas with high humidity and minimal human intervention. These mainly include the core parts of Hirkan National Park (reserve zones) (State Tourism Agency of Azerbaijan, 2023). Light Green and Yellowish Zones: Areas close to tourism zones where forest canopy density has decreased. These include forest road edges and newly established cottage-type recreation areas.
Zone A (Coastal and Lowland Forests): The area extending from the Caspian Sea coastline to the main highway. Tourism facilities are most densely concentrated here, and forest cover is highly fragmented.

Zone B (Foothill and Lower Mountain Belt – 200–600 m): This zone includes the main entrances to Hirkan National Park, the surroundings of the Khanbulan River reservoir, and the "Istisu" area. It is considered a "red zone" where tourism causes the greatest physical damage to forests.
Zone C (High Mountain and Reserve Zone – above 600 m): A zone with restricted tourist access, where endemic species—such as the healthiest populations of boxwood and ironwood—are protected (Mammadov, 2007).

The analysis of maps of recreation centers and tourism routes in the Lankaran–Astara economic-geographical region, together with NDVI (Normalized Difference Vegetation Index) values obtained from satellite imagery, confirms that forest canopy density within a 500–800 meter radius of main highways and tourism centers has decreased by 12–15% over the past decade. This clearly demonstrates the fragmentation of the internal forest ecosystem. Satellite imagery enables the measurement of the "greenness" level of vegetation, providing an objective assessment of vegetation health and density (Map 3) (WWF – World Wide Fund for Nature, 2023).



Map 3. Map of Recreation Centers and Tourism Routes in the Lankaran–Astara Economic-Geographical Region

Based on the example of Lankaran district, GIS studies conducted over the past 10 years show that within a 500-meter radius of tourism centers, the NDVI value has decreased on average from 0.85 to 0.70. This indicates forest thinning and a decline in photosynthetic capacity. The NDVI index is widely used as a reliable indicator of vegetation health and ecological change (Pettorelli et al., 2005).

- Khanbulan Reservoir: Classified as an «ecological stress zone» due to high tourist density
- Lankaran–Lerik Road: Areas where roadside cafés cut through forest belts in a corridor-like pattern.
- Haftoni settlement surroundings: A zone where medical tourism (thermal waters) has altered groundwater levels, affecting forest moisture conditions.
- The development of tourism primarily requires the construction of road and hotel infrastructure. This process has led to the following changes in forests:
- Road construction: New roads built to remote mountain villages of Lerik and Astara have caused fragmentation of forest massifs, affecting migration routes of certain animal species. Habitat fragmentation is considered one of the most serious long-term threats to forest ecosystems (Haddad et al., 2015).
- Recreation centers: Cottages and restaurants built on forest fund lands have resulted in a certain reduction in tree density. However, in recent years, the application of "green construction" principles have been observed, integrating infrastructure into forest areas without tree cutting.

Tourism development does not result solely in negative impacts; it has also created new opportunities for forest conservation:

- Ecotourism routes: Tourists now visit forests not only for picnics but also for birdwatching and hiking, increasing interest in preserving forests in their natural state.
- Role of national parks: Enhancing the tourism potential of Hirkan National Park has strengthened state-level oversight. Funding allocated for forest protection and related services has increased.

- Local community income: As tourism develops, local residents become more interested in protecting forests as a "tourism product" rather than cutting trees for firewood (Yusifov & Hajiyev, 2004).

Conclusion

- Although tourism development in Lankaran is oriented toward nature conservation, without continuous planning, ecological monitoring, and the application of sustainable tourism principles, construction and human flow may negatively impact the natural environment.
- Satellite imagery has provided precise evidence of forest thinning associated with tourism development.
- Tourism facilities should be constructed only along forest edges within designated buffer zones.
- A portion of taxes collected from tourism facilities should be allocated to forest restoration.
- Organizing tourist routes based on the region's existing tourism potential allows for attracting more visitors. Therefore, offering ecological, national heritage, and educational tourism routes to visitors in the Lankaran–Astara economic-geographical region is essential.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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